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Western Horizons for U.S. Climate Policy

An Economic Assessment of Challenges and Opportunities in a Regional Climate Initiative

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Research Papers on Energy, Resources, and Economic Sustainability

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David Roland-Holst[1]

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1 Introduction

The Western Climate Initiative (WCI) is a collaboration established on February 26, 2007 between the governors of Arizona, California, New Mexico, Oregon, and Washington to devise and adopt policies that would more effectively address climate change, primarily through lowering greenhouse gas emissions within the entire region. Montana, Utah, British Columbia, Manitoba, and Quebec later became WCI partners within months. By August 2007, all WCI participants collectively agreed on an aggregate reduction of 15% below 2005 emission levels by 2020. By September of 2008, WCI was finalizing discussions of market based mechanisms to help achieve these reduction goals through cap and trade, carbon offsets, etc.

This report provides an in-depth analysis of the economic implications for climate chane and climate policy for the Western US states who are members of the WCI. Due to date and resource limitations, we do not analysis the Canadian provinces who are WCI members. While this is an important omission, the results and insights obtained here remain of considerable relevance to climate policy in the region, nationally, nad even globally. As more appropriate data become available, the same detailed economic

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assessment can be extended to include all WCI members, but the main insights obtained and set forth in this work are likely to remain.

To evaluate the economic implications of western regional climate policy, we used a state-of-the art forecasting model that modeled detailed economic interactions within and between the seven US state members of the WCI, comparing impacts of different design schemes for GHG mitigation through Cap and Trade market mechanisms. In addition to many detailed findings for individual states and sectors, three overarching conclusions follow from our analysis:

1. The member states are very diverse, particularly with respect to the carbon intensity of aggregate and sectoral production, and this diversity will significantly influence WCI adjustment experience.

2. Simply putting a price on carbon emissions, without complementary policies that recognize adjustment needs and incentive properties, will undermine economic growth for the member economies, particularly those with high initial carbon liabilities.

3. Determined efforts to promote greater efficiency on the demand side of energy markets, as well as alternative fuel and renewable technology development on the supply side, can be combined with Cap and Trade mitigation to significantly accelerate growth, and more so in states with higher initial carbon liabilities.

In other words, every state can accelerate growth by promoting three climate strategies in unison: GHG mitigation via Cap and Trade, energy efficiency, and renewable energy development. Ironically, the more carbon dependent the economy, the higher its downside risk from pursuing Cap and Trade alone, but the higher too is the upside potential from promoting energy efficiency and renewable alternatives to traditional carbon fuels.

Thus we are reminded of the inexorable link between innovation and growth, as we have seen again and again since the Industrial Revolution set us on a path toward living standards beyond the imagining of our ancestors. Technological change always offers new opportunities for economic expansion, but only to those who adapt and overcome emerging constraints. In agriculture, the constraint in the last century was arable land area, and agricultural technology overcame this. In the era of globalization, the constraint was on wage appreciation, and knowledge-intensive firms overcome this with ever higher labor productivity. Today, the constraint is carbon intensity, and economies that overcome it with ever greater energy efficiency will discover a potent catalyst for growth.

It is clear from our analysis that heterogeneity of initial conditions matters very much to adjustments that will ensue from climate policy. From a policy perspective, evidence of this kind is very important to promote constructive stakeholder engagements anticipate adjustment needs. Any policy commitment as large and far reaching as a regional cap

and trade system will inevitably occasion structural change. Our results show, however, that significant growth potential exists within this process of change as long as policies include the right adaptation incentives. The more fully structural changes can be anticipated, the more effective and growth-oriented can be the complementary policies.

The next section gives an overview of the analytical tools use for this research, followed by discussion of the policy scenarios evaluated and the primary results. Following the results, we provide detailed background information on the policy context for WCI, including state-by-state information and background on WCI observer institutions and public interest stakeholders. This information is all combined in the present report to facilitate more inclusive and informed policy dialogue on the important emerging agenda of climate action.

2 Economic Assessment Methodology

In this section follows, we review the economic modeling methodology used to evaluate the Western Climate Initiative. Our economic assessment relies on the Berkeley Western states economic assessment model (BWest), a state-of-the art forecasting tool derived from the Berkeley Energy and Resources (BEAR) model used for climate policy assessment in California. BWest is calibrated to data for the seven United States WCI members, Arizona, California, Montana, New Mexico, Oregon, Utah, and Washington, obtained from the IMPLAN data base on economic activity. Because of the level of structural detail at which this analysis was conducted, we were unable to obtain comparable data for the Canadian provincial members of WCI. While this is an important omission, we feel strongly that the policy lessons from this research can be generalized to other WCI members and even observers.

In today's world, economic linkages are so complex that it is unlikely that policy makers relying on intuition alone will achieve anything approaching optimality. Indeed, much evidence now suggest that indirect effects of many policies outweigh direct effects and, if not adequately understood, can substantially offset or even reverse them. This is particularly true for climate policy, where indirect effects are largely responsible for climate initiative and impacts of policy responses can be very complex. Because of their abilities to capture exactly such linkages, computable general equilibrium (CGE) models have become preferred tools for tracing supply and demand linkages across extended chains of price-directed exchange. Because of their detailed behavioral specification, these models are particularly good at elucidating adjustments in income distribution and economic structure. Technically, a CGE model is a system of simultaneous equations that simulate price directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also specified, with varying degrees of detail and passivity, to close the model and account for economywide resource allocation, production, and income determination.

The Berkeley Western States (BWest) economic forecasting model used in this study is a multi-state version of the original Berkeley Energy and Resources (BEAR) model developed for climate policy research on California. In reality, this represents a constellation of research tools designed to elucidate economy-environment linkages across the western regional ecnomies. The schematics in Figures 1 and 2 describe the four generic components of the modeling facility and their interactions. This section provides a brief summary of the formal structure of the model.[2] For the purposes of this study, the 2006 IMPLAN national dataset was aggregated along certain dimensions. The current version of the model includes 20 activity sectors and ten households aggregated from the original data for the seven US member states of the WCI. The equations of the model are completely documented elsewhere (Roland-Holst: 2008), and for the present we only discuss its salient structural components.

The role of markets is to mediate exchange, usually with a flexible system of prices, the most important endogenous variables in a typical CGE model. As in a real market economy, commodity and factor price changes induce changes in the level and composition of supply and demand, production and income, and the remaining endogenous variables in the system. In CGE models, an equation system is solved for prices that correspond to equilibrium in markets and satisfy the accounting identities governing economic behavior. If such a system is precisely specified, equilibrium always exists and such a consistent model can be calibrated to a base period data set. The resulting calibrated general equilibrium model is then used to simulate the economywide (and regional) effects of alternative policies or external events.

The distinguishing feature of a general equilibrium model, applied or theoretical, is its closed-form specification of all activities in the economic system under study. This can be contrasted with more traditional partial equilibrium analysis, where linkages to other domestic markets and agents are deliberately excluded from consideration. A large and growing body of evidence suggests that indirect effects (e.g., upstream and downstream production linkages) arising from policy changes are not only substantial, but may in some cases even outweigh direct effects. Only a model that consistently specifies economywide interactions can fully assess the implications of economic policies or business strategies. In a multi-country model like the one used in this study, indirect effects include the trade linkages between countries and regions which themselves can have policy implications.

The model we use for this work has been constructed according to generally accepted specification standards, implemented in the GAMS programming language, and calibrated to the new multi-state dataset estimated for the year 2006.[3] The result is a seven economy model calibrated over the fifteen-year time path from 2006 to 2020.[4]

[2] See Roland-Holst (2005) for a complete description of the original BEAR model.
[3] See e.g. Meeraus et al (1992) for GAMS. Berck et al (2004) for discussion of the California SAM.
[4] The present specification is one of the most advanced examples of this empirical method, already applied to over 50 individual countries or combinations thereof.

Using the very detailed accounts of IMPLAN, we include the following in the present model:

2.1 Production

All sectors are assumed to operate under constant returns to scale and cost optimization. Production technology is modeled by a nesting of constant-elasticity-of-substitution (CES) functions. See Figure A1.1 for a schematic diagram of the nesting.

In each period, the supply of primary factors — capital, land, and labor — is usually predetermined.[5] The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be partially mobile, reflecting differences in the marketability of capital goods across sectors.[6] Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply conditions in all markets.

2.2 Consumption and Closure Rule

All income generated by economic activity is assumed to be distributed to consumers. Each representative consumer allocates optimally his/her disposable income among the different commodities and saving. The consumption/saving decision is completely static: saving is treated as a "good" and its amount is determined simultaneously with the demand for the other commodities, the price of saving being set arbitrarily equal to the average price of consumer goods. The government collects income taxes, indirect taxes on intermediate inputs, outputs and consumer expenditures. The default closure of the model assumes that the government deficit/saving is exogenously specified.[7] The indirect tax schedule will shift to accommodate any changes in the balance between government revenues and government expenditures.

The current account surplus (deficit) is fixed in nominal terms. The counterpart of this imbalance is a net outflow (inflow) of capital, which is subtracted (added to) the domestic flow of saving. In each period, the model equates gross investment to net saving (equal to the sum of saving by households, the net budget position of the government and foreign capital inflows). This particular closure rule implies that investment is driven by saving.

[5] Capital supply is to some extent influenced by the current period's level of investment.

[6] For simplicity, it is assumed that old capital goods supplied in second-hand markets and new capital goods are homogeneous. This formulation makes it possible to introduce downward rigidities in the adjustment of capital without increasing excessively the number of equilibrium prices to be determined by the model.

[7] In the reference simulation, the real government fiscal balance converges (linearly) towards 0 by the final period of the simulation.

Figure 1: Component Structure of the Modeling Facility

BWest is being developed in four areas and implemented over two time horizons.

Components:

1. Core GE model
2. Technology module
3. Electricity generation/distribution
4. Transportation services/demand

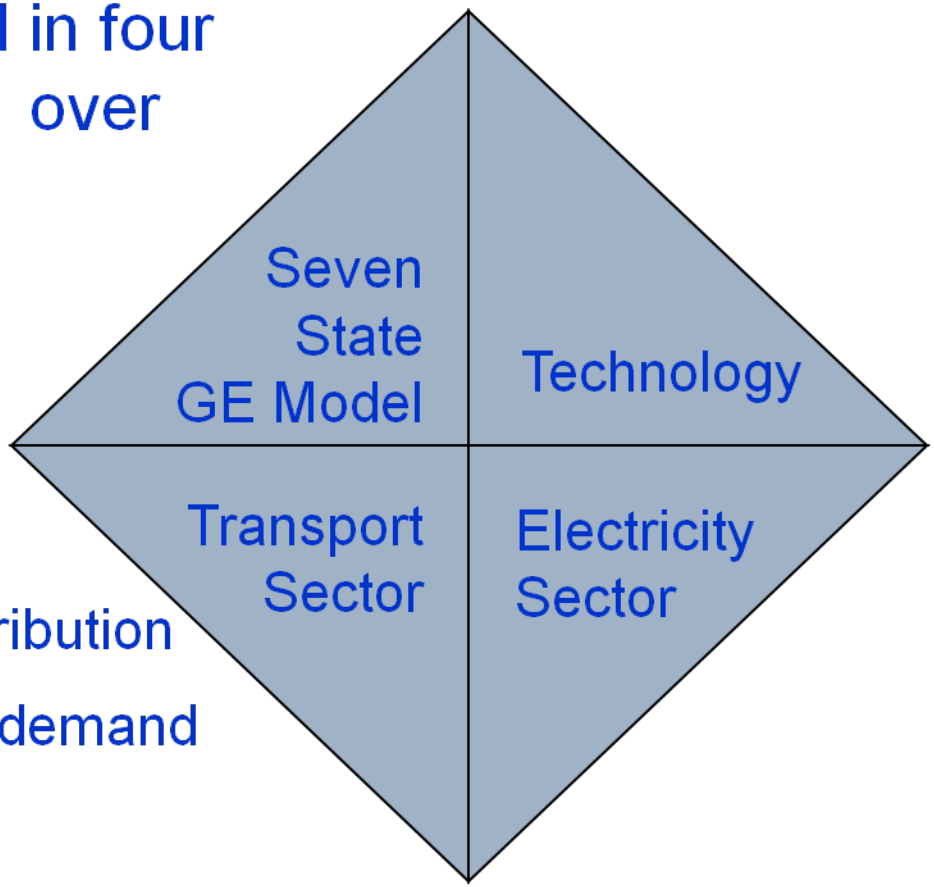
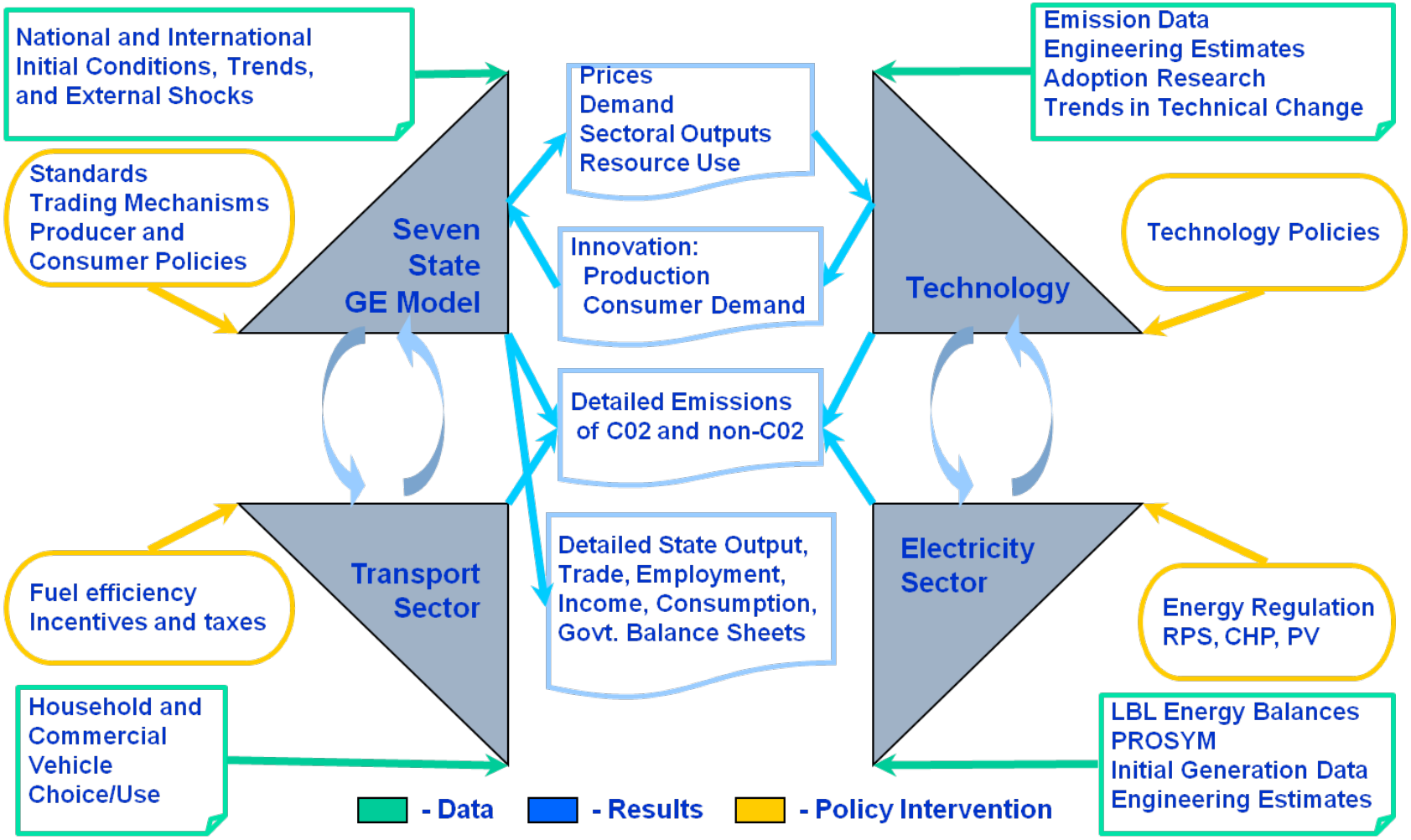


Figure 2: Schematic Linkage between Model Components



2.3 Trade

Goods are assumed to be differentiated by region of origin. In other words, goods classified in the same sector are different according to whether they are produced domestically or imported. This assumption is frequently known as the *Armington* assumption. The degree of substitutability, as well as the import penetration shares are allowed to vary across commodities. The model assumes a single Armington agent. This strong assumption implies that the propensity to import and the degree of substitutability between domestic and imported goods is uniform across economic agents. This assumption reduces tremendously the dimensionality of the model. In many cases this assumption is imposed by the data. A symmetric assumption is made on the export side where domestic producers are assumed to differentiate the domestic market and the export market. This is modeled using a *Constant-Elasticity-of-Transformation* (CET) function.

2.4 Dynamic Features and Calibration

The current version of the model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. Dynamics in the model originate in three sources: i) accumulation of productive capital and labor growth; ii) shifts in production technology; and iii) the putty/semi-putty specification of technology.

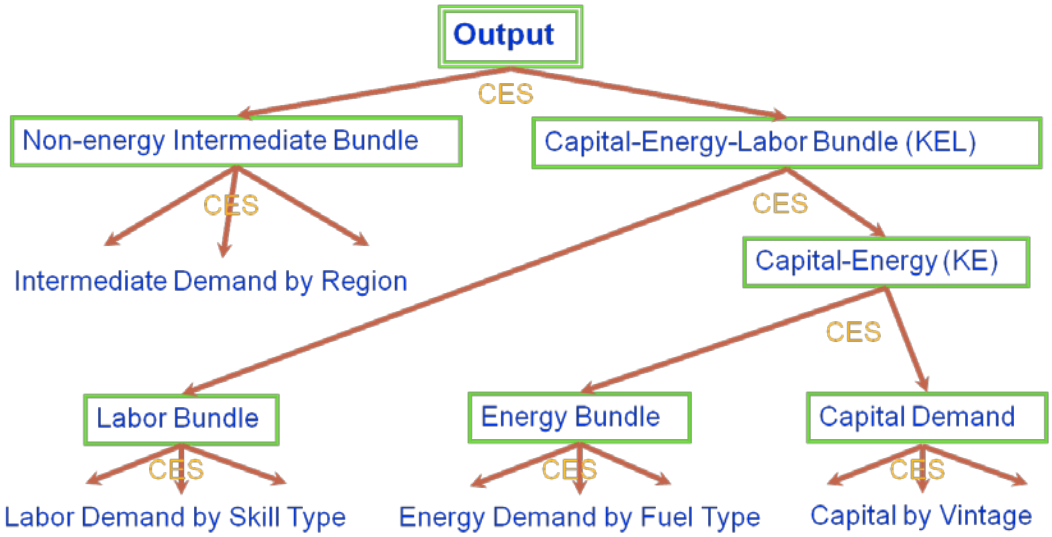
2.5 Capital accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total saving generated by the economy, consistent with the closure rule of the model.

2.6 The putty/semi-putty specification

The substitution possibilities among production factors are assumed to be higher with the new than the old capital vintages — technology has a putty/semi-putty specification. Hence, when a shock to relative prices occurs (e.g. the imposition of an emissions fee), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater the possibility to achieve the long-run total amount of substitution among production factors.

Figure 3: Production Structure for BWest



2.7 Dynamic calibration

The model is calibrated on exogenous growth rates of population, labor force, and GDP. In the so-called Baseline scenario, the dynamics are calibrated in each state economy by imposing the assumption of a balanced growth path. This implies that the ratio between labor and capital (in efficiency units) is held constant over time.[8] When alternative scenarios around the baseline are simulated, the technical efficiency parameter is held constant, and the growth of capital is endogenously determined by the saving/investment relation.

2.8 Modeling Emissions

The BWest model captures emissions from production activities in agriculture, industry, and services, as well as in final demand and use of final goods (e.g. appliances and autos). This is done by calibrating emission functions to each of these activities that vary depending upon the emission intensity of the inputs used for the activity in question. We model both CO2 and the other primary greenhouse gases, which are converted to CO2 equivalent. Following standards set in the research literature, emissions in production are modeled as factors inputs. The base version of the model does not have a full representation of emission reduction or abatement. Emissions abatement occurs by substituting additional labor or capital for emissions when an emissions tax is applied. This is an accepted modeling practice, although in specific instances it may either understate or overstate actual emissions reduction potential.[9] In this framework, mission levels have an underlying monotone relationship with production levels, but can be reduced by increasing use of other, productive factors such as capital and labor. The latter represent investments in lower intensity technologies, process cleaning activities, etc. An overall

[8] This involves computing in each period a measure of Harrod-neutral technical progress in the capital-labor bundle as a residual. This is a standard calibration procedure in dynamic CGE modeling.
[9] See e.g. Babiker et al (2001) for details on a standard implementation of this approach.

calibration procedure fits observed intensity levels to baseline activity and other factor/resource use levels. In some of the policy simulations we evaluate sectoral emission reduction scenarios, using specific cost and emission reduction factors, based on our earlier analysis (Hanemann and Farrell: 2006).

The model has the capacity to track 13 categories of individual pollutants and consolidated emission indexes, each of which is listed in Table 2.1 below. Our focus in the current study is the emission of CO2 and other greenhouse gases, but the other effluents are of relevance to a variety of environmental policy issues. For more detail, please consult the full model documentation.

An essential characteristic of the BWest approach to emissions modeling is endogeniety. Contrary to assertions made elsewhere (Stavins et al:2007), the BWest model permits emission rates by sector and input to be exogenous or endogenous, and in either case the level of emissions from the sector in question is endogenous unless a cap is imposed. This feature is essential to capture structural adjustments arising from market based climate policies, as well as the effects of technological change.

Table 1: Emission Categories

Air Pollutants

1.	Suspended particulates	PART
2.	Sulfur dioxide (SO_2)	SO2
3.	Nitrogen dioxide (NO_2)	NO2
4.	Volatile organic compounds	VOC
5.	Carbon monoxide (CO)	CO
6.	Toxic air index	TOXAIR
7.	Biological air index	BIOAIR

Water Pollutants

8.	Biochemical oxygen demand	BOD
9.	Total suspended solids	TSS
10.	Toxic water index	TOXWAT
11.	Biological water index	BIOWAT

Land Pollutants

12.	Toxic land index	TOXSOL
13.	Biological land index	BIOSOL

Table 2: IMPLAN State Data for 2006 – Structural Characteristics

1.	509 production activities
2.	509 commodities (includes trade and transport margins)
3.	3 factors of production
4.	2 labor categories
5.	Capital
6.	Land
7.	8 Household types, defined by income tax bracket
8.	Enterprises
9.	Federal Government (3 fiscal accounts)
10.	State and Local Government (2 fiscal accounts)
11.	Consolidated capital account
12.	External Trade Accounts (2, domestic and foreign)

Table 3: Aggregate Accounts for the BWest CGE Model

1. 20 Production Sectors and Commodity Groups

	Label	Description
1	Agric	Agriculture
2	Coal	Coal
3	OilGas	Oil&Gas
4	FoodPr	Food Processing
5	WoodPap	Wood&Paper
6	PetRef	Refined Petroleum
7	Chem	Chemicals
8	Mineral	Mineral Products
9	Metals	Metal Products
10	Vehicle	Vehicles
11	ElEqp	Electrical Equip
12	Mfg	Manufacturing
13	Const	Construction
14	Elect	Electric Power
15	GasDist	Gas Distribution
16	Water	Water
17	Trade	Wh&Ret Trade
18	Transport	Transportation
19	Comm	Communication
20	Services	Services

2 Labor Categories

1. Skilled
2. Unskilled

C. Capital
D. Land
E. 8 Household Groups (by income
   1. HOUS0 (<$0k)
   2. HOUS1 ($0-12k)
   3. HOUS2 ($12-28k)
   4. HOUS4 ($28-40k)
   5. HOUS6 ($40-60k)
   6. HOUS8 ($60-80k)
   7. HOUS9 ($80-200k)
   8. HOUSH ($200+k)
F. Enterprises
G. External Trading Partners
   1. ROUS Rest of United States
   2. ROW Rest of the World

These data enable us to trace the effects of responses to climate change and other policies at unprecedented levels of detail, tracing linkages across the economy and clearly indicating the indirect benefits and tradeoffs that might result from comprehensive policies pollution taxes or trading systems. As we shall see in the results section, the effects of climate policy can be quite complex. In particular, cumulative indirect effects often outweigh direct consequences, and affected groups are often far from the policy target group. For these reasons, it is essential for policy makers to anticipate linkage effects like those revealed in a general equilibrium model and dataset like the ones used here.

2.9 Emissions Data

Emissions data at a country and detailed level have rarely been collated. An extensive data set exists for the United States which includes thirteen types of emissions, see Table 2.1.[10] The emission data for the United States has been collated for a set of over 400 industrial sectors and all 50 states. In most of the primary pollution databases, measured emissions are directly associated with the volume of output. This has several consequences. First, from a behavioral perspective, the only way to reduce emissions, with a given technology, is to reduce output. This obviously biases results by exaggerating the abatement-growth tradeoff and sends a misleading and unwelcome message to policy makers.

More intrinsically, output based pollution modeling fails to capture the observed pattern of abatement behavior. Generally, firms respond to abatement incentives and penalties in much more complex and sophisticated ways by varying internal conditions of production. These responses include varying the sources, quality, and composition of inputs, choice of technology, etc. The third shortcoming of the output approach is that it give us no guidance about other important pollution sources outside the production process, especially pollution in use of final goods. The most important example of this category is household consumption.

[10] See Martin et. al. (1991).

3 Scenarios and Results

The Western Climate Initiative has already set forth a series of policy commitments to GHG mitigation, and we consider a generic version of these to assess its long run economic implications. At the same time, the climate policy dialogue across the nation and beyond is in a very dynamic state. Because of this, it may be reasonable to expect WCI to adapt, but this regional initiative also provides valuable precedence to inform the national climate agenda. Thus our economic assessment includes one policy scenario that represents the basic principles of the existing WCI agreement, as reflected in official documents and supporting research commissioned by the WCI.[11] In particular, we evaluate one baseline reference case and five alternative policy scenarios extending over the period 2006-2008. The first year is the latest for which complete official economic data are available, and the last is the primary milestone year for GHG targets in WCI and California's AB 32.

For the baseline reference case, we adopt the assumptions enunciated in ICF (2008ab), as these are thought to conform most closely to official expectations about business as usual (BAU) growth trends in the WCI states. As the table below indicates, these growth rates (last column) are optimistic relative to historic trends and (particularly) relative to recent events, but since this is merely a scenario baseline we conform to them for the sake of comparability with other research findings. Other important baseline scenario variables, such as population growth rates and energy prices, also conform to those used in the same study.

Table 4: Historical and Baseline Future Growth Rates of Real GSP

	1991-1995	1996-2000	2001-2005	Average	BAU 2006-2020
AZ	4.8	6.3	3.6	4.9	3.1
CA	0.3	5.2	2.2	2.6	3.2
MT	2.4	1.8	2.9	2.4	2.5
NM	6.4	3.9	2.2	4.1	3.0
OR	3.5	6.1	2.3	4.0	3.6
UT	4.4	4.3	2.3	3.7	2.9
WA	2.1	4.6	1.4	2.7	3.1
WCI	1.3	5.1	2.3	2.9	3.1
US	2.1	3.3	1.8	2.4	

[11] For the latter, see ICF (2008ab), which will be referred to repeatedly in this section.

To elucidate the policy design characteristics of primary importance to economic impacts, we set forth five counterfactual scenarios. For all five, we assume a Cap and Trade program is implemented with four basic design characteristics.

Cap and Trade Design

Reduce 2020 regional GHG emissions to 85 percent of 2006 levels.

Only stationary non-residential sources and fuels are covered.

No offsets or banking.

Permit revenues are assumed to returned to households as lump-sum transfers.

Counterfactual Scenarios

Scenario 1: WCI Group – This is the policy framework that most closely conforms to the current version of the WCI agreement.[12] Among other features, it calls for all member states to join a regional cap and trade system, with region emissions to fall about 15 percent below baseline trend by 2020. We assume the permit licensing applies only to stationary sources, but emissions from industry carbon fuels are covered at their source. No offsets are available and we assume that energy and carbon intensity of individual energy use and supply technologies remains constant.

Scenario 2: WCI Individual – Like Scenario 1, except that each state implements it's own cap and trade program, thereby limiting spillover effects through competition between carbon intensive sectors, particularly energy fuel and carrier supply sources.

Scenario 3: National – Like Scenario 1, except that the WCI states now belong to a national Cap and Trade system which targets to achieve the same percent overall GHG reductions. In this case, permits will be tradable nationally between the same categories of emissions sources.

Scenario 4: WCI with Energy Efficiency - Like Scenario 1, but with concurrent improvements for each WCI member of 1 percent annually in average statewide energy efficiency, Pavley program vehicle efficiency improvements, and reductions in Vehicle Miles Traveled of 2 percent. Al efficiency measures apply to both enterprises and households, although the latter are not covered by the cap and trade mechanism.

Scenario 5: Renewable Portfolio Standard (RPS) – Like Scenario 4, except in including state-by-state, 30 percent renewable energy supply requirements for electric power generation. We assume a blended portfolio of major renewables sources.[13]

[12] See e.g. @@ for details.
[13] It should be noted that this scenario is indicative only and does not consider many complexities of the interaction between renewables and Cap and Trade. The latter are authoritatively summarized in Murtishaw (2008).

Of course there are countless alternatives to the above, including many variations within these five. As the WCI policy initiative progresses, it will be important to extend this work in several directions, including evaluation of more detailed design characteristics and their incentive properties. Of at least equal priority should be more detailed incidence analysis to identify adjustment needs for the diverse stakeholder groups that will be affected by these policies. For the present, however, this study has chosen to highlight policy features that drive the most substantial structural adjustments.

3.1 Aggregate Results

In this section we present the results of a detailed economic analysis of opportunities and challenges presented by the WCI initiative. As a major regional climate agenda, WCI requires careful consideration of diverse economic structures and interests to achieve credible agreement, effective implementation, and ultimately to set a positive example for the many GHG mitigation arrangements that we all know lie ahead. While every state, region of the US, and indeed region of the world is unique, we find in this analysis that the most important policy design features have universal characteristics. Thus an empirical assessment of the Western States can inform our own climate action, but also that in many other important contexts.

Any policies as far reaching as those considered in the WCI will have pervasive effects on the regional economies, including structural adjustments in patterns of supply, demand, and trade. Before examining these detailed features of the adjustment process, the following table summarizes aggregate growth effects, by state and region, of the five scenarios we evaluate. Measured as percent variations in real Gross State Product (GSP), these results show changes in aggregate real value added in 2020, compared to the BAU baseline.

The results are quite variegated, but a few salient findings deserve emphasis. Firstly, simply implementing a Cap and Trade system, without complementary measures to promote lower carbon technologies on the demand and supply side of energy markets, has a distanced repressive effect on economic growth. Indeed, in the simply WCI group scenario, every economy returns sub-baseline growth by 2020, although variation in this shortfall is significant. In this result we see the classic industry objection to Cap and Trade, i.e. that it represents an indirect tax on business activity and will therefore be directly contractionary. Few economists would disagree. It is well known in economic theory that a tax (which in the end is what the carbon permit fee represents) that differentially impacts resource allocation will distort market signals and lead to inefficiency. The justification of this particular distortion, i.e. that it is correcting for a negative environmental externality, does not mitigate this efficiency cost. A more complete accounting for long term environmental costs might provide a countervailing pecuniary benefit, but this is outside the scope of current analysis.

If a simple Cap and Trade program has these adverse effects, what alternatives might be more growth-oriented? The next two scenarios consider alternative policies for targeting mitigation. In

the WCI Individual case, we assumed that the states met the same overall regional mitigation objective, but did so with individual state cap and trade programs. Here we see that the overall effects remain negative, but dispersion is smaller. The reason is that approach limits spillover effects, where states can outsource mitigation and/or pollution depending on inter-state emission intensity differences. For example, because Montana, New Mexico, and Utah have higher prior pollution intensities (primarily in electric power production), they contract in response to lower emission competition from within the trading system. In other words, California power can produce a megawatt at lower permit cost (other things equal). Unfortunately, absence of any technological change still leads to negative growth in response to the trading scheme. For this reason, it can noted generally that more pollution intensive states are better off with individualized Cap and Trade programs.

When we embed WCI in a national trading scheme (Scenario 3), the dispersion and average level of negative growth effects increases even more. This is because the national program scope provides even more diversity of adjustment allocation, driving both the more emissions intensive (MT, NM, UT) and less pollution intensive (CA, WA) WCI states further away from the mean. Indeed, when national reallocation of the adjustment burden is possible, one of the least pollution intensive WCI states (Washington) actually benefits. We will examine detailed in-state structural adjustments below, but for the time being it is apparent that, in the absence of technological change, carbon caps and fees have a negative overall effect on regional economic growth. The more inclusive the trading system, the greater these disparities among individual state outcomes.

Table 5: Real Gross State Product
(percent changes from baseline in 2020)

	WCI Group	WCI Individual	National	WCI Energy Efficiency	WCI RPS
WCI	-6.26	-5.35	-5.12	2.20	3.81
AZ	-7.71	-5.75	-4.88	2.92	4.38
CA	-1.68	-3.12	-1.11	3.08	1.43
MT	-9.54	-6.68	-11.00	1.09	6.45
NM	-8.77	-3.43	-10.58	0.62	6.74
OR	-4.14	-7.97	-4.95	2.75	2.40
UT	-8.23	-3.55	-9.27	1.22	4.02
WA	-3.76	-6.93	5.97	3.74	1.24

The first three scenarios affirm the risk of imposing fees on private agency without appropriate complementary measures that recognize incentives. Perhaps the most arresting results in the

table above, however, are in the last two columns. Here we see that, market oriented GHG mitigation is combined with efficient demand and supply side energy policies, the result can be a potent catalyst for economic growth. This is a vital lesson for climate policy in the region and well beyond. Markets alone could identify the climate change externality, and markets for carbon alone may not provide adequate incentives for innovation and efficiency. The first market failure brought on humanity's greatest environmental challenge, while the second threatens to undermine dedicated climate action responses. If we are to effective promote the mitigation agenda, we must recognize the importance of complementary policies that add efficiency and yield a low carbon, higher growth economic future.

As stated before, Scenario 4 assumes that state-specific average energy efficiency improves at a rate of 1 percent annually over the forecast period. Given that the WCI largest member state (California) sustained such improvements for 35 years, this does not seem an unrealistic goal, particularly in the face of unprecedented mitigation incentives coming from a new Cap and Trade regime. Whether these efficiency gains are achieved by private or regulatory initiative, the result would be a reversal of the adverse Scenario 1 results for every state, yielding growth of up to 3 percent higher real GSP by 2020. As we have seen in California over the last four decades, the environment-growth tradeoff is in no way inevitable, and efficiency measures prove this. When households and enterprise save money on energy, these dollars are redirected from the fuel supply chain to much more employment-intensive services and goods.[14] The result is higher employment and income for every state that makes significant progress in reducing its energy dependence.

Table 6: Gross State Product
(changes in 2006 billions from baseline in 2020)

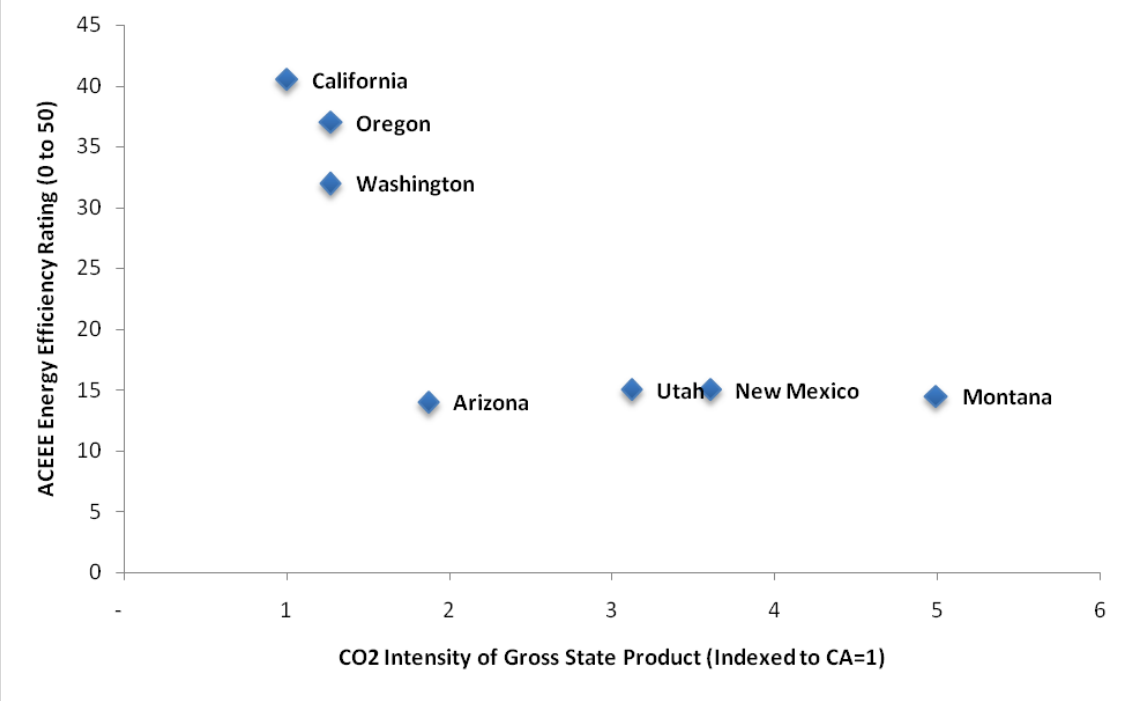
	Scenario 1	Scenario 2	Screnario 3	Scenario 4	Scenario 5
	WCI Group	WCI Individual	National	Energy Efficiency	RPS
WCI	-128	-169	-66	121	83
AZ	-31	-23	-19	12	17
CA	-46	-85	-30	84	39
MT	-4	-3	-5	0	3
NM	-9	-4	-11	1	7
OR	-11	-21	-13	7	6
UT	-12	-5	-13	2	6
WA	-16	-29	25	16	5

[14] This is the central finding of Roland-Holst (2008a), which estimated that California created 1.42 million more jobs and $45B more in payrolls over the 1972-2006 period because of energy efficiency.

Scenario 5 adds to the efficiency and innovation agenda on the energy supply side, calling for a 30 percent Renewable Portfolio Standard for each state. Although this may be a high bar for some states, it provides a useful reference for the benefits of substituting fossil fuels out of the energy supply. In particular, we find that combining Cap and Trade across the WCI (Scenario 1) with demand side efficiency (Scenario 4), and lower carbon fuel supplies provides a very strong stimulus for growth in the region, particularly in economies with relatively high prior carbon liabilities(MT, NM, UT). For the latter, "greening" the supply side of their energy markets offsets a major competitive disadvantage under Cap and Trade, and they experience reversals of fortune of up to 10 percent of GSP as a result.

As the next figure suggests, the states with relatively high GHG intensity in GSP are also those with relatively low rates of energy efficient technology adoption. For this reason, efficiency policies represent low hanging fruit for these economies, and the substantial stimulus effects of Scenarios 5 and 6 are within easier reach for them.

Figure 4: Relative Energy Efficiency and GHG Intensity by State



Sources: ACEEE energy efficiency rating is from ACEEE, "The 2008 State Energy Efficiency Scorecard", http://www.aceee.org/pubs/e086_es.pdf. CO_2 data used throughout the report are from the Energy Information Administration (EIA) website, GSP data are from the Bureau of Economic Analysis (BEA) website.

Thus we see from the aggregate results that simple Cap and Trade schemes may achieve emissions reduction, but can also have unwelcome negative growth effects without policies to facilitate innovation and efficiency improvements for lower carbon energy demand and supply. This interaction was apparent in the research, dialogue, and policy design to implement California's AB 32 legislation, where an extensive combination of standards and incentive measures were included to promote pro-growth mitigation.

The next table summarizes carbon accounts for the scenarios. The first row indicates the permit price estimated for the Cap and Trade system, followed by permit revenues generated within each state. Note first of all that the permit price estimates for Scenarios 1-3, because they make no allowance for efficiency improvements, are likely to be significantly higher than would be observed. Indeed it is apparent that, to the extent that carbon prices can be seen as an incentive to innovate for efficient energy demand and alternative energy supply, Arizona will have little choice but to adapt. Having said this, the carbon prices estimated are still within ranges set out in dialoge between different stakeholder groups, both regionally and nationally.

Table 7: Carbon Permit Accounts

	Scenario 1	Scenario 2	Screnario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Permit Price	$ 33	$ 38*	$ 66	$ 7	$ 0**
Permit Revenues in Billions of 2006 Dollars					
AZ	20	25	59	5	
CA	11	7	21	2	
MT	1	2	2	0	
NM	1	1	2	0	
OR	1	0	2	0	
UT	1	4	2	0	
WA	2	1	6	1	
WCI	20	39	41	5	

** This price is an average of state-specific permit prices.*

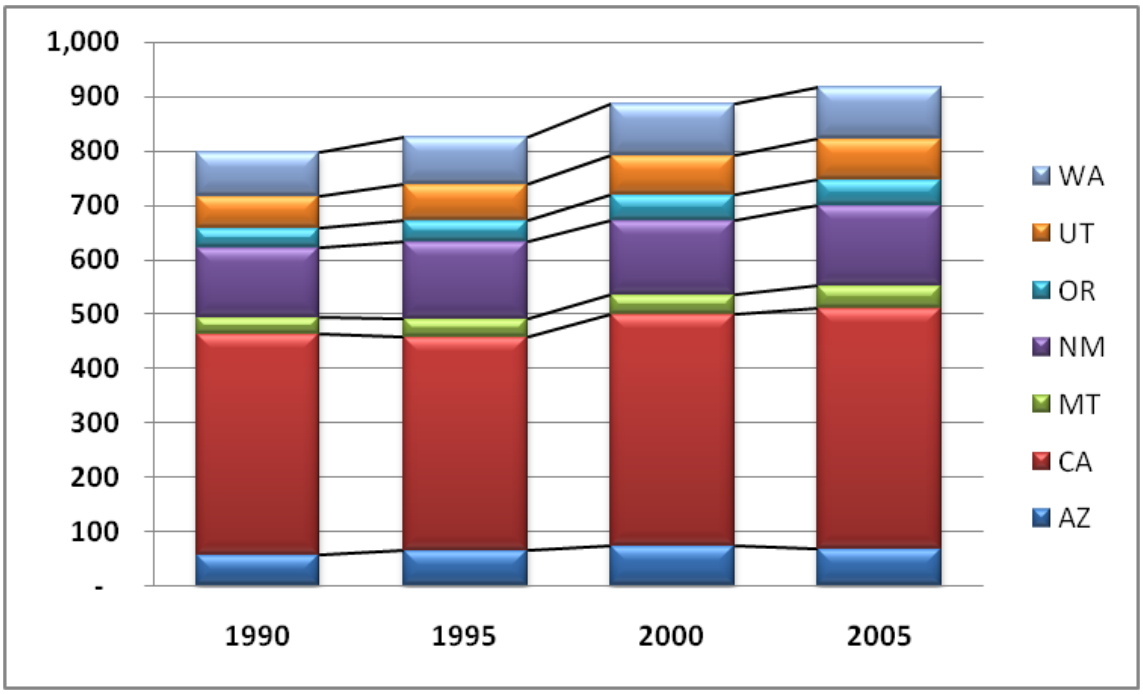
*** The RPS and Efficiency Measures reduce GHG emissions below the target, rendering the Cap and Trade mechanism superfluous.*

3.2 Initial conditions

To elucidate the aggregate results above and more detailed ones that follow; it is useful to look in more detail at the emission characteristics of the WCI member states. For any choice of a regional climate policy, one of the most important determinants of the WCI adjustment process will be differences of initial conditions between the member states. For the present assessment

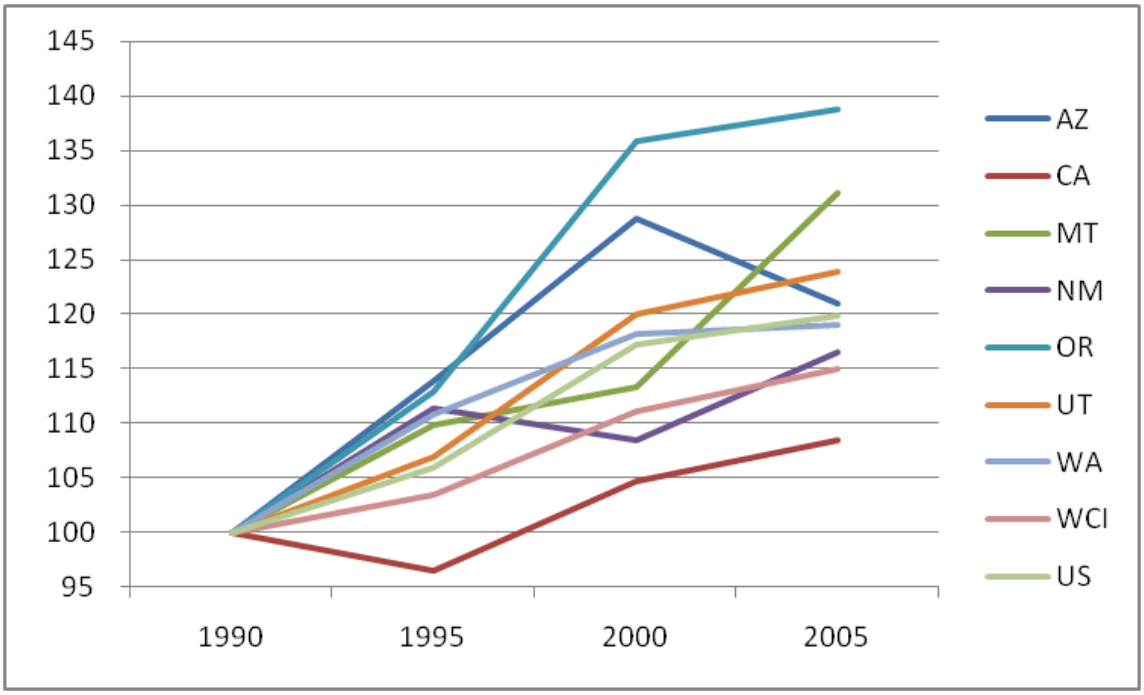
the most important aspects of this relate to economic structure and the underlying emissions intensity of economic activities. In this section, we review these structural features from a relatively aggregate level, but even here it becomes apparent that states in the region are highly diverse.

Figure 5: Regional GHG Emissions by State and Year



The figure above summarizes the composition of emissions growth in the region since the policy reference year 1990. In some cases (e.g. CA and IR), these shares suggest mere proportionality to the size of the economies in question, while others (e.g. NM) exhibit emissions intensities much higher than average. By contrast, the Figure below highlights individual state emissions growth. Only Arizona has managed to reduce aggregate GHG emissions over the period considered, and growth rates have been quite high for some states. California has the lowest growth rate overall, thanks to a wide array of energy efficiency programs sustained from the early 1970's

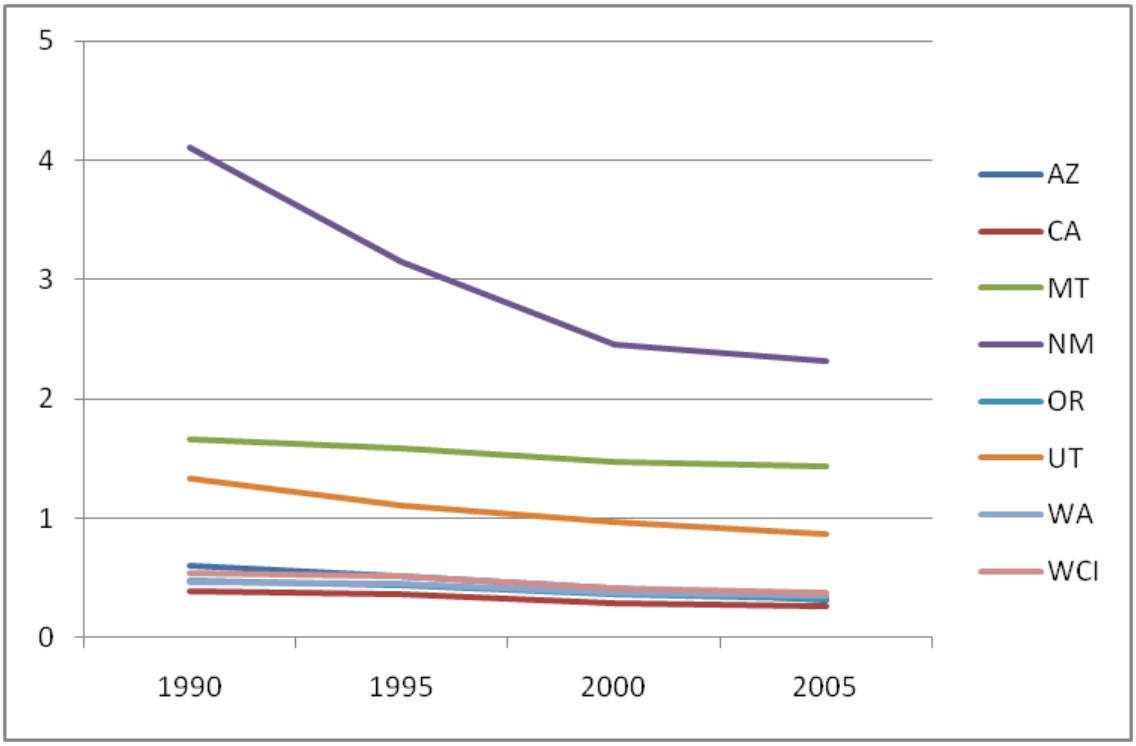
Figure 6: Emissions Growth Since 1990
(indexed to 1990=100)



We can take some comfort in the trends of the next Figure, which show the relationship between emissions and economic growth, i.e. the ratio of total GHG emissions to GSP. These trends reveal that emissions intensity has been declining monotonically in all states over the same period. However, the dispersion between these trends suggests that adjustment in response to a trading system that puts a price on carbon will affect each member state very differently. In particular, New Mexico, Montana, and Utah have relative carbon cost liabilities well above the regional average.

Higher levels of relative carbon intensity for these three economies explain why they are outliers in the adverse impact scenarios (1-3). If energy demand and supply technologies remain unchanged, putting a price in carbon emissions will more adversely impact these states. Ironically, however, it is the same high carbon exposure that gives them more upside potential in the technological change scenarios (4-5). This is because they have relatively more to gain from re-deployment of savings realized from energy efficiency and renewables.

Figure 7: Emissions Intensity of GSP
(Metric Tons per Thousand Dollars)

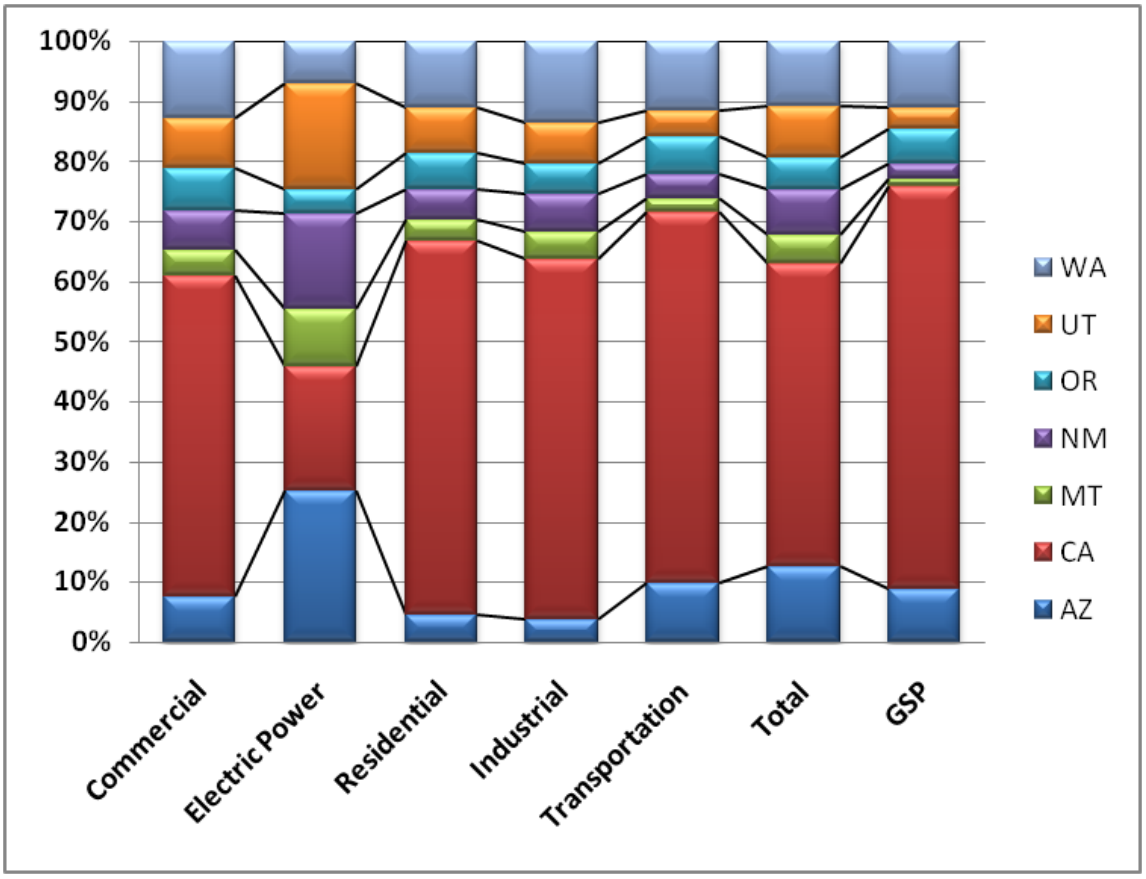


The more detailed structural drivers of the adjustment process are shown in the next figure, which summarizes regional composition of GHG by generic source. While the previous figure reveals aggregate differences in aggregate carbon exposure, these results identify where states differ in carbon intensity of specific economic activities. The most prominent case is electric power generation, responsible for over a third of GHG emissions in all states, but with very different levels of carbon intensity. For example, California's GHG share in regional electric power emissions is less than one quarter of its GSP share. Utah is in the opposite situation, with an electric power emission share more than five times its GSP share. Likewise, New Mexico and Montana have much higher carbon liabilities in electric power than regional averages. In this sector, we identify the primary driver of both the downside and upside WCI potential for these three states. Their commitments to WCI mitigation will make a disproportionate contribution to the region's climate goals, and for this they could be rewarded if determined complementary policies achieve demand and supply side energy innovation in the same states.

Another important GHG source is transport fuels, but in this case the states are more comparable. Emissions shares from transportation are more similar to GSP shares, but states with higher average Vehicle Miles Travelled have slightly higher carbon liabilities from this source. Again, however, this means more downside risk from carbon prices but more growth potential from energy innovation. Finally, other GHG sources are somewhere between Electric Power and Transport in terms of comparability to GSP shares. This suggests that states with

high carbon intensity in Electric Power may have more emissions-intensive downstream activities, but in any case all these results are stringing influenced by California's relatively high efficiency standards.

Figure 8: Regional GHG Emissions Composition by State and Activity



3.3 Economic Impacts by Sector

It is clear from the discussion above that heterogeneity between the WCI states has important implications for economic adjustments that will ensue from climate policy. In this section, we examine more detailed structural adjustments and highlight opportunities and challenges for individual sectors. From a policy perspective, evidence of this kind is very important to promote constructive stakeholder engagements anticipate adjustment needs. Any policy commitment as large and far reaching as a cap and trade system will inevitably occasion structural change. Our results show, however, that significant growth potential exists within this process of change as

long as policies include the right adaptation incentives. The more fully structural changes can be anticipated, the more effective and growth-oriented can be the complementary policies.

Table 8: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-9%	-7%	-12%	2%	12%
Coal	-7%	-6%	-8%	1%	8%
Oil&Gas	-3%	-3%	-4%	5%	8%
Food Processing	-8%	-7%	-15%	9%	18%
Wood&Paper	-9%	-8%	-15%	4%	12%
Refined Petroleum	-24%	-17%	-1%	-7%	-14%
Chemicals	1%	1%	1%	1%	1%
Mineral Products	9%	9%	18%	3%	-2%
Metal Products	-26%	-16%	0%	-6%	19%
Vehicles	1%	-1%	-6%	9%	10%
Electrical Equip	-2%	-2%	-3%	-1%	1%
Manufacturing	-4%	-4%	-15%	12%	17%
Construction	-6%	-4%	-9%	2%	9%
Electric Power	-13%	-14%	-15%	0%	-29%
Gas Distribution	-13%	-13%	-9%	-1%	-15%
Water	4%	3%	6%	2%	0%
Wh&Ret Trade	1%	0%	-3%	-2%	-2%
Transportation	-16%	-15%	-14%	-2%	10%
Communication	3%	1%	-2%	12%	11%
Services	-2%	-1%	3%	1%	3%
Total	-6%	-5%	-5%	2%	4%

The table above summarizes changes in regional output for twenty economic activities and the five scenarios considered. Here we see the adjustment process in more graphic detail, with direct implications for individual enterprises and workers employed by them. Although the diversity of scenario outcomes is reflected in the Total Output row, the fates of individual sectors are even more divers. Service sectors, for example, expand in every scenario as the region's economies rotate away from energy-intensive production. Whether or not this shift is accompanied by de-industrialization depends on how well industry adapts, exactly as one would expect. If industry continues with business as usual energy use technology (Scenarios 1-3), the region is condemned to de-industrialization by rising carbon costs. If, on the other hand, the region continues on the energy efficiency path laid out by California, industries benefit across

the board and some very dramatically so. Thus we are reminded of the inexorable link between innovation and growth. Just as we have seen throughout the Industrial Revolution, technological change offers new opportunities for economic expansion, but only to those who adapt and overcome emerging constraints. In agriculture, the constraint in the last century was arable land area, and agricultural technology overcame this. In the era of globalization, the constraint was labor costs, and knowledge-intensive firms overcame this with ever higher labor productivity. Today, the constraint is carbon intensity, and those firms who overcome this with ever greater energy efficiency will remain competitive and continue to grow.

The main exception to this general rule is of course sectors producing energy itself (Coal, OilGas, PetRef, and GasDist), and these decline in every scenario because their product is the primary target of climate action. In fuel-allied sectors like Transport and Electric Power, outcomes are more mixed. In efficiency standards reduce average carbon intensity of residential and enterprise emissions in both categories, stimulating aggregate growth with a rebound effect for energy sectors. This effect is even more pronounced with innovation on the supply side of the Electric Power sector, where RPS lowers its average carbon liability and permits even greater expansion.

3.4 State Results

More detailed background information on each state follows this economic assessment, but for the present we review scenario impacts by sector for each state. As the aggregate results suggest, there are important differences in the state's adjustment experiences, and each will probably need to devise its own complementary measures recognition of different stakeholder needs. Having said this, however, it appears that the policy direction suggested but the aggregate results would still the dominant policy for each state. In other words, our results suggest that the states would be better off choosing the same policy (Scenario 5) whether they did so individually or collectively.

3.4.1 Arizona

As the aggregate results indicated, Arizona has relatively high GHG intensity within the WCI region. Thus its downside risk and upside potential in response to climate policy is greater than average. Among individual sectors, its relatively GHG intensive Petroleum product and Electric Power sector wills experience the most significant downward adjustments, and these sectors contract in almost every scenario. If the state can adapt effectively to more efficient energy technologies (Scenario 5), however, broad-based expansion will overcome these adverse sectoral adjustments and the state can achieve 4 percent higher real output by 2020.

Table 9: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-8%	-5%	-17%	6%	10%
Coal	-5%	-4%	-9%	4%	6%
Oil&Gas	0%	0%	-1%	5%	4%
Food Processing	-2%	-1%	-9%	10%	10%
Wood&Paper	-6%	-4%	-15%	7%	10%
Refined Petroleum	-33%	-27%	3%	-7%	-14%
Chemicals	0%	0%	-3%	0%	-1%
Mineral Products	5%	4%	15%	2%	-1%
Metal Products	-27%	-21%	36%	-1%	29%
Vehicles	-3%	-2%	-14%	9%	9%
Electrical Equip	-2%	0%	-5%	0%	1%
Manufacturing	-2%	-2%	-13%	13%	14%
Construction	-7%	-5%	-11%	2%	6%
Electric Power	-28%	-22%	-17%	0%	-12%
Gas Distribution	-23%	-17%	-28%	1%	-6%
Water	3%	2%	4%	1%	-1%
Wh&Ret Trade	-1%	-1%	-7%	-2%	-2%
Transportation	-15%	-11%	-13%	-1%	10%
Communication	3%	3%	1%	12%	9%
Services	-5%	-4%	6%	0%	6%
Total	-8%	-6%	-5%	3%	4%

3.4.2 California

Because of the size of this economy, its higher relatively energy efficiency, and greater reliance on service output, California's adjustment to WCI will be less dramatic at the macro level. Moreover, since the state is already committed to its own low carbon policies, including extensive efficiency measures, it is more likely to land in a Scenario 5 future regardless of complementary measures taken by its regional partners. The result in this case will be significantly less reliance on Electric Power and Natural Gas than in the baseline, but modest aggregate expansion driven by significant growth of more efficient basic industries.

Table 10: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-4%	-8%	0%	5%	9%
Coal	-4%	-6%	-2%	0%	3%
Oil&Gas	0%	0%	1%	6%	6%
Food Processing	-1%	-2%	-3%	10%	11%
Wood&Paper	-3%	-5%	-4%	5%	7%
Refined Petroleum	0%	0%	0%	0%	0%
Chemicals	0%	0%	1%	2%	2%
Mineral Products	6%	10%	10%	2%	-1%
Metal Products	-2%	-5%	3%	0%	2%
Vehicles	0%	0%	-3%	6%	6%
Electrical Equip	-4%	-7%	2%	-4%	-1%
Manufacturing	-2%	-4%	-7%	11%	13%
Construction	0%	0%	2%	5%	5%
Electric Power	-8%	-13%	-13%	2%	-35%
Gas Distribution	-3%	-5%	2%	0%	-18%
Water	2%	3%	3%	1%	1%
Wh&Ret Trade	-1%	-1%	-3%	-2%	-2%
Transportation	-13%	-23%	-12%	-1%	7%
Communication	2%	4%	0%	12%	11%
Services	0%	0%	1%	1%	2%
Total	-2%	-3%	-1%	3%	1%

3.4.3 Montana

The alternative futures facing Montana are among the most dramatic in this regional policy framework. High levels of initial carbon-intensive energy dependence mean that downside risks from Cap and Trade are significant, but upside potential from efficiency gains are likewise well above average. The states Mineral Products sector can maintain competitiveness even when energy is heavily burdened by carbon pricing, but Agriculture, Metals, Manufacturing, and Food Processing could contract significantly unless significant commitments are made to new technology. Even without RPS or other energy supply innovation, the economy could expand with greater use efficiency, but alternative energy sources would confer much more growth on this economy.

Table 11: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-18%	-11%	-24%	1%	22%
Coal	-15%	-10%	-21%	1%	15%
Oil&Gas	-11%	-7%	-15%	4%	17%
Food Processing	-28%	-20%	-41%	7%	38%
Wood&Paper	-26%	-18%	-31%	-4%	20%
Refined Petroleum	-31%	-24%	-33%	-8%	-21%
Chemicals	4%	3%	2%	0%	-2%
Mineral Products	16%	11%	30%	4%	-4%
Metal Products	-22%	-17%	-26%	-8%	23%
Vehicles	20%	14%	18%	14%	4%
Electrical Equip	-2%	-1%	-1%	-1%	-1%
Manufacturing	-9%	-7%	-25%	14%	23%
Construction	-24%	-17%	-36%	-2%	25%
Electric Power	-21%	-15%	-20%	-2%	-33%
Gas Distribution	-20%	-13%	1%	-6%	-19%
Water	8%	6%	12%	3%	-1%
Whl&Retail Trade	1%	0%	-5%	-2%	-1%
Transportation	-27%	-17%	-23%	-5%	17%
Communication	15%	11%	18%	12%	5%
Services	-2%	-1%	-1%	0%	3%
Total	-10%	-7%	-11%	1%	6%

3.4.4 New Mexico

Like Montana and Arizona, high initial carbon intensity in electric power makes this economy quite sensitive to WCI policy design. In particular, Agriculture and Metal Products contract in four of the five scenarios because carbon pricing undermines their profitability. Even services contract without energy efficiency measures, but this economy can deliver higher growth with demand side efficiency measures. Like the rest, however, a more emphatic commitment to renewables innovation would yield an additional premium, and because of its prior coal dependence the RPS dividend would be the highest for this state.

Table 12: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-16%	-5%	-22%	-8%	16%
Coal	-8%	-3%	-9%	-1%	10%
Oil&Gas	1%	1%	0%	4%	6%
Food Processing	-2%	-1%	-7%	6%	12%
Wood&Paper	-10%	-5%	-18%	2%	16%
Refined Petroleum	-46%	-22%	-27%	-18%	-17%
Chemicals	4%	1%	3%	1%	1%
Mineral Products	13%	6%	22%	4%	-5%
Metal Products	-60%	-24%	-67%	-18%	35%
Vehicles	-5%	-1%	-13%	8%	25%
Electrical Equip	-1%	1%	-3%	1%	4%
Manufacturing	-6%	-4%	-17%	18%	26%
Construction	-7%	-3%	-11%	2%	11%
Electric Power	-7%	-3%	-9%	0%	-24%
Gas Distribution	-10%	-3%	-10%	-1%	-18%
Water	5%	2%	8%	3%	1%
Wh&Ret Trade	5%	1%	2%	-2%	-1%
Transportation	-22%	-7%	-26%	-3%	15%
Communication	2%	0%	-8%	14%	16%
Services	-4%	-1%	-3%	0%	6%
Total	-9%	-3%	-11%	1%	7%

3.4.5 Oregon

Although Oregon experienced high total emission growth since 1990, this was a reflection of even more rapid GSP growth and it remains with California among the least carbon intensive states. This lower level of carbon exposure, particularly in Electric Power, means it will be less WCI responsive in output terms than the average for the region. Efficiency measures will take the Electric Power sector well below baseline production levels, without the rebound effect of decarbonizing coal that was apparent in some other western states. Efficiency and RPS will also stimulate this state's important agro-food sectors and manufacturing, while energy savings would stimulate services.

Table 13: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-3%	-7%	2%	5%	7%
Coal	-5%	-10%	-1%	0%	3%
Oil&Gas	-5%	-9%	-2%	4%	7%
Food Processing	-5%	-11%	-9%	8%	12%
Wood&Paper	-7%	-13%	-11%	7%	11%
Refined Petroleum	0%	0%	0%	0%	0%
Chemicals	0%	-1%	2%	1%	1%
Mineral Products	7%	14%	14%	2%	-2%
Metal Products	-4%	-8%	-6%	0%	2%
Vehicles	-7%	-13%	-10%	9%	13%
Electrical Equip	-3%	-5%	-5%	-1%	1%
Manufacturing	-3%	-6%	-11%	11%	13%
Construction	-1%	-2%	1%	4%	4%
Electric Power	-10%	-21%	-18%	-1%	-36%
Gas Distribution	-29%	-50%	-33%	-1%	-1%
Water	2%	4%	5%	2%	1%
Wh&Ret Trade	-1%	-2%	-3%	-2%	-2%
Transportation	-10%	-21%	-11%	0%	7%
Communication	1%	1%	-3%	6%	6%
Services	-1%	-2%	2%	2%	2%
Total	-4%	-8%	-5%	3%	2%

3.4.6 Utah

Like several other states with high carbon intensity, Utah's challenges and opportunities contrast sharply between different WCI scenarios. In addition to the carbon fuels that universally contract against baseline growth trends, Agriculture, Food Processing, Metals, Manufacturing, and Construction would all grow more slowly if Cap and Trade were implemented without energy efficiency improvements. These adverse results could all be reversed (except for Minerals) if complementary measures are taken to improve energy demand efficiency and develop alternative renewable supplies.

Table 14: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-11%	-4%	-12%	1%	13%
Coal	-8%	-3%	-6%	3%	13%
Oil&Gas	-3%	-1%	-3%	5%	10%
Food Processing	-10%	-6%	-21%	10%	23%
Wood&Paper	-8%	-4%	-11%	3%	12%
Refined Petroleum	-48%	-23%	-42%	-15%	-21%
Chemicals	1%	1%	3%	2%	2%
Mineral Products	9%	4%	17%	3%	-3%
Metal Products	-62%	-26%	-67%	-19%	32%
Vehicles	3%	1%	-3%	6%	5%
Electrical Equip	0%	0%	-2%	0%	0%
Manufacturing	-7%	-4%	-16%	9%	17%
Construction	-6%	-3%	-8%	4%	10%
Electric Power	-8%	-4%	-15%	1%	-30%
Gas Distribution	-5%	-1%	-1%	0%	-20%
Water	5%	2%	8%	3%	0%
Wh&Ret Trade	2%	0%	-1%	-2%	-2%
Transportation	-12%	-3%	-8%	0%	9%
Communication	5%	3%	2%	11%	9%
Services	-1%	0%	0%	1%	2%
Total	-8%	-4%	-9%	1%	4%

3.4.7 Washington

The state of Washington represents another intermediate case in terms of both production structure and carbon intensity. For this reason, its downside risk and upside potential against WCI alternatives is about average, but there are still important choices for this state to make. In particular, without complementary policies, Cap and Trade will result in lower output growth for nearly every sector of Washington's economy. This "growth tax" for climate action can be averted, however, with determined commitments to demand side energy efficiency, yielding 4 percent additional aggregate output growth by 2020 and expansion in virtually every sector. Interestingly, the RPS option still promotes aggregate growth for the state in a Cap and Trade policy environment, but not as much as energy efficiency alone.

Table 15: WCI Overall Real Output by Sector
(percent change from baseline in 2020)

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	WCIGrp	WCIInd	Nat	EE	RPS
Agriculture	-5%	-9%	-10%	3%	6%
Coal	-5%	-9%	-7%	1%	4%
Oil&Gas	-3%	-5%	-6%	3%	5%
Food Processing	-5%	-9%	-16%	14%	18%
Wood&Paper	-6%	-11%	-13%	6%	10%
Refined Petroleum	-12%	-23%	89%	-2%	-28%
Chemicals	0%	-1%	-2%	1%	2%
Mineral Products	7%	12%	18%	2%	-1%
Metal Products	-6%	-13%	124%	5%	8%
Vehicles	-2%	-3%	-15%	8%	10%
Electrical Equip	-3%	-5%	-5%	-1%	0%
Manufacturing	-3%	-4%	-13%	11%	12%
Construction	1%	0%	3%	4%	4%
Electric Power	-11%	-19%	-13%	1%	-36%
Gas Distribution	-2%	-4%	4%	1%	-19%
Water	2%	4%	4%	1%	0%
Wh&Ret Trade	-1%	-2%	-6%	-3%	-2%
Transportation	-13%	-23%	-9%	-1%	7%
Communication	-8%	-13%	-25%	17%	23%
Services	-1%	-2%	18%	2%	2%
Total	-4%	-7%	6%	4%	1%

4 Arizona Background Review

Arizona is a state whose recent growth in population and economic activity have come at a time when there has also been a growth in environmental awareness. In the 1990s Arizona's population increased by 39%. Arizona's population has continued to outpace the National growth rate in the period since. This increase in people caused the amount of energy being used in Arizona to grow as well. The surge in energy demand is the driving force behind Arizona's greenhouse gas (GHG) emissions from electricity generation. [see table 1] Despite having the Nation's largest capacity nuclear power plant, Arizona's energy supply sector still accounts for over a third of Arizona's GHG emissions. "The Southwest is seeing rising demand eat into available supply. The Western electricity Coordinating Council estimates that the Southwest faces a roughly 1,000 MW shortfall in 2009."[15] The population boom has also lead to increased vehicle miles traveled (VMT) causing the transportation sector to become Arizona's leading GHG emitting sector. [see table 2] Together these two economic sectors account for nearly 80% of Arizona's emissions, leaving Arizona with a lot of work to do but with huge potential gains.

Arizona's desert climate poses a few challenges for the State in trying to cope with the effects of climate change. Arizona's temperamental climate can be seen as one of the major motivating factors behind Statewide efforts to curtail GHG emissions. Unfortunately for Arizona it already has a climate of intense storms and intense dry spells. Annually Arizona gets its precipitation in two seasonal periods, winter and summer. The precipitation in the summer comes in quick and unpredictable thunderstorms that dump loads of water in a concentrated area that can even cause local flooding. The winter precipitation falls from slow moving storms and usually in the form of snow. Currently Arizona is balanced between a period of precipitation made for storing water and another period prone to giving quick relief. As the effects of climate change begin to take off their impacts will mean chaos for Arizona's water supply and distribution mechanisms.

The State Government has recognized many of these symptoms and potential issues and has begun to look into the problem. Their largest scale effort has been to join the Western Climate Initiative (WCI) and join fellow Western Region States in an effort to investigate GHG mitigation policies. The goal is to one day have a regional cap-and-trade scheme in place for carbon emissions. Prior to the signing of the WCI Arizona had also signed agreements with New Mexico and Sonora, the Mexican state they share a border with, declaring cooperation and collaboration in investigating and implementing policies for the reduction of GHG emissions within the region. Arizona's biggest challenge is to slow down the current and predicted future growth of their GHG emissions. There is enough GHG stock in the atmosphere for climate change effects to already be felt, reducing the growth rate of future emissions is important for the reduction in severity of those effects.

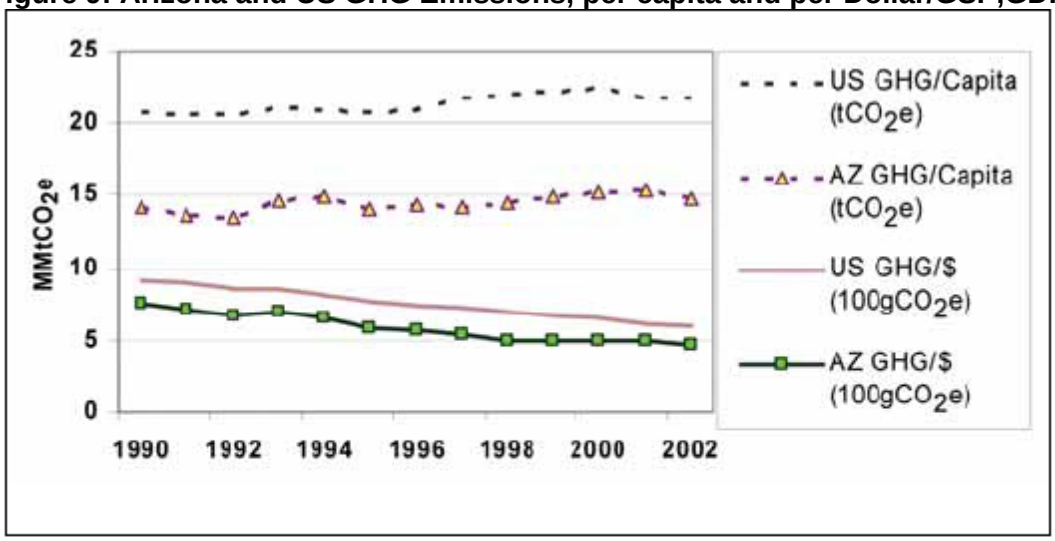
[15]Howland p.13

4.1 Current Evidence and Projected Climate Impacts

Emissions

In the year 2000 Arizona was responsible for 1.2% of the total GHG emissions in the U.S., approximately 82.3 million metric tons of net carbon dioxide equivalent (MMtCO2e).[16] This figure has since grown and is expected to continue growing in the near future. In fact from the time period from 1990 to 2005 Arizona's GHG emissions increased by 56%, up from 59.3 MMtCO2e to 92.6 MMtCO2e.[17] Estimates made by the Center for Climate Strategies (CCS) predict that Arizona's emissions will increase by 159% from 1990 to 2020 with a business as usual approach. The state as a whole increased their GHG emissions at a greater rate than the National average from 1990 to 2000, approximately 39% compared to 23%.[18] However, Arizonans are emitting less on a per-capita basis, 14 MMtCO2e per-cap versus the National average of 22 MMtCO2e per-cap.[19] [see figure below] This trend of lowering emissions more than the National average can be seen when considering emissions per unit of output as well. For the 1990 to 2002 period Arizona's emissions per unit of gross domestic product fell by 33%, while Nationally the figure fell by only 29%.[20] [see figure below].

Figure 9: Arizona and US GHG Emissions, per capita and per Dollar/GSP,GDP

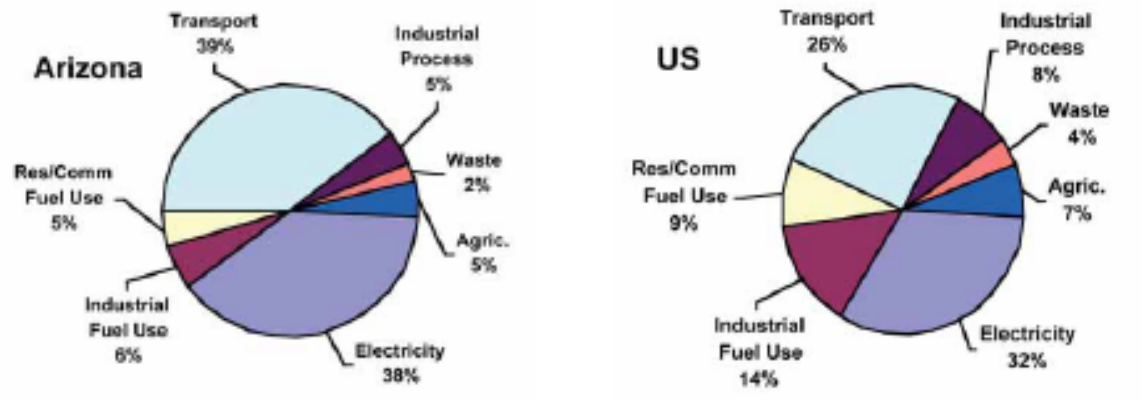


$MMtCO_2e$ – million metric tons carbon dioxide equivalent
tCO_2e – metric tons carbon dioxide equivalent
$100gCO_2e$ – 100 grams carbon dioxide equivalent

[16] Owens et al.
[17] Owens et al.
[18] Owens et al.
[19] Owens et al. Figure 3-1
[20] Owens et al. Figure 3-1

In 2000 the transportation sector accounted for 39% of Arizona's emissions, while electricity use contributed 38% of emissions. Industrial fuel use and industrial processes made up 11% of Arizona's emissions, with residential and commercial fuel use along with agriculture accounting for 10%. Landfills and waste management made up the remaining 2% of the state's emissions.[21] [see figure below]

Figure 10: GHG Emissions by Sector, 2000



The primary sources of emissions for Arizona are the transportation sector and electricity use, accounting for nearly 80% in 2000. 65% of Arizona's transportation emissions come from gas-powered vehicles, with 20% coming from diesel-powered vehicles, 10% from air travel with the remaining emissions coming from natural gas and liquified petroleum gas vehicles. Arizona's emissions from transportation increased by 3% annually during the 1990s.[22] This can be attributed to the fact that Arizona's VMT increased from 35 billion in 1990 to 50 billion in 2000, an increase of over 42% which lead to a 3.2% annual increase in gasoline usage and a 6.5% annual increase in diesel fuel use.[23] Even with these growth patterns, Arizona's gasoline use was still below the National average for 2000, 1.1 gallons per person per day versus 1.3 gallons per person per day.[24] The larger increase in diesel fuel use is evidence of the huge increase in freight traffic, causing major concern about the environmental impacts of Arizona's increased economic growth.

Compared to the National average, Arizona's emissions from electricity use represent a slightly higher share of the total. Arizona's electricity use accounts for 38% of their total

[21]Owens et al. Figure 3-2, to see forecast of sources for electricity generation see Figure 3

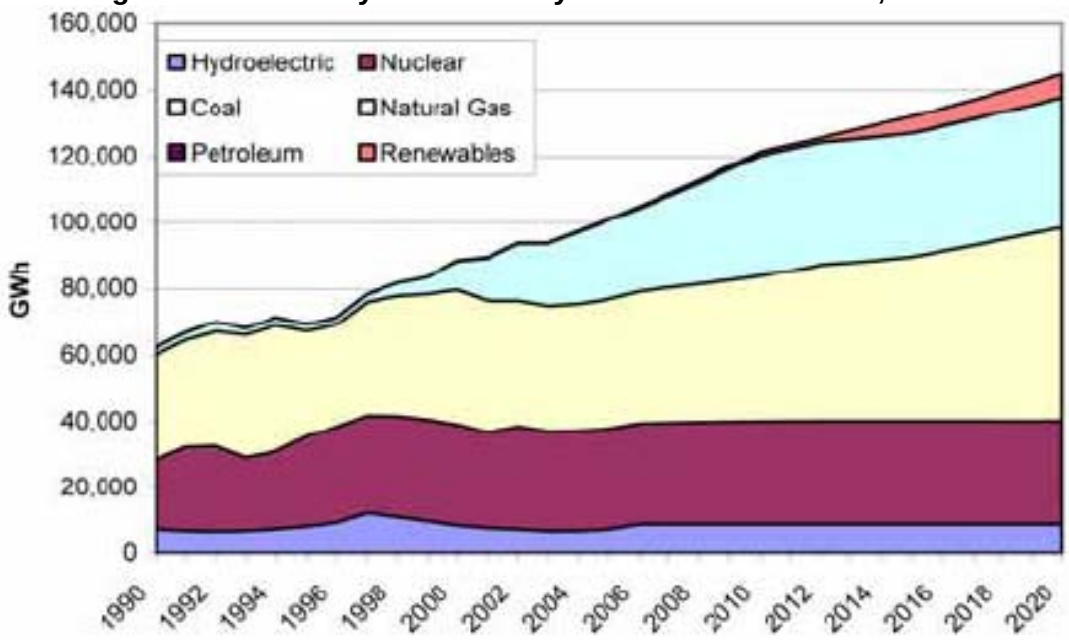
[22]Owens et al.

[23]Estimates based on U.S. Department of Energy, Energy Information Administration

[24]Estimate for U.S. national average based on U.S. Department of Energy statistics

emissions while the Nation's electricity use makes up about 32% of the total.[25] The average Arizonan uses the same amount of electricity as the average American, 12,000 kWh per person per year, but Arizona emits less GHG due to electricity use per person. The figures are about 6.7 tons of carbon dioxide equivalent per-capita (tCO2e per-cap) versus 8 tCO2e per-cap nationally in 2000.[26] Electricity demand grew by 4% annually during the 1990s for Arizona, while Arizona's emissions from electricity use grew by only 3.3%, reflecting a decline in emission per kWh.[27] [see figure below] This decrease in emissions per kWh is due in large part to increased use of natural gas-fired generation of electricity and nuclear generation of electricity.[28] In February 2008 Arizona generated 40% of its electricity from burning coal, but 52.5 % of Arizona's electricity generated in February 2008 came from natural gas and nuclear sources.[29] [see table 3] The statistics above are based on electricity used by Arizonans and are not based on emissions associated with electricity produced within the state's borders. In the year 2000, Arizona produced 23% more electricity than was consumed by the people of Arizona and that much was exported to nearby states for their electricity use.[30] [see figure 12] Consumption based numbers are typically reported in order to avoid double counting, since importers of electricity should be including the emissions associated with the generation of their imported electricity in their state's electricity use data.

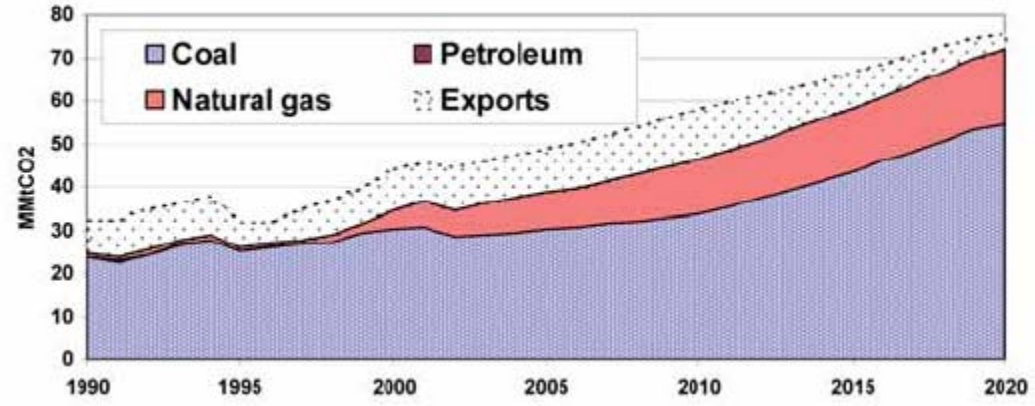
Figure 11: Electricity Generated by Arizona Power Plants, 1990-2020



Source: Owens et al.

[25]Owens et al.
[26]Owens et al.
[27]Owens et al.
[28]Owens et al.
[29]U.S. Department of Energy
[30]Owens et al. Figure 6-2

Figure 12: Emissions from Electricity Consumption and Exports, 1990-2020



Source: Owens et al.

Temperature & Health

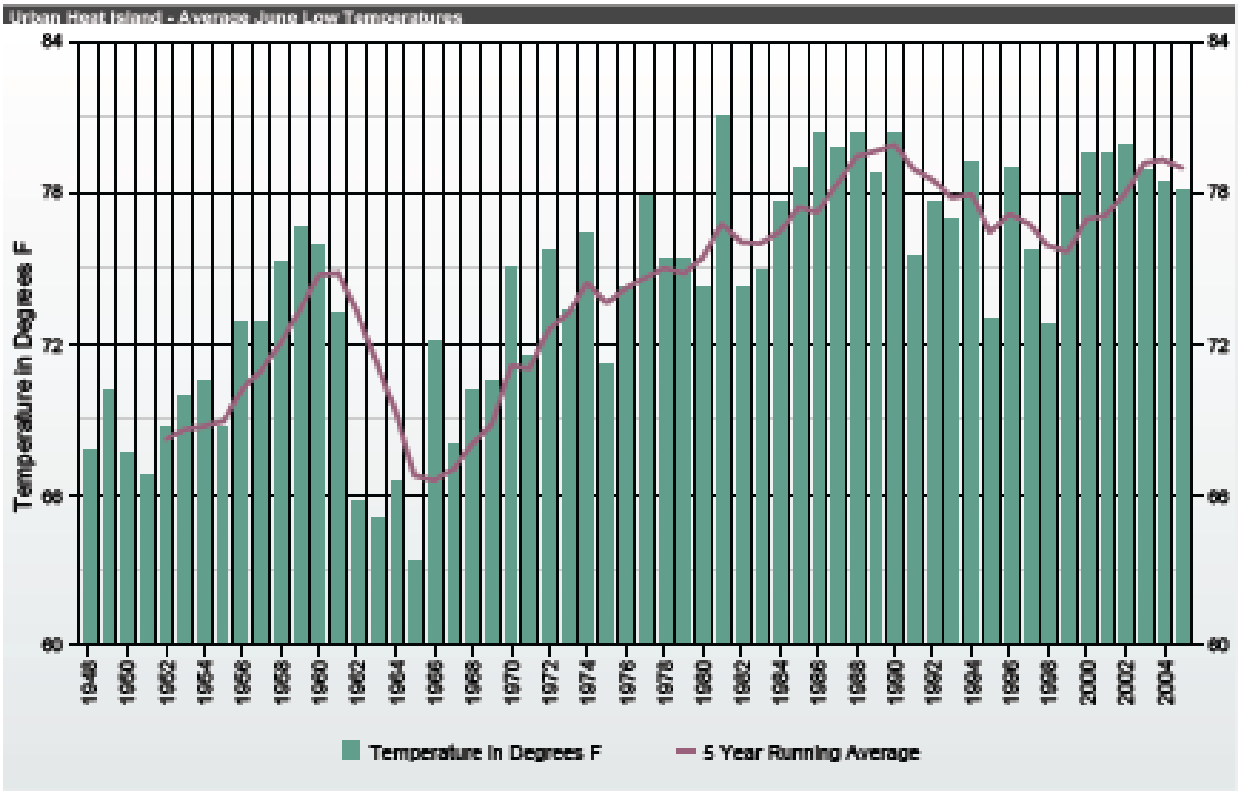
Over the past century Arizona has experienced a general warming trend. In fact the average temperature in Arizona has increased by 3.6 degrees Fahrenheit (EF) over the past 100 years. The average June low temperature for Arizona has increased from 70.5EF in 1954 to 78.5EF in 2004.[31] [see figure below] This trend is expected to continue into the future. As estimated by the Intergovernmental Panel on Climate Change (IPCC), using the HadCM2 model, Arizona's temperatures are projected to increase by 3-4EF in the spring and fall season and by 5EF in the winter and summer seasons by the year 2100.[32] These projections have predictions ranging from 1-6E for spring and fall and 2-9E for winter and summer.

The increase in average temperature causes many health concerns. Public health concerns range from issues of increased respiratory disease, heat related deaths and water-borne diseases. Increased ground-level ozone is associated with respiratory diseases such as asthma, reduced lung function and respiratory inflammation. In 2002 six out of ten data stations, in Maricopa County, reported that ground-level ozone levels exceeded 0.08 parts per million (the EPA set indicator level).[33] This could have influenced the rate of hospitalization for asthma in the Phoenix area, which for 2002 was 1.46 per 1,000 hospitalizations.[34] Arizona's increasing temperatures have also been affecting the number of heat related deaths in the state. The

[31]"Arizona Indicators" Arizona State University
[32]"Climate Change and Arizona" U.S. EPA
[33]"Arizona Indicators" Arizona State University
[34]"Arizona Indicators" Arizona State Univesity

number of deaths from exposure to excessive natural heat totaled ten in the year 1992, then jumped to 119 deaths in 2002.[35]

Figure 13: Temperature Trends



Precipitation & Water

Along with these temperature projections, the IPCC expects to see a continuation of the trend in the amount of precipitation Arizona receives. Over the past century precipitation has increased by 20% for most parts of the states, except the Northwest where precipitation has decreased by 20%.[36] [see figure below] The application of the HadCM2 model by the IPCC resulted in the projection of increased precipitation in the spring by 20%, 30% in the fall and 60% in the winter, with only a slight decrease in the summer ranging from 0-15%.[37] The expectations are that the amount of precipitation on extreme wet or cold days will likely increase, and the intensity and frequency of winter storms are also expected to increase. If Arizona does experience these changes in weather pattern the results will be very concerning.

[35]Mrela Department of Health Services
[36]"Climate Change and Arizona" U.S. EPA
[37]"Climate Change and Arizona" U.S. EPA

According to the Arizona Department of Water Resources the State's watersheds are experiencing severe drought conditions.[38]

Figure 14: Precipitation Trends Since 1900

Source: Karl et al. (1996)

Droughts are naturally reoccurring events in Arizona's desert climate, but with the population growth experienced since the 1990s the increased demand has put an incredible strain on an already scarce resource. In 2006 Arizona used about 7.2 million acre feet of water, 78% of which was used by agriculture, 18% used by residential and municipal consumers with the rest going towards industrial usage.[39] Arizona receives most of its water from precipitation that occurs during the cool winter months. During this time precipitation falls from slow moving storms that allow water to soak into the soil and replenish aquifers or reservoirs.[40] Arizona receives additional water during the winter months as snow falls and stores water until later in the year when temperatures rise. Arizona's other rainy season occurs during the warmer summer months, during this time precipitation is often the result of a strong thunderstorm that moves fast and is very intense.[41] Precipitation falls so fast and in such great amounts that water

[38]"Arizona Drought Preparedness" Arizona Department of Water Resources
[39]"Arizona Drought Preparedness" Arizona Department of Water Resources
[40]"Restructuring Past Climate..." University of Arizona
[41]"Restructuring Past Climate..." University of Arizona

usually runs off the land's surface before plants can absorb it, the water is then subject to high evaporation rates that go along with Arizona's intense summer heat.[42]

Arizona's desert climate is already in a delicate balance between winter and summer precipitation and year long demands. With a warmer climate and these projections Arizona's winter will see less snow fall and more winter rain, leading to faster and earlier snow melt. Less water stored in the mountains means less water available for summer irrigation. When temperatures increase in the summer months, thunderstorms will get more intense and evaporation rates will increase. Arizona will be faced with a situation where the state will be getting more water ready for use in the winter, when water is already relatively abundant, and less water in the summer due to evaporation increases and precipitation declines. A study done by the School of Geological Sciences at Arizona State University concluded that Arizona's streamflows will be declining in the near future.[43] The team of researchers used different emissions scenarios from the IPCC and six global climate models to estimate water runoff for Central Arizona. And while each model gave them a range of estimates they concluded that there is an 85% chance of lower river and lake levels around mid-century.

Ecosystem & Biodiversity

These changes to the water cycle and seasonal temperatures could shock many of Arizona's diverse ecosystems. Arizona is filled with "landscapes [that] include a host of environments ranging from Alpine tundra...to Sonoran Deserts...These climatic conditions have given rise to some of the most interesting and unique species as well."[44] The CCS has estimated that Arizona's previous level of native forest cover was 155,000 acres. The U.S. Forest Service estimates that between 1985 and 2002 Arizona's forests sequestered around 6.7 MMtCO2e per year, on average.[45] Another study, done by the U.S. EPA, suggests that Arizona's forests could decline by as much as 15-30%.[46] Arizona's narrow strips of riparian vegetation are extremely important to local wildlife and would be adversely impacted by the altered timing in the water cycle and the hotter temperatures. Hotter and drier temperatures in the spring and summer months could increase the frequency and severity of wildfires. Additionally milder winters could increase pest population levels. This could also increase the chances of wildfires as the insect outbreaks would leave behind more dead fuel for fires.[47] More wildfires would mean the destruction of many forested areas which are the habitat for much of Arizona's wildlife and plant species. There are over 2,000 plant species that thrive in the border

[42]"Restructuring Past Climate..." University of Arizona
[43]Ellis et al.
[44]"Arizona's Natural Heritage" Arizona Game and Fish Department
[45]Based on U.S. Forest Service estimations
[46]"Climate Change and Arizona" U.S. EPA
[47]"Climate Change and Arizona" U.S. EPA

region of Arizona, New Mexico and Mexico, accounting for nearly 10% of all species found in the United States.[48]

Aggregate Economy

Also limiting the acreage of habitat for Arizona's native species is the agriculture industry. In 2005 Arizona's agricultural output was worth $3.6 billion.[49] The industry was made up of crops, livestock and services/forestry. For 2005 crops accounted for $1.66 billion, roughly 45%. Livestock output was worth $1.45 billion, 39% and services/forestry earned about $500 million or 15%.[50] In 2002 Arizona had over 36% of its total land area dedicated to farmland, about 26.59 million acres, 23.24 million acres were dedicated to pastureland and 1.26 million acres to cropland. Of that 1.26 million acres 70%, or about 887,000 acres, was irrigated.[51] [see table 4] For the year 1998 the major crops for Arizona were cotton, wheat and hay. The increased temperatures could reduce cotton yields by 5-11% and decrease wheat yields by as much as 70%.[52] These changes in yields will influence farmers' decisions to plant. In fact Arizona farmers have already switched away from planting wheat, by 2006 the crop was only the 13th highest income earning crop. [see table 4] The increased temperatures are expected to increase the yields of hay and of Arizona's pastureland by 3-12%.[53] In 2006 the top five agricultural commodities were cattle/calves earning 25.6% of total state receipts, dairy products 17.5%, lettuce 13.5%, cotton 5.9% and hay 5.0%. [see table 4] The good news for Arizona is that the amount of farmed acres fell from 1992 to 2002, down from 35 million to less than 27 million, and the state also saw a reduction in the total acreage irrigated to about 19 million acres, down from 23.5 million acres.[54] While temperature's impact on agricultural output may be ambivalent, the other effects of climate change will decrease profitability. Agriculture currently uses well over two thirds of Arizona's water resources, and with increasing residential demand and contracting supply in the future the fight for water will surely effect agricultural output negatively. With less farmland in use and less water available for irrigation Arizona's farmers will need to be very careful about the crops they plant or adopt incredible yield maximizing technologies to continue producing at the same levels of output.

The increase in population experienced by Arizona in the past two decades has also meant an increase in th amount of energy demanded. Both in the form of electricity for households and fuel for transportation. It also means an increase in the demand for jobs. The ideal situation would have the job creation come from a statewide effort to increase their energy efficiency. One area of energy efficiency being looked at is the increased use of alternative

[48]"Climate Change and Arizona" U.S. EPA
[49]Parker U.S. Department of Agriculture
[50]Parker U.S. Department of Agriculture
[51]Parker U.S. Department of Agriculture
[52]"Climate Change and Arizona" U.S. EPA
[53]"Climate Change and Arizona"U.S. EPA
[54]Parker U.S. Department of Agriculture

fuels. This not only has the effect of reducing GHG emissions per VMT but also means the creation of another industry. The CCS estimates that a 50 MMgal/year ethanol plant would equal the creation of 70 jobs. If Arizona implemented requirements for ethanol use and continued to increase those requirements it could create over 1,000 new jobs in the ethanol production industry alone. The creation of a new industry is not the only means of job creation. Many of the emissions reduction policies being considered would require the development of many support policies that could create employment as well. Jobs like retraining building contractors, architects and inspectors in the new energy efficient building codes would be created. Staffing of outreach programs to educate businesses, policy makers and the general public about the benefits of energy efficiency would be required. The population's health will only negatively effect Arizona's economy if the work force is hampered by increased heat related diseases, respiratory illness or water-borne diseases. So while climate change impacts may adversely affect certain employment sectors, the overall heath of Arizona's workforce should remain relatively strong. Arizona's population growth may be driving GHG emitting practices upward, but those same people can be employed to lead the statewide effort to reduce the effects of those actions.

The loss of ecosystems will also negatively effect Arizona's Economy. In a state that is well endowed with natural beauty and blessed with a successful tourism industry the increased threat of wildfires and constriction of forestland will mean less options for wilderness seekers. Many parts of Arizona are still rural and depend on tourism to support their local economy. In a study done at the University of Northern Arizona, researchers found that of the $21 million brought in by tourism, specifically rafting in the Grand Canyon, less than 50% remained within the local community.[55] Hjerpe and Kim concluded that, although the rafting industry brought about plenty of good to the Grand Canyon National Park region and the rural economy surrounding it, Arizona should look to limit future growth of the recreational use of the Colorado River. They cited huge leakage amounts and low wages as reasons to temper recreational development in rural economies. While rafting and other recreational uses of resources are considered non-extractive and sustainable, Hjerpe suggests that a better understanding of the factors limiting the benefits of recreational tourism will lead to a better development plan for the future. In early April, the Wall Street Journal printed an article that credited an above normal snow pact with boosting Arizona's extractive river industry, fishing.[56] The 2008 wet weather was enough to pull Arizona out of drought conditions for the first time this decade. And while the extreme wet conditions brought on by climate change may be benefitting Arizona's fishing industry now, the predicted extreme fluctuations may hurt fishing in the future.

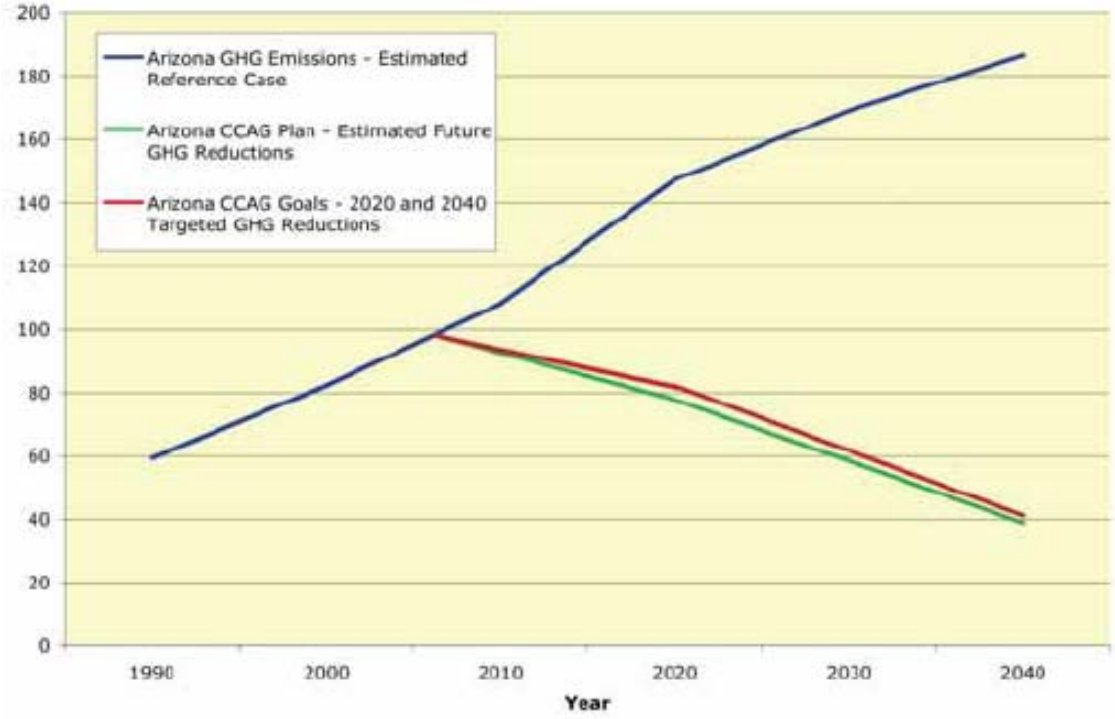
[55]Hjerpe
[56]Calton

4.2 Climate Policies

4.2.1 Government Level Policies

Arizona's State Government has some existing policies in action designed to enhance the knowledge base surrounding climate change, its impacts on Arizona, and possible measures that can be adopted to reduce those impacts. Additionally Arizona has implemented some measures aimed at reducing practices that contribute to climate change in the State of Arizona. Arizona turned its legislative attention towards the Climate Change issue back in 2005. Governor Janet Napolitano signed Executive Order 2005-02 on February 2, 2005. The order established the Climate Change Advisory Group (CCAG), a 35 member organization coordinated by Arizona's Department of Environmental Quality (ADEQ). The group's first task was to prepare an inventory and forecast of Arizona's GHG emissions. The second task was to develop a Climate Change Action Plan with policy recommendations aimed at reducing Arizona's emissions. [see figure below] Governor Napolitano then focused on increasing the regional effort in the fight against climate change. The Governor's office signed two agreements with the State Governments of New Mexico and Sonora, the Mexican State that Arizona shares a border with. The Southwest Climate Change Initiative and the Arizona-Sonora Regional Climate Change Initiative were declarations of cooperation.[57] All three State Governments pledged to develop a regional inventory of GHG emissions and to coordinate their efforts in identifying emission reduction opportunities within the region.[58]

Figure 15: Arizona Emissions Trajectory



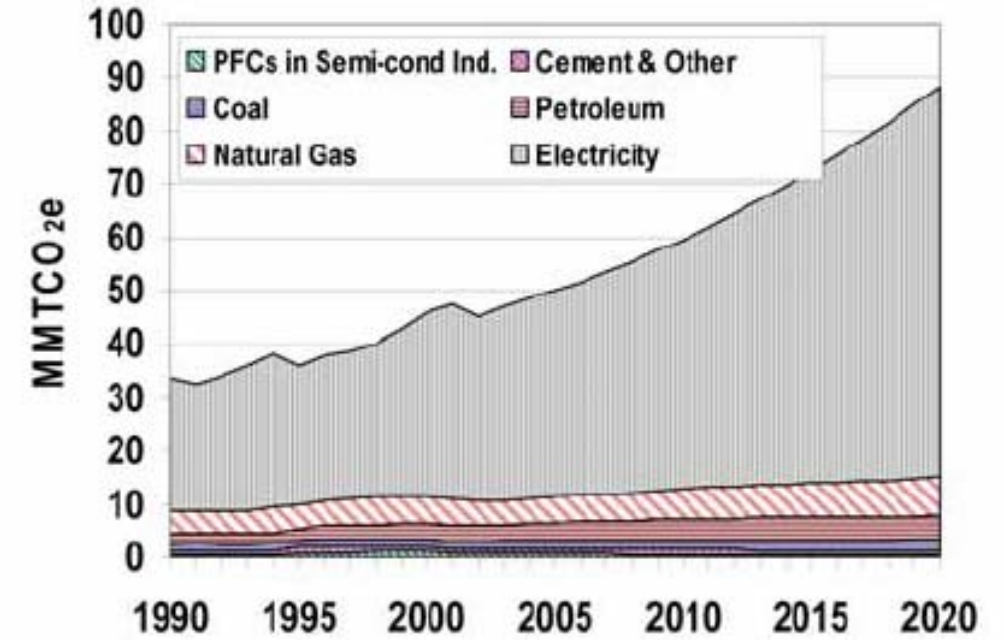
[57]Napolitano Southwest Climate Change Initiative
[58]Napolitano Arizona-Sonora Regional Climate Change Initiative

Less than a month after the CCAG issued its Action Plan the Governor signed Executive Order 2006-13.[59] In addition to establishing the Climate Change Executive Committee, charged with advising the Governor's office on strategies for implementing the policy recommendations made by the CCAG, the order also issued five directives to be carried out by Arizona's State Government to assist in reducing the statewide GHG emissions.[60] The ADEQ was ordered to develop a GHG reporting mechanism and establish a multi-state registry. The ADEQ and the Arizona Department of Transportation (ADOT) was ordered to adopt and implement the Clean Car Program. The Arizona Department of Weights and Measures was ordered to develop standards for biodiesel and ethanol sold in Arizona. ADOT was also ordered to implement a pilot program for hybrids in the high occupancy lanes on Arizona freeways. And all state departments were to convert all state vehicles to low-GHG-emissions vehicles.[61] The boldest statement made against climate change by Executive Order 2006-13 was the establishment of a state wide goal for reducing GHG emissions. The goal set by the Governor's office was determined by the WCI agreements made by the participating states, to reduce regional GHG emissions to 15% below 2005 levels by 2020, and for Arizona to reduce its statewide emissions to 2000 levels by 2020 and 50% below 2000 levels by 2040.[62] Less than six months after the CCAG's report was released Governor Napolitano signed two more initiatives requiring State Departments to follow recommendations made by the CCAG. Executive Order 2007-02 required ADOT to compile a list of mass transit options for Arizona.[63] Signed on the same day, Executive Order 2007-05 required the State to create a smart growth and development process complete with an implementation plan.[64]

In addition to these existing strategies to help reduce GHG emissions in Arizona, the State is looking at ways to implement more policies which should improve their efforts towards mitigation. Arizona's umbrella stance on GHG emissions to reduce statewide emissions to 2000 levels by 2020 is a very aggressive yet achievable goal considering the state's economic and population growth. To obtain this goal Arizona is working with other states in the region to establish a GHG reporting mechanism as well as a regional GHG registry.[65] The establishment of these two applications will allow for better monitoring, management and credit distribution of GHG emissions. Arizona's State Government is also focusing on creating better public awareness about climate change, and the effort needed to ensure long-term success of mitigation, through an extensive education and outreach program.[66]

[59]Napolitano 2006-13
[60]Napolitano 2006-13
[61]Napolitano 2006-13
[62]Napolitano 2006-13
[63]Napolitano Expanding Arizona's Transportation Options
[64]Napolitano Promoting Smarter Growth
[65]Owens et al.
[66]Owens et al.

Figure 16: Historical and Projected Residential, Commercial, and Industrial GHG Emissions, 1990-2020



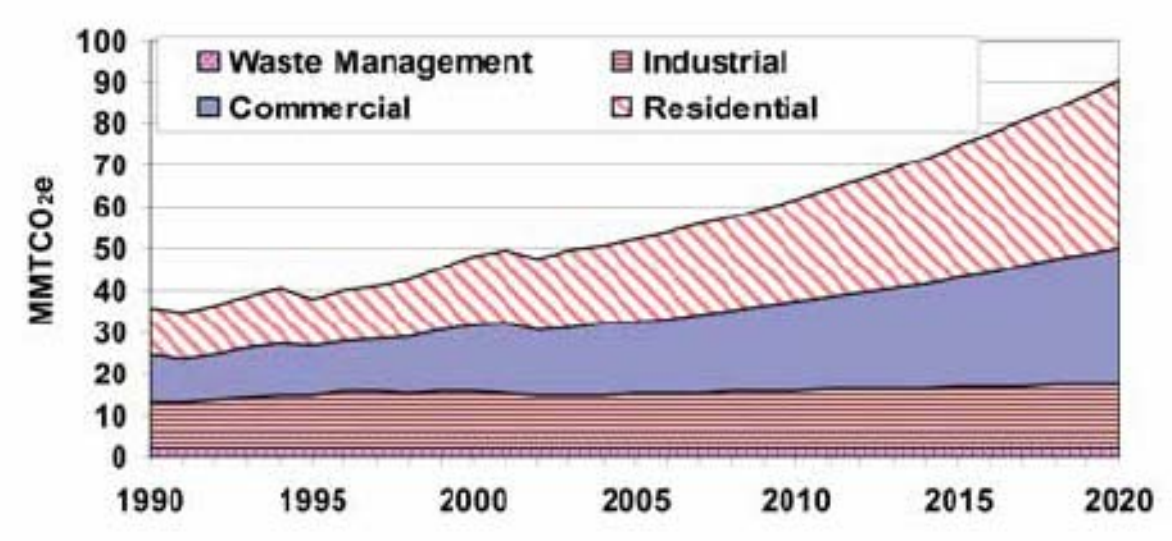
Source: Owens et al.

Reaching the public and creating a social sense of responsibility will be very crucial for Arizona. With the population growth, and increased emphasis on the commercial sector, the electricity consumption trends are staggering. The emissions associated with electricity and natural gas consumption in 2020 are projected to be twice the levels they were in 2000.[67] [see figure above] The State's strategy for offsetting these increases in consumption is to set demand-side efficiency goals while establishing funds, incentives and programs to aid in the achievement of those goals. Proposed energy savings targets are to reach 5% savings by 2010 and 15% savings by 2020, while the suggested utility spending target is set to 1.5% of gas utility revenues on energy efficiency programs by 2015.[68] Another option being considered to influence residential and commercial decisions is to adopt some policies that show the state and local governments to be leading by example. Updating and enforcing stricter building codes and implementing an enhanced state building energy savings goal is an attractive lead by example policy option. The State could also adopt the 2004 International Energy Conservation Code and innovative features of California's Title 24. These are particularly tempting options considering Arizona's growth and long lifetime of buildings.[69] Arizona is also attempting to encourage the implementation of distributed generation with clean combined heat and power systems (DG/CHP systems). "DG/CHP systems can improve the overall efficiency of fuel use as well as electricity systems benefits."[70] There are many advocates of adjusting the price structure for

[67]Owens et al.
[68]Owens et al.
[69]Owens et al.
[70]Owens et al. p. 69

electricity use. “The CCAG recommends that changes in Arizona electricity pricing and tariffs be designed to provide improved incentives for end-users to adjust timing of energy use so as to reduce greenhouse gas emissions as much as possible.”[71] Arizona also believes that a two-part approach should be taken to promote demand-side fuel switching. First by promoting switching to lower-carbon fuels and then by setting targets of lower-carbon fuel use, through the promotion of solar water heating and the substitution of biodiesel for diesel in commercial and industrial equipment. There are many fuel switching opportunities in Arizona including the use of natural gas instead of electricity for thermal end-uses or instead of coal for industrial uses, biomass fuels instead of electricity for thermal end-uses or instead of diesel for commercial and industrial equipment or even solar thermal energy in place of electricity.

Figure 17: GHG Emissions by Sector, 1990-2020



Source: Owens et al.

The State is also considering many policy options to reduce GHG contributions from their Agriculture and Forestry Sector. The primary opportunities for emissions reductions include the production of renewable fuels, beneficial use of forest biomass, control and utilization of methane from dairies, protection of forest and agricultural land from conversion to development uses and the restoration of forest land.[72] Arizona has looked deeply into manure digesters and energy capture technologies for use on the state’s dairies. Arizona has suggested a modest goal of using manure digesters to cover 15% of the state’s dairies by 2010 and increasing that proportion to 50% by 2020.[73] In an effort to provide incentives for the production of ethanol to offset the use of fossil fuels Arizona has suggested three production goals. The first goal would more than double Arizona’s current levels of ethanol use by the year 2010. The second two goals were suggesting that the State of Arizona fall in line with New Mexico’s alternative

[71]Owens et al. p. 70
[72]Owens et al.
[73]Owens et al.

fuel/ethanol use goals by 2020 and 2040.[74] Arizona has also taken steps to identify marginal agricultural land and is trying to convert those lands to permanent grassland or forest cover. These actions would increase the soil carbon content and above-ground carbon sequestration throughout the state.

4.2.2 Energy Supply Sector

Arizona's energy supply sector is wonderfully endowed with renewable resources that have yet to be fully utilized. The state's most plentiful resource is solar energy, and Arizona has a significant opportunity in the commercialization of solar technologies. Solar photovoltaic has been successfully commercialized for certain applications, but in order for the technology to provide baseload power a cost-effective storage technology is required. Concentration Solar Power (CSP) is a developing technology that is almost ready for commercialization, currently some CSP applications can provide power for up to six hours after sunset.[75] In order to reduce GHG emissions from Arizona's energy supply sector the State has considered a few policy options. The Arizona Corporation Commission set a renewable energy standard in 2006, that required utilities to get at least 15% of the electricity they sell from a renewable source by 2025.[76] Some of Arizona's electro utilities are already upgrading their energy portfolio to be more environmentally friendly. The Arizona Public Service (APS) utility unveiled plans to build a 280-megawatt solar power plant outside of Phoenix. APS has signed a contract that will allow them to purchase all of the new facility's output, which is scheduled to begin producing electricity in 2011. This source of solar energy would give APS more solar electricity per customer than any other U.S. utility.[77] The State is also thinking about setting a carbon intensity target, basically a limit on the ratio of carbon emissions to a measure of output, either a dollar amount or megawatt hours for sectors like electricity supply. Overall Arizona's legislature is considering adopting an Integrated Resource Planning (IRP) process. Essentially a process that would incorporate demand-side technology and policy with the more traditional supply-side options in order to meet anticipated future demand growth. Arizona is also trying to regionally coordinate mitigation efforts to ensure faster dissemination of information and create a clearer market signal. Arizona along with other Southwestern States are trying to coordinate the provision of direct financial incentives that would encourage investment in renewable energy facilities. The WCI and its members are also trying to regionally coordinate the implementation of a cap-and-trade system that would not only lower emissions but also allow it to occur more cost-effectively. Arizona and the Southwest region are also attempting to remove any and all barriers to renewable energy sources and clean distributed energy generation.

In addition to all the efforts being made by Arizona's State Government, the Arizona Utilities are also getting in on the act of providing incentives for the promotion of clean

[74]Owens et al.
[75]Owens et al.
[76]Truini
[77]Truini

technologies. There are three major electro utilities in Arizona, all of them have numerous programs and policies aimed at inducing adoption of more energy efficient technologies. Each utility has done a great job of developing individual programs and incentives for their own customers, but their collaboration through their involvement in the Southwest Energy Efficiency Project (SWEEP) has allowed them to promote energy efficiency in a much more effective way. SWEEP is a non-profit organization that works within Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming to promote energy efficiency in the Southwestern region.[78] SWEEP works in collaboration with utilities, state agencies, businesses, environmental groups and elected officials in order to conduct research on cost-effective energy efficiency policies and practices while educating consumers and businesses regarding energy efficiency opportunities, and ultimately promoting state-of-the-art building codes trying to get them signed into law.[79] APS is the largest utility in Arizona, serving 1.1 million customers.[80] It sponsors programs like APS Energy STAR Homes, APS Photovoltaics and the APS Solar Water Heating Systems. Tucson Electric Power (TEP) sponsors the Guarantee Home Program, the TEP Sun Share Program and a Low-income Weatherization measure. The Salt River Project (SRP) is the other major utility in Arizona and sponsors the Power Wise Homes Programs, the Earth Wise Solar Energy Program and the Power Wise Cool Cash Rebate Program. All three major utilities seem to agree that an incentives program for new home builders is essential, all three also have a solar power promotional program and each utility provides assistance for appliance upgrades and household maintenance.

4.2.3 Transportation Sector

As we have noted, the transportation sector is a huge contributor to Arizona's GHG emissions. Key determinants of transportation emissions are the technologies and fuels used, along with population and economic growth. Of the 35 MMtCO2e emitted by the transportation sector in 2000, 97% was carbon dioxide emissions from fuel use, the other 3% was mostly nitrous oxide emissions from gasoline engines.[81] ADOT expects VMT to grow faster than the population and they predict a rapid growth in freight VMT because of the economic growth and cross-border trade.[82] The primary actions needed to reduce emissions from the transportation sector include improving vehicle fuel efficiency, substituting towards lower-emission fuels, modal switches to lower-emissions means of travel and various strategies to decrease the growth of VMT. Arizona's legislature is seriously considering adopting the State Clean Car Program and the stronger set of standards for new cars and light trucks applicable in California. The State legislature is also juggling many different ideas centered around the development of mixed-use land around transit stops so that people can meet their daily needs for travel with a number of different transit options, either by foot, bicycle or public transit.

[78]Southwest Energy Efficiency Project
[79]Southwest Energy Efficiency Project
[80]Truini
[81]Owens et al.
[82]ADOT Arizona Transportation Research Center

Arizona feels that hybrid vehicle sales are currently constrained by the supply side, an inability of auto manufacturers to keep up with an already existing demand.[83] Assuming manufacturers respond to this demand, and they will, the promotion of hybrid vehicles through incentive programs will likely have a very positive effect on consumer purchase behavior. It is this same logic that has lead the State to consider a variety of strategies to promote the sales of hybrid gasoline-electric power train vehicles. Some of their ideas have included reductions in fees and taxes and giving hybrid vehicles preferential infrastructure access to carpool lanes or metered parking. Arizona is also looking to set up a few studies on experimental programs, such as a pay-as-you-drive insurance coverage program and a "feebate" program, essentially establishing fees for lower fuel economy vehicles and rebates for high fuel economy vehicles. Arizona is also trying to develop and implement a State standard for biodiesel, ethanol, and biodiesel and ethanol blends in order to ensure fuel quality and better vehicle performance.

Beginning with the model year 2007, the federal emission standards for new heavy-duty diesel vehicles were improved, the sulfur content of diesel was also lowered from 500 parts per million to 15 parts per million.[84] In anticipation of those measures Arizona began implementing incentives to accelerate the replacement and retirement of the highest-emitting diesel vehicles. Arizona also attempted to reduce idling from diesel and gasoline heavy-duty vehicles and buses through a combination of anti-idling ordinances and the promotion of heavy-duty vehicle idling reducing technologies. The technologies included truck stop electrification, auxiliary power units, automatic engine shutdown/start-up systems controls and direct fired heaters.[85] The State legislation is also debating the benefits to reducing the speed limit for commercial trucks to 60 mph on all Arizona highways and freeways.

4.2.4 WCI Participation

Arizona's most advanced and comprehensive work towards a climate change solution has been through its participation in the WCI. As one of the original five states, Arizona has taken the steps necessary for WCI membership. Arizona has set a state goal within the WCI regional goal for emissions reductions and has joined the Climate Registry. The WCI regional goal is to reduce aggregate GHG emissions to 15% below the 2005 level by 2020. Arizona has set their state goal to reduce statewide GHG emissions to the 2000 levels by 2020 and to 50% below the 2000 levels by 2040.

Arizona and the other WCI members currently hold regular meetings and teleconferences via Arizona's Department of Environmental Quality. Arizona's participation in the Climate Registry is crucial for establishing accurate and meaningful reporting of emissions across North America. The Climate Registry is currently developing standard protocol for the reporting of emissions, a vital process that must be completed before implementing any sort of market mechanism for the pricing of carbon.

[83]Owens et al.
[84]Richards
[85]Owens et al.

Arizona has a lot to gain from its participation in the WCI. As a state with huge potential for improvement, especially in the energy generation sector, it can influence the procedures that become standardized regionally and nationally. By participating early and forming close working relationships with other states looking to "clean up" their industries as well, Arizona can be on the cutting edge of cost-effective techniques and technologies. Arizona is also in a unique position to capitalize on its strong nuclear and solar power technology potential. If a cap-and-trade system is implemented in North America, Arizona could potentially profit from staying under the cap by increasing its use of their nuclear and solar capacity to generate energy.

4.3 Conclusion

Arizona is a state that has recently experienced big growth rates in both population and economic output. In the 1990s Arizona was booming growing faster than the Nation, increasing their population by 39%, while the U.S. grew by just 13% during that decade. Perhaps as a cause or simply a correlation, Arizona also experienced an economic growth rate that was greater than the Nation during the 1990s as well. Arizona's output grew by 63% on a per-capita basis while the U.S. economy grew by 52% during the decade. And even though Arizona was outpacing the U.S. in growth rates the state experienced larger reductions in GHG emissions on both a per-capita and per unit of gross product basis. Most attributed this trend to Arizona's electricity sector which receives less electricity from coal sources (46% versus 52%) and more electricity from renewable sources, like nuclear, hydro and other renewables, (44% versus 29%) compared to the national average, for the year 2000.

Arizona certainly can feel proud that their population and economic growth experience resulted in the types of emissions increases as it did, comparatively. That still does not change the fact that Arizona increased its demand for energy, and did it in a big way. "Some power supply for Arizona, the second fastest growing state in the U.S., may [soon] come from other states."[86] Fortunately Arizona's State Government recognizes that emissions growth rates similar to the past are not even an option going forward. And an attitude and culture dedicated to the reduction of emissions has been adopted in Phoenix. The bottom line is that Arizona creates 77% of its total GHG emissions from two sectors, energy supply and transportation. Two sectors, interestingly enough that have felt huge increases in demand since the 1990s. It is clear that Arizona's growth up to this point has not and will not be sustainable. The good news is that the State has two sectors it can focus its policies on to achieve huge gains in emissions reductions.

The principle means of reduction for both sectors is improving energy efficiency, then substituting away from high-GHG emitting fuels and sources of energy towards lower-emitting energy sources. Arizona is in a unique position to gain a first mover advantage in the development of solar technology. Stirling Energy Systems, of Phoenix, has already signed 20

[86]Howland p.14

year contracts to provide 900 and 850 megawatts to two Southern California utilities, accounting for nearly six times the utility-scale solar power being produced in the U.S. today.[87] Arizona's desert and intense sun make it the perfect state for research and development into solar technology. Arizona is also the home of the largest capacity nuclear power plant in the U.S.. If Arizona can take advantage of these endowments they can be first in line to ride the huge swell of energy efficiency demand when it hits.

Arizona's government has been very forward thinking and this is the first step to big success. Before the signing of the WCI, Arizona had their own Advisory Group recommending that they pursue many of the avenues that the WCI has come to take. Because of the nature of climate change and the inherent regional impacts, it benefits everyone to be working with like-mind states in similar situations. The policy options become more effective, technology transfers become easier and everyone benefits from the relationship.

5 California Background Review

The cost of neglecting environmental sustainability is not zero. The longer California and other States of the Western Climate Initiative (WCI) delay environmental protection, the more costly the impacts of climate change will become. California has already established itself as a leader in climate change policy, and WCI participation will allow California to expand its sustainable development programs both within the state, and within all states participating in the WCI, improving technological advancement and reducing emissions for the entire western United States. This paper outlines the expected impacts of climate change according to the latest projection scenarios, and highlights a number of potential and existing policies that will help curb these impacts.

5.1 Current Evidence and Projected Climate Impacts[88]

From the most general perspective, our review of research on climate risk suggests three findings:

1. At the aggregate level, California has the economic capacity to adapt against foreseen climate risk, but doing so effectively will require better information and policy

[87] Woody

[88] Discussion in this section is excerpted from a much more exhaustive California Climate assessment produced by Kahrl and Roland-Holst:2008b.

determination. Our estimates indicate that Climate Risk, damages if no action is taken would include tens of billions per year in direct costs, even higher indirect costs, and expose trillions of dollars of assets to collateral risk. Climate Response, on the other hand, can be executed for a fraction of these net costs by strategic deployment of existing resources for infrastructure renewal/replacement and significant private investments that would enhance both employment and productivity.

2. At the sector level, there will be some very significant adjustment challenges, requiring as much foresight and policy discipline as the state can mobilize. In this context, the political challenges may be much greater than the economic ones. The state's adaptation capacity depends upon flexibility, but divergence between public and private interests may limit this flexibility.

3. Despite the extent and high quality of existing climate research reviewed in this document, the degree of uncertainty regarding many important adjustment challenges remains very high. This uncertainly is costly, increasing the risk of mistakes, including deferral of necessary adaptation decisions. To further improve understanding of climate effects may itself be costly and difficult, but policy makers must have better visibility regarding risks and response options.

Thus California can respond to climate risk by developing effective strategies for Climate Response, including defense (against adverse impacts like rising sea level) and adaptation (shifting to more sustainable growth patterns). A real commitment to this would begin immediately by establishing and extending capacity for technical assessment and policy analysis, followed by timely and sustained policy activism. California's historic AB32 initiative is a positive model for this, but only a beginning. The scope of long term climate issues is much wider, and could sustain a longer term agenda for economic stimulus based on Climate Defense.

Like the New Deal or Homeland Security, the government can turn adversity into a growth economy with the right policy leadership. Pro-active measures such as new and renewed public expenditures on infrastructure (e.g. the new Bay Bridge, rapid rail, etc.) can stimulate local job creation and complementary private investments. Also included should be investment incentives and other promotion for energy efficiency, technologies for adaptation including better home insulation, more efficient air conditioners, etc.

Defense and adaptation strategies will entail a combination of hard (infrastructure) and soft (institutional) adaptation. Included in this process will be historic changes public-private resource and risk management partnerships. A process of this importance and complexity requires the best available information to support policy dialog, design, and implementation. This leads to perhaps our most important finding: Much more research is needed to support effective climate adaptation.

Water

Essential to all economic activities, water is very unequally distributed across California. In-state water supplies originate in northern weather patterns, yet most water is consumed in the south because it is relatively more arid. Because of this, water re-allocation has been necessary to support extensive development across the state. Meanwhile, the primary functional division in water is between agriculture and residential users, with industry a small user.

Most climate models agree that global warming will increase California's winter precipitation and reduce it at other times. This may not change the state's annual water budget, but warming will dramatically reduce California's second most important water storage facility (after aquifers), the Sierra snowpack, leading to larger and more volatile seasonal disparities in natural water availability. Combined with significant expected population growth, this will lead to considerable stress on existing water storage and allocation systems. Higher water flow variability will also lead to increased risks of flooding, saline intrusion, and drought-induced habitat destruction. Water conservation offers the most cost-effective means of reducing scarcity and its attendant costs, but it is unlikely to offset a substantial part of long-term growth in residential demand.

In the absence of climate defense measures, the potential costs of these climate impacts remain very uncertain, with estimates ranging from a few hundred million to several billion per year. To a significant extent, these differences are due to assumptions about how the state would adapt to scarcity. Initial conditions in the state's water economy are seriously distorted by legacy rights, allocation and pricing policies, so there would seem to be scope for trading systems to achieve more efficient allocation. In particular, urban water users pay about 50 times what agriculture (the major user) pays, suggesting that markets could shift water in the event its scarcity value rises. Indeed, the leading simulation models used to study this assume that trading will significantly mitigate climate induced scarcity. There are also out of state water resources, primarily from the Rocky Mountains, that are assumed to offer a additional water at competitive prices. Finally, state groundwater resources are assumed to offer transitory flexibility to smooth annual water access.

We are concerned that institutional rigidities and Rocky Mountain water scarcity may lead water costs to escalate more sharply in response to climate change. Trading systems are unlikely to operate smoothly with existing patterns of water entitlement and conveyance infrastructure. Indeed, a number of trades worth several hundred million dollars have been offered in recent years, with no takers in the agricultural community. Assuming the Rocky Mountains experience the same snow impacts as the Sierras, it may be unrealistic to rely on this source as a backstop. Finally, California acquifers, the state's primary water storage facility, are not well captured by any existing models, and their entitlement and exploitation characteristics do not suggest competitive allocation opportunities.

Climate adaptation in the water context will require extensive investments in both hard and soft infrastructure. Climate defense or damage mitigation is feasible, largely within renewal and replacement budgets. For longer term adaptation, significant investments in storage, conveyance, and water management institutions are needed. Financing the former can be sustained by public-private partnership, but the latter will break new ground with respect to the public interest in water access and use. We believe that more research may support a

simple but challenging conclusion: California water has been too cheap for too long, and a significant rise in its scarcity value could trigger intense rural-urban competition and a complete re-appraisal of rules governing the state's water entitlements and private use.

Energy

The electric power sector comprises less than one percent of California GSP, but the services of this commodity are so pervasive it is liked to all economic activity and employment. Climate change will have a threefold impact on California's energy systems. First, changes in the seasonal availability of water would lead to a reduction in the state's hydropower resources, which accounted for 17 percent of California's total system power in 2006. Second, an increase in the number of extreme heat days could lead to a substantial rise in electricity demand for use in air conditioning. Lastly, a rise in winter storm activity might lead to an increase in power outages. All of these impacts can be tempered by both mitigation and adaptation measures, but will require proactive strategies from a variety of state agencies.

The costs of climate change in the energy sector are currently estimated in billions per year for replacement, renewal, and demand-induced capacity increases. On the supply side, compensating for an expected 20% reduction in hydropower capacity is much less important than anticipating climate-induced demand growth. The most reliable estimates indicate that per capita electricity use could increase by up to 50% over this century, which combined with population growth would require enormous commitments to new generation and transmission capacity.[89] Fortunately, these trends annualize to 0.5-1.0% growth, meaning that adaptation is probably feasible but should not be deferred.

Both climate mitigation (AB 32) and adaptation imperatives suggest the need for a radical rethinking of electricity production and distribution in California. Renewable energy can make an important contribution in both contexts, particularly distributed technologies such as photovoltaic. The state can facilitate this with more aggressive renewable standards, but this will still meet only part of the expected growth in demand. In addition to renewables, Demand Side Management policies need fuller consideration. Without this kind of guidance, induced innovation and technology adoption will fall short of California's climate innovation potential.

Actual future electricity demand will depend significantly on the way energy users respond to policy. For example, current electricity pricing is not based on scarcity, so consumers actually consume more per capita as temperatures rise and availability falls. Price reform in this sector should be a high priority. Finally, the residual demand growth, unmet by renewables, will fall to a combination of new in-state and out of state electric power capacity. For the former, it is essential that California promote low and even negative carbon technologies, including Carbon Capture and Storage. A large part of energy adaptation costs will be borne privately, but the state should seriously consider greater public commitments to technical progress in this sector. The benefits of innovation for more effective climate adaptation could be quite significant, both to the state economy and to local public health.

[89] This estimate is very recent and should be considered preliminary. It also takes only limited account of California's capacity for improvements in energy efficiency.

Transportation

Transportation is the foundation of the state's spatially diverse but highly integrated economy, as well as its lifeline to the national and global economy. Its ports account for 40% of US container volume and mediate 23% of total foreign trade. Climate change will be an important consideration for transportation planning in California. However, the vulnerability of California and U.S. transportation infrastructure to climate change, both committed and avoidable, is still poorly understood. Only a small amount of research has been done on climate adaptation in the transportation sector. The first federally funded overview of potential impacts of climate change for the transportation sector in the U.S. was published by the National Research Council (NRC) in 2008 (NRC, 2008).

Climate impacts on the state's transport infrastructure remain very uncertain, but are likely to be concentrated in coastal areas where sea level rise and storm/wave action will threaten maritime facilities, airports, and coastal/fluvial ground transport assets. In the Bay Area, for example, all three major airports are near sea level. They could be raised or barricaded again level rises, but storm/wave action might pose unacceptable risk. Because of easement issues in a dense metropolitan area, the cost difference between fortification and relocation would be one or even two orders of magnitude. [90] Expected costs of maritime and ground transport defense currently range in hundreds of millions per year. These are within range of current public infrastructure budgets, but remain quite speculative. Among other things, these estimates include annualized costs of intermittent disasters, as well as significant uncertainty about the amplitude and frequency of Pacific storm and tidal cycles. Improving these estimates should be a very high priority, however, because the use value of these assets is enormous and their lifespan very long. Thus timing and sequencing of adapting investments is critical.

In light of expected population growth, less intensive use would not appear to be an option for adapting the state's transport infrastructure. Although there has been virtually no research in this area, the remaining options should certainly include more stringent design standards for new structures and retrofits to existing structures. Both would likely require some increase in costs, but engineering solutions of this kind are in most cases likely to be cheaper than relocation. In any case, foresight will again save money by avoiding irreversible misallocation and parallel capacity losses from extreme events, but early action must be better informed.

More generally, the infrastructure decision-making process needs to be completely overhauled and potentially combined with life cycle assessment to ensure that adaptation isn't putting undue stress on the state (or the world) to mitigate. For example, the GHG implications of large public works (esp. cement intensive construction) need to be assessed in concert with contributions to adaptation.

Soft adaptation options could also be important for reducing climate damages, both inside the transport sector and more broadly. Transportation shapes land use, migration/population growth, and economic development patterns, and more adaptive transportation planning decisions could have a significant influence on property-related climate damages. Policies that discourage settlement in high risk areas, for example, will reduce the state's long-run Climate

[90] The latest SFO scale "green field" airport, in Hong Kong, cost $20 billion.

Defense costs. In the truest sense, these linkages reveal the extent to which the climate issues are lifestyle issues.

Tourism and Recreation

Tourism is a major activity and source of income and employment in the California economy. Because the majority of people classified as "tourists" in the state are actually residents, we consider Tourism and Recreation as one sector for the analysis. Many of California's top tourism destinations are outdoors, including beaches, ski resorts, state and national parks, and golf courses. Climate change is expected to affect all of these venues and their appurtenant activities, but in different ways. If the earth's climate is actually stabilized, not all the climate impacts on this sector will be negative. In some industries, such as recreational gold mining, lower levels of warming will be beneficial. In others, such as the winter sports industry, any warming will be negative. Similarly, even as some areas lose revenue from tourism, other areas will gain. Thus, the net effect of climate change on California's tourism and recreation sector will likely mask large distributional shifts.

The primary sources of damage relate to snow, water, and heat tolerance. Under most climate scenarios, the California ski industry is threatened with extinction. Water sports will likely be attenuated somewhat on an annual basis and shift more strongly on a seasonal basis. Heat intolerance will reduce the appeal of outdoor activities generally, but those in natural environments in particular. The cumulative cost estimates for these impacts still vary considerably, between hundreds of millions and billions annually. More important, however, may be the distributional impacts, which shift income and employment around the state and between very different activities. People who can't ski may still take holidays in California, but this industry currently represents $500 million in direct revenue annually.

For this sector, the financial burden of adaptation will be relatively evenly divided between public and private stakeholders, at least according to existing patterns of asset ownership and use. Adaptation options differ for each of the three main categories of recreation (beaches, winter sports, and other outdoor). Most of the states recreational beach capacity can be sustained or substituted with "nourishment" strategies. For winter sports, artificial snow making can extend useful facility life, but this appears to be part of an end-game process that should include non-winter use diversification that could be significantly facilitated by public investments. Other outdoor activities can best adapt with strategies that combine diversification with ecosystem development to improve the recreational capacity of public and private lands.

Real Estate and Insurance

In the industrialized world, the economic implications of climate change will be dominated by asset valuation of real property. Whereas in many parts of the developing world other concerns, such as the spread of disease, may take precedence, in California the dominant climate issues will likely be related to demographics, land use, and real estate. Deeply implicated in the same discussion is the insurance industry, whose risk exposure will increase

dramatically, offering new market opportunities and a central role in market guidance for both mitigation and adaptation.

Taken together, these two sectors represent the largest economic climate risk for the state, although they are among the least studied to date. Because of relatively frequent natural disasters — earthquakes, fires, and floods — many parts of California are intrinsically risky places to live and work. Despite the deterrent effect of such risks, California has an estimated $4 trillion in residential real estate assets, large portions of which are built in fire prone areas and zip codes along the coastline. Natural disasters have historically taken their toll on California's homes and businesses. The state suffered a total of $6.2 billion (2006$) in damages from hazardous weather from 1997-2006. Climate change may increase the frequency and severity of these adverse events, and climate-induced sea level rise will threaten coastal real estate. An increase in the frequency and severity of wildfires will further threaten homes and businesses across the state. Depending on the extent of defensive measures, real estate asset exposure in the coastal areas could vary from billions to hundreds of billions. In montane and other fire vulnerable areas, the vulnerability range is less than ten percent of this, but still quite significant.

Adaptation strategies for real estate and insurance are very complex, both from a material and behavioral perspective. As fixed assets, property values are highly vulnerable to changing local conditions. Residents and values in risk-prone areas should to a significant extent internalize such risks, but if history is any guide they will use political means to resist that. However, the geographic concentration of flood and fire vulnerabilities means that defense and adaptation policies are inherently distributional, using scarce public funds to secure the wealth of some residents but not others. Also, moral hazard in this context may undermine the insurance industry's capacity to price risk accurately, increasing exposure and the ultimate risk of costly public bailouts. Despite these reservations, our general conclusion is that defensive investments will be made in coastal areas because initial property values are very high, while public defensive investment in fire prone areas is less likely. Finally, an important distinction needs to be made between defense of private property assets, where markets can offer options for private financing, and public property. Adaptation and climate defense needs for the latter will necessarily be addressed with public resources.

Agriculture, Forestry, and Fishing

Although agricultural activities represent a small percent of GSP, they are politically very important and are linked deeply to a resource base (water, land) that is threatened by climate change. Climate change will mean significant changes for agriculture, forestry, and fisheries in California. In lower warming scenarios, some of these changes will be beneficial for agriculture and forestry, although there is still a debate about net impact. Both higher and likely lower warming scenarios, even if they cause no net economic impacts, will lead to a gradual but substantial change in the composition and location of agricultural, forest, and fish production. Agriculture will experience at least seasonal and perhaps annual water scarcity, spatial changes in crop eligibility, higher yields and pest activity, and greater vulnerability to energy prices (agro-fuel and chemicals). Forestry will experience high yields, but also higher fire risk and

drought vulnerability. Fishery changes are less predictable, but rising sea temperatures may displace coastal fisheries.

The nets costs of these effects are generally agreed to be positive, with adjustment or transactions costs by far the largest component. Direct impacts range from hundreds of millions to billions annually, while very little has been done to estimate the very extensive costs of sector displacement, food source substitution, and surplus land effects on related property markets. Structural change in this sector is expensive because of high fixed asset and fixed cost proportions. For this reason, higher quality information can play an essential role in limited adjustment costs. There are many activity-specific options open to agricultural operators, but they need reliable guidance to commit to these. Forestry is a regional activity in the state, and over the time horizon considered demographic trends will probably exert more influence in this area than climate change. For fisheries, better quality information or insurance is again essential to facilitate adjustment.

In the end, however, these sectors are quite important for policy, but small relative to the states' overall economy and even the state budget. This suggests that public-private partnerships can meet significant elements of the adjustment challenge. Other sector adaptation discussed in this study, particularly water, will exert collateral influence on this one, but it must be recalled that California has a very high-value portfolio of crops, including wine and specialty fruits and nuts. Thus it is better positioned to make investments needed for climate defense and adaptation.

Public Health

Those who justly admire California for its progress in energy efficiency and emissions standards may be surprised to learn that it has the worst average air quality of all 50 United States. Air pollution leads to respiratory and cardiovascular disease that cause thousands of residents to die prematurely every year, with the number of California deaths from air pollution currently on par with those due to traffic fatalities (ARB, 2004). In addition to air quality, heat-related mortality is becoming an increasing concern for California policymakers.

Climate change has already begun to create new public health risks around the world, and in California most of these will be tied to air quality and temperature rather than malnutrition or pandemic diseases. Official estimates of the public cost of current air pollution are high, at about $70 billion annually. Most of this is actuarial valuation of premature death, but over $2 billion per year are spent on air pollution related hospital visits, and no account has yet been taken for an estimated 4.7 million and 2.8 million days of missed school and lost work (respectively). Climate change will increase all these amounts, which we estimate under a variety of climate scenarios to average in the range of $3-13 billion annually. It must be emphasized, however, that no other estimation work of this kind has been done yet, so these estimates must be seen as highly uncertain.

Effective government intervention could significantly reduce health-related impacts from climate change. Controlling criteria pollutant emissions is the most powerful option for reducing the pollution-related impacts of climate change. Relatively simple strategies could significantly reduce mortality during heat waves in California. These include early warning

systems, public education, cooling centers, and air conditioning. As with other sectors described in this report, however, developing the capacity to deal with current problems will be the first step in an adaptation strategy.

Longer-term solutions for air quality may instead require a host of other considerations, from transportation and land use planning to fuel choices to greater attention to environmental justice issues. Among older and poorer groups, adaptive capacity is also significantly lower than in the population at large. Given the potentially high rates of risk and relatively low costs of intervention there is an obvious role for state agencies in reducing heat-related mortalities.

5.1.1 Current Energy Use Policy

In 2003, 40.4% of California's energy was used for Transportation, 23.5% was used by industry, 18.1% for residential, and 18% for commercial.(10) California's energy use is highly regulate across all sectors, and the California legislature has been actively pursuing measures to curb emissions. In 2006, California passed The Global Warming and Solutions Act, which aims to reduce emissions by 25% by 2020 through mandatory cuts and cap-and-trade measures.(7) Since 1978, California has maintained comprehensive, mandatory building efficiency standards which have saved a total of over $56 billion in reduced energy consumption.(2) The California Air Resources Board adopted regulations for car emissions in 2004, but is still in the process of overcoming legal hurdles to implementation.(3)

There are also a number of other programs in California working to help reduce energy consumption. California's Renewable Energy Program allocates over $500 million to provide market based support for renewable energy development using a cents-per-kilowatt-hour incentive program.(9) Another state program has allocated over $25 million to subsidize the purchases of Zero Emissions Vehicles (ZEVs) for business and residential use.(8) California also funds the California Climate Action Registry, which administers a voluntary green house gas registry and acts as an information clearinghouse for information on climate change issues.(3) To help utilities expand in an environmentally safe and economically sound manner, California has devoted resources to the development of Strategic Value Analysis (SVA) methodology which optimizes the value of ratepayer investments into new renewable resources. SVA has shown that California can meet its 2010 energy goal with minimal transmissions upgrades by using zero emissions technology that could improve reliability.(4)

California has also taken the initiative in the development of energy efficient technologies for specific businesses. Individual wineries across California have started replacing conventional cooling tanks with new STARS systems to reduce energy costs.(4) Other companies which require both cooling and heating have begun using a new TermoSorber system which creates both cold and hot water with only a fraction of the energy.(4) These two systems are examples of emissions reduction technologies being pioneered in California, but could be easily expanded and shared with California's neighbors.

5.1.2 WCI Participation

Climate change is not something specific to California. Global Warming is a global problem, but the place to start is here at home. Inside California momentous steps have been taken to reduce emissions growth and curb the impacts of climate change, but these steps mean little without the support and cooperation of the entire region. The WCI is a regional program that stands to benefit not just California, but the whole United States through the sharing of technology, standardization of regulation, and expansion of environmental protection. California is unique in the United States because it is the only State that has extensively examined the range of impacts from climate change in detail, and thus stands in a position to be a leader in climate change policy. The United States Energy Commission is already working with the University of California to develop a knowledge that could serve to help model impacts for the region, and possibly the entire country.

5.2 Conclusion

California is in good standing to make a serious contribution to global emissions reductions, both because it has done so much, and because it has so much to do. With such high international esteem, it is clear that California has much to offer the community to avert *'the day after tomorrow'*, but just as much to lose if it does not.

6 Montana Background Review

Montana GHG emissions have steadily gone up over the last decade, from a net emission of 6.8 million metric tons of CO2e in 1990, to 11.4 million metric tons in 2005 and a projected 16.3 million metric tons in 2020. [91] After establishing a committee to evaluate the effects of climate change on the state of Montana, Governor Schweitzer began implementing policies to help reduce energy consumption and CO2 output. Montana also became the seventh state to join WCI.

6.1 Current Evidence and Projected Climate Impacts

Temperature

Temperatures in 2100 are projected to increase 4°F in spring and summer (with) range of 1-8°F) and 5°F in fall and winter (with range of 2-10°F)[92]

Precipitation

Precipitation estimated to increase by 10% during spring, summer, and fall. Winter precipitation estimated to increase by 15-40%.[93]

Forestry

Montana has 23 million acres of forest which help provide carbon sinks contributing to a reduction of 23.1 million metric tons of CO2.[94] There has been an increase in insect infestation, forest fires, and drought, all which may have worsen due to climate change and can cause serious harm to the forests, decreasing CO2 absorption.

Wildlife

Montana is home to a wide variety of wildlife including several endangered species which may be more endangered due to lost of habitat from climate change. Bull trout need cold water to live in and with melting glaciers due to warmer weather, the bull trout is losing their habitat.

Glaciers

There are only 27 glaciers remaining in Glacier National Park out of 150 the park had in 1850[95], due to an increase in temperature from climate change. These remaining glaciers are projected to be gone by 2030.[96]

Agriculture

[91] "Montana's Greenhouse Gas Inventory and Reference Case Projections 1990-2020"
[92] "EPA Climate Change and Montana"
[93] "EPA Climate Change and Montana"
[94] "Montana's Greenhouse Gas Inventory and Reference Case Projections 1990-2020"
[95] "Warming climate shrinking Glacier Park's glaciers"
[96] "Modeled Climate-Induced Glacier Change in Glacier National Park, 1850-2100"

Montana's largest industry is agriculture, which supports 30% of all economic activity, with 64% of the state's land is farm and ranch land, and total annual sales for Montana agricultural products are over $2 billion; half livestock and half crops[97] Agriculture accounts for 26% of GHG emissions in Montana, second only to electricity, and is expected to remain constant over time.[98] While temperature increases may not adversely affect agriculture in Montana, precipitation remains a concern as changes in the water supply can have a devastating effect to the crops and livestock.

Water

Climate change can cause there to be an increase in heat waves, floods, and droughts. A warmer climate would increase spring snowmelt, causing there to be higher stream flows in winter and spring and lower stream flows in summer and fall. Changes in stream flows can negatively impact the reservoir system in Western Montana which in turn will impact power generation, fisheries, recreation, etc.

Health

Montana could be susceptible to increases in heat waves due to increase in temperature from climate change, which can lead to an increase to heat-related illnesses and deaths. Warmer climate may also expand the habitat and infectivity of disease-carrying insects, which in turn will increase the transmission of diseases. Mosquitoes capable of transmitting equine encephalitis thrive in warmer climates and conditions in Montana may increase their population.

Aggregate State Economy

Creation of Green collar jobs, manual labor job opportunities in businesses which improve environmental quality through their products or services. Tourism which accounts for $2.9 billion and 48,000 jobs[99] may be adversely affected by climate change. Most tourists visit Montana for activities with strong ties to environment such as skiing, sightseeing in national parks, fishing, hunting, and rafting, all of which can be negatively impacted upon through climate change.

[97] "Climate Change and Agriculture"
[98] "Montana Climate Change Action Plan"
[99] "Climate Change and Tourism"

6.2 Current Stances and Policies in Coping with Climate Change

6.2.1 Government Level

Senate Bill 415, The Montana Renewable Power Production and Rural Economic Development Act signed by Governor Brian Schweitzer on April 28, 2005 required that the state received 15% of its energy from renewable sources by 2015.[100]

Renewable Fuels Standard enacted by Montana on May 2005 required all gasoline (except 91-octane) to contain 10% ethanol.[101]

HB 25, enacted on May 14, 2007 sets a CO2 emissions performance standard for electric generating units in the state and prohibits the state Public utility Commission from approving electric generating units primarily fueled by coal unless at least 50% of the CO2 produced is captured and sequestered. This applies to units made after January 2007.[102]

Montana's Governor Schweitzer announced the 20X10 initiative which calls for a 20% reduction in energy consumption by state agencies by 2010. In addition to the reduced consumption, the governor also asked that state vehicles be more fuel efficient and set a standard for 30mpg vehicles except for industrial vehicles and pickups.[103]

6.2.2 Industry/Business Level

Sustainable Agriculture is an emerging trend in Montana which helps store more carbon in soil along with making more efficient usage of nonrenewable resources and integrating biological controls in agriculture.

Tourism-based businesses have had to cope with unfavorable weather conditions to their businesses by encouraging tourists to arrive earlier in order to avoid bad weather conditions.

6.2.3 Individual/Household Level

With 715,000 licensed drivers and 1 million registered cars in Montana, the ratio of vehicles to drivers is one of the highest in the country.[104] Education efforts on car maintenance along with fuel consumption reduction practices are underway. Tax incentives are in place for households to invest in energy saving products.

[100] "Montana Sets Renewable Energy Target"
[101] "Montana Biofuel Standard"
[102] "Montana Adopts a Carbon Dioxide Emissions Performance Standard for New Electricity Plants"
[103] "Montana Climate Action Project Website"
[104] "Climate Change and Transportation"

6.2.4 WCI Participation

As of January 2008, Montana joined the WCI as a partner and plans to reduce GHG emissions by 15% of the 2005 levels by 2020. By joining WCI, Montana will be able to help develop mechanisms to achieve more extensive GHG reductions. According to official sources, Montana hopes to emphasize the importance of offsets, particularly land management activities used to increase absorption of CO2.

8 New Mexico Background Review

Climate change has already begun to affect the state of New Mexico. This is most evident in the 2°F rise in temperature since the mid 20th century, a rate that is about twice the global average.[105] This accelerated temperature rise is expected of regions of the continental interior. Although to date little climate change modeling is available that is specific to New Mexico, future impacts of climate change on the state are predicted to have significant effects on the state's natural resources and economy. Among these are the state's diverse ecosystems that harbor the organisms that give New Mexico the 4th highest native species diversity in the U.S, and the state's sensitive water resources.

The state of New Mexico has recognized the urgency of the situation at global, national, and local levels, and has taken many steps to reduce its greenhouse gas (GHG) emissions. In 2004, Governor Bill Richardson declared New Mexico "The Clean Energy State." As an energy exporter, the state faces the challenge of maintaining its presence as a major energy source while reducing GHG emissions, which per capita, are about double the national average. However, the state has great opportunity to benefit from energy efficiency improvements and innovation in infrastructure. Additionally, desert sun makes solar power potential in New Mexico the second largest in America. New Mexico was the first major coal, oil and gas-producing state to set targets for cutting global warming emissions.

New Mexico is active in developing a comprehensive multi-sector climate action plan. The state was one of the five original founders of the Western Climate Initiative, which aims to achieve regional greenhouse gas emission reduction of 15% below 2005 levels by 2020.

8.1 Current Evidence and Projected Changes

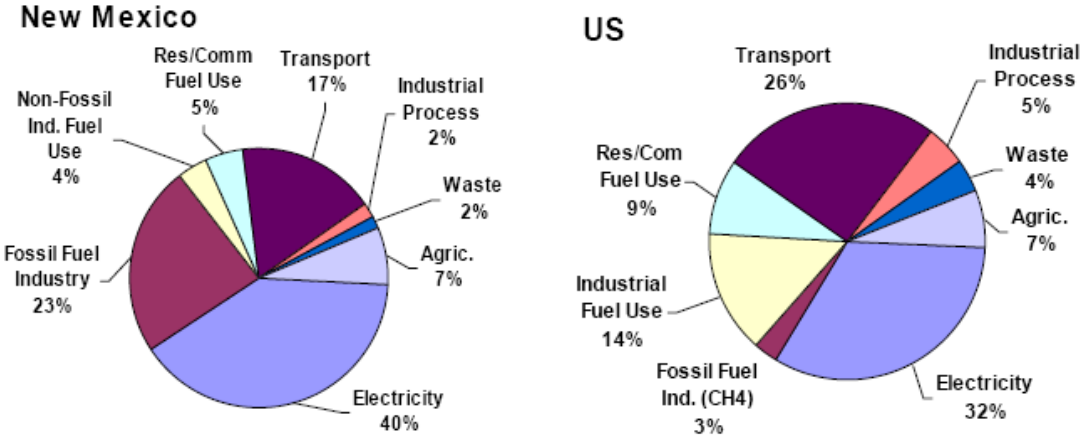
Emissions

The most comprehensive strategy for reducing GHG emissions in New Mexico is presented in a report by the New Mexico Climate Change Advisory Group in 2006 and one of its appendices, *Inventory and Projections*. Analysis suggests that in 2000, New Mexico produced about 83 MMtCO2e (million metric tons of carbon dioxide equivalent) emissions, an amount equal to 1.2% of total gross US GHG emissions.[106] In the 1990s, New Mexico's gross GHG emissions rose at a lower rate compared to the U.S as a whole, which is attributed to limited growth in new power generation facilities and the decline of the mining industry. However, on a per capita basis, New Mexico produces nearly twice the GHG emissions as the national average (45 vs. 25 tCO2e per person)[107], which are primarily the result of its GHG-intensive gas, oil, and electricity production industries. Energy producing industries are the dominant feature of New

[105] D'Antonio
[106] CCAG
[107] CCAG

Mexico's GHG emissions profile. The production of electricity and fossil fuels accounted for two-thirds of New Mexico's gross GHG emissions in 2000, whereas these activities accounted for only 35 to 40% of national gross GHG emissions (figure below).[108] Transportation-related GHG emissions rose by 29% in the 1990s, and are one of New Mexico's fastest growing GHG emissions sources.[109]

Figure 18: Gross GHG Emissions by Sector and Gas, 2000, New Mexico and US



Source: CCAG

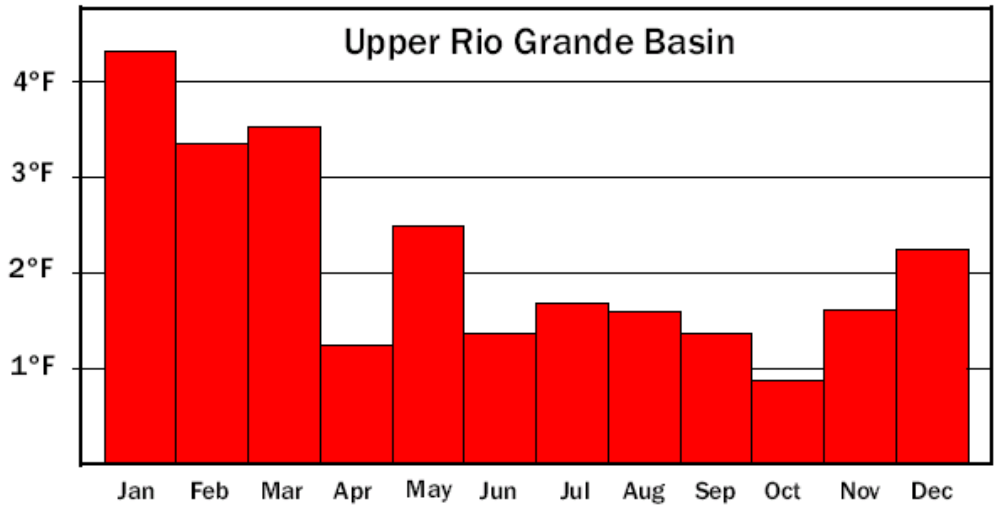
The inventory and projection of New Mexico's GHG emissions provided several important pieces of information. First, the electricity and transportation sectors are two of the sectors with the largest emissions, and are expected to grow faster than other sectors. Second, over 20% of New Mexico's emissions come from fossil fuel production, rather than solely final product consumption, whereas in many states, this contribution is negligible. Overall, by 2020 emissions from electricity generation and the fossil fuel industry are expected to increase from 1990 levels by approximately 32% on a production basis.[110]

According to CCAG, the two primary challenges in addressing GHG emissions from New Mexico's energy supply sector are continued growth within the State and increasing demand for energy from other states. Roughly two-thirds of the State's fossil fuel emissions are associated with exports, while slightly less than half of New Mexico's electric generation emissions are associated with exports.[111] Another significant challenge is uniform adoption of CCAG recommendations because generating facilities are subject to different regulations based on whether they are regulated by the Public Regulation Commission, their own elected board, or if they are located on tribal lands.

[108] Bailie et al.
[109] Ibid
[110] Ibid
[111] Baile et al.

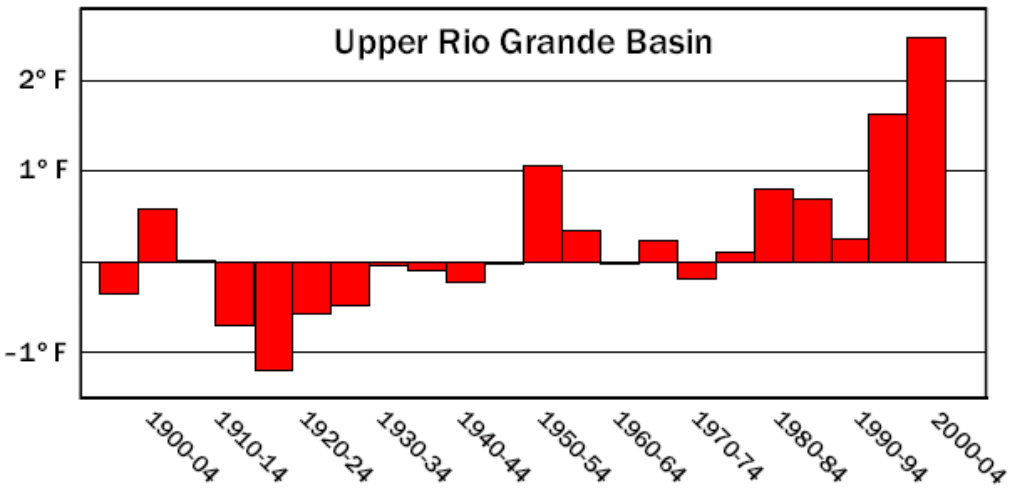
While continuing its status as a major energy source and reducing emissions at the same time is a considerable challenge, New Mexico also has great opportunity for efficiency gains through upgrade and innovation in infrastructure of power-generating facilities. Additionally, New Mexico possesses significant solar and wind energy resources. New Mexico appears to be in a good position to implement strategies to reduce emissions and mitigate impacts.

Figure 19: Average monthly temperatures in 1995-2004 in the Upper Rio Grande Basin, compared to 1961-1990 average values



Data from the climate division series, National Oceanic and Atmospheric Administration. Analysis by the Rocky Mountain Climate Organization. Historical average monthly temperatures are from the period 1961-1990. Source: D'Antonio [Figure from RMCO 2005]

Figure 20: Five-year average temperatures, 1895 to 2004, compared to historical averages



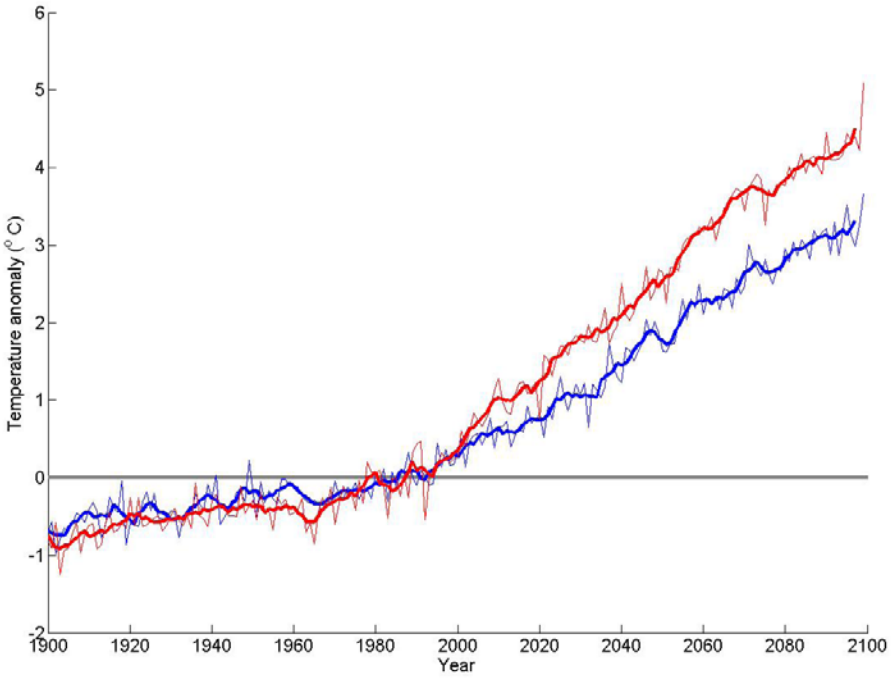
Source: D'Antonio [Figure from RMCO 2005]

Temperature

Temperatures in New Mexico are now warmer than at any other time in the past century and can be expected to continue to rise. A report prepared by the Office of the State Engineer showed that the largest increases in temperatures over the past several decades have occurred in the winter months, resulting in recent annual average temperatures more than 2°F above mid-20th Century values (two previous figures).[112] The same report said that recent model simulations predict accelerated summertime warming in the future (Figure 4 and Figure 5). According to New Mexico climatologist David Gutzler, rapid warming has occurred year-round since the 1960s and continues today with an increase of roughly 2°F in the cold season and nearly 3°F n the warm season (Figure 6).[113]

[112] D'Antonio
[113] Gutzler 2007

Figure 21: Simulated New Mexico seasonal temperature changes in the 21st Century for summer (red line; June-August) and winter (blue line; December-February), compared with model climatology (1971-2000)

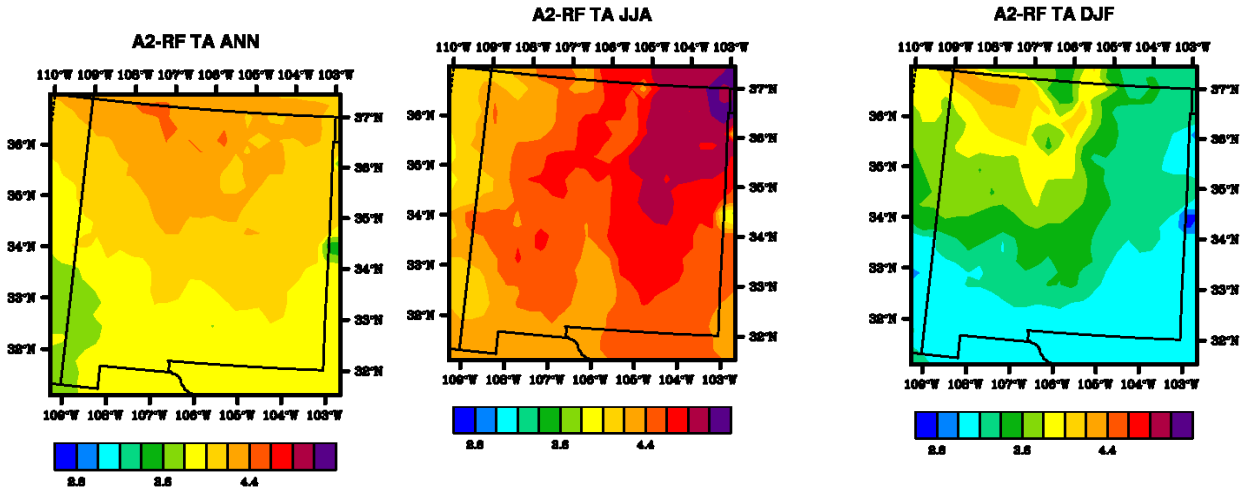


Source: D'Antonio.

Projected changes in temperature for the following decades vary. The IPCC and the United Kingdom Hadley Centre's climate model predicts that by 2100 temperatures in New Mexico could increase by 3°F in spring (with a range of 1-5°F), 4°F in fall (with a range of 2-7°F), and 5°F in winter and summer (with a range of 2-9°).[114] According to Gutzler, we may expect up to an increase in temperature across the state of New Mexico of more than 5°F in winter and up to 8°F in summer by the end of the century.[115] The State of New Mexico Agency Technical Working Group reports that by mid- to late-21st century, air temperatures in New Mexico are projected to warm by 6-12°F on average, but more in winter, at night, and at high elevations.[116]

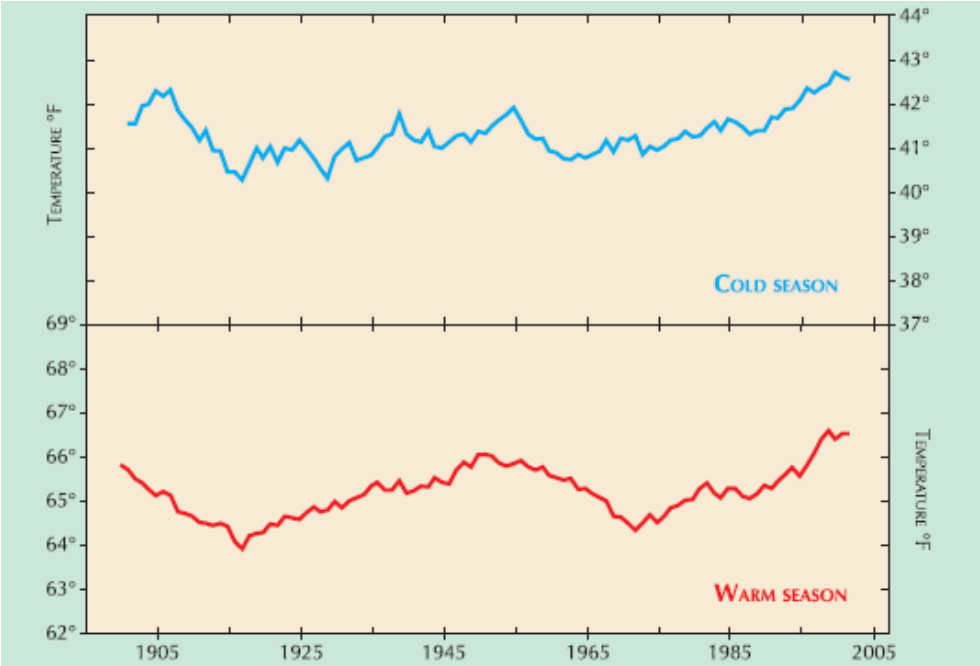
[114] EPA
[115] Gutzler 2007
[116] New Mexico Agency Technical Work Group

Figure 22: Simulated change in temperature (°C) from 1961-1985 to 2071-2095 across New Mexico for a) annual mean b) summer (June-Aug) c) winter (Dec-Feb)



Source: D'Antonio [Figure from Diffenbaugh et al, 2005]

Figure 23: 20th century time series of observed New Mexico temperature



20th-century time series of observed New Mexico statewide temperature, with the year split into a 6–month "cold season" (October–March, blue curve) and a 6-month "warm season" (April–September, red curve). The time series have been smoothed to emphasize decadal variability. Data were obtained from the Western Regional Climate Center, Reno, Nevada.

Source: Gutzler 2007

Water

Groundwater is the primary source of water for public, industrial, and agricultural uses in New Mexico. Additionally, a significant amount of streamflow in New Mexico is a result of spring and summer rainfall and snowmelt in the mountains. Although the biggest impact of climate change on New Mexico is predicted to be its effect on the State's water resources[117], there is little quantitative data and literature on New Mexico's water supply. The Governor directed the Office of the State Engineer to prepare a report analyzing New Mexico's water supply and ability to manage its water resources by 2006. The report is a compilation of scientific opinion and synthesis of existing literature on the effect of climate change on various water resources, the majority of which is not specific to New Mexico. The New Mexico State Water Plan, created in 2003, was created as a strategy for managing the state's water supplies. It provides a policy framework in which to address climate variability and incorporate many of the policies and strategies that need to be re-evaluated in the context of climate change. However, New Mexico has a long way to go to understand, evaluate, and mitigate the impacts of climate change on the state's water supply.

Water is crucial to the growth and economic vitality of New Mexico, and water resources are generally already over-allocated in some of New Mexico's water basins. The pressure on water resources in New Mexico is already substantial, as many areas of the state are already facing shortages in meeting the current needs of expanding cities, agriculture, and manufacturing. Without large increases in rainfall, higher temperatures may cause less water to be available for distribution especially to the central and southern parts of the state, where sufficient supply of water for irrigation and municipal use is already a concern. The Rio Grande Valley is a densely populated area of the state where the continued availability of water is a major issue. Additionally, the system of water appropriation in New Mexico is complex and strongly political. Long term effects of decreased water supply or insufficient management of water resources will include economic hardship, reduced biological diversity, and lack of food security.

Predicted impacts of climate change on New Mexico's water supply include: reduced groundwater recharge, greater evaporative loss from lakes and reservoirs, greater evaporative loss from soils and plants, more soil drought, smaller mountain snowpacks, and earlier snowmelt. [118]

Snowpack

As a result of rising temperatures, climate models predict a trend toward higher freezing altitude and reduction in Western snowpack over the following decades. Higher temperatures will have several significant effects: delay in the arrival of the snow season, acceleration of

[117] D'Antonio
[118] New Mexico Agency Technical Work Group

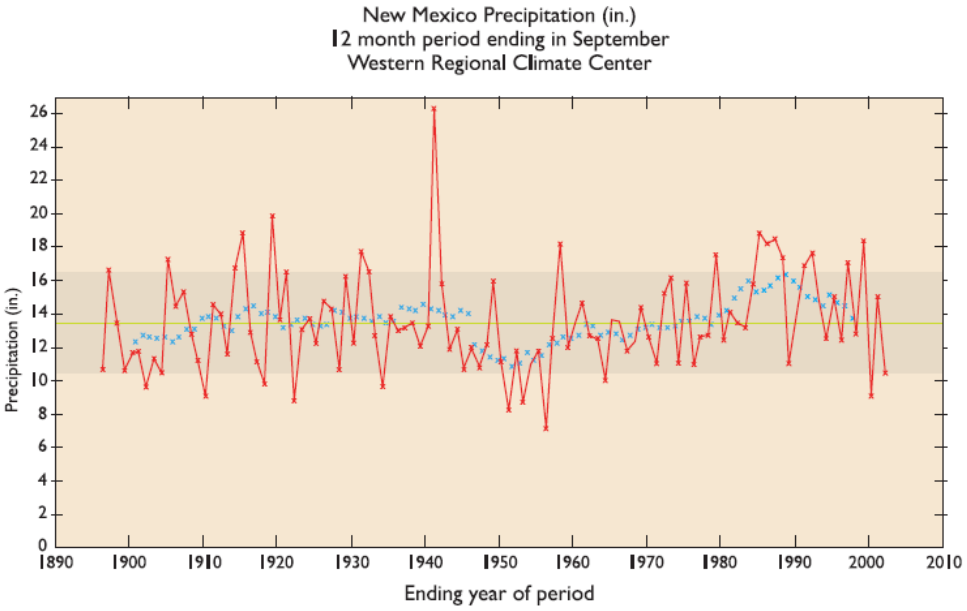
spring snowmelt, and early and rapid seasonal runoff due to a shorter snow season. Annual average temperatures have been rising in the mountainous areas of New Mexico during the winter and early spring, supporting the projections that snowfall will begin later and total snowfall with decrease. [119] Snowpack has been below average for 11 of the past 16 years in the Colorado River Basin and 10 of the past 16 in the Rio Grande Basin. [120]

The report prepared by the Office of the State Engineer provides a brief review of fairly scarce literature on snowpack, most of which is specific to New Mexico. It concludes that recent observed data of decreased snowpack in the Southwest coincides with the warming trend.

Precipitation

The largest percentage increases in precipitation falling as rain are likely to be in the Southwestern U.S.[121] An accelerated hydrological cycle would contribute to increased rainfall. According to the EPA, from 1900 to 1998, precipitation increased by up to 20% in many parts of the state.[122] However, there are large uncertainties associated with precipitation predictions for New Mexico, and models have predicted both decreases and increases in total winter precipitation. However, there is general agreement that even a moderate increase in precipitation would not offset losses to the water supply due to temperature increases.

Figure 24: 20th century time series of precipitation in New Mexico



Time series of annual water-year (October–September) precipitation averaged across New Mexico from 1896 to 2002. Red line shows annual data points; blue x's show 10-year running average; yellow line shows average annual precipitation for the entire period of record. Data and plotting routine are available online from the Western Regional Climate Center at http://www.wrcc.dri.edu

Source: Gutzler 2003

[119] D'Antonio
[120] D'Antonio
[121] D'Antonio
[122] EPA

Drought

Dendrochronological records provide reliable documentation of periods of drought in New Mexico. They show that droughts have occurred in New Mexico for centuries independent of anthropogenic effects. Severe multi-year drought episodes, which are apparently a natural component of climate in the Southwest, are expected to continue in New Mexico. The State saw a severe drought from 1950 through 1956, in which annual precipitation was less than 12 inches for seven consecutive years. Average annual precipitation ranges from less than 10 inches over much of the southern desert and the Rio Grande and San Juan Valleys to more than 20 inches at higher elevations of New Mexico.[123] The 1950s drought stood out as a severe episode for the century but was by no means an outstanding event in a larger historical context. The 1980s and 1990s were years of abundant rainfall, though this was as anomalous an occurrence as the drought years of the 1950s. [124] New Mexico saw another drought in 2003, which despite some fear, was not as severe as that of the 1950s. Analysis of the drought pattern in New Mexico shows that severe droughts occur at least once a century (Figure 7). El Niño is the most well understood phenomenon that influences periods of drought in New Mexico.

According to a report on Colorado River water availability by the National Academies, 2002 and 2004 were among the 10 driest years on record in the upper basin states of Colorado, New Mexico, Utah, and Wyoming. [125] The general consensus in the academic community is that increasing temperatures, earlier snowmelt, and decreased soil moisture and subsequent effects will increase the intensity, frequency, and duration of droughts. In any case, New Mexico can expect episodes of drought in the future.

Ecosystems and Biodiversity

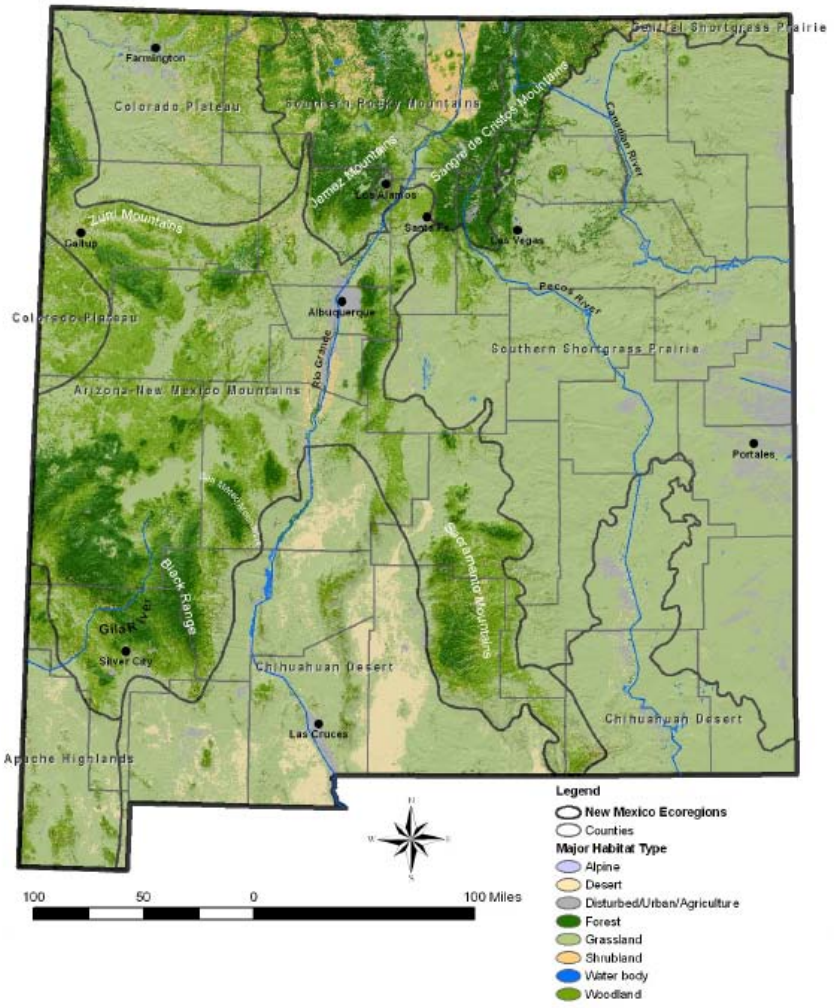
New Mexico is ranked as having the 4th highest native species richness in the U.S.[126] The area of New Mexico includes a diverse range of ecoregions: the Southern Rocky Mountains, the Southern High Plains, the Northern Chihuahuan Desert, the Madrean Archipelago, and the Great Basin. Grasslands comprise over half (65%) of New Mexico's land cover, with the remaining area comprised of woodland (17%), forest (10%), desert (4%), shrubland (3%), and riparian/wetlands (1%) (figure below).[127] As depicted in Figure 9, most of New Mexico's major habitat types experienced warmer-wetter conditions during 1991-2005. However, in 2000-2005, most semi-desert grassland and montane grasslands experienced warmer-drier conditions, whereas a majority of Great Plains grasslands experienced warmer-wetter conditions.[128] According to a study conducted by the Nature Conservancy, warming is greatest in

[123] WRCC
[124] Gutzler 2003
[125] The National Academies
[126] Stein
[127] Enquist and Gori
[128] Ibid

northwestern, central, and southwestern New Mexico.[129] There is limited regional data on the impacts of climate change on New Mexico's ecosystems. The Nature Conservancy in New Mexico published in April 2008 the most comprehensive assessment of climate change vulnerability of New Mexico's ecosystems to date.

8.1.1 New Mexico Ecoregions

Figure 25: Thematic map of New Mexico, including the seven ecoregions that cross the state and major habitat types.



Source: Enquist and Gori [Image from Southwest Regional GAP Analysis Project 2004]

The following table lists key conservation areas in New Mexico based on levels of climate exposure, determined by the Nature Conservancy.

[129] Ibid

Table 16: Key conservation areas with the highest drought-sensitive (D-S) species richness sorted by highest (white) and lowest (shaded) climate exposure percentile ranks. Significantly increasing trends (1970-2006) are indicated by an asterisk (*) for minimum temperature (Tmin) and maximum temperature (Tmax)

ID	Key Conservation Area	Ecoregion	# D-S Taxa	Total # D-S Species	Percent Rank	*Tmin*	*Tmax*
131	Jemez Mountains	Southern Rocky Mountains	5	12	100.0%	*	*
137	Rio Hondo	Southern Rocky Mountains	5	6	99.1%	*	*
86	Sierra Blanca	Arizona - New Mexico Mountains	5	9	98.6%	*	*
139	Southern Sangre de Cristo Mountains	Southern Rocky Mountains	5	12	98.2%	*	*
135	Rio Chama	Southern Rocky Mountains	4	8	96.9%	*	*
149	Sierra San Luis/ Peloncillos Mountains	Apache Highlands	5	27	96.5%	*	*
90	Northern Black Range	Arizona - New Mexico Mountains	5	8	96.0%	*	
88	Sacramento Mountains	Arizona - New Mexico Mountains	5	10	95.2%	*	*
84	Mogollon Divide	Arizona - New Mexico Mountains	5	14	89.5%	*	
69	Mimbres River	Arizona - New Mexico Mountains	5	6	88.6%	*	
67	Gila River	Arizona - New Mexico Mountains	4	12	87.8%	*	
6	Bottomless Lakes	Chihuahuan Desert	3	5	20.4%	*	*
12	Lost River	Chihuahuan Desert	3	3	23.4%	*	*
10	Pecos River High Plains	Chihuahuan Desert	1	6	26.9%	*	*
9	Bitter Lake	Chihuahuan Desert	5	10	30.0%	*	*
143	Blue River/Eagle Creek	Apache Highlands	3	15	35.6%	*	
14	Rio Felix	Chihuahuan Desert	1	6	37.3%	*	*
0	Lower Hondo	Chihuahuan Desert	1	8	42.6%	*	*
17	Pecos River Delaware	Chihuahuan Desert	1	12	45.6%	*	*
13	Pecos River Carlsbad	Chihuahuan Desert	1	14	46.0%	*	*
8	Pecos River Roswell	Chihuahuan Desert	4	18	49.5%	*	*

Source: Enquist and Gori

Southern Rocky Mountains

Projected decline in snow cover in this century anticipates many changes in the alpine ecosystems of the Sangre de Cristo, Jemez, and San Juan Mountains. From 1991 to 2005, most of New Mexico's mid- to high-elevation woodlands have experienced consistently warmer and drier conditions or greater variability in temperature and precipitation. [130] These include increase in soil drought, higher rates of evapotranspiration, and losses of area in forested ecosystems because of restriction of populations to higher elevations. High-elevation subalpine ecosystems and areas occupied by whitebark pine will be lost.[131] New Mexico's drought-stressed forests may be among the most vulnerable ecoregions to climate change.

Wildfires in the western U.S. have become more frequent, intensive, and expansive at least in part due to higher temperatures and reduced soil moisture. As the Cerro Grande wildfire of 2000 in the Jemez Mountains of New Mexico exhibited, soils that are stripped of vegetation by fire show higher probability of erosion, especially where they are on elevation gradients.[132] The Nature Conservancy ranked the Jemez Mountains as the most vulnerable ecoregion to climate exposure in New Mexico. The most rapid landscape-scale shift of a woody ecotone ever documented occurred in northern New Mexico in the 1950s, in which the ecotone between semiarid ponderosa pine forest and piñon-juniper woodland shifted extensively and rapidly (in less than 5 years) through mortality of ponderosa pines in response to a severe drought.[133] This shift has persisted for 40 years. Forest patches became more fragmented and soil erosion accelerated. Additionally, drought-stressed forests are more susceptible to widespread insect outbreaks, as that which occurred in the population explosion of pine bark beetles that killed millions of trees in New Mexico and Arizona due to a region-wide drought beginning in 2002.[134]

Arizona-New Mexico Mountains

This ecoregion is home to more species of birds and mammals than any other ecoregion in the Southwest. A study site at Mount Taylor exhibited consistent warmer-drier conditions and was identified by the Nature Conservancy as a highly vulnerable ecoregion to climate change.

Southern High Plains

Decreased precipitation may eliminate many of the smaller bodies of water and communities that depend on them. Many isolated spring systems that harbor endemic fishes would be at risk. [135] The Nature Conservancy identified the Pecos River Headwater as a site with high vulnerability to climate change.

[130] Ibid
[131] New Mexico Agency Technical Work Group
[132] Moody
[133] Allen and Breshears
[134] US Forest Service
[135] New Mexico Agency Technical Work Group

Northern Chihuahuan Desert

Arid and semiarid lands such as the Northern Chihuahua Desert may be among the first regions in which ecosystem dynamics become altered by global environmental change. The changes would include 1) reduction in soil fertility, carbon to nitrogen ratios, and microbial action 2) enhanced physical changes, all resulting in soils less conducive to plant production and 3) reduced resistance to erosion.[136] A study conducted of the Chihuahuan Desert ecosystem of southeastern Arizona and southwestern New Mexico documented large changes that have occurred since the late 1970s. The three-fold increase in density of woody shrubs and shift in animal species composition were apparently caused by increase in winter rainfall.[137] Encroachment of shrubs into grasslands is likely to continue as increased CO2 concentrations and change in seasonal precipitation patterns favor the establishment of vegetation with the C3 photosynthetic pathway (e.g. woody shrubs) at the expense of C4 species (e.g. warm season perennial grasses). [138] Changing habitats will result in changes in the distribution of animal species associated with shrublands and grasslands.

Great Basin

The Colorado plateau ecoregion is ecologically important because of its complex geological formations and its more than 300 endemic plant species.[139] An increase in warm-season, perennial grasses over the present shrubs and perennial herbaceous species is predicted in the Great Basin.[140]

Madrean Archipelago

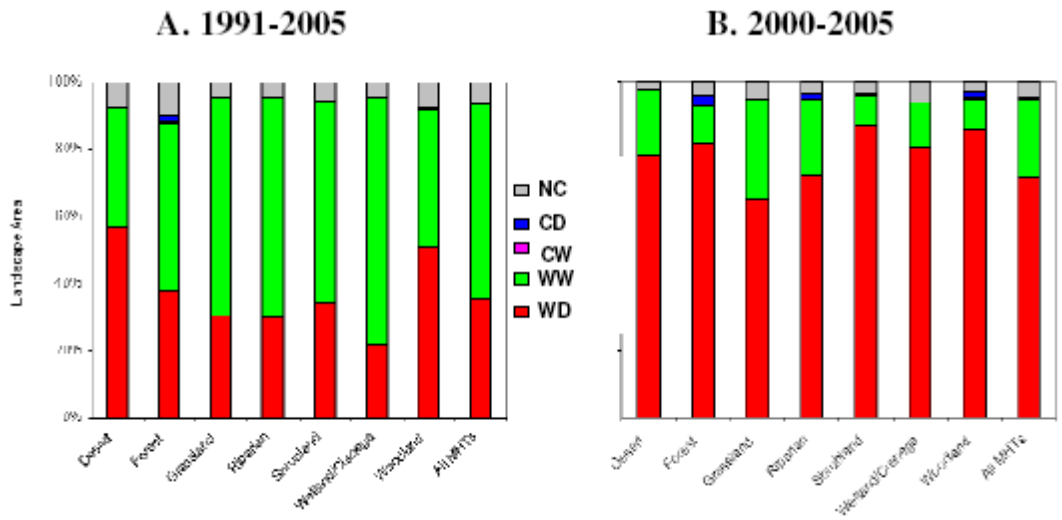
The Madrean Archipelago consists of the mountains and highlands of northwestern Mexico, southeastern Arizona, and extreme southwestern New Mexico. It is characterized by its isolated mountain ranges and semi-desert grasslands in valley basins. Climatic and other effects of a doubling of atmospheric carbon dioxide on forest communities of the Madrean Archipelago might include a 200-1500 km shift northwest of some tree species.[141] As in the alpine ecosystems, at many locations in the Madrean Archipelago a rise in temperature is predicted to cause the upper boundary of the forest to shift upward, resulting in shrinkage in area of the forest or disappearance altogether.

[136] New Mexico Agency Technical Work Group
[137] Brown
[138] Enquist and Gori
[139] Enquist and Gori
[140] New Mexico Agency Technical Work Group
[141] New Mexico Agency Technical Work Group

8.1.2 Biodiversity

The destruction of riparian areas, primarily through overwhelming pressures for water resources and overgrazing, is the most important factor threatening and endangering many species of fish and wildlife in New Mexico.[142] Climate change can worsen these threats through effects on water supply and composition of riparian areas. Warming will cause a substantial number of fish species endemic to the streams of the southern Great Pains to face extinction. These include the Rio Grande silvery minnow and the Southwest willow flycatcher.

Figure 26: Percent area of major habitat types exposed to anomalous climate conditions relative to 1961-1990. A) 1991-2005 departure period B) 2000-2005 departure period



WD=warmer-drier, WW=warmer-wetter, CW=cooler-wetter, CD=cooler-drier, NC=no change in temperature and/or precipitationSource: Enquist and Gori

8.1.3 Agriculture

New Mexico's production agriculture is a $1.6 billion annual industry, two-thirds of which comes from livestock, mainly cattle.[143] More than one-half the area of the State is pastureland.[144] The majority of ranching operations in New Mexico depend entirely on the range to support their cattle, and variability in precipitation could affect both the quantity and type of vegetation available for grazing animals. Elevated levels of carbon dioxide may induce a shift from grasses towards shrubs and other woody plants.[145] Thus decline in water availability would seriously decrease the economic viability of grazing.

[142] EPA
[143] New Mexico Agency Technical Work Group
[144] WRCC
[145] New Mexico Agency Technical Work Group

Cultivated land comprises less than four percent of the State's area.[146] One-third to one-half of the farmed acres in New Mexico is irrigated. The major crops in the state are sorghum, wheat, and hay. Projected climate change could reduce wheat yields by 10-30% and sorghum yields by 7-9%. Hay and pasture yields could fall by 4% or rise by 9%. Farmed acres could fall by 20-25%. [147]

8.1.4 Health

Heat

In New Mexico, episodes of extreme heat are projected to increase several-fold in the mid to late 21st century because of global warming. Daily maximum temperatures which are now exceeded on the hottest 18 days of the year are projected to be exceeded on 60 to 70 days per year.[148] In New Mexico, the adverse effects of heat waves may be more greatest not in the desert, but in northern, higher elevation areas, where air-conditioning is lacking.[149]

Infectious Disease

Disruption of ecosystems may lead to outbreaks of infectious diseases that are transmitted by our have reservoirs in rodents, birds, or insects. New Mexico leads the nation in total number of human plague and hantavirus cases.[150] Both of these diseases are spread by rodents. Outbreaks of plague in New Mexico have been linked to increased winter and spring precipitation. Additional diseases that may be influenced by climate change are dengue fever, arboviruses such as West Nile virus, and Valley Fever. For mosquito-borne diseases such as dengue fever, West Nile virus, and malaria, warmer temperatures may augment the mosquito breeding season and shorten the incubation period of the disease-causing organism within the mosquito.[151] Global warming is projected to increase winter minimum temperatures substantially, which could bring areas of southern New Mexico within the climate range of dengue fever vectors. Limited studies suggest that global warming is likely to increase the distribution and incidence of valley fever in New Mexico.

Pollution

Climate change is likely to increase air pollution in New Mexico, particularly levels of ground-level ozone, which is an air pollutant that can exacerbate asthma and chronic lung diseases. New Mexico currently has three areas with elevated ozone levels that nearly exceed the federal

[146] WRCC
[147] EPA
[148] Diffenbaugh et al.
[149] New Mexico Agency Technical Work Group
[150] New Mexico Department of Health
[151] New Mexico Agency Technical Work Group

health standards: Bernalillo County, Rio Rancho, Sunland Park, and San Juan County.[152] Modeling studies suggest that the effect of temperature increases in New Mexico could be a 5-20% increase in ozone concentrations, and the number of air stagnation days, in which pollutants accumulate in the lower atmosphere near the source, is likely to double.[153] 21st century ozone levels will depend significantly on changes in emissions of ozone precursors, which are largely produced by fuel combustion.[154]

The impact of particulate matter and smoke on air quality is also a significant concern in New Mexico. Global warming is predicted to increase the risk of large wildfires, the occurrence of which has already led to deterioration of air quality in New Mexico for several consecutive days at a time.

The increasing severity of droughts projected in climate models is predicted to increase the frequency and severity of dust storms, which are already a regular occurrence in the drier parts of New Mexico. This will significantly reduce air quality.

8.1.5 Infrastructure

The impact of climate change on urban infrastructure and built systems has been significantly less studied than impacts on natural systems. The report "Potential Effects of Climate Change on New Mexico" prepared by the State of the New Mexico Agency Technical Work Group provides a brief summary of predicted impacts of climate change on urban infrastructure and systems. Infrastructure systems sensitive to climate include those for flood control and drainage, climate control in buildings, electrical power distribution, sewage, water supply, and transportation.

Higher temperatures will place extreme levels of demand on energy-providing systems. There will be a need to prepare for changes in cooling demands represented by increases in use of air conditioning, as responses to warmer temperatures are already evident. Annual heating degree day (HDD) and cooling degree day (CDD) values measured by New Mexico utility companies have already changed by more than 15 percent since the middle of the 20th century.[155] Winter heating needs are diminishing while the energy required for summer cooling is rising rapidly. Retrofitting existing cooling systems with more energy efficient systems, designing buildings to stay cooler and to withstand a wider range of climatic conditions will be important measures.

Drainage and sewage systems may be damaged by overflow due to changing rainfall patterns, particularly more intense storms and droughts. Excessive surface water due to intense precipitation events may overwhelm catchment and drainage systems and lead to flooding of

[152] New Mexico Agency Technical Work Group
[153] New Mexico Agency Technical Work Group
[154] New Mexico Agency Technical Work Group
[155] Gutzler 2007

roadways. Potential solutions include retrofitting drainage and sewage systems for a wider range of flow patterns and increasing the storage capacity of drainage and sewage systems.

8.1.6 Population

The population of New Mexico grew at the rate of 1.8% from 1990 to 2000 and is expected to grow at the rate of 1.4% from 2000 to 2020. The greatest concern of population growth in New Mexico is pressure on the state's water supply. Effects of eastern New Mexico population growth on water quality of the Pecos River Basin have already become a concern.[156] The increase in New Mexico's population over the past several decades has further increased vulnerability to drought.[157]

8.1.7 Aggregate State Economy

New Mexico is highly dependent on its landscape and natural resource endowments for its economic vitality. State tourism is estimated to be a $4.95 billion dollar industry.[158] Reduced opportunity for outdoor recreation will likely adversely affect the state's economy because outdoor activities are a major attraction to New Mexicans and tourists. Climate change may significantly affect the tourism industry in the areas of snow sports; water recreation; camping, fishing, and hunting; and scenic vistas.

8.2 Current Stances and Policies in Coping with Climate Change

8.2.1 Governmental Level

Cumulative GHG reductions from 2007-2020 are estimated at 267 MMTCO2e. The recommendations provided by the CCAG are projected to create net economic savings of over $2 billion for the State's economy over the period 2007-2020.[159]

The State has implemented many initiatives and programs to reduce GHG emissions, and particularly, to promote clean energy. These include:

- **Establishing a strong telework and flexible work hours to help reduce fuel use and taxpayers' costs** – According to Executive Order 08-28, this measure:
  1. Directs state agencies to adopt a written policy defining specific criteria and procedures for those programs by September 1, 2008.[160]

[156] McLemore and Brandvold
[157] State Water Plan.
[158] Rez Biz
[159] CCAG
[160] New Mexico Energy, Minerals and Natural Resources Department

2. Calls for changes to state vehicle usage, with emphasis on public transit and technology improvements. Improves and promotes the existing flex-pay transit deduction program to encourage employees to use public transit.

3. Creates a pool of short term lease vehicles and enhances existing fleet capabilities to match the most efficient vehicles to intended uses.

4. Directs the Department of Information Technology to improve and promote state government's use of technology such as telephone, video, and internet conferencing to support telework and reduce unnecessary transit.

- **Increasing energy efficiency in state government by 2015 and statewide by 2012 and 2020** – Executive Order 07-53 sets goals of 20 percent energy usage reduction in state buildings and transportation by 2015 through the Lead by Example Initiative, based on building energy per square foot and fuel energy per employee. It also sets a goal of 20 percent energy usage reduction for statewide energy usage, based on total energy per capita. It additionally sets an interim goal of 10 percent energy usage reduction by 2012. [161]
- **New Mexico climate change action** – Executive Order 06-69 established a Climate Change Action Implementation Team to oversee seven state departments in development of their respective strategies to address GHG emissions.
- **Energy efficient green standards for state buildings** – Executive Order 06-01 required that all public buildings over 15,000 square feet to be LEED Silver certified. The executive order also established the Public Schools Clean Energy Task Force that makes recommendations to implement energy efficiency measures in existing school buildings, construction of new schools, and renovations.
- **Requiring the increased use of renewable fuels in New Mexico state government** — Executive Order 05-49 requires that all cabinet level agencies, public schools and institutions take action toward obtaining 15 percent of their total transportation fuel requirements from renewable fuels by 2010.[162]Additionally, 75 percent of vehicles acquired each year must be capable of operating on alternative fuels or are gas-electric hybrids.
- **Climate change and greenhouse gas reduction** – Executive Order 05-33 outlined greenhouse gas reduction strategies for New Mexico. The order set greenhouse gas reduction targets for New Mexico to 2000 levels by 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050.
  The order established the Climate Change Action Council and the New Mexico Climate Change Advisory Group (CCAG). CCAG represents a diverse group of stakeholders from industry, agriculture, nongovernmental organizations, government, tribes, labs, and universities. The CCAG, in conjunction and with the support of the New Mexico Environment Department and the Center for Climate Strategies, was directed to prepare a comprehensive report that included proposals for reaching the emissions reduction goals, consideration of costs and benefits of proposals, an inventory of historical and forecasted GHG emissions in New Mexico, and findings on initiatives to create policy to address climate change.

[161] New Mexico Energy, Minerals and Natural Resources Department
[162] New Mexico Energy, Minerals and Natural Resources Department

CCAG developed 69 policy recommendations for the Governor in the areas of cross-cutting issues; energy supply; residential, commercial, industrial and waste management; transportation and land use; and agriculture and forestry. These recommendations are summarized in the table at the end of this sub-section.

- **Declaring New Mexico "The Clean Energy State"** – Executive Order 04-19 created the Clean Energy Development Council to provide policy recommendations for clean energy business growth and communicate with stakeholders about clean energy development.
- **SB 418** (2007) required that at least 15 percent of an electric utility's power supply come from renewable sources by 2015 and 20 percent by 2020.[163] SB 418 revised the Renewable Energy Act of 2004, which had a major loophole that allowed biomass power plants to emit nitrogen oxides at a rate that is over 50 percent of typical coal fired plants in the United States. SB 418 doubled New Mexico's Renewable Portfolio Standard for investor-owned utilities and created a separate standard for rural electric cooperatives.
- **HB 188** (2007) created a Renewable Energy Transmission Authority (RETA) to promote clean energy jobs and help New Mexico develop clean energy resources and market them to other states. This will support and facilitate development of new transmission designed to carry 30% renewable energy. New Mexico was the first US state to form a renewable energy transmission authority that provides financing for new high-voltage lines and towers.[164]
- **SB 489**, the Biodiesel Standards Act, mandated that after July 1, 2010 and before July 1, 2012, all diesel fuel sold to state agencies, political subdivisions of the state and public schools for use in motor vehicles on the streets and highways contain five percent biodiesel. It further mandates that after July 1, 2012, all diesel fuel sold to consumers for use in motor vehicles on the streets and highways contain five percent biodiesel.
- **HB 825** (2007) created a $500,000 revolving loan fund to help finance energy efficiency assessments. It enacted technical amendments to existing statute to ease implementation of law that allows state agencies and public schools to fund energy efficiency and renewable energy renovations from the energy utility bill savings.
- **SB 463** (2007) approved several tax incentives, including a sustainable building tax credit, an advanced CO2 injection rules and regulations by July 2008, and exempts CCS property and any electric generation unit utilizing CCS from all property taxes for five years following completion of construction or installation of the property and allows for accelerated depreciation of CCS equipment.[165]
- **SB 269** (2005) creates a 30 percent tax credit, allowing an individual tax credit of 30 percent of the purchase and installation costs for solar electric and solar thermal systems, up to $9,000 for each system. The bill provides $3 million for solar electric tax credits and $2 million for solar thermal tax credits each year, and the credit is available for 10 years.
- (2007) New Mexico created the first tax credit in the nation to cover carbon capture technology and include specific capture goals at coal-fired power plants.
- (2007) The New Mexico Public Regulation Commission unanimously approved a large expansion to the state's net meeting policy to allow electric utility customers to net-meter electricity generated from renewable energy systems with a peak capacity of up to 80

[163] Goldstein
[164] Schor
[165] WGA

megawatts, whereas previously net interim in the state was limited to systems small than 10 kilowatts.

- (2006) Governor Richardson announced a legislative agenda designed to invest in tax incentives, biofuels and green buildings, which includes a $23 million investment in energy efficiency and green buildings, a recurring investment of $9.6 million a year for land, wildlife, and clean energy projects, and $3 million in tax incentives for biofuels, energy efficient appliances and renewable energy manufacturers. [166]
- (2005) New Mexico enacted the Efficient Use of Energy Act which authorized and directs electric and gas utilities to implement cost-effective energy efficiency programs in order to reduce utility expenditures and keep energy dollars in the state.
- (2005) New Mexico enacted the Energy Efficiency and Renewable Energy Bonding Act which funds energy efficiency and renewable energy renovations at existing state, tribal, and public school facilities by capturing energy utility bill savings to pay the debt service on bonds. New Mexico was the first state in the nation to approve of this funding mechanism.
- (2004) Governor Richardson signed New Mexico's first Renewable Portfolio Standard into law, which mandated that 5% of New Mexico's electricity come from renewable sources by 2006, increasing by 10% by 2011.

8.2.2 Industry/Business/Household Levels

Under the governor's mandate, PNM, New Mexico's largest electricity and natural gas provider, has created a set of discounts and rebates that make it attractive for consumers to save energy. The PNM Energy Efficiency Program is a collection of customer offers that give homeowners, business owners, and home builders discounts or rebates on products that save energy.[167] Under a new load management program, PNM will shut off air conditions, lighting and other fixtures using remote controls for short periods when electric demand spikes. About 8,000 residential and small-business customers signed up, representing a cumulative total of 8 megawatts of electric demand. Another 20 large commercial customers have joined, adding 7 more megawatts of power. Program runs from June to September. Customers earn monetary incentives for participation. Homes and small businesses get an initial $25 upon enrollment, and then $25 per year for each cooling unit added in the network.[168]

New Mexico's range of tax credits, incentives, and programs to encourage renewable energy and efficiency has attracted green businesses and industries in this last decade. Schott Solar Inc, Emcore, Advent Solar Inc, Tesla Motors, Altela Inc, Miox Corp, and Autotroph Design are a handful of examples.

[166] Goldstein 2006

[168] Robinson-Avila

8.3 WCI and other Regional Actions

As a member of the Western Climate Initiative, New Mexico has committed to 15 percent reduction of 2005 GHG emissions levels by 2020. New Mexico's original state reduction goal, defined in 2005, was 2000 levels by 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050. As called for by the WCI, New Mexico has a clear plan for action in all sectors, including stationary sources, energy supply, residential, commercial, industrial, transportation, waste management, agriculture and forestry, as outlined in the report prepared by the Climate Change Action Group.

New Mexico is also a member of the Western Governors' Association and the Clean and Diversified Energy Initiative (CDEi)**,** formed in 2004. Western governors formed the Western Governors' Association, under the leadership of Governors Bill Richardson, Arnold Schwarzeneggar (CA), Dave Freudenthal (WY), Jon Huntsman (UT), and John Hoevan (ND). The Clean and Diversified Energy Initiative is comprised of goals to:

- Develop an additional 30,000 megawatts of clean energy by 2015 from both traditional and renewable sources
- Achieve a 20% increase in energy efficiency by 2020
- Ensure a reliable and secure transmission grid for the next 25 years [169]

[169] WGA

Table 17: Summary of CCAG Policy Recommendations by Sector

Explanatory Note on "Level of Support" column: UC=Unanimous Consent. Majority=Simple majority. Obj's=number of objections. Total number of options=69 due to counting both ES-1b and ES-1c.

	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2007-2020	Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
	CROSS-CUTTING ISSUES						
CC-1	State Greenhouse Gas Reporting	*Non-quantified enabling policy*					UC
CC-2	State Greenhouse Gas Registry	*Non-quantified enabling policy*					UC
CC-3	State Climate Public Education and Outreach	*Non-quantified enabling policy*					UC
	RESIDENTIAL, COMMERCIAL AND INDUSTRIAL						
RCI-1	Demand Side Management (DSM) Programs, Energy Efficiency Funds,and/or Energy Efficiency Requirements for Electricity	0.2	1.0	5.5	-$98	-$18	UC
RCI-2	Demand Side Management (DSM) Programs, Energy Efficiency Funds, and/or Energy Efficiency Requirements for Natural Gas and Other Fuels	0.03	0.2	1.0	-$55	-$55	UC
RCI-3	Regional Market Transformation Alliance	0.1	0.5	2.9	-$79	-$27	UC
RCI-4	State Appliance Standards	0.1	0.3	2.1	-$97	-$46	UC
RCI-5	Green Power Purchasing	0.3	0.1	2.3	$15	$7	UC
RCI-6	Rate Design (Including Time of Use Rates, Increasing Block Rates, and Seasonal Use Rates)	0.3	0.3	3.6	-$141	-$40	UC
RCI-7A	Improved Building Codes	0.9	2.4	16.6	-$200	-$12	UC
RCI-7B	Solar Hot Water-ready and Solar-PV-ready Codes for New Buildings	*Not quantified*					UC
RCI-7C	Solar Hot Water Systems as an Element of Building Codes for New Buildings	*Not quantified*					UC
RCI-8A	Building Energy Performance Requirements for State-funded and Other Government Buildings ("Reach Codes")	0.01	0.04	0.2	0.2	$1	UC
RCI-8B	Building Energy Performance Promotion and Incentives for Energy Performance Enhancements (Attaining "Reach Codes") in Non-Government Buildings (Including Existing Buildings)	0.3	1.3	7.4	-$16	-$2	UC
RCI-9	Government Agency Requirements and Goals (including procurement) -- Focus on operations	0.04	0.2	0.9	-$18	-$20	UC

	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2007-2020	Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
RCI-10	Education and Outreach for Building Professionals	*Not quantified*					UC
RCI-11	Consumer Education Programs	*Not quantified* *Jointly considered with CC TWG*					UC
RCI-12	Increased Emphasis on Energy and Environmental Consideration in Higher Education						UC
RCI-13	Incentives and Promotion for Renewable Energy and Clean Combined Heat and Power	*Jointly considered with Energy Supply TWG*					UC
RCI-14	Regulatory/Legislative Grid, Pricing, and other Policies to Support Distributed Generation						UC
RCI-16	Participation in Regional (or National) Industry Emissions Cap and Trade Programs	*Jointly considered with Energy Supply TWG*					UC
RCI-17	Voluntary Emissions Targets	0.3	0.7	4.6	*Not quantified*		UC
RCI-18	Use of Alternative Gases (Non-Energy Emissions, Indus. Process Gases)	*Not quantified*					UC
RCI-19	Solid Waste Recycling, Source Reduction, and Composting						UC
	Scenario A: Financial/Technical Support	0.2	0.5	3.6	*Not quantified*		UC
	Scenario B: Financial/Technical Support and Mandatory Recycling	0.5	1.1	8.4	*Not quantified*		UC
	ENERGY SUPPLY						
ES-1	Mandate(s) for Renewable Energy (RPS, etc.)						
	Scenario B: 10% in 2011, 1% increase/year to 2021	1.1	2.6	17.8	$102	$6	UC
	Scenario C: 10% in 2011, 2% increase/year to 2021	*See ES-4 below*					Majority (9 Obj's)
ES-2	Financial Incentives for Distributed Renewables	0.02	0.4	1.6	$164	$105	UC
ES-3	Renewable Energy Transmission and Storage	*Not quantified*					UC
ES-4	RPS with Financial Incentives for Centralized Renewables	1.2	4.2	26.0	$215	$8	UC
ES-5	R&D including Energy Storage	*Not quantified*					UC
ES-6	Advanced Coal/Fossil Technologies (e.g., IGCC with carbon capture)	0.8	4.3	22.7	$650	$29	UC
ES-7	Nuclear Power	*Not quantified*					UC
ES-8	Incentives and Barrier Reductions for Combined Heat & Power (CHP)	0.3	0.9	6.1	$26	$4	UC

	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2007-2020	Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
ES-9	Demand-Side Management, Energy Efficiency, and Integrated Resource Planning (IRP)	*Jointly considered with RCI TWG (RCI-1)*					
ES-10	Transmission Capacity and Corridors	*Not quantified*					UC
ES-11	CO2 Capture and Storage or Reuse (CCSR) in Oil and Gas Operations	1.6	3.0	25.1	*Not quantified*		UC
ES-12	Methane Reduction in Oil and Gas Operations: BMPs and PROs	2.7	3.4	35.3	*Not quantified*		UC
ES-13	CO2 Reduction from Fuel Combustion in Oil and Gas Operations	0.6	1.4	10.6	*Not quantified*		UC
ES-14	GHG Cap and Trade	*Not quantified*					UC
ES-15	Generation Performance Standard	1.2	3.8	24.3	$522	$21	Majority (9 Obj's)
ES-16	Clean Energy Development for Electric Cooperatives	*Non-quantified enabling policy*					UC
	TRANSPORTATION AND LAND USE						
TLU-1	State Clean Car Program	0.4	1.9	10.4	$1,207	-$117	UC
TLU-2	Low Rolling Resistance Tires	0.5	0.6	5.5	$506	-$92	UC
TLU-3	Low-GHG Operation of State Fleet Vehicles	*Not quantified*					UC
TLU-4	Pay-As-You-Drive Insurance	0.2	1.0	5.0	Zero net cost		UC
TLU-5	Incentive/Disincentive Options Bundle	*Not quantified*					UC
TLU-6	Alternative Fuels Use	0.4	1.7	9.1	-$119	-$13	UC
VMT Reduction Bundle TLU-7 to TLU-11							
TLU-7	Infill, Brownfield Re-development	1.2	1.3	13.4	*Zero net costs or positive cost savings*		UC
TLU-8	Transit-Oriented Development						UC
TLU-9	Smart Growth Planning, Modeling, Tools						UC
TLU-10	Multimodal Transportation Bundle						UC
TLU-11	Promote LEED for Neighborhood Development						UC
TLU-12	Targeted Open Space and Croplands Protection	*Considered in Agriculture and Forestry TWG (F-1 and A-8)*					
TLU-13	Diesel Retrofits	*Incorporated as part of TLU-5*					
TLU-14	Truck Stop Electrification/Anti-Idling	0.4	0.7	6.3	$23	$4	UC

	Policy Option	GHG Reductions ($MMtCO_2e$) 2012	2020	Total 2007-2020	Net Present Value 2007–2020 (Million $)	Cost-Effectiveness ($/tCO_2e$)	Level of Support
TLU-15	Intermodal Freight Initiatives	0.1	0.5	2.6	*Not quantified*		UC
TLU-16	Lower Speed Limits	0.2	0.3	2.8	*Not quantified*		UC
	AGRICULTURE AND FORESTRY						
F-1	Forestland Protection from Developed Uses	0.1	0.1	1.2	$46	$22	UC
F-2a	Forest Health & Restoration - Residential Lands	0.2	0.2	2.5	-$115	-$46	UC
F-2b	Forest Health & Restoration – Other Lands	0.5	0.5	6.3	-$92	-$15	UC
A-1	Manure Energy Utilization	0.3	0.8	6.3	$29	$3	UC
A-2	Biomass Feedstocks for Electricity or Steam Production	0.2	0.3	2.6	-$198	-$76	UC
A-3	Ethanol Production	0.5	1.0	7.5	$20	$3	UC
A-6	Conservation Tillage/No-Till	0.1	0.1	0.6	$14	$15	UC
A-7	Convert Agricultural Land to Grassland or Forest	0.4	0.4	4.0	$27	$7	UC
A-8	Reduce Permanent Conversion of Agricultural Land and Rangeland to Developed Uses	0.1	0.2	1.6	$97	$62	UC
A-9	Programs to Support Organic Farming	0.2	0.4	4.4	$2	$0.5	UC
A-10	Programs to Support Local Farming/Buy Local	0.3	1.1	5.9	$1	$0.2	UC
A-11	Biodiesel Production	0.1	0.3	2.3	*Not quantified*		UC
	TOTAL AFTER ADJUSTING FOR OVERLAPS AND RECENT POLICY ACTIONS	16	35	267	-$2,239		n/a

Source: CCAG

8.4 Conclusion

New Mexico has acknowledged the impacts that climate change may have on the state and has shown vision and initiative in its efforts to tackle global warming. Although the effects of climate change on the state have been seldom quantified, New Mexico should be prepared for considerable losses to its natural resources and economy in coming decades. The impact of climate change on the state's water resources is an area that calls for more attention, as water is already over-allocated in some areas and the system of appropriation is complex. Legislation regarding water use and management of the state's water supply with some foresight can go a long way in mitigating the future impacts of climate change, whereas the effects on other areas, such as on New Mexico's ecosystems and air quality, will be less easily mitigated.

New Mexico's presence as "The Clean Energy State" has been somewhat subdued, as the state has been a step behind most other WCI states in development of climate policy. However, as a member of the Western Climate Initiative, New Mexico takes part in a process that has the potential to set an example as a unified action plan for the rest of the nation in climate change policy. As an energy-producing state, New Mexico has great potential to host emerging green industries and to be an example of renewable energy production, especially considering its vast potential for solar power generation. Overall, the state is in a good position for development and implementation of climate policy that, in the long run, will help conserve its abundant natural resources and boost its economy.

9 Oregon Background Review

Internally, Oregon took its climate initiative relatively early in formal legislation: granting authority to the Energy Facility Siting Council to set standards for carbon dioxide emissions for new energy facilities in 2003. Considered the first wave of climate policies in Oregon, these standards included a net emissions rate of 0.675 lb. CO_2 per kilowatt-hour (base load gas plants and non-base load plants) and 0.376 lb. CO_2 per kilowatt-hour.[170]

A second wave of climate policies occurred in 2003 as Governor Ted Kulongski met with Governors of other western states and provinces to form the Western Climate Initiative (WCI). Subsequently, the Governors approved 36 recommendations in five jointly-developed areas to prioritize climate change and economic security. Climate policies modeled California's automobile emissions standards to reduce GHG tailpipe emissions by 30% when it takes full effect in 2016 vehicle models. Further, the climate policies seek to regulate appliance efficiency, although no efficiency standard is defined yet.

In House Bill 3543, Oregon formalized its WCI goals for GHG emission reductions in the following time frames:

1. To arrest emissions growth in the short term (2010–2012).
2. To reduce emissions to 10% below 1990 levels in the medium term (by 2020)
3. To reduce emissions by >75% below 1990 levels in the long term (2040–2050).

Of the WCI partners, Oregon's is a rather strong goal to reduce emissions of GHG: Oregon ties with British Columbia in leading the 2020 goals for reducing emissions in absolute terms, and it leads in its relative reduction levels.[171]

According to the Tellus Institute's 2004 report advising the Western coast state governors on climate initiative, Oregon's electricity uses the highest fraction of coal as compared with California's and Washington's electricity mix. Thus, proposals[172] to back out much of the coal-based electricity can lower emissions most steeply in Oregon. Furthermore, a strategy to reduce fossil-based electricity generation will also yield greater emission reductions in Oregon (by about 8%) by emphasizing efficiency, renewable, and CHP resources.

The Oregon government has stipulated a policy budget to support this climate control effort and endorses groups such as the Department of Environmental Quality (DEQ).[173] The purpose of this report, then, is to examine: (1) the efficacy of these climate policies in terms of GHG reduction and (2) the balance of public and private interest. Besides the state-sponsored DEQ, national and international bodies have sought to engage the climate and air quality dialogue.

[170] Drumheller, Bill. "Oregon Climate Change Regulatory Activities and Policy Initiatives." URL: http://enr.uoregon.edu/org/jell/docs/symposium_drumheller.ppt
[171] Appendix D shows a comparison of state goals to reduce emissions over the years for Oregon, California, and Washington states.
[172] Tellus Institute. "Ten GHG Reduction Strategies for the West Coast." URL:
[173] Department of Environmental Quality. "DEQ Budget Sheet for 2007." URL: http://governor.oregon.gov/Gov/budget0507/intro.shtml

Among these is the Center for Clean Air Policy,[174] an independent, non-profit group seeking to build stakeholder dialogues, education and outreach, qualitative and quantitative research, technical analyses of emission mitigation options, and policy recommendation development.

9.1 Current Evidence and Projected Climate Impacts

According to both the Oregon Department of Energy and the Environmental Protection Agency (EPA), the state's GHG emissions are recorded at about 67.9 $MMtCO_2E$. Oregon comprises 1.135% of national gross GHG emissions. In 2000, Oregon had a gross level of 20 $MtCO_2E$ per capita, which is considerably lower than the national average. Moreover, Oregon's state inventory reports a landfill carbon storage that provided a "sink" of 0.8 $MMTCO_2E$ to offset 1% of Oregon's gross GHG emissions (excluding forestry-related sources due to lack of available data).

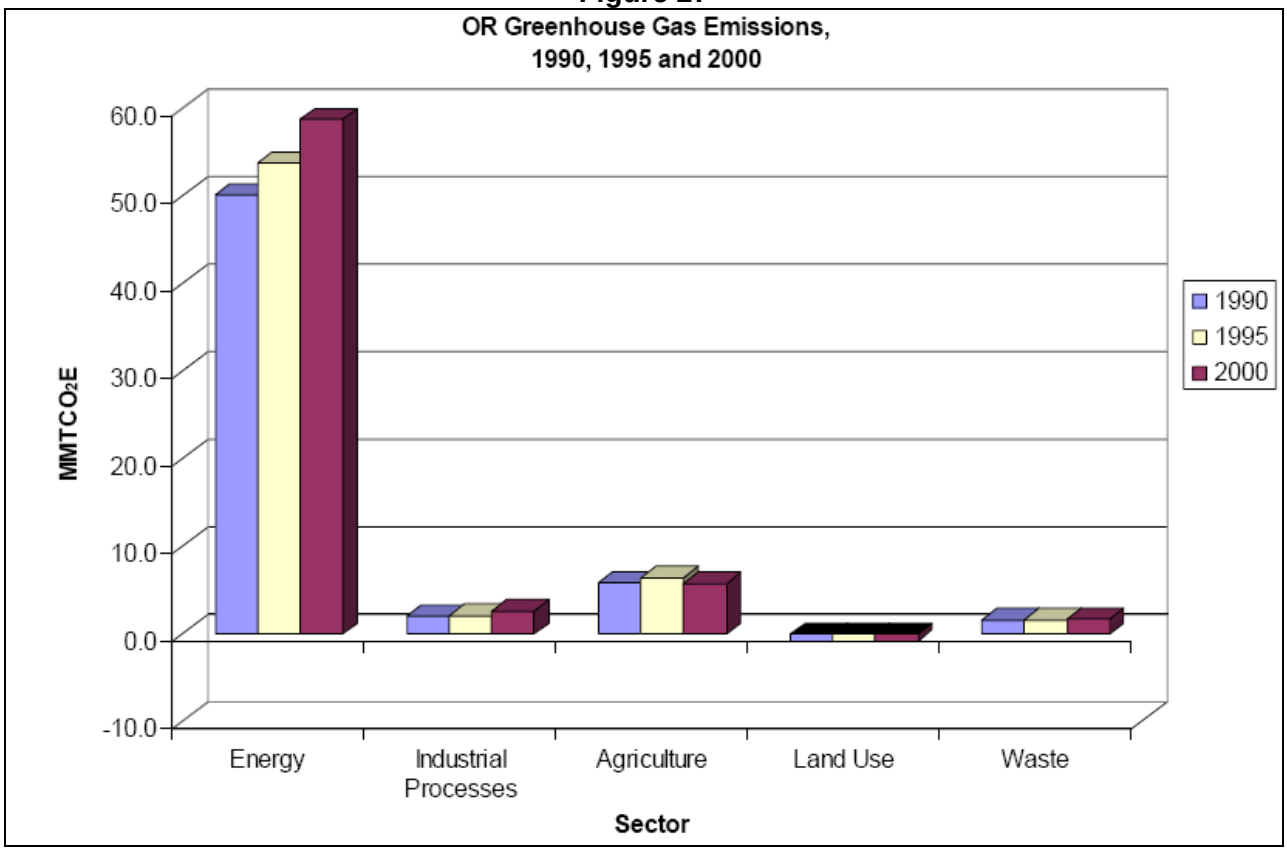
In order to assess the emissions with better and more consistent data, in July 2007, Governor Kulongski had asked the Environmental Quality Commission (EQC) to consider mandating the report of GHG emissions from sources. As a result, the Oregon DEQ is beginning to develop such a rule for consideration by the EQC. For mandatory reporting of emissions, Oregon will be using the Climate Registry, a common platform and quantification protocol agreed to by 38 states, Canada, and Sonora, Mexico. Further organizations enforcing climate change initiatives include:

- Climate Change Integration Group
- Carbon Allocation Task Force
- State Agency Greenhouse Gas Inventory
- Western Climate Initiative
- The Climate Registry
- Western Public Utility Commissions' Joint Action Framework on Climate Change

In a proposal to the Governor in January 2007, the Carbon Allocation Task Force (CATF) had devised a "load-based" emissions cap and trade system – following California's model – to capture CO_2 from electricity imports. The proposal is yet in session and has not yet been voted upon.

[174] Center for Clean Air Policy. URL: http://ccap.org/index.htm

Figure 27



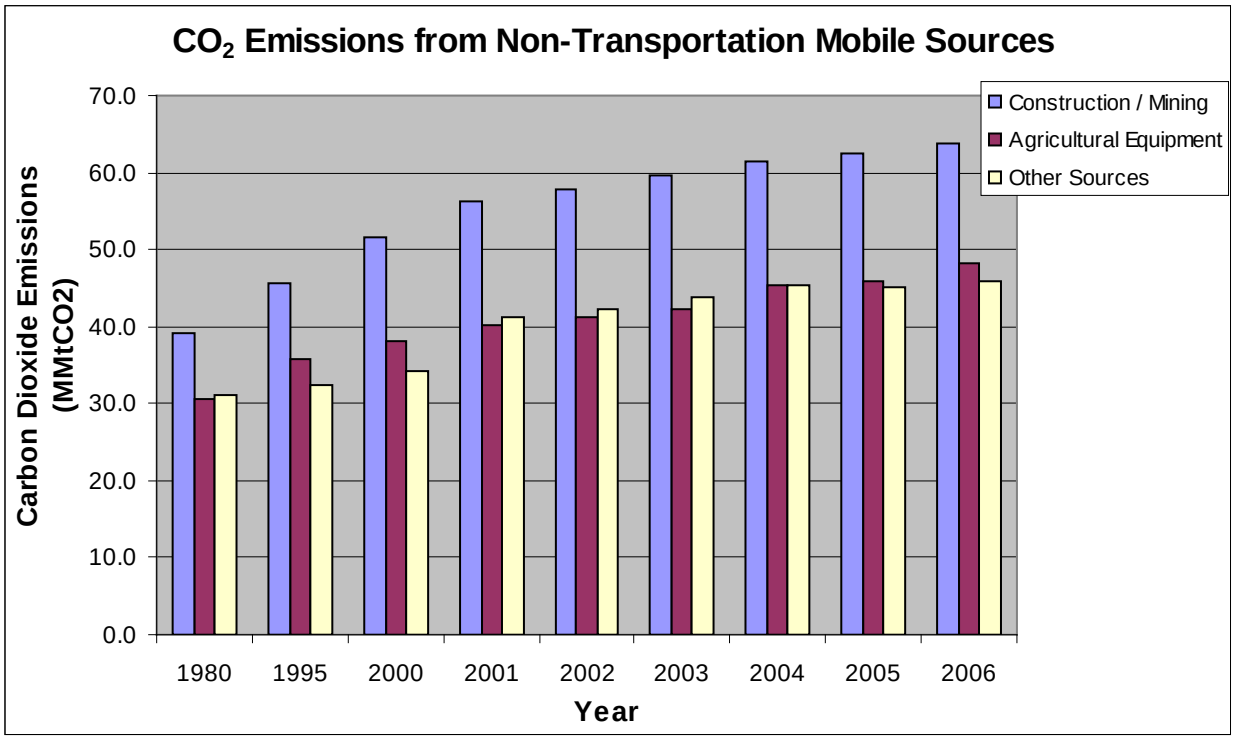
Source: Oregon Inventory Summary.

Between 1990 and 2000, CO_2 emissions trends have increased without deceleration despite the 1997 legislation of emissions standards for energy companies. However, when measuring emissions from non-transport mobile sources, as the emissions from construction / mining, agricultural equipment, and other sources each decelerate after 1997 and seem to plateau. It is yet unclear whether any significant change in emissions took place since the WCI policy goals were made in 2003.

Using 1990 as a base year, emissions of CO_2 from energy usage have grown modestly through the 1990's then hit 11% growth rates in the years 1999 and 2000. As a contrast, Oregon's per capita emissions have decreased by 3% to 25% across the same years. Such trends reveal that rising GHG emissions is not due to higher consumption levels, but rather to other influential factors.[175]

[175] See Appendix F for tabular data from Oregon State inventory.

Figure 28



Source: Inventory of U.S. GHG Emissions and Sinks: 1990 through 2005.

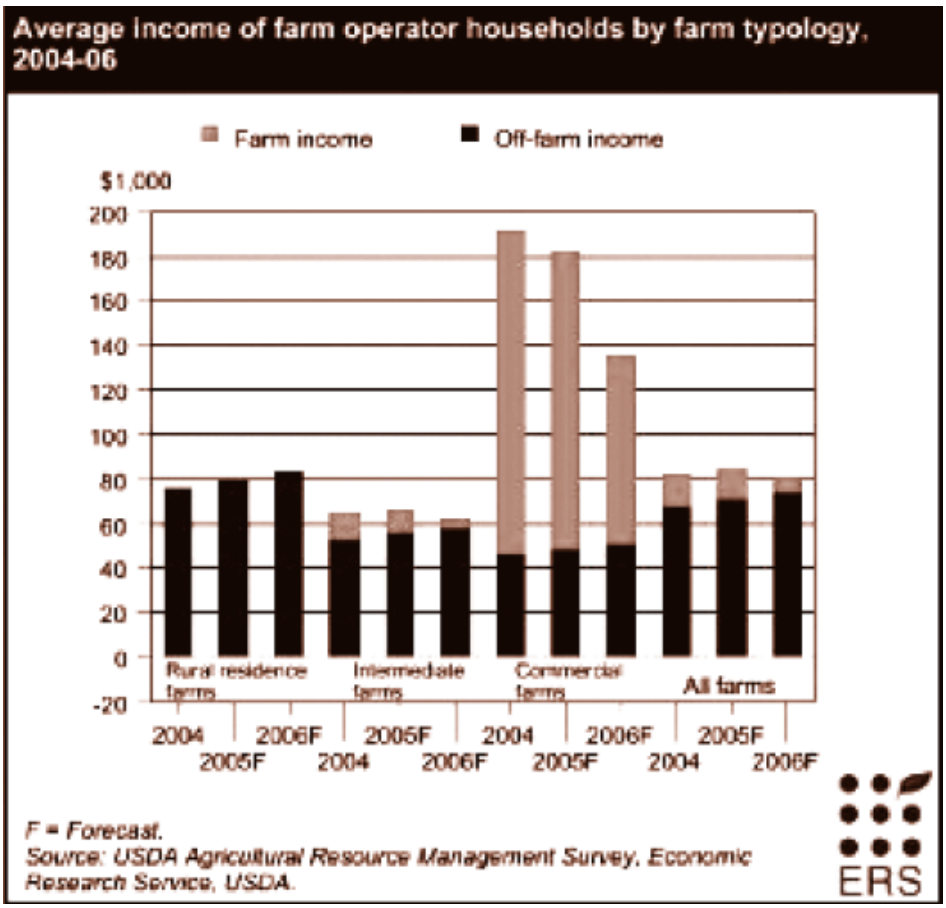
In contrast, the climate has been closely monitored by organizations such as the Oregon Climate Service, run by Oregon State University climatologist, George Taylor. Regarding climate change, Taylor believes that there is clear human influence on climate, although he believes that "natural variations dominate the climate system and will continue to do so." Yet, he contends that there are many reasons to reduce energy consumption and emissions. Taylor manages the state Climate Service website to monitor Oregon weather and climate issues against statistical precedents.

9.1.1 Industry, Development, and Emissions

Agriculture is Oregon's leading industry occupying over 25% of Oregon's land and over 20% of Oregon's income ($4.3 billion per annum). The total value of production has steadily rose over the past two decades as farmers continue to adopt technologies, operational efficiencies, and new production methods to expand output despite shrinking land base. Nominally, the production value of the industry has grown by more than double during the past two decades with cyclical effects driven by weather, policies, world markets, and other factors. As seen from Figure 3, the average in household farm income hit a high point in 2004, and has since

declined. Yet, Oregon's per-capita income in rural areas rose from $26,412 in 2005 to $26,981 in 2006, in terms of 2006 dollars.[176] On average, farmers' net income pre-tax is 20% for the market price of commodities.

Figure 29: State of Oregon Agriculture.[177]



In 1999 and in recent years, Oregon led the nation in industry growth – rising to 88% of the state's annual $109 billion economy and consuming 31% of the state's energy. Industry became the single largest energy-use segment and resources for business assistance to achieve lower energy, higher efficiency became the more vital. According to the EPA's EPA's facility emissions report from 1999, industrial emissions totaled 54.600 short tons (109.2 million lbs.) of carbon monoxide. Top industries emitting carbon monoxide included metals, pulp mills, paper mills, steel mills, and sawmills.[178] Top emissions counties include Linn, Douglas, Lincoln, Multnomah, and Lane Counties. The urban county of Linn experiences 42 different hazardous air pollutants, totaling 4.82 million short tons, as reported in 1999.

[176] USDA. URL: http://www.ers.usda.gov/StateFacts/OR.htm
[177] State of Oregon Agriculture, January 2007. URL: http://oregon.gov/ODA/docs/pdf/bd_rpt_status.pdf
[178] See Appendix G for the top 25 emissions facilities of 1999.

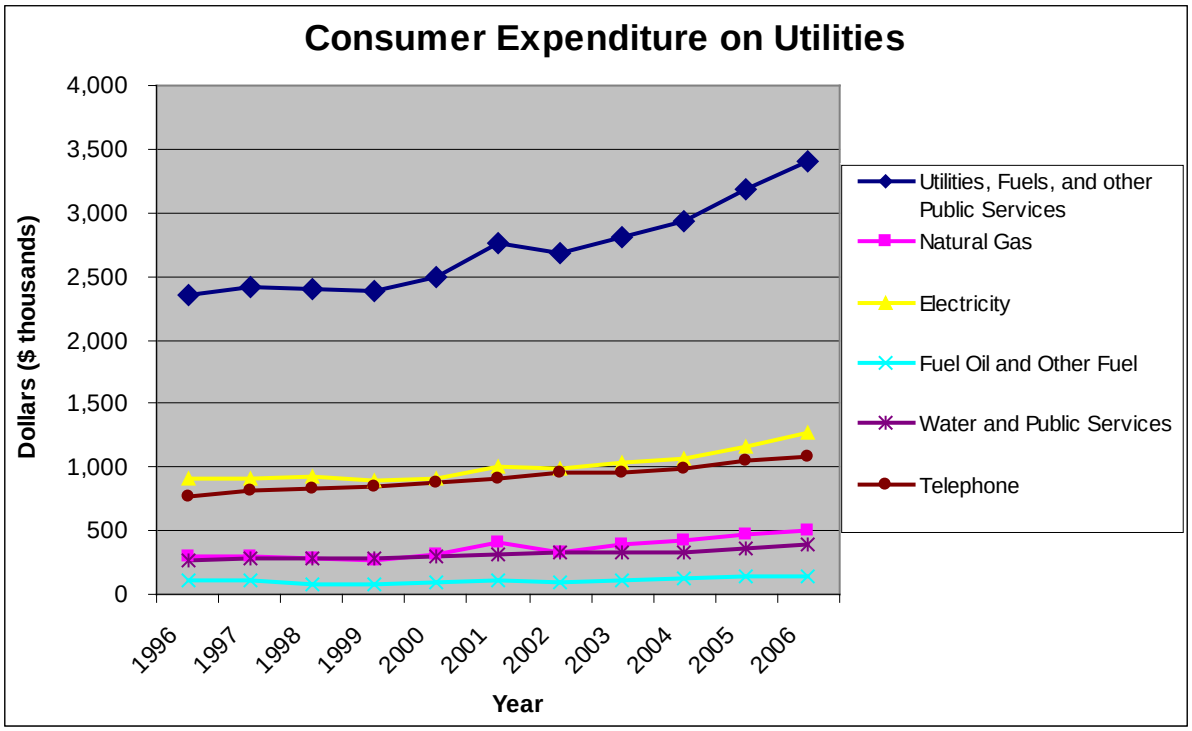
In order to stimulate energy conservation and recycling processes, the Department of Energy offers tax credits to businesses and consumers who apply. Tax credits return 50% for: high efficiency combined heat and power, renewable energy resource generation, and renewable energy resource equipment manufacturing facilities. Tax credits return 10% each year for five years for: homebuilder installed renewable energy facilities and high performance homes. Tax credits return 35% for other eligible project costs. Other methods to help businesses convert to lower energy, higher efficiency regimes include: an energy loan program, energy savings performance contracts (between energy services companies and building owners), and so on. The EPA and other organizations work to invest in programs, cooperatives, and workshops to induce company reductions in waste and emissions.

While climate awareness and policies have so far worked to curb industrial pollutions via taxes and emissions caps, the industrial sector is as much driven by market demand. Thus, the private sector must also bear the same level of environmental awareness in its consumption decisions in order for climate policies to be sustained by the economy. In order to assess the private sector's effect on the energy consumption and emissions levels, this report will first examine the living costs and economic opportunities forming the residents' economic environment.

9.1.2 Private Consumption, Emissions, and State Employment

Oregon's public stance on climate control via GHG reductions has been vocalized by its 5 year Governor Kulongski, by local news, by academics, and by bloggers. Since each of these sources represent the strong views or voices of the population, the public stance may also be assessed by the consumption choices that Oregon citizens make and by the emissions that they drive. Using data from the Bureau of Labor Statistics, one can see Oregonians' pre-tax expenditures on energy-consumption (or utilities).

Figure 30



Source: OLMIS.

As seen from the graph above, consumers spend the most on electricity and telephone use, followed by expenses on natural gas, water and public services, and fuel oil. In terms of electricity consumption, Oregon has one of the top five state net metering programs. Net metering – the generation of electricity by the users themselves (a "single, bi-directional meter") required for most investor-owned utilities – was pushed for within the state.[179]

In 2006, energy consumption amounted to a total state expense of $3.397 million per year. It is not yet clear whether climate policies and Oregon's climate initiative has curbed energy consumption and emissions. Rather, the rise in energy consumption may reflect rises in "cost of consumption" (or cost of living, based on the CPI shown in Figure 3).[180] Consumer spending gives a subtle view of the public sector's decision process and support for climate control in economic terms.

Currently, there is high contention for gas-mileage-conscious consumers: when an automobile show promoted "virtually emission-free" vehicles, the Union of Concerned Scientists (UCS)

[179] DSIRE: Summary Tables. URL: http://www.dsireusa.org/library/includes/incentivesearch.cfm?Incentive_Code=OR03R&Search=TableType&type=Net&CurrentPageID=7&EE=0&RE=1

[180] OLMIS – Cost of Living. URL: http://www.qualityinfo.org/olmisj/OlmisZine?zineid=00000003

countered that the average new car today emits more CO_2 than did 20 years ago[181] on account of SUV's. Oregon's sway on this and auto emission standards could mean a clean air region along the west coast. Thus, the Auto Alliance increased its efforts to persuade citizens and legislators to oppose this public health initiative. For example, the Auto Alliance submitted a "fact sheet" to Oregon legislators titled "Higher Costs, NO Environmental Benefits: Senate Bill 344 Harms Consumers and the Oregon Economy." The UCS rebutted by saying that Oregonians stand to gain greater choice in cleaner vehicles, savings in gasoline, and key influence for major regional initiative to clean up air pollution on the West Coast. Thus, consumer choice emerges from influences of state policies, economic incentives, and manufacturing mixes. Consumer choices are also vastly affected by available information.

9.1.3 Policy Responses

Climate policy has been enforced by state government, the Oregon DEQ, national agencies such as the EPA, and various local NPO's and independent community groups that have sprang up over the years with the same line of consciousness. For example, the Oregon Environmental Council has been an established volunteer organization since 1968 and has been working toward environmental strategies and visions for protecting the land and residents.

Making information available is the key step in decentralizing the state's climate initiative. As data is published or made available by telephone hotline, private consumers and public firms may each evaluate the circumstances of their lifestyle and market actions. In order to encourage environmental awareness and consideration in market decision-making, the Oregon DEQ endorses air pollution advisories, business assistance program, clean air stations, hazardous waste annual reporting, and many more programs.[182]

Particularly relevant to emissions measures and policies, the air pollution advisories encourage individuals and businesses to reduce their pollution-producing activities during hot summer spells and winter stagnation times. This service results in constantly monitoring air quality and pollutant concentration. As warning levels are issued, the DEQ may issue advisories to the public in order that residents and firms both may make adjustments. Only four counties in Oregon issue their own air advisories: La Grande, Lakeview, Lane, and Jackson Counties.

Measures of Air Quality

[181] Automaker vs. the People: Oregon Response. URL: http://www.ucsusa.org/clean_vehicles/avp/automaker-v-the-people-oregon-response.html
[182] Oregon DEQ: Projects and Programs. URL: http://www.deq.state.or.us/programs.htm

Air quality forecasts are measured using an index to report actual levels of ozone and other common air pollutants. The scale is divided into categories corresponding to different levels of health concern, in which higher indices refer to higher health concerns. The AQI is available to the public by a telephone hotline. Information provided in the EPA's Emissions Inventory database are compiled from primary sources of: state and local environmental agencies' emissions inventories, EPA's Maximum Achievable Control Technology (MACT) programs, EPA's Emission Tracking System / Continuous Emissions Monitoring data, and Department of Energy fuel use, Federal Highway Administration's estimate of vehicle miles traveled and emission factors from the EPA's MOBILE computer model, and so on.

Six criteria air pollutants – carbon monoxide, nitrogen oxides, sulfur dioxide, particulate matter, ozone, and lead – are tracked by the EPA to measure: (1) actual pollutant concentrations and (2) engineering estimates of total pollutants released into the air. From 1990 to 2007, each of Oregon's recorded monitoring sites has lower (and generally decreasing) levels of carbon monoxide than the national average.[183]

Public Advisory

Toward industry and stakeholders, Oregon DEQ offers the Business Assistance Program (BAP) to provide technical assistance on air quality rules and related environmental issues. The BAP works with trade associations, interest groups, suppliers, and business owners to find practical and cost-effective solutions.[184] This program is free to all Oregon businesses, however, BAP relies on companies to take the initiative to ask for help and is premised on business owners' environmental concerns. To say the least, most business initiatives involve profit and not environmental concerns. Seeking out external advice for greener business processes requires conscientious business owners or potential regulatory procedures. Thus, in order to develop conscientious business owners and stakeholders, potential regulation or education or incentive programs need to be in place.

Toward private households, the DEQ air pollution advisories provide tips on reducing pollution from cars, wood stoves, mowers, paint, and aerosol sprays. For the long term, private households are encouraged to support ecological businesses, to buy renewable power, and to buy energy efficient appliances. Such advice is reinforced by ratings on appliances, paint, landscaping equipment, and energy producers: PGE, Pacific Power, and Energy Trust of Oregon.[185] Again, the DEQ advisories require some individual initiative to seek out to learn and then to implement the environmentally-friendly utilities.

[183] EPA. "Carbon Monoxide Air Quality Monitoring Sites in Oregon – 1990 to 2007." URL: http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.maptest_07.sas&parm=42101&stfips=41
[184] Oregon DEQ: Business Assistance. URL: http://www.deq.state.or.us/aq/BAP/index.htm
[185] Oregon DEQ: Air Quality Air Pollution Advisories. URL: http://www.deq.state.or.us/aq/advisories/cando.htm

9.1.4 Metrics for Climate Change

Precipitation

As a result of GHG composites and atmospheric pollution, climate change can be measured most notably by patterns of precipitation. In a method developed by PRISM, the de facto group in spatial analysis of climate, rainfall can be calculated across regions by topographical index and distance from weather stations. PRISM uses a linear model assessing steepness of the terrain as the "orographic effectiveness" against moisture-bearing winds. Precipitation is measured at weather stations for each county. Precipitation data from six counties in Oregon show a trend of dryness from the period 1985 to 1995.[186]

Drought

Shifts in precipitation patterns result in dryness patterns that are monitored by the National Drought Mitigation Center, which generates weekly data reflecting broad-scale conditions of dryness. By June 10, 2008, the NDMC reported 44.71% of the land of Oregon as touched by drought and dryness. In total, 14 counties experienced dryness: three of which experience moderate drought and two of which experience severe drought conditions. The impact of drought is measured by the number of reported issues in categories of agriculture, water / energy, environment, fire, social, and other impacts. From the state of Oregon, there have been two reported sources of impact in the past six months.

Global Warming

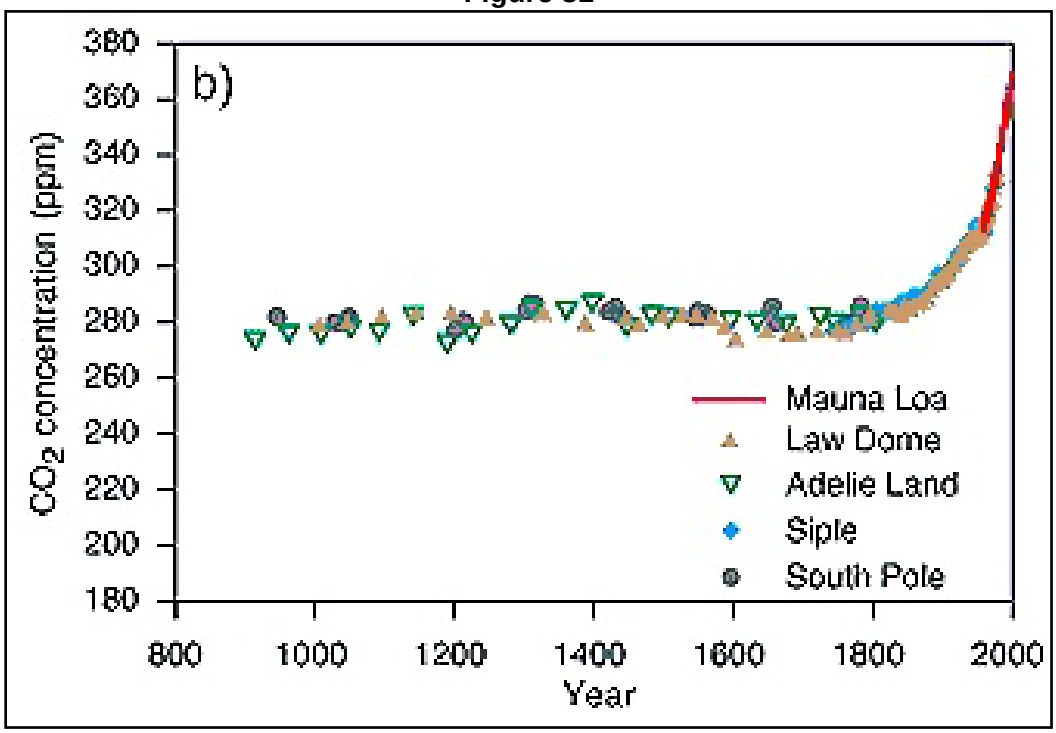
According to the National Oceanic and Atmospheric Administration (NOAA), human activity has been increasing the concentration of GHG in the atmosphere (mostly carbon dioxide from combustion of coal, oil, and gas; and other trace gases). In fact, the global concentration of CO_2 in the atmosphere currently ranges from 490 to 1260 ppmv, which is 75% to 350% above the pre-industrial concentration level. While global temperature data reveals no significant interannual variability, there is indication of variability in temperatures within each year. Surface temperatures have increased about 0.74°C (±0.18°C), yet the effect of GHG accumulation towards global warming is yet debated.[187] The NOAA believes that global warming is a reality, and Oregon's legislature specifically states the need to combat global warming. Meanwhile, Oregon State University's George Taylor, who runs the Oregon Climate Service, remains skeptical. Disagreements on the global warming diagnosis have led Governor Kulongski to ask Taylor to refrain from titling himself as state climatologist.

[186] See Appendix C for precipitation trends as calculated by PRISM.
[187] NOAA. URL: http://www.ncdc.noaa.gov/oa/climate/globalwarming.html#q7

Taylor's counterpart – Philip Mote of University of Washington – claims that human influence on climate has already emerged. Mote points to hydrologic changes in Oregon as the most distinct evidence of global warming. He presents carbon dioxide emissions across the centuries and concludes that carbon dioxide content "is up by 32%." Mote's model measures climate influence by temperature anomalies and estimates influences from natural, human, and other climate factors.[188]

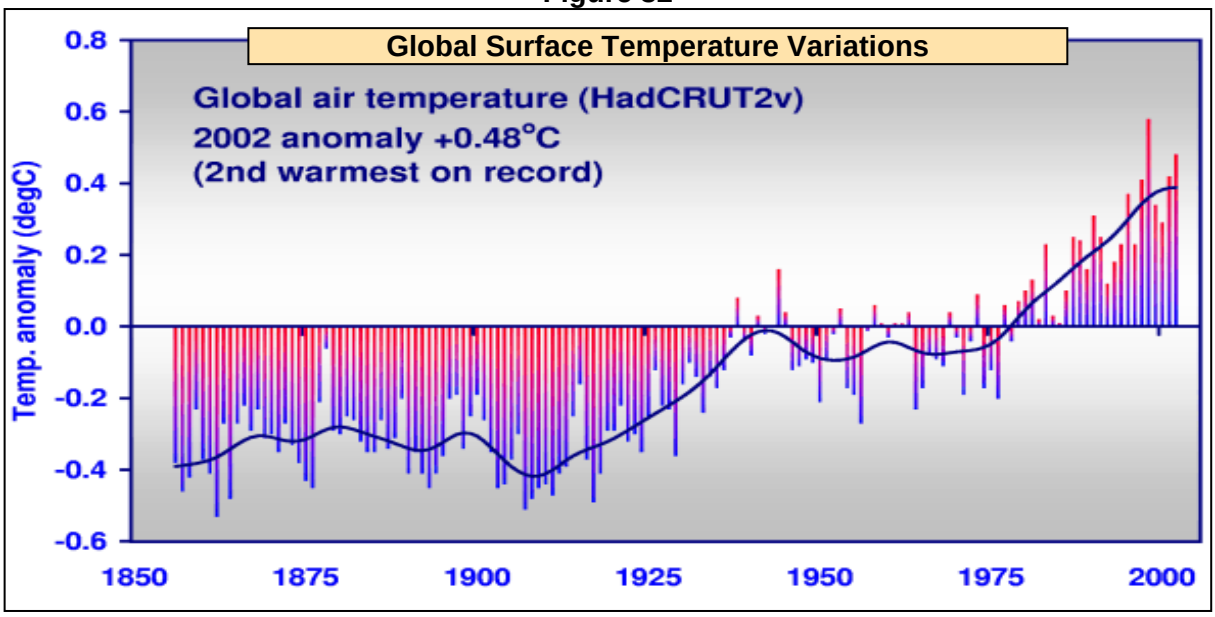
[188] See also, Appendix E, for Mote's modeled temperature changes in the 21st century.

Figure 31



Source: Philip Mote, University of Washington.[189]

Figure 32



Source:Philip Mote, University of Washington

Figure 33

[189] Mote, Philip. University of Washington. URL: http://www1.wrd.state.or.us/files/Publications/staff_reports/2005%20Jan/presentations/Philip%20Mote.ppt

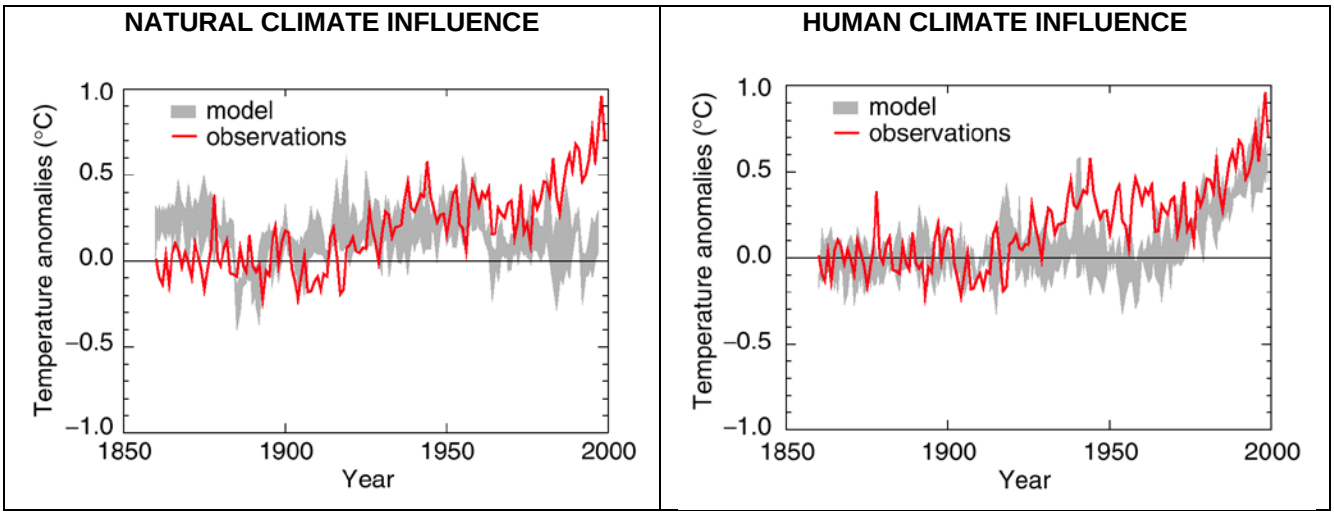
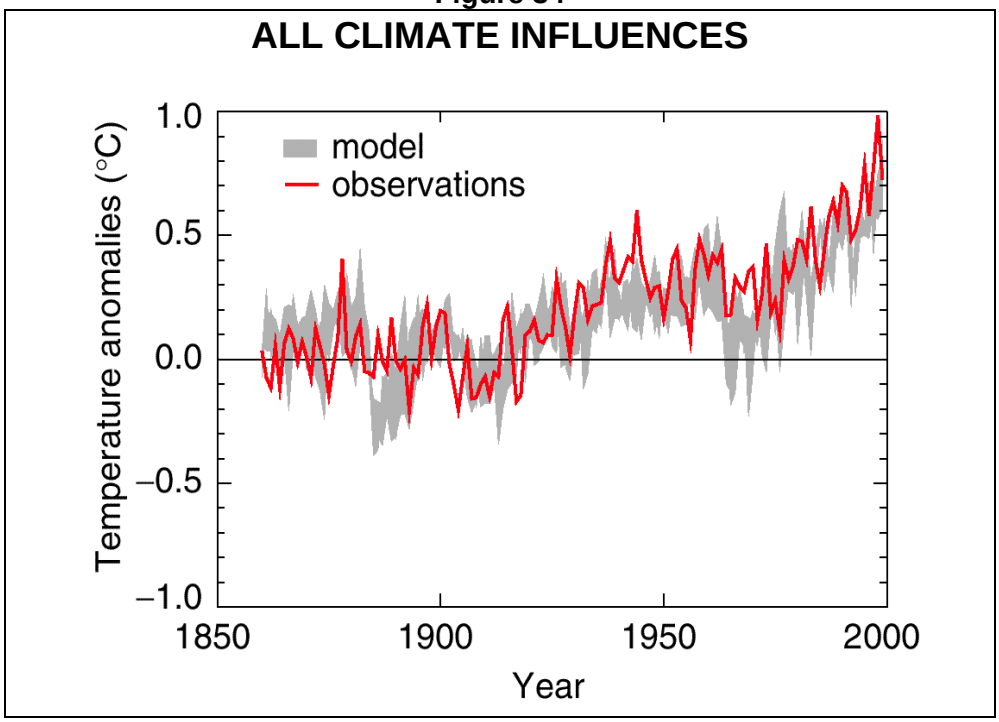


Figure 34



9.1.5 Conclusions

As the Western Governors' Association (WGA) resolved to reach a goal of 30,000 megawatts of clean energy by 2015 and a 20% improvement in efficiency by 2020, the Governors sought to examine the actions needed to meet environmental challenges and the feasibilities of new technologies. The resolution is stated as a "incentive-based, non-mandatory approach" to protect against energy shortages and to accommodate growing energy needs in the population.

The Clean and Diversified Energy Advisory Committee was created to oversee the conversion to clean energy. Market incentives for energy usage are provided in the form of tax incentives.

Even before joining the regional efforts (i.e., that of WCI) or associations' efforts (i.e., that of EPA, NOAA), Oregonians have recognized and voted and passed and acted against human influence on environmental pollution and climate change. Whether due to Oregon's agricultural primacy and culture, there is greater awareness and attention given to changes in climate. At least, the consequences are perhaps more immediate to this community. Regardless of the exact reasons, various businesses, citizens, and governmental figures have each taken environmental initiatives.

Previously, gathering data on GHG emissions was less precise, but since 2003 the WCI and other agencies began to require extensive reporting by member states to account against their goals. Reporting requirements have placed pressure on businesses, NPO's, and environmental groups to attune to the accuracy of their measures – that, in turn, contribute to more precise, aggregate figures gathered by the state.

Oregon's climate policies have been effective with regard to: (1) generating public awareness and cooperation, (2) monitoring of emissions figures, and (3) attending to emissions factors. Public awareness may be detected with the number of NPO's and agencies that have sprang up in relevance to the emissions controls. For example, the Climate Trust is a nonprofit organization that executed contracts with the city of Portland to develop a website for carpooling services and a Lummi Tribe for permanent forest sequestration of CO_2, wind energy projects, transferring landfill gas to electricity in order to recover CO_2, and among other projects, and permanent forest sequestration. These five projects alone will save about $1.50 per MMtCO2, according to the PEW.[190] Reportedly, the Trust had received 78 responses for project proposals in 2001 – demonstrating some success and stimulation of the Oregon Carbon Dioxide Standard toward innovation and public support.

9.2 Lessons Learned

As stated by Mike Burnett, the Executive Director of the Climate Trust, there are a few lessons to be found in the past few years of the landmark Oregon legislative actions to curb emissions. He notes the following three weaknesses in implementing legislation:

- Ambiguity in the law set back payment timelines by power developers to facilities
- Contracting, defining and clarifying the attributes of monitoring and verification plans require extra attention and protocols
- Greater amount of internal administrative funding was needed than anticipated

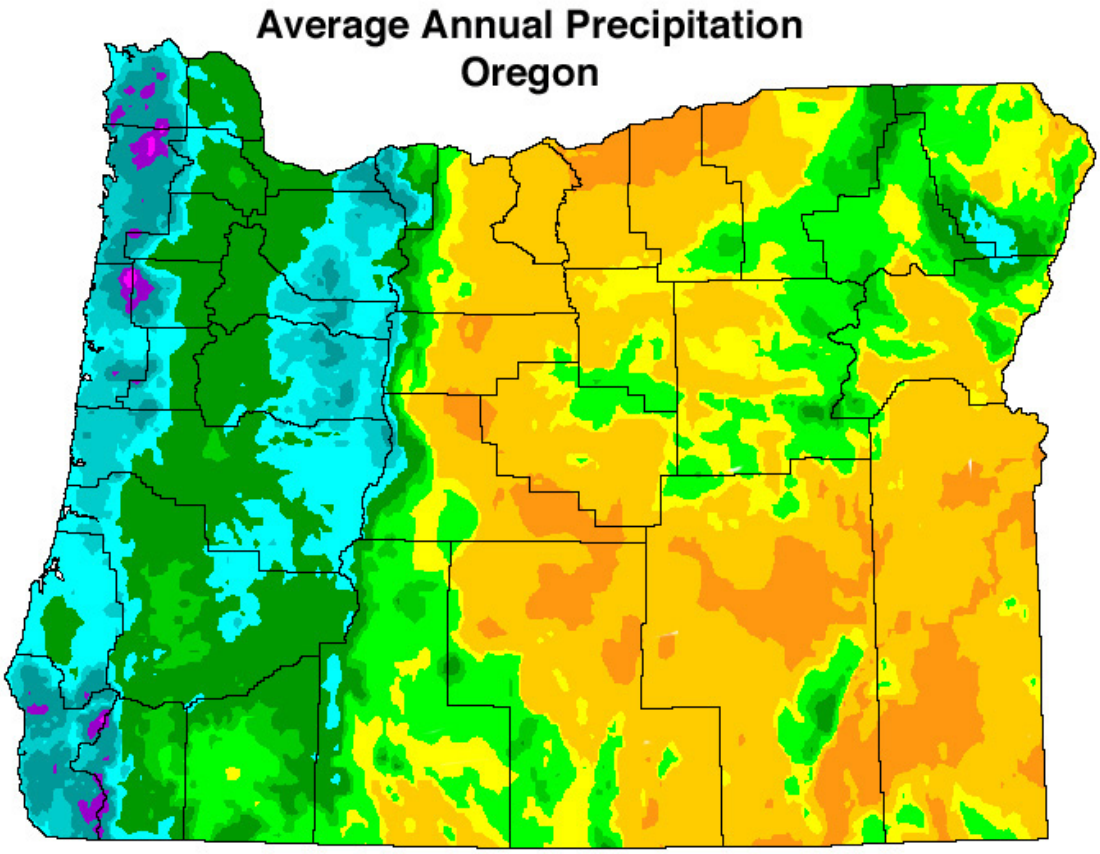
[190] "State and Local Net Greenhouse Gas Emissions Reduction Programs." URL: http://www.pewclimate.org/states.cfm?ID=17

On the other hand, the state of Oregon and the associated climate organizations and programs had purported to offset carbon dioxide emissions and, in fact, were able to do so at reasonable cost so far. Benefits so far include reducing traffic congestion, assistance in developing renewable electricity resources, and preserving a forest.[191] In the following years and phases of projects, GHG emissions must continually be evaluated and actions must be strengthened to achieve the original goals.

[191] The Pew Climate. URL: http://www.pewclimate.org/states.cfm?ID=17

Appendix A.

PRISM – model of annual precipitation averaged over the period from 1961 to 1990.



This is a map of annual precipitation averaged over the period 1961-1990. Station observations were collected from the NOAA Cooperative and USDA-NRCS SnoTel networks, plus other state and local networks. The PRISM modeling system was used to create the gridded estimates from which this map was made. The size of each pixel is approximately 4x4 km. Support was provided by the NRCS Water and Climate Center.

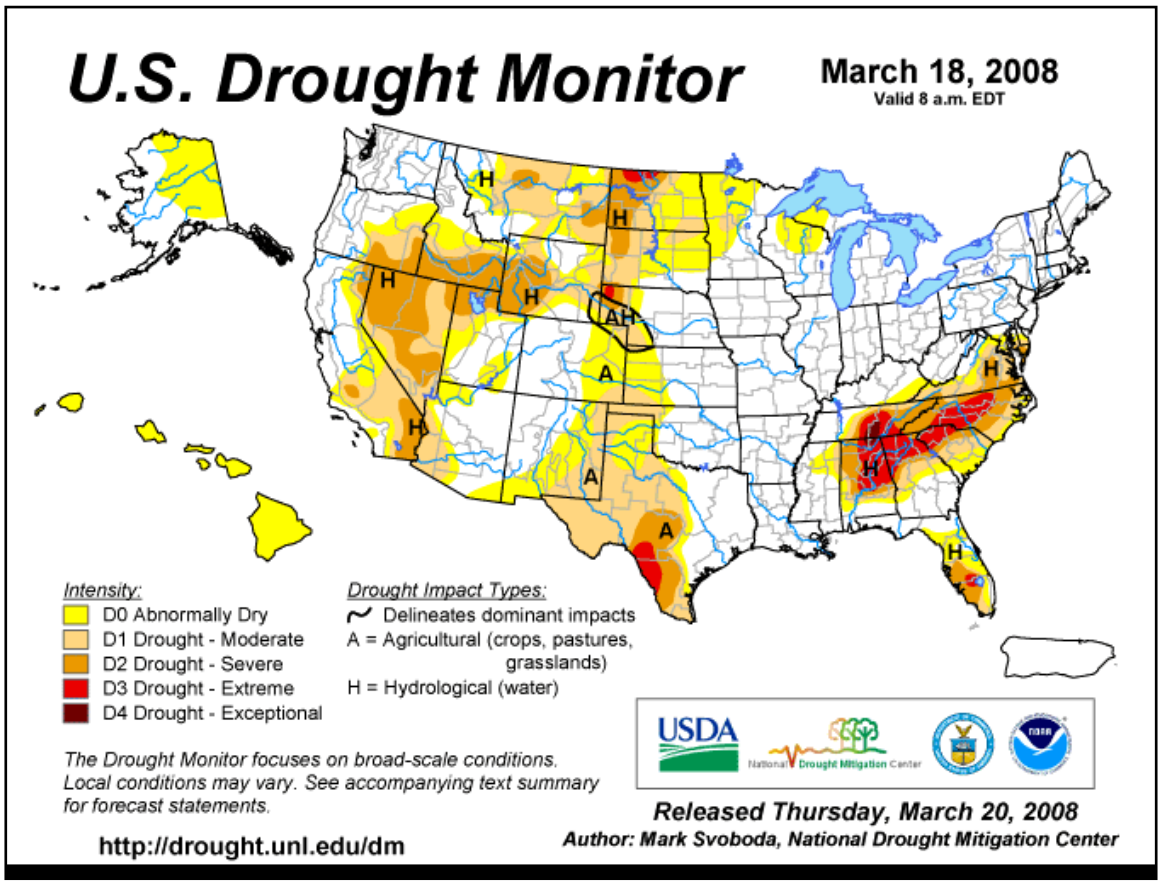
For information on the PRISM modeling system, visit the SCAS website at http://www.ocs.orst.edu/prism

The latest PRISM digital data sets created by the SCAS can be obtained from the Climate Source at http://www.climatesource.com

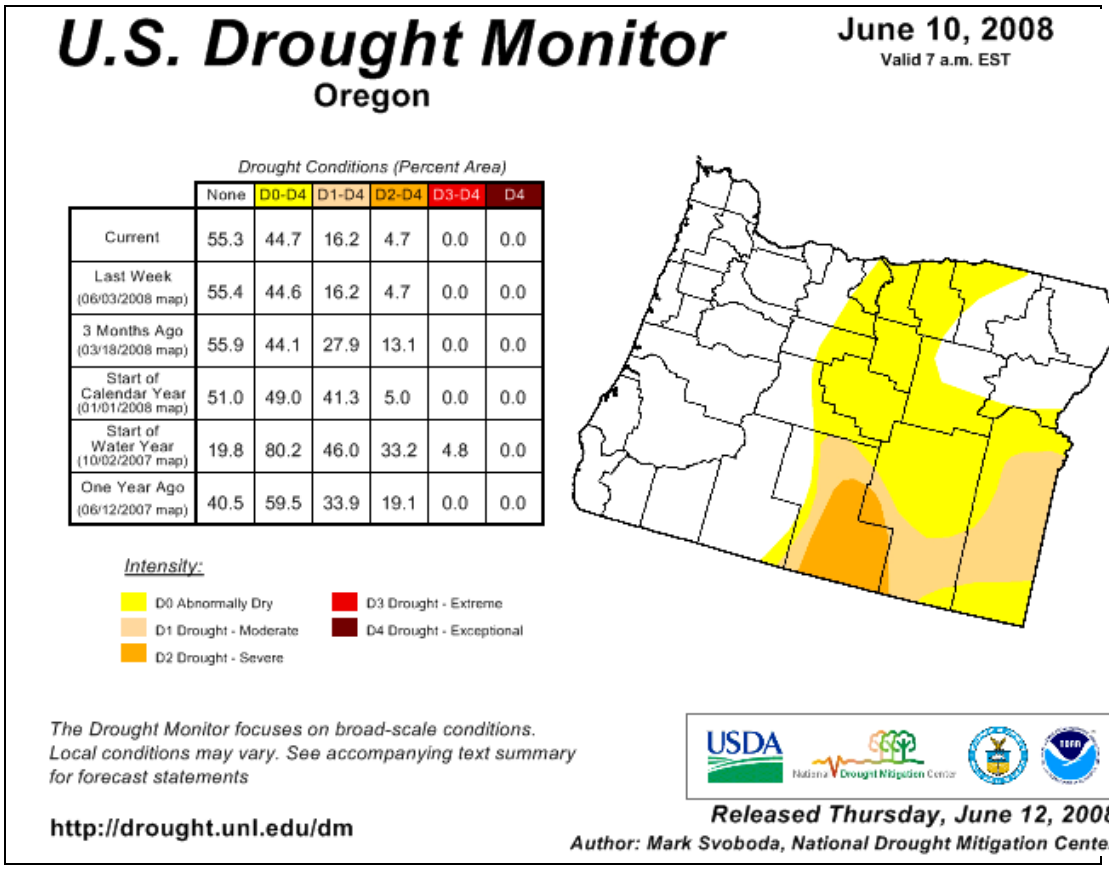
Precipitation (inches)

Under 10	60-80
10-15	80-100
15-20	100-140
20-30	140-180
30-40	Above 180
40-60	

Appendix B. National Drought Monitor map (for animated .gif, please click link below pictures to view original webpage.)



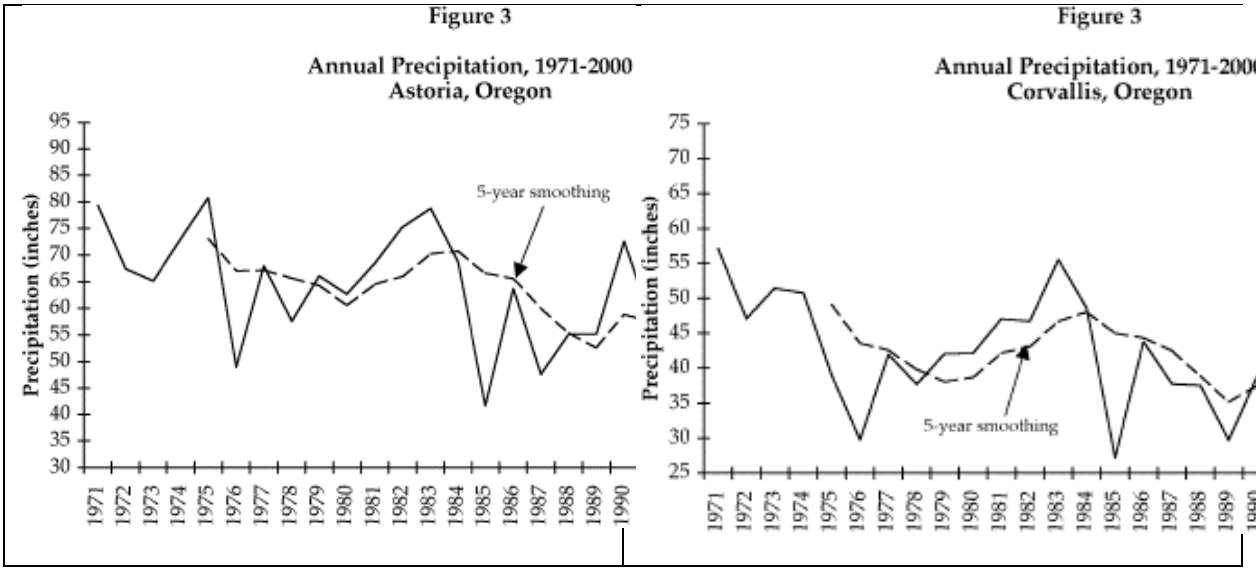
Source URL: http://drought.unl.edu/dm/12_week.gif

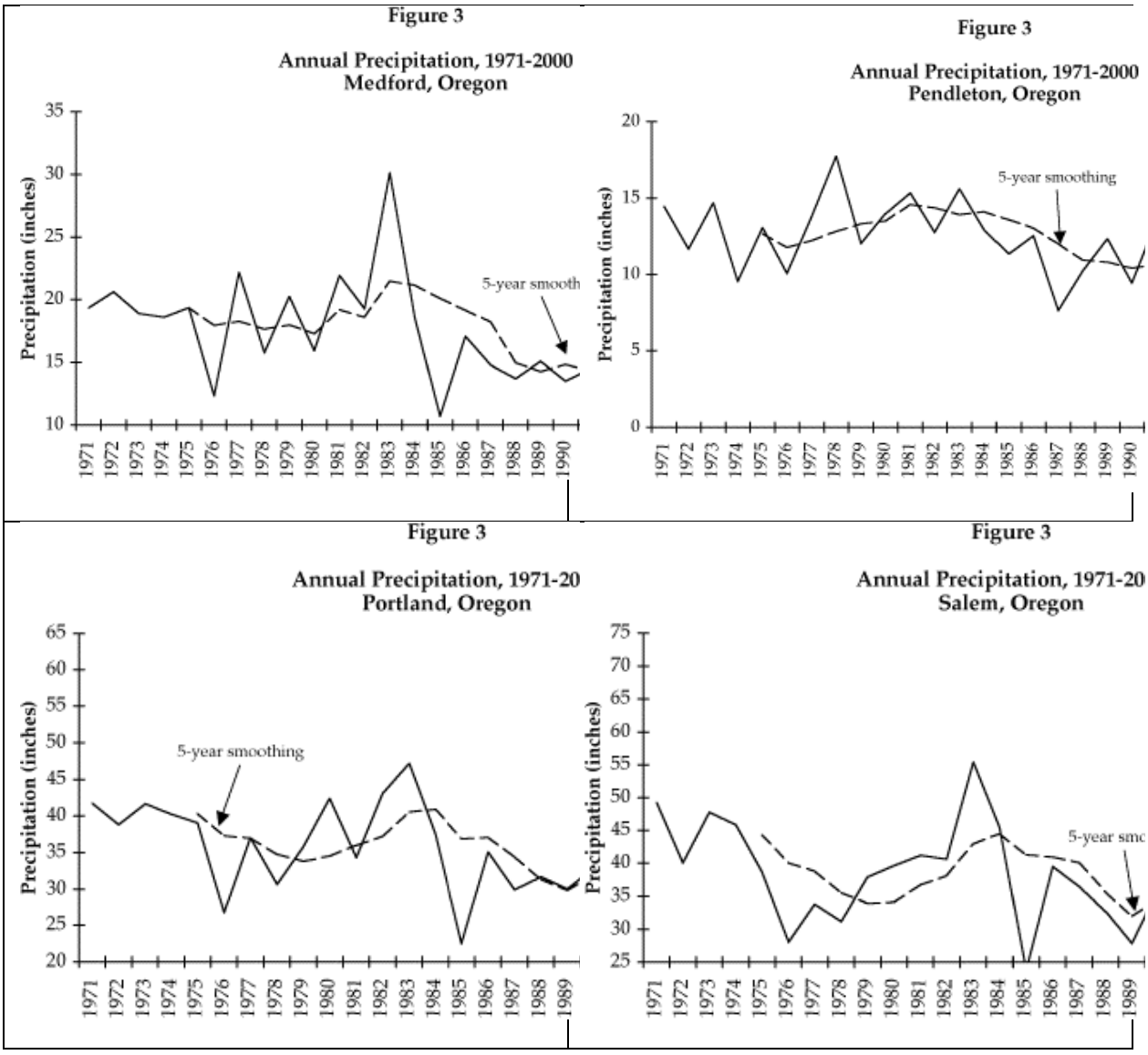


Source URL: http://drought.unl.edu/dm/DM_state.htm?OR,W

Appendix C. Precipitation Levels 1971 – 2000

From the OCS Local Climatological Data, the following graphs show precipitation in 6 major weather stations in Oregon.

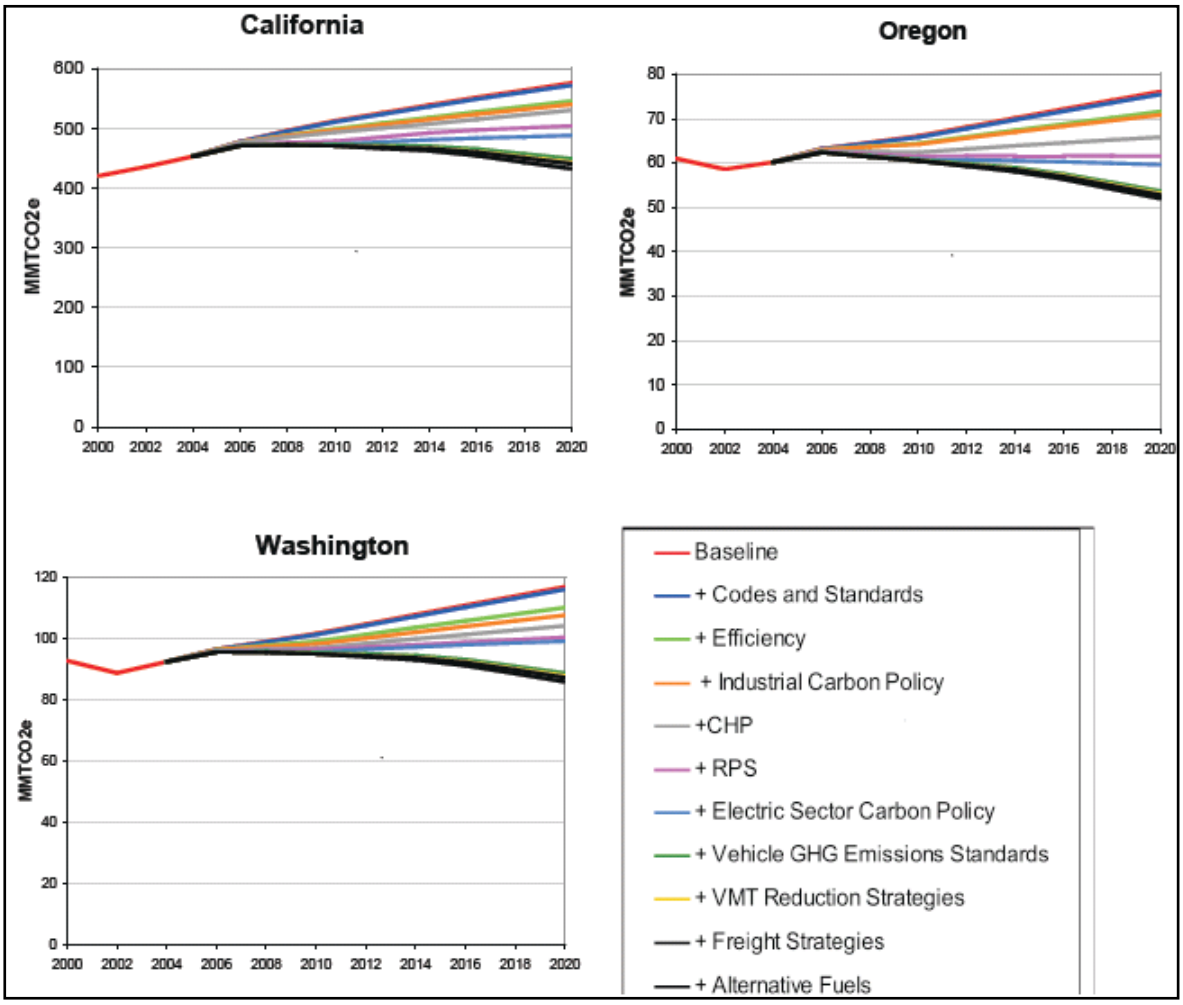




Source URL:

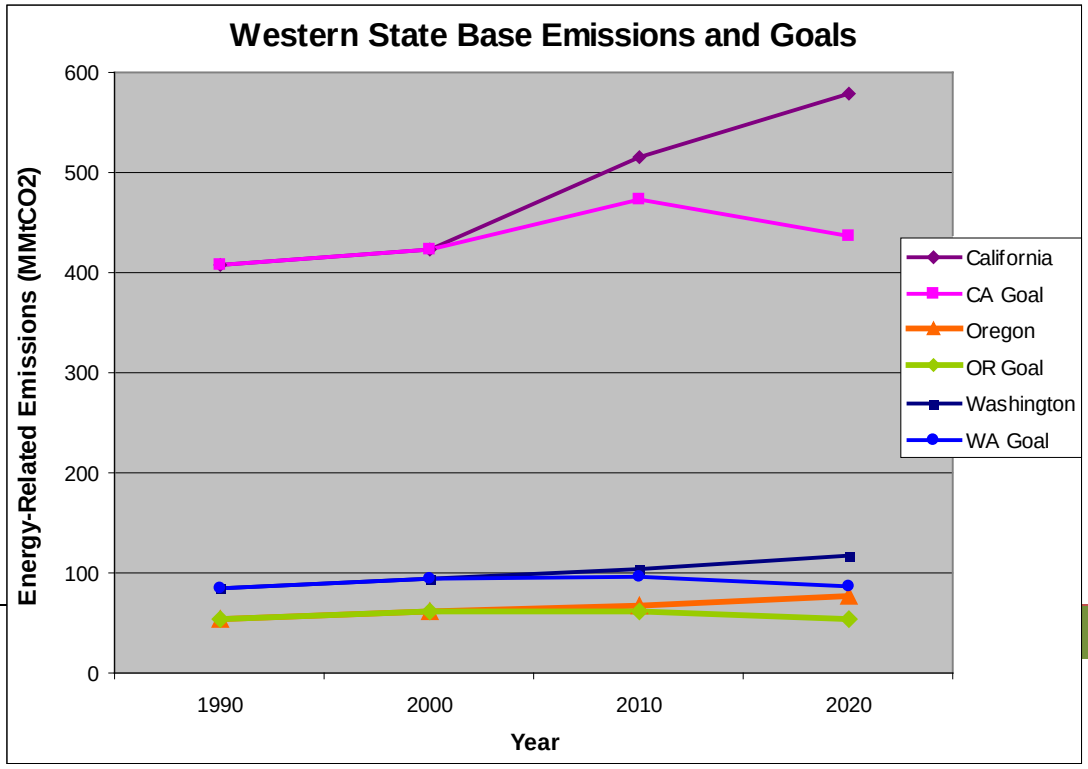
- Astoria, OR -- http://www.ocs.orst.edu/Reports/0328ap.html
- Cornvallis, OR -- http://www.ocs.orst.edu/Reports/1862ap.html
- Medford, OR -- http://www.ocs.orst.edu/Reports/5429ap.html
- Pendleton, OR -- http://www.ocs.orst.edu/Reports/6546ap.html
- Portland, OR -- http://www.ocs.orst.edu/Reports/6751ap.html
- Salem, OR -- http://www.ocs.orst.edu/Reports/7500ap.html

APPENDIX D. Department of Environment Quality -- http://www.deq.state.or.us

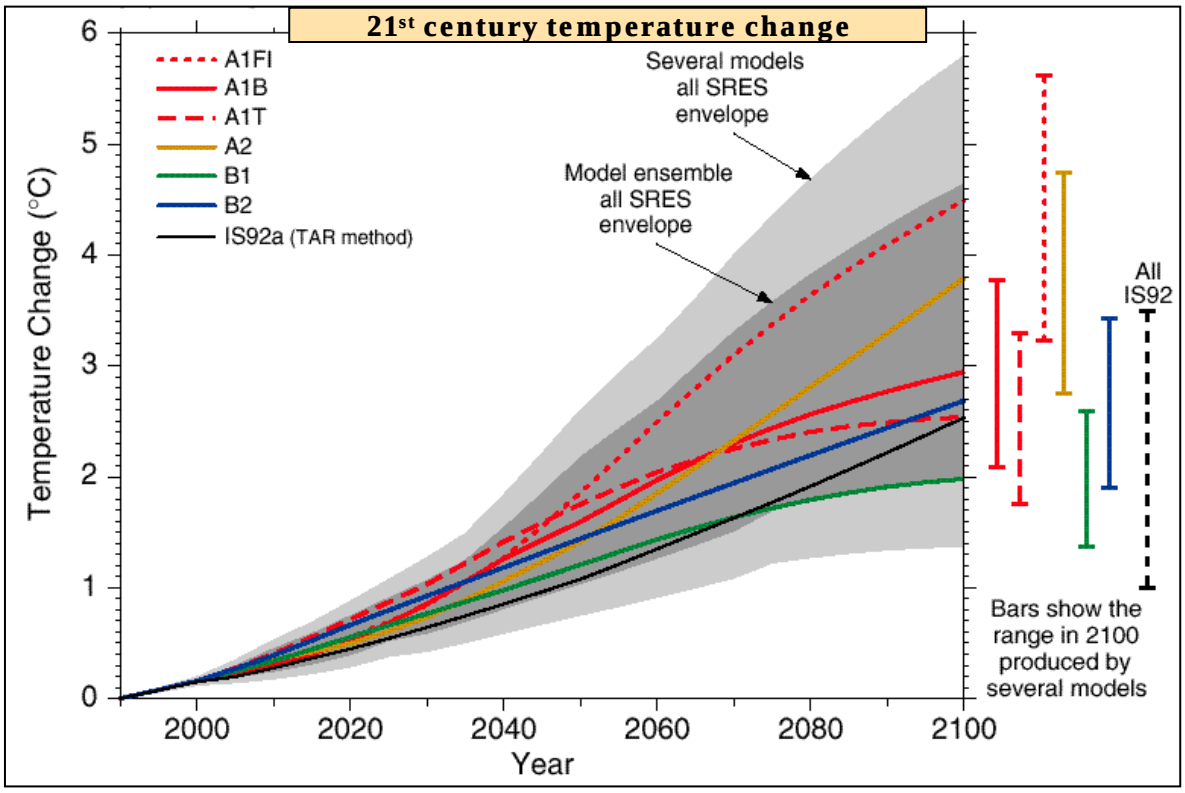


	Energy-Related Emissions (MMtCO2e)			
	1990	2000	2010	2020
CALIFORNIA				
Base Case Emissions	408	424	516	579
Emissions after Strategies			474	436
Emissions relative to base case			-8.14%	-24.70%
Emissions relative to 2000			11.79%	-15.50%
Emissions relative to 1990			16.18%	2.83%
OREGON				
Base Case Emissions	53	62	67	77
Emissions after Strategies			61	53
Emissions relative to base case			-8.96%	-31.17%
Emissions relative to 2000			-1.61%	-20.90%
Emissions relative to 1990			15.09%	-14.52%
WASHINGTON				
Base Case Emissions	85	94	103	118
Emissions after Strategies			96	87
Emissions relative to base case			-6.80%	-26.27%
Emissions relative to 2000			2.13%	-15.53%
Emissions relative to 1990			12.94%	-7.45%
REGIONAL TOTAL				
Base Case Emissions	545	579	685	774
Emissions after Strategies			631	575
Emissions relative to base case			-7.88%	-25.71%
Emissions relative to 2000			8.98%	-16.06%
Emissions relative to 1990			15.78%	-0.69%

Source: http://www.sustainableoregon.net/documents/climate/WCGGWI-App_B.pdf



Appendix E. From the IPCC (www.ipcc.ch), Philip Mote – 21st Century Temperature Change



Appendix F. Oregon state's base emissions and goals through 2020.

Inventory of Oregon Carbon Dioxide Emissions

(Electricity Emissions at Regional Emission Rates)

Million Short Tons

ENERGY SOURCE	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Transportation Petroleum	20.0	20.1	20.4	20.2	20.9	21.0	21.4	22.3	22.5	22.9	22.9
Other Petroleum	4.6	4.0	4.1	3.9	3.5	3.9	3.3	3.2	3.9	3.6	3.6
Slow-Release Petroleum Products	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Electric Utilities	22.1	23.4	24.6	25.5	26.8	23.9	24.0	22.9	22.2	25.1	26.9
Natural Gas*	6.1	6.8	6.5	7.2	7.3	7.7	8.6	9.0	8.3	9.8	9.3
Non-Utility Coal	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.0	0.0
Timber Harvest	1.9	1.9	1.9	0.2	0.1	0.2	0.2	0.2	0.1	0.1	0.2
Cement, Clinker, and Lime Manufacturing	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Alumina Reduction	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
TOTAL	55.6	57.2	58.3	57.8	59.5	57.6	58.3	58.5	57.8	62.2	63.6
TOTAL (DEQ)	**55.7**	**57.1**	**58.4**	**57.8**	**59.5**	**57.6**	**58.3**	**58.4**	**57.9**	**62.3**	**63.5**
OREGON'S CO_2 BENCHMARK											
% Change from 1990	0.00 %	2.51 %	4.85 %	3.77 %	6.82%	3.41%	4.67%	4.85%	3.95%	11.85 %	14.00 %
OREGON'S PER CAPITA CO_2 EMISSIONS											
Population (millions)	2.8	2.9	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.4	3.3
Tons CO_2 per capita	19.6	19.6	19.6	19.0	19.3	18.3	18.2	18.0	17.3	18.4	19.0
% Change from 1990	1.16 %	3.45 %	6.67 %	9.52 %	11.06 %	15.67 %	18.75 %	19.64 %	25.11 %	22.69 %	17.75 %

APPENDIX G. Oregon's Top 25 Carbon-Monoxide-Emitting Facilities

Row #	Pollutant Emissions	Percent of Total Emissions	Facility Name	Facility Mailing Address	County	State	Industry Type (SIC)
1	14,321	26.23	Northwest Aluminum Company, Inc.	3313 W 2nd, The Dalles, Or 97058	Wasco Co	OR	3334 - Primary Aluminum
2	7,756	14.20	Reynolds Metals Company	5100 Ne Sundial Rd, Troutdale, Or 97060-9521	Multnomah Co	OR	3334 - Primary Aluminum
3	6,521	11.94	Boise Cascade Corporation	1300 Kaster Rd, St Helens, Or 97051	Columbia Co	OR	2611 - Pulp Mills
4	1,933	3.54	Fort James Operating Company	92326 Taylorville Rd-Wauna Mil, Clatskanie, Or 97016-8264	Clatsop Co	OR	2621 - Paper Mills Exc Building Paper
5	1,873	3.43	Willamette Industries, Inc.	3251 Old Salem Rd Ne, Albany, Or 97321	Linn Co	OR	2621 - Paper Mills Exc Building Paper
6	1,680	3.08	Cascade Steel Rolling Mills, Inc.	3200 N Hwy 99w, Mcminnville, Or 97128	Yamhill Co	OR	3312 - Blast Furnaces And Steel Mills
7	1,613	2.95	Roseburg Forest Products Co.	Old Hwy 99 South, Dillard, Or 97432	Douglas Co	OR	2421 - Sawmills & Planing Mills General
8	1,259	2.31	Amalgamated Sugar Company, The	105 E Main St, Nyssa, Or 97913	Malheur Co	OR	2063 - Beet Sugar
9	1,257	2.30	Ash Grove Cement Company	33060 Shirttail Creek Road, Durkee, Or 97905-0287	Baker Co	OR	3241 - Cement, Hydraulic
10	1,223	2.24	Stimson Lumber Company	49800 Sw Scoggins Valley Rd, Gaston, Or 97119	Washington Co	OR	2421 - Sawmills & Planing Mills General

APPENDIX H. Oregon's County Emissions Report for Hazardous Air Pollutants – Carbon Disulfide.

Row #	State	County	Urban / Rural	Emissions	% of Emissions Total
1	OR	Linn Co	Urban	35,500	58.72
2	OR	Douglas Co	Rural	6,460	10.69
3	OR	Lincoln Co	Rural	3,560	5.89
4	OR	Multnomah Co	Urban	3,520	5.82
5	OR	Lane Co	Urban	1,980	3.28
6	OR	Marion Co	Urban	1,560	2.58
7	OR	Columbia Co	Urban	1,400	2.32
8	OR	Washington Co	Urban	1,360	2.25
9	OR	Jackson Co	Urban	1,100	1.82
10	OR	Clackamas Co	Urban	860	1.42
11	OR	Morrow Co	Rural	340	0.56
12	OR	Yamhill Co	Urban	280	0.46
13	OR	Clatsop Co	Urban	260	0.43
14	OR	Baker Co	Urban	240	0.40
15	OR	Benton Co	Urban	240	0.40
16	OR	Umatilla Co	Urban	240	0.40
17	OR	Deschutes Co	Rural	220	0.36
18	OR	Polk Co	Urban	200	0.33
19	OR	Klamath Co	Rural	200	0.33
20	OR	Coos Co	Urban	180	0.30
21	OR	Josephine Co	Rural	120	0.20
22	OR	Malheur Co	Rural	100	0.17
23	OR	Wasco Co	Rural	80.0	0.13
24	OR	Tillamook Co	Rural	80.0	0.13
25	OR	Union Co	Rural	80.0	0.13
26	OR	Gilliam Co	Rural	60.0	0.10
27	OR	Jefferson Co	Rural	40.0	0.07
28	OR	Curry Co	Rural	40.0	0.07
29	OR	Hood River Co	Rural	40.0	0.07
30	OR	Harney Co	Rural	20.0	0.03
31	OR	Lake Co	Rural	20.0	0.03
32	OR	Crook Co	Rural	20.0	0.03
33	OR	Wallowa Co	Rural	20.0	0.03
34	OR	Grant Co	Rural	20.0	0.03
35	OR	Wheeler Co	Rural	7.69	0.01
36	OR	Sherman Co	Rural	4.55	0.01
Grand Total				60,452	

Appendix I. OLMIS – Consumer Expenditures.

Consumer Expenditure Survey …based on income before taxes

Year	Utilities, Fuels, and Public Services	Natural Gas	Electricity	Fuel Oil, other	Water and other public svcs	Telephone Services
1996	2,347	291	907	108	268	772
1997	2,412	301	909	108	286	809
1998	2,405	284	921	85	285	830
1999	2,377	270	899	74	285	849
2000	2,489	307	911	97	296	877
2001	2,767	411	1,009	112	321	914
2002	2,684	330	981	88	328	957
2003	2,811	392	1,028	110	326	956
2004	2,927	424	1,064	121	327	990
2005	3,183	473	1,155	142	366	1,048
2006	3,397	509	1,266	138	397	1,087

Consumer Expenditure Survey …based on income before taxes

Year	Vehicle Purchases	New	Used	Other	Gasoline and Motor Oil
1996	2,815	1,209	1,568	38	1,082
1997	2,736	1,229	1,464	43	1,098
1998	2,964	1,383	1,532	49	1,017
1999	3,305	1,628	1,641	36	1,055
2000	3,418	1,605	1,770	43	1,291
2001	3,579	1,685	1,848	46	1,279
2002	3,665	1,753	1,842	70	1,235
2003	3,732	2,052	1,611	68	1,333
2004	3,397	1,748	1,582	66	1,598
2005	3,544	1,931	1,531	82	2,013
2006	3,421	1,798	1,568	54	2,227

URL: http://data.bls.gov/PDQ/servlet/SurveyOutputServlet

URL: http://data.bls.gov/PDQ/outside.jsp?survey=cx

Appendix J. U.S. Census Bureau. State Retail Trade by Sector.

CENSUS BUREAU

Retail Trade by Firms with Payroll, 2002

Trade	Establishments	Sales ($ thousands)	Annual Payroll ($ thousands)	Paid Employees
Motor vehicle & parts dealers	**1,805**	**10,000,299**	**899,462**	**25,723**
Furniture & home furnishings	**902**	**1,028,533**	**149,903**	**6,250**
Electronics & appliance stores	**681**	**1,089,735**	**123,727**	**5,006**
Building material & garden equipment & supplies dealers	**1,288**	**2,942,542**	**377,416**	**13,948**
Food & beverage stores	**1,938**	**6,076,852**	**661,022**	**35,933**
Health & personal care stores	**818**	**1,294,063**	**192,624**	**8,155**
Gasoline stations	**1,146**	**2,484,577**	**165,143**	**11,916**
Clothing & clothing accessories	**1,514**	**1,783,687**	**244,935**	**14,409**
Sporting goods, hobby, book, music	**1,073**	**1,160,133**	**152,029**	**10,117**
General merchandise stores	**396**	**7,027,120**	**681,818**	**35,142**
Miscellaneous store retailers	**1,964**	**1,332,581**	**186,454**	**11,753**
Nonstore retailers	**752**	**1,675,900**	**149,277**	**5,354**
TOTAL RETAIL TRADE	**14,277**	**37,896,022**	**3,983,810**	**183,706**

URL: http://www.census.gov/econ/census02/data/or/OR000_44.HTM

10 Utah Background Review

10.1 Current Evidence and Projected Climate Impacts

10.1.1 Overview of Utah's Energy Use

Utah emitted approximately 69 million metric tons (MMt) of gross[192] carbon dioxide equivalent (CO2e) in 2005. While this figure only accounted for about 1% of total emissions from the United States, Utah's GHG emissions are rising faster than those of the nation as a whole; Utah's emissions increased by 40% during the 15-year period between 1990 and 2005, while total US emissions only increased by 16%. It is also notable that while total Utahn emissions are increasing rapidly, its emissions per unit of output are actually declining. According to Governor Jon Huntsman's Blue Ribbon Advisory Council on Climate Change, emissions per unit of output during the 1990's fell approximately 40% nationally and 52% in Utah.[193] It is estimated that, should climate change continue on its current course, Utah could be emitting 96.1 MMt of CO2e by 2020. This represents a 95% increase in emissions over the 1990 level of 49.3 MMt.

The three primary sources for Utah's GHG emissions are electricity generation, transportation and residential/commercial/industrial fossil fuel combustion. In 2000, electricity generation accounted for 34% of Utah's GHG emissions (compared to 32% nationally), transportation accounted for 24% (compared to 26% nationally), and residential/commercial/industrial use accounted for approximately 24% (compared to 23% nationally). Other emissions sources included agricultural emissions, emissions from landfill and wastewater management facilities, and emissions from certain industrial processes.

10.1.2 Energy and Transportation: Utah's Primary Sources of Emissions

Generation of electricity used within the state of Utah accounted for about 37% of total GHG emissions in 2005. Utah has lower *per capita* consumption of electricity than the United States as a whole. However, Utah's population and economy are growing faster than any other state in the nation, so their total GHG emissions from consumption of energy are rising unusually fast; emission from consumption of energy rose from 15.3 MMt of CO2e in 1990 to 25.6 MMt in 2005, and are projected to reach 36.2 MMt in 2020. This averages out to about a 3.3% increase in GHG emissions due to energy consumption per year. Residential and commercial use are rising slightly faster than this rate, while industrial use is growing slightly slower.

The Rocky Mountain Power Company generates about 80% of Utah's retail electricity sales. As a group, Utah's power plants generate 99% of their electricity from coal (the other 1% is accounted for by the diesel used occasionally for start-up and other sources).

[192] This gross total accounts for greenhouse gasses removed from the atmosphere by carbon sinks, such as forests (estimated at approximately 12.3 MMt of CO2e, high-end). It excludes GHG emissions resulting from electricity generated for export.
[193] Roe, Stephen et al., *Final Utah Greenhouse Gas Inventory and Reference Case Projections, 1990-2020*. Page iii.

According to the Center for Climate Strategies (CCS), the Rocky Mountain Power Company is "showing interest in new wind and thermal plants."[194]

Utah's transportation sector accounted for 25% of statewide GHG emissions in 2005, and this figure has been rising by approximately 3% annually. In order of impact, the primary emissions sources from *within* the transportation sector are gasoline-powered vehicles, diesel-powered vehicles, locomotives, and other sources. Between 1990 and 2005, onroad gasoline use increased by 45%, onroad diesel use increased by more than 100%, and aviation fuel use increased by 32%. In total, the transportation sector created 10.9 MMt of CO2e in 1990, and this figure rose to 16.9 MMt in 2005. By 2020, the CCS predicts that Utah's transportation sector will create 22.4 MMt of CO2e.

Temperature

Since 1900, the average temperature in Utah has increased by 1.4 degrees Fahrenheit. Based on projections made by the Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's Climate Model, temperatures over the next century could rise by approximately 3-4 degrees in the spring and fall and 5-6 degrees in the winter and summer.[195]

According to the Governor's Blue Ribbon Advisory Council on Climate Change, "Utah is projected to warm more than the average for the entire globe and more than coastal regions for the contiguous United States. The expected consequences of this warming are fewer frost days, longer growing seasons, and more heat waves."[196]

Precipitation

Since 1900, precipitation in many parts of Utah has increased by about 20%. According to the United States EPA 1998 report on Climate Change and Utah, current climate change trends could cause precipitation to increase by 10% in the spring, 30% in the fall, 40% in the winter, and decrease by 10% in the summer by the year 2100.[197] Due to higher temperatures year-round, winter rains are predicted to increase while winter snowfall decreases. This will likely result in lower snowpack stored in Utah's mountains during the winter, which will lead to earlier and lower runoff during the spring and summer seasons.[198] With continued warming, the frequency of extremely hot summer days is also predicted to increase, which will lead to increased evaporation of already threatened water supplies.

According to the Governor's Blue Ribbon Advisory Council on Climate Change, precipitation in Utah was unusually high during the 20th century; "droughts during other

[194] Roe, Stephen et al., *Final Utah Greenhouse Gas Inventory and Reference Case Projections, 1990-2020*.
[195] US Environmental Protection Agency. "Climate Change and Utah." September 1998. Page 2.
[196] Governor's Blue Ribbon Advisory Council on Climate Change. *Final BRAC Report*. Appendix A-1, Page 2.
[197] US Environmental Protection Agency. "Climate Change and Utah." September 1998. Page 2.
[198] Currently, there is no reliable evidence available to show that climate change over the last century has already contributed to reduction in Utah's snowpack; however, these trends have already been observed in California and the Pacific Northwest, and further warming is predicted to have a significant impact.

centuries have been more severe, prolonged, and widespread."[199] However, it also states that "ongoing greenhouse gas emissions at or above current levels will likely result in a decline in Utah's mountain snowpack and the threat of severe and prolonged episodic drought in Utah is real." They also state that climate change in the western United States in the last 50 years has been responsible for "a several-day increase in the frost-free growing season" and "an earlier and warmer spring."

Ecosystems and Biodiversity

Forests: If conditions become drier in Utah, forests will likely become less dense, and some will be replaced with pasture land and fields. If conditions become warmer and wetter, as they seem likely to do during the winter months, then trees better suited to the warmer, wetter climate (like fir and spruce trees) will thrive, and forests will become more dense. According to the EPA's 1998 report, the extent of forested area in Utah is unlikely in increase and will likely decrease by 15-30%.[200]

Ecosystems: Utah is ranked fifth in the state in terms of biodiversity. It lies at the intersection of four distinct regions: the Great Basin, the Rocky Mountains, the Colorado Plateau, and the Mojave Desert. Some significant features of Utah's ecosystem are its playas and alkaline flats, salt-tolerant plants, salt flats and dunes, marshes, sagebrush, pinon-juniper woodlands, and the 4,000 year old bristlecone pines, the oldest living trees on the planet.

Utah's Great Salt Lake is the 33rd largest water body on the planet. It is also one of the most vulnerable to climate change. The lake is used as a stopover for a number of species of migratory birds, including phalaropes, avocets, white-faced ibis, white pelicans, and California gulls. The warmer climate that is sure to result from climate change would increase evaporation of the lake, causing an increase in its salinity levels. The current ecosystem of the lake is well suited to the migratory bird populations that depend on it, so a change in its makeup could have a negative impact on these populations.

The Governor's Blue Ribbon Advisory Council on Climate Changes predicts that climate change will lead to the warming of Utah's lakes and rivers; this will come with associated algal increase and a general upstream shift of the fish habitat.[201]

Agriculture

Agriculture is an $1 billion dollar industry in Utah.[202] About 80% of this revenue comes from livestock, composed primarily of cattle. Wheat, barley, and hay are the industry's main crops, and each of these stand to be affected differently with increasing temperatures due to climate change. When temperatures rise above the tolerance level of the wheat crop, wheat yields could decline by 10-30%. However, barley, hay, and pasture yields could rise by up to 7% with increased temperatures due to climate change *if* irrigation

[199] Governor's Blue Ribbon Advisory Council on Climate Change. *Final BRAC Report.* Appendix A-1, Page 2.
[200] US Environmental Protection Agency. "Climate Change and Utah." September 1998. Page 4.
[201] Governor's Blue Ribbon Advisory Council on Climate Change. *Final BRAC Report.* Appendix A-1, Page 18.
[202] Governor's Blue Ribbon Advisory Council on Climate Change. *Final BRAC Report.* Appendix A-1, Page 19.

for these crops could be adequately provided. Livestock and dairy production could suffer if summer conditions become significantly drier. In this case, livestock gain less weight and pasture yields will decline.

Water

According to the EPA's 1998 report on Climate Change in Utah, "a warmer climate could result in less winter snowfall, more winter rain, and faster, earlier spring snowmelt."[203] Additionally, if precipitation does not increase by at least 15-20% in the summer, increased temperatures will create evaporation significant enough to reduce lake and reservoir levels. Currently, groundwater levels in Utah are already decreasing because of public supply and irrigation needs in southwestern Utah. Energy production and mining in the eastern part of the state also make heavy demands on state's aggregate water supply. In many regions of Utah, groundwater and surface water have been fully allocated, so any reduction in state supply could raise major issues of water rights and availability.

Another concern regarding climate change's impact on Utahn water issues is it's affect on lake and river levels. The densely populated Wasatch Front has been faced with lake levels that rise and fall rapidly due to warming in the winter (creating more rainfall) and in the summer (lowering lake levels through evaporation). The 1980's were extremely wet years for Utah, while the years 1999-2004 saw Utah experiencing drought. However, there is no clear relation between water level variability and recent climate change.

Population and Health

If temperatures throughout the year continue to rise, Utah could experience an increase in heat-related deaths during the summer. However, according to the EPA's 1998 report, there is little evidence that even a 3-4 degree temperature increase would lead to increased heat-related deaths because the Utahn population seems to be accustomed to intense, dry summer heat. Conversely, hypothermia-related deaths are expected to decline as Utah's average temperature during the winter months increases.

Increased warming will likely result in poorer air quality for Utah's urban population. With continued climate change, the concentration of ground-level ozone (currently classified as "moderate" in Salt Lake City) will increase, which could lead to an increase in respiratory illnesses such as asthma and respiratory inflammation. Upper and lower respiratory allergies will also likely increase with at leave 2 degrees of warming and wetter conditions, both of which are expected in Utah if climate change continues unabated.

Some mosquitoes in Utah are known to carry malaria and western equine encephalitis. With the warmer and wetter conditions that are predicted to occur due to climate change, the mosquito population will likely increase, increasing the risk of spreading malaria and western equine encephalitis. However, according to the EPA's report, the US

[203] US Environmental Protection Agency. "Climate Change and Utah." September 1998. Page 3.

already has systems in place to treat these diseases and minimize their spread and contraction, so the Utahn population does not seem to be at great risk.[204]

Aggregate State Economy

One area in which the state economy stands to suffer is in Utah's skiing industry. Lower snow and higher rainfall levels in the winter, coupled with earlier snowmelt in the spring each year, will reduce the length and quality of the ski season.

10.2 Current Stances and Policies in Coping With Climate Change

Clean Energy Policies

Renewable Energy Systems Corporate and Personal Tax Credits: According to the DEQ's Utah Stakeholder Working Group on Climate Change, Utah has had a policy in place under which corporations are eligible for a 10% tax credit for the cost of installation of a renewable energy system up to $50,000. The credit is 25% of the cost of installation up to $2,000 for residential buildings owned by the business. An individual income tax credit of 25% of the cost of installation for renewable energy systems (up to $2,000 of credit) is also available. Both tax credits expired on December 31, 2006 and were reviewed during the 2007 legislative session.

Renewable Energy Sales Tax Exemption: Purchase or lease of equipment used to generate electricity form renewable sources (including wind generation, solar, biomass, landfill gas, anaerobic digestion, hydroelectricity, and geothermal energy) are exempt from the state sales tax in Utah. Restrictions are placed on the size and capacity of the facility that can benefit from the restriction, as well as on types of equipment that are considered exempt. The exemption is scheduled for repeal in June 2009.

Clean Fuels and Vehicle Technology Grant and Loan Program and Clean Fuel Vehicle Tax Credit: The DEQ's Division of Air Quality provides grants and tax credits to government entities, businesses, and individuals to encourage the use of alternative fuel technology in vehicles. Both the grant and the credit program compensate the buyer for up to half of the incremental cost of using an alternative fuel system, as opposed to a traditional motor gasoline- or diesel-fueled vehicle. Grants and credits are capped at $3,000 for original installation and $2,500 for conversions.

The Net Metering Program, enacted in 2002, allows electricity consumers "to connect renewable energy systems to the [communal] grid."[205] If a customer produces more electricity with their renewable system than they use, the utility or cooperative must credit the customer for their net generated electricity. In addition, there are at least four **Green Pricing Programs** (including the City of St. George's Clean Green Power program, Desert Power's GreenWay program, Pacificorp: Utah Power's Blue Sky program, and Tri-State Generation and Transmission: Empire Electric Association, Inc.'s Renewable Resource Power Service

[204] US Environmental Protection Agency. "Climate Change and Utah." September 1998. Page 3.
[205] Utah Stakeholder Working Group on Climate Change. *Current Utah Clean Energy Policies*., Page 3.

program) that give consumers the opportunity to consume electricity while reducing their GHG emissions. Rocky Mountain Power's Cool Cash Incentive and Refrigerator Recycling Program provide cash incentives for installation of energy efficient heating and air conditioning systems and for recycling old fridges/freezers, respectively.

Future Goals for Advancing Energy Efficiency

In accord with the Western Governor's Association's goal of a 20% increase in energy efficiency by 2020, Utah Governor Jon Huntsman is aiming to reach the 20% efficiency increase target by 2015. The American Institute of Architects is aiming to reduce the use of fossil fuels in the construction and operation of their buildings by 2010, and Utahn architects are working to meet this goal. Additionally, Governor Huntsman plans to "encourage energy efficiency in Utah's manufacturing, industrial, and agriculture sectors" and "in energy generation and distribution."[206]

Governor's Blue Ribbon Advisory Council on Climate Change

The Governor's Blue Ribbon Advisory Council on Climate Change (BRAC) was officially formed by Governor Jon Huntsman on August 26, 2006. It's purpose was essentially to gather information regarding the climate change situation and its pertinence to the state of Utah, as well as to provide policy recommendations for discussion and review.

The BRAC considered a vast array of proposals and options for reducing GHG emissions in Utah, and they categorized each of these proposals as either high, medium, or low priority. Within each priority category, options are divided among five subgroups: agriculture/forestry, cross-cutting issues, energy supply, residential/commercial/industrial, and transportation/land use. An exhaustive list of all suggested policies can be found in the BRAC Final Report. Only the policies deemed high priority are considered here.

In the **agriculture/forestry** division, high priority suggestions include preserving open space/agricultural land, protecting forest land by conversion to non-forest land, promoting the production of biomass fuels, increasing forest health risk reduction programs, increasing fire management and risk reduction programs, and promoting urban and community trees.

In the **cross-cutting issues** division, high priority suggestions include the GHG registry, GHG reduction targets, a regional/state cap and trade program, carbon tax, or hybrid, research and development into low/no carbon energy strategies, public education and outreach, climate adaptation strategies and policies, setting guidelines for climate policy and coordinating with other policies, evaluating existing climate proposals and the regional, federal, and international levels, and bridging strategies to achieve a low-carbon economy.

In the **energy supply** division, high priority suggestions include: developing significant amounts of renewable energy resources, to be achieved by creating energy development zones, green power purchases and marketing, public benefit charge, establishing tax credits and incentives for renewable energy, pricing and metering strategies,

[206] Utah Stakeholder Working Group on Climate Change. *Current Utah Clean Energy Policies*., Page 4.

and research and development; encouraging carbon capture and sequestration technology, to be achieved by setting CO2 capture and sequestration policy, dealing with issues for CO2 transmission, and research and development; developing and deploying advanced generation technology, to be achieved by creating incentives for advanced fossil fuel technologies that yield carbon reduction benefits; improving efficiency and reducing CO2 at existing electricity generation plants through generation or emissions performance standards, efficiency improvements, retrofitting plants with CO2 capture, and building new, low-carbon Greenfield plants to replace old plants; promoting combined heat and power distributed generation using incentives and removing institutional and other barriers; improving efficiency of electric transmission and distribution systems by removing transmission/distribution system limitations and other infrastructure barriers for renewables and other clean distributed generation and transmission systems upgrading; and addressing other miscellaneous energy supply options through research and development, removal of regulatory barriers, and establishment of tax credits and incentives.

In the **residential/commercial/industrial** division, high priority suggestions include utility demand side management, promotion of voluntary efficiency targets, rate design, government leading by example with mandatory efficiency targets, distributed generation with combined heat and power programs, distributed generation with renewable energy applications, state appliance efficiency standards, state promotion and tax or other incentives for efficient products, focusing on small and medium enterprises, incentives for improved design and construction (i.e. Energy Star, LEED, and green buildings), improved building codes, and waste and recycling.

In the **transportation/land use** division, high priority suggestions include development and implementation of an aggressive mass transit strategy, quality growth programs, promotion of trip reduction, rideshare, vanpool, and telecommuting, implementation of clean car and idle reduction programs, vehicle speed reduction, government setting example with the state fleet, promotion of low-carbon fuels and vehicle technologies, education programs, and exploration of funding options for the suite of transportation and land use options.

11 Washington Background Review

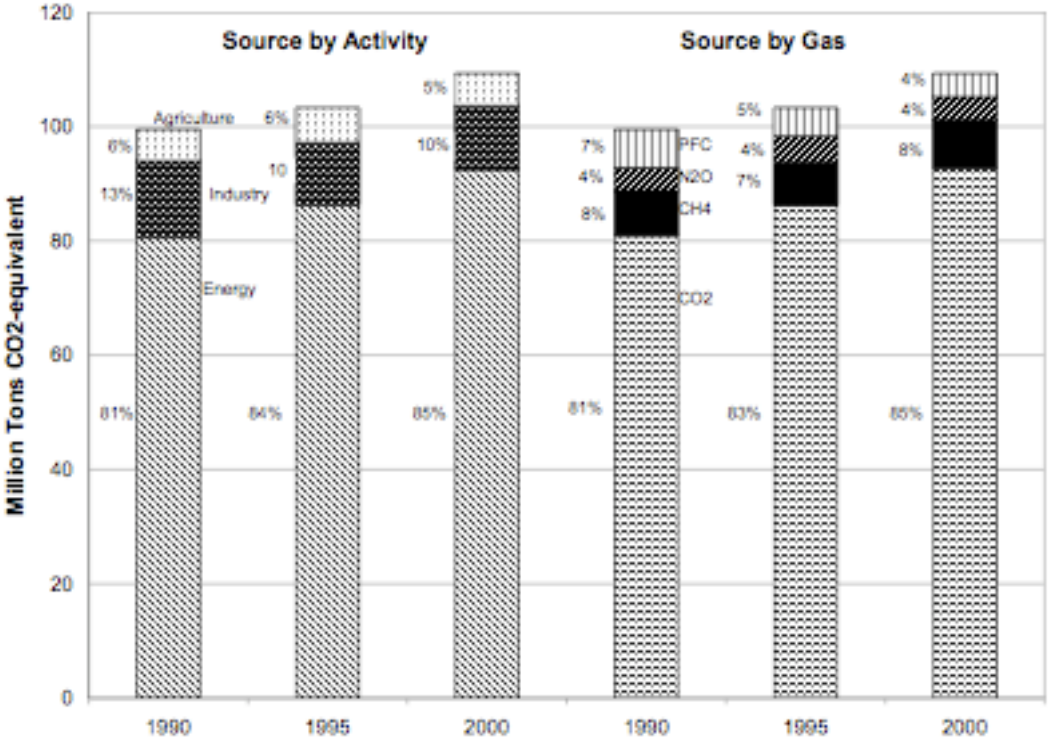
11.1 Current Evidence on Emissions and Climate Change

11.1.1 GHG Emissions

There is no established mechanism that tracks GHG emissions in Washington and as a result, estimates vary somewhat from report to report. One report estimates that total GHG emissions were 99.5 million metric tons (MMt) of gross[207] carbon dioxide equivalent[208] (CO_2e) in 1990. However, another report found that 1990 levels of CO_2e were only 88.4 MMt.[209] By 2000, GHG emissions increased to either 109.3, or 105.4 MMt of CO_2e.[210] In 2005, GHG emissions fell to 95 MMt of CO_2e due to the response of industries and utilities from energy price swings, limited availability of hydroelectricity during the 2000-2001 period (a drought year), and the decline of aluminum production in the state (which is responsible for large amounts of emissions). Since 2003, GHG emissions have continued to increase and are projected to reach 122 MMt of CO_2e by 2020, representing a 38% increase over 1990 levels. Transportation accounted for 47% of total GHG emissions in 2005, followed by fossil fuel combustion in the residential, commercial and industrial sectors (20%) and electricity consumption from those sectors as well (20%). On a per capita basis, Washington residents emit approximately 15 metric tons (Mt) of CO_2e annually, which is significantly lower than the national average of 25 Mt of CO_2e largely reflecting the state's heavy reliance on hydroelectricity.[211]

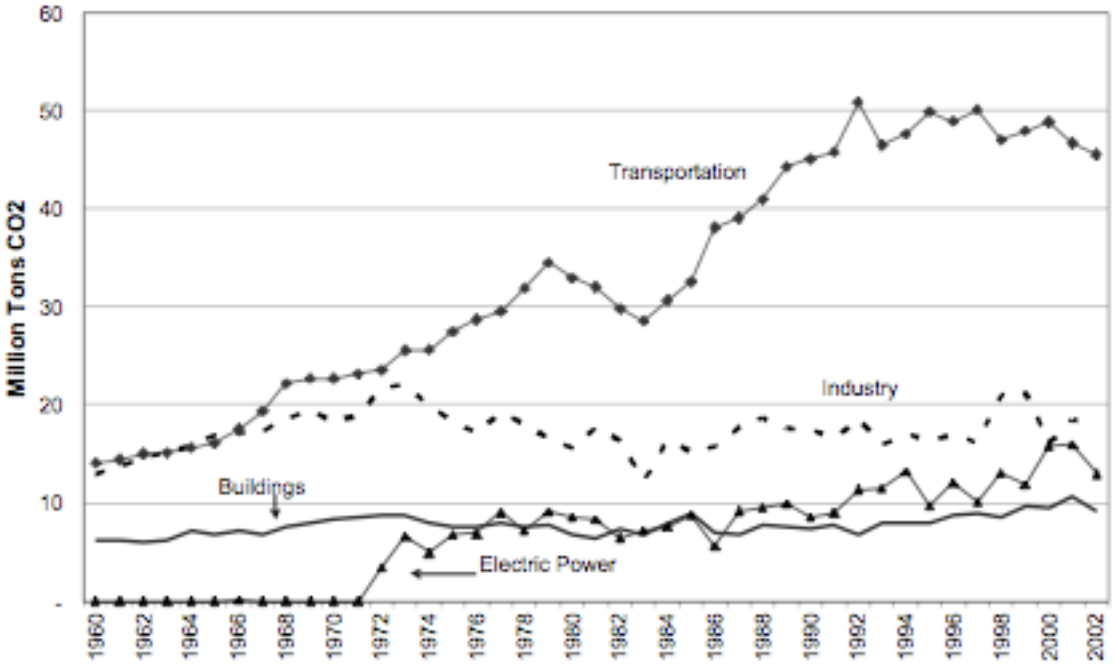
[207] Gross emissions estimates exclude carbon dioxide removed or sequester from the atmosphere from the result of land use, land use change, and forestry activities.
[208] Because the various greenhouse gases have different global warming potential they are expressed as CO2 equivalent emissions.
[209] Table 1
[210] Kerstetter and Table 1
[211] "Washington State: Greenhouse Gas Inventory and Reference Case Projections, 1990-2020."

Figure 35: Greenhouse Emissions by Sector and Gas Type



Source: Kerstetter

Figure 36: Historical Trends of Carbon Dioxide Direct Use Emissions by Sector
*Note: Buildings sector includes both commercial and residential sectors



***Source*: Kerstetter**

Table 18: Washington Historic and Reference Case GHG Emissions, by Sector

	1990	2000	2005	2010	2020
Electricity, Net Consumption-based	16.9	23.3	18.9	20.2	24.9
Coal	16.8	17.4	15.2	15.9	18.4
Natural Gas	0.1	5.3	3.6	4.2	6.3
Petroleum	0.0	0.6	0.0	0.1	0.2
Biomass and Waste (CH_4 and N_2O)	0.0	0.0	0.0	0.0	0.0
Residential/Commercial/Industrial (RCI)	18.6	20.3	19.4	21.3	24.3
Coal	0.6	0.3	0.2	0.3	0.3
Natural Gas	8.6	11.4	10.3	11.0	12.7
Oil	9.1	8.4	8.5	9.7	11.0
Wood (CH_4 and N_2O)	0.2	0.2	0.3	0.4	0.4
Transportation	37.5	45.9	44.5	48.5	56.9
Onroad Gasoline	20.4	24.5	24.8	26.2	29.1
Onroad Diesel	4.1	7.6	7.5	8.8	12.0
Marine Vessels	2.6	2.9	3.0	3.3	4.1
Jet Fuel and Aviation Gasoline	9.1	10.0	7.8	8.1	8.5
Rail	0.8	0.3	0.8	0.8	0.8
Natural Gas, LPG, other	0.6	0.6	0.7	1.3	2.5
Fossil Fuel Industry	0.5	0.7	0.9	1.0	1.1
Natural Gas Industry (CH_4)	0.4	0.7	0.9	0.9	1.0
Coal Mining (CH_4)	0.0	0.0	0.0	0.0	0.0
Industrial Processes	7.0	6.6	3.3	4.2	6.2
Cement Manufacture (CO_2)	0.2	0.5	0.5	0.5	0.5
Aluminum Production (CO_2, PFC)	5.9	3.9	0.4	0.4	0.3
Limestone and Dolomite Use (CO_2)	0.0	0.0	0.0	0.0	0.0
Soda Ash (CO_2)	0.1	0.1	0.1	0.1	0.1
Ozone Depleting Substitutes (HFC, PFC & SF_6)	0.0	1.6	2.1	3.0	5.1
Semiconductor Manufacturing (HFC, PFC & SF_6)	0.0	0.1	0.0	0.0	0.0
Electric Power Transmission & Distribution (SF_6)	0.8	0.4	0.3	0.2	0.1
Waste Management	1.5	2.2	2.4	2.8	3.6
Solid Waste Management	1.0	1.5	1.8	2.0	2.7
Wastewater Management	0.5	0.6	0.7	0.8	0.9
Agriculture	6.4	6.4	5.4	5.1	4.8
Enteric Fermentation	2.0	1.8	1.6	1.5	1.3
Manure Management	0.7	0.9	0.9	1.0	1.2
Agricultural Soils	3.7	3.8	2.8	2.6	2.2
Total Gross Emissions	88.4	105.4	94.8	103.0	121.9
Increase relative to 1990		*19%*	*7%*	*17%*	*38%*
Forestry and Land Use	-28.6	-28.6	-28.6	-28.6	-28.6
Agricultural Soils	-1.4	-1.4	-1.4	-1.4	-1.4
Net Emissions (including sinks*)	58.4	75.4	64.8	73.0	91.9

Source: "Washington State: Greenhouse Gas Inventory and Reference Case Projections, 1990-2020."

Temperature

During the 20th century Washington experienced an average temperature increase of approximately 1.5° F.[212] The data for projected changes that is most commonly cited comes from a report produced by the Climate Impacts Group from the University of Washington that combines 10 different climate models to estimate the future climate impacts on the Pacific Northwest region. The study found that the average warming rate during the next century is expected to be in the range of 0.2-1.0° F per decade, with a best estimate of 0.5° F increase per decade. Averaged across the entire region, the report estimates that annual temperatures will be 1.9° F higher in the 2020s compared with the 1970-1990 average, and 2.9° F higher in the 2040s compared with the 1970-1990 average.[213]

Table 19: Recent and Projected Temperatures for the Pacific Northwest

	1970-99	2020s	2040s
Annual	47.0° F	48.9° F	49.9° F
(increase)		*1.9° F*	*2.9° F*
Oct.-Mar.	36.1° F	37.8° F	38.6° F
(increase)		*1.7° F*	*2.5° F*
Apr.-Sept.	57.9° F	60.0° F	61.2° F
(increase)		*2.1° F*	*3.3° F*

Source: Mote, Salathe, and Peacock

Precipitation

Historical evidence for precipitation varies both across seasons and time periods with no clear influence from rising GHG.[214] However, the majority of models project a *slightly* wetter future with most of the precipitation increases occurring in the cool season in the form of rain.[215]

Table 3: Recent and Projected Precipitation in the Pacific Northwest

	1970-99	2020s	2040s
Annual	28.0"	28.5"	28.5"
Oct.-Mar.	19.4"	20.2"	20.4"
Apr.-Sept.	8.5"	8.4"	8.2"

Source: Mote, Salathe, and Peacock

Returning to the widely cited study produced by the Climate Impacts Group, they estimate that total precipitation is not expected to change significantly over the next several decades. On average across the Pacific Northwest region, precipitation is expected to increase by 0.5”

[212] Bauman et al.
[213] Mote, Salathe and Peacock and Table 2
[214] Casola et al.
[215] Casola et al.

in the 2020s and 2040s. They estimate this increase is expected to occur as a result of a larger increase in precipitation in the winter months (in the form of rain), compared to a smaller fall in precipitation rates in the summer.[216]

Sea Level Rise

Washington State's 3,026 miles of shoreline means the state is at risk for increasing sea levels. However, the change in sea level is quite difficult to model in Washington because different portions of the state's shorelines experience different vertical motions due to tectonic activity.

Table 20: Calculation of very low, medium, and very high estimates of Washington sea level rise (SLR) for 2050 and 2100.

*Note: Negative vertical land movement (VLM) values represent vertical up shift and a negative total represents a sea level drop. Both the very low and very high SLR estimates are considered low probability scenarios.

SLR Estimate	Components	2050			2100		
		NW Olympic Peninsula	Central & Southern Coast	Puget Sound	NW Olympic Peninsula	Central & Southern Coast	Puget Sound
Very Low	Global SLR	9 cm			18 cm		
	Atm. Dynamics	-1 cm			- 2 cm		
	VLM	-20 cm	- 5cm	0 cm	- 40 cm	-10 cm	0 cm
	Total	-12 cm (-5")	3 cm (1")	8 cm (3")	-24 cm (-9")	6 cm (2")	16 cm (6")
Medium	Global SLR	15 cm			34 cm		
	Atm. Dynamics	0 cm			0 cm		
	VLM	- 15 cm	- 2.5 cm	0 cm	-30 cm	- 5 cm	0 cm
	Total	0 cm (0")	12.5 cm (5")	15 cm (6")	4 cm (2")	29 cm (11")	34 cm (13")
Very High	Global SLR	38 cm			93 cm		
	Atm. Dynamics	7 cm			15 cm		
	VLM	-10 cm	0 cm	10 cm	- 20 cm	0 cm	20 cm
	Total	35 cm (14")	45 cm (18")	55 cm (22")	88 cm (35")	108 cm (43")	128 cm (50")

Source: Mote et al. 2008

The most recent study was conducted by the Climate Impacts Group in January 2008 and sheds light on the subject by providing updated climate models and tectonic activity in Washington. Their study determined that the evidence on vertical land movement (VLM) in Washington is very mixed, except for the Northwest Olympic Peninsula, which consistently demonstrates there is an uplift of >2mm/year. Data for the central and southern coast is quite sparse, but the best estimates are a 0-2 mm of uplift per year. The Puget Sound region has the least consistent data and as a result the study only accounts for VLM for the upper bound estimate of Sea Level rise. Under medium bounds, the study estimates by 2050 the Northwest Olympic Peninsula will have no sea level rise, the central and southern coast will

[216] Mote, Salathe and Peacock and Table 3

rise 5", and Puget Sound will rise 6". By 2100, the Northwest Olympic Peninsula will rise 2", the central and southern coast will rise 11", and Puget Sound will rise 13".[217]

Ecosystems and Biodiversity

Fish: Increased temperatures and changing precipitation patterns will have effects on fish populations throughout Washington. Historically, climate has played a crucial role in determining fish populations. In 2001, Washington suffered a severe drought, where hundreds of thousands of juvenile salmon were stranded by low flow in the Columbia River and were unable to travel to the Pacific Ocean.[218] In 2005, above average ocean temperatures and reduced coastal ocean upwelling resulted in juvenile marine salmon populations that were 20 to 30% below average along the Pacific Northwest coast.[219] Cold-water fish species such as trout and salmon are particularly at risk, as stream temperatures are expected to raise due to changing watersheds and increased air temperatures. Higher stream, lake, and ocean temperatures may exceed the tolerable limits for many fish and could reduce nutrient availability, further reducing fish populations and increasing competition in those ecosystems..[220]

Forests: Forests will also certainly be affected by climate change. Currently, over half of Washington (22 of 43 million acres) is classified as forestland.[221] During the 21st century, increased temperatures will cause some tree species to likely shift their geographic range to higher elevations and latitudes. Other species may be unable to adapt and their numbers could decline. Additionally, rising temperatures and changing precipitation patterns could lead to favorable conditions for fire and pest outbreaks. Increasing temperature and reduction in soil moisture in summer months can cause trees to become heat and moisture-stressed, making them more susceptible to fire.[222] A study conducted in 2004 showed that climate change could increase the average annual area burned in Washington by a factor of 1.4 to 5. The study is based on a relatively cool climate model, with little precipitation change, meaning the estimate is most likely on the conservative side.[223] Higher temperatures also enhance reproductive rates of insects. Matched with milder winters that increase survival rates for larva, pests will likely be able to increase their abundance and migrate northward or up in elevation. Preserving Washington's forests are of the utmost importance, as the US Forest Service estimates that forest lands sequester about 29 MMt of CO_2e every year, representing almost a third of total yearly emissions.[224]

[217] Mote et al. 2008 and Table 4 (contains upper and lower bound estimates as well)
[218] Casola et al.
[219] Stanton
[220] Casola et al.
[221] Department of Natural Resources Fire Suppression Study, Report 05-11
[222] Casola et al.
[223] McKenzie et al.
[224] Washington State: Greenhouse Gas Inventory and Reference Case Projections, 1990-2020" and Table 1

Agriculture

Agriculture is a $6.7 billion dollar industry in Washington. The top five commodities by value in 2006 were apples ($1.386 billion), milk ($688 million), wheat ($626 million), livestock ($588 million), and potatoes ($562 million).[225]

Agriculture is another complex topic because different crops are grown in very different regions throughout the state and therefore climate change will affect each crop and region differently. In places of sufficient soil moisture or access to irrigation water, projected increase in temperature and atmospheric CO_2 concentrations will likely increase crop yields. Although this too is a complicated process as changes in watersheds could reduce the availability of irrigation water during the summer when it is needed most. Furthermore, projected increases in temperature may benefit pests and weeds, mitigating projected yield and productivity increases. Therefore, the overall impacts will vary throughout the state, being highly contingent on the types of crops being produced and the amount of water.[226]

Water

Climate change will affect three different areas of Washington's water resources: Glaciers, Snowpack, and Flowing Water.

Glaciers: The North Cascade Glacier Climate Project (NCGCP) is an ongoing project conducted since 1983 that monitors data on specific glaciers in the North Cascade region. The study has determined that since 1983, Cascade glaciers included in the study have thinned by more than 31 feet on average, representing a loss of 18 to 32% of their entire volume. Forty-seven glaciers have shrunk in size, length, and volume and four have disappeared entirely. Project director, Mauri Pelto foresees "the loss of up to 65-75% of North Cascade Glaciers due to a 3.6° F warming..."[227] Considering Washington's glaciers store as much water as all of the state's lakes, rivers, and reservoirs combined and supply more than 30 billion of cubic feet of summer runoff to rivers each year, shrinking glaciers will present a significant problem in the future.[228]

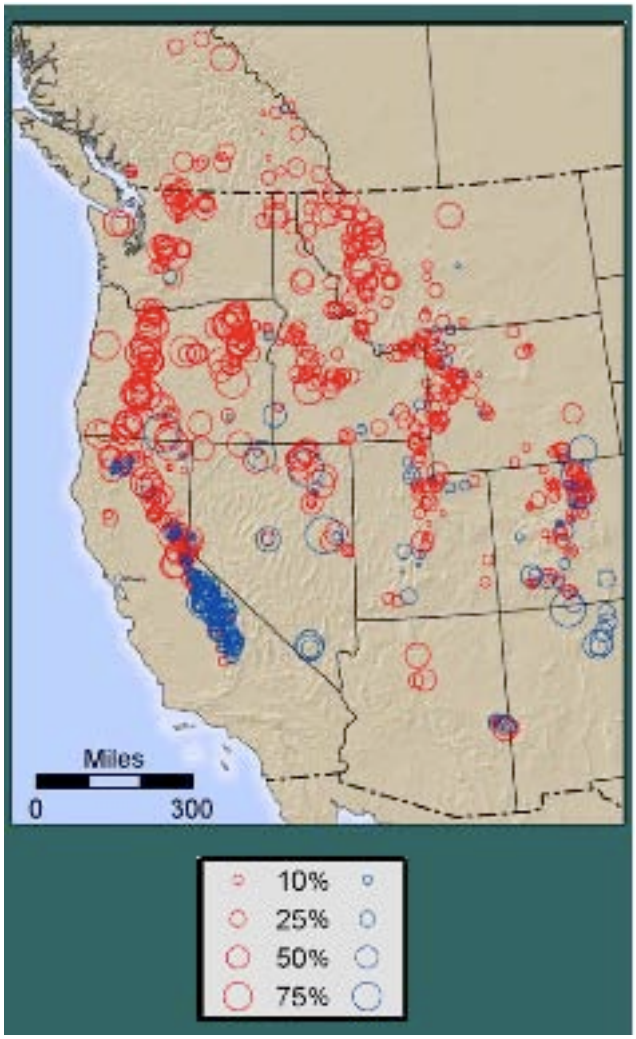
Snowpack: Although average precipitation has not declined since the middle of the 20th century, the mountain snowpack has decreased significantly, signaling the role rising temperatures have on snowpack levels. Rising temperatures decrease snowpack in a two-part effect; higher temperatures in winter lead to faster melting in winter months and increased frequency of winter rain precipitation further facilitates snowpack melt. The April 1st mountain snowpack, an indicator of summertime water availability, declined at virtually every measurement location in the Pacific Northwest after 1950 and is especially pronounced in the Cascades.[229] One study estimates that the April 1st snowpack in the Washington Cascades has declined by 15-35% since mid-century with larger declines at low elevations and smaller declines or increases at high elevation.[230] Due to this decline in snowpack, the

[225] 2007 Washington State Data Book
[226] Casola et al.
[227] Pelto
[228] Pelto and Bauman et al.
[229] Figure 3
[230] Mote et al. 2007

proportion of annual river flow to Puget Sound during summer months has declined 18% since 1948.[231]

Figure 37: Mountain Snowpack Across the West 1950-2000

Red circles indicate locations where a decline in April 1 snow water equivalent (SWE) has been recorded relative to 1950. Blue Circles indicate locations where in an increase in April 1 SNE has been recorded.



Source: Casola et al.

Flowing Water: Washington's watersheds fall into three groups: rain-dominant, snow-dominant, and transient snowmelt.

- Rain-dominant: these rivers are fueled by rain precipitation flows, and thus peak flows occur in winter when precipitation is heaviest.
- Snow-dominant: these rivers have headwaters at high elevations and therefore receive mostly snow during the winter. Their rivers yield peak flows after the snow begins to melt or several months after the heaviest precipitation falls.

[231] Mote, Snover, Binder, Hamlet, and Mantua

- Transient snowmelt: these rivers have a double peak as the receive flows from both rain and snow. These rivers are especially sensitive to changes in temperature that shift the snow/rain balance in favor of rain.[232]

Climate change is expected to shift many of the state's snow-dominant watersheds into transient snowmelt watersheds, and shift transient watersheds into rain-dominant watersheds. Reduced summer flows in the state's snow-dominate and transient basins allow stream and river temperatures to rise, which has profound effect on ecology as previously discussed. Changes in watersheds also affect the soil, which in turn changes agriculture productivity as previously discussed as well.

Health

Increased temperatures will result in warmer summer averages leading to an increase in the frequency of days classified as extremely hot (>100° F). The increase in extremely hot days will contribute to the incidence of heat cramps, heat exhaustion, and heat stroke. Another health concern is that many insects are able to expand their ranges as temperatures warm and this appears to be the likely mechanism in the transcontinental spread of mosquito born West Nile Virus and also a factor in the spread of tick-borne Lyme disease.[233] Climate change can also increase respiratory illness in a variety of ways.

Infrastructure

Municipal and Industrial Water Supplies: For the 21st century, decreased steam flows during the summer could exacerbate competition over water resources, making it more difficult to reliably fulfill commitments. Impacts will be most severe in transient watersheds that will shift to rain-dominate watersheds, and also for watersheds where the current demands are nearing the limits for summer use.[234]

Flood and Stormwater Management: In transient watersheds, increased temperature will cause more precipitation to fall as rain instead of snow, leading to an increase in flooding in winter even if precipitation levels remain the same. In snowmelt dominant watersheds, reduced snowpack may reduce spring flood risks. However, elevated soil moisture in spring (due to earlier melting) may also increase vulnerability to flooding. In urban areas, stormwater management depends on the frequency and intensity of individual cool season storms, and less so on temperature and precipitation changes. Therefore, it is unclear how urban stormwater flooding may change in the future, as modeling how climate change will affect the behavior of individual storms is not known.[235]

Seawall Heights: Rising sea level heights will mean urban areas will need to increase seawall heights to account for the increased sea levels.

Bridges: Climate change could impact bridge conditions in a variety of ways. As warmer temperatures cause greater thermal expansion, bridges will require ongoing maintenance if

[232] Bauman et al.
[233] Bauman et al.
[234] Casola et al.
[235] Casola et al.

thermal expansion is not considered or accounted for adequately. Additionally, increased winter precipitation can affect bridges by exacerbating erosion problems. Finally, increased sea levels can impact clearance levels of low bridges as water or debris may be able to reach the bottom.[236]

Roads: Increased winter rainfall matched with warmer temperatures can lead to more rapid deterioration of roads. However, new specifications for concrete and asphalt mixes could potentially mitigate some of the anticipated problems brought on by climate change.

Hydropower

Hydroelectricity power is especially important for Washington as it accounts for approximately 69% of the electricity generated in the state.[237] Projected climate change will alter both the demand for electricity as well as water flows, creating challenges for hydropower. In Washington, demand for electricity peaks during winter months due to short days and cold temperatures.[238] Projected changes in temperature will decrease demand in winter (due to warmer temperatures) and increase demand during the summer (due to increased use of air conditioning from warmer temperatures). According to the Northwest Power and Conservation Council (NWPCC), studies show that projected increases of 3-5° F could reduce monthly wintertime electricity demand across the Northwest power pool in excess of 1000 megawatts (MW) per month. Although demand is projected to increase in July and August, their studies forecast that the net annual change will be for decreased electricity demand.[239]

Population

There have been no studies demonstrating that climate change will affect Washington State's population. In fact, the Washington population is expected to grow at a rate of 1 million every decade, which will exacerbate many problems created by climate change such as water and electricity use.[240]

Economic Impacts

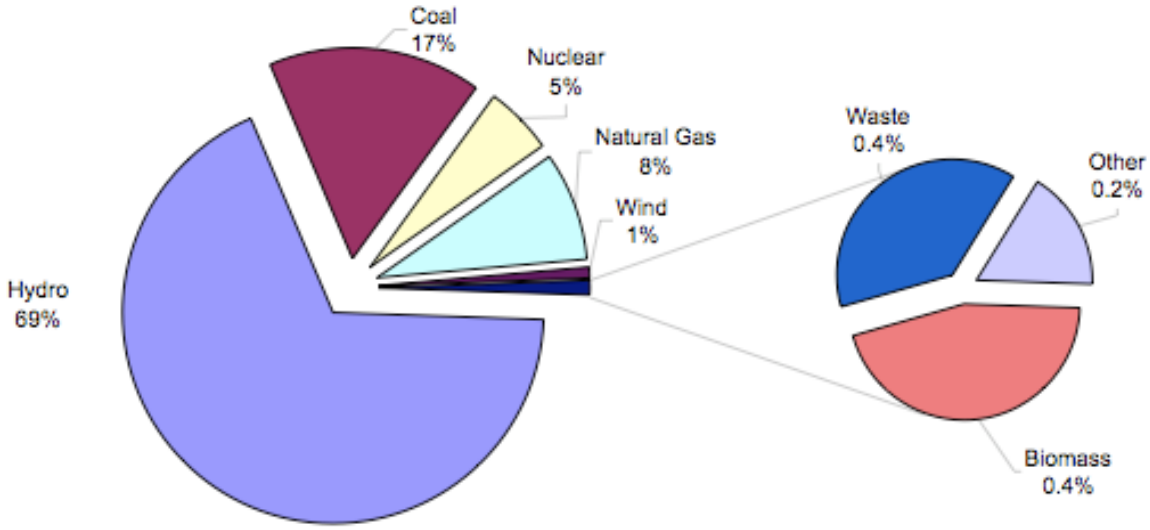
Forests: Washington State's forests support a variety of activities from timber production to recreation. In 2002, total employment in lumber, wood products, and pulp and paper was 43,700.[241] Climate change could impact Washington's forests both directly (affecting rates of tree growth, growth ranges of species) and indirectly (pests and fires). Direct impacts from climate change arise because changing levels of temperature, soil moisture, atmospheric CO_2 concentrations, and other factors affect tree growth. Although no studies have been conducted on the direct impact for Washington forests, other studies can be used to estimate

[236] Cohen
[237] Figure 4
[238] Figure 5
[239] Figure 6
[240] US Census
[241] Blatner et al.

the affects. For example, according to a study of the Sierra mixed conifer timberlands in El Dorado County, California, climate change could reduce timber yields by 18-31% by the end of the 21st century.[242]

Forest fires will cause the most indirect costs and as mentioned earlier, forest fires are expected to increase because summer weather will continue to get hotter and drier. Currently the Washington State Department of Natural Resources (DNR) bears firefighting responsibility for 13 million acres of private and state-owned forests. The remaining acres of forest are owned federally and federal services bear firefighting responsibilities. The average number of private and state-owned acres burned in an average year would increase from the current figure of 12,000 acres to over 18,000 acres with a 2° F warming and to 24,000 acres with a 3° F warming.[243] The DNR expenditures on fire control averaged $12 million between 1996 and 2005. With the expected increase in burning acres, DNR expenditures are projected to rise to over $18 million with a 2° F warming and to $24 million with a 3° F warming. There are other costs as well, for example the state spends $14 million a year on related activities such as fire prevention and preparedness. If these expenditures increase in proportion to DNR fire suppression expenditures, total state costs could increase from $26 million to over $39 million with a 2° F warming and to $52 million with a 3° F warming.[244]

Figure 38: Washington State Electric Utility Fuel Mix, 2006



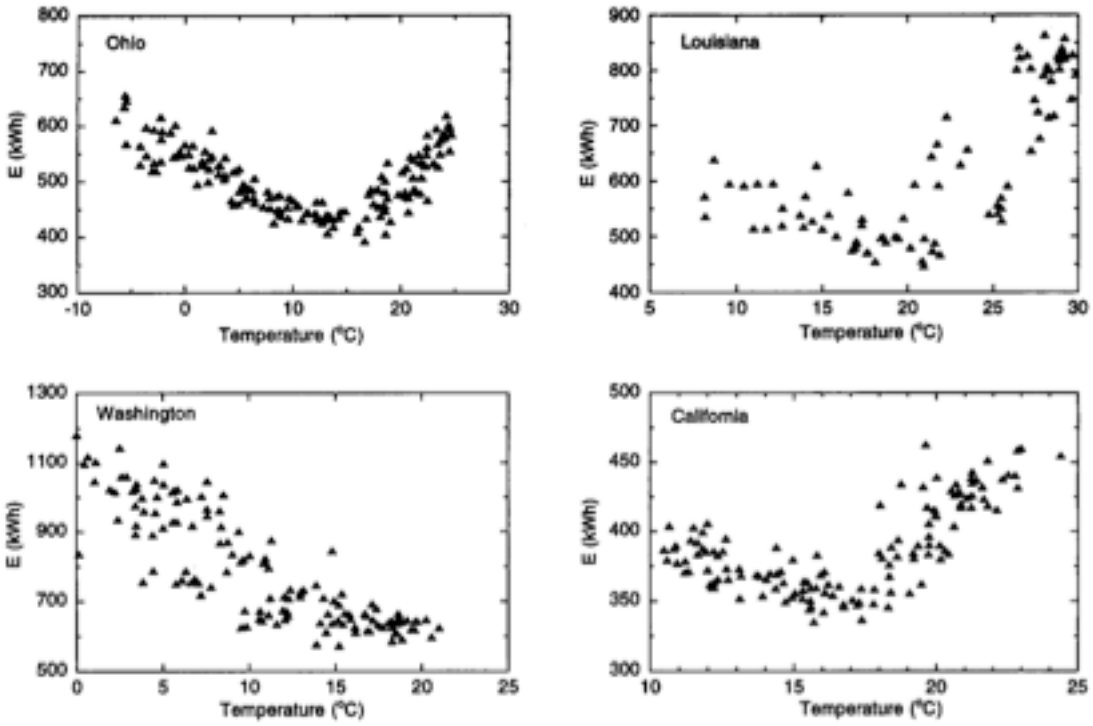
Source: Washington Department of Community, Trade and Economic Development

Electricity: Climate change will affect both the supply of (shift in timing of peak hydroelectric power generation) and demand for electricity (reduced consumption in winter and increased consumption in summer). Returning to estimates from the NWPCC, the Council estimates a reduction of 300 MW of demand for each 1° F rise in temperature.[245] This would correspond to a 750 MW reduction in demand with the 2.5° F increase in average winter temperatures projected for the 2040s. Summer demand is likely to increase because of air conditioning and irrigation pumping, but the exact extent is not known because the council did not account

[242] Battles et al.
[243] Bauman et al. using estimates from McKenzie et al.
[244] Bauman et al.
[245] NWPCC 2005

for the growth in use of air conditioning units. Nonetheless the NWPCC estimates that annual net impacts on power sales from a range of plausible precipitation changes could run from a gain of $777 million to a loss of $231 million by 2020, and from a gain for $169 million to a loss of $730 million by 2040. However the NWPCC notes that these figures are likely to exaggerate gains and underestimates losses, since the NWPCC model does not incorporate assumptions about the growth of air conditioning.[246]

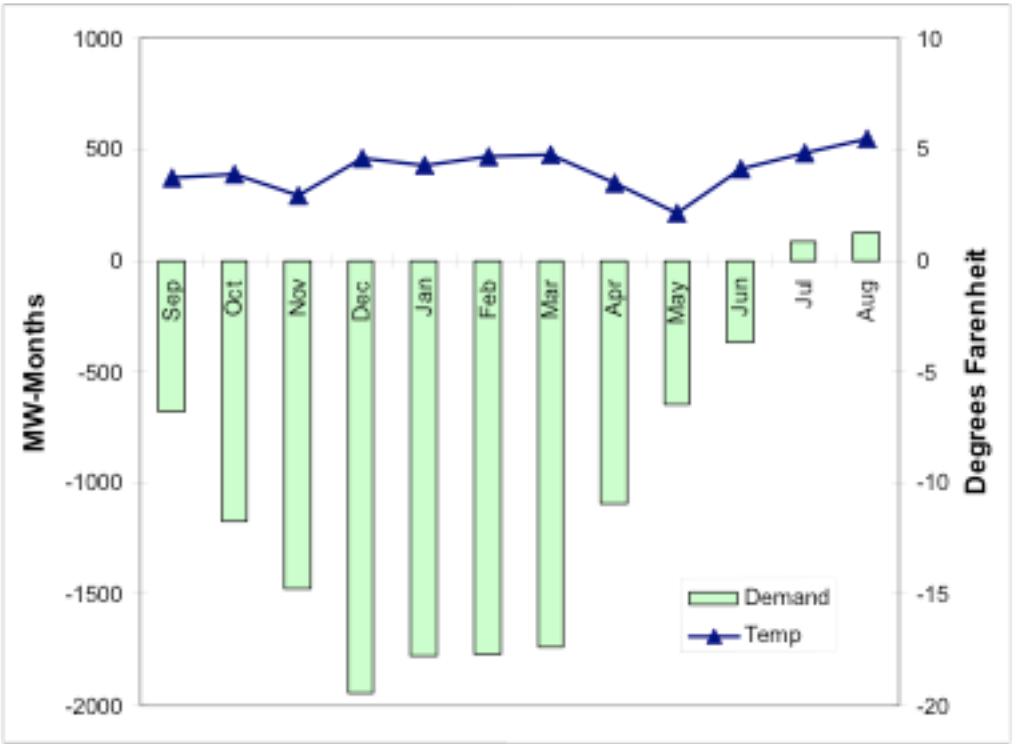
Figure 39: Scatter Plots Indicating the Sensitivity of Per Capita Electricity Consumption (kWh) to Monthly Air Temperatures



Source: Sailor and Munoz

[246] NWPCC 2005

Figure 40: Projected 2040 Monthly Temperature Increases and the Estimated Impact on Electricity Demand.



Source: "The Fifth Northwest Electric Power and Conservation Plan."

Municipal and Industrial Water Supplies: Most analysis of economic impacts is conducted on highly populated areas, specifically in the Puget Sound region. An analysis of Seattle's Cedar and Tolt watershed, estimate that combined inflows to the Cedar and Tolt river reservoirs will decline by 6% per decade due to decreased snowpack from climate change.[247] However, the ability of the water supply system to handle this strain depends on the specific system in question. Seattle and King County in general are growing rapidly and thus decreased flows will present a problem. The Seattle Public Utilities (SPU) estimates the "firm yield" of their system (the level or service expected to be maintained in 49 out of 50 years) to be 171 million gallons per day (MGD), while current demand only averages 130 MGD. Demand has fallen in the past few years due to conservation efforts, economic forces, and changing regional priorities and is forecast to remain flat for the next 40 years. Taking climate change into account, it is projected that firm yield will fall by about 6.1 MGD per decade, reducing SPU's firm yield to 159 MGD by 2020 and 147 MGD by 2040. By mid-century, demand would exceed supply if no changes are made in how the system operates.[248]

Agriculture: Washington's agriculture is highly export-dependent and market shifts appear likely to be more significant than the direct impacts of changes in temperature and precipitation. Additionally, Agriculture is practiced in almost every region in the state and is therefore too complex to have a comprehensive analysis of climate change impacts.

[247] Wiley and Palmer
[248] Wiley

However, there are studies conducted on specific regions and industries that do provide insight:

- Yakima River Basin: Of the $5.3 billion agriculture business in Washington State in 2002, $1.3 billion came from the Yakima River Basin making it the states highest-value agricultural region.[249] One study conducted on the Yakima region found no significant impact on yield assuming water availability remained constant, due to increased temperatures decreasing yield but elevated CO_2 concentrations increasing yield.[250] For dryland agriculture, this assumption seems strong, as precipitation rates are not expected to significantly change in Washington. Another study, suggests that dryland winter wheat production in the Yakima region may actually increase anywhere from 5-35%, mostly as a result of increased CO_2 concentrations.[251] However, for irrigated agriculture this assumption does not seem likely as water availability is expected to decline in summer months as previously discussed. Further adding to the complications is the fact that water is not allocated on an efficiency basis but rather on the concept of those who get to the water first have senior rights. This means those with "senior" rights get to fill their water allocation before those with "junior" rights get any. Under the current climate, Scott et al. estimate that there is a 14% probability that junior water rights holders will face pro-rationing of at least 50%. Under a 3.6° F warming, that probability increases to 54%. This translates to expected crop losses due to water shortage rising from the historic average of $13 million per year to $79 million per year.[252]
- Dairy Production: Milk and other dairy products are the 2nd most valuable agricultural commodity in Washington State (valued at $688 million in 2006). Yakima and Whatcom counties dominate dairy production accounting for over half the state total (Yakima and Whatcom also represent the two distinct climates of Washington, as Yakima is east of the cascades and Whatcom is west.) Bauman et al. analyzed potential climate changes on diary production in these two counties using a 1981 National Research Council study of temperature effects on dairy production. The National Research Council study determined that milk production decreases by almost 1 lb/day for each degree that temperatures are sustained above 68° F (cows produce 60 lb/day under optimal conditions). Taking historic temperatures for Yakima and Whatcom counties and projected temperatures for the 2040s and 2090s, Bauman et al. estimate that there will be a decline in milk production in the two counties of 1 to 3% by the 2040s and 3 to 6% by the 2090s, with larger declines in Yakima than Whatcom county due to higher average temperatures. This translates to lost sales of $6 million per year by the 2040s ($4.8 in Yakima) and $19 million per year by the 2090s ($13.2 in Yakima).
- Wine Production: Washington State is the second largest wine producer in the country (after California), and at $144 million, wine grapes are the states third largest fruit crop by value.[253] The industry is comprised of approximately 540 wineries, 350 vineyards, and over 30,000 vineyard acres. In 2005, Washington wineries employed 19,000 people and had a total economic impact of $3 billion.[254] The effects of climate change on wine production are likely to be mixed across the state, with some areas benefiting from conditions

[249] 2002 Census of Agriculture
[250] Scott et al.
[251] Thomson et al.
[252] Scott et al.
[253] 2007 Washington State Data Book
[254] "Washington Wine State Facts."

that favor new varieties, and other areas experiencing changes that are harmful to existing varieties. Specifically, some growing areas in Eastern Washington may approach the upper limits of temperature tolerance by mid-century for both red and white-wine varieties. Conversely, warmer temperatures could increase the number of varieties in the state's cooler growing zones such as the Puget Sound.[255]

Human Health: The relationships between warming, weather, and health patterns are complex, making economic impacts difficult to access. However, three areas of health impacts for which links to climate are relatively well documented and prove useful: infectious disease, respiratory illness, and heat-related illness.

- Infectious Disease: As mentioned earlier, increasing temperatures expand the ranges of insects and are believed to be responsible for the spread of West Nile Virus (WNV) in recent years. Washington State reported its first two human cases of WNV in September 2006, and based on the other states experiences with WNV, a broader outbreak appears possible if and when conditions favor the disease and mosquito vector. Although economic costs are not known in Washington, WNV outbreaks in other states can provide insight. Louisiana is the only state for which the economic impacts of WNV outbreak have been tallied. Researchers estimated the single-year cost of the 329 cases in 2002. They determined that the single-year cost was $20.1 million, or $61,094 per case. Their estimates include $10.9 million in medical and non-medical direct costs and $9.2 million in costs related to the public health response.[256] Washington's Department of Health has taken steps to prepare for WNV. The department currently spends $145,000 per year to conduct environmental surveillance for the virus and approximately $101,000 a year to conduct epidemiological follow-up and clinical testing on suspected human cases.[257] If WNV outbreaks increase, these prevention techniques would be expected to increase as well.
- Respiratory Illness: Climate change could increase the economic burden of asthma in the state. As previously mentioned, activities that emit GHG can cause or worsen the disease. According to Washington's Department of Health, approximately 400,000 adults and 120,000 youth currently have asthma, representing costs of medical expenditures and lost productivity of more than $400 million every year.[258]
- Heat-related Illness: Washington's incidence of heat-related illness and death is typically quite low and expenses have been modest as a result. In 1998, the state had 60 heat-related hospitalizations and three deaths, representing charges of $6,250 per patient. In 2005, there were approximately 30 hospitalizations and no deaths.[259]

Shorelines: Geographical forces and the physical diversity of the Washington shoreline mean that different areas will have different impacts. Low-lying areas of Washington State, particularly in South Puget Sound, are especially at risk. The city of Seattle is prepared to rebuild the Alaskan Way seawall protecting downtown Seattle from Elliot Bay. The current proposal, with a design life of 75 years and a budget of $500 million, was engineered to

[255] Bauman et al.
[256] Zohrabian
[257] Bauman et al obtained from personal communications
[258] Asthma Program
[259] CHARS

accommodate a sea level rise of 11 inches.[260] If revised projections show that sea levels are expected to exceed 11 inches in the next 75 years, the project will have to redesigned, with an estimated cost of 5 to 10% of total project costs or, $25 to $50 million.[261] The Department of Ecology estimates that 2' rise in sea levels would be sufficient to inundate a total area of 35,848 acres. At least 44,429 people live in areas that would be affected by this inundation.[262]

Impacts on Salmon and Other Fisheries: A study conducted by Anderson et al. determined that an increase in temperature of 2° to 4° F would reduce the value of Yakima River spring Chinook salmon by $3.8 million, (from $7 million to $3.2 million). If the state undertook various enhancements to improve the fishery, the value of Yakima River spring Chinook could increase to $30.6 million, and climate change would be expected to reduce that value by $19.5 million to $11.1 million.[263]

Flooding: Flood damage in Washington costs an average of $40 million a year.[264] Although the exact frequency or impact of more severe storms due to climate change is still not known, policymakers should prepare for the possibility that the economic costs of flooding will increase as temperatures warm.

Economic Opportunities

Clean Energy: Perhaps the largest economic opportunities arise from the clean energy industry, which includes energy efficiency, renewable energy, and smart energy. The NWPCC estimates that from 2005 to 2025, the region will have to increase output by almost 7,000 average megawatts (aMW), which represents about a 40% increase over existing capacity[265]. According to the NWPCC, Washington's clean energy industry can supply 60% of the growing power needs for the *entire region* (mainly Oregon, Montana, and Idaho).[266]

Table 21: Washington's Clean Energy Industries, 2004

[260] Cohen
[261] Bauman et al. estimated from Titus
[262] Bauman et al. obtained from personal communication with Department of Ecology.
[263] Anderson et al.
[264] Bauman et al. estimated from Pielke and Downtown
[265] "The Fifth Northwest Electric Power and Conservation Plan."
[266] "The Fifth Northwest Electric Power and Conservation Plan."

	# Orgs	2004 Employees	2004 Avg Wages	2004 Total Wages	2004 Total Revenues
All Organizations	241	8,373	$59,908	$501,617,149	$2,138,493,292
Energy Efficiency	133	4,279	$60,369	$258,330,893	$878,761,251
Renewable Energy	207	2,259	$56,980	$128,739,681	$783,004,164
Smart Energy	48	1,826	$61,927	$113,054,530	$474,989,955
Unidentified Sector	*10*	*9*	*$37,644*	*$338,795*	*$1,737,922*
Average Organization		45	$59,770	$2,676,278	$8,873,416

Note: The number of organizations in the efficiency, renewable, and smart industries sum to more than all organizations because many organizations address more than one industry. The employee, wage, and revenue data do sum and represent the amount of employees and dollars exclusive to each industry.

Source: Suter

- Energy Efficiency: Increased energy efficiency offers businesses and households' savings as well as increased business opportunities on the growing demand for energy efficient products. In the past 25 years, the Pacific Northwest has avoided the need for 3000 aMW of electric power through efficiency, which lowered the region's carbon emissions by about 13 million tons in 2004 and saved the region's consumers $1.25 billion the same year.[267]. The NWPCC estimates energy efficiency costs less than new power generation: $34 per megawatt-hour (MWh), as opposed to coal at $47 per MWh, natural gas at $51 per MWh, and wind at $39 MWh.[268] The NWPCC claims that 2,800 average megawatts can come from conservation over the next 20 years, filling the need for the majority share of energy demand growth. The average levelized cost of these 2,800 average megawatts is 2.4 cents/kWh, which is about half the cost of power generated by new hydropower, natural gas, wind or coals plants. Thus, increased conservation is more cost effective than new power plant construction.[269] Energy efficiency also produces more jobs: 500 megawatts of conserved energy results in 100,800 job years spread throughout the state, whereas 500 megawatts of new coal-generated power leads to 51,600 job years.[270] In 2004, the industry employed almost 4,300 people through 133 organizations in Washington and earned revenues of nearly $900 million.[271]
    - Product Efficiency Standards: Washington has standards for 12 products not covered by federal standards, which are expected to result in a net savings of $465 million over 14 years. With standards in place between 2006 and 2020 the state is expected to reduce its CO_2 emissions by a cumulative 7 million tons, its annual water use by 1.7 billion gallons, and electric use sufficient to power more than 90,000 homes.[272]

[267] Bauman et al. obtained from a NWPCC conference
[268] "The Fifth Northwest Electric Power and Conservation Plan." Converted from 2000 to 2004 dollars.
[269] Bauman et al. obtained from a NWPCC conference
[270] Sullivan
[271] Table 5
[272] Bauman et al.

Table 22: Employment and Revenue Data by Industry and Sub-Industry

Industry or Sub-industry	# of Orgs	Employees	Total Wages	Total Revenues	Avg % of business in other state	Avg % of business international
Renewables	25	586	$24,315,806	$220,600,502	*52.5%*	*4.6%*
Fuel Cells	29	510	$27,406,784	$192,693,388	*28.1%*	*10.6%*
PV/Solar	40	389	$24,521,144	$188,272,931	*43.3%*	*14.4%*
Geothermal	17	205	$13,701,658	$35,499,231	*43.3%*	*14.8%*
Small Scale Hydro	35	278	$19,358,700	$60,608,246	*32.3%*	*16.2%*
Wind	34	111	$8,105,035	$43,560,710	*32.5%*	*9.0%*
Biomass	27	181	$12,313,554	$41,769,157	*32.6%*	*31.3%*
Efficiency	133	4,279	$258,330,893	$878,761,251	*33.2%*	*11.4%*
Smart	48	1,826	$113,054,530	$474,989,955	*34.7%*	*17.2%*
Unidentified	10	9	$338,795	$1,737,922		
Totals		**8,373**	**$501,617,149**	**$2,138,493,292**		

- Because only 30% of the organizations identified whether they have out-of-state business or not, actual figures for the final two columns may be significantly different.

- Ten companies did not identify a clean energy category for their work, nor did they indicate if any of their business is in another state or country.

- The # of Orgs in each of the sub-industries sum to more than 241 because many organizations work in more than one sub-industry. Employees, wages, and revenues have been adjusted to reflect only that attributable to a given sub-industry. Adjustments assume that an organization evenly distributes its work among all sub-industries it is involved in.

Source: Suter

- Renewable Energy: In 2004, Washington's renewable energy sector consisted of 207 organizations with a total of 2,259 employees and revenues of $783 million. The largest potential for renewable energy appear to be in wind, fuel cell, and solar, with components for the latter two being developed and researched in the state. Currently the largest renewable energy sector in Washington is fuel cells, with 29 firms and revenues of $193 million.[273]However, the wind sector has tremendous potential with more than a million acres of windy land. Recent estimates of Washington's capacity for wind energy range from 1,900 aMW to 7,000 aMW.[274] The renewable energy sector leads to job creation as well, as the sector generates more jobs per unit of installed power, per unit of produced power, and per dollar invested than does the fossil fuel industry.[275] In fact, the Renewable Energy Policy Project estimates that wind and solar electric production offer 40% more jobs than coal.[276] In 2003, the WSU Energy Extension Program predicted that a 15% to 25% linear growth in the industry would create between 1,960 and 4,300 jobs in the next decade.[277]
- Smart Energy: In 2004, Washington's smart energy sector consisted of approximately 48 organizations with a total of 1,826 employees and total revenues of $475 million. [278]Pacific Northwest National Laboratory estimates that the application of smart grid technology could save the nation a cumulative $80

[273] Table 5 and 6
[274] "Economics of Wind Energy."
[275] Kammen et al.
[276] Singh et al.
[277] Bauman et al.
[278] Table 5

billion by 2020 by alleviating the need for an additional infrastructure to meet demand. [279] This sector is expected to receive $3 billion in Pacific Northwest investments and $500 billion in worldwide investments by 2020.[280]

Improved Transportation Efficiency: Improving transportation efficiency is especially important for Washington because the largest share (47%) of total GHG emissions come from transportation. Washington has already taken measures and has adopted California's tailpipe emissions standards. By 2016, the standards are expected to lower GHG emissions by about 30% compared to the 2002 fleet.[281] These standards result in increased fuel efficiency, which will lead to savings on fuel costs.

Another way costs can be lowered is by further increasing fuel efficiency in passenger vehicles. For example, plug-in hybrids with a 40-mile range could cut fuel use by 50% and CO_2 emissions by 1/3rd. Although these vehicles do cost more than standard cars, a plug-in vehicle should be able to cover the incremental costs due to fuel savings. In fact, with gas prices in excess of $4 a gallon and batteries on the low end of their feasible price range, a plug-in would be expected to cover the incremental costs in only three years.[282]

Yet another way to achieve cost savings while reducing GHG emissions is through reducing the number of miles driving in a given period (known as vehicle miles traveled or VMT). For example, the Tellus Institute estimates that just a 5% reduction in VMT by 2020, relative to the predicted trend, could save nearly 120 million gallons of gasoline. This could be accomplished through increased use of mass transit, carpooling, telecommuting, growth management, and land use planning. The study did not calculate the costs of measures needed to achieve those savings however, so the net cost or benefit is unknown.[283]

Finally, freight and transportation related fuel costs and GHG emissions could also be reduced to more fuel-efficient modes of travel. For example, moving freight by rail is about 50% more fuel efficient than transporting goods by truck, particularly in the case of long-haul delivery.[284]

Biofuels for Transportation: Although biofuels are highly controversial, Washington State regulations require 2% biodiesel blended with all diesels by December 2008 or sooner. This 2% blend will elevate Washington's biodiesel consumption to around 20 million gallons per year, since the state uses nearly 1 billion gallons of diesel annually. Currently, Midwestern plants fill the void in supply, but there is a large-scale plant (100 million gallon capacity) in development, which places Washington in a good position to lead the West Coast.[285]

[279] "Pacific Northwest National Laboratory Unveils GridWise Initiative to Test New Electric Grid Technologies."

[280] Suter
[281] "Climate Change Emissions Control Regulation Fact Sheet"
[282] Kliesch and Langer
[283] Bailie et al.
[284] "Energy Intensity of Domestic Freight Models."
[285] Bauman et al. obtained from personal communications with Imperium Renewables

Biological Sequestration: One study found that owners of riparian (streamside) forests in Western Washington could sequester 110 million tons of carbon in the forests over 50 years. Compensating landowners at a rate of $2 per ton would cost an estimated $230 million over that time period.[286] However, given that carbon is valued at approximately $5.75 a ton on the Chicago Climate Exchange (as of 6/17/2008), it is expected that Washington's private forest landowners hold even greater financial potential.

11.2 Current Stances and Policies in Coping with Climate Change

State Government Level

Washington has already taken significant actions to address climate change including:

1. Adopting the 2005 Clean Car Act requiring certain automobiles to meet California emissions standards beginning with 2009 models.
2. Retrofitting 50% of school busses and 20% of local government diesel engine vehicles to reduce highly toxic diesel emissions
3. Leading the nation in requiring fuel suppliers to ensure that 2% of the fuels they sell are biodiesel (for diesel) or ethanol (for gasoline) by November 30, 2008 and December 1, 2008 respectively.
4. Leading the nation in adopting high performance green building standards and having one of the most energy efficient building codes in the nation.
    - Enacted into law through SB 5509, which created Leadership in Energy and Environmental Design (LEED) requirements that require green standards for state-funded projects larger than 5,000 square feet and major renovation projects. This made Washington the first state to require that new public buildings meet green building standards.[287]
5. Implementing the best energy efficiency standards for appliances.
6. Passing a clean energy initiative to increase the amount of energy efficiency and renewable resources in the state's electricity system.
    - Enacted into law through Initiative I-937 that requires public and private energy utilities to secure 15% of their power supply from renewable resources by 2020.
7. Purchasing hybrid or low emissions vehicles for state agency use.
    - Public agencies have purchased more than 1,100 hybrids to date.
    - HB 1303 Section 202 requires all state and local government owned vessels, vehicles, and construction equipment to operate on electricity or biofuel by 2015.[288]
8. Adopting the Columbia River Water Management Act, which will work toward meeting the water storage needs for agriculture, communities, and salmon.[289]
9. Creating a GHG emission performance standard.
    - SB 6001 established a performance standard that requires new resources to emit no more than the emissions rate of an average

[286] Perez-Garcia et al.

[287] "Leading the Way: Regional, State, and Local Actions."
[288] "Leading the Way: Regional, State, and Local Actions."
[289] Footnote for policies 1-8. Gregoire. Executive Order 07-02

new, natural gas, combined-cycle combustion turbine, or 1,100 lb CO_2e/MWh, whichever is less.[290]

10. SB 5111, which gives tax incentives for manufactures of solar energy systems
11. SB 5101, which offers tax credits to owners of solar and other small, renewable energy systems.
12. HB 1985, which allows local governments to do energy conservation measures together with other local governments and the state.[291]
13. SB 6309, requiring discloser of GHG vehicle emissions.
14. HB 2815, providing a framework for reducing GHG emissions in the Washington economy.

Governor Christine Gregoire also issued Executive Order 07-02, which was enacted into law by the Washington State SB 6001. Executive Order 07-02, and the subsequent SB 6001 established a list of goals to address climate change:

- By 2020, reduce GHG emissions in Washington to 1990 levels, a reduction of 10 MMt below 2004 levels.
- By 2035, reduce GHG emissions in Washington to 25% 1990 levels, a reduction of 30 MMt below 2004 levels.
- By 2050, reduce GHG emissions in Washington to 50% below 1990 levels, a reduction of 50 MMt below 2004 levels.
- By 2020, triple the number of existing jobs in clean energy fields to 25,000 (approximately 8,400 jobs in 2004).
- By 2020, reduce expenditures by 20% on fuel imported into the state by developing Washington resources and supporting efficient energy use.[292]

The successful implementation of existing policies (1-8) is expected to provide 60% of the reductions needed to accomplish the emission reduction goals for 2020. To fully meet the goals, the Governor directed the Departments of Ecology and Community, Trade and Economic development to lead an organization currently known as the Climate Action Team (CAT) to help the state meet these goals. Additionally, the State realizes the importance of regional and national solutions as well, which is why Washington is part of the WCI.[293]

Industry/Business Level

Many of the states utilities companies have created actions to reduce GHG emissions. The most notable utility companies in the state are the Chelan Public Utilities District, and Seattle City Light.

Additionally there are several climate change organizations throughout the state that included businesses as members. The most prominent climate change organization in the state is the CAT, which is responsible for advising the state legislature on how to meet their emission goals and brace for the impacts of climate change. Businesses such as Microsoft, Weyerhaeuser, BP, Boeing, and JR Simplot all have representatives who serve as members

[290] Leading the Way: Regional, State, and Local Actions."
[291] Footnote for policies 9-11. "Washington Governor Signs Clean Car Act into Law."
[292] Gregoire. Executive Order 07-02
[293] "Issue up Close: Facing the Challenge of Climate Change."

of the CAT.[294] Other climate change organizations tend to be on the local level such as the Seattle Climate Partnership, which is a group committed to take action to reduce their own emissions. The Seattle Climate Partnership includes well-known businesses such as, Starbucks and REI, and several local businesses as well.

Perhaps most importantly, Washington has several businesses that are energy innovators. Boeing is a large innovator for Washington and its new 787 Dreamliner assembled in Everett offers 20% increased fuel efficiency than existing plans. MicroPlanet is a global pioneer in least-cost power planning and is marketing its voltage reduction products international. Their products improve an electrical grid's reliability that prevents expensive infrastructure upgrades. REG SGS Moses Lake plant is the worlds only dedicated producer of polycrystalline silicon for solar cells. Washington is also home to several important smart energy organizations including Spokane-based Itron and Pullman-base Schweitzer Labs. [295]

Individual/Household Level

Washington's citizens can play a huge role in reducing GHG emissions as 47% of total emissions come from transportation. I did not encounter any significant current efforts on the individual/household level, which leads me to believe this segment is quite small. However, the state is actively trying to reverse that and get individuals/households much more engaged. In fall 2007, the Department of Ecology hosted three summits around the state to discuss a plan for citizen engagement recommendations.

11.3 Regional Actions Including the WCI

Memorandum of Understanding

In 2007, Governor Gregoire and British Columbia's Premier signed a Memorandum of Understanding between the state of Washington and the Province of British Columbia to protect their shared climate and ocean. Under the Memorandum, Washington and British Columbia commit to work together on a variety of issues such as capping GHG emissions, combine efforts to improve air quality, and coordinate efforts to encourage clean technologies.[296]

Western Climate Initiative

By far the most developed and important regional action is the Western Climate Initiative, which Washington is one of the five original founding members. Washington has already completed the necessary steps for WCI membership including setting a GHG reduction goal within the regional goal and joining The Climate Registry.

The regional reduction goal for the WCI is a 15% reduction of 2005 levels by 2020. Washington's own goal is to reduce GHG emissions to 1990 levels by 2020, which is consistent with the regional goal if the other members meet their goals as well.

[294] "2008 Climate Action Team (CAT)."
[295] "What are we doing about it in Washington State?"
[296] "Leading the Way: Regional, State, and Local Actions."

Washington is also a member of The Climate Registry, which is a non-profit organization that is developing standard protocol to ensure consistent, accurate and verifiable reporting of GHG. Without this system in place, reductions would be difficult to verify and a carbon market would most likely fail.

Washington currently conducts regular meetings with WCI stakeholders in person and via teleconference. Through the Department of Ecology, Washington has a comprehensive climate change website with WCI and The Climate Registry information as well as posting information over a list serve. Washington is currently working with other stakeholders to try and find a common ground on the major design options being considered by the subcommittees.[297]

Washington has a lot to gain from working with the WCI. As a leader in clean energy industries, other states will turn to Washington as they begin to transition their own industries into cleaner alternatives. This will provide Washington with increased business opportunities and a chance to demonstrate their proven success in the field. Additionally, Washington's energy industry already has very low emissions as the majority of electricity is produced through hydropower. Therefore under a cap-and-trade scheme, Washington's energy industry will most likely be under the cap and will be able to sell their credits on the regional market receiving further economic advantages.

[297] "Leading the Way: Regional, State, and Local Actions."

13 Background Review on the U.S. Observers of the Western Climate Initiative: Alaska, Colorado, Idaho, Kansas, Nevada, Wyoming

This paper will extensively and intensively explore the background of each of the observers in the WCI within the context of climate change. Current U.S. observers include Alaska, Colorado, Idaho, Kansas, Nevada, and Wyoming. Observers are not bound to any of the policies WCI enact. Information on each state's past and projected greenhouse gas emissions will be presented in addition to the damages caused by climate change on temperature, agriculture, infrastructure, population, and so forth. Furthermore, each state's policies and stances on climate change will be presented on the governmental and organizational/firm levels in order to evaluate progressions in mitigation. Lastly, an analysis of these policies will be given to investigate to see what each state needs to do in becoming a participant of the WCI. The objective of this research is to showcase the possibilities and limitations available in each state in joining WCI and eventually adopting its policies.

To become a WCI partner, the observers must meet a set of criteria which essentially make comparable advances in ameliorating the onset of difficulties presented by climate change. These include[298]:

- Adopting economy wide greenhouse gas reduction goals comparable to those of partners
- Developed or are developing multi-sector climate action plan to achieve greenhouse gas emission goals
- Committed to adopting greenhouse gas tailpipe standards for passenger vehicle
- Participation in Climate Registry (which supports common greenhouse measurement and reporting standards to provide accuracy, completeness, consistency, and transparency in greenhouse gas emissions data)

The observing states range from meeting none or close to all the criteria above, meaning that they are in different stages of dealing with climate change. Progressions in climate change will be discussed in great detail later. Furthermore, it is imperative to study the effects of climate change on western states in particular because the American West has warmed 70% more than the rest of the world, having important implications on the availability of water in an area that is dry and hot to begin with. Refer to Exhibit 0.1 for a graphic showing regional temperature increases from 2000 to 2006, which shows that the West has experienced the dramatic temperature increases compared to the rest of the country. This is why the West must act quickly and effectively in mitigating climate change.

[298] "Western Climate Initiative Statement of Regional Goal." 22 August 2007. Western Climate Initiative. 30 May 2008. < http://www.westernclimateinitiative.org/ewebeditpro/items/O104F13012.pdf>.

13.1 Alaska

13.1.1 Evidence and Effects of Climate Change

Temperature

Alaska has experienced substantial warming since the 1950s at approximately 4 degrees Fahrenheit. The most substantial warming of 7 degrees Fahrenheit has occurred during the wintertime. Climate change models such as the Hadley and Canadian both predict that global warming will continue this century. By 2030, Alaska can warm between 1.5 to 5 degrees Fahrenheit, and by 2100, anywhere between 5 to 18 degrees Fahrenheit.[299]

Precipitation

Precipitation has increased dramatically by 30% since 1968. The Hadley and Canadian climate models estimate that precipitation in north and northwest Alaska will increase by 20-25% while the southern region will experience a decrease of 10%[300]. It is predicted that evaporation will offset the increased precipitation, but soils will become drier due to higher temperatures, possibly having important effects on agricultural productivity and output.

Thawing of Permafrost and its Effects on Infrastructure

The thawing of permafrost is particularly important to Alaska because permafrost underlies approximately 85% of the state, which has many implications for the viability of the Alaskan ecosystem and human infrastructures. Infrastructures are crucial in providing people with the resources and services necessary for their livelihoods, such as hospitals, schools, office buildings, and so forth. So, the melting of permafrost can impose large effects on Alaska's economy and society.

Permafrost in Northern Alaska has warmed between 4 to 7 degrees Fahrenheit in the last century. Since the permafrost in this area is below 23 degrees Fahrenheit, warming will not significantly thaw the permafrost. However, the permafrost in Southern Alaska will be subject to substantial thawing since it is usually above 28 degrees Fahrenheit, meaning that this area is highly sensitive to even marginal temperature increases. Permafrost thawing in Southern Alaska will have catastrophic effects because the population is the densest in this area, meaning that the state will have to find effective solutions that accommodate temperature increases promptly to prevent any future damage.

From a scientific standpoint, permafrost plays a large role in the hydrology cycle and is essential in keeping groundwater frozen and plants intact. Permafrost thawing slowly creates a thermokarst terrain where the landscape is uneven, which is conducive to the formation of

[299] "Alaska." 2001. US Global Change Research Program. 31 May 2008. <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/11AK.pdf>.
[300] IBID

pits, troughs, mounds, and depressions[301]. This can have devastating effects on current ecosystems since they can evolve into different ecosystems over times, such as the transformation of forests to grasslands or bogs. Furthermore, the formation of thermokarst terrain can induce mudslides since the landscapes are no longer stationary, putting any human populations and infrastructure in proximity at great peril.

Thawing will lead to warmer soils, which in effect will increase greenhouse gas emissions since decomposition processes of the soils will accelerate. In addition, permafrost thawing will increase groundwater mobility, causing erosion and landslides to be more likely. This would have catastrophic effects on the sustainability of Alaskan infrastructure, implying that huge economic costs would take place if thawing continues to occur.

Though thawing permafrost can bring some benefits to certain sectors such as agriculture, marine transport, and offshore oil production in the short run, the costs in the long run will outweigh any benefits gained. Building on permafrost in the presence of climate change is costly because it requires structures to be stabilized in permanently frozen ground below the layer that thaws. Furthermore, to prevent thawing, buildings have to limit their heat transfer of pipes to the permafrost by usually elevating them on piles[302], which imposes costs that would otherwise be absent in warmer climates.

Permafrost thawing has already caused damages to infrastructures such as houses, roads, and buildings, which leads to them either being damaged or subject to large costs in reparations. Estimated annual costs from repairing infrastructure that has been damaged by permafrost thawing is estimated to be around $35 million, most of which is allocated to fixing roads.

Melting Sea Ice

Sea ice plays profound roles in marine ecosystems and coastal development. Sea ice in the Arctic region has been decreasing 3% a year since the 1970s. The melting of sea ice accelerates the erosion processes along the coastal lines, threatening human development and populations that reside in these areas. Erosion has caused losses of up to 1,500 feet along the Alaskan coast within the past few decades.

More broadly, melting sea ice calls the need for the increased protection of infrastructure along these coasts in form of construction, maintenance, and insurance. This phenomenon could displace labor employment in the construction sector as well since it would be counterintuitive to build infrastructure in these coastal regions that could potentially be completely damaged by climate change. Projected future costs would easily outweigh the benefits if maintenance is constantly required to keep the infrastructures intact.

According to the U.S. Global Change Research Group, the net economic impacts of melting sea ice are unclear. Higher sea levels would make oil exploration (fossil fuel production is a

[301] "US National Assessment of the Potential Consequences of Climate Variability and Change." US Global Change Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/nacc/education/alaska/ak-edu-3.htm>.
[302] IBID

prominent industry in Alaska) and extraction more difficult, but could reduce the marine transportation costs of shipping oil. However, the benefits that climate change can possibly bring should not be overly emphasized since the associated costs of experiencing a significant shift in temperatures will impose strains and difficulties on Alaskans' livelihoods.

Forest and Tundra Ecosystems

Forests cover approximately one-third of the state, or 129 million acres, with sixteen percent of it productive. Due to global warming, the average increase in growing days is about 20% in areas that are not moisture limited. Areas that are moisture limited are expected to experience decreasing productivity. Increased temperatures have caused the boreal forest to expand on the Seward Peninsula. For every one degree (Fahrenheit) increase, the boreal forest expands by 35 miles due to tundra receding[303]. Alaska has seen the most moisture stress and decrease in productivity in the past two decades than any other time period in the boreal forest.

There have also been increases in the outbreak of spruce bark beetles, which have historically been absent most of the time due to colder temperatures. Spruce bark beetles are extremely aggressive in eating forests. In the presence of global warming, these beetles are much more likely to reside in the forest. Spruce bark beetles have devastated the southeast coastal and boreal forests; since 1992, 2.3 million acres of forest have been lost in the Kenai Peninsula[304]. Furthermore, since 1970, there has been an increase in the frequency and intensity of fires, resulting in seven million acres of forest being burnt. The continuation of increasing temperature will exacerbate the conditions already present. Not only do fires pose a threat environmentally, it has also displaced communities and incurred large costs for the citizens that have had to rebuild or relocate.

In the long run, climate change will change the vegetation landscape of Alaska, with forest horizon expanding while tundra shrinks. Temperature increases have increased nitrogen availability, having positive effects on nutrition availability. As a result, shrubbery has increased while mosses, forbs, and lichens have reduced or disappeared completely.

Marine Ecosystems and Fisheries

Fisheries are highly valuable and vital to Alaska's economy. In 1995, Alaska fisheries had output of 2.1 million tons valued at $1.45 billion, accounting for 27% of total U.S. value from fisheries[305]. Alaska employs approximately 20,000 people in the fishery industry. Climate variability greatly affects the variety and availability of marine life, which will in turn affect productivity of one of Alaska's backbone industries. Climate fluctuations have caused a shift in the types of fish fisheries catch, which then causes fluctuations in the how much revenue

[303] "US National Assessment of the Potential Consequences of Climate Variability and Change." 2001. US Global Change Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/nacc/education/alaska/ak-edu-5.htm>.
[304] US National Assessment of the Potential Consequences of Climate Variability and Change." 2001. US Global Change Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/10Alaska.pdf>.
[305] "Climate Change Impacts on the United States The Potential Consequences of Climate Variability and Change Overview Alaska." 2001. US Global Change and Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewalaska.htm>.

they earn since some types of fish have more market value than others. For instance, from 1997 to 1998, the volume of fish caught was average, but the composition was quite different from previous catches. The Bristol Bay sockeye run fish variety, which has high value per unit, declined heavily in volume. In the meanwhile, salmon, a less lucrative fish, increased in volume. The availability in the type of fish also affects those animals that feed upon them, such as seabirds, seals, and other marine wildlife. Many seabirds have declined by fifty to ninety percent since the 1970s, Northern Fur seals declined by 50% between 1970 and 1986, while certain types of sea lions have declined more than 80%[306].

To adapt to climate variability, fisheries will have to be more flexible in catching different species of fish and shift operation/production capabilities accordingly. Capital equipment that is used in catching fish should be increased in variety since certain fish species require special equipment. In the face of climate change, fisheries will have to adjust such that they are able to adapt to catching different variety of fishes than what they might be accustomed to.

Subsistence Populations

Alaska has a significant population, numbered at approximately 117,000, which includes different native tribes that live in rural communities. This population has been significantly disadvantaged by climate change. They depend heavily on subsistence for their livelihoods, and subsistence is important to enriching their cultures and identities as individual groups. The rural population collects about 43 million pounds of food annually[307]. On average, fish supplies 60% of their diet, but this figure fluctuates due to settlements in different areas of Alaska, with coastal communities consuming a lot more fish than their interior counterparts. Climate change has brought changes in the availability and variety of fish and other animals which these communities depend heavily upon for subsistence. As a result of this, subsistence populations either have to change their consumption habits or move elsewhere. They cannot continue to stay where they are and sustain the lifestyles their cultures have been accustomed to for many generations.

Miscellaneous: Agriculture, Tourism

Climate change effects on agriculture are ambiguous. Due to the increased temperatures, growing seasons have been lengthened by as much as 20%, as mentioned above. However, at the same time, soil moisture is decreased and soil erosion increased due to melting permafrost. Tourism has increased with the climate change, though a causal connection cannot be proven. It is possible that with more warming, tourism will increase economic activity but further hurt the already vulnerable ecosystems.

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[306] US National Assessment of the Potential Consequences of Climate Variability and Change." 2001. US Global Change Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/10Alaska.pdf>.

[307] "Climate Change Impacts on the United States The Potential Consequences of Climate Variability and Change Overview Alaska." 2001. US Global Change and Research Group. 31 May 2008. <http://www.usgcrp.gov/usgcrp/Library/nationalassessment/overviewalaska.htm>.

13.1.2 Greenhouse Gas Emissions

The "Alaska Greenhouse Gas Inventory and Reference Case Projections, 1990-2020," was released in February 2007 by the Center for Climate Strategies for the Alaska Department of Environmental Conservation. The purpose of compiling such a report is not only to enumerate and calculate aggregate greenhouse gas emissions, but more importantly, to pinpoint the sources of emissions to aid in creating the appropriate carbon emissions reduction policies.

The Center for Climate Strategies estimates that in aggregate, as of 2005, Alaska emitted 50 million metric tons of carbon dioxide[308]. In 2005, 49% of total gross carbon emissions originate from residential, industrial, and commercial sources, with the industrial sector contributing 85% of emissions in the entire sector. Emissions from these sources are predicted to increase by 28% in 2020. The second leading contributor is transportation, at 37% of 2005 gross carbon emissions. Examining these statistics shows us that industry and transportation are the main contributors to Alaska's carbon emissions, so proposed policies that will be successful need to largely address the roles of these two sectors in climate change mitigation. By 2020, the report predicts that total gross emissions will be 61.5 million metric tons of carbon dioxide, which is 44% above 1990 levels, with the majority of the emissions still coming from the same sources as mentioned above. Refer to Exhibit 1.1 for the distribution of emissions by different sectors from 1990 to 2020.

Residential, commercial, and industrial fuel consumption consists of fuel that is used for space/process heating and other applications, excluding the fuel used for transportation. Emissions from industrial fuel consumption alone contributed 85% to the sector's total emissions, meaning that approximately 42% of the entire state's total emissions come from fuel combustion in industries. The majority of the fuel used by the industrial industry is natural gas, as shown in Exhibit 1.2. This has an important implication for the drafting of policies in the near future of adopting more renewable energies to decrease emissions.

Additionally, the fossil fuels industry and transportation sector cause large discrepancies between the greenhouse gas emissions per capita of the average U.S. state and Alaska. Thus per capita greenhouse gas emissions are not indicative or telling of consumption patterns and emissions of individuals. Refer to Exhibit 1.3 to observe the degree of the discrepancy. Furthermore, the shares of sectors' greenhouse gas emissions differ greatly between Alaska and U.S., as shown in Exhibit 1.4. We see that in 2000, the most noticeable differences are caused by transportation and industrial fuel use sectors. This is not surprising

[308] Roe, Stephen, et al. "Final Greenhouse Gas Inventory and Reference Case Projections 1990-2020." July 2007 Center for Climate Strategies. 1 June 2008. <http://www.climatechange.alaska.gov/docs/ghg_ei_rpt.pdf>.

because unlike other U.S. states, Alaska has a prominent fossil fuel industry, which would induce more transportation on average in comparison to other countries because of oil exports. Alaska is the second largest crude oil producer in the United States, accounting for 17% of total crude oil produced[309]. Broadly, these realities imply that any climate change policies Alaska creates and implements will have to be highly stringent towards these two sectors for any significant improvements in greenhouse gas emissions to take place.

The inventory of greenhouse gas emissions in Alaska taken by the Center for Climate Strategies was amongst the first of its kind. Thus, it was likely to be subject to miscalculations and incomplete or imperfect methods of data collection. In January 2008, the Alaska Department of Environmental Conservation released a report titled "Summary Reports of Improvements to the Alaska Greenhouse Gas Emissions Inventory" upon realizing the importance of accuracy, consistency, and transparency in data collections if any significant strides were to be made in policy making. Several refinements were made to the original estimations, but the overall results remained consistent with the original findings. The report outlined a list of suggestions to provide a more detailed greenhouse gas emissions inventory, which include[310]:

The development of a standardized protocol to incorporate the inventory of green house gases into our existing emission inventory work;

The collection of additional data and improvement to emission factors;

The continued identification and correction of data gaps in the original February 2007 report;

Continued refinement of estimates for large source categories such as power generation, oil and gas, and transportation, including more analysis on the impacts of commercial passenger and cargo flights;

Calculation of fugitive emissions of GHG associated with energy production and transport of the fuel to markets;

Analysis of the contribution of natural sources of GHG

Joining the Climate Registry would likely aid Alaska in achieving such goals, which will be discussed in Section 1.4.

13.1.3 Policies that Address Climate Change

Initiatives Taken on State Government Level

[309] "Alaska State Energy Profiles." 12 June 2008. Energy Information Administration. 2 June 2008. <http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=AK>.
[310] "Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory." January 2008. Alaska Department of Environmental Conservation. 1 June 2008. <http://www.climatechange.alaska.gov/docs/ghg_ei_rpt.pdf>.

At the state level, Alaska has enacted laws that have created means and resources to closely evaluate the impacts of climate change, effectively establishing committees specializing in researching climate change mitigation.

Administrative Order 238

On September 14, 2007, Alaskan Governor Sarah Palin established the Alaska Climate Change Sub-cabinet to advise on preparation and implementation of the state's climate change strategies that addresses both economic growth and resource development. The sub-cabinet's primary tasks include but not limited to[311]:

- Scientific research to aid policymakers understand current and projected outcomes of climate change
- Assessment and development of an action plan addressing climate change impacts on coastal and other vulnerable communities
- Policies and measures to reduce likelihood of damage to infrastructure
- Research potential benefits of Alaska participating in various climate agreements and greenhouse gas registries
- Identification of economic opportunities for Alaska that might emerge as a result of climate change mitigation

Alaska Climate Change Sub-Cabinet

The Alaska Climate Change Sub-Cabinet created by Administrative Order 238 has been highly active in dealing with climate change mitigation. In May 2008, it assigned a hundred Alaskans to help write the state's Climate Change Strategy, or a climate action plan. Writing a climate action plan would be greatly beneficial because it would create a set of comprehensive policies that would effectively address greenhouse emissions reductions through state-specific mechanisms based on independent research.

To develop an extensive and comprehensive Climate Change Strategy, the team is divided into two broad groups: adaptation and mitigation. The adaptation group will focus on how to present and address future impacts of climate change in the areas of public infrastructure, health and culture, natural systems, and economic activities. As mentioned before, public infrastructure has already been noticeably devastated by permafrost thawing. Further understanding of the mechanisms behind infrastructure damage will lend knowledge to future prevention measures and adaptations. Each of these areas constitutes as a technical group, which will research intensively the possibilities and limitations of adopting climate change in their designated area. Essentially, the adaptation group will evaluate the contributions of each technical area and suggest any alterations that can be made in the near future to be more responsive to climate change policies.

The mitigation team overlooks areas that have made notable contributions to greenhouse gas emissions in the state. These areas include: oil and gas, energy supply and demand,

[311] Palin, Sarah. "Administrative Order No. 238." 14 September 2007. Administrative Orders. 2 June 2008. <http://www.gov.state.ak.us/admin-orders/238.html>.

transportation and land use, forestry, agriculture, and waste, and cross-cutting issues. Analogous to the areas within the adaptation group, each mitigation area is a technical group. Each technical group will examine exact sources of emissions and offer efficiency measures in areas that can feasibly adopt them. Given that transportation and residential, commercial, and industry use contribute the majority of greenhouse gas emissions, the work the mitigation group takes on will be highly valuable in helping construct viable policies such as greenhouse emissions cap and trade.

The technical groups within the mitigation and adaptation teams will meet monthly while the mitigation and adaptation teams will meet bi-monthly to discuss findings and brainstorm a feasible yet effective climate change action plan. It is estimated that the complete climate change policy plan will be presented to the Governor in a year after finishing collecting and analyzing data.

Since the Sub-Cabinet was only recently established, it is still in its early stages of development and influence over climate change. As climate change policy discussions become more prevalent on the national level and within the Western Climate Initiative, it can be predicted that the Sub-Cabinet will become even more vocal and active in the decision-making processes.

Alaska HCR 30

In 2006, the Alaskan Legislature passed a bill to create the Alaska Climate Impact Assessment Commission. Its duties are to use the Artic Climate Impacts Assessment as a basis to conduct research and report the effects of climate change on Alaska. In addition, the Commission is to suggest any techniques that would effectively deal with the adverse consequences of climate change. The creation of the Commission allowed the state for the first time to thoroughly and seriously assess how climate change's effects have infiltrated into the economy, environment, and people's livelihoods.

On March 17, 2008, the commission released a final report that discussed the effects of climate change on the economy, communities, natural resources, and ecosystems. At the end of their analysis, they offered a list of suggestions the state should follow to better deal with climate change, such as expanding village relocation efforts, innovative infrastructure planning, offering loans to homeowners to protect their homes from potential damages caused by climate change, and continuing the climate change mitigation efforts through commissions such as the Alaska Climate Change Sub-Cabinet.

State and Regional Energy Planning

Since Alaska is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

*13.1.4 **Initiatives** Taken **on Organizational and Firm Level***

Alaska Energy Authority: Alternative Energy Division

This division promotes the use of renewable sources and local energy sources such as natural gas and coal. They also create measures that improve energy efficiency. Within the division, there are sub-divisions that each represents a kind of energy source, such as biomass, geothermal, hydroelectric, solar, and wind. In 2007, the division released a biennial report that describes[312]: 1) available and needed funding for alternative energy and energy efficiency investments, 2) assistance it projects to provide, and 3) criteria for allocating the funds. That same year, it also released an energy atlas that succinctly provided information on energy sources within the different regions of the state.

Golden Valley Electric Association (GVEA)

GVEA is an electric utility company located in Fairbanks, Alaska. In a survey conducted in 2002, many customers indicated that they would like to see the company investing in alternative energy source. As a result, the Green Power Advisory Committee was established to find and implement alternative energy resources.

GVEA also took a Green Power Pledge, where one of their goals by 2014 is to provide 20% of their peak load using renewable energy. To achieve this, the company runs a hydroelectric dam at Bradley lake, uses energy extracted from wind power, and implements Energy$ense conservation programs, outlined below, which entice individuals and businesses to conserve energy.

Incentives given to Individuals: Build$ense[313]

Build$ense is an incentive program for homeowners that adopt energy efficient appliances during house construction by giving rebates. This program has a long run effect as well: homeowners will substantial amounts of money by simply installing energy conserving devices.

Incentives given to Businesses: Business$ense[314]

[312] "AEA Alternative Energy." 16 May 2008. Alaska Energy Authority. 2 June 2008. <http://www.akenergyauthority.org/programsalternative(2).html>.
[313] "Builder$ense." Golden Valley Energy Association. 2 June 2008. <http://www.gvea.com/memserv/energysense/buildersense.php>.
[314] "Business$sense." Golden Valley Energy Association. 2 June 2008. <http://www.gvea.com/memserv/energysense/businesssense.php>.

Business$ense is a program designed to promote energy conservation and efficiency to the commercial sector through rebates. It provides rebates up to $20,000 to businesses that reduce energy use through the adoption of energy efficient technologies. Long term effects of notable cost savings occur with businesses, where they can invest elsewhere to improve efficiency.

GVEA is unique in comparison to other Alaskan electric utilities in the sense that it has taken a strong stance on climate change mitigation by forming a committee and a pledge in adopting renewable energies and curbing greenhouse gas emissions. In addition, providing monetary incentives at the micro level are an innovative way of garnering interest amongst businesses and individuals in using green energy. The most important aspect of these incentive programs are not simply the rebates received, but the knowledge transfer between the utility company and associated parties. Having the knowledge of energy efficiency and conservation has a large intrinsic value because it can alter behavior, and thus consumption patterns in energy usage.

What Still Needs to be Done

Though Alaska has made impressive attempts in progressing in dealing with the onset of climate change through enacting climate change commissions, having a greenhouse gas inventory in hand, and beginning to develop a formal climate change action plan, it still has a lot of work ahead of them to mitigate climate change successfully in the long run.

Once a more careful evaluation of the exact sources of greenhouse gases is made, a cap/target and trade system can be created where industries, in aggregate, have a maximum amount of emissions they can produce. At the same time, emissions can be "traded" between companies within high emission industries such that more technologically innovative and energy efficient companies can sell their emissions permit to those that need to emit more greenhouse gases. The motivation behind this is to induce companies to develop new processes or alter old ones such that they are more energy efficient.

Since transportation is the second largest contributor to greenhouse gas emissions, the Climate Change Sub-cabinet will need to include standards for low emissions automobiles and low carbon fuel if any significant emission cuts are to take place. Furthermore, industries should be required to report their greenhouse gas emissions to facilitate a quicker, more time saving method to create an inventory. However, this could pose challenges because of moral hazard and the lack of standardized inventory procedures. Individual companies might have the incentives to lie since no overarching commission or entity is taking inventory of greenhouse gas emissions. Furthermore, the lack of standard greenhouse gas inventory methods would cause inconsistencies between different industries.

All Alaskan electric utilities should use GVEA as an example in adopting climate change policies on the micro level through commitments to using green renewable energies and incentive programs to lower emissions levels. Alaska, to date, has not implemented many clean energy standards. It has energy efficiency standards for residential and commercial buildings and those negotiated under the Western Governor's Association, but lacks measures for public facilities or renewable portfolio standards. Renewable portfolio standards

mandate that electric utilities must obtain a certain percentage of their energy from renewable sources. A reason why this might not have been proposed yet is because electricity does not constitute a significant portion of total greenhouse gas emissions. In general though, more investment towards research and development of energy-efficient technologies could greatly benefit Alaska as a whole, contributing to the future call for emission cuts.

13.1.5 Alaska and WCI: Analysis

Based on the criteria given in the Introduction on the qualifications states need to meet before becoming a WCI partner, Alaska has only met one of the four criteria thus far, which is the development of a multi-sector climate action plan to achieve greenhouse gas emission goals. In meeting this goal, the other criteria will most likely quickly follow since once greenhouse gas emissions goals are established, the policies/standards that remain to be met will be implemented to aid in meeting emission goals.

Joining the Climate Registry will help standardize the reporting of greenhouse gas emissions such that the data are consistent so accurate comparisons can be made between different inventories of greenhouse gas emissions in subsequent years. It is logical for the WCI to require all partners to be part of Climate Registry for this reason as well. Partners can share knowledge, resources, and technology to mutually benefit one another since states might have differing relative emissions in certain areas. This would be beneficial to Alaska to adopt the practices of the Climate Registry to reap the benefits of such knowledge/technology transfers.

Since Alaska is one of the states most affected by climate change, being an observer of WCI is highly beneficial since it can learn from the WCI partners which policies work best in different types of institutional and economic settings. It is urgent that Alaska adopts feasible policies soon if it wants to slow or stall the negative effects of climate change, which have already shown its strains on ecosystems, coastal cities, and public infrastructure. The WCI can give Alaska the resources and support to develop viable policies that will address all of the state's concerns. However, because Alaska is structurally different from WCI partners since it is more of a resource-extraction based economy (commercial fishing, oil production, etc.), policies that others adopted might not be as effective. The Alaska Climate Change Sub-Cabinet will need to conduct extensive and detailed independent research to figure out the policies that would be most effective for the states' goals.

Early action in the midst of climate change dialogue is also crucial because it gives Alaska the opportunity to develop region-specific technology that can be used in other Arctic areas that are experiencing similar climate change effects of melting sea ice and permafrost thawing, for instance. Being at the forefront of developing new technologies, conducting research, and allocating sufficient resources to mitigate climate change can be an invaluable (perhaps even lucrative) and highly beneficial experience for Alaska.

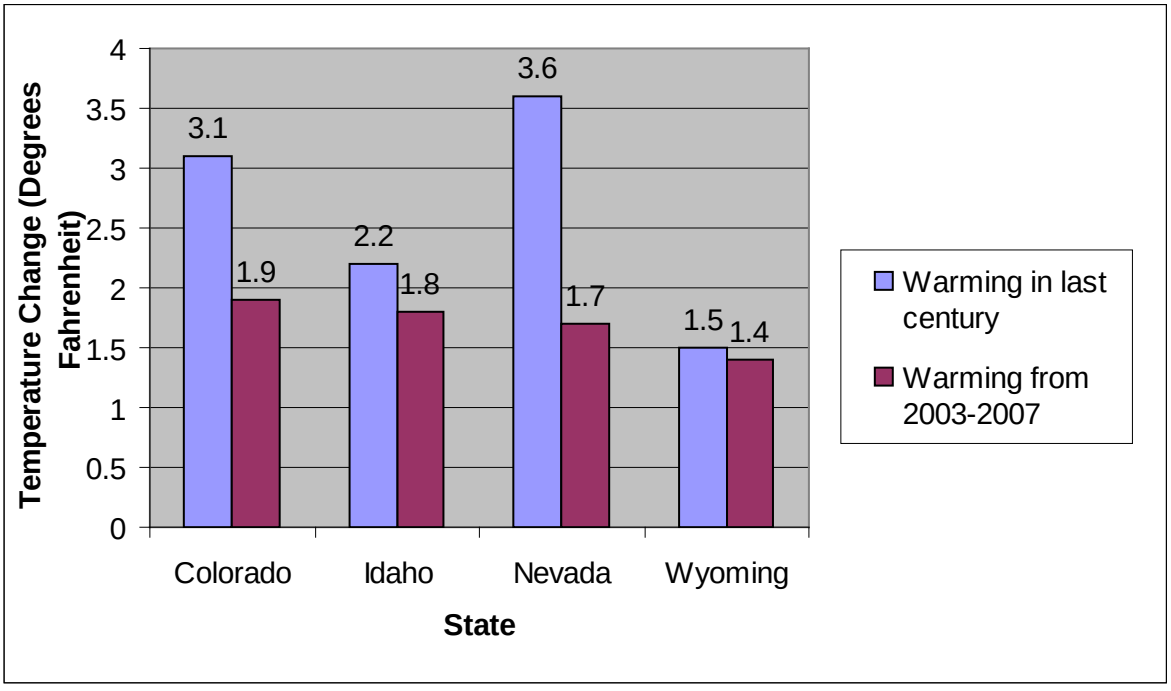
13.2 Evidence And Effects Of Climate Change In Other Western States: Colorado, Idaho, Nevada, Wyoming

Since the Western states are in close vicinity, their environments, ecosystems, and waterways are interrelated. It is common that these states experience broadly the same climate change effects. In this section, I will discuss evidence and effects of climate change of the western states (which excludes KS and AK) to present and facilitate the linkages between them. Major areas that have been victim to climate change will be examined. State-specific effects will still be given individual treatment in their respective sections below. Factual information presented in this section on all states (unless otherwise specified) is all derived from the report "Hotter and Drier" compiled by the Rocky Mountain Climate Organization and National Resources Defense Council.

13.2.1 Temperature

All of the WCI observer states in the west have detected both long and short term increases in observed temperatures. The figure below shows the changes in temperature in each of the states from 2003-2007 (short term) and 1908-2007 (long term). All of the states have experienced substantial warming during these time periods. It is projected the west will continue to experience significant temperature increases on the average of 6.1 degrees Fahrenheit (compared to average temperatures from 1980-1999).

Figure 41: Warming in CO, ID, NV, WY in the last century and from 2003-2007



Note: These are all average changes over a specified time period
Sources: Rocky Mountain Climate Organization; Natural Resources Defense Council

Furthermore, temperature increases have been more significant at higher altitudes, dramatically influencing the time in which snowpack melt. Temperature increases will cause snowpack to melt earlier, which shifts away water supply when it is most needed during the summers. This implies climate change mitigation is direly needed to prevent or stall this from happening in order to ensure a smooth water supply year round.

Temperature increases are associated with decreased water availability and increase in occurrences of drought (especially in an area that is dry and arid to begin with) through the premature melting of snowpack in the mountains, subsequently drying the rivers. Focus on the impacts of warmer weather on water supplies will be emphasized here since it has been and will continue to be greatly impacted. Furthermore, hotter weather poses viable threats to the health of human populations due to the increased frequencies in heat waves. All these areas will be explored further later in subsequent sub-sections.

13.2.2 Human Health

Excessively high temperatures are associated with heat waves. In an area that is already susceptible to heat waves, temperature increases in the west will only further aggravate the frequency of their occurrences. It is projected that the West will experience a larger influx in heat waves compared to any other area in the world. More significantly, the extreme temperatures for some heat waves are not only constricted to daytime occurrences. In the event that high temperatures continue into the nighttime, it can be even more deadly as there is no relief for people from the heat. Heat waves pose as a major health issue because many people can die or become seriously ill from them. Approximately 1,500 people die annually in the United States because of heat waves, and it can be assumed that this figure will increase as temperatures continue to rise in the west if no additional precautionary measures are taken.

2.2 Water Availability

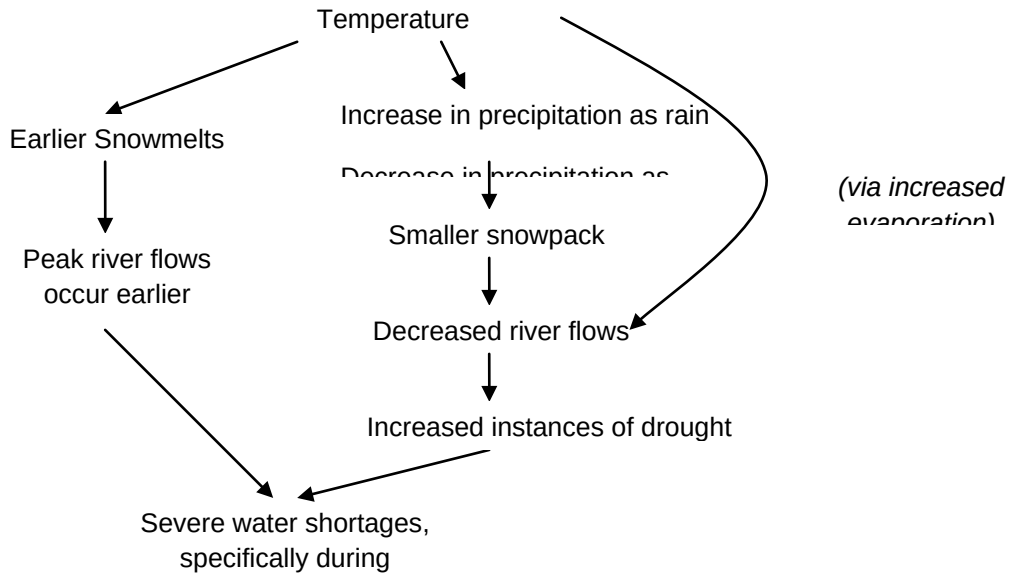
The diminishing water availability in the western states is heavily affected by increased temperatures, smaller snowpack, reduced stream flows, less precipitation, and increased drought. Each of these factors, its mechanisms, and linkages with one another are discussed briefly below.

As mentioned before, snowpack in the West play an integral role in supplying the majority of the area's water supply. If the proper role of the snowpack is compromised, it will have cataclysmic effects on water supply. Based on a few studies, snowpack have been decreasing in size in the past few decades while melting earlier in the year, as evidenced by the peak annual river flows occurring anywhere between ten to thirty days earlier than before, with minor variations depending on elevation and location. These dual effects simultaneously occurring amplify the extent of water supply shortages. Furthermore, since the West is an arid area with little precipitation to begin with, the combination of rapidly increasing temperatures and premature snowmelt are devastating.

The premature melting of the snowpack creates a domino effect. As a result, the peak flows of rivers that receive the runoffs from the snowpack occur earlier, meaning that water supply

is subsequently increased during the winter and decreased in the summer. This creates a huge problem because water demand is the highest during the summers, putting further constraints on already limited water supplies. Furthermore, increasing temperatures have a direct effect on stream flows as well. Higher temperatures means that more water will be evaporated, further decreasing stream flows even if precipitation levels stay constant. The figure below gives for a diagrammatic representation of the causal chains just discussed.

Figure 42: Causal Chains Resulting in Decreased Water Supply



Source: Rocky Mountain Climate Organization

Due to smaller river runoffs and decreased soil moisture, there have been increased instances of extreme drought in the West since 1999. The consequences and economic costs of droughts can be substantial. Agricultural fields become dry and infertile, thus causing unemployment and decreases in food output. Wildfires become an increasingly common occurrence, causing damage and demolition of infrastructures while taking many lives.

Conditions are expected to become direr as temperatures rise further and precipitation patterns deviate from those experienced historically. In response, water managers have been increasingly attentive and proactive in fashioning strategies that would protect Western water sources. The National Resource Defense Council published a journal addressing water issues (with special emphasis on the West) and offering sound policies water managers can follow to prevent/dilute the consequences of increasing temperatures[315]:

1. Vulnerability Analysis: Water managers should study the regional effects of climate change and then evaluate whether current water infrastructure would mitigate such effects. Collaboration between regional water districts might be highly valuable in the technology and

[315]Nelson, Barry et al. "In Hot Water." July 2007. Natural Resource Defense Council. 5 June 2008.

information exchanges that can occur. Such an analysis would aid water managers in defining their roles and investigating what exactly needs to be done by the water districts in terms of improvements, adjustments, alterations, etc.

2. Response Strategies: Developing policies, strategies, appropriate infrastructures, and technologies that would help mitigate the effects of climate change in areas of water supply and water management. Using the information collected under the vulnerability analysis, water managers can experiment and pinpoint the strategies that would be viable in the long term.

3. Prevention: Water companies in regions where water supplies are adversely affected by climate change should back support for carbon emissions reductions, caps, and targets advocated by external organizations/groups or set in place by state governments.

4. Public Outreach: Water companies should also be responsible for educating consumers and businesses on water conservation and the consequences of excessive water usage in the presence of increased temperatures as to offset/prevent any large shortages in water supplies during summer. More importantly, water providers should emphasize the link between climate change and water supply to help with the prevention efforts discussed above.

The success of future policies is a two way street: water companies can provide the right policies, incentives, and infrastructures, but any efforts made on their behalf will be negligible if support from individuals and businesses are absent.

2.4 Environment

The West, even without the relatively recent temperature increases, is prone to wildfires due to its hot and arid climate. In the presence of climate change, the frequency and severity of wildfires are predicted to increase. Since 1980, an average of 7.4 million acres of forest area has burned annually, 70% more than prior years.

Warmer climate will lead to increase in infestation of bark beetles that feed on forest trees. The mountain pine beetle in particular poses a great threat to forests because they are unusual in the sense that they have to kill trees in order to reproduce, accelerating forest loss. Warmer winters also increase the probabilities of beetle larvae surviving until spring. Thus, warmer climates lead to increase in the beetle population, causing a further decrease in forest coverage. Increase in wildfires coupled with rises in beetle population work hand in hand to decrease forest areas in the West very rapidly.

Increase in temperatures also leads to significant losses in glaciers. This has important effects on water availability since there is less or no river runoff later in the year if glaciers are not present. Furthermore, many wildlife species can become extinct if the temperature rises dramatically. It is estimated that an excess of four to five degree Fahrenheit increase would decrease existing wildlife by 20-30%, or these affected species would have to move to areas with higher elevations with colder temperatures.

2.5 Economy

Agricultural yield and output is overall predicted to decrease given the increased droughts, pest infestation, and heat waves associated with increased temperatures. All western states have experienced agricultural losses due to climate change and incurred significant costs. Fisheries are to experience changes in availability and variety of fish species that they catch, with climate change undoubtedly depleting supply of cold water fish. The hunting industry is also adversely affected since wildfires and decreased food availability as a result of rising temperatures lead to declines in wildlife populations. Snow-oriented sports and recreational activities are at stake under climate change with skiing seasons cut short. Snow is in limited availability in lower elevations, so resorts that are in those areas are suffering substantially.

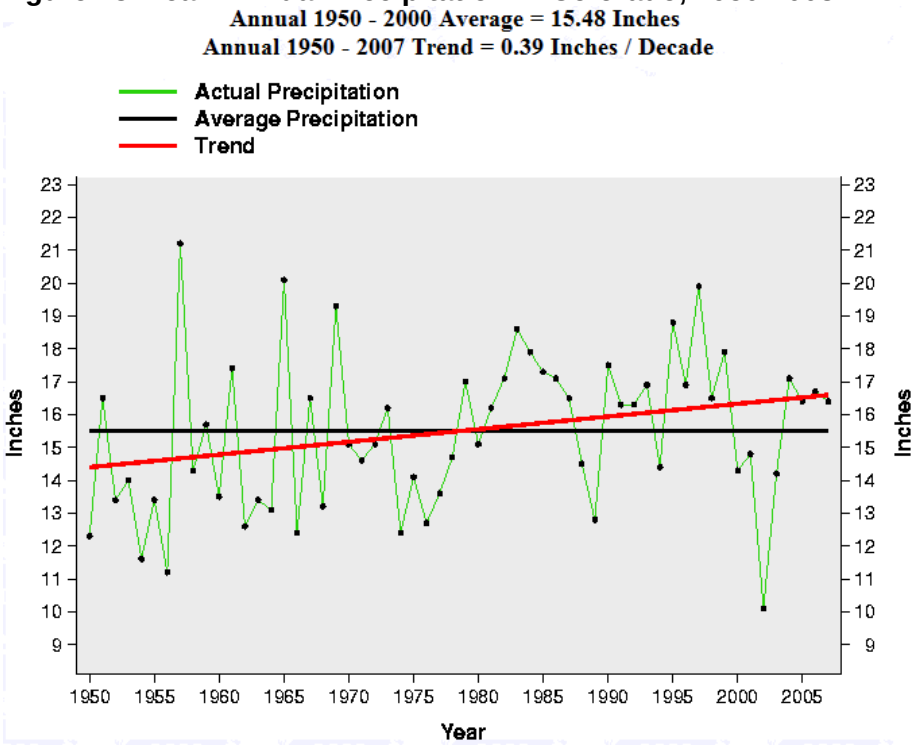
13.3 Colorado

13.3.1 Effects and Evidence of Climate Change

Temperature

Exhibit 2.1 shows the historical temperature increases in Colorado. According to the Environmental Protection Agency, by 2100, temperature could increase by three to four degrees Fahrenheit in the spring and fall while summer and winter can experience increases between five to six degrees Fahrenheit. In addition, since Colorado is an interior state, it experiences more temperature variability to begin with, so climate change would probably magnify this further.

Figure 43:Mean Annual Precipitation in Colorado, 1950-2008



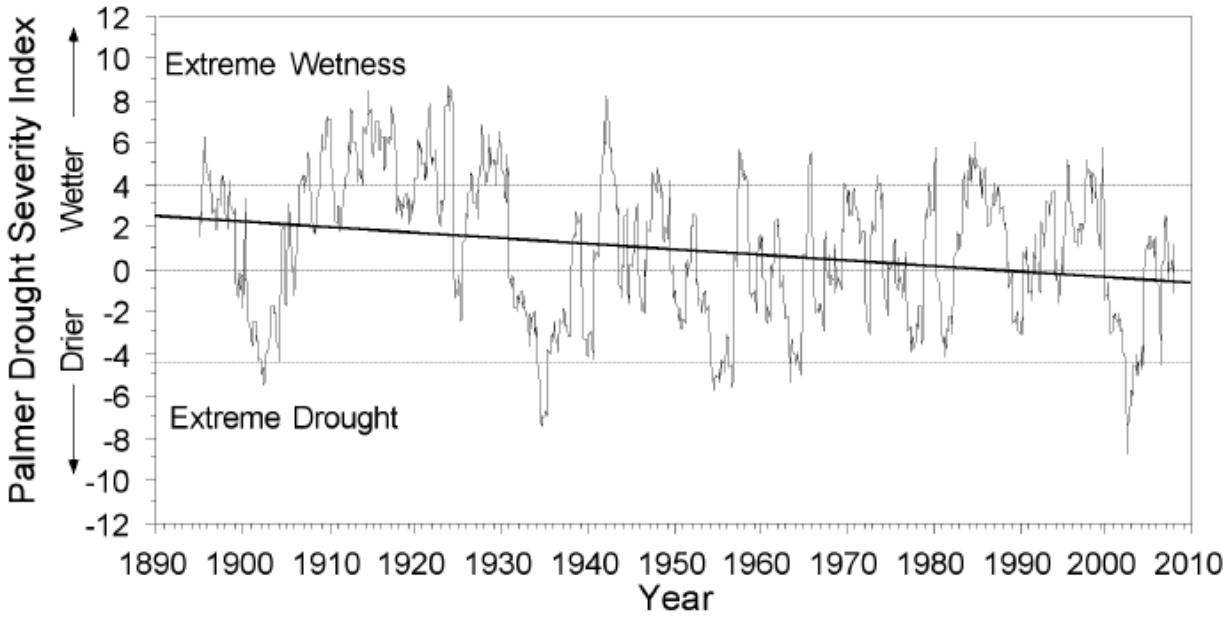
Source: National Oceanic and Atmospheric Administration

Water-related Issues

From 1950 to present day, precipitation has increased by approximately 0.39 inches per decade. The figure above shows the observed trend. Precipitation is expected to continue its increasing trend. During the spring and fall, precipitation can increase by 10% while 20-70% increases are projected during winter time.

Observing the Palmer drought severity index, Colorado has been getting drier over the last century, as shown in the figure below. (The Palmer Index uses rainfall and temperature information in a formula to figure out drought severity[316].) Although precipitation has increased, it could lead to more droughts. Under increased temperatures, precipitation will more likely come in the form of rain than snow. Thus, snowpack are smaller and river runoffs occur earlier, leading to more droughts during summers.

Figure 44: Colorado Drought Severity Palmer Index, 1895-2007



Source: Science and Public Policy Institute

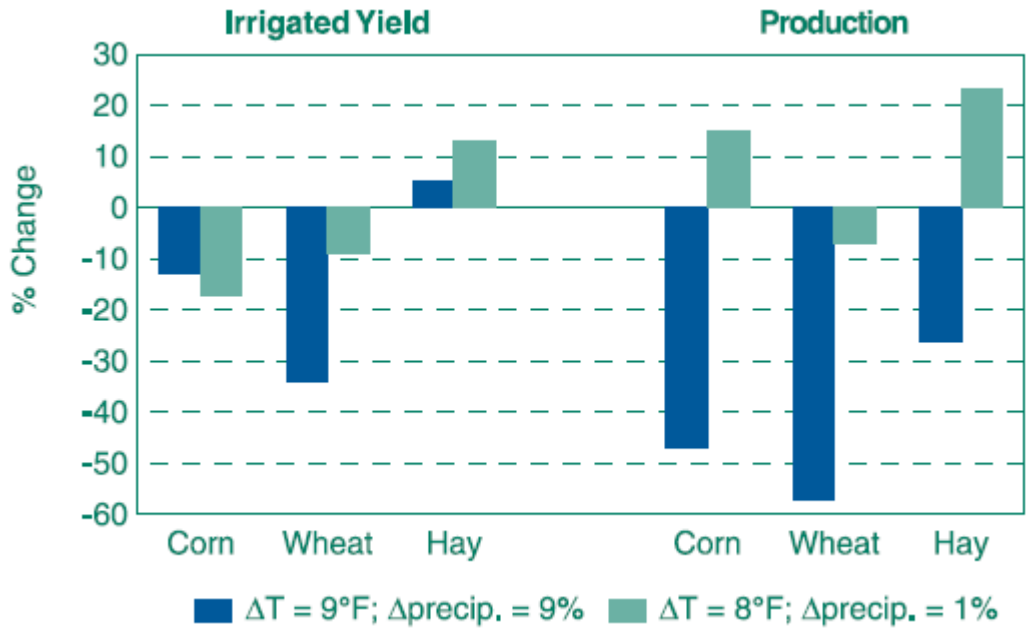
Precipitation in the western part of Colorado runs off to the Colorado River. If this runoff is decreased or its timing interrupted, it can have large, negative consequences for water availability for Colorado and the states that are dependent on the River, such as California and Arizona. Reservoirs in Colorado are currently not large enough to withstand the earlier runoffs that would occur.

Agriculture

[316] "The Palmer Drought Severity Index." National Oceanic and Atmospheric Administration. 3 June 2008. <http://www.drought.noaa.gov/palmer.html>.

The variety and amount of crops and livestock produced greatly depends on climate. Increases in temperature decreases soil moisture which will increase irrigation usage, which will divert the much needed water supply away from others that need it. The farming industry contributes $4 billion a year to the state. Colorado's livestock industry alone constitutes three quarter of the state's entire farming industry. Large staple crops are wheat, corn, and hay. Wheat is projected to decrease whether irrigation is used or not, while hay and corn yields are ambiguous, as observed in the figure below. In addition, agriculture is indirectly affected by decreased water availability and increased instances of pest, further reducing agricultural output. Improved farming practices, irrigation techniques, and technology will all be needed to reduce the potential losses in agriculture.

Figure 45: Colorado's Agricultural Irrigated Yields and Production under Climate Change



Source: Environmental Protection Agency

Human Health

Increases in temperature can exacerbate pollution concentration in urban areas, which causes more respiratory illnesses, such as asthma or inflammation. Furthermore, warmer weathers are more conducive to disease transmissions through mosquitoes. Heat waves will become more commonplace, causing many people that are vulnerable to extremely high temperatures to die. Extreme weather events such as droughts and floods could also cause deaths or illnesses to the population.

Environment

Species in forests are adapted to specific climatic conditions, so temperature increases would change the composition of forests, leading certain types of plants to become nonexistent and those that are more tolerant to heat to prosper. Decreases in soil moisture will cause forests to become grasslands and pastures in the long run if climate change is not

mitigated. Forest area can decline anywhere between 15 and 30 percent, dependent on the extent of temperature increase on affecting soil moisture, precipitation, etc.

Warming can also affect ecosystems in the Rocky Mountains. The alpine areas on the side of mountains are highly sensitive to climate change; every 1 degree (Fahrenheit) increase leads to the receding of 350 feet of alpine[317]. In turn, this will displace or kill animal species that rely on the alpines for food and shelter. Coldwater fish are also negatively affected by increases in temperature, decreasing their populations.

Tourism

Colorado has been traditionally a tourist destination for skiing and other snow-related activities. With temperature increases, there is less snow and the snow that is available melts earlier, imposing negative consequences on the large snow-oriented tourist industry in Colorado.

Greenhouse Gas Emissions

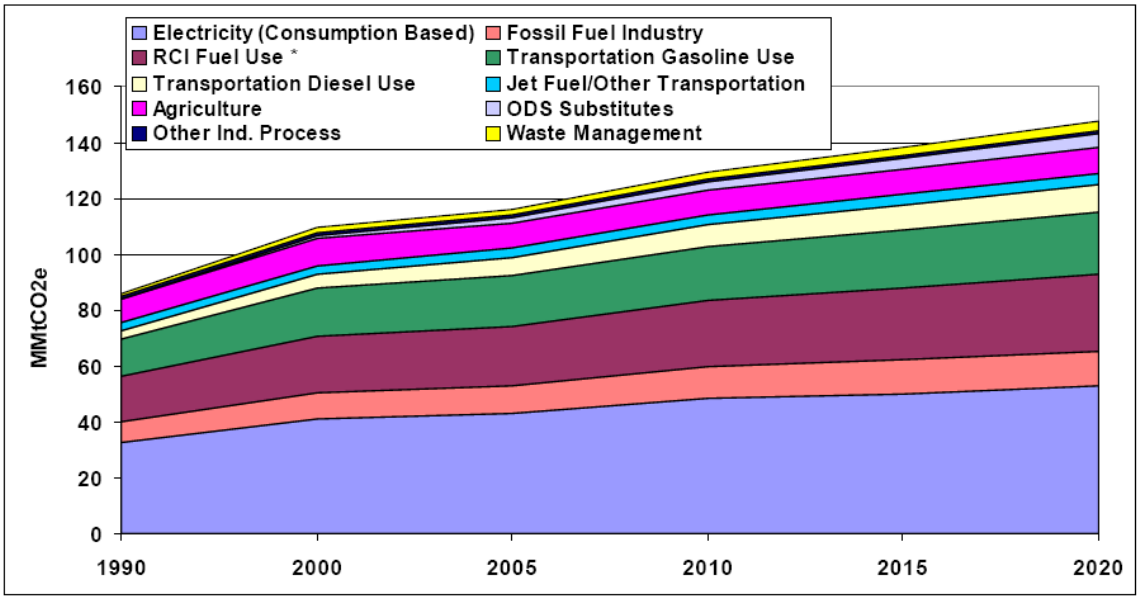
In October 2007 in collaboration with the Center for Climate Strategies (CCS), Colorado released its final greenhouse gas inventory and emission projections from 1990-2020 after the revisions suggested by the Climate Action Panel were made. Such an inventory will aid the Climate Action Panel and the state in deciding which policies and incentives to implement in order to reduce greenhouse gas emissions most effectively given its main sources.

In 2005, there were 117.7 million metric tons of greenhouse gas emissions[318]. Colorado's greenhouse gas emissions have increased dramatically between 1990 and 2005 by 35%, most of which can be attributed to rapid population growth. From 1990 to 2005, Colorado's population grew by 43%, having significant implications on greenhouse gas emissions due to increase in electricity and transportation usages. These two sectors are also significant contributors to greenhouse gas emissions: 37% for the former and 23% for the latter from 1990-2005. Within transportation emissions, gasoline contributed 66% to total emissions while diesel contributed 20%. Growth in gasoline emissions grew by 32% between 1990 and 2002 while growth in diesel emissions increased by 151%, implying that movement of cargo has increased inter- or intra- state. Lastly, usage of fossil fuels in the residential, commercial, and industrial sectors and fossil fuels production in aggregate emitted 27% of the carbon during this time period. According the report's projections, emissions will continue to grow substantially up until 2020, up 71% from 1990 levels at 148 million metric tons of carbon. Much of this explosive growth will be due to the increase in electricity usage. It is estimated that in 2020, electricity will be the largest contributor of gross emissions, followed by transportation and usage/production of fossil fuels. Refer to the next figure for detailed breakdown of emissions by sector from 1990-2020.

[317] "Climate Change and Colorado." September 1997. Environmental Protection Agency. 15 June 2008. <http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BPPNK/$File/co_impct.pdf>.

[318] Strait, Randy, et al. "Final Colorado Greenhouse Gas Inventory and Reference Case Projections 1990-2020." October 2007. Center for Climate Strategies. 4 June 2008. <http://www.coloradoclimate.org/ewebeditpro/items/O14F13894.pdf>.

Figure 46: Colorado's Gross Greenhouse Gas Emissions by Sector, 1990-2020

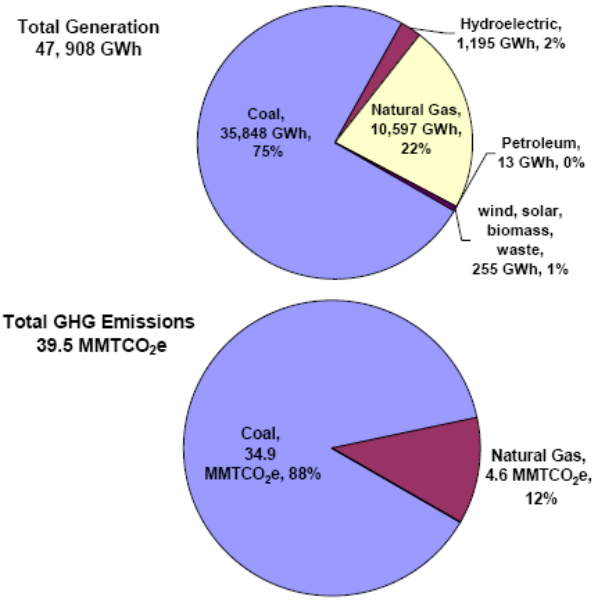


* RCI = direct fuel use in residential, commercial, and industrial sectors; ODS Substitutes = ozone depleting substances substitutes. Other Industrial Processes include process-related GHG emissions from cement and lime manufacturing; semiconductor manufacture; soda ash, limestone, and dolomite use; and electricity transmission and distribution systems.

Source: Center for Climate Studies[319]

[319] Relating to graphs from Center for Climate Studies' greenhouse gas emissions inventories, future projections of greenhouse gas emissions were made not accounting for any WCI involvement. Furthermore, projections were made on some key assumptions for the various emitting sectors. Detailed state and sector specific assumptions can be found in the corresponding links to the greenhouse gas emissions inventories provided in the footnote citations. The Center for Climate Studies couples with state agencies to provide the most accurate and consistent projections. If there is a lack of reliable information, projections will be made based on historical trends instead of using complex modeling. Greenhouse gas emissions guidelines adopted by the Center for Climate Studies were those put in place by the Intergovernmental Panel on Climate Change.
All the states' electricity sector emissions are based on a consumption basis versus a production basis to ascertain the most accurate and consistent depictions possible since states trade electricity. With this approach, states can monitor changes in demand and energy source usage shifts to better determine which policies should be enacted to decrease emissions effectively.
Reference case projections are based on a set of demographic and economic assumptions, perceived consumption behaviors/patterns, and policies—some of which are bound to change in unanticipated ways that were not accounted for in the initial drafting of these inventories. This lends to practicing some caution in extensive usage and analysis of these graphs as a basis for future policies.

Figure 47: Electricity Generation and Carbon Dioxide Emissions from Colorado Power Plants, 2004



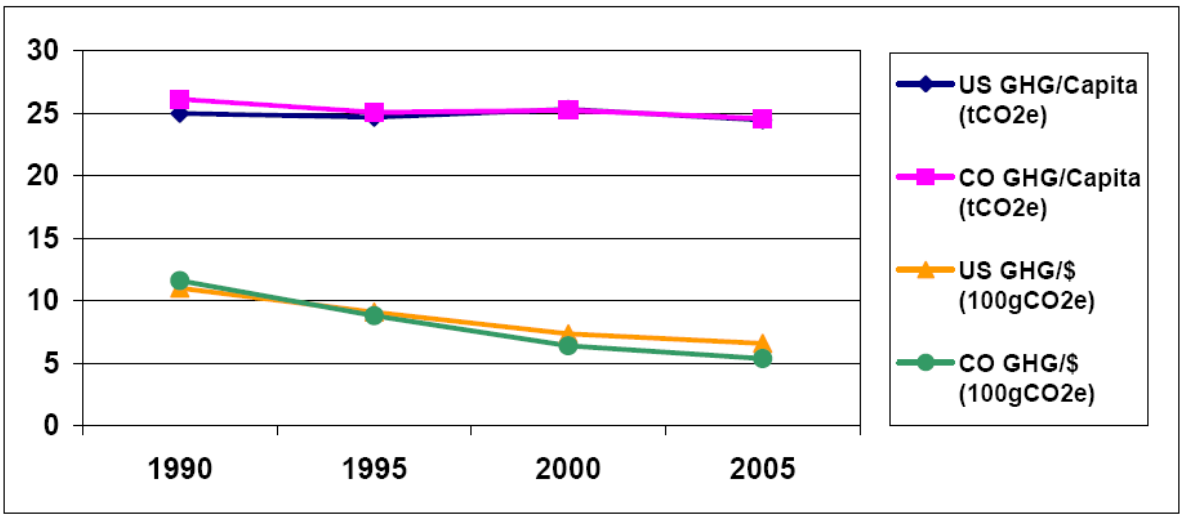
Source: Generation data from EIA Electric Power Annual spreadsheets, GHG emissions figures calculated from EIA data on consumption and SGIT GHG emission factors.

Source: Center for Climate Studies

Within the electricity sector, the energy source used predominantly to generate energy is from coal, at 75%. Coal is considered a 'dirty' energy source since it emits large amounts of carbon dioxide every unit of coal burned. Examine the figure above for electricity generation and carbon emissions from each type of energy source. This implies that the state can greatly benefit from adopting clean energy sources in decreasing greenhouse gas emissions.

Furthermore, the state's per capita emissions are slightly higher than that of the nation. Between 1990 and 2005, per capita emissions stayed relatively constant because economic growth exceeded emissions growth, implying that energy efficient measures might have been adopted during this time. This conclusion could also be drawn from observing the emissions per unit of economic output. The next figure shows the national and Colorado State per capita emissions and per unit of economic output emissions. Similarity between the state and nation per capita emissions trends might enlighten on the level of easiness/difficulty as to how effectively and successfully Colorado can adopt national climate change policies. It could be crudely (perhaps even rashly) hypothesized that the more similar state figures and national figures are, the easier the adoption and implementation of policies since national policies will be based on state averages.

Figure 48: Comparison of per capita and per unit of economic output greenhouse gas emissions between Colorado and United States, 1990-2005



Source: Center for Climate Strategies

13.3.2 Policies that Address Climate Change

Initiatives taken on State Government Level

The only act taken on the behalf of the Colorado State government thus far was on November 5, 2007 when the governor released a statewide climate action plan that provided a list of goals and strategies Colorado would adopt to effectively deal with climate change. These goals were simultaneously extensive and intensive in breadth and scope. Strategies were set for sectors including but not limited to: transportation, carbon sequestration via agriculture, greenhouse gas emissions reductions, and electricity.

The most notable goal set in the climate action plan is to reduce greenhouse gas emissions by a certain percentage by a specific year in comparison to 2005 levels[320]:

- By 2020, reduce greenhouse gas emissions by 20% below 2005 levels.
- By 2050, reduce greenhouse gas emissions by 80% below 2005 levels.

Now, with this goal initiated by the Governor and approved by the Climate Action Panel (discussed later), it is in the stage legislature's hands for this to become law and having a defined trajectory towards emissions reductions.

Other ambitious goals include promoting to sequester carbon through agriculture by providing incentives to farmers and ranchers. Energy companies are encouraged to buy carbon offsets from farmers to reduce their net emissions. Within the transportation sector, the governor calls for the adoption of greenhouse gas emissions standards for passenger vehicles. Large electric utilities were given a goal to reduce greenhouse gas emissions by

[320] Ritter Jr., Bill "Colorado Climate Action Plan." November 2007. 5 June 2008. <http://www.pewclimate.org/docUploads/COClimatePlan_0.pdf>.

20% by 2020. Since water availability is of great concern, the climate action plan also called to do additional research on the vulnerabilities of water supplies.

Though the climate action plan is a great initiative on the behalf of the Colorado to mitigate climate change in pinpointing what needs to be done, bills and laws need to be passed to make these goals concrete. Incentive-based initiatives might not always be effective enough due to the possibly high short run costs associated with institutional adjustments, so more serious measures need to take place. Only through officiating climate change action plans goals will the state meet them.

As of date, even though on the state level there have not been numerous direct efforts to mitigate climate change, many clean energy standards and laws have been implemented and adopted, some of which are listed below[321]. Clean energy policies play a key role in decreasing greenhouse gas emissions since energy efficiency measures renewable energy sources are encouraged or required.

- Energy Efficiency in Public Facilities
  - SB 07-051 (enacted in 2007) requires that the state architect to adopt standards that state building projects have to meet. The standards must be recognized by an independent third party that will evaluate energy efficiency based on energy, water, and other resource consumption usages. Costs in these areas are required to be reduced.
  - Put into place in 2006, SJR 06-032 requires that LEED (Leadership in Energy and Environmental Design) certification to be met if cost effective.
  - In 2005, Executive Order D005-05, enacted in July 2005, required that all state agencies and departments to adopt the LEED rating system to ensure that energy efficiency measures are in place.
- Energy Efficiency Portfolio Standards
  - On February 5, 2008, Colorado Legislature's House Transportation and Energy Committee passed HB 1107, requiring all electric utilities entities to allocate 1% of revenues on energy efficiency programs in 2009 and 2% annually thereafter.
- Renewable Portfolio Standards (RPS)
  - Colorado requires electric utilities and other providers to supply a specified minimum percentage of total electricity provided from renewable energy sources. Electric cooperatives with more than 40,000 customers must meet the following goals: 1% renewable energy (of total energy produced) by 2008, 3% by 2011, 6% by 2015, and 10% by 2020 thereafter. All investor-owned utilities will follow a schedule of 3% by 2007, 5% by 2008, 10% by 2011, 15% by 2015, and 20% for the year 2020 thereafter. Furthermore, energy generated in Colorado is highly favored and for every kWh of renewable energy produced, it counts as 1.25 kWh to energy efficiency requirements.
- State and Regional Energy Planning
  - Since Colorado is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

[321] "Colorado." 5 May 2008. Environmental Protection Agency. 5 June 2008. <http://www.epa.gov/cleanenergy/energy-programs/state-and-local/states/co.html#eepf>.

Such energy efficient policies initiated by the government will indirectly aid in the climate action policies being met because electricity entities are required by law to meet certain goals within a time period. Since electricity consumption constitutes a sizeable percentage of Colorado's greenhouse gas emissions, any measures taken in reducing emissions in the electricity sector will most likely be effective, which will hopefully be indicated by future greenhouse gas emissions inventories.

Under the laws enacted in regards to energy efficiency in public facilities, adopting the LEED rating system in determining energy efficiency will aid agencies and departments in following set standards and focusing their efforts in increasing energy efficiency. Also, it provides a benchmark in which Colorado can compare itself to other states (that also use the LEED rating system) and see how the measures, standards, or changes they have adopted reflect in changes in their LEED ratings periodically. Furthermore, the incentives given under RPS to electricity entities to generate renewable energy were intelligent on the government's behalf because it will induce technology innovation, stimulating economic growth in an emerging energy efficiency sector. Also, this will lower the long run costs associated with the externalities of pollution compared to the situation where these renewable portfolio standards were not in place under the business as usual scenarios.

Initiatives taken on Local Government Level

A few major cities including Aspen, Denver, and Boulder have adopted measures including Building Energy Codes, Energy Standards for Public Buildings, and Green Power Purchasing. All these measures promote the usage of renewable energy. Some of these local policies were set in place before the enactment of state energy efficiency measures while others were initiated afterwards. In addition, some local governments have local grant programs for those individuals that want to adopt renewable energy sources within their homes but cannot afford to do so. Also, in 2006, Boulder put in place a tax refund where a percentage of the revenues earned from solar water heating systems. Collectively, local governments can bring significant reductions in greenhouse gas emissions by clearly defining what regulations need to be followed. Though the state government officially enacts and writes energy efficiency policies, the implementation task is largely carried out by local governments that can manage and oversee all arrangements.

Initiatives taken on Firm and Organizational Level

Though there have not been many direct state initiatives and policies set so far in mitigating climate change, the non-profit Rocky Mountain Climate Organization (RMCO) has taken it upon itself to form the Colorado Climate Project to start the climate change mitigation process in the state. The Colorado Climate Project's mission is to develop solutions and offer recommendations to reduce greenhouse gas emissions in an effort to slow climate change. Within the Colorado Climate Project, there exists six policy working groups whose tasks are to work with the stakeholders, provide technical analysis, and offer policy proposals based on their findings.

Under the Rocky Mountain Climate Organization, the Climate Action Panel (CAP) was hired to help Colorado in forming plausible solutions/policies and evaluating the recommended policies put forth by the state government. The CAP worked in conjunction with the Governor's office in offering seventy detailed policies the state can follow after careful

examination of greenhouse gas emissions and the institutional structures/policies already in place. These policies were made based on the research the CAP conducted in areas including agriculture, energy, water, and transportation. Having the assistance of CAP in the process of policy formation is greatly beneficial in helping the state because it can be considered a learning experience to have a knowledgeable source teaching RMCO and Colorado State to collect and evaluate data. Through the efforts, work, and recommendations on the behalf of RMCO, it can guide the state towards developing a full-fledged climate change mitigation policy plan in the near future.

Colorado Public Utilities Commission also has interconnection standards for distributed generation and net metering to increase usage of clean energy and energy efficiency. Under these standards, the Colorado Public Utilities Commission is calling for greater energy efficiency. Under distribution generation, renewable energy systems over 10 megawatts must be connected to the electric grids such that costs of interconnection are the same across all utilities. Distributed generation imposes consistent processes and requirements and allows the selling of excess energy that is produced. Under the net metering system, the customers are paid if excess energy is produced[322].

Various electric utilities in Colorado (Delta-Montrose Electric Association, Fort Collins Utilities, and Gunnison County Electric) have taken several steps to promote the usage of renewable energies through loan and rebate programs[323]. Under the loan programs, electric utilities will loan residents money to repair their homes to make them more energy efficient, such as improving the insulation, replacing furnaces, and fixing house heating systems. Another policy electric utilities implemented to promote energy efficiency was rebate programs. Under this, electric utilities rebate a certain dollar amount for each kWh produced by a renewable energy resource, such as solar panels, wind power, or hydroelectric, within a certain system size limit. Both private and public electric utilities have this program available for their customers. The rebate and loan programs offered are perfect complements for one another because financial incentives are given to residential customers to be more energy efficient. With the loan program, even low-income households can afford to renovate their houses to be more cost-efficient in the long run. Initially, the savings gained from investment in more efficient energy usage can offset the payments need to be made. In the long run however, benefits will outstrip costs for the household. In addition, there are large and positive externalities associated with adoption of energy efficient measures on the micro level. On the macro level, if individual households continue and increase their consumption of renewable energy resources, Colorado will be able to meet the emissions targets it sets in the near future.

What Still Needs to be Done

Though Colorado's track record thus far in mitigating climate change is quite impressive due to the substantial efforts from the Rocky Mountain Climate Organization and electric utilities, Colorado has a long way to go on the state legislative level. The state is still in its beginning stages of discussing climate change mitigation with only a state action plan proposed. There

[322] "Interconnection Standards Fact Sheet." 5 June 2008. Environmental Protection Agency. 14 June 2008. <http://www.epa.gov/CHP/state-policy/interconnection_fs.html>.
[323] "Colorado Incentives for Renewable Energy." DSIRE. 6 June 2008. <http://www.dsireusa.org/library/includes/map2.cfm?State=CO&CurrentPageId=1&EE=0&RE=1>.

needs to be state legislation that directly addresses the problems of climate change via feasible solutions and targets, which is what Colorado is in the process of doing. Also, the state should mandate a board entirely dedicated to climate change commission. It is quite feasible for members of the Climate Change Project become advisories to a state commission to maintain consistency, quality, and level of knowledge in the state's progression towards climate change mitigation.

Another step that Colorado should take is to have greenhouse gas emission targets set into law as other states have already. A proposal has already been made on the behalf of the governor (section 3.2.1) in the climate action plan, which the state will use as a reference point in addition to the contributions and suggestions made by the Climate Action Panel. Mandatory greenhouse gas emissions inventories taken periodically will also need be enacted to confirm or deny whether the implemented policies are effective. Colorado is still in the process of joining the Climate Registry, which will be discussed in more detail in the following section. This will standardize the fashion in which the state takes inventory of all greenhouse gas emissions.

Colorado has great potential in making huge strides towards authoring a comprehensive and extensive climate change policies, given that it continues on its current trajectory. It has the institutional qualities in place for their policies to be successful. Furthermore greenhouse gas per capita and per capita unit for both Colorado and U.S. are quite similar. This could imply that when there is a federal climate change mitigation policy in place in the near future, Colorado could have an easier time implementing it compared to other states since federal policies could take into consideration of per capita and per economic unit emissions during the creation of policies. Lastly, there is much room for growth in emissions reduction efforts given that much of the state's electricity generation comes from coal. Colorado's extensive efforts thus far in adopting cleaner energy standards through renewable energy sources should show its effectiveness in decreased emissions.

13.3.3 Colorado and WCI: Analysis

In regards to the WCI membership requirements, Colorado is well on its way to meeting all the criteria. Though an officiated greenhouse gas emissions target is not yet present in the state, the proposal set by the Governor that by 2020, emissions are to be 20% below 2005 levels, is more ambitious than what the WCI has set (refer to Introduction). Furthermore, it already has a very detailed and comprehensive climate action policy that addresses goals for key areas of the economy that have the greatest effects on greenhouse gas emissions based on its inventory reporting. As part of the climate action policy, the Governor proposed the state to adopt greenhouse gas auto standards to reduce transportation's contributions to emissions within one to two years within the plan's release in November 2007. Since the transportation sector is one of the top emitters in Colorado, the implementation automobile standards would greatly assist the state in meeting its emission targets.

Colorado is also a member of the Climate Registry, which will help the state standardize all future greenhouse gas emissions inventory based on certain protocols. These set protocols will aid in data collection while providing a basis for which Colorado can compare its emissions to other states, such as those that are already WCI partners/observers. As an observer, Colorado can examine the states, if any, that have similar breakdowns of sector

emissions and what technologies and policies they have adopted and whether they have been successful or not.

Based on what has already been initiated and proposed, Colorado will be eligible to fully participate in WCI within a couple of years, if not sooner, given that the climate change efforts will continue in the right direction. The only hurdle standing in its way is its lack of state legislation in climate change mitigation to formalize policy proposals.

13.4 Idaho

13.4.1 Evidence and Effects of Climate Change

Temperature

The figure above shows historical and recent temperature trends in Idaho. It is projected that by 2100, temperatures could increase by as much as five degrees Fahrenheit in the winter and summer and four degrees in spring and fall[324].

Precipitation

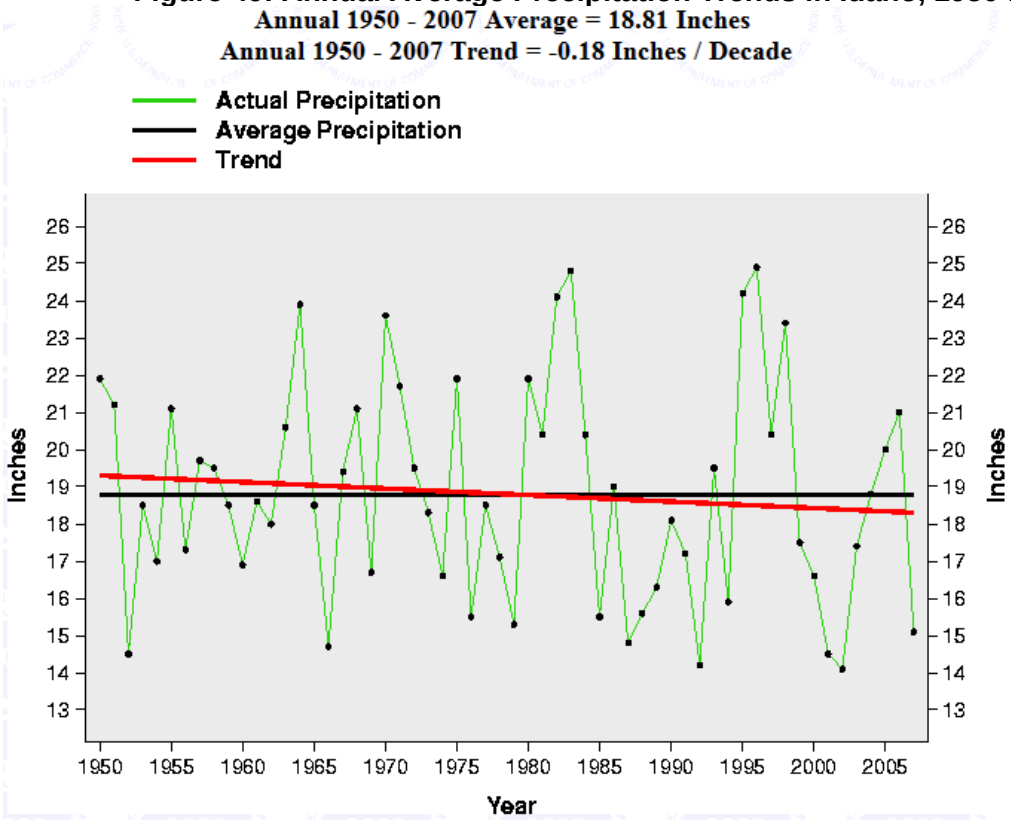
Exhibit 4.1 displays the historical trends in annual average precipitation in Idaho. Precipitation has been decreasing on average 0.18 inch per decade. It is projected that precipitation is to increase by 10% in spring and fall and 20% in winter, with little or no change during the summer.

Human Health

Increases in temperature can exacerbate pollution concentration in urban areas, which causes more respiratory illnesses, such as asthma or inflammation. Furthermore, warmer weathers are more conducive to disease transmissions through mosquitoes. Heat waves will become more commonplace, causing many people that are vulnerable to extremely high temperatures to become ill or die. Extreme weather events such as droughts and floods could also cause deaths or illnesses to the population.

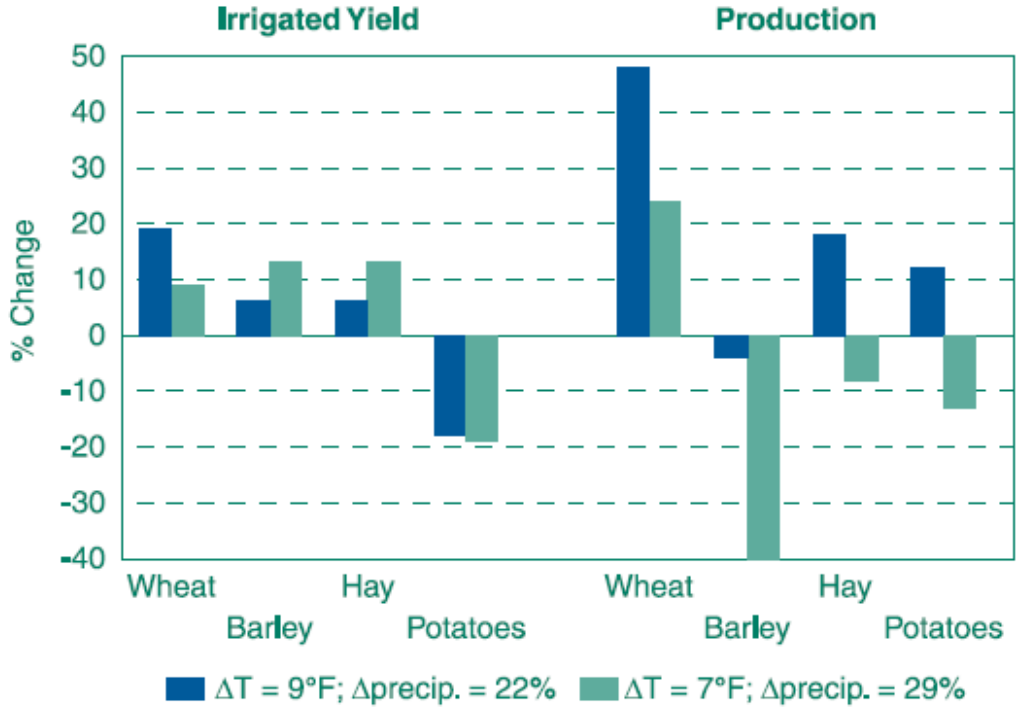
[324] http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUP3C/$File/id_impct.pdf

Figure 49: Annual Average Precipitation Trends in Idaho, 1950-2007



Source: National Oceanic and Atmospheric Administration

Figure 50: Changes in Agricultural Yield and Production in Idaho



Source: Environmental Protection Agency

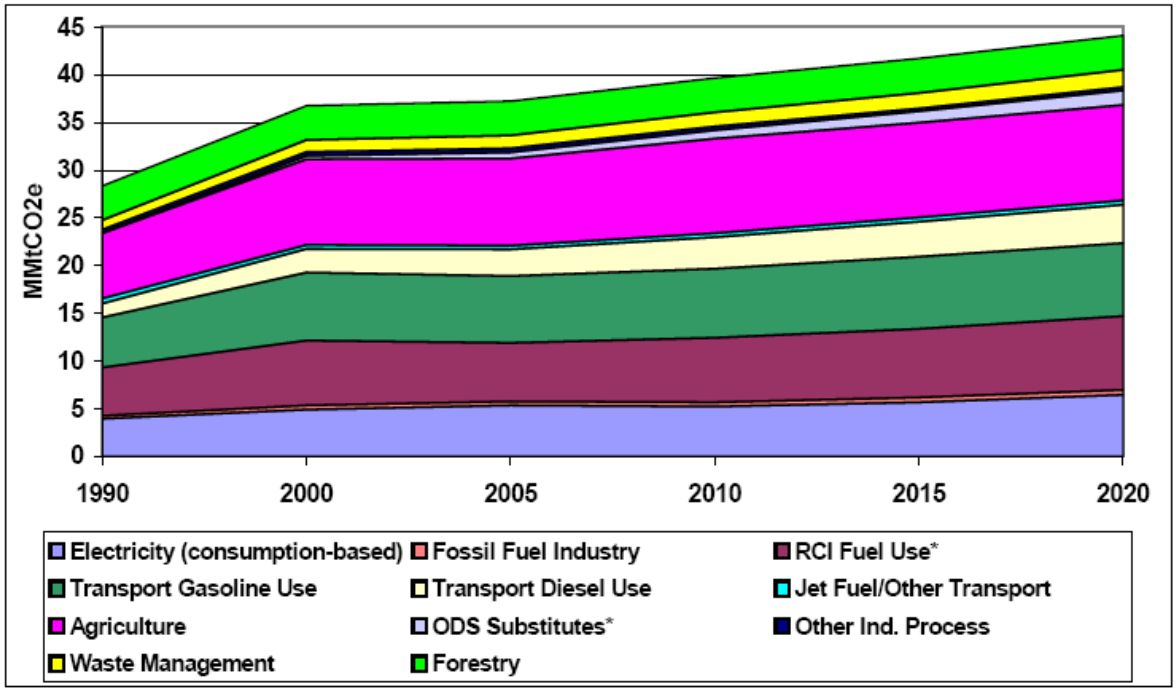
Agriculture

Agriculture plays a large role in Idaho's economy and is a $2.8 billion annual industry, the majority of which is crops. Seventy percent of farmland is irrigated. Idaho's main crops include wheat, hay, barley, and potatoes under temperature increases. Wheat, hay, and barely yields are expected to increase while potato yields are expected to decrease, as shown in the figure above.

Water Availability

Idaho relies on both surface and groundwater for water its water supply, which comes from tributaries of the Colorado River than run throughout the state. The water flows of tributaries are controlled by dams and reservoirs to prevent flooding and ensure water availability during the summers when there is no or insufficient river runoff. Increased temperatures would affect the size of snowpack and earlier times in runoffs, decreasing water availability when it is needed most during the summer. Available water supply is already being highly constrained due to a growing economy. Groundwater levels have been declining due to over pumping aquifers, increased instances of drought, and changes in irrigation practices. Increased precipitation can benefit the production of hydroelectric power but simultaneously increase possibility of flooding.

Figure 51: Idaho's Gross Greenhouse Gas Emissions by Sector, 1990-2020



* RCI – direct fuel use in residential, commercial, and industrial sectors. ODS – ozone depleting substance.

Source: Center for Climate Studies

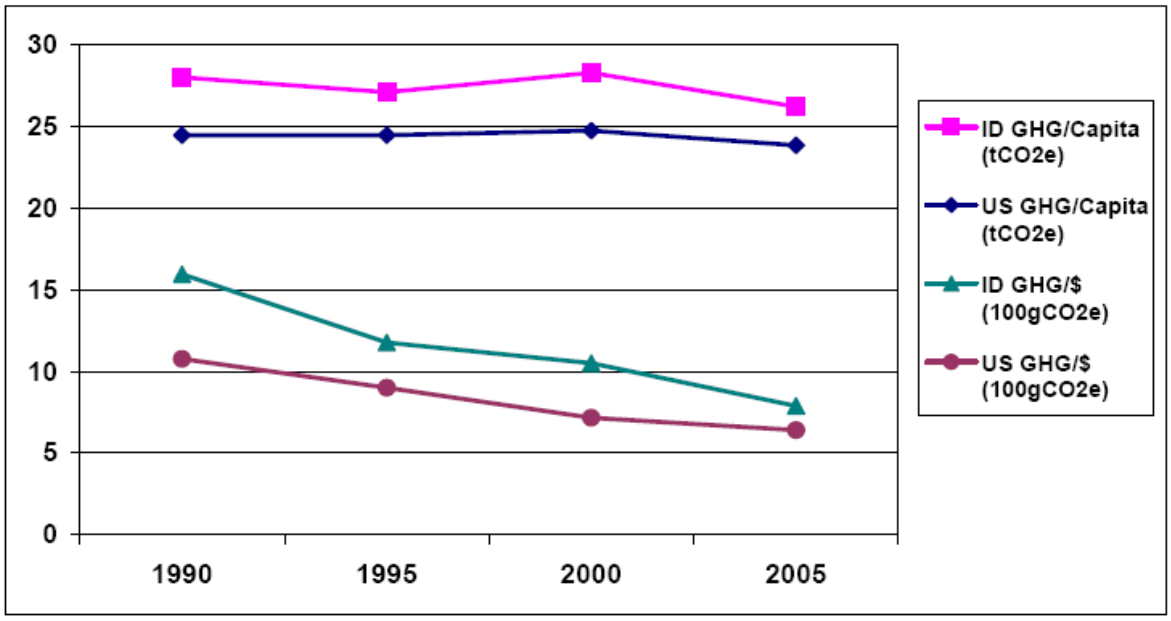
Environment

Under climate change, forests in Idaho can decline between 15-30%, depending on extent of temperature increases. Grassland areas can increase with the receding of forest cover on the side of Rocky Mountains due to warming. However, if precipitation increases in the future, it might be able to offset some of these changes. Warmer weather can also increase the instances of insect infestation and wildfire in forests, which could diminish landscape if temperature increases were severe enough. Currently, the forests are infested with diseases and bugs in addition to being highly vulnerable to wildfire due to fire suppression practices. Thus, increases in temperature put Idaho's ecosystems at high risk for demolition.

13.4.2 Greenhouse Gas Emissions

In conjunction with the Department of Environmental Quality, the Center for Climate Strategies released a greenhouse gas emissions inventory for 1990-2020 in spring 2007. This inventory will serve as a starting point for the state to develop specific policies that would mitigate climate change.

Figure 52: Comparison of per capita and per unit of economic output greenhouse gas emissions between Idaho and United States, 1990-2005



Source: Center for Climate Studies

In 2005, Idaho released 37 million metric tons of carbon dioxide is projected to increase emissions by 19.19% to 44.1 million metric tons in 2020[325]. In 2005, the largest contributors to emissions in the state were the agricultural and transportation sectors, accounting for 27% and 25% of the state's total emissions, respectively. Emissions from the residential, commercial, and industrial sectors contributed 17% of total emissions in 2005. In 2020, it is estimated that transportation will overcome agriculture as the leading contributor to

[325] Strait, Randy, et al. "Idaho Greenhouse Gas Inventory and Reference Case Projections 1990-2020." Spring 2007. Center for Climate Strategies. 7 June 2008. <http://www.wrapair.org/WRAP/ClimateChange/ID_GHG_I&F_Report_WRAP_08-20-07.pdf>.

greenhouse gas emissions in Idaho. Refer to the previous figure for the breakdown of emissions in different sectors.

From 1990-2002, emissions growth in the transportation sector has been rising steadily at 2.6% a year. In 2002, gasoline vehicles contributed the majority of the emissions in the transportation sector at 70% while diesel vehicles accounted for 24% of total transportation emissions. Between 1990 and 2002, emissions growth from gasoline powered vehicles increased by 32% whereas diesel emissions increased by 72% during this period. Both of these sub-sectors experienced increases due to economic and population growth.

On per capita and per economic unit bases, Idaho is higher in both areas than the U.S. average, as shown in the figure above. Per capita emissions are higher in Idaho because its agricultural sector is larger than the average U.S. state. In the U.S., agriculture only contributes 7% to total greenhouse gas emissions, whereas for Idaho, it is 24%. Per economic unit has been decreasing steadily because economic growth has exceeded greenhouse gas emissions growth.

Given this, it means that when Idaho develops its own climate change mitigation policies, it must address some effective and viable emissions reductions strategies in these sectors. For instance, renewable energy should be promoted to decrease residential, commercial, and industrial fuel consumption and agriculture carbon sequestration through better management practices can be utilized to reduce emissions within the agricultural sector. Greenhouse gas auto standards should also be included to make vehicles more efficient. Furthermore, since emissions from diesel powered vehicles experienced the most growth, it is advisable that Idaho adopt some fuel efficiency standards for the freight trucks that use diesel.

13.4.3 Policies that Address Climate Change

Executive Order No. 2007-05[326]

On May 16, 2007, the Governor of Idaho C.L. "Butch" Otter addressed the need for the states to take the leading role in climate change mitigation. The executive order announced that the Department of Environmental Quality in Idaho will act as the state's climate change advisory board. Its tasks include creating a report on the state's greenhouse gas emissions inventory and offering policy recommendations to the governor. Furthermore, the department is in charge of working with all state government agencies and departments in helping them to reduce their greenhouse gas emissions.

Department of Environmental Quality

The Department of Environmental Quality is still the process of gathering data to write an inventory of greenhouse gas emissions in Idaho. In regards to reducing greenhouse gas emissions from state agencies and departments, the Department of Environmental Quality formed an organization called the Greenhouse Gas Working Group, which consists of contacts from each state agency and department. Their mission is to work together to develop and share practices that mitigate climate change.

[326] Otter, C.L. "Butch." "Executive Order 2007-05." 16 May 2007. The Office of the Governor. 7 June 2008. <http://gov.idaho.gov/mediacenter/execorders/eo07/eo_2007_05.html>.

The department also publishes annual strategic plans, which includes environmental-based goals it hopes to achieve in the next few years. The most recent plan addresses improvements to be made that span from 2008-2012. A main goal is to maintain and improve air quality in Idaho's, where one of its main objectives is to develop a greenhouse gas reduction plan for state agencies starting in 2008[327]. In 2009, its goal is to complete a greenhouse gas inventory with statewide policy recommendations. Another major goal is educating the public on consequences of business and personal practices on the environment and pollution-reducing strategies. Its goal by the end of 2008 is to reach 6,000 stakeholders through outreach activities that inform them about ways to prevent pollution.

Recently, the department released a report titled "Greenhouse Gas Emissions Reduction Action Plan for Fiscal Year 2008-2009," which contains an inventory of the emissions the department produced from its buildings, electricity usage, internal combustion engines, and employees' commutes (based on survey answers). Given this information, the department proposed solutions and policies in each of these areas to reduce emissions. The reason for developing such an inventory is multi-fold. First, the department is taking the lead in reducing greenhouse gas emissions by evaluating their main sources and offering immediate and long term solutions. Second, it set an example of what other state agencies and departments should do and how to do it. Third, reporting their own emissions can be seen as a learning experience for them since they are in charge of inventorying the entire state's greenhouse gas emissions.

Executive Order No. 2007-21

On December 31, 2007, Governor C.L "Butch" Otter issued this order upon recognition that transportation accounts for a significant portion greenhouse gas emissions in the state. It called for a reduction of fossil fuel use in state-owned vehicles by increasing vehicle fuel efficiency and decreasing the amount of miles driven by employees[328]. It also advises that state agencies and department to not purchase sport utility vehicles if the need is not present and purchase hybrid and low-emission vehicles. The state's Division of Purchasing is responsible for releasing a list of vehicles that meet these standards. If a vehicle is not on the list, the department or agency will need to justify the circumstances as to why it needs a specific vehicle that was not pre-approved. In addition, the department will provide quarterly reports of vehicle purchases to the Department of Environmental Quality and Governor for evaluation. Though this was an ambitious strategy put forth by the Governor and a step in the right direction, its impacts will not be greatly significant in reducing carbon emissions because state employees do not constitute a significant portion of fossil fuel usage.

Idaho Code Section 22-502

In 2002, the Carbon Sequestration Advisory Committee was formed by Idaho legislature in response to the growing concerns about carbon emissions and greenhouse gases. It is currently developing a carbon market for private agricultural and forest landowners. Since agriculture is a major sector emitter, any answers or policies the committee can provide will be invaluable in Idaho's goal in lowering carbon emissions.

[327] "Strategic Plan for Fiscal Years 2008-2012." Department of Environmental Quality. 8 June 2008. <http://www.deq.idaho.gov/about/publications_deq/strategic_08.pdf>.
[328] Otter, C.L. "Butch." "Executive Order 2007-21." 20 December 2007. The Office of the Governor. 9 June 2008. <http://gov.idaho.gov/mediacenter/execorders/eo07/eo_2007_21.html>.

Executive Order 2005-12

In July 2005, former Governor Dirk Kempthorne enacted a law in which all state-owned agencies and departments must employ energy conservation measures, such as mandating standards for thermostat settings, turning off lights and computers[329], and others. There are no targets set under this law, which could make it hard for this to be effective and successful.

HCR 62

In January 2007, the Interim Committee on Energy, Environment, and Technology provided the state legislature with an energy plan for the state. The goals of the plan are to ensure a reliable energy system, to maintain low-cost energy supply, protect public health and environment, promote sustainable economic growth, and allow Idaho's energy policy to adapt to changing circumstances. The plan called for the creation of an income tax incentive for investments in energy-efficient technologies by businesses and households and stricter building codes and more collaboration between government and utilities around conservation, and requires the Idaho Public Utilities Commission to establish annual targets for conservation achievement based on estimates of cost-effective conservation in the service territories of Idaho's investor-owned utilities[330].

State and Regional Energy Planning

Since Idaho is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

In addition to the above, Idaho State also has a few financial incentive measures to promote the use of renewable energies, such as sales/property tax exemptions, low-interest loans, and bonds. Under these circumstances, monetary support or refunds are given to entice businesses and residents to adopt energy efficient appliances that use renewable energies.

13.4.4 Initiatives Taken on Firm Level

Electric utilities in Idaho offer loan and rebate programs similar to the ones from the state government, but tend to be much more specific in their terms. For instance, Idaho Falls Power offers a zero-interest loan program to businesses when they follow energy conservation measures by installing energy efficient lighting, furnaces, air conditioners, etc. The loans can actually cover up to 100% of the expenses (not to go past $25,000), depending on some circumstances. Utility rebate programs span a large area in which they can be applied to, from commercial, building efficiency, retrofitting, to residential appliances. Having a wide coverage in the nature of the rebate programs increase the incentives for residents and businesses to exchange their old appliances and practices for newer ones.

[329] Otter, C.L. "Butch." "Executive Order 2005-13." 29 July 2005. The Office of the Governor. 9 June 2008. <http://gov.idaho.gov/mediacenter/execorders/eo05/eo_2005-12.htm>.
[330] "Idaho." 5 May 2008. Environmental Protection Agency. 9 June 2008. <http://www.epa.gov/cleanenergy/energy-programs/state-and-local/states/id.html#eepf>.

Furthermore, Idaho Public Utilities Commission also has interconnection standards for net metering to improve energy efficiency of utilities.

Residents and businesses can all greatly benefit from these loan and rebate programs, especially if they are offered at both the state and local levels. These increase the financial incentives that can be reaped while enticing more energy efficient and renewable energy measures. Financial incentives are perhaps the most effective because people see and gain an immediate payoff in their favor in adopting something that is high cost in the short run but saves a lot of in the long run.

13.4.5 What Still Needs to be Done

The climate change mitigation steps the state government has taken thus far are mostly self-contained, meaning that the policies set in place are mostly applicable to only state-owned entities. While this is a great start and can serve to be worthy because of the learning process during implementation, it is not enough. Statewide measures applicable to every citizen will need to be initiated soon in order for noticeable emission reductions to take place. However, it is understandable that more effective policies have not been adopted is due to the fact that Idaho is still in its early stages in learning how climate change affects itself. As soon as the Department of Environmental Quality is done taking inventory of the state's greenhouse gas emissions in 2009, the state legislature can make great leaps forward in discussing climate change mitigation more intelligently and figuring out which measures would be most successful in achieving state goals.

As mentioned before, during the formation of the mitigation policies by the state, it is important to keep in mind the major emitters and have specific goals for these sectors to meet. This is to ensure that meeting greenhouse gas emissions targets/caps will be successful when they are formulated under a more sophisticated climate action plan. In regards to the electricity sector, the Idaho Public Utilities Commission should set targets for all public electric utilities to meet and conduct research on which solutions would be most feasible. The commission needs to take a more authoritative and decisive role in promoting and requiring the use of renewable energies. Furthermore, a likely solution in decreasing emissions in the transportation sector is to adopt greenhouse gas automobile standards that set targets for automobile emissions by certain dates. Within the agriculture sector, the state should be highly receptive to the Carbon Sequestration Advisory Committee's policies in the use of carbon credit markets or increased incentives for high-emitting industries to utilize carbon sequestration.

13.4.6 Idaho and WCI: Analysis

Being that Idaho is still in its beginning phase of tackling climate change, it still has much to do before becoming a WCI partner. All the criteria can be expected to be met when a defined climate action plan is proposed by the Department of Environmental Quality. The plan will need to include strategies for different areas of the economy, which will be possible after the greenhouse gas inventory is completed and detailed information on historical and projected emissions by sector is available. Consequently, more stringent automobile standards will most likely be implemented to reduce emissions in the transportation sector. Any greenhouse gas emissions target proposed by the plan should be comparable to that of the WCI if the state wishes to join in the future.

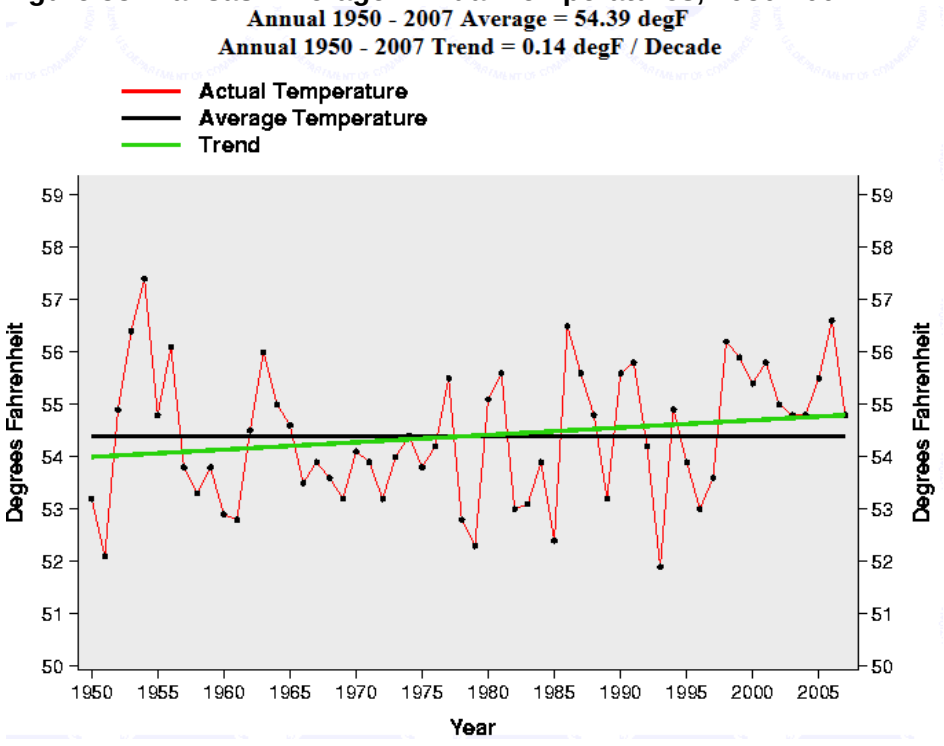
The only WCI criterion Idaho has actually met thus far is its membership in the Climate Registry, which Idaho joined in August 2007. Being part of the Climate Registry is largely beneficial for Idaho since it is currently in progress of taking inventory of its greenhouse gas emissions. The Climate Registry has reporting protocol that all states have to follow when taking an in-depth and comprehensive inventory, which proves highly useful to Idaho since it does not need to independently create its own procedures and data collection techniques. Furthermore, being amongst other U.S. states is advantageous since the facilitation of dialogue regarding climate change mitigation between them is possible.

Perhaps one of the greatest gains Idaho can reap from being a WCI observer is to examine what other states have already implemented. Since Idaho has a large agricultural sector, it can refer to California's policies on reduce greenhouse gas emissions since California is the largest producer of agricultural outputs in the nation and help further develop their carbon sequestration efforts. It will be awhile until Idaho is eligible to become a partner in WCI, but granted its progress thus far, Idaho is definitely taking the initiatives in the right direction.

13.5 Kansas

Exhibit 5.1

Figure 53: Kansas' Average Annual Temperatures, 1950-2007



Source: National Oceanic and Atmospheric Administration

13.5.1 Evidence and Effects of Climate Change

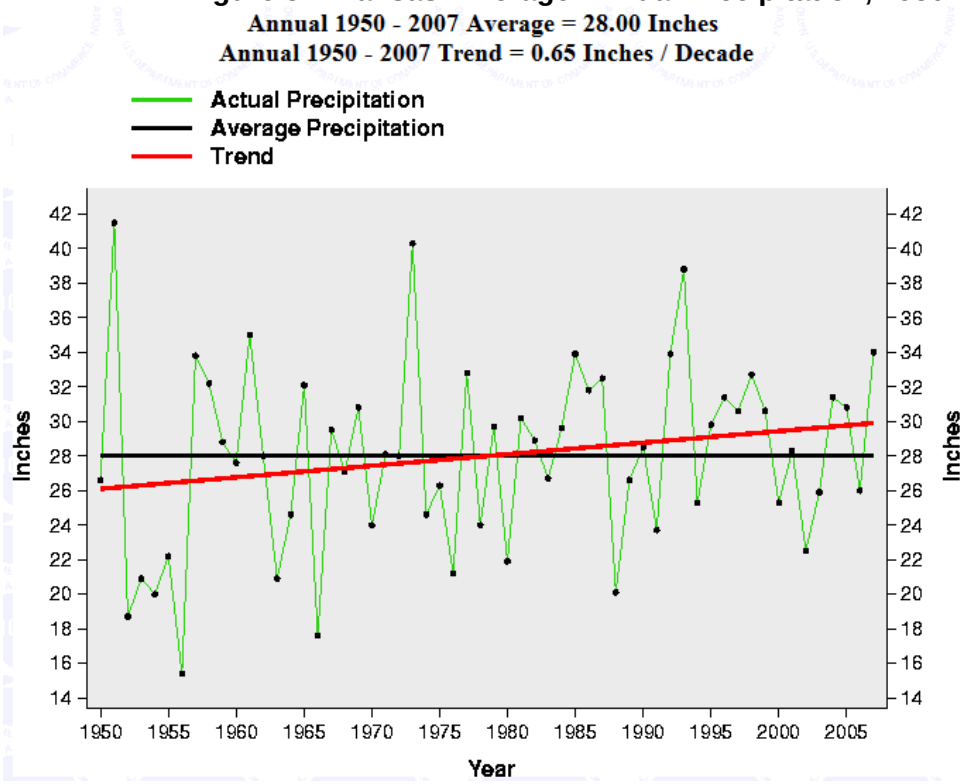
Temperature

Kansas has experienced a slight increase in average annual temperatures since 1950 at 0.14 degrees Fahrenheit per decade. By 2001, increases in temperature can be up to two degrees Fahrenheit in spring, three degrees in summer, and four degrees in fall and winter[331]. Refer to the figure above for a historical trend of temperature increases.

Precipitation

Precipitation has increased in Kansas from 1950 to 2007 at 0.65 inches on average per decade, as observed in the next figure. Precipitation has increased by 20% in some parts of the state. In the future, it is expected that precipitation will not change much during the winter but can increase by 15% for other seasons.

Figure 54: Kansas' Average Annual Precipitation, 1950-2007



Source: National Oceanic and Atmospheric Administration

Human Health

Kansas has historically been a frequent victim of heat waves, which causes death and illnesses. For example, Kansas City (border of Missouri and Kansas) could experience an increase of 150% in heat-related deaths if the temperature increased by 4 degrees

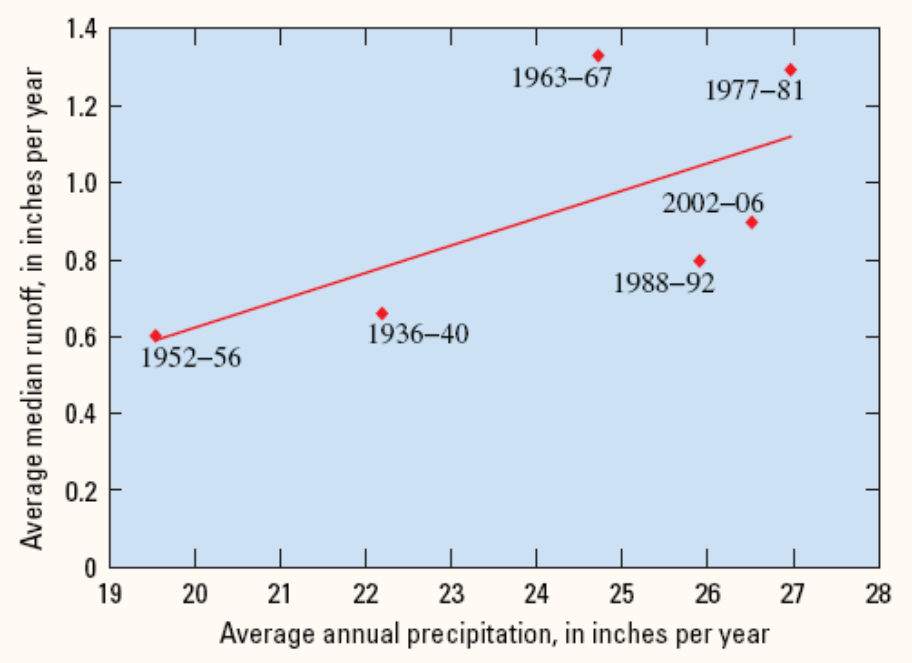
[331] "Climate Change and Kansas." September 1998. Environmental Protection Agency. 15 June 2008. <http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BUQME/$File/ks_impct.pdf >.

Fahrenheit and 250% if temperature increased between 4-5 degrees[332]. In urban areas, an increase in two degrees can potentially increase smog by 8%, all else held constant. Furthermore, warmer temperatures are ideal for diseases and bacteria to foster. Mosquito populations can increase and spread disease more quickly if a new disease comes into the area. Lyme disease and other tick-related diseases, which are common in Kansas, can experience increases in transmission rates if temperature increases.

Water Availability

Water availability is unevenly distributed throughout the state. River runoffs from the mountains are largely dependent on snowpack and rainfall. When temperatures rise, snowpack become smaller and rainfall decreases, thus diminishing the availability of water in the summer. In western Kansas, this is especially problematic because there are no reservoirs to store excess water. There can still be shortages in water supply in areas that have the infrastructure in place due to the decline in river runoff. In the case that rainfall increases, though it can increase much needed water supply, it can also increase the instances of flooding, which causes soil erosion, infrastructure damage, spread of disease, and death.

Figure 55: Relationship between Precipitation and Runoff Ratios during droughts in Kansas



Source: U.S. Geological Survey

Multi-year droughts have been common occurrences in Kansas since the 1930s. The last drought that occurred was from 2000 to 2006, representing the sixth in the last eight decades. The river runoffs during each drought episode decreases over time, implying that water availability is becoming an increasingly serious issue. Even though precipitation has

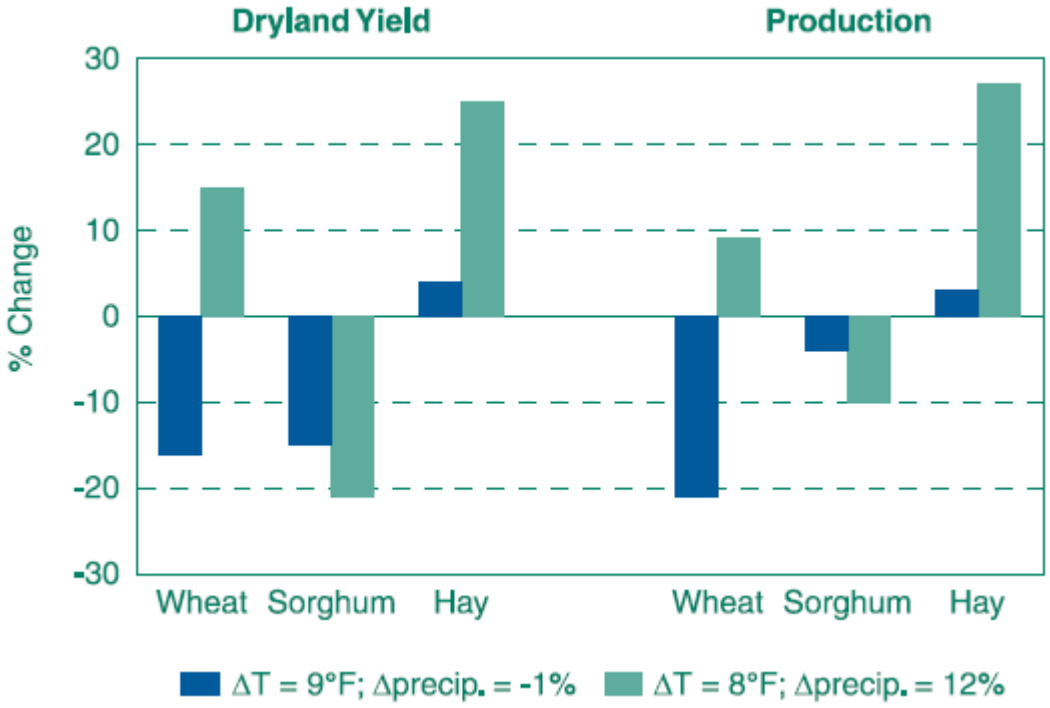
[332] IBID

not decreased (it has in fact increased according to section 5.1.1), runoff has decreased, resulting in worsening droughts. This is because of a decline in the runoff ratio, or the amount of precipitation that becomes river runoff. Runoff ratios have decreased because of water management practices. Kansas has constructed many small lakes and reservoirs to store water, which divert much of the runoff to these sources instead of the rivers. As the figure above shows, the drought from 2000 to 2006 had lower than expected (below red line) runoff ratio despite relatively high precipitation.

Agriculture

Agriculture is a $7.3 billion dollar industry in Kansas and can be considered to be a backbone of its economy. Thus, any adverse climate changes that influence agricultural output can greatly affect Kansas' economic health. Approximately fifteen percent of the farmland is irrigated. Key crops are wheat, sorghum, and hay. Dependent upon extent of temperature increase and precipitation changes, a variety of results can occur according to evidence in the next figure. Sorghum production and yield are both projected to decrease between five and twenty percent while there are mixed results for both wheat and hay. Livestock production, which accounts for two-thirds of activity in agricultural sector, is not expected to be greatly affected by increasing temperatures unless it becomes significantly hotter and drier.

Figure 56: Agricultural Yields and Production in Kansas under Climate Change



Source: Environmental Protection Agency

Environment

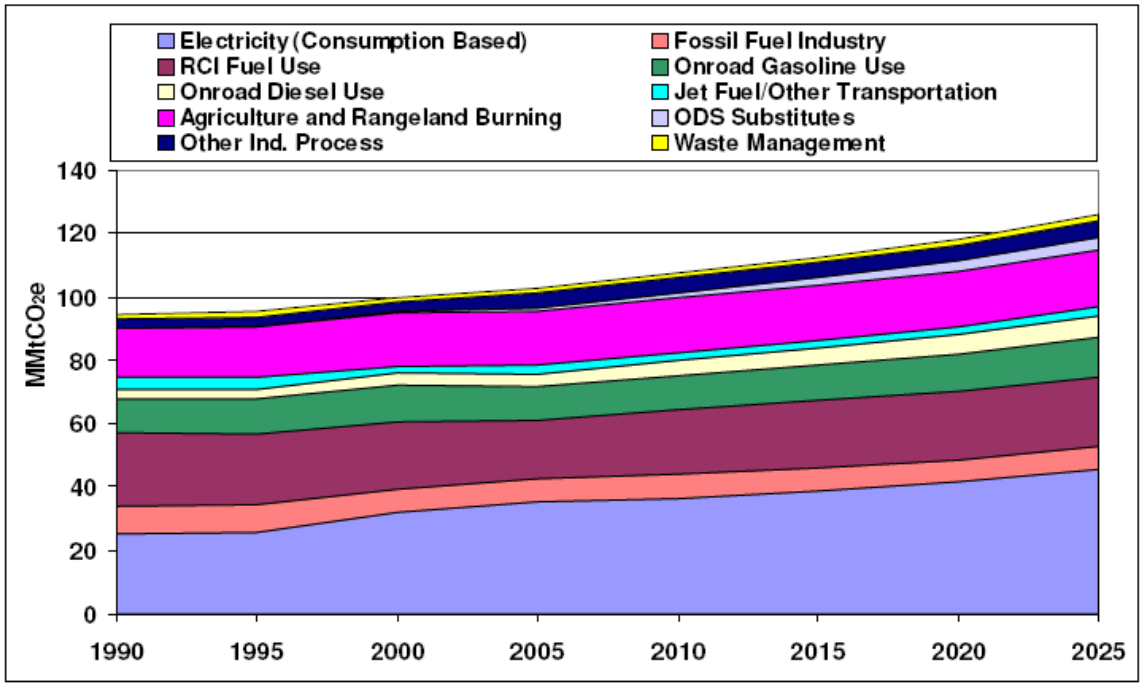
About 5% of Kansas is covered by forest. In the event of temperature increases, forest area can decline anywhere between 10-30%. Declines depend largely on the extent of decline in

soil moisture. Under an extreme case, the forests can turn into grasslands and savanna, both types of ecosystems that exist under drier conditions. Wildfires are also more likely to occur if the climate becomes too hot and dry. Wetlands in Kansas are important in the livelihoods of waterfowl. Half of all shorebirds in North America are believed to stop in the Kansas wetlands[333]; if the wetlands disappear, the existence of the birds would be greatly threatened. Changes in water availability would also greatly affect the migratory bird populations. If the wetland ecosystem is steadily diminished, many species would be expected to die off.

13.5.2 Greenhouse Gas Emissions

In May 2008, the Center for Climate Strategies released a preliminary version of the state's greenhouse gas emissions inventory which presents historical and projected emissions from 1990-2025. The report was prepared for Kansas Department of Health and Environment and Kansas Energy and Environmental Policy Group to aid them in figuring out what policy options are appropriate in mitigating climate change in the state.

Figure 57: Kansas' Gross Greenhouse Gas Emissions by Sector, 1990-2025



RCI – direct fuel use in residential, commercial, and industrial sectors. ODS – ozone depleting substance.

Source: Center for Climate Strategies

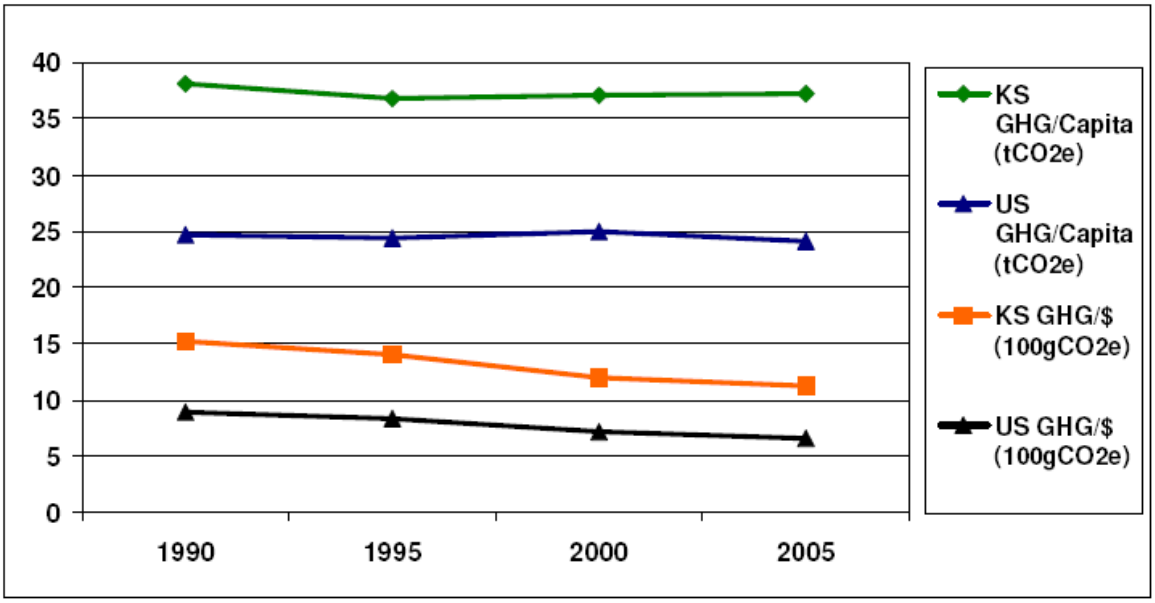
In 2005, Kansas emitted 103.2 million metric tons of carbon dioxide and is projected to increase emissions by 22.58% to 126.5 million metric tons of carbon dioxide in 2025. In 2005, the main contributors to state emissions were electricity (34%), residential, commercial, and industrial fuel consumption (18%), transportation (17%), and agriculture

[333] IBID

(17%)[334], which is shown graphically in the figure above. Electricity will still continue to be the largest contributor to carbon emissions.

Residential, commercial, and industrial fuel consumption of oil, natural gas, wood, and coal is used to power space/process heating applications. The industrial sector's constitutes the majority of the greenhouse gases emitted at 68% of all residential, commercial, and industrial fuel use. Emissions in these areas are projected to aggregately increase 20% from 2005 to 2025. Agriculture is extremely important to the state's economy, so its sector emissions are much higher than the national average. In 2002, Kansas agriculture's market value was ranked fifth in the United States at $8.7 billion dollars[335]. Emissions are expected to increase by 5% between 2005 and 2020. Lastly, the bulk of the transportation emissions come from onroad gasoline vehicles at 62% in 2005. The future climate change mitigation policy plan will have to direct significant efforts towards decreasing emissions of gasoline powered vehicles.

Figure 58: Comparison on per capita and per unit of economic output greenhouse gas emissions between Kansas and United States, 1990-2005



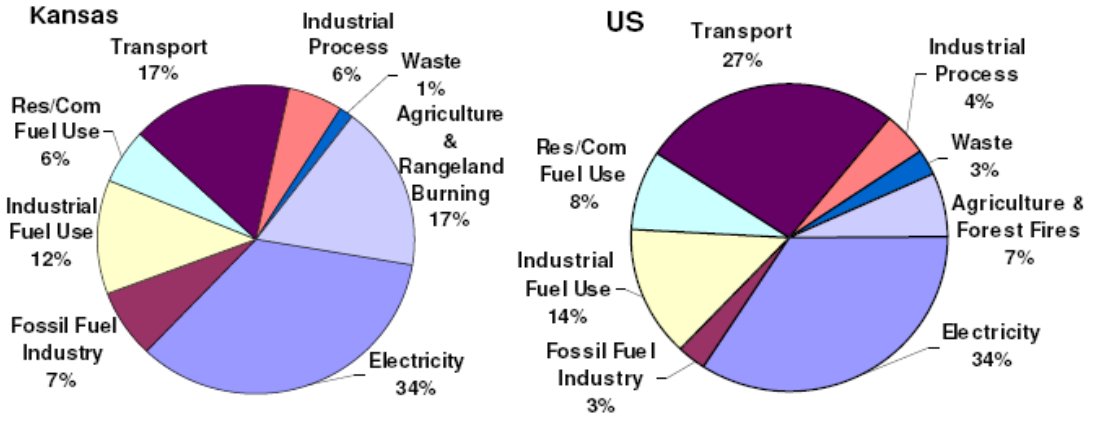
Source: Center for Climate Strategies

Per capita and per economic unit of greenhouse gas emissions in Kansas are both greater than that of the U.S, shown above. This discrepancy can be credited to the low population density since Kansas is overall more rural and has a larger agricultural sector than the average U.S. state. Per economic unit of greenhouse gas emissions has been decreasing since economic growth has outstripped greenhouse emissions growth, possibly indicating that Kansas has adopted some energy efficient technologies as the economy grew and

[334] Strait, Randy, et al. "Draft Kansas Greenhouse Gas Emissions Inventory and Reference Case Projections 1990-2025." May 2008. Center for Climate Strategies. 11 June 2008. <http://www.ksclimatechange.us/ewebeditpro/items/O1F17410.pdf>.
[335] IBID

increased its consumption of energy. Another way to compare emissions between Kansas and the U.S. is to observe sector contributions, as shown beow. The structure of greenhouse gas emissions substantially differ in the areas of transportation and agriculture. Transportation constitutes a smaller share in Kansas compared to U.S. possibly because of lower population density, which leads to agriculture being a larger contributor to emissions because the state is more rural than the average U.S. state.

Figure 59: Gross Greenhouse Gas Emissions by Sector in 2005, Kansas and U.S.



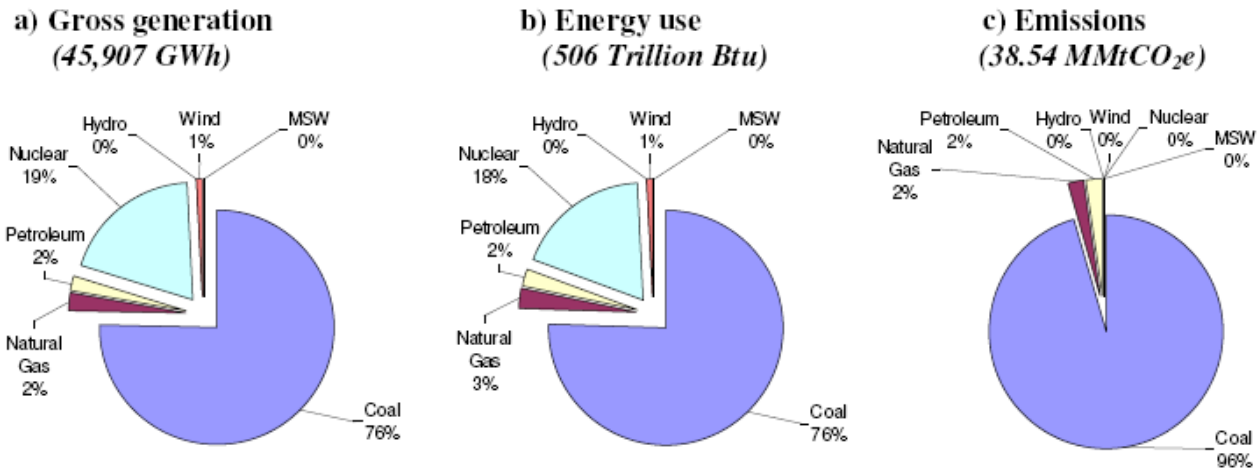
Notes: Res/Comm = residential and commercial fuel use sectors; emissions for the residential, commercial, and industrial fuel use sectors are associated with the direct use of fuels (natural gas, petroleum, coal, and wood) to provide space heating, water heating, process heating, cooking, and other energy end-uses. The commercial sector accounts for emissions associated with the direct use of fuels by, for example, hospitals, schools, government buildings (local, county, and state), and other commercial establishments. The industrial processes sector accounts for emissions associated with manufacturing and exclude emissions included in the industrial fuel use sector. The transportation sector accounts emissions associated with fuel consumption by all on-road and non-highway vehicles. Non-highway vehicles include jet aircraft, gasoline-fueled piston aircraft, agricultural and construction equipment, railway locomotives, boats, and ships. Emissions associated with rangeland burning are low (~4% of total agricultural emissions in 2005). Electricity = electricity generation sector emissions on a consumption basis (depending on the year, consumption-based emissions either exclude emissions associated with net exports of electricity by Kansas generators to other states, or include emissions associated with net imports of electricity produced by generators in other states and consumed in Kansas).

Source: Center for Climate Studies

Electricity is primarily generated through the use of coal and nuclear energy. Coal-fired power plants supplies more than three quarters of the state's energy. Renewable energy from wind power is insignificant in supplying electricity to the state[336]. Refer to the next figure, which shows the breakdown of electricity usage, production, and emissions on a production basis. Kansas is also a net exporter of electricity, meaning it supplies enough energy for itself and aids in meeting energy needs for other states.

[336] "Kansas." Energy Information Administration. 11 June 2008. <http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=KS>.

Figure 60: Breakdown of Generation, Usage, and Emissions of Electricity in Kansas, by power plants, 2005 (Production Basis)



Source: Center for Climate Studies

13.5.3 Policies that Address Climate Change

Executive Order No. 08-03

On March 21, 2008, Governor Kathleen Sebelius created the Kansas Energy and Environmental Planning Advisory Group (KEEP) to serve as the state's official advisory board on climate change. The objectives of the group include to research possibilities to increase energy efficiency and independency while taking into account of economic growth of the state. Other tasks of the advisory group include the evaluation of the greenhouse gas emissions inventory published by the Center for Climate Strategies and suggest ideal policies based on findings of the inventory. Such policies include[337]: 1) incentives for the development of diversified electricity generation portfolio, 2) appropriate energy generation portfolio goals, 3) laws, rules, and policies needed to diversify the energy generation portfolio, and 4) studies undertaken by Kansas research universities that will aid the advisory board in its mission. Lastly, the advisory board is responsible for authoring a comprehensive climate action plan for the state. The governor called the need for a climate action plan for the state during her state-of-the-state address in January 2008.

Within KEEP, there are five technical work groups that represent different areas that contribute to and/or are affected by climate change, such as agriculture, energy, transportation, and residential, commercial, and industrial. Their duties are to analyze the potentials and challenges within each sector in the climate change mitigation process and offer recommendations on the appropriate measures that should be taken.

Thus far, KEEP has not made any substantial strides in meeting its objectives since it was only established a few months ago. The board had its first meeting on May 20, 2008.

[337] Kansas Energy and Environmental Policy Advisory Group. 9 June 2008. <http://www.ksclimatechange.us/index.cfm>.

Between each KEEP meeting (which are approximately once every three to four months), the technical work groups are supposed to meet twice to report progressions and research findings.

Executive Order 08-06[338]

This restructures the duties and responsibilities of the Kansas Energy Council, which now includes collecting data on the state's energy resources (wind and biomass included) and the availability, production, and use of energy in Kansas. In addition, the council will establish policies regarding energy efficiency, sustainable energy supply, and the available and potential renewable and alternative energy sources. These findings will be reported every year in the Kansas Energy Report. Contents of the report will include energy consumption estimations for the following 12, 36, and 60 months and revise if needed.

Executive Order 08-01[339]

Given that Kansas has a huge potential in being a supplier of energy generated by wind, a law was put into place on January 7, 2008 establishing the Governor's Wind Working Group, which will optimize wind energy utilization, foster national leadership in the area of wind power, establish professional relationships between them and wind power stakeholders, and aid in providing feedback in wind power policies in the future.

Midwest Governor's Greenhouse Gas Accord

On November 15, 2007, ten Midwestern state governors and premier of Canadian province Manitoba signed a regional greenhouse gas agreement in an effort to mitigate the effects of climate change through a cap and trade system, which will ultimately decrease emissions in the region. The reasons for implementing a cap and trade system is multifold[340]: to facilitate linkages between the states to achieve economies of scale and increase market efficiencies while maximizing economic and employment benefits and minimizing potential job losses, and be ready for federal climate change policies in the near future. Furthermore, the accord will establish greenhouse gas emission targets that will be consistent with each state's goals, complete the details of the cap and trade system by November 2008, and complete all policies set forth in the accord within 30 months after November 2007. Kansas already committed itself to 2% reduction in energy use by 2015.

Joining this regional initiative was practical on the state's behalf since it doesn't have a defined greenhouse emissions target or cap in place. Being a member of the accord will force Kansas to move quickly in developing policies to mitigate climate change. After the greenhouse gas emissions inventory is finished, KEEP will be able to set an appropriate target and/or cap that the state can achieve. Furthermore, Kansas can reap the benefits of communicating and working collaboratively with other states since technology and knowledge transfers can take place, allowing states to reach their goals more quickly and

[338] Sebelius, Kathleen. "Executive Order 08-06." May 2008. Kansas Office of the Governor. 9 June 2008. <http://www.governor.ks.gov/executive/Orders/exec_order0806.htm>.
[339] Sebelius, Kathleen. "Executive Order 08-01." January 2008. Kansas Office of the Governor. 9 June 2008. http://www.governor.ks.gov/executive/Orders/exec_order0801.htm
[340] "Midwestern Greenhouse Gas Accord." May 2007. Midwestern Governors Association. 9 June 2008. <http://www.midwesterngovernors.org/resolutions/GHGAccord.pdf>.

efficiently. At the same time, it will place Kansas on the fast track to being eligible for WCI partnership.

State and Regional Energy Planning

Since Kansas is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

Interconnection Standards: Net Metering

On February 18, 2008, House Bill 2066 was enacted to establish net metering for solar-power generators not exceeding 100 kilowatts which are controlled by the customer to cater their own energy needs[341] to increase energy efficiency by only using what is necessary.

In addition to the state-level policies above, Kansas also has building codes for commercial sector. In April 2007, the Governor mandated by issuing HB 2036, which requires contractors that build homes to reveal home energy efficiencies to potential homeowners at any time upon request.

Westar Inc. and Kansas Department of Health and Environment[342]

Westar Inc. is the largest electric utility in Kansas. On February 29, 2008, Westar Inc. made a voluntary agreement with Kansas Department of Health and Environment to decrease their greenhouse gas emissions. Westar is the first electric utility committing itself to such a venture. In addition, they were granted an air quality construction permit to upgrade one of its facilities such that it is more energy efficient. As a part of this agreement, Westar will take inventory of all of its greenhouse gas emissions in an effort in investigating and identifying areas of improvement. In addition, Westar will join the Climate Registry to learn how to take inventory of its emissions and standardizing its protocol in reporting past, current, and future emissions.

Westar is taking a significant step forward in taking action against climate change on the firm level. Its efforts are in hopes that other electric utilities will step forward and make some sort of commitment in reducing their firm's greenhouse gas emissions.

Kansas Corporation Commission's Facility Conservation Improvement Program[343]

The program is designed to increase energy efficiency and usage in state buildings. The program connects the state agency or office with a pre-approved private energy service company that will examine energy-saving opportunities. The costs associated with replacing

[341] "Kansas." 5 May 2008. Environmental Protection Agency. 10 June 2008. <http://www.epa.gov/cleanenergy/energy-programs/state-and-local/states/ks.html#nm>.
[342] "KDHE Issues Air Quality Permit for Project and Jeffrey Energy Center.: 29 February 2008. Kansas Department of Health and Environment. 11 June 2008. <http://www.kdheks.gov/news/web_archives/2008/02292008b.htm>.
[343] "Facility Conservation Improvement Program." Kansas Corporation Commission. 11 June 2008. <http://www.kcc.state.ks.us/energy/fcip/index.htm>.

old equipment will newer, more efficient ones will be offset by the savings incurred as a result. Financing is available and easily accessible, which is also tax-exempt, increasing the incentives to adopt more energy efficient practices and measures.

Interconnection Standards: Distributed Generation

Kansas Corporation Committee adopted interconnection standards for both distributed generation and net metering to increase energy efficiency of electric utilities by imposing set standards and protocol in energy distribution. On August 7, 2007, the distributed generation standards were enacted for distributed renewable energy systems greater than five megawatts[344].

Initiatives Taken on Individual Level

A group of 70-100 farmers in Kansas joined an agricultural soil carbon pilot program sponsored by the Chicago Climate Exchange. The goal of this program is to adopt a no till strategy where soil is left untouched such that carbon remains there and is not released as pollution[345]. This practice also brings other benefits as well, such as preventing soil erosion, increasing soil fertility and water quality.

What Still Needs to be Done

To effectively deal with climate change, Kansas will need to enact policies and measures that will emphasize heavily on ways to reduce greenhouse gas emissions in the sectors that are considered major emitters. Since agriculture plays a substantial role in the state's economy, solutions that would reduce emissions in this sector such as carbon sequestration or improved and more efficient farming practices are ideal. The no-till strategy adopted by the small group of farmers could be a starting point for policy making though obviously it can only be used in moderation.

Due to the fact that industries emit the majority of residential, commercial, and industrial greenhouse gas emissions, the government should take an authoritative role in offering incentives and/or impose restrictions to industry stakeholders. Natural gas and water utilities should offer conservation incentives to decrease fuel consumptions in these areas. Furthermore, automobile measures that use gasoline more efficiently in conjunction with financial incentives for buying highly fuel-efficient or hybrid vehicles should both be included in the policy development process to decrease emissions that come from the transportation sector.

Lastly, substantial improvements can be made in the electricity sector, given that the majority of the electric power generated in the states is derived from coal, which is non-renewable and polluting, the severity depending on coal grade. Requirements or incentives given to electric utilities to switch the source of electric generation to renewable energies would seriously aid in reducing greenhouse gas emissions in Kansas. The government can offer bonds or loans to help with the financing portion of adoption of new technologies that can be pricey. Electric utilities in the state should offer more financial incentives on the residential

[344] "Kansas." 5 May 2008. Environmental Protection Agency. 10 June 2008. <http://www.epa.gov/cleanenergy/energy-programs/state-and-local/states/ks.html#nm>.
[345] "Global Warming and KANSAS." 21 June 2007. National Wildlife Federation. 10 June 2008. <http://www.nwf.org/globalwarming/pdfs/Kansas.pdf>.

and commercial levels such as rebates or loans to entice these sectors to adopt more energy efficient appliances and practices.

13.5.4 Kansas and WCI: Analysis

Out of the four criteria that are required to become a WCI partner, Kansas is in the progress of meeting three of them. The time of eligibility will depend heavily upon when the final draft of the greenhouse gas emissions inventory is released by the Center for Climate Strategies. Only when the inventory is available can the state proceed with climate change mitigation since it knows on which areas to focus climate change mitigation policies.

Under the Midwest Governor's Greenhouse Gas Accord, Kansas will be required to have a greenhouse gas emissions target set since the regional targets are based on state targets. A climate change action plan has been proposed and is now under the KEEP's responsibility. The plan will most likely include an emissions target/cap and other market-based mechanisms to mitigate climate change. Whether the climate change action plan will include greenhouse gas tailpipe standards for passenger vehicles is unknown, but given that transportation is one of the largest contributors to the state's emissions, it only seems logical that automobile standards would be adopted. Lastly, Kansas already joined the Climate Registry. This will be largely beneficial for the state because it will prepare them for the possibility of mandatory emissions reporting imposed by the federal government in the near future when it creates a climate action plan for the entire country. Furthermore, membership in the registry can facilitate dialogue, interaction, and exchange of ideas and measures between participating states that would decrease the costs of doing unnecessary research, for instance.

Kansas will most likely be eligible to become a WCI member in a few years given its past and current achievements. Kansas can benefit greatly from being a WCI observer by seeing whether policies and measures institutionalized by the partners are successful or not in guiding Kansas when it is writing its climate action plan. If and when Kansas becomes a partner, it can use the regional agreement's goals to reinforce its own.

13.6 Nevada

13.6.1 Evidence and Effects of Climate Change

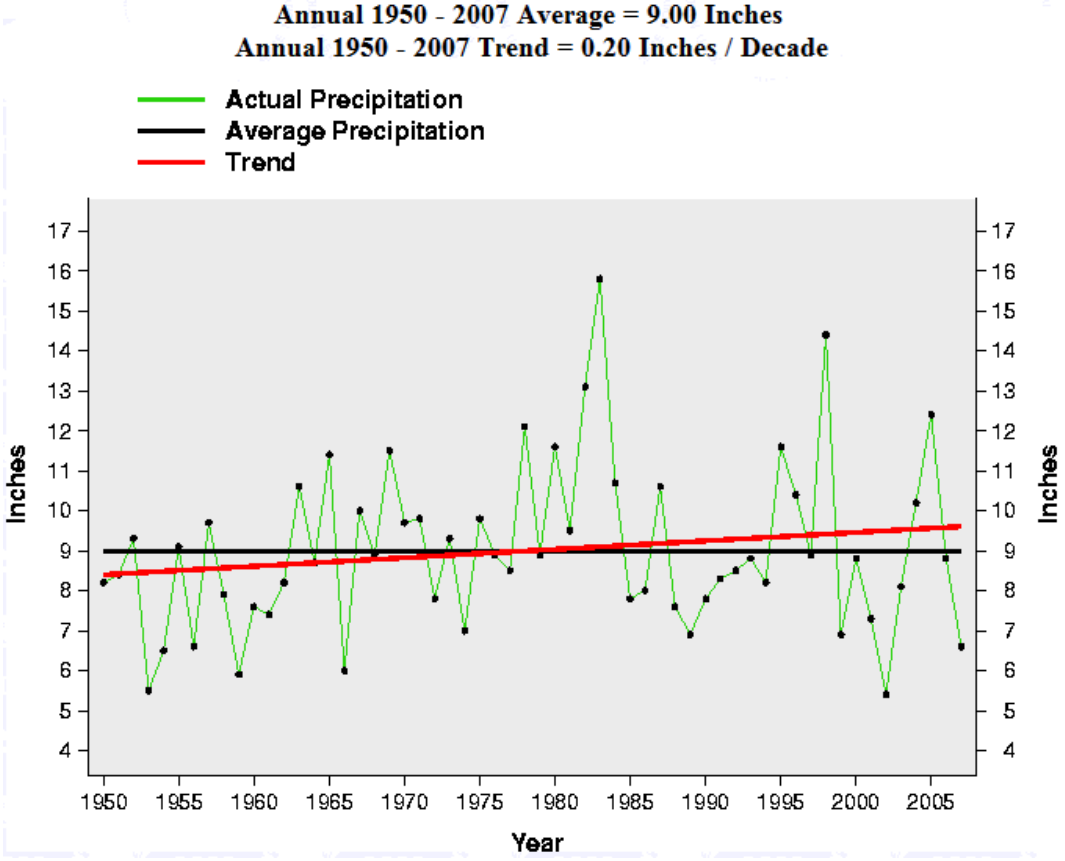
Temperature

The next figure shows the past temperature trends in Nevada. It is predicted that by 2100, spring and fall temperatures could increase between three to four degrees Fahrenheit and five to six degree increase during summers and winters.

Precipitation

Annual average precipitation has been on the rise since 1950 at 0.2 inches a year, as observed in the next figure. Under a warming climate, it is projected that precipitation will decrease 10% during summers, increase 15% in spring, increase 30% in fall, and increase 40% during winters.

Figure 61: Annual Average Precipitation in Nevada, 1950-2007



Source: National Oceanic and Atmospheric Administration Human Health

Increases in temperature can exacerbate pollution concentration in urban areas, which causes more respiratory illnesses, such as asthma or inflammation. Furthermore, warmer weathers are more conducive to disease transmissions through mosquitoes. Heat waves will become more commonplace, causing many people that are vulnerable to extremely high temperatures to become ill or die. Extreme weather events such as droughts and floods could also cause deaths or illnesses to the population.

Agriculture

Nevada has a relatively small agricultural industry, valued at $300 million a year. Two-thirds of the agricultural sector consists of livestock and almost all land is irrigated. The main crops in Nevada are hay and potatoes. Potato yields are expected to decrease by 12% while hay yields are expected to increase by 7%[346], as shown in the figure below.

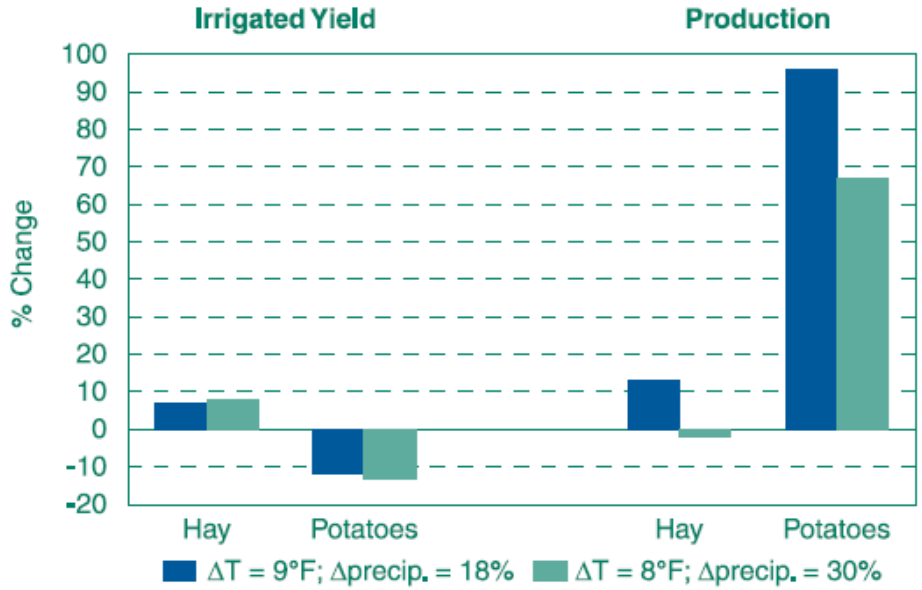
Water Availability

A significant amount of Nevada's water supply depends on river runoffs from snowpack in the mountains. Increased temperatures would reduce snowpack size and river runoffs would occur earlier such that water flows are larger during winter and spring. This prevents any

[346] "Climate Change and Nevada." September 1998. Environmental Protection Agency. 11 June 2008. <http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BVJPC/$File/nv_impct.pdf>
.

water from being stored for summer when water is needed most. Recall that precipitation is projected to decrease during the summers, exacerbating an already burdening problem. Nevada has grown extremely rapidly over the last decade, putting further constraints on the limited water resources. Nevada's future economic development could be jeopardized if measures are not taken to conserve water and find new techniques to store earlier runoffs.

Figure 62: Agricultural Yield and Production in Nevada



Source: Environmental Protection Agency

Environment

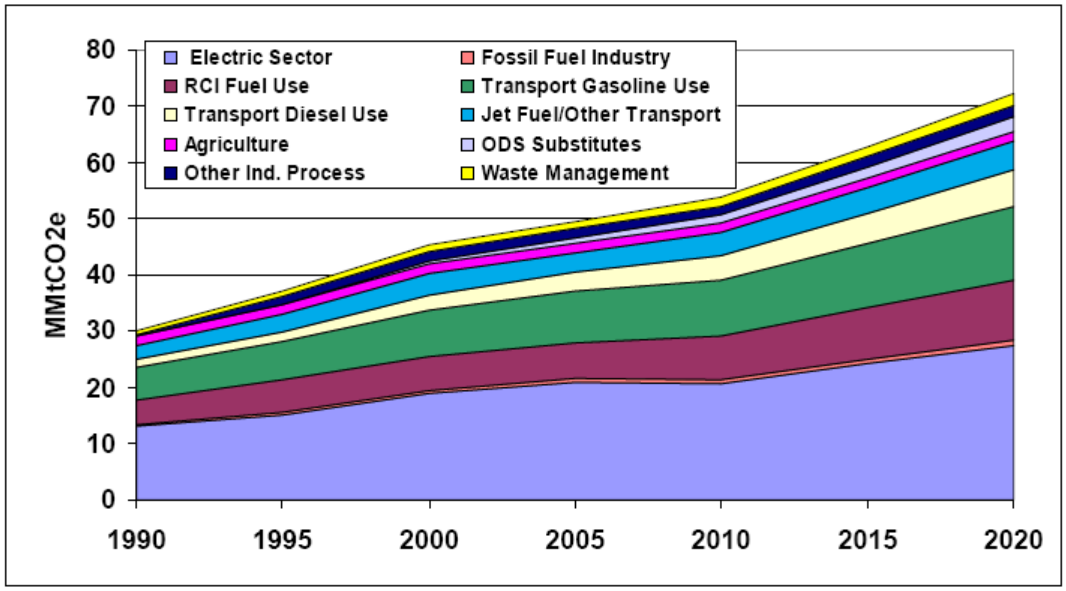
Forest cover can decline anywhere between fifteen to thirty percent under climate change. Forests will become grasslands, arid land, or even desert if temperatures rise and less precipitation falls enough. Drier weather would also increase the risk of wildfires, damaging infrastructure and ecosystems while putting people's lives at stake. Nevada also has a plethora and variety of ecosystems containing rare animal and plant species, which are posed to be highly threatened under climate change. Marshes serve as breeding grounds for many types of waterfowl and are susceptible to damage and extinction if temperatures increase and more water is diverted towards human development.

13.6.2 Greenhouse Gas Emissions

The Center for Climate Strategies released Nevada's greenhouse gas emissions inventory for 1990-2020 in spring 2007. The inventory will aid Nevada in identifying major sources of emissions in the state such that the authoring and implementation of climate change mitigation policies in the future will be highly effective.

In 2005, Nevada produced 49.5 million metric tons of carbon dioxide and is expected to emit 72.3 million metric tons in 2020[347]. Nevada's emissions growth rate from 1990 to 2004 was an astonishing 62%, while the nation's growth rate for this period was only 16%. This large growth rate can be attributed to rapid population growth of 4.9% within the last two decades. As a result of this, the main contributors to Nevada's gross emissions are the electricity and transportation sectors. Electricity accounted for 42% while transportation contributed 32%. The next figure shows the contributions to state's total gross emissions by sector. This shows that electricity emissions will still continue to grow and be the largest contributor in 2020. However, in regards to the state's future emissions growth, the transportation sector will be the greatest contributor by 2020.

Figure 63: Nevada's Gross Greenhouse Gas Emissions by Sector, 1990-2020



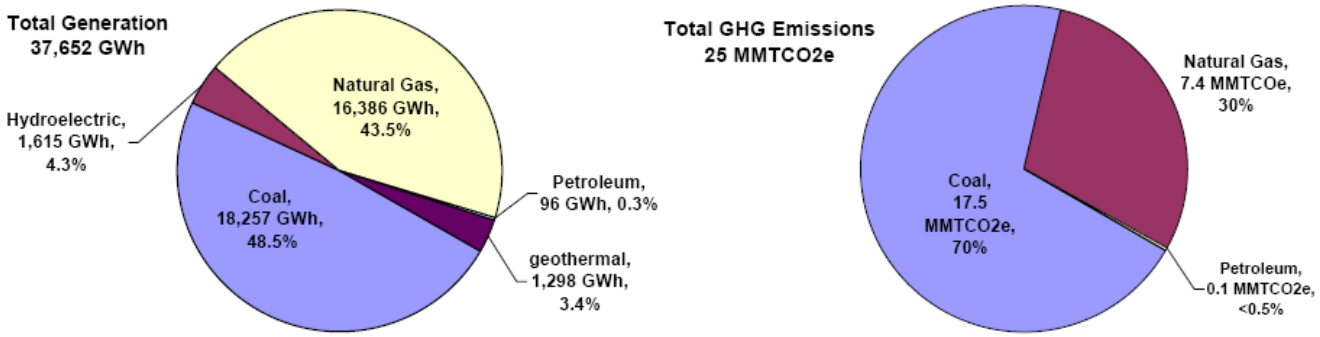
Notes: Fossil Fuel Industry emissions include emissions not associated with fuel combustion (fugitive CH_4). Fossil fuel combustion emissions are included in the RCI Fuel Use sector. RCI – direct fuel use in residential, commercial and industrial sectors. ODS – ozone depleting substance.

Source: Center for Climate Studies

Historically, the electricity generated in Nevada was by coal, which emits a large amount of greenhouse gas emissions per unit. However, Nevada has adopted renewable portfolio standards, which is discussed in Section 6.5, which have forced Nevada's electric utilities to adopt renewable energies that have low or no emissions. However, coal is still predominantly used in electricity generation and accounts for the majority of emissions in the electricity sector, as shown in the following figure. Within the transportation sector, gasoline vehicles contribute the most emissions to the sector overall at 58%. Diesel emissions contributed 19% while air travel constituted 22% of the entire sector's emissions. Between 1990 and 2002, emissions growth from gasoline vehicles increased by 52%. Most of this increase can be traced back to the rapid population growth. Aviation emissions increased by 34% during this time.

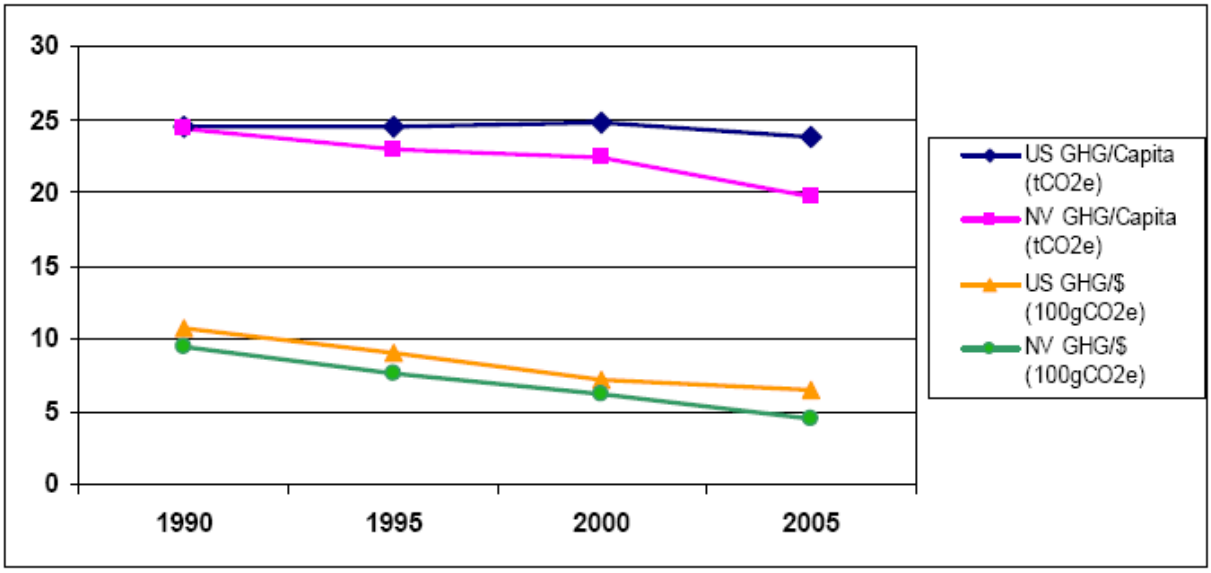
[347] Roe, Stephen, et al. "Nevada Greenhouse Gas Inventory and Reference Case Projections 1990-2020." Spring 2007. Center for Climate Strategies. 11 June 2008. <http://www.wrapair.org/WRAP/ClimateChange/NV_GHG_I&F_Report_WRAP_08-20-07.pdf>.

Figure 64: Electricity Generation and Emissions by Source in Nevada by Power Plants, 2004



Source: Center for Climate Studies Analyzing the per capita and per economic unit greenhouse gas emissions for Nevada and U.S. can give some insight on the structural differences in emissions between them. Nevadans emit less emissions per capita compared the average U.S. citizens. Nevada also emits less greenhouse gases on a per economic unit basis; this figure has decreased by 50% from 1990 to 2004. The next figure provides further details. This can possibly indicate that under a federal climate change policy, so it might be easier for Nevada to implement those policies and be more successful since it has, on average, lower emissions per capita and per economic unit to begin with.

Figure 65: Comparison on per capita and per unit of economic output greenhouse gas emissions between Nevada and United States, 1990-2005



Source: Center for Climate Studies

13.6.3 Policies that Address Climate Change

Executive Order establishing Nevada Climate Change Advisory Committee[348]

On April 10, 2007, Governor Jim Gibbons created the Nevada Climate Change Advisory Committee, which will propose recommendations on appropriate policies the state should adopt in mitigating climate change in the state. Policy suggestions will be put into a climate action plan for the state. The committee was scheduled to submit a final report and recommendation to the Governor on May 31, 2008.

Nevada Climate Change Advisory Committee

The goals and expectations that are to be met by the committee are[349]: 1) serious policy review, 2) understanding past, present, and future conditions and opportunities, 3) creating strategies that take into account the environment, citizens, and businesses, and 4) meaningful and actionable set of recommendations.

The committee holds meetings once to twice a month. Within the advisory committee, there are three sub groups that deal with different parts of the state that have influences in greenhouse gas emissions: 1) Transportation, Electricity, and Consumption, 2) Residential, Commercial, and Industrial Sectors, and 3) Waste and Agriculture. The entire committee was previously working on a draft that addressed impact of climate change in Nevada, efforts taken so far in mitigating climate change in the state, and policy recommendations. Unfortunately, the draft has not been made public so a discussion on reported findings is impossible. It is assumed that the Governor and his staff are currently reviewing the final draft.

Electricity Disclosure

From October 1, 2001 and onwards, electric utilities are required to reveal information on electric services, mix of energy sources used in electricity generation, average emissions (pounds/megawatt hour), and more. The purpose of such a disclosure could be to inform the public on the utilities' operations such that consumers can demand cleaner inputs in producing electricity, such as renewable energies.

Nevada has one of the most impressive collections of clean energy initiatives and incentives in the United States. In requiring or encouraging the use of renewable energy to increase energy efficiency, Nevada can more easily reach its greenhouse gas emissions target or cap when it is created in the climate action plan in the near future. Below are some major clean energy measures adopted by Nevada thus far.

Energy Efficiency in Public Facilities

This law required the Director of the Office of Energy to create a reduction plan in which state agencies would have to reduce grid-based energy purchases by 20% by 2015. Furthermore,

[348] Gibbons, Jim. "Establishing the Nevada Climate Change Advisory Committee." 10 April 2007. State of Nevada Executive Department. 11 June 2008. <http://gov.state.nv.us/EO/2007/EO-ClimateChange.pdf>.
[349] "Minutes of the Nevada Climate Change Advisory Committee." 16 May 2007. Nevada Climate Change Advisory Committee. 11 June 2008. <http://gov.state.nv.us/Climate/Minutes/2007/2007-05-16-Minutes-Climate.pdf>.

the director must establish Green Building Standards all state-owned or state-sponsored buildings.

Energy Efficiency and Alternative Fuel Goals for Public Fleets

A state statute requires that fleets that have at least 10% of state-owned vehicles to purchase Environmental Protection Agency approved ultra-low emission vehicles or alternative fuel vehicles. After 2000, 90% of state vehicles have to fall into one of the two categories just mentioned.

State and Regional Energy Planning

Since Nevada is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

Energy Efficiency Portfolio Standards

Senate Bill 188 was signed into law on June 18, 2005. These portfolio standards will allow electric utilities to receive credits for any energy savings received by following energy efficient measures.

Renewable Portfolio Standards

Under these standards, investor-owned utilities Nevada Power and Sierra Pacific Power are to increase the supply of their electricity generation (to be sold) from renewable energies by 3% every two years and up to 20% by 2015. At least 5% of the energy generated must come from solar power. The utilities can meet this standard by renewable energy generation and energy savings from efficiency measures. The Public Utilities Commission of Nevada also allows the buying and selling of portfolio energy credits to meet this standard.

Initiatives Taken on Organizational and Firm Level

Electric utilities in Nevada have numerous financial incentives that they offer to their residential, commercial, and industrial customers to adopt energy efficient practices. One of them is a partial property tax abatement offered to commercial and industrial consumers if their buildings meet or exceed standard LEED ratings. This was a highly successful incentive program because as of June 2007, 63 million square feet of commercial and industrial buildings applied for LEED certification in order to reap the benefits of property tax deductions. The percentage of tax deduction also depends on high the LEED ratings were.

The investor-owned utilities Nevada Power and Sierra Pacific Power both have financial incentive programs for residential, commercial, and industrial customers. For instance, Nevada Power offers a program to low-income households where qualified households can get full assistance on one month's electricity bill and/or installing energy-saving technologies. The utility also offers rebates to homebuilders that install energy-efficient central air conditioners. Sierra Pacific Power has a residential rebate program when households buy certain energy saving appliances.

Public Utilities Commission of Nevada has also interconnection standards for customers of both investor-owned utilities. Interconnection standards refer to the regulations set by state or utilities for those who wish to connect their distributed generation sources to the power grid. This is so that distributed generations sources can contribute to the power grid, allowing for energy and cost efficiencies and preventing delays in electricity distribution[350]. Nevada adopted these standards for all their customers that have on-site generation greater than 20 megawatts. Interconnection standards would be greatly beneficial in trying to achieve greater energy and cost efficiencies between the utilities.

What Still Needs to be Done

The greenhouse gas emissions inventory indicated that substantial measures need to be taken in the electricity and transportation sectors in order for the state to effectively mitigate climate change. As of now, the state has not adopted any greenhouse gas auto standards or fuel economy standards, but hopefully it will include these standards when a completed climate action plan is in place in the future. It is crucial to take action as soon as possible because emissions growth in the transportation sector is predicted to be the largest compared to other sectors.

Nevada, as mentioned before, has made great strides in ensuring that more of its energy comes from renewable sources through the many measures it already has in place. Since electricity is a major emitter and is projected to be in the future according to the inventory, more broad-based approaches to adopting clean energies are desperately needed, given that Nevada has a large tourist industry and growing population. Nevada only has two electric utilities, so they can easily collaborate and communicate with one another as to which technologies, policies, incentive programs, and measures work best. Technology and information transfers can be facilitated and exploited in this setting to mutually help one another.

13.6.4 Nevada and WCI: Analysis

Nevada has met two of the four criteria required to become a WCI partner. The Nevada Climate Change Advisory Committee is still in the process of developing a climate change action plan. On May 31, 2008, the committee submitted a report regarding a background review of climate change evidence, enacted policies, and policy recommendations to the governor. It will take some time for the report to be evaluated by the governor for appropriateness and viability. As a part of the climate action plan draft, Nevada would have to include a greenhouse gas emissions target in addition to greenhouse gas emission standards for passenger vehicles in order to be eligible for membership in WCI. Nevada is already in the process of becoming a member of the Climate Registry, which will help Nevada follow standard protocol in taking inventory of emissions in the future and more importantly, establish connections with other participating states to exchange information and technologies.

Nevada can learn a great deal from just being an observer of WCI. It can look to California for guidance in adopting and developing automobile standards since the transportation sector is the second largest contributor to emissions in the state. Any effective efforts in

[350] "State Energy Alternatives." U.S. Department of Energy. 12 June 2008. <http://www.eere.energy.gov/states/alternatives/interconnection_standards.cfm>.

mitigating climate change would have to include policies that decrease emission in sectors that contribute to the majority of greenhouse gas emissions. Perhaps more significantly though, when Nevada joins WCI, it will greatly contribute to the initiative. Given that it has extensive clean energy policies, it could potentially aid other WCI members to adopt similar measures to help them decrease emissions. The technology and knowledge transfer opportunities are invaluable with Nevada in the initiative.

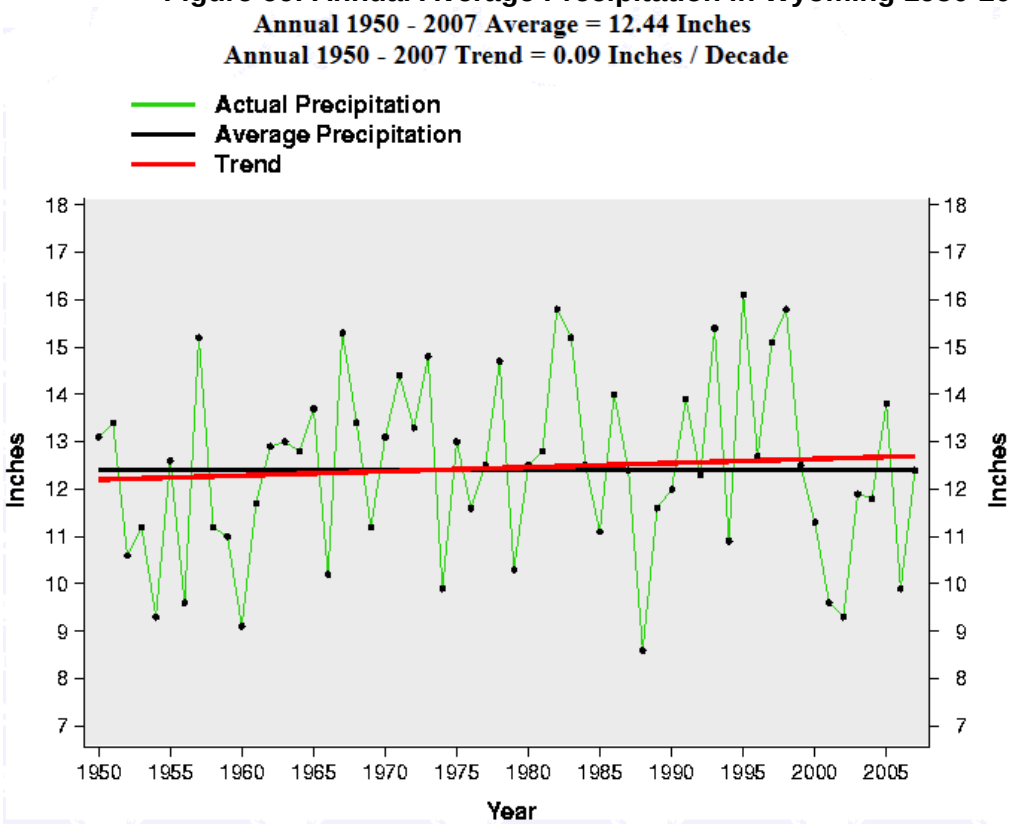
13.7 Wyoming

13.7.1 Evidence and Effects of Climate Change

Temperature

The next figure summarizes Wyoming's historical temperature trends, which have been steadily increasing. In 2100, it is projected that temperatures are to increase by 4 degrees Fahrenheit in spring and fall, five degrees in the summer, and six degrees in the winter[351].

Figure 66: Annual Average Precipitation in Wyoming 1950-2007



Source: National Oceanic and Atmospheric Administration

[351] "Climate Change and Wyoming." September 1998. Environmental Protection Agency. 13 June 2008. <http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BWK88/$File/wy_impct.pdf>.

Precipitation

Precipitation has increased approximately 0.09 inches per decade since the 1950s, as show in Exhibit 7.1. It is estimated that in 2100, precipitation will decrease slightly in the summers (0-10%), increase by 10% in spring and fall, and 30% in the winter.

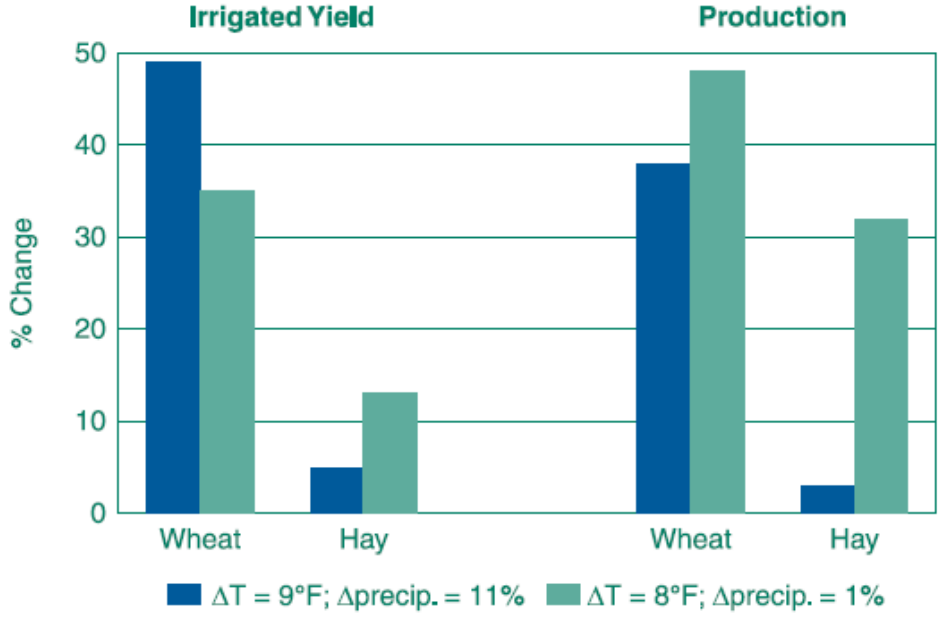
Human Health

Increases in temperature can exacerbate pollution concentration in urban areas, which causes more respiratory illnesses, such as asthma or inflammation. Furthermore, warmer weathers are more conducive to disease transmissions through mosquitoes. Heat waves will become more commonplace, causing many people that are vulnerable to extremely high temperatures to become ill or die. Extreme weather events such as droughts and floods could also cause deaths or illnesses to the population.

Agriculture

Agricultural production contributes $800 million annual to Wyoming's economy, eighty percent of which comes from livestock. Seventy percent of farms are irrigated. The major crops in Wyoming are wheat and hay. Temperature increases are expected to increase wheat yields by 35 to 48 percent while hay output can rise or fall depending on whether irrigation is implemented. This is shown graphically below.

Figure 67: Agricultural Yield and Output in Wyoming, 1950-2007



Source: Environmental Protection Agency

Water Availability

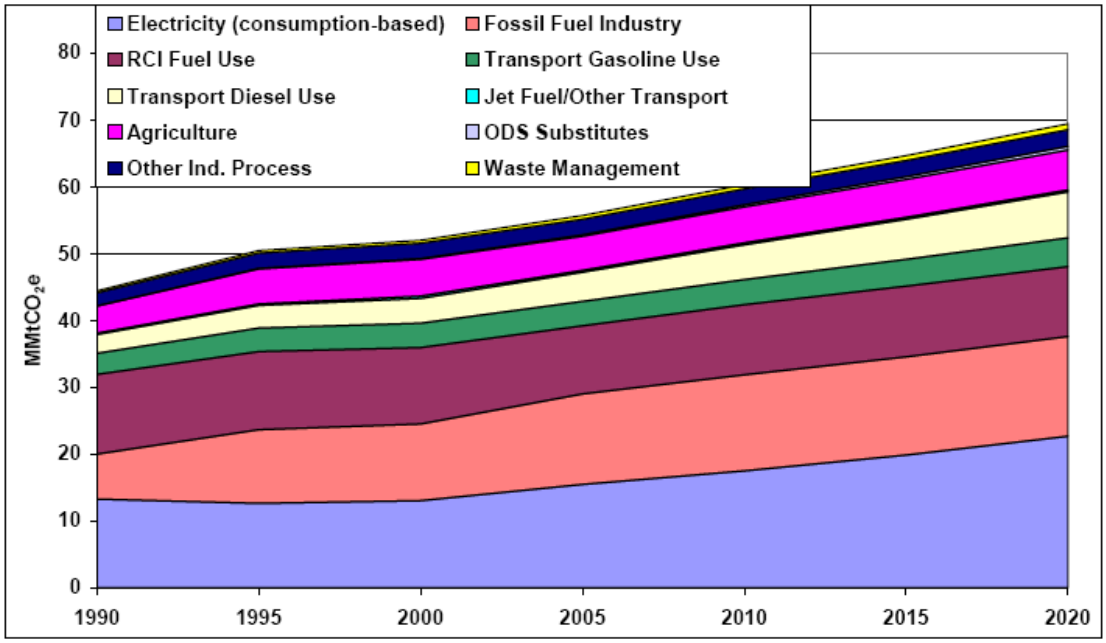
There is an uneven distribution of water in Wyoming such that it is scarce in some places and plentiful in others. Many headwaters of large rivers start in Wyoming. So, the state's water supply is largely dependent on the runoffs from mountain snowpack. Warmer climate can decrease snowpack size and result in earlier runoffs and increased evaporation, which all lead to a decline in water supply. Increased demand for water in residential, commercial,

and industrial sectors will amass significant strains on the limited water availability. In fact, groundwater is already being over pumped because stream flows are not able to provide enough water.

Environment

With Yellowstone National Park within its boundaries, Wyoming has diverse wildlife. Wyoming's forests have been subject to fire suppression, which leads to infestation of disease and insects in addition to a dense forest cover, making them highly vulnerable to wildfires under increasing temperatures. After Yellowstone's massive wildfire in 1988, scientists have been closely examining the effects of climate change on forests. They discovered that the cause of the wildfire was a result of a dry summer coupled with a winter drought proving that climate change is already taking effect. In addition, the whitebark pine population is at high risk of depletion of up to 90% in the next few decades even under a slight temperature increase. Whitebark pine nuts provide food for caterpillars that grizzly bears consume, so if the whitebark population dwindles, it also threatens the livelihoods of the grizzly bears residing in Wyoming.

Figure 68: Wyoming's Gross Greenhouse Emissions by Sector, 1990-2020



RCI – direct fuel use in residential, commercial, and industrial sectors, ODS – ozone depleting substance.

Source: Center for Climate Studies

13.7.2 Greenhouse Gas Emissions[352]

Wyoming's greenhouse gas emissions inventory for 1990-2020 was reported by the Center for Climate Strategies for Wyoming's Department of Environmental Quality. The report was released in spring 2007. As of date, Wyoming has not made significant strides towards

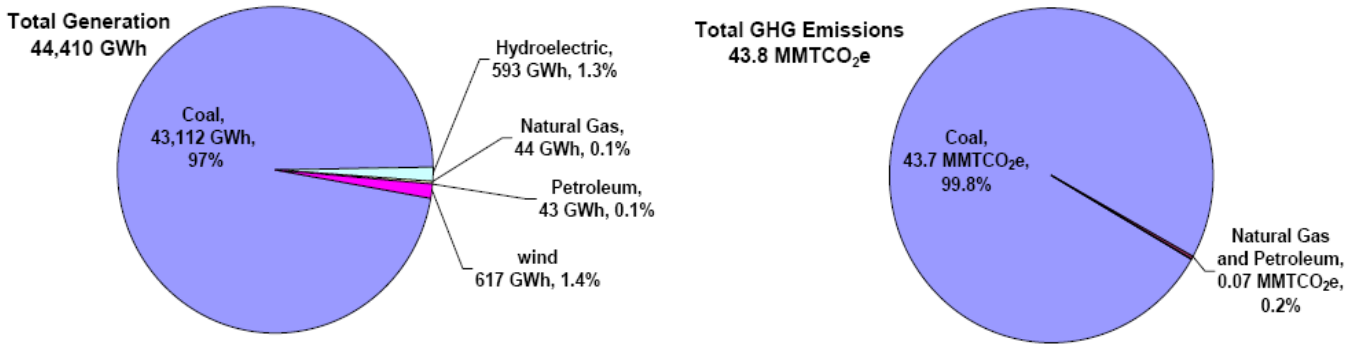
[352] Bailie, Alison, et al. "Wyoming Greenhouse Gas Inventory and Reference Case Projections 1990-2020." Spring 2007. Center for Climate Strategies. 14 June 2008. <http://www.wrapair.org/WRAP/ClimateChange/WY_GHG_I&F_Report_WRAP_08-20-07.pdf>.

mitigating climate change in the state, so this inventory will serve as a starting point for officials to enact suitable policies in decreasing greenhouse gas emissions.

In 2005, Wyoming emitted 56 million metric tons of carbon dioxide. Wyoming's gross greenhouse gas emissions have increased by 25% from 1990 to 2005 compared to the national average of 16%. Gross greenhouse gas emissions are expected to increase by 24.8% between 2005 and 2020 to 69.4 million metric tons. Furthermore, Wyoming practices carbon sequestration through forestry and land use. In 2005 alone, Wyoming sequestered 36 million metric tons of greenhouse gas emissions.

The main contributors to emissions are electricity, and residential, commercial, and industrial fuel consumption sectors. The electricity sector is expected to contribute the most to the future emissions growth, with transportation right behind it. The previous figure displays the breakdown of historical and projected gross greenhouse gas emissions by sector. Electricity consumption accounted for 28% of Wyoming's total emissions in 2005 below the national average of 34%. It accounted for 20% of the emissions growth between 1990 and 2005. The majority of the electricity generated in the state is from coal, meaning that the majority of the emissions are from coal, as shown in the following pie charts. It is projected that coal will continue to be the dominant energy source used in electricity production. This implies that there is a large opportunity for Wyoming to adopt clean energy policies to decrease greenhouse gas emissions and effectively mitigate climate change. Furthermore, emissions from the fossil fuel industry (classified under industry sub-sector of the residential, commercial, and industrial sector) accounted for about 24% of the state's gross greenhouse gas emissions in 2005.

Figure 69: Source of Electricity Generation and Greenhouse Gas Emissions by type of energy source from Wyoming Power Plants, 2004

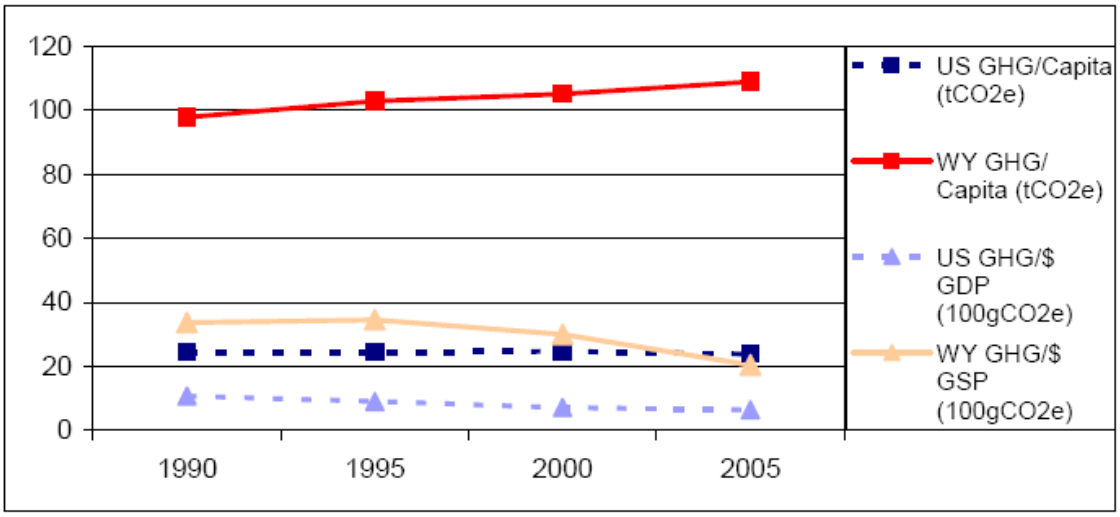


Source: Center for Climate Studies

Comparison between per capita and per economic unit greenhouse gas emissions between Wyoming and U.S. shows that there are large discrepancies between them, as shown in the figure below. These differences between them are largely attributed to Wyoming's large fossil fuel industry, large agricultural industry in conjunction with low and sparse population. The per capita emissions in the majority of the sectors are higher than the national average because of this. Between 1990 and 2005, per capita emissions have increased because of the increase in fossil fuel production. During the same period of time, per economic unit

emissions have decreased because economic growth has outstripped emissions growth. The structure of the economy (industry dominant) and state population profile (small, sparse population) lends itself to have high per capita and per economic unit greenhouse gas emissions.

Figure 70: Comparison on per capita and per unit of economic output greenhouse gas emissions between Wyoming and United States, 1990-2005



Source: Center for Climate Studies

13.7.3 Policies that Address Climate Change

Wyoming Carbon Sequestration Advisory Committee

In 2001, Wyoming legislature passed the Wyoming Carbon Storage Law (House Bill 47) that created the Wyoming Carbon Sequestration Advisory Committee to research on helping to decrease the state's greenhouse gas emissions through carbon sequestration. The role of the committee officially ends on July 1, 2009. Carbon sequestration is considered to be a very cost-effective way of reducing greenhouse gas emissions since it is utilizing resources that are readily available.

The key objectives of the committee are to[353]: 1) provide the state with information and advice regarding management practices and economic opportunities to store carbon in Wyoming's agricultural and forest lands and 2) educate citizens about carbon sequestration through conferences, media, and other means. In December 2001 after the committee was formed, it released a comprehensive report to the state legislature in the methods of implementing carbon sequestration and most importantly, how carbon sequestration could be used as a means of reducing greenhouse gas emissions in the state. Wyoming could develop a carbon credit market for itself and other states, allowing it to exploit its comparative advantage in having vast availability of forestry and agricultural lands.

[353] Wyoming Carbon Sequestration Committee. 13 June 2008. <http://www.wyomingcarbon.org/>.

House Bill 90

On March 4, 2008, Wyoming passed an important bill addressing carbon sequestration. The bill directs the state's Department of Environmental Quality to develop standards for regulating long term carbon sequestration, provides a list of requirements that are to be in a permit application for owning carbon sequestration wells, allows Department of Environmental Quality to issue permits, and lastly, requires the State Oil and Gas Supervisor, state geologist, and director of Department of Environmental Quality to form a working group to create a bonding procedure[354]. This bill is effective as of July 1, 2009. This measure will greatly propel the efforts in adopting carbon sequestration to new heights.

State and Regional Energy Planning

Since Wyoming is a member of the Western Governor's Association, each governor of the participating states agreed to meet/exceed the goal of having 30,000 megawatts of clean energy by 2015 and increase energy efficiency by 20% in 2020. The association also highly encourages investments to be made in developing energy efficient technologies and creating regional energy markets to help achieve economies of scale. All WCI observers are participants in the association.

Interconnection Standards: Net Metering

Wyoming requires that all renewable energy systems (solar, wind, hydropower) over 25 megawatts to be interconnected. If excess power is created, the electric utilities must pay customers or deduct from next month's bill. This facilitates efficiency within utilities to make sure that superfluous energy (causing excess greenhouse gas emissions) would not be produced.

Carbon Power and Lighting

Electric utility Carbon Power and Lighting offers a utility rebate program for residential and commercial residents. Customers can receive rebates when they purchase energy efficient appliances[355]. Furthermore, they offer a loan program called EC Home Improvement residential customers can take advantage of if they want to install energy efficient products ranging from heaters to insulation[356].

Lower Valley Energy

This electric utility has a green rate where customers can use electricity entirely produced by wind power. The green rate adds 1.167 cents for every kWh used compared to traditional electricity. The utility also gives rebates to those customers that purchase Energy Star appliances, such as water heater, washer, dishwasher, and refrigerator.

Powder River Energy

[354] "Carbon Capture and Sequestration." 2001. Wyoming Legislature. 14 June 2008. <http://legisweb.state.wy.us/2008/Summaries/HB0090.htm>.
[355] "Wyoming Incentives for Renewable Energy." 20 July 2007. DSIRE. 13 June 2008. <http://www.dsireusa.org/library/includes/incentive2.cfm?Incentive_Code=WY13F&state=WY&CurrentPageID=1&RE=1&EE=0>.
[356] "Financial Services." Carbon Power & Light. 13 June 2008. <http://www.carbonpower.com/financial_services.htm>.

This cooperative electric utility has a green tag program where customers can choose whether their electricity comes from a renewable source or not. For a 100 kWh block from a renewable energy electric grid, it would only cost 50 cents more per month. The purpose of this is to displace the usage of non-renewable energies such as goal or gas and decrease greenhouse gas emissions. Furthermore, the utility is in the process of getting certified for a Green Seal, which is a federal government program promoting energy efficiency and conservation practices in businesses. They are replacing fluorescent lights with more energy efficient ones and using green cleaning agents in their janitorial services. Lastly, they have a photovoltaic program where customers can take advantage of solar power and will assist in deciding what system would work best in a give place. All these measures taken are under the cooperative's Environmental Stewardship Policy[357] implemented on September 21, 2007.

Initiative taken on Local Government Level

In 2008, the town council of Jackson passed the fiscal year budget for that year and the mayor approved to have all its operations run by renewable energy. Jackson and Lower Valley Energy are working together to make this possible by obtaining the renewable energy from a green power hydro project at Strawberry Creek. The town's goal is to decrease its emissions by 3035 tons every year[358].

What Still Needs to be Done

Though Wyoming has a variety of clean energy measures in place, it is almost entirely lacking in its efforts towards mitigating climate change. No direct policies or legislation has been enacted thus far. The state needs to take action soon in order to prepare itself for the federal legislation that is on the horizon in addition to protecting its people, economy, and environment. A climate action plan needs to be authored and proposed with specific solutions to decreasing emissions in sectors that are the large contributors. The government can either achieve this by creating an advisory board or using an existing government agency, such as the Department of Environmental Quality. Wyoming can use the greenhouse gas inventory created by the Center for Climate Strategies as a starting point for action to decipher what specifically needs to be enacted.

Since the carbon sequestration infrastructure and institution are in place already, Wyoming should exploit this heavily since a significant portion of emissions come from the agricultural sector. House Bill 90 further solidified carbon sequestration's role in the reducing greenhouse gas emissions and hopefully from this a mature carbon credit market can be developed to benefit Wyoming and surrounding states in reducing greenhouse gas emissions.

Given that coal is used heavily in the electricity sector, there should be policies from the state and/or Wyoming Public Service Commission offering incentives or help in developing more renewable energy technologies. Most of the efforts thus far have been made on the behalf of individual utilities. Statewide standards such as Renewable Portfolio Standards will force utilities to be technologically innovative and create/adopt renewable energy sources.

[357] "Environmental Stewardship." Powder River Energy. 14 June 2008. <http://www.precorp.coop/InfoDocs/ESteward/EStewardship.cfm>.
[358] "Town of Jackson City Council Agenda Documentation." 25 July 2008. Town of Jackson City Council. 14 June 2008. <http://www.townofjackson.com:8307/agendas/2007/2007pkts/080607/Public%20Hearings,%20Discussion,%20Action/LVEMOU.pdf>.

13.7.4 Wyoming and WCI: Analysis

Out of all the WCI observers, Wyoming seems to be the least progressive and proactive in mitigating climate change. It will take quite some time until the state is eligible to become a member of WCI. Participation in the Climate Registry is the only requirement met by the state to become a WCI partner. Membership in the Climate Registry would assist Wyoming in publishing its own greenhouse gas emissions inventory in the future through a proper set of protocols while permitting easier communication between other states about climate change mitigation.

The lack of leadership is an impediment that is preventing Wyoming from moving forward in the climate change dialogue. The state legislature needs to assign an advisory board or government entity to be in charge of researching which policies would be most appropriate and to closely examine how exactly climate change affects all aspects of the state. Without this authoritative entity in place, Wyoming will probably not make any significant advances in mitigating climate change without a climate action plan. If a plan is enacted, the state can implement auto standards, carbon sequestration techniques, and more clean energy standards.

Wyoming is benefiting greatly from purely observing the actions WCI take since it showcases what opportunities and options are available when a climate action plan is eventually drafted. In addition, it can be argued that Wyoming can also benefit WCI partners as well with its advancements in carbon sequestration, which would help states that have large agricultural sectors, such as California and Idaho. Technology and knowledge transfers can run in both directions, benefiting all parties.

13.8 Conclusion

The devastating prospects of climate change on states' environments, economies, and peoples are now irrefutable. Fortunately, all WCI observers are taking their own initiatives, extensive or not, on various levels to mitigate climate change, from the formation of climate change action plans to local farmers changing their management practices at the micro level. Small or large, these efforts combine aggregately to reduce greenhouse gas emissions in the states.

WCI observers are at different stages of climate change policy development, with some close to becoming eligible to join the WCI in the next year if current progress continues while others are only at the preliminary stages of climate change policy planning. Using their individual greenhouse gas emissions inventory, each state can use it as a blueprint for policy implementation and adaptation as to effectively mitigate climate change.

Although gaining eligibility for WCI membership is crucial, what is more important is the learning experience that can take place on the behalf of all observers and partners. They can examine what WCI members have done so far in designing and enacting policies and any hurdles they met during the process of enactment so they are aware of what to do and expect in the future. In addition, the knowledge and technology transfers that can take place are invaluable to all states, observers and members alike. States can exploit one another's strengths while leveraging their weaknesses. For instance, Kansas is in the processing of taking lead in wind power technology, Idaho has a sophisticated carbon sequestration

system, and Nevada has a comprehensive collection of clean energy policies. By forming a regional group with common ends, the barriers to extensive communication and sharing of information collapse. Economies of scale and technology and knowledge transfers can be exploited. All members and observers alike can benefit from WCI.

14 Public Interest Stakeholders Background Review

14.1 Current Evidence & Projected Impact Of Climate Change

The evidence on climate change is unequivocal. Observations of average temperature increases in both the air and sea have coincided with the widespread melting of snow and ice and a net increase in the global sea level. The IPCC asserts that this increase in temperature has occurred on a global scale, with particular intensity in higher northern latitudes.[359] The repercussions for the natural environment and human society abound. Numerous studies predict that increasing air and sea temperatures will result in extreme weather patterns, natural disasters, wildfires, coastal flooding, and the interruption of natural and biological processes.

14.2 Areas of Public Interest

14.2.1 Economic

The sector-specific economic impacts associated with climate change raise concerns about the competitiveness of regional economies and consumer surplus. The rising costs to industry associated with global warming will likely result in increasing levels of unemployment in affected industries and losses in wealth to communities and regional economies that rely heavily on these industries. Consumers will suffer from higher prices (due to rising costs of production and the prices of raw materials), unplanned losses in income (due to unpredictable and extreme weather patterns) and a decline in the availability of services.

Recreation

The Fourth Assessment Report of the IPCC found that warming in the western mountains will likely cause decreased snow pack. (IPCC 14) In fact, the fraction of annual precipitation falling as rain rather than snow increased at over 70 percent of the weather stations studied in the western mountains of the United States in the period 1949 to 2004. (Knowles et al., 2006) Combined with predicted changes in precipitation patterns, the result will be a decrease in the number of snow days in the Western United States, resulting in losses to the recreation industry and more specifically, the skiing industry, worth an estimated $1 billion for the region. (US Census Bureau 2005) This will have enormous consumer surplus implications for the households that spent $15,867,766,320 in total in recreational expenses on trips in 2002. (New Strategist Publications 688)

Insurance

The increased instance of extreme weather patterns, natural disasters, wildfires and coastal flooding associated with climate change have contributed to the overall risk exposure of insurers, which has grown considerably in recent years. (Coelho et al. 15) An increase in heat waves, intense precipitation events (and associated flooding and mudslides), wildfires, crop failure, coastal erosion, hurricane peak wind intensities and storm duration will

[359] See appendix for IPCC's figure, "Observed Changes in Temperature, Sea Level, & Northern Hemisphere Snow Cover"

collectively have a direct impact on health, life, property, flood, business interruption and vehicle insurance lines. (NRDC October 2007) In the period 1980 to 2005, private and federal insurers paid out more than $320 billion in claims. (Coelho et al. 15) A great deal of these rising costs to insurers will likely be passed on to insurance customers in the form of rates.

Agriculture

Many studies have examined the impact that climate change will have on agricultural yields, and the effects will seemingly be mixed and varied among regions. The two primary drivers behind the changes that will be faced by the agricultural sector are higher temperatures and water shortage due to less frequent but more intense precipitation patterns and earlier and lower spring snowmelt in the mountainous West. One study predicts that higher temperatures will reduce livestock production during the summer season, though these losses will be somewhat offset by warmer winter temperatures. (US CCSP 4) Meanwhile, the IPCC projects an increase of 5 to 20 percent in aggregate yields of rain-fed agriculture as a result of changing precipitation patterns in the next few decades, though these numbers will of course vary widely across regions. These gains will be offset by losses in yields for crops near the warm end of their suitable range or which depend heavily on shared water sources. (IPCC 14-15) Indeed, an already strained water system in the West will be met with increasing demand and diminishing supply in the coming years, signaling dire effects for the agricultural industry in the West and Northwest. One study predicts that in the period "2070 to 2099, an additional 254,000 acres now producing crops will have to be fallowed because of water shortages around the Central Valley, which will generate an annual loss of $278.5 million." (Coelho et al. 27) And while the Pacific Northwest may benefit from a longer growing season, expected annual crop losses from water shortages are predicted to rise from $13 million to $79 million by mid-century. (Coelho et al. 32) Higher temperatures could also provide fresh breeding grounds for agricultural pests and crop diseases. Wine production and dairy cow productivity in California will also likely suffer as a result of higher temperatures. In the United States, the agricultural industry as a whole was valued at approximately $200 billion in 2002. (US CCSP 3) The projected losses in agricultural yields will mean still higher prices for the already burdened consumer and economic hardship for agriculture-based communities.

Real Estate/Construction

The water shortage in the West will create losses for other industries as well, such as real estate. One study predicts that decreased water supply will reduce the value of affected farmland by around 36 percent of the overall value of the farm, which on average amounts to about $1,700. (Schlenker et al. 2005) Projected sea level rise also poses a threat to residential real estate as it is likely to cause some areas of dry land in the US to become inundated as well as increase storm surge levels. (US CCSP 3) Coastal erosion and population migration to these vulnerable areas will exacerbate the risks posed to coastal areas. The IPCC estimates that the global sea level will rise between 7 and 23 inches by the end of the century. The NRDC predicts that by 2100, US residential real estate losses due to the inundation of low-lying coastal properties and increases in storm damage will amount to $360 billion per year. (NRDC May 2008) Such unplanned losses in income to homeowners will greatly reduce their consumption and spending power.

14.3 Environmental

14.3.1 Ecosystems and Biodiversity

Thriving ecosystems are essential to human health. Not only do they provide indispensable public goods such as a natural mechanism for removing waste products and habitats that sustain biological diversity, but they also provide the raw materials necessary to producing food, fuel, pharmaceutical products and other goods that human society depends upon. Climate change poses a threat to the well-being of such systems by way of rising temperatures and associated disturbances in the natural environment such as drought, flooding, wildfire and ocean acidification.

Loss of Wildlife

Rising surface temperatures due to carbon dioxide pollution have already begun to result in loss and change of habitat for numerous species around the world. In North America, global warming has generally resulted in species range shifts toward the poles and higher altitudes. The NRDC maintains that the complex exigencies of rapid adaptation could push more than 1 million species to extinction by 2050. (NRDC May 2007) In the Arctic region, polar bears and other sea-ice dependent species are rapidly losing habitat as higher sea temperatures cause snow and ice to melt. Higher sea temperatures pose a threat to marine mammals due to accompanying changes in prey distribution and abundance, and to tropic coral reefs through massive coral bleaching and death. Rising sea levels and coastal flooding have resulted in loss of wetlands, which has already been attributed with a reported decline of 44 percent of the world's waterbird species. Climate warming has also been linked to changes in plant growth, flowering, animal reproduction, and migration patterns, disrupting preexisting symbiotic relationships among species. Finally, mountain-restricted species that have nowhere to migrate in the face of warming temperatures and habitat changes are being pushed to the brink of extinction.

Landscape Change

Many scientists maintain that the American West is warming faster than the East. The effect of warmer temperatures and the diminishing snow and water supply of the West is perhaps most evident in the region's national parks where climate change, if allowed to continue unchecked, is projected to have a number of dire effects on scenery, natural resources and wildlife. The NRDC maintains that such changes could include the disappearance of glaciers in Glacier National Park and North Cascades National Park, snow-barren summers in Glacier, Grand Teton, Mount Ranier, North Cascades, Rocky Mountain and Yosemite, the elimination of treeless alpine tundra in Rocky Mountain National Park, the disappearance of Joshua tress from Joshua Tree National Park, the elimination of entire forests in the American Southwest, the disappearance of meadows and wildflowers in mountain areas across the West, the spread of invasive plant species, changes in the characteristic plant cover of many national parks, the marginalization of natural resources due to increases in the frequency and severity of wildfires, and the destruction of historic and cultural landscapes and artifacts. (NRDC July 2006)

Figure 71: Observed Changes in Temperature, Sea Level, & Northern Hemisphere Snow Cover

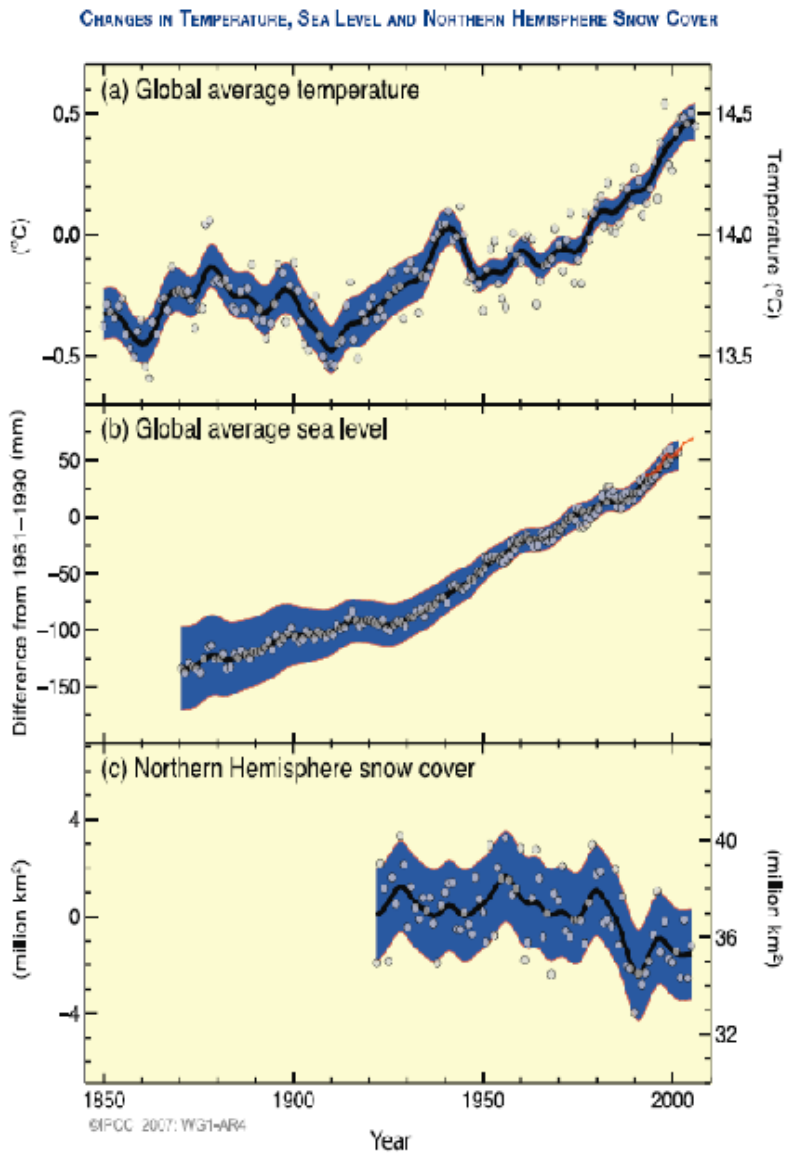


Figure SPM.3. *Observed changes in (a) global average surface temperature, (b) global average sea level from tide gauge (blue) and satellite (red) data and (c) Northern Hemisphere snow cover for March-April. All changes are relative to corresponding averages for the period 1961–1990. Smoothed curves represent decadal average values while circles show yearly values. The shaded areas are the uncertainty intervals estimated from a comprehensive analysis of known uncertainties (a and b) and from the time series (c). (FAQ 3.1, Figure 1, Figure 4.2, Figure 5.13)*

Resource Availability

As mentioned previously, disruptions in the natural environment associated with climate change are likely to constrain the ability of ecosystems to provide the raw materials and public services that society depends on for everyday necessities. A decline in the availability of water and raw materials will pose economic hardships for the American West and Northwest in particular, whose flagship industries include agriculture, mining, construction and tourism in the West and agriculture, fisheries, natural resource extraction (forestry and

mining) and tourism (especially visitation to national parks) in the Northwest, all of which rely heavily on natural resources.

The projected effect of warming temperatures on water quality and supply will perhaps be felt most strongly in the American West, where water management systems are based on historical conditions and will likely face challenges in current and future planning as the abundance and nature of the regional water supply becomes increasingly unpredictable. (US CCSP 4) Increasing stream temperatures are likely to have dire effects on aquatic ecosystems and water quality, while earlier snowmelt peaks and reduced water flows in the summer and fall seasons will have a negative impact on the performance of reservoir systems.

Table 23: Estimated Cost of Climate Change in Four Impact Areas

The Global Warming Price Tag in Four Impact Areas, 2025 through 2100

	In billions of 2006 dollars				As a percentage of GDP				U.S. Regions Most at Risk
	2025	2050	2075	2100	2025	2050	2075	2100	
Hurricane Damages	$10	$43	$142	$422	0.05%	0.12%	0.24%	0.41%	Atlantic and Gulf Coast states
Real Estate Losses	$34	$80	$173	$360	0.17%	0.23%	0.29%	0.35%	Atlantic and Gulf Coast states
Energy-Sector Costs	$28	$47	$82	$141	0.14%	0.14%	0.14%	0.14%	Southeast and Southwest
Water Costs	$200	$336	$565	$950	1.00%	0.98%	0.95%	0.93%	Western states
SUBTOTAL FOR FOUR IMPACT*	**$271**	**$506**	**$961**	**$1,873**	**1.36%**	**1.47%**	**1.62%**	**1.84%**	

Source: NRDC May 2008

14.3.2 Public Health

Airborne/Respiratory Illnesses

Studies have shown that global warming could potentially worsen levels of air pollution in various regions of the United States, having deleterious effects on human health. The poor quality of air and increasing allergenic pollen production associated with global warming and rising CO2 levels may increase the severity of asthma and other respiratory diseases in afflicted individuals. A report by the NRDC asserts that global warming could spur the formation of more ozone pollution in some regions and intensify health problems associated with allergenic pollen such as ragweed. In addition, the development of stagnant air masses associated with warmer air temperatures could also foster a breeding ground for infectious diseases in previously unaffected areas due to habitat and genetic shift in insect and rodent populations and create new travel hazards associated with storms and unstable weather patterns. Coelho et al. suggest that the health issues associated with global warming could be further exacerbated during periods of interruption in electricity supply, rendering the sick, elderly and less affluent particularly vulnerable to airborne illness. The NRDC cites concerns by other researchers that the rise in asthma cases as a result of climate change poses a serious threat to children's health. Respiratory health issues as a result of climate change will have negative welfare effects for the estimated 36 million Americans afflicted with some type of seasonal allergy. By one estimate, individuals with seasonal ragweed pollen allergies miss over 3.8 million days per year of school or work due to allergy-related complications.

(Certified Allergy and Asthma Consultants 2003) NRDC research shows that 110 million Americans live in areas with both ragweed and ozone problems, which in combination act to worsen respiratory health more than either pollutant on its own. Regions in the west such as the Los Angeles basin are some of the most vulnerable to these projected increases in respiratory health complications.[360] In a particularly severe yet illustrative example, Colorado spent a reported sum of over $120 million in medical and non-medical costs over a five year period combating the West Nile Virus. (Coelho et al. 33)

Mortality Associated with Heat Waves. Historically, increased levels of mortality have been associated with periods of extremely high temperatures in the United States. This includes increases in the number of deaths from heart diseases and diabetes, accidents, violence and suicide associated with heat waves. After Chicago's five day heat wave in 1995, the death toll increased by a shocking 85 percent, suggesting that the increased incidence of heat waves as a result of global warming could pose a serious risk to human health.[361] (Coelho et al. 12).

Table 24: Estimates of Total Heat-related Morality for Average Summer on Three Climate Change Scenarios

	Present total	Estimated deaths on non-acclimatized (and climatized) basis for (*)					
City		A. GISS Trans A		B. GISS 2 × CO_2		C. GISS +2°C	
Atlanta	18	45	(23)	159	(79)	203	(148)
Chicago	173	295	(145)	412	(622)	177	(88)
Cincinnati	42	93	(83)	226	(195)	378	(189)
Dallas	19	61	(61)	309	(244)	158	(79)
Detroit	118	201	(152)	592	(295)	302	(152)
Kansas City	31	33	(40)	60	(100)	330	(212)
Los Angeles	84	153	(81)	1654	(824)	164	(82)
Memphis	20	28	(14)	177	(88)	480	(229)
Minneapolis	46	96	(47)	142	(186)	209	(105)
New York	320	777	(386)	1743	(880)	577	(289)
Philadelphia	145	288	(142)	938	(700)	441	(220)
St Louis	113	325	(162)	744	(372)	749	(275)
San Francisco	27	44	(23)	246	(202)	66	(49)

(*) Full report has five scenarios: 1) Goddard Institute of Space Studies (GISS) Trans A (A in this table), 2) another modified scenario, 3) GISS 2 × CO_2 (B here), and 4) temperature rises of 3.6°F (2°C) (C here) and 5) 7.2°F (4°C). Source: Kalkstein 1993

Source: Coelho et al.

[360] See appendix for NRDC's map, "Ozone and Ragweed Occurrence in the Continental United States"
[361] See appendix for Coelho et al.'s "Estimates of Total Heat-related Morality for Average Summer on Three Climate Change Scenarios"

14.4 WCI Stakeholder Position & Analysis

14.4.1 Introduction: WCI Participation & Stakeholder Criteria

Public interest stakeholders have a clear-cut agenda with respect to the WCI cap and trade program. They want to reduce the costs of the program to society and they want to maximize public benefit from the program. These organizations employ each of the following criteria in their assessments of WCI policy options in the interest of furthering these aims.

Real Reductions

The central goal of WCI is to prevent dangerous global warming, which is clearly in the interest of the public good. Hence maximizing public benefit from a WCI cap and trade program requires measures to ensure both the validity and permanence of emissions reductions. This entails the inclusion of targets and timetables that are aligned with the latest scientific understanding of reductions necessary to avoid severe impacts associate with climate change, and the creation of policies that minimize leakage, i.e. the transfer of emissions to areas outside WCI boundaries.

Soundness of Policy

Unnecessary administrative burdens both increase the costs of implementation and hinder the efficiency of the overall program. Accordingly, public interest stakeholders seek the creation of a cap and trade program with sufficient administrative simplicity and the potential for linkage with pre-existing and currently developing state and federal programs. These concerns come into play especially in stakeholder recommendations for the point of regulation of the electricity sector (most public interest organizations anticipate that a federal cap and trade program will be primarily source-based), standards for reporting, and scope of the program.

Many organizations, such as the NRDC, believe that WCI should employ an integrated package of policies to meet economy-wide targets and timelines. Any regional cap should be accompanied by other clean energy strategies, such as energy efficiency programs, building and appliance efficiency standards, renewable portfolio standards, generation emissions performance standards, vehicle emissions standards, low-carbon fuel standards and land use location efficiency. Many organizations point to California and Washington state legislation (CA SB 1368 and WA SB 6001) as prime examples of how a low-carbon fuels standard and a clean generation performance standard might be implemented. In their comments to the Reporting and Scope Subcommittees, the Union of Concerned Scientists, US PIRG and several environmental advocacy groups suggest that effective enforcement of WCI legislation requires that emissions reductions be verifiable and based on transparent, mandatory reporting by all entities under the cap.

Cost Minimization

A main prerogative of consumer advocacy groups in particular such as the California Public Utilities Commission – Division of Ratepayer Advocates, Citizens' Utility Board of Oregon and Industrial Consumers of Northwest Utilities is to promote policies that minimize costs to customers. Much of this cost is passed on from industry to the consumer through prices, so many of the recommendations necessarily include concessions to industry as well as schemes to ensure that any revenue from the sale or auction of allowances go directly to

the public benefit. Some examples are the inclusion of "off sets", "safety valves" and allowances from outside of the WCI partner jurisdictions in order to reduce the cost of compliance and increase compliance flexibility. Other organizations such as the Union of Concerned Scientists, US PIRG and Western Resource Advocates are in opposition to the inclusion of safety valves and favor quantitative limits on offsets, stating that while WCI policies should allow for some compliance flexibility to minimize costs to businesses and economic dislocations, compliance with a firm cap on emissions will be compromised if firms are allowed to use such devices, which break the cap.

Equity

The prospect of WCI regulation raises concerns about the economic competitiveness of individual sectors, income transfers between firms and consumers, and structural changes in the economy. In recognition of the heterogeneity in the physical characteristics and economic and political systems of California and the Northwest and Southwest regions under WCI jurisdiction, the issue of equity across sectors and regions appears as a principle concern in the comments of WCI stakeholders and is extremely influential in their policy recommendations with respect to allocation methodology and the use of auction revenues.

The regulation of polluting firms will impose economic costs on the public in the form of job losses and higher prices. Many organizations recommend focusing on workers, low-income consumers and poor communities in particular in efforts to mitigate the economic impacts of the cap and trade program. In addition, as firms can and will pass on the costs of compliance with a cap and trade program to consumers in the form of rates, most of the proposals to WCI aim to protect consumers through allocation methodology and compensation schemes. Using permits to emit carbon for the public benefit both ensures the avoidance of windfall profits for unregulated firms and mitigates the economic costs imposed on the public. Covering as many big emitters under the cap as feasible is paramount to ensuring equal treatment of relevant industries and avoiding economic distortions arising from market manipulation.

4. Technological Innovation

In order to maximize public benefit from a WCI cap and trade program, it is necessary to take measures to ensure the permanence of emissions reductions by laying the foundations for a sustainable energy future. Public interest organizations view WCI legislation as an indispensable opportunity to create long-term climate change solutions by initiating industry transformation. Investment in energy efficiency technologies such as more efficient vehicles, appliances, homes and factories will create new industries and job opportunities in the domestic market. Organizations such as the Center for Resource Solutions (CRS), Renewable Northwest Project (RNP) and Pembina Institute advocate investment in renewable and efficient energy technologies as their main platform. These groups hold the view that promoting technological innovation in the electricity sector is the least-cost way to achieve GHG reductions and recommend a business-oriented approach to the cap and trade system that economically incentivizes firms to undertake structural changes in their industry with special attention to equity among vested business interests. Transforming the electricity sector into a cleaner industry also requires ensuring that any WCI program will preserve the voluntary market for renewable energy. CRS maintains that the benefits from this will be two-fold: it will encourage voluntary action to reduce GHG

emissions beyond what is required by the mandatory cap, and it will "prevent renewable energy and its environmental benefits from being double counted."[362] CRS pinpoints three types of voluntary renewable activities that should be supported in the cap and trade system: renewable electricity purchases, REC-only purchases, and customer-sited renewable distributed generation.

Protection of Natural Resources

While many welfare analyses take into account conceptions of environmental justice, the protection of natural resources has quantifiable economic benefits to society as well. Not only do resilient ecosystems provide a host of indispensable public goods and services to society, but "[h]ealthy natural resources are vital as the first line of defense to protect our communities from droughts, storms and other severe climate events"[363] that could potentially interrupt economic growth and societal development. The regional economies of the American West and Northwest are particularly vulnerable to disruptions in critical landscapes, water supply and species, as many of their most important industries such as agriculture and tourism are extremely dependent on these resources.

14.5 Recommendations to WCI

14.5.1 Allowances

Method of Allocation

The vast majority of organizations that submitted comments to the WCI Allocations Subcommittee are in consensus that, given the principal goal of maximizing public benefit from the cap and trade program, auctioning allowances is the preferred method of allocation. The Sierra Club, Union of Concerned Scientists (UCS) and Western Climate Advocates Network (WeCAN) all explicitly favor a 100 percent auction of allowances. Consumer advocacy groups such as the CPUC's Division of Ratepayer Advocates (DRA) and environmental action groups such as those that comprise WeCAN advocate strongly against the distribution of free allowances, i.e. "grandfathering" for a number of reasons. The DRA maintains that using historical emissions to determine allocations penalizes participants who have taken early action to cut down on emissions while WeCAN underscores "the potential for favoritism and market distortion in the distribution of free allowances."[364] UCS and the Sierra Club both elaborate on this point in their comments to the WCI, stating that auctioning allowances will encourage early price discovery, carbon price stability, greater liquidity, and greater confidence in investments to reduce GHG emissions, all of which are crucial to developing a smoothly operating allowance market. The UCS also stresses the importance of auctioning as a tool to promoting cost equity both to new market entrants and consumers. On the latter point, the UCS claims that most firms will be able to pass on the much of the cost of compliance to consumers, regardless of whether allowances are distributed for free or through auction. This "pass through" is the source of windfall profits, which the UCS defines,

[362] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F14410.pdf, pg. 6
[363] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F15318.pdf, pg. 2
[364] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F15318.pdf, pg. 1

broadly, as income transfers high-income to low-income groups (i.e. from large firms to poor households).

Other public interest organizations are apprehensive about adopting a full-fledged auction methodology. In contrast to the view of UCS, the Center for Resource Solutions (CRS) asserts that auctioning off allowances may not necessarily be the most effective way to minimize windfall profits, perhaps because its consideration of cost equity in its comments to the WCI appears to pertain to similarly situated business interests rather than consumer protection. According to CRS, if the WCI were to adopt a source-based cap and trade system, allocating allowances by auction would be the most effective way to reduce windfall benefits. If the WCI were to alternatively adopt a load-based cap and trade system, CRS is in favor of distributing allowances for free proportional to the load being served. If the WCI elected, however, to distribute allowances free proportional to the emissions of each entity under the load-based system, CRS finds it preferable to auction allowances in this case, as the former method would run the risk of penalizing those LSEs that have taken more aggressive action to reduce emissions while rewarding those that have not. One consumer advocacy group, the Industrial Consumers of Northwest Utilities (ICNU), suggests that allowances be allocated for free at least initially or that auctions be utilized in only a limited capacity, citing the possibility that "ratepayers would bear the cost to reduce emissions plus the auction cost to continue 'permitted' emissions."[365]

The comments of CRS underscore how creating a distributive design that ensures cost equity requires considerations beyond the preliminary question of auction versus free allocation. The DRA maintains that "there is a very real risk that inconsistent distribution methods across the states will create an unfair competitive situation among covered entities."[366] Accordingly, the DRA suggests a centralized allowance distribution methodology with limited discretion to states on how to allocate their apportioned allowances. The ICNU, which represents large end-use consumers of electricity in Oregon and Washington, suggests that the WCI design be tested against a quantitative economic impact model in order to avoid disproportionate environmental and economic impacts, and that apportionment of allowances among the partners, the sectors covered within each region, and the method for calculating the total number of tradable allowances should be uniform across all WCI jurisdictions. And in an expression of concern for the competitiveness of its own economy in particular, ICNU also proposes that the allocations of total regional allowances should recognize the Northwest's use of emissions-free hydroelectric power.[367]

Use of Auction Revenues

For public interest advocates, the generation of auction revenues is the key distinguishing factor that makes an auctioning distribution methodology more suitable to advancing the public interest than free distribution. Since the atmosphere is a public good and much of the cost associated with a pollution cap will likely be passed on to consumers, it is of paramount importance that "allowances…be seen as a public asset"[368] and auction

[365] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F15378.pdf, pg. 4
[366] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F15173.pdf, pg. 2

[367] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F14448.pdf

[368] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F15318.pdf, pg. 1

revenues go towards programs and activities that constitute the public benefit rather than back into the pockets of regulated firms. According to WeCAN, this means that the purposes funded by auction revenues should be limited to: benefiting energy consumers, advancing efficiency and renewable energy technologies as well as other GHG reduction strategies, helped affected workers and communities cope with structural changes in the economy, and protecting natural resources. The Nature Conservancy suggests that 20 percent of auction revenues be devoted exclusively to adaptation programs for ecosystems and human communities threatened by climate change,[369] while CRS recommends that revenues from auctioned allowances be invested solely in energy efficiency projects.

Regulation of Electricity

The recommendations of public interest organizations with regard to the regulation of electricity are grounded in a wholesale analysis of how the different approaches put forth by the WCI Electricity Subcommittee, that is, load-based, generator-based and hybrid approaches, satisfy the stakeholder criteria outlined in the previous section, with a particular emphasis on issues of implementation and regional equity as well as consideration of the unique market structure of the electricity sector. As is to be expected, organizations with a narrower public interest agenda i.e. consumer advocacy and energy efficiency groups, weigh criteria relevant to their respective platforms more heavily.

Members of WeCAN advocate WCI adoption of either the load-based or hybrid approaches in the regulation of electricity. Consideration of either option involves a tradeoff between soundness of policy on the one hand, and cost minimization and technological innovation on the other. The hybrid approaches would facilitate linkage with a federal program that is primarily source-based as well as the creation of a robust system of reporting by allowing for more precise emissions accounting for regulated entities. The load-based approach would minimize costs to consumers and promote investments in long-term emission reduction strategies such as energy efficiency and renewable energy. Prioritization of these criteria should be left up to WCI state jurisdiction, meaning that the point of regulation should not necessarily be uniform across states participating in WCI. WeCAN believes that a generator-based approach shares the advantages of the hybrid approaches but fails to address the issue of leakage. Accordingly, WeCAN maintains that implementation of a generator-based approach must necessarily be accompanied by an emissions performance standard for new financial commitments to generation in every state.

The Sierra Club supports the initial positions of WeCAN in its comments to the Electricity Subcommittee and goes one step further to make a specific recommendation for the point of regulation of the electricity sector. In recognition of the unique characteristics of the electricity sector, the Sierra Club recommends that the electricity sector adopt a separate approach from other industries, specifically, a load-based approach. Since LSEs essentially have a natural monopoly over transmission and distribution and they are in a unique position to assess the costs the GHG from both the perspective of long-term supply and long-term demand, rendering them the ideal candidates for WCI regulation. A particular concern expressed by the Sierra Club in its consideration of alternatives for electricity sector design is equity across existing classes of ratepayers and regions. Accordingly, the Sierra Club, like

[369] http://www.westernclimateinitiative.org/ewebeditpro/items/O104F14441.pdf

WeCAN, underscores the importance of allowing for state by state flexibility in questions of program design in order to protect specific areas from rate shocks, while focusing in particular on design elements that provide real reductions in the cleanest, cheapest and fastest way in order to mitigate such concerns about equity.

The Western Resource Advocates (WRA), like the Sierra Club, recommends an approach to regulating the electricity industry separate from other economic sectors. Generally, WRA is in favor of a load-based approach. However, in consideration of the various implementation and enforcement issues raised by a load-based approach to the regulation of electricity, the WRA has crafted its own alternative load-based CO2 cap and trade system for the West, called the CO2RC method, which assigns credits i.e. CO2RCs for *not polluting* (rather than allowances to pollute) to regulated entities. WRA maintains that the CO2RC method will help mitigate administrative challenges in a number of ways: it does not require tracking emissions back to their sources; it avoids almost all leakage by assigning CO2RCs to every generator located in the WECC; it does not require WCI to design an auction for allowances; it leaves electricity markets unaffected; it does not require a "transmission" path to deliver emission attributes. Furthermore, CO2RCs can be traded back and forth with allowances from source-based systems and sectors, allowing for linkage with source-based systems, while the sale of CO2RCs prevents wealth transfers, particularly if they are awarded from older generators to LSEs.

Consumer advocacy groups, while seemingly convinced of the administrative benefits associated with the CO2RC method, still harbor some skepticism about the ability of such a program to ensure equity across regions, which in this context appears to be their primary concern. While the Division of Ratepayer Advocates (DRA) strongly encourages the consideration of the CO2 Reduction Credits approach for the point of regulation, it cites the potential transfer of wealth from WCI participating to non-WCI participating states as a significant drawback of the method. In light of these concerns about economic competitiveness, it suggests that any WCI design be tested against a quantitative economic impact model in order to avoid disproportionate environmental and economic impacts.

Likewise, organizations that have adopted technological innovation as their main climate change platform advocate a program design that will facilitate the attainment of long-term energy efficiency goals. The Center for Resource Solutions (CRS) supports the point of regulation at the retail provider level, that is, a load-based cap and trade model. This would be the most direct way to promote private sector investments in clean generation and efficient energy technologies, since such investments depend on the initiative of retail providers, who are responsible for choosing an investment strategy to meet current and future demand for energy. One of the major justifications that CRS puts forth for its support of a load-based model is that such a model is compatible with existing state programs for renewable and energy efficiency programs, increasing the likelihood that they will be successful. Thus a consideration of administrative feasibility also comes into play here.

Inclusion of Offsets

In general, public interest organizations support the inclusion of offsets provided that they meet a rigorous set of criteria to ensure the attainment of additional environmental benefits from offset provisions, the integrity of the WCI regional cap, and equity among affected regions and entities. The consensus is that offsets will encourage growth in the

voluntary market, hence enabling regulated firms to go above and beyond their regulatory compliance obligations. Provided that offsets are real, additional, verifiable, permanent, enforceable, and fully fungible with other emissions reductions, they could serve as an instrumental cost-containment and compliance mechanism for regulated entities while providing additional environmental benefits.

WeCAN asserts that whenever possible, mandatory GHG reductions should be achieved through market-based and cap and trade regulations, but supports the inclusion of offsets from sectors not under the cap as a compliance mechanism provided that they satisfy the following criteria: they are real, quantifiable, verified, additional, permanent, enforceable and subject to third-party verification; they play a limited role in compliance i.e. they provide short-term cost management flexibility beneath a strong, vigorously enforced cap; they are subject to performance, category and valuation standards specific to offset categories; they are subject to discounting when appropriate; they are sourced uniquely from sectors not subject to WCI regulation. WeCAN and the Union of Concerned Scientists (UCS) support quantitative limits on offset provisions in the interest of preserving the option of linkage. UCS maintains that an additional advantage of quantitative limits is that they could serve as an imperfect substitute for geographic limits on offsets. Climate Solutions agrees with the recommendations of WeCAN, with the addendum that project types should be limited to those that hold the most environmental integrity in order to mitigate concerns regarding additionality, permanence and verification.

Environmental organizations underscore the potential environmental co-benefits that could be reaped from the inclusion of a robust forest carbon offsets system, and as a result are more reluctant to place quantitative limits on offsets projects; presumably for fear that such environmental co-benefits will not realize their full potential. The Pacific Forest Trust (PFT) maintains that such co-benefits include clean water, fish and wildlife habitat, biodiversity, beautiful landscapes for recreation, and improved forest resilience to wildfire, disease and pests. Defenders of Wildlife maintains that carbon offset projects should meet the following criteria: biodiversity co-benefits, additionality, landscape scale (to determine whether offset projects provide meaningful ecological benefits), permanence, the avoidance of leakage and rewards for early actors to avoid the creation of perverse incentives for forest landowners. The Nature Conservancy strongly favors the inclusion of offset provisions in the WCI cap and trade program. Not only would the inclusion of offset provisions offer real emissions reductions and encourage further reduction of GHG emissions and sequestration in land use activities, it would increase the flexibility and lower the cost of emission reduction programs. With respect to the scope and quantitative limits on the use of offsets, the Nature Conservancy recommends that the WCI allow offsets from all Partner jurisdictions and from areas outside the WCI as well as their unlimited use, provided that the offsets meet rigorous WCI standards of quality and are paired with a strong cap on regulated sectors. The Nature Conservancy supports the following eligible offset project types within the WCI: biological sequestration from forest and agricultural activities, improved forest management, avoided deforestation and conservation tillage, emissions reductions from forest and grassland conservation, reduction in landfill gas methane, reduction in coal mine methane, and reduction in methane from biodigestors.

Standards for Reporting and Program Enforcement

The organizations that submitted comments to the WCI Reporting Subcommittee are primarily concerned with creating a system of reporting that serves its purpose, that is, to allow each jurisdiction to create an inventory of its GHG emissions and to track those emissions over time, while ensuring the achievement of real emissions reductions and facilitating linkage with other complementary policies. Accordingly, WCI reporting would ideally cover as many emitting sectors as possible and commence as soon as is feasible.

WeCAN asserts that no sectors should be excluded a priori from reporting, and that the reporting threshold should be set no higher than 1000 metric tons of CO2 equivalent per year for stationary sources. Of particular importance is that liquid transportation fuels are subject to mandatory reporting as they are the single largest source of WCI emissions. Emissions reporting for any fuel entering the economy under WCI jurisdiction should account for significant upstream GHG emissions embedded in that fuel, while emissions from natural gas production and processing should be reported within the upstream component of imported fuels, regardless of whether or not they enter the WCI economy. Each sector should be subject to reporting as soon as practicable, and initiation of mandatory reporting should ideally occur before the first compliance period, in order to facilitate comprehensive and accurate inventories, allow for the demonstration of potential compliance obligations, and minimize complications of accounting for early actions. With regard to coordination among partner jurisdictions on reporting, WeCAN supports the creation of a WCI reporting rule that specifies a core set of reporting specifications in order to ensure uniformity across jurisdictions, while leaving it up to individual provinces and states to develop supplemental reporting specifications. To facilitate policy linkage with federal and international programs, WeCAN asserts that the WCI should work in close collaboration with the US Environmental Protection Agency, the TCR and the Canadian Environment Minister in crafting the WCI core and additional reporting requirements.

While the organizations that submitted comments hesitate to recommend with certainty that WCI require all capped sources report directly to The Climate Registry (TCR), they acknowledge the advantages of TCR, most notably its commitment to transparency. Regardless of whether WCI elects to adopt TCR as its reporting agency, WeCAN and the Nature Conservancy emphasize the importance of WCI commitment to a centralized registry, credit tracking and trading platform that adheres to the same principles as TCR, in order to facilitate standard measurement and verifiability of all data throughout WCI jurisdictions. Climate Solutions suggests that WCI include a provision in the *Draft Reporting Protocols* that requires reporting from upstream sources in order to make TCR more applicable to the cap and trade program as mandatory emissions reporting by downstream businesses under an upstream point of regulation does little to facilitate program enforcement.

Other organizations make no explicit comments with regard to TCR but still underscore the importance of transparency as a main criterion in determining a reporting design. The Pembina Institute maintains that a major pro of mandatory reporting for sectors and sources outside the cap is that it enables citizens to hold polluters accountable by giving them access to the necessary information. Hence, the information made publicly available should be comprehensive in scope. The NRDC asserts that a provision of the WCI should be to make emissions, allowances, prices and evaluations of compatibility with air quality and toxic reduction efforts all publicly available by source and sector.

14.5.2 Scope and Timing of the Program

Scope

The majority of public interest organizations, including WeCAN, the Pacific Forest Trust and the Sierra Club, are in favor of a cap that covers all sectors deemed feasible for coverage in the short-term by the Scope Committee. This would create a more secure market while furthering stakeholder goals with respect to technological innovation and equity. Including the broadest number of economic sectors possible under the WCI cap will help ensure that regions under WCI jurisdiction meet the economy-wide target. The organizations that submitted comments emphasize in particular the importance of including the electric sector, transportation fuels, residential and commercial natural gas production and consumption, and oil and gas. WeCAN asserts that transportation emissions should be a top WCI priority as they amount to a much greater than emissions from any other sector. The Union of Concerned Scientists believes that including transportation fuels will both minimize economic distortions and provide environmental benefits in the long-run. Setting a quantitative cap for this particularly salient sector is crucial to achieving comprehensive coverage of all major emitters and would in turn promote smart growth in the long-run. Sending the appropriate price signals to all relevant sectors in the economy will encourage efficient investment decisions while minimizing the potential for system inequities. Indeed, consumer advocacy groups stress in particular that the cap and trade system should apply to all major emitting sectors to ensure that all polluting industries (including more disparate emissions sources such as agriculture) are held accountable and that no one sector (such as electricity) bears a disproportionate burden of the overall goal. The National Wildlife Federation and a number of other environmental advocacy groups echo this concern about regional equity, asserting that failing to include oil and gas operations under the regional cap would place a disproportionate share of the burden of meeting the cap on a few industries, severely hampering the ability of WCI participants to reach its emissions reduction target.

Timing

In recognition of the difficulties associated with obtaining accurate emissions estimates for particular industries, many organizations are in favor of a two-phase approach to initiation of the cap. WeCAN and UCS both argue that transportation fuels should be covered under the initial cap as it is the greatest source of regional emissions, and that the phasing-in of industries should only occur in the face of significant administrative challenges. The organizations that submitted comments suggest that fossil fuel production, agriculture emissions and forestry emissions be considered for long-term inclusion.

14.6 Conclusion: Stakeholder Analysis

14.6.1 The Public Interest

It is important to first of all note potential areas of divergence within the public interest stakeholder category. The volume of concessions that should be allotted to industry is one point of disagreement, particularly among consumer advocacy groups, who are primarily concerned with the economic competitiveness of their own regions, and organizations advocating more broadly for the public interest. Inherent in the decision of how much

compliance flexibility should be included in the program design is a tradeoff between short-term cost minimization and the enforcement of a rigorous cap, which will ensure real, permanent emissions reductions in the long term.

The tension between public and regional interests is likewise manifest in the policy recommendations to WCI regarding equity. For consumer advocacy groups, considerations of equity differ depending on the region being represented. For example, the DRA maintains that apportionment of allowances among the partners, the sectors covered within each region, and the method for calculating the total number of tradable allowances should be uniform across all WCI jurisdictions, while the ICNU suggests that the method of allocation should reward early actors. Environmental and general public interest groups seem more concerned with creating a robust cap and trade program that will be successful in implementation, asserting that policies need not be uniform across regions, so long as the option of linkage with other programs is preserved. Organizations such as WeCAN advocate for the creation of a core set of reporting regulations that are uniform across the WCI economy, leaving it up to individual regions to determine supplementary regulations and other elements of program design, such as the point of regulation for electricity.

14.6.2 Industry Engagement

Public interest stakeholders are well-aligned with industry in their interest in a market-oriented approach to implementing a cap and trade program. It is in the interest of both groups to mitigate the costs of compliance and ensure equitable treatment of covered sectors. Providing economic incentives for firms to comply with a regional cap minimizes market distortions, reduces the costs of the program for consumers and producers alike, and promotes investment in long-term energy solutions. Public interest advocacy for a market-oriented, economically-sound approach to reducing emissions acknowledges the economic incentives of firms and harnesses these motives to further a collective climate action agenda.

The use of auction revenues and the inclusion of cost-containment compliance mechanisms are certainly points of contention between the two groups. While not all of the various organizations representing the public interest believe that auction revenues should be allocated exclusively to the public, the vast majority agree that these funds should be used to further the public benefit. Few are in favor of distributing the economic benefits from allowances directly to firms to help mitigate the costs of compliance, but rather suggest that funds given to firms be earmarked for specific clean-energy projects. Furthermore, the majority of public interest organizations favor quantitative limits on offsets and other compliance mechanisms such as safety valves, citing concern that the use of such devices would compromise compliance with a rigorous, economy-wide cap.

3. Government Engagement

Developing policies that will be effective in implementation is a paramount concern for public interest stakeholders, and accordingly they advocate strongly for policies with administrative simplicity and bilateral and nation-wide linkage with other climate action programs. In recognition of Congressional legislation on December 18, 2007 requiring mandatory reporting of GHG emissions and Canadian legislation on December 8, 2007 requiring Canada's major industrial sectors to report their 2006 GHG emissions, members of WeCAN urge WCI to work in close collaboration with US EPA and the Canadian government

in crafting WCI reporting standards and core regulations. Taking advantage of this parallel development scenario will reduce the costs of implementation and ensure the efficiency of emissions reductions programs at the international, federal and state levels in the long run. In addition, public interest recommendations regarding the point of regulation for electricity take into account how federal legislation regarding the regulation of electricity is likely to proceed. In the long term, coordination with the federal government will prove critical to the development of a comprehensive package of climate change policies that employ a diverse set of clean energy strategies.

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