Energy Efficiency, Climate Action, and Sustainable Growth in California

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"It is not the strongest of the species that survives,
nor even the most intelligent,
but the one most responsive to change."
– Charles Darwin

Support from Next 10 is gratefully acknowledged (www.next10.org)

Contents

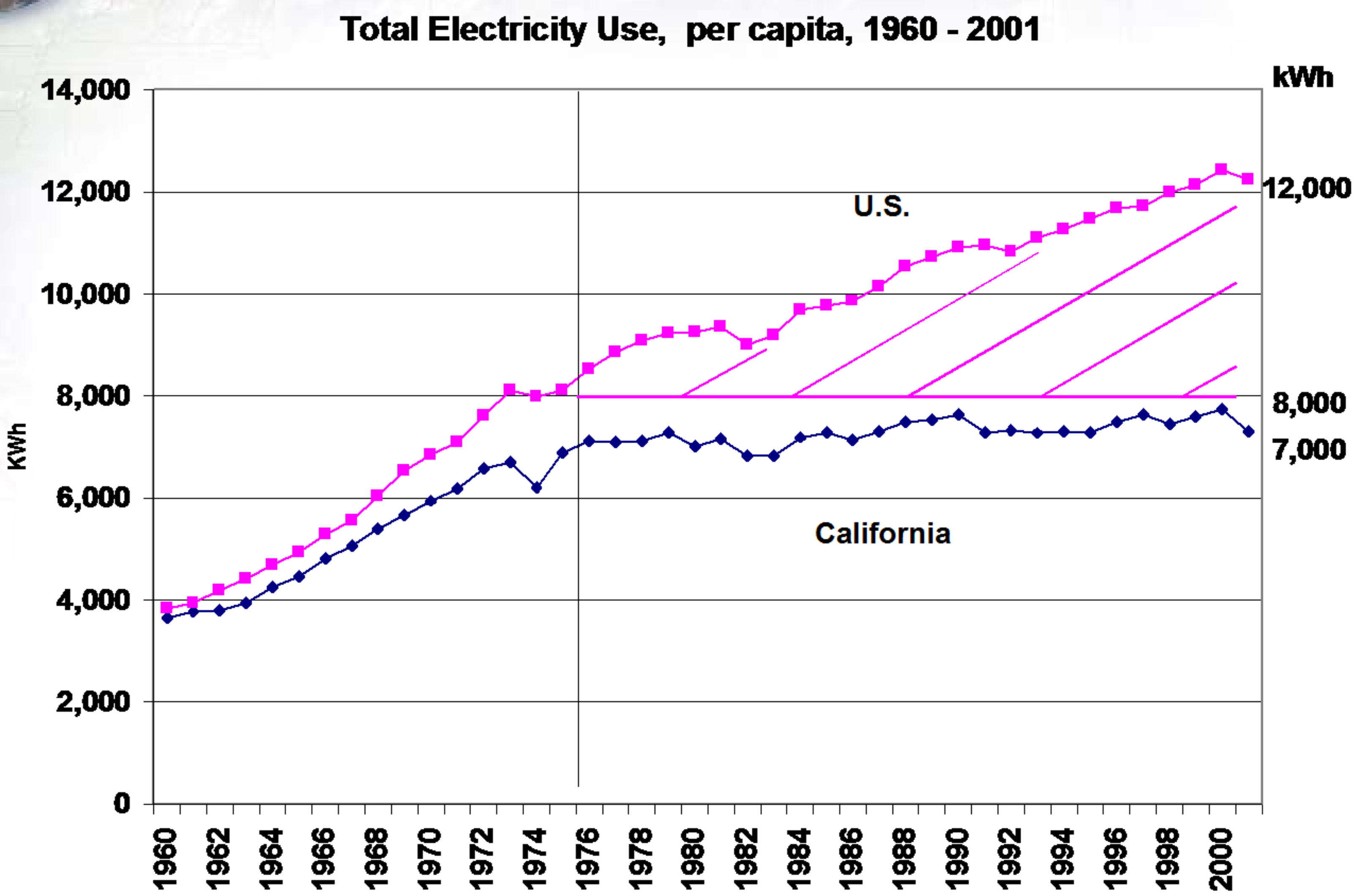
1. Historical Energy Efficiency and Jobs
2. From Mitigation to Adaptation
3. Smart Stimulus and the SuperGrid

Overview

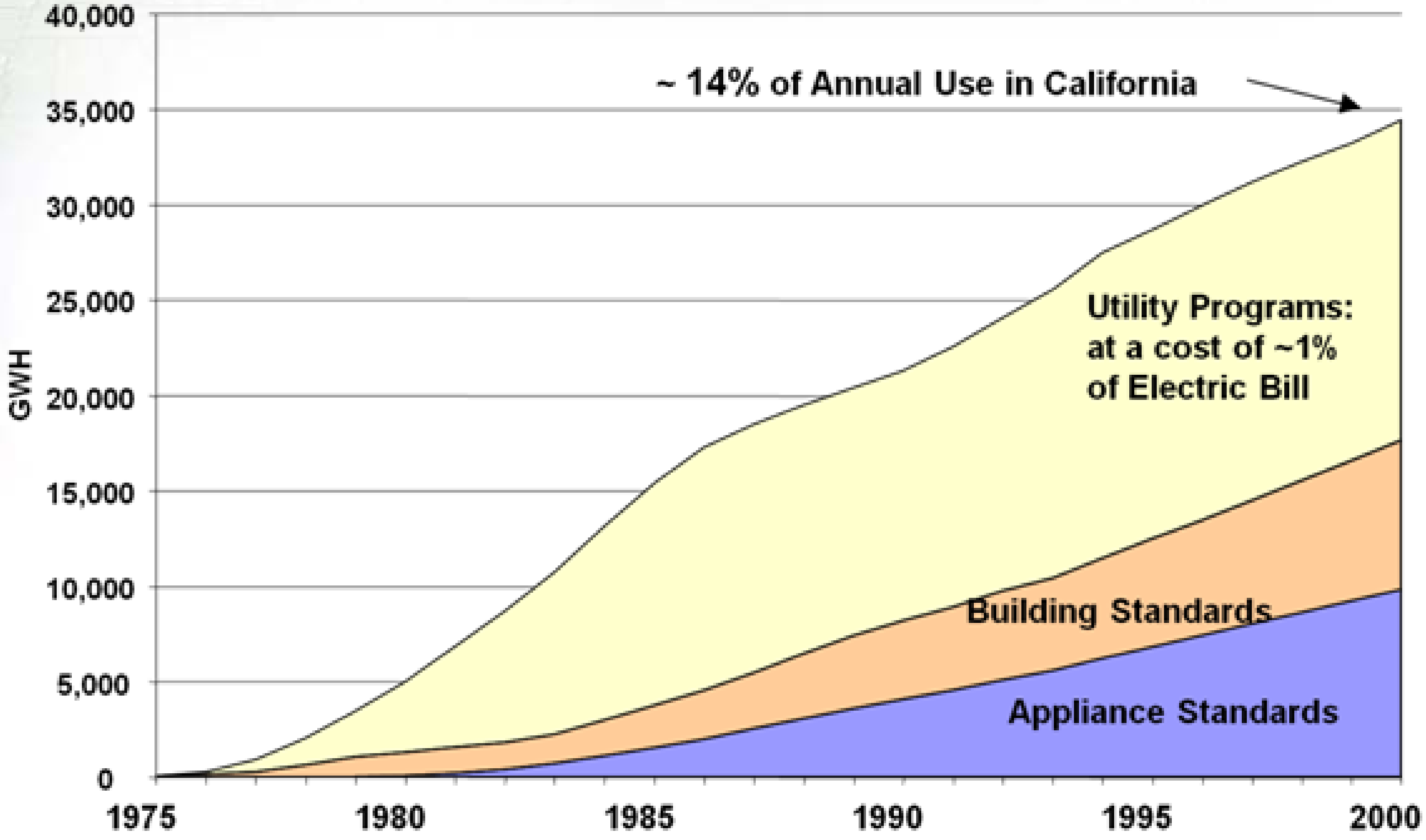
This talk summarizes results from three studies (available @ www.next10.org):

1. Energy Efficiency and Job Creation in California (September)
2. California Climate Risk and Response (November)
3. Energy Pathways for California (March)

Energy Efficiency and Jobs: California's Legacy



Energy Efficiency Gain Impacts from Programs Begun Prior to 2001



Historical Jobs Assessment

- A retrospective multiplier analysis of demand shifting
- Detailed BEA five-year Input-output Tables
- Employment data from California Employment Development Department dataset (CREE)

Job Creation from Household Energy Efficiency

	1972	1977	1982	1987	1992	1997	2002	2007	Total
Agriculture	-	36	112	204	266	631	849	869	2,967
EnergyRes	-	0	-1	-1	0	-1	-1	-1	-5
ElectPwr	-	-266	-1,140	-2,236	-3,405	-4,720	-5,809	-5,944	-23,520
OthUtl	-	-12	-78	-2	13	71	77	79	149
Constructio	-	-	-	-	-	-	-	-	-
Light Indus	-	821	2,688	4,593	6,095	8,392	9,247	9,463	41,300
OilRef	-	-14	-6	-9	-10	-14	-24	-25	-102
Chemica	-	48	190	448	764	555	2,234	2,287	6,526
Cement	-	0	0	0	0	0	0	0	0
Metals	-	2	1	4	-5	-16	-16	-16	-46
Machinery	-	14	26	54	44	-38	-51	-52	-2
Semicon	-	0	0	3	8	176	318	325	830
Vehicles	-	20	38	133	133	240	427	437	1,428
OthInd	-	37	125	265	397	1,136	1,770	1,811	5,541
WhlRetTr	-	4,740	15,254	32,236	46,139	83,118	136,402	139,587	457,475
VehSales	-	-	-	-	-	215	0	0	215
Transport	-	9	31	-211	76	202	305	312	724
FinInsREst	-	1,191	5,340	15,075	30,808	21,500	34,201	35,000	143,114
OthServ		3,137	14,816	48,336	101,656	163,263	245,043	250,765	827,016
	-	9,763	37,396	98,892	182,977	274,710	424,974	434,898	1,463,161

Employee Compensation (millions of 2000 US dollars)

	1972	1977	1982	1987	1992	1997	2002	2007	Total
Agricultur	-	0	2	3	4	9	16	17	52
EnergyRes	-	0	0	0	0	0	0	0	0
ElectPwr	-	-10	-50	-111	-190	-303	-441	-546	-1,652
OthUtl	-	-1	-4	0	0	4	5	6	10
Constructi	-	-	-	-	-	-	-	-	-
LightIndus	-	20	70	117	162	214	284	323	1,190
OilRef	-	-1	0	0	-1	-1	-2	-3	-8
Chemica	-	2	7	16	27	23	87	97	258
Cement	-	0	0	0	0	0	0	0	0
Metals	-	0	0	0	0	-1	-1	-1	-2
Machinery	-	0	1	2	2	-1	-2	-2	-2
Semicon	-	0	0	0	0	11	25	32	69
Vehicles	-	1	2	7	7	11	22	22	72
OthInd	-	1	3	7	12	36	67	82	208
WhlRetTr	-	105	336	707	1,026	1,859	3,530	3,647	11,211
VehSales	-	-	-	-	-	7	0	0	7
Transport	-	0	1	-8	3	8	14	13	32
FinInsREs	-	31	158	512	1,207	971	2,036	2,415	7,329
OthServ	-	78	316	1168	2690	4,516	7,966	9,101	25,836
	-	227	840	2,420	4,950	7,363	13,605	15,205	44,611

Efficiency for Growth

- Promoting efficiency saves money for individuals and enterprises, liberating resources for more job-intensive growth
- We need to extend standards and incentives nationally, using public policy to overcome adoption barriers and innovation constraints
- Energy efficiency is the next breakout technology sector, and domestic standards to promote innovation will establish global market advantages

Adaptation: The New Climate Defense Agenda

- No country or state can stop Climate Change alone, but we have a responsibility to protect ourselves
- Over the next century, we face enormous adaptation challenges, regardless of our own mitigation policies

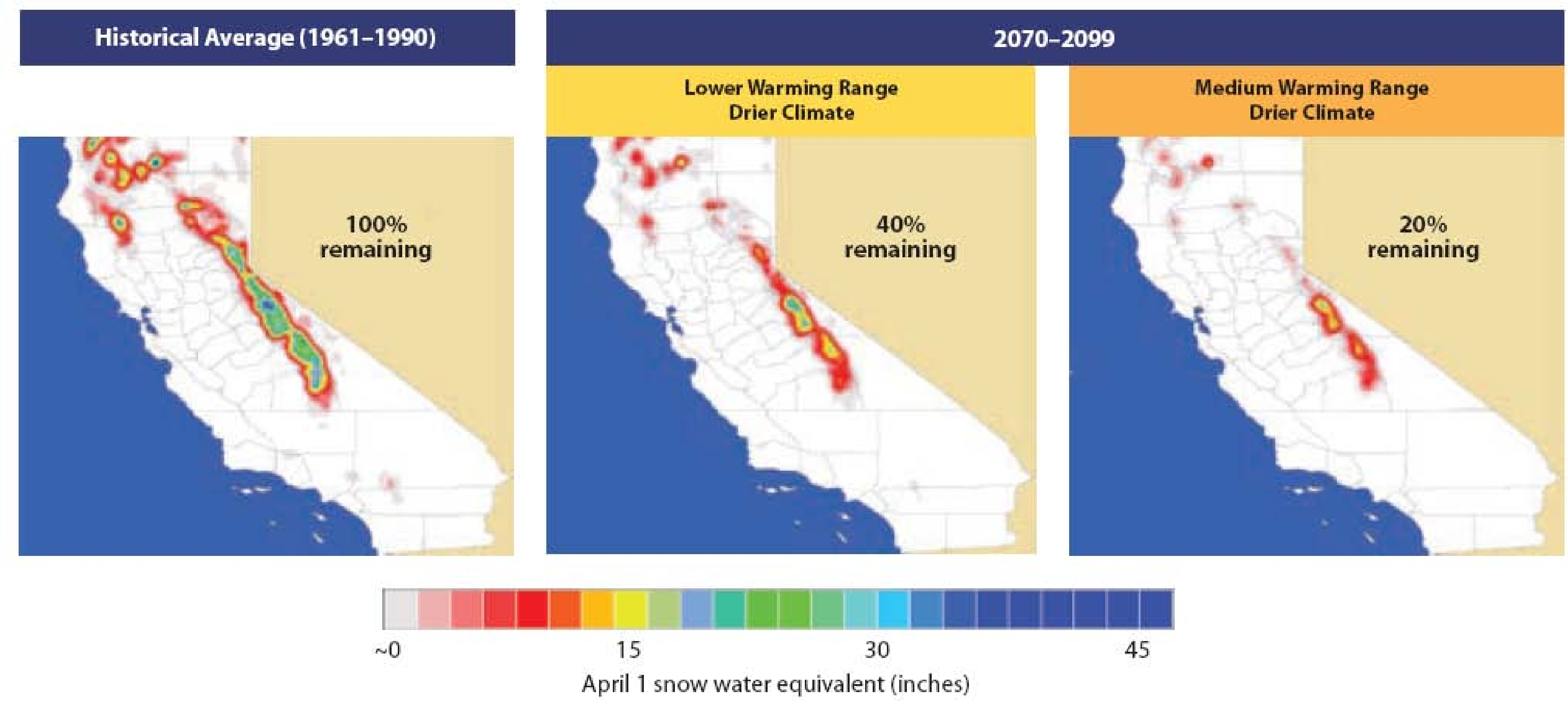
Economic Damage and Asset Risk Estimates for California

2006 USD Billions	Damage Cost/Year		Assets	
Sector	Low	High	at Risk	
1 Water	NA	0.6	5	
2 Energy	2.7	6.3	21	
3 Tourism and Recreation	0.2	7.5	98	
4 Real Estate	0.2	1.4	900	Water
	0.1	2.5	1,600	Fire
5 Agriculture, Forestry, Fisheries	0.3	4.3	113	
6 Transportation	NA	NA	500	
7 Public Health	3.8	24	NA	
Total	7.3	46.6		

Source: Roland-Holst and Kahrl, "California Climate Risk and Response"

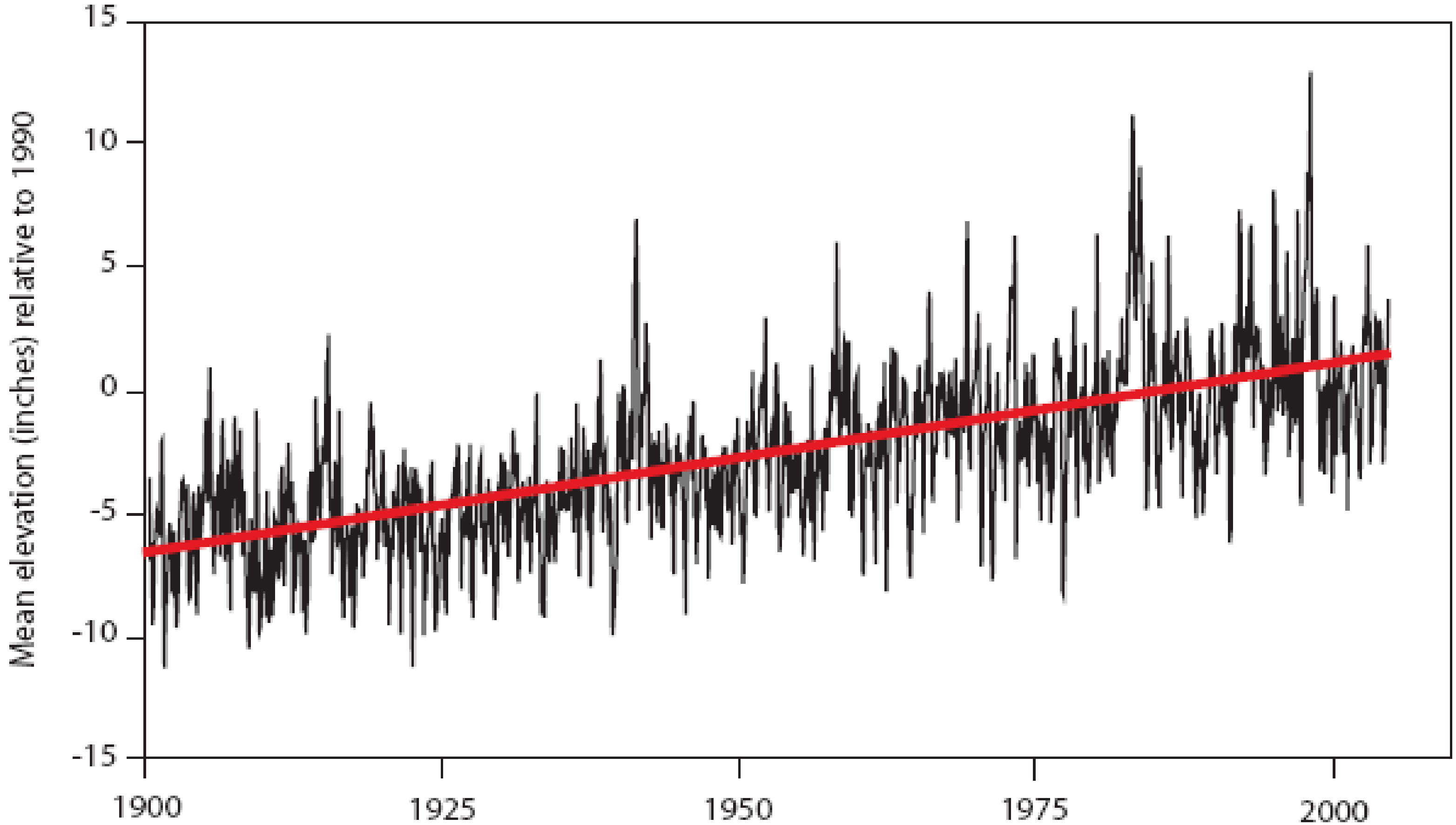
www.next10.org

Reduction in the Sierra Snowpack by 2070-2099



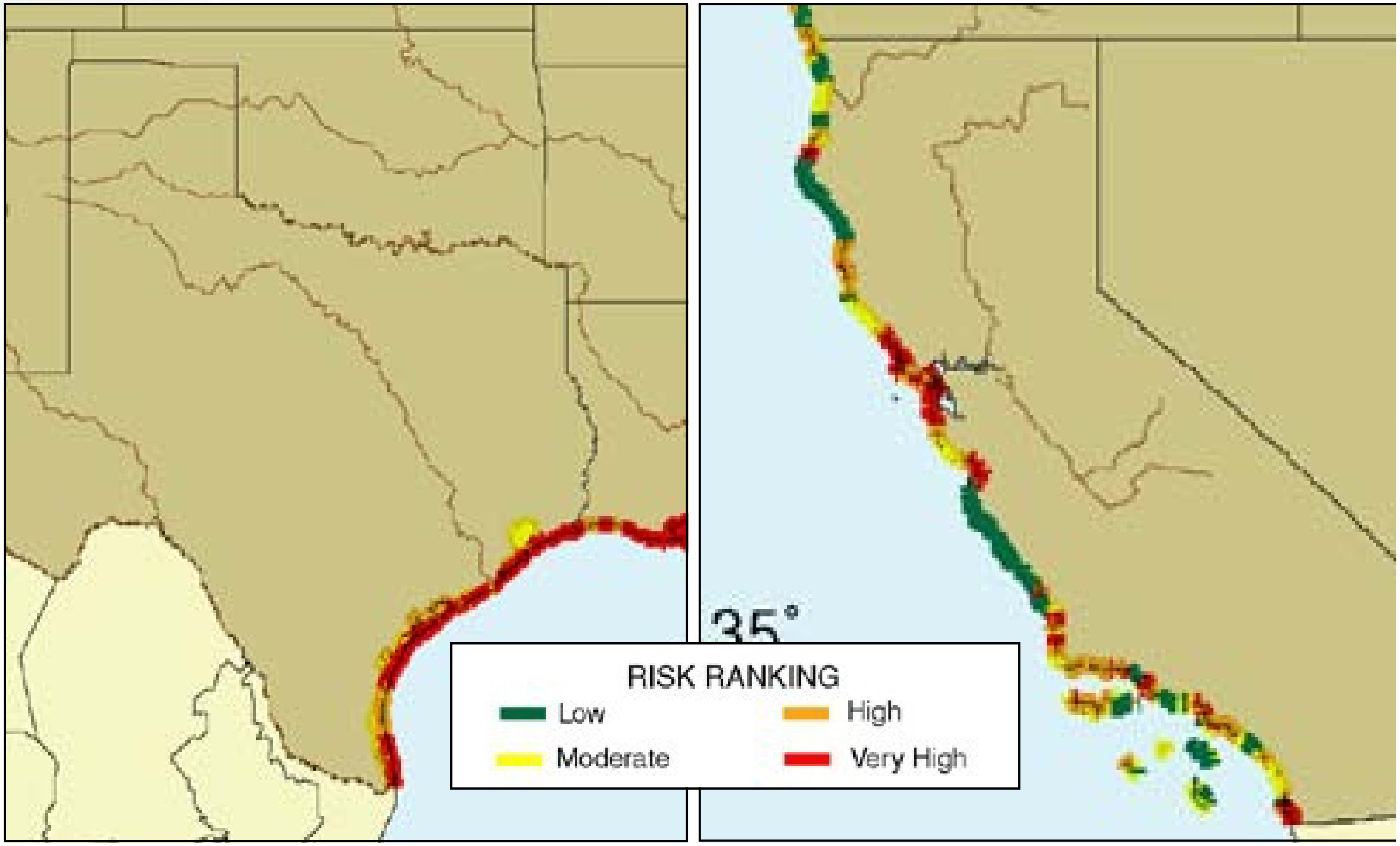
Notes and Source: "Lower Warming Range Drier Climate" is based on an GFDL B1 scenario; "Medium Warming Range Drier Climate" is based on a GFDL A2 scenario. Luers et al., 2006.

San Francisco Bay Sea Level



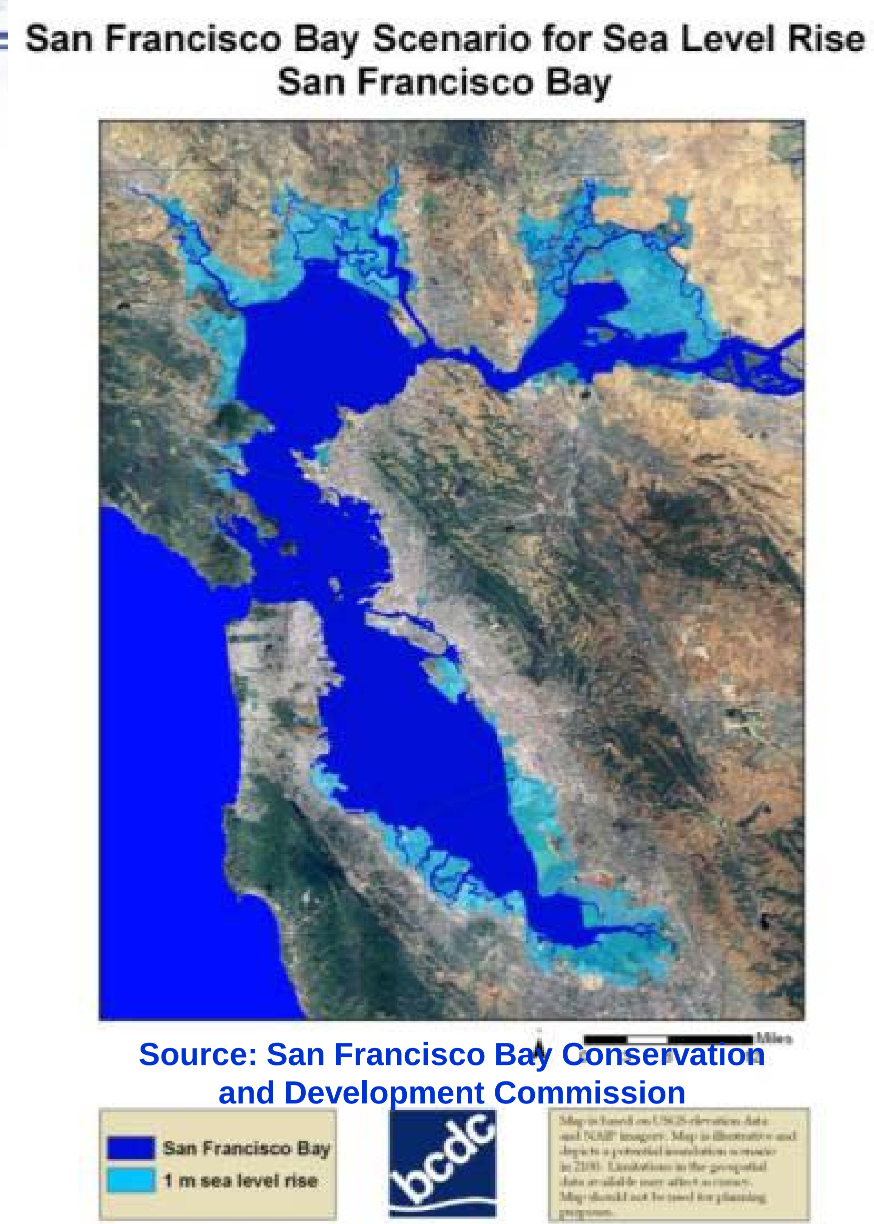
Notes and Source: "Lower Warming Range Drier Climate" is based on an GFDL B1 scenario; "Medium Warming Range Drier Climate" is based on a GFDL A2 scenario. Luers et al., 2006.

Coastal Vulnerability



Source: Adapted from USGS Woods Hole Science Center website, http://woodshole.er.usgs.gov/project-pages/cvi/

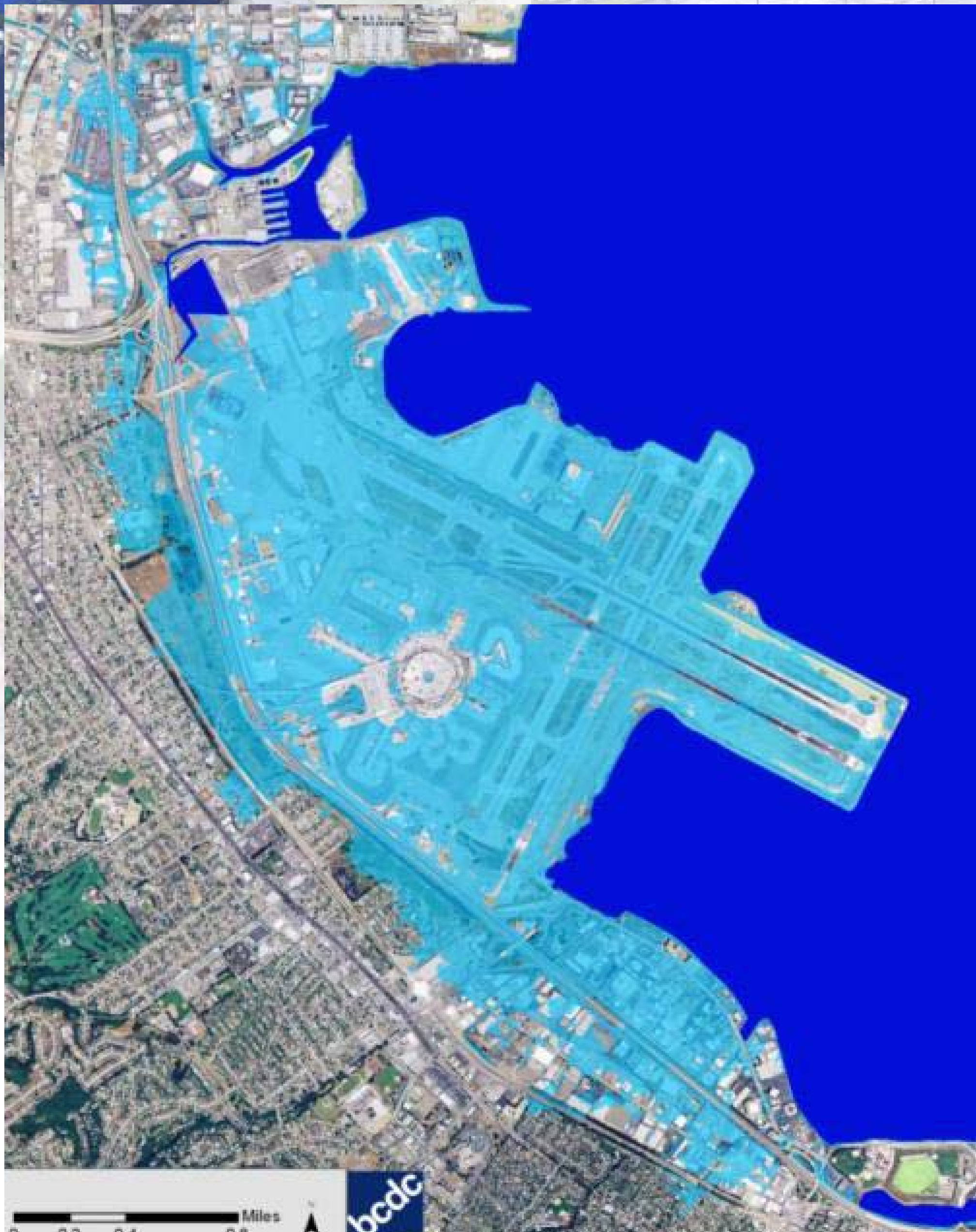
Inundation Risk



Source: San Francisco Bay Conservation and Development Commission

•*San Francisco International Airport*

•One Meter Sea Level Rise

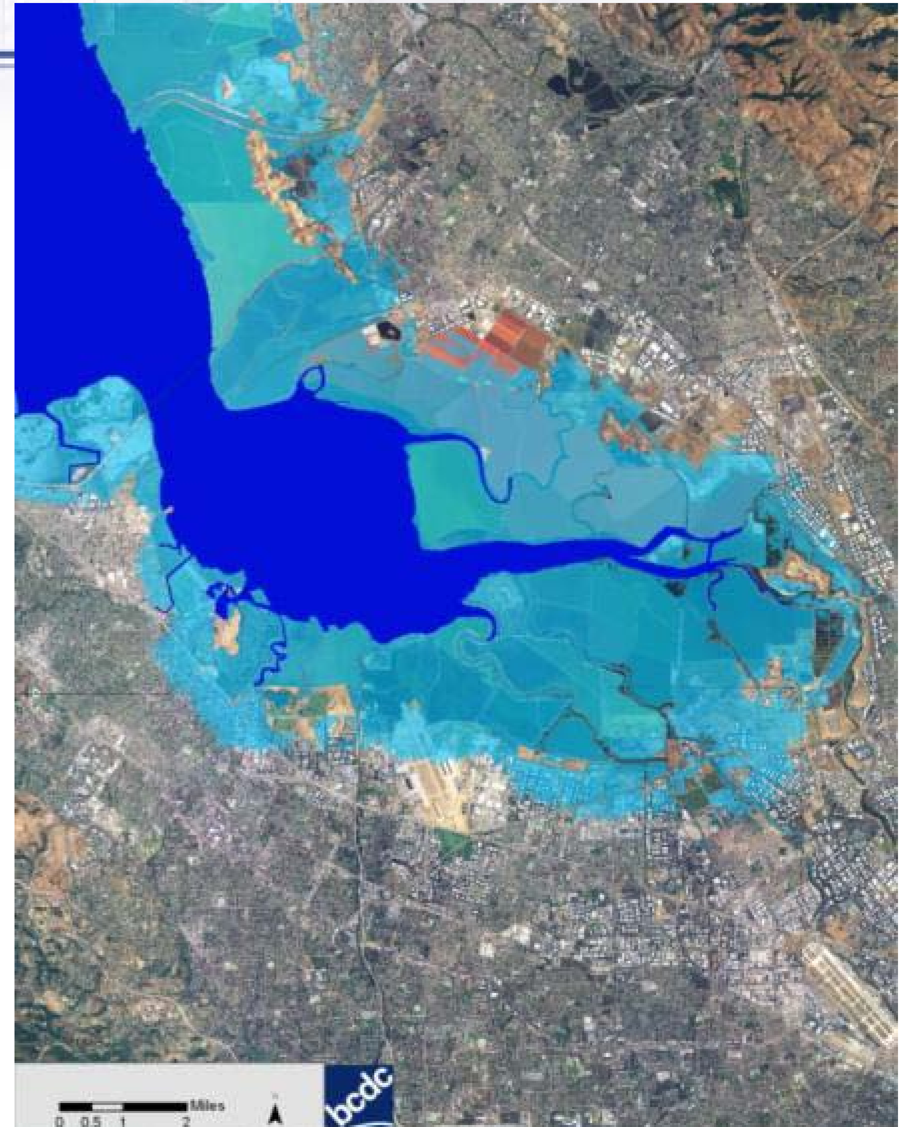


Oakland International Airport

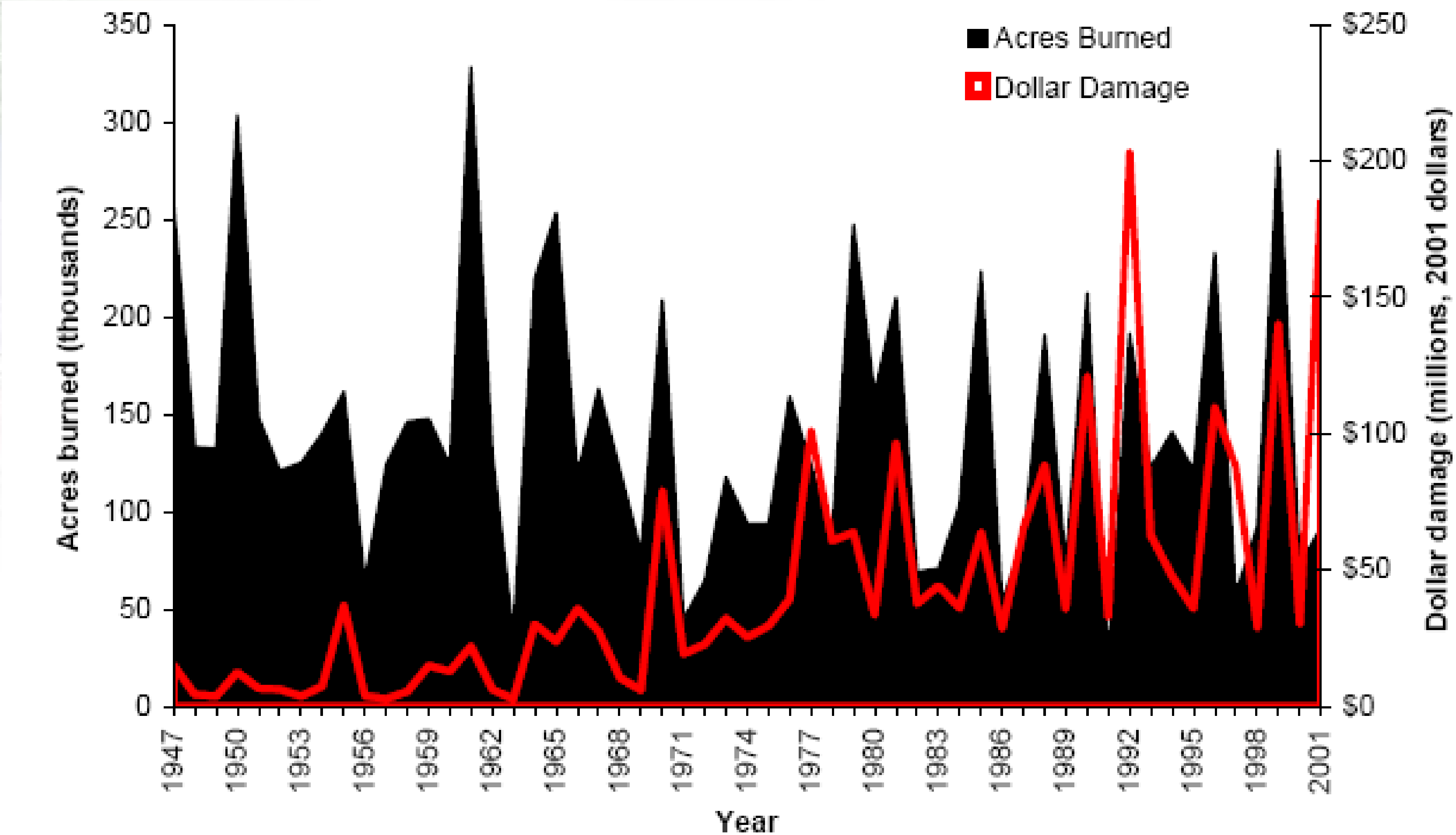
One Meter Sea Level Rise

Silicon Valley

One Meter Sea Level Rise



Acres Burned and Dollar Damage



Source: CDF, 2004

Smart Stimulus: SuperGrid

Energy pathways for the Digital Age:

- Electric power has been hailed as the greatest engineering achievement of the 20th century – illuminating light bulbs
- Sustainable diffusion of universal, high resolution information will surely be that of the 21st – illuminating people
- To achieve this requires development of a new generation of integrated energy infrastructure (IEI)

The Next Big Thing

- If the Federal government is looking for the next big public works commitment (after TVA, interstates, internet), IEI is it
- With its private technology leadership and forward-looking utility sector, California can define global standards for public/private partnership in energy infrastructure
- For rapid deployment of large scale public spending and job creation, this is better than picking winners in the underlying technologies (highways vs. cars, dams vs. subdivisions, internet vs. software/content)

Three Emerging Needs

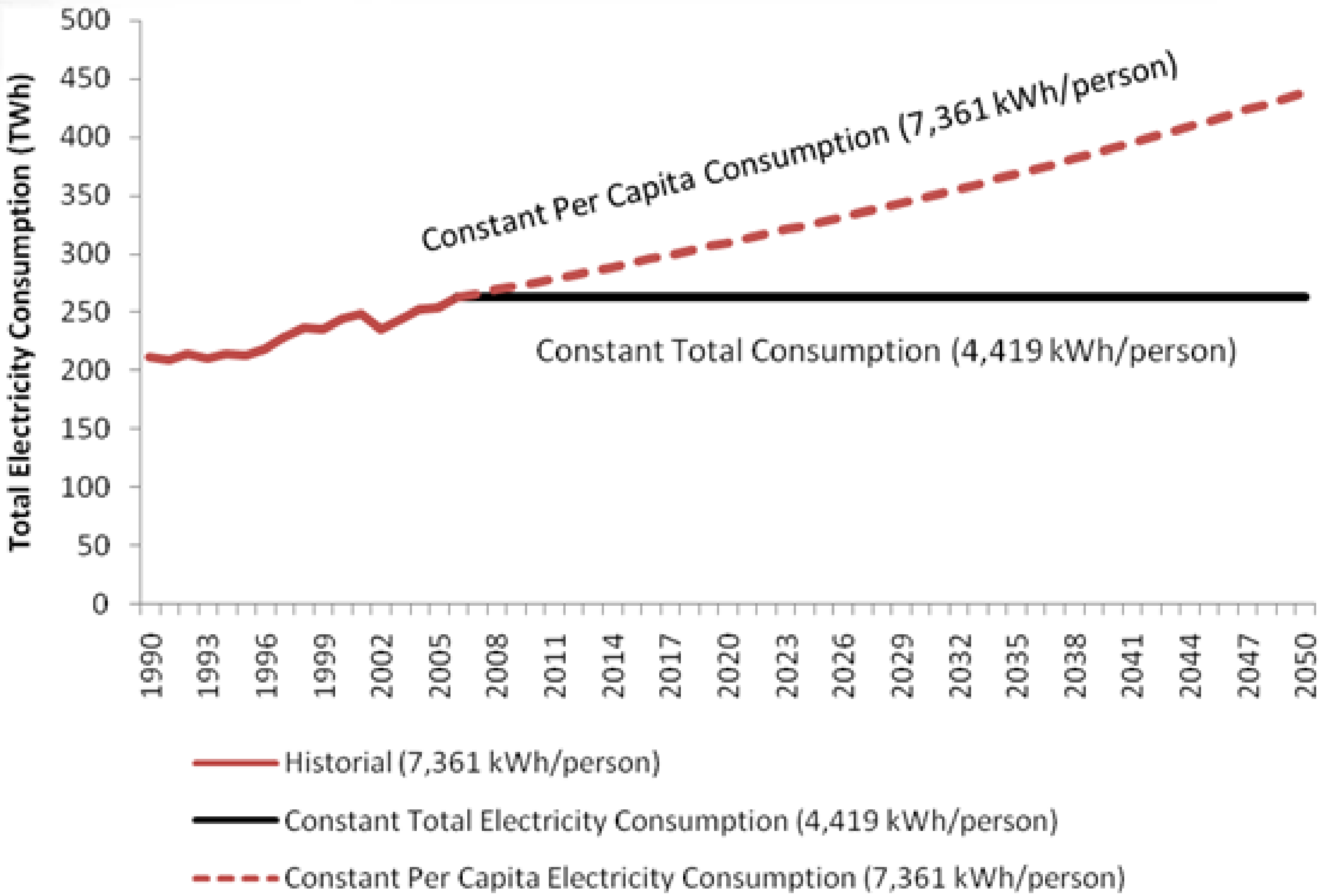
1. Residential and industrial electric power needs for a growing economy
2. Capacity to integrate extensive and diverse renewable energy sources
3. Capacity for continuous reliability and high resolution support of more extensive and intensive IT diffusion

Energy Demand Growth

Primary drivers:

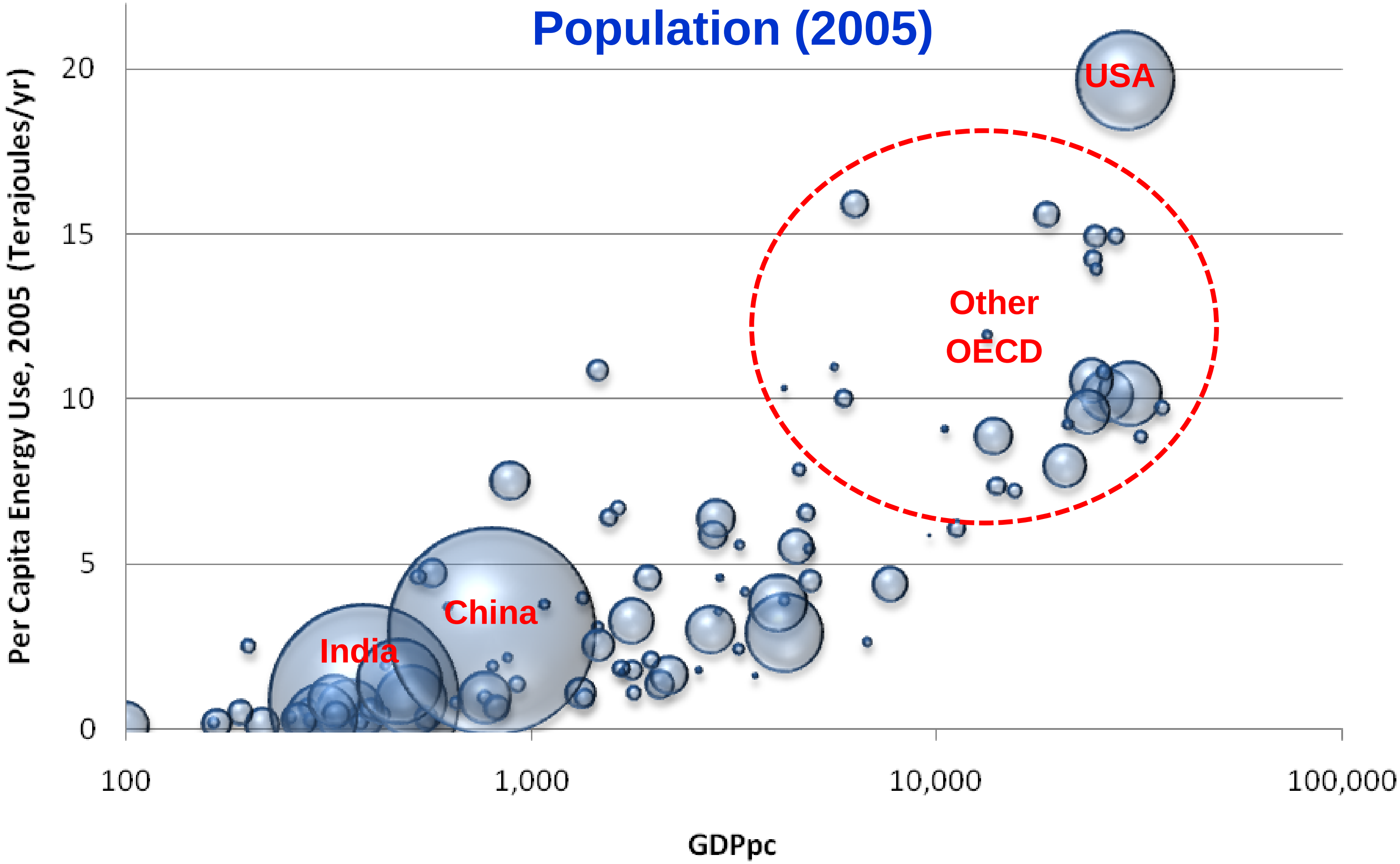
- Population/income growth
- Climate change
- Electric vehicle integration

Population to Double by 2050



Why the World Needs Leadership

Energy and Income, by Country, Income, and Population (2005)



•Source: Author estimates from International Energy Agency and World Bank data. Bubble diameter is proportional to population

Renewables Integration

Two primary challenges:

1. Extensification - Geothermal and large scale solar sources are in areas outside current transmission networks
2. Storage – two of the largest renewable sources, solar and wind, are intermittent

Super-critical reliability

- Intensive digital information and media systems (ICT, finance, medical, security/defense) have critical requirements for energy continuity and resolution
- Today's grid is remarkably efficient and reliable given its sheer complexity, but it cannot meet the needs of a modern information economy.
- Power shortages and interruptions alone cost the U.S. as a whole at least $150 billion per year (DOE:2006).

Medium and Message: Energy and Information

The grid of the future will embody the essential synergy between energy and information

- Digital infrastructure is powered by electricity, but electricity infrastructure will be managed by digital technology
- The SuperGrid will be an intelligent, auto-balancing, cost minimizing, self-monitoring power network that integrates a variety of energy sources and delivers critical reliability and resolution
- It must provide the comprehensive foundation for decentralized, “smart” energy systems

Why this is Difficult

- Most of the legacy grid was designed to support local electrification, resulting in fragmentation and inefficiency
- The grid of the future must be integrated for efficient allocation, load/cost sharing, and continuous technology diffusion and reliability
- Big Push - To make this work and trigger the necessary private agency will require a commitment device: huge initial investment and exercise of property rights

Why this is Worth It

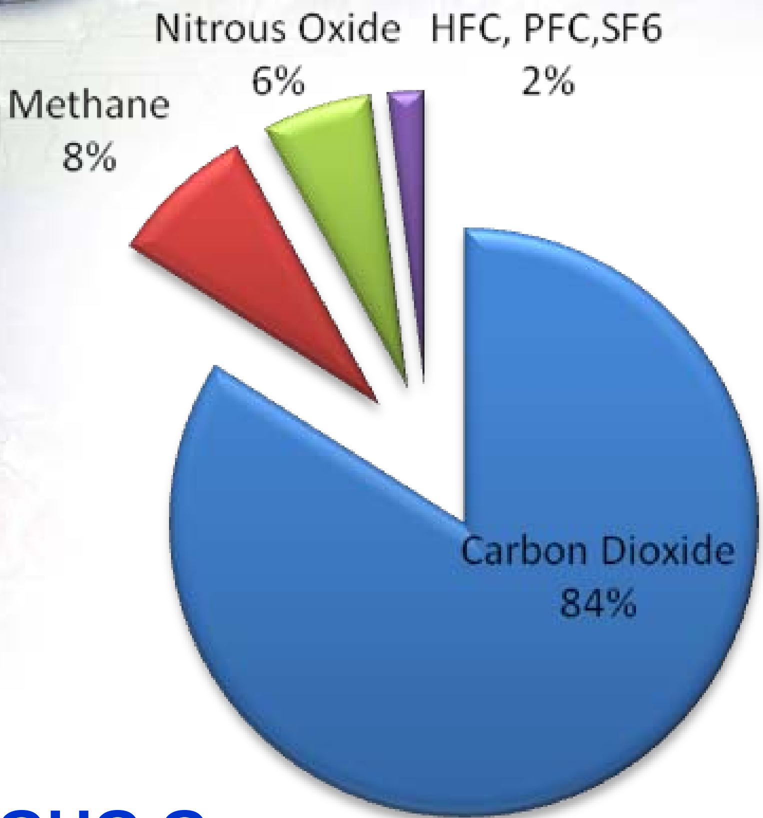
- Early harvest of employment-intensive infrastructure development
- Strong complementarities across an energy triangle of utilities-technology-endusers to facilitate adoption and innovation
- Long term benefits for sustainability and knowledge-intensive, higher wage economic growth

Conclusions

1. The supposed tradeoff between environment and economic growth is a fallacy, and in California we have proven this.
2. Energy efficiency is a potent catalyst for job creation, not just in boutique technology sectors, but across the economy.
3. We face substantial risks from climate change, but Climate Defense offers a new agenda for economic stimulus and growth that is employment, technology, and skill intensive
4. By taking public initiative and facilitating private participation, we can set global standards for growth-oriented adaptation
5. One of the most important commitments in this context is to develop a statewide SuperGrid, a flagship infrastructure project that integrates all electric power sources and uses for knowledge-intensive economic development

Discussion

Climate Change and Carbon Fuel

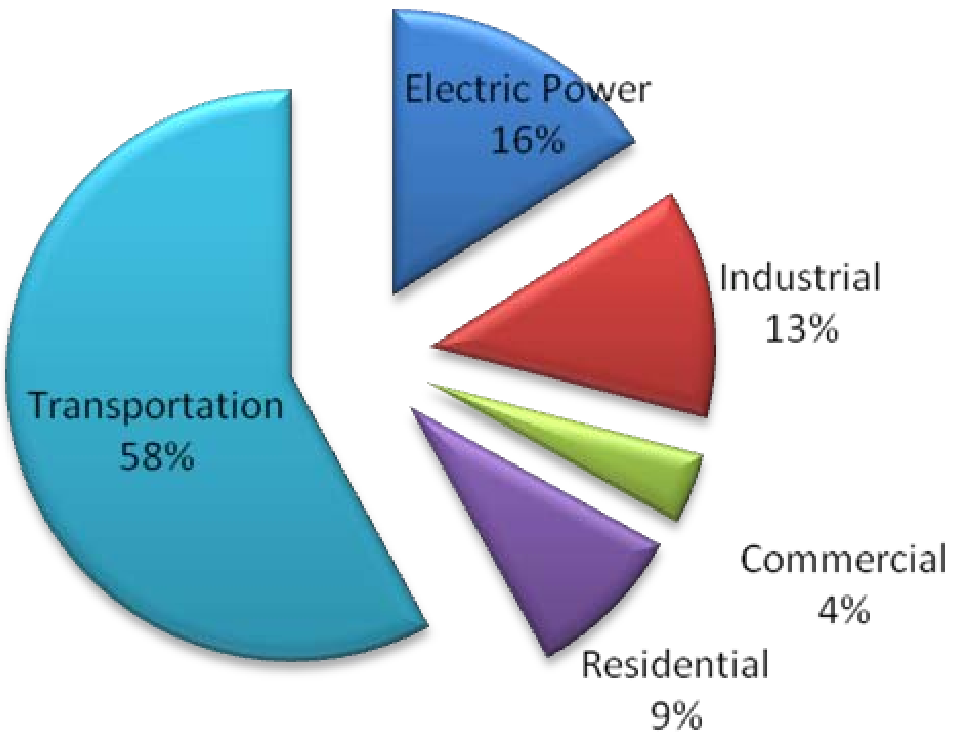


GHG Gases

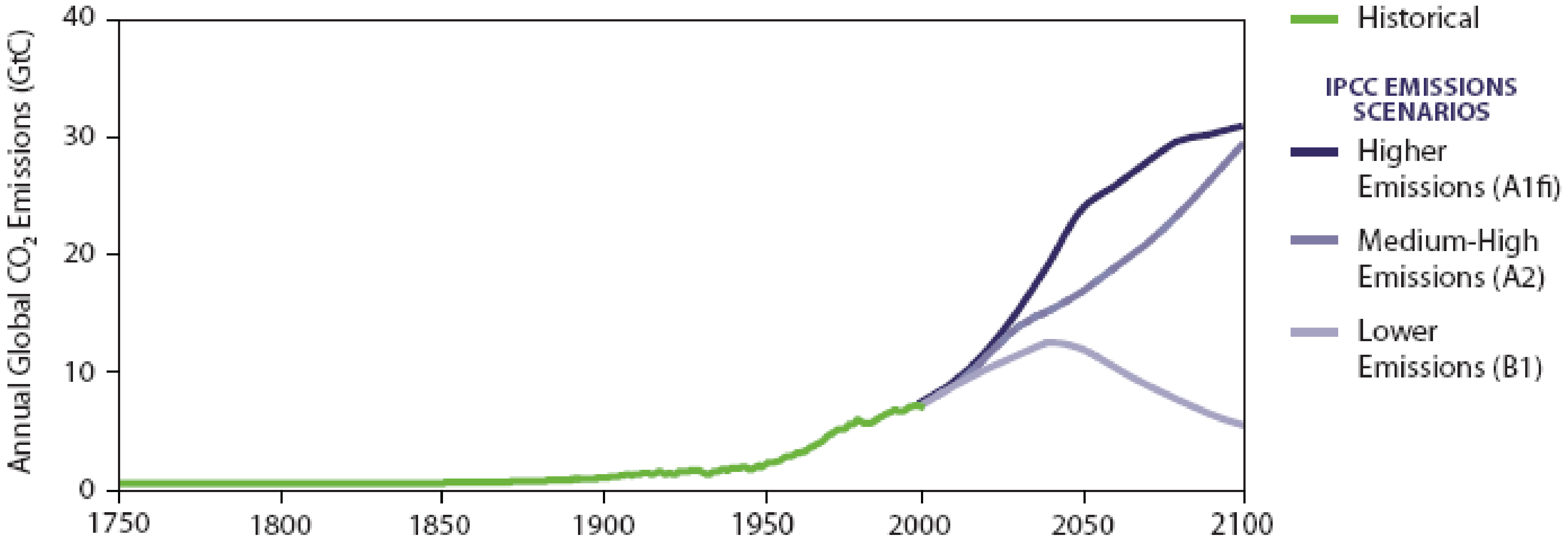
(CO2 equivalent shares)

Source: CEC

CO2 Sources



Global Emissions to 2100 under Af1i, A2, and B1 Scenarios



Estimated Electric Power System Costs of Warming

	B1	A2
Increase in system costs at CPUC market price referent (2007)	$2.7 billion/year	$5.8 billion/year
Required investment in NGCC case	$3.6 billion	$7.6 billion
Required investment in “5 sources” case	$19.9 billion	$41.8 billion

Notes: “5 sources” here refers to 20 percent of solar concentrating (CS) PV, wind, geothermal, natural gas, and biomass, NGCC refers to natural gas combined cycle. We use high capital cost for CS here; a reduction to more reasonable levels (e.g., $3,000/kW) could reduce required investment by 30 percent.

Water - Risk

- Water scarcity in California will increase sharply because of climate change, at least on a seasonal basis. Even in the most optimistic scenario, Sierra snowpack, a major source of water storage in California, is projected to shrink by 30-80 percent by 2070-2099.
- All scenarios show significantly increased water flow in the winter, and decreased flow in the spring and summer, when water demand is highest. Combined with significant expected population growth, this will lead to considerable stress on the state's physical and institutional capacity for water storage and allocation. Higher water flow variability will also lead to increased risks of flooding, levee failure, saline intrusion and drought-induced habitat destruction.
- All told, there are an estimated $5 billion in assets at risk in the water sector; damage costs for the high warming scenario are projected to reach $600 million a year. Adaptation will add hundreds of millions of dollars to renewal and replacement cost.

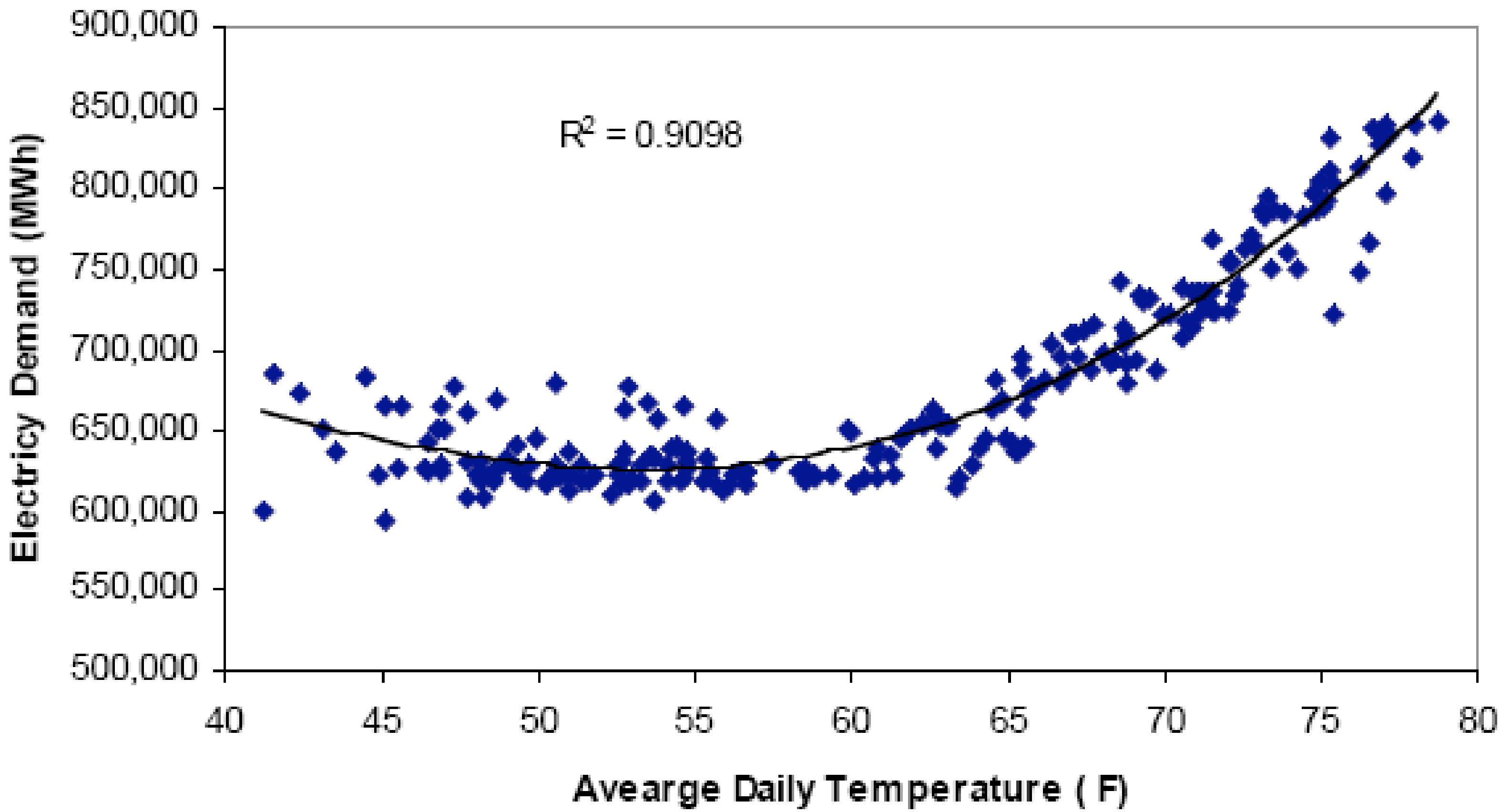
Water - Response

- Even if the earth's climate is stabilized, major adjustments will need to be made in California's water sector to adapt to scarcity imposed by population and unavoidable climate damage.
- Water conservation is the most cost-effective means of reducing these pressures, but it is unlikely to be sufficient to avert more intense rural-urban competition.
- The water economy is seriously distorted by legacy rights, allocation, and pricing policies. Urban water users pay over 50 times more than agriculture.
- Policies should promote
  – demand side management, including water market reforms and incentives for technology adoption.
  – Investments in conveyance and storage infrastructure.
  – Facilitation of more efficient water allocation within the state, including a comprehensive re-examination of regulatory approaches to efficient water and energy use, including systems of legacy entitlement and public/private cost sharing.

Energy - Risk

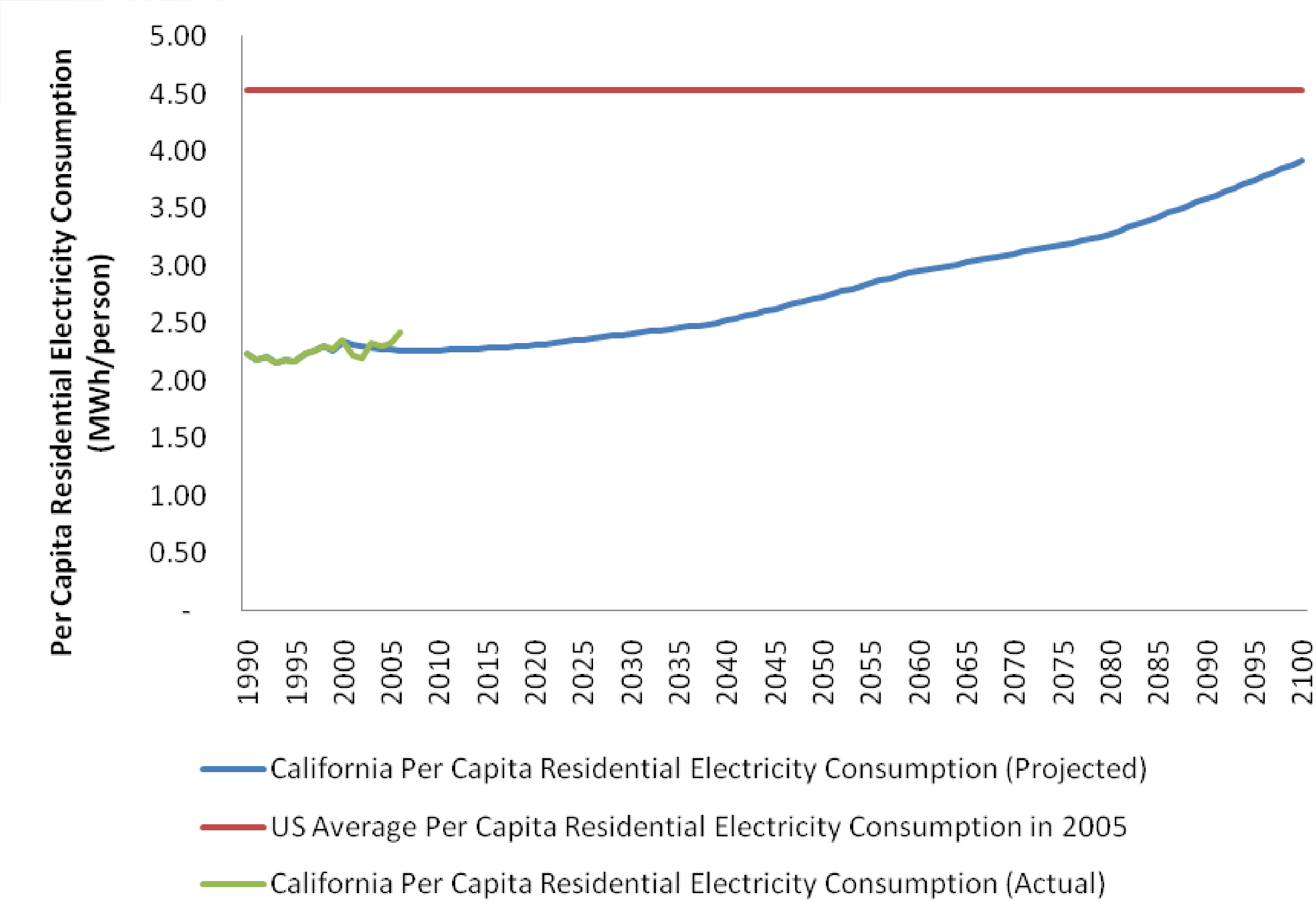
- Energy conditions in California depend on the evolution of the electric power and transportation sectors:
  - Storm damage to transmission lines causing power outages leads to lost revenues and repair costs on the supply side and lost productivity for commercial customers.
  - Changes in the seasonal availability of water will lead to a reduction in the state's hydropower resources, which last year accounted for 14.5 percent of California's total system power.
  - Projected inland migration and population growth combined with higher temperatures will increase residential electricity demand. If, as some predict, per capita consumption rises by up to 50 percent over this century in low warming scenarios and 75 percent in higher but not the highest warming scenario (still below 2005 levels for the greater United States), as a result of dramatically higher air conditioning use, the state must fundamentally rethink policies toward electric power.
- The annual economic impact of climate induced damage in the energy sector range from $2.7 billion in the low warming scenario to $6.3 billion in the high warming scenario. $21 billion in energy assets are at risk.

Warming and Energy



Source: Franco and Sanstad, 2005

Per Capita Residential Electricity Consumption in California



Energy - Response

- Demand Side Management:
  - Short term programs that encourage reductions in peak load could effectively reduce the economic and environmental implications of an increase in summer electricity demand.
  - Longer-term, much more aggressive action is needed
- Electricity supply growth could cause even greater climate damage, so more aggressive commitments to renewable energy must be considered, particularly distributed technologies such as photovoltaic.
- Considering the public health, greenhouse gas, and economic implications of peak electricity demand in California , the state is in urgent need of innovations that address the timing of electricity demand and the severity of social, environmental and economic impacts.
- Both climate mitigation (AB 32) and adaptation imperatives suggest the need for a radical rethinking of electricity production and distribution in California.
- Without this kind of guidance, induced innovation and technology adoption will fall short of California's climate innovation potential.

Transportation - Risk

- Transportation is vital to the state's diverse but integrated economy, and especially to its national and international economic linkages. California's seaports (Los Angeles, Long Beach and Oakland) accounted for more than 40 percent of U.S. container shipping by volume and more than 23 percent ($425.5 billion) of the total foreign trade through the nation's top 50 international freight gateways in 2004.
- Extreme weather (frequency and intensity of Pacific storms, extreme heat days) and sea level rise are the two largest climate induced impacts on the state's transportation infrastructure.
- Unfortunately, there has been very little research on this issue, so policy guidance at the present time is very limited. What we do know is that
  - California's port infrastructure has several hundred billion dollars of real asset exposure to changes in sea level, tidal amplitude, and weather induced wave action.
  - This includes many of the state's major airports, which will require fortification or, at dramatically higher cost, relocation.
  - Road systems around the state are also vulnerable to temperature increases in ways that are only beginning to be understood.
- In addition to asset exposure, the spillover effects of disabling this infrastructure would multiply economic damages significantly.

Transportation- Response

- Much of California's transportation infrastructure is in disrepair. Nearly 30 percent of the state's roads and bridges are structurally deficient or functionally obsolete. The American Society of Civil Engineers gives the state a below average rating in both aviation and surface transportation infrastructure, and estimates that nearly $20 billion per year would be required to bring it up to "b" rating.
- Given the longevity of transportation infrastructure, investment decisions being made now will have a dramatic impact on the state's ability to cope with climate change impacts.
- No assessment of the transportation sector's climate change vulnerability and potential risks, possible responses and costs or evaluation of tradeoffs has been carried out at either the state or Federal level.
- California's transportation infrastructure will be strained by population growth over the next century. Climate change should be integrated in a broader discussion of how transportation infrastructure is designed, where and whether it is build, retrofitted or rebuilt, and how it is financed in California. Less development in high-risk areas could limit damage.

Tourism and Recreation - Risk

- Tourism and recreation are important sources of state income and employment and a large category of services to state residents and visitors. The California travel and Tourism Commission estimated that travel spending alone in California was 96.7 billion or 5 percent of GSP, supporting nearly 925,000 jobs in 2007. Travel spending is also a significant source of local and state revenues. 44 percent of total travel dollars were spent in three coastal destinations: Los Angeles ($22 billion), Orange ($8 billion) and San Diego ($10.5 billion).
- Climate change impacts on this sector overall will be negative, though there may be some winners and losers. In the highest warming scenario, California's ski industry collapses, taking with it $500 million annual revenue and 15,000 jobs (not including supporting service industries).
- But warmer water and air temperatures will open new and expand existing recreation opportunities like golf, though weather variability, extreme heat, and drought may reduce the benefits.
- Of all tourism and recreation, beaches will suffer the greatest cost-related climate impact primarily through inundation as a result of sea level rise and accelerated erosion through an increase in Pacific storm activity and attendant changes in wave patterns.
- We estimate that there are $98 billion in tourism and recreation assets at risk, with a projected annual price tag of $200 million to $7.5 billion in climate damage costs depending on the warming scenario.

Tourism and Recreation - Response

- As the state adapts to changing patterns of use in this sector, important opportunities and challenges will arise for public and private investment in environmental assets and services.
- Population growth has historically and will continue to have the largest impact on ecosystems.
- Going forward, the state should give greater recognition to linkages between environmental asset quality (e.g. coastal ecology, forest cover, parks) and willingness to pay for environmental services.

Real Estate and Insurance - Risk

- Taken together these two sectors represent the largest economic climate risk for the state, although they are among the least studied to date. California has $4 trillion in real estate assets, of which $2.5 trillion are exposed, deeply implicating the insurance industry.
- Three major climate change impacts have direct consequences for real estate:
  - Increases in the frequency and severity of wildfires, which burn property. The number of wildfires in California is projected to increase by 12-53 percent, depending on the climate scenario. Impacts are highly uneven across the state with a 90 percent increase in risk in Northern California and a 30 percent reduction in risk in Southern California.
  - Sea level rise and coastal erosion, which permanently inundate property.
  - Increases in the frequency and severity of Pacific storms, which destroy or temporarily inundate property through high winds, coastal flooding or other storm related activity.
- The magnitude and scope of these impacts are not static; they are conditioned by demographics, economics and policy. Put simply, more people living in more high-risk areas means more damage.
- A relatively small percent of the state's residential and commercial property faces direct climate damage, but it is concentrated in the most valuable markets. In addition to structures directly threatened, there is significant collateral depreciation risk across all markets linked to forested, coastal, estuarial, or riverine real estate markets.
- Combined estimates show that Californians could face from $200 million to $1.4 billion in additional annual water damage costs from climate change and from $100 million to $2.5 billion in additional annual fire damage costs. The state has over $900 billion of assets at risk because of water and $1.6 trillion in assets at risk because of fire.

Real Estate and Insurance - Response

- Private insurers pay three-fourths of all weather related losses in the U.S., with the federal government paying the rest.
- Climate change will substantially increase risks faced by the insurance industry and insurers are trying to better assess their exposure. Insurers have historically played and could again play a leading role in loss prevention by pricing risk.
- The federal government's role of insurer of the last resort has historically created huge distortions in insurance markets by effectively depressing insurance premiums in high risk areas.
- Efficient adaptation to this challenge will depend critically on how the cost is allocated between private and public interests. If the government assumes the costs of climate defense and risk management, this represents a massive transfer of wealth from taxpayers to selected property owners, as well as a moral hazard in insurance and property markets that may drive prices far above more realistic risk-adjusted valuations, further inflating the public's climate liability.
- Very little research is extant to support policy guidance in this area.

Ag, Forests, Fisheries - Risk

- Climate change will have significant impacts on the agriculture sector, and while important politically, its will be challenged to keep pace with the scarcity value of its underlying land and water resources.
- Long term economic and population growth will increase land prices all over the state, and climate change will raise the scarcity value of agriculture's second most important input, water, to unprecedented levels.
- Both higher and lower warming scenarios will lead to a gradual but substantial change in the composition and local of agricultural, forest and fish production.
- At higher temperatures, there is a marked decrease in feed intake in livestock, with more of their energy used for cooling. California dairy cows are particularly vulnerable because higher temperatures mean less milk.
- Forestry accounts for a small part (.1% of 2000 GSP) of the state's economy, but forests cover 39.7 million acres and 40 percent of California's total land area, playing an important role in our ecosystem. Fisheries are negligible in aggregate, worth about $100 million annually.
- We estimate that the agriculture, forestry and fisheries combined have $113 billion in assets exposed to climate damage, with an annual price tag of $300 million if climate is stabilized, to over $4.3 billion in the highest warming scenario.

Ag, Forests, Fisheries - Response

- To remain viable, California agriculture will have to improve the productivity of increasingly scarce land and water resources available to this sector, at the same time upgrading average product quality to pay much higher operating costs.
- Generally, we expect significant agricultural consolidation around high value and more technology-intensive crops.
- The most effective policies in these circumstances would be incentives for technology adoption and sustainable insurance mechanisms.

Public Health - Risk

- California has the worst air quality in the United States, with the number of deaths attributed to air pollution equal to traffic fatalities. Two public health risks are significant and relatively certain: an higher ozone and temperature levels.
- Rising average surface temperatures could lead to substantial increase in number length and severity of heat waves which dramatically increase the risk of heat stroke, heart attack, severe dehydration, particularly among elderly, children, ethnic minority and farm workers.
- The California Air Resources Board (ARB) estimates that air pollution — primarily ozone and fine particulate matter pollution — currently costs the state $71 billion/year as a result of 8,800 premature deaths ($69 billion), hospital visits ($2.2 billion). Not included are
  - lost productivity from losing 4.7 million school and 2.8 million work days.
  - additional annual cost from ozone ranges from .5 to 10.2 billion
  - heat related impacts wiht additional annual costs ranging from $3.3 to $13.9 billion.
  - overall annual public health costs rising from $3.8 to $24 billion

Public Health - Response

- Public policy can play a significant role in adaptation, mainly through health education and targeted assistance to vulnerable (elderly and low income) groups who will need improved access to mitigating technologies (e.g. air conditioning, refrigeration).
- Controlling criteria pollutant emissions is the most powerful option for reducing the pollution-related impacts of climate change.
- AB 32 will undoubtedly play a role in pollution control efforts in California, but are not sufficient to address local and criteria pollution issues.

Recommendations I

- Taken together, these sector impacts portend direct losses of up to tens of billions of dollars per year if no action is taken, far greater indirect costs, and assets exposed to risk valued in trillions of dollars.
- In the absence of state action, private agency would combine limited defensive investment with long-term asset depreciation, as threatened real estate and other economic interests are abandoned or converted to lower value activities.
- Some of this is inevitable and perhaps desirable, as the alternative would be state intervention that promotes unsustainable resource use and/or transfers wealth from taxpayers to inefficient private investment.
- However, public policy still needs to play a prominent role in the adaptation process and, by a combination of forward-looking fiscal and regulatory determination, the state can promote more sustainable growth at lower private cost.

Recommendations II

A wide array of adaptation policies, supported by more intensive and extensive research of the kind reported here can overcome market failures and provide the support and guidance needed for private agency to effectively share this adjustment burden. These would include, but by no means be limited to:

1. Facilitation of more efficient water allocation within the state, including a comprehensive re-examination of regulatory approaches to efficient water and energy use, including systems of legacy entitlement and public/private cost sharing.
2. More extensive and, where appropriate, intensive promotion of renewable energy technology, including innovation, diffusion, and adoption
3. Investments for climate defense of strategic state infrastructure
4. Investments in state natural landscape and recreational assets, and promotion of public-private partnerships for a new generation of tourism and recreation based on high quality, sustainable environmental services
5. Reassessment of state agricultural policy, with emphasis on knowledge-intensive agricultural innovation, higher value crops, water and land use efficiency, and environmental services
6. An integrated climate action plan for public health, including targeted policies to mitigate risk for the elderly and low income groups

Recommendations III

All these measures and more will help the state make its transition to a more climate resilient future, and continue California's legacy of innovative policy solutions that deliver sustained prosperity.

Some will be very difficult to achieve politically, but all are necessary to avert higher long-term climate costs.

Meanwhile, the present level of uncertainty regarding expected California climate damage is so high that returns to investment in more research could be quite substantial.

In reality, year-to-year costs will fluctuate very significantly, and the state must be prepared for the peaks of this variance.

Until more detailed and precise guidance emerges, however, the best strategic option for the state must be: Hope for the best, but prepare for the worst.