Sustainable Fuel Partnership

An initiative co-financed by the Government of Austria

Barcelona, Spain

Meeting Agenda

Time	Item	Facilitator(s)
10h00 – 10h10	**Welcome and introductions**	Jamie Leather
10h10 – 10h15	**Meeting overview and objectives**	Lloyd Wright
10h15 – 11h00	**Oil demand and costing**	Lloyd Wright
11h00 – 12h45	**Economic modeling**	David Roland-Holst
12h45 – 13h45	**Lunch**	
13h45 – 14h45	**Case studies**	Nawon Kim
14h45 – 15h00	**Pilot Fund Study**	Lloyd Wright
15h00 – 15h15	**Break**	
15h15 – 16h15	**Market Mechanism Study**	Sonja Butzengeiger
16h15 – 16h30	**Next steps**	Lloyd Wright
16h30 – 17h00	**Final remarks**	Jamie Leather

Meeting Objectives

1. **Update partners on oil demand analysis and case studies**
2. **Provide input to Economic Modeling work stream**
3. **Provide input to Pilot Fund and Market Mechanism development**

2011 Project Timeline

Activities	Completion date	Time Period			
		2011 (Q1)	2011 (Q2)	2011 (Q3)	2011 (Q4)
Rationale Study	31-Jul-11				
Region-Wide Analysis	01-Jul-11				
Case Study Analysis	01-Jul-11				
Economic Modeling Study	31-Jul-11				
Second Mid-Term Review	01-Jun-11				
Pilot Fund Study	15-Jul-11				
Market Mechanism Study	03-Aug-11				
Final Review	12-Sep-11				
Final Report	Oct-11				

Oil Demand and Costing

(10h15 – 11h00)

Interventions selected for region-wide analysis

Category		Intervention
I. Avoid Strategies		
	1	Transit-Oriented Development / mixed-use development / densification
	2	Telemobility
II. Shift Strategies		
	3	Bus Rapid Transit
	4	Underground metro
	5	Elevated urban rail
	6	Pedestrian upgrades
	7	NMT vehicles (bicycles, pedicabs)
	8	Congestion pricing
	9	Parking levy
	10	Fuel pricing
	11	Shift of air passenger travel to high-speed rail travel
	12	Shift of road-based freight to rail-based freight

Interventions selected for region-wide analysis

Category	Intervention
III. Improve Strategies	
	13 Fuel switch to CNG from land-fill methane
	14 Flex-fuel vehicles (biofuels)
	15 Electric vehicles
	16 Hybrid-electric vehicles
	17 Fuel economy standards
IV. Bundled Interventions	
	18 Avoid strategies (TOD, Telemobility)
	19 Selection of shift strategies
	20 Selection of improve strategies
	21 Complete sustainable transport package

Cumulative oil reduction savings from baseline

	2010 – 2030		2010 - 2050	
	Moderate	High	Moderate	High
Transit-oriented development (TOD)	4.70%	12.17%	12.50%	29.13%
Telemobility	0.43%	4.56%	0.53%	5.63%
Bus rapid transit (BRT)	0.51%	2.76%	1.47%	8.18%
Underground metro	0.15%	1.19%	0.20%	3.09%
Elevated urban rail	0.59%	2.59%	1.16%	5.32%
Pedestrian upgrades	0.82%	1.56%	2.01%	4.03%
NMT vehicles	1.65%	3.04%	3.75%	7.55%
Congestion pricing	0.22%	0.87%	0.31%	1.24%
Parking levy	0.71%	2.86%	1.02%	4.08%

Confirmation of core oil demand assumptions

- ❑ Core assumptions in initial analysis conducted through data research and expert inputs through Delphi technique

- ❑ Re-confirmation of assumptions currently being undertaken by consultant (Robin Hickman of Halcrow Fox)

Cost analysis

1. Baseline costs

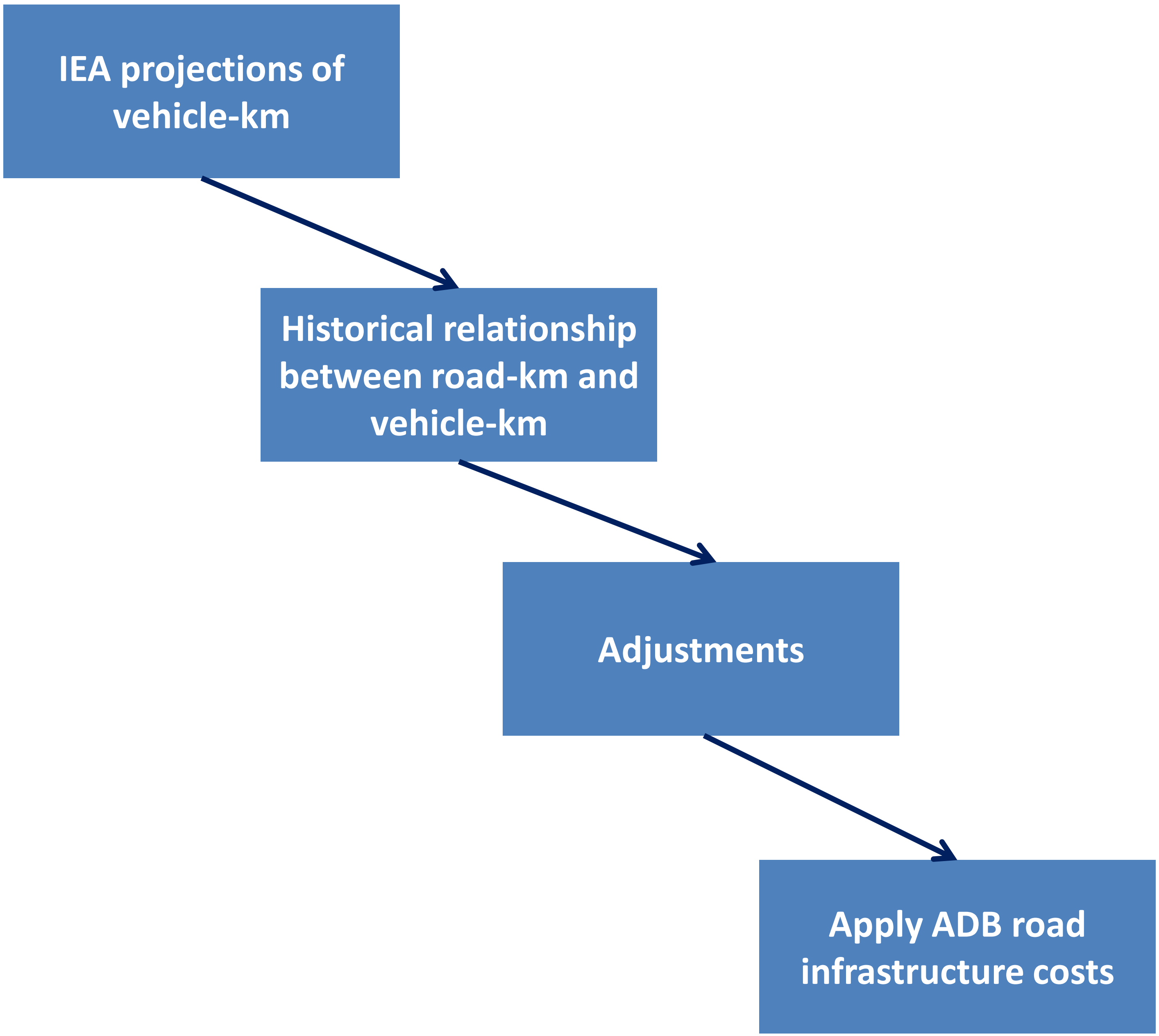
    - Public costs
    - Private costs

2. Marginal abatement costs of alternative interventions

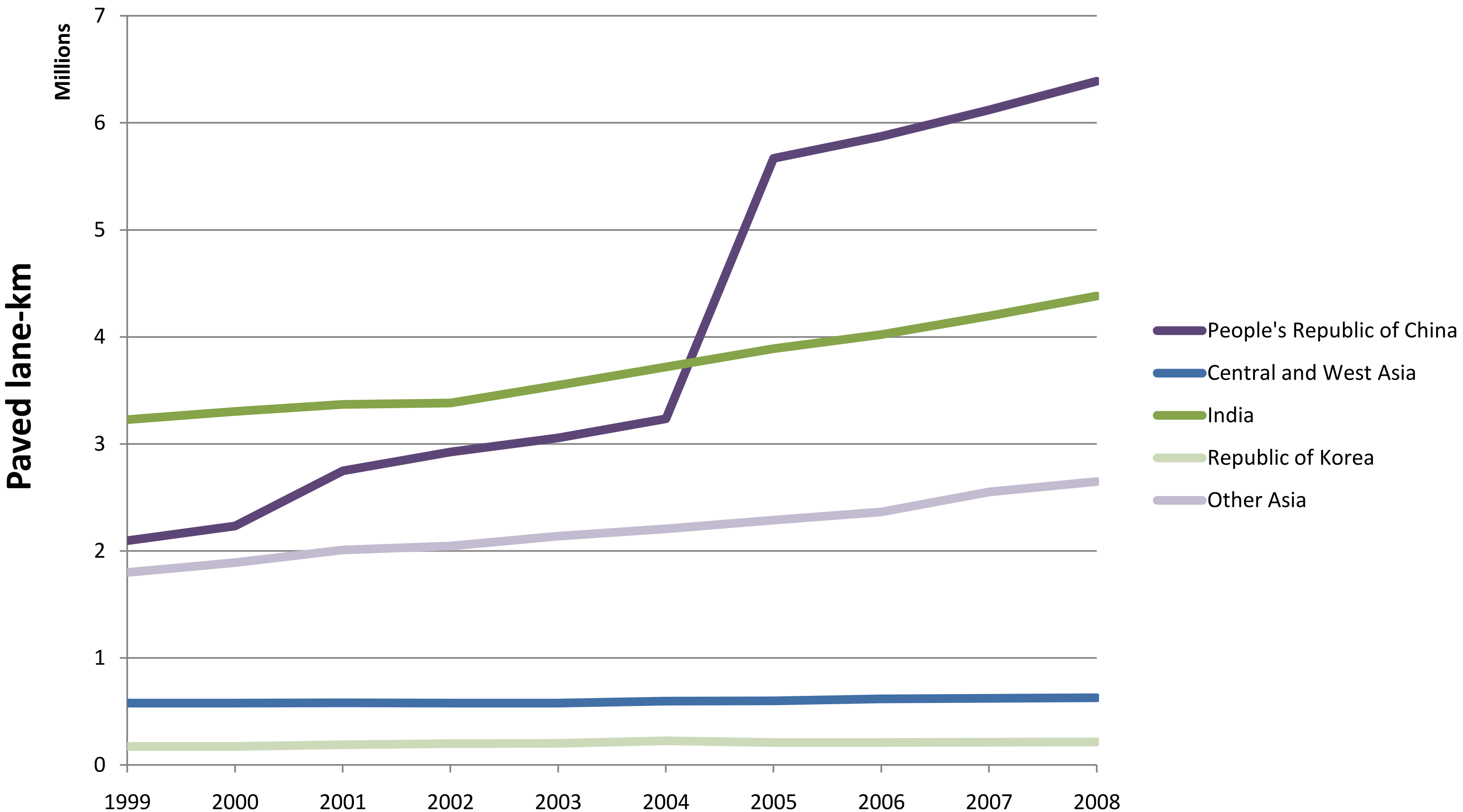
Baseline costs: Public and private

1. Infrastructure
   - Road
   - Rail
2. Vehicles
3. Fuel
4. Parking

Roadway infrastructure cost projections



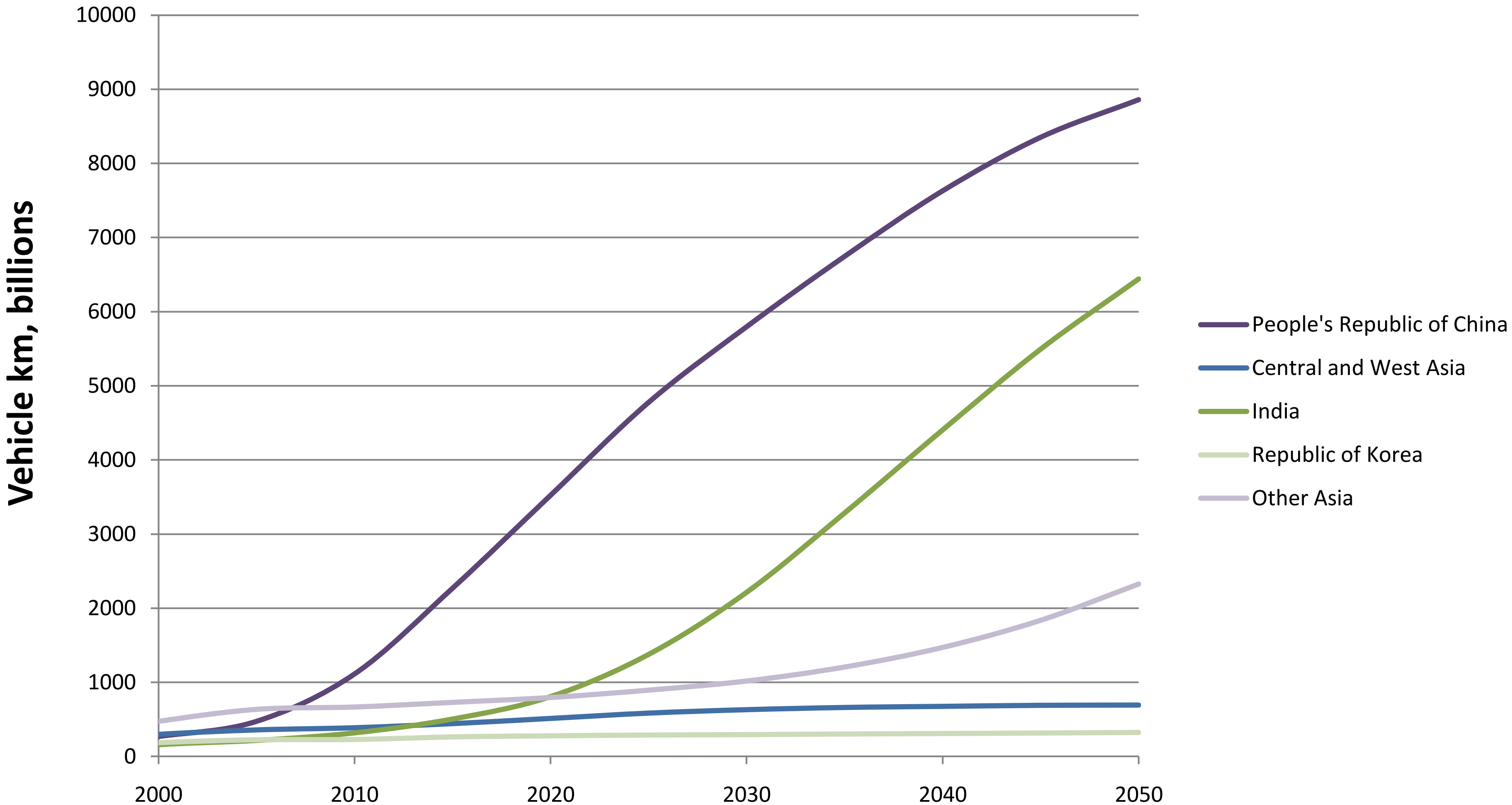
Existing road infrastructure



Source: IRF, IEA

Paved lane-km in Asia and the Pacific increased from 21% to 29% of global total between 2000 and 2008

Projected vehicle kilometers

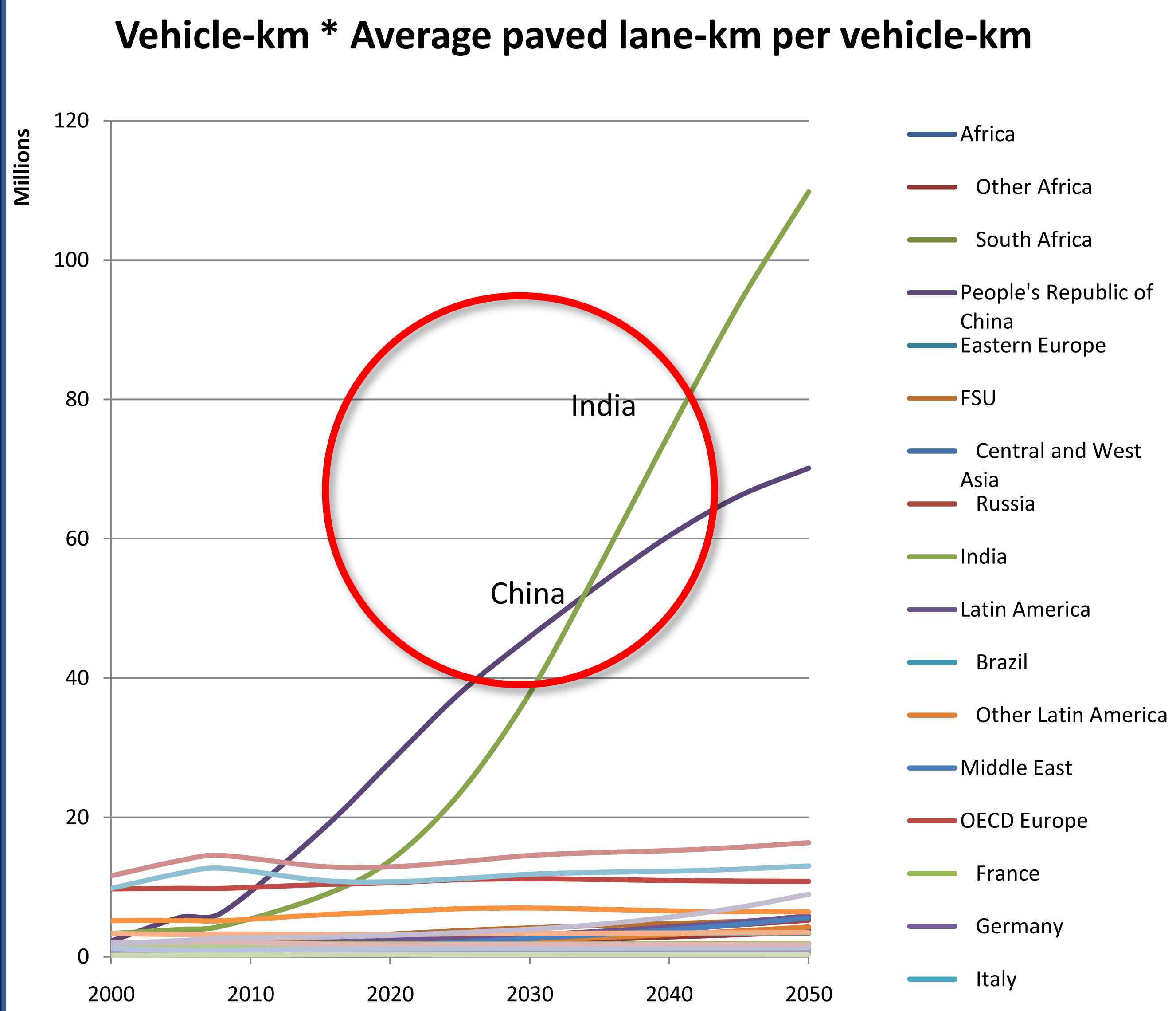


Source: IEA

Vehicle-km in Asia and Pacific projected to increase from 18% to 48% of global total between 2010 and 2050

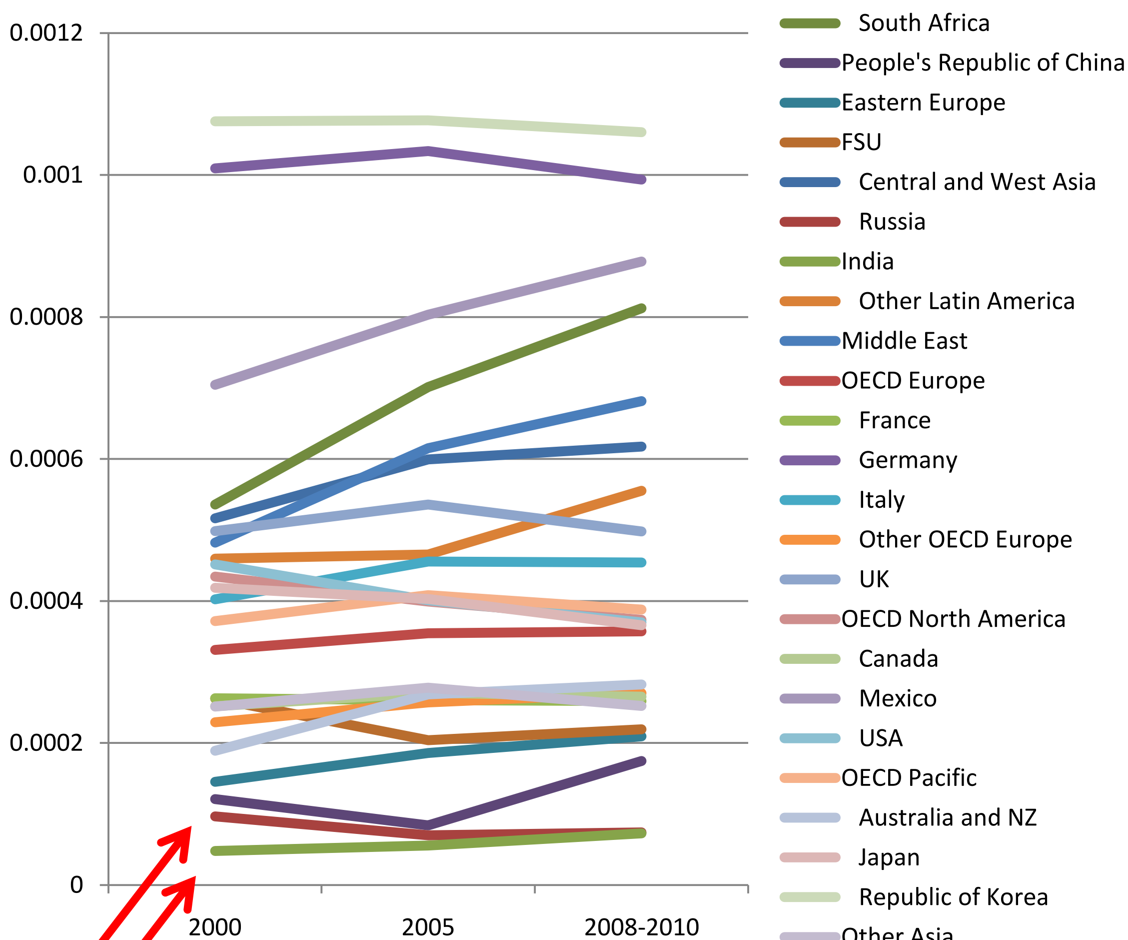
Paved lane-km projections (no limits applied)

The derived paved lane-km may be unattainable since it represents a quadrupling of total 2010 world paved road infrastructure by 2050, in China and India alone



Historic ratio of congestion factor

Vehicle-km / paved-lane km

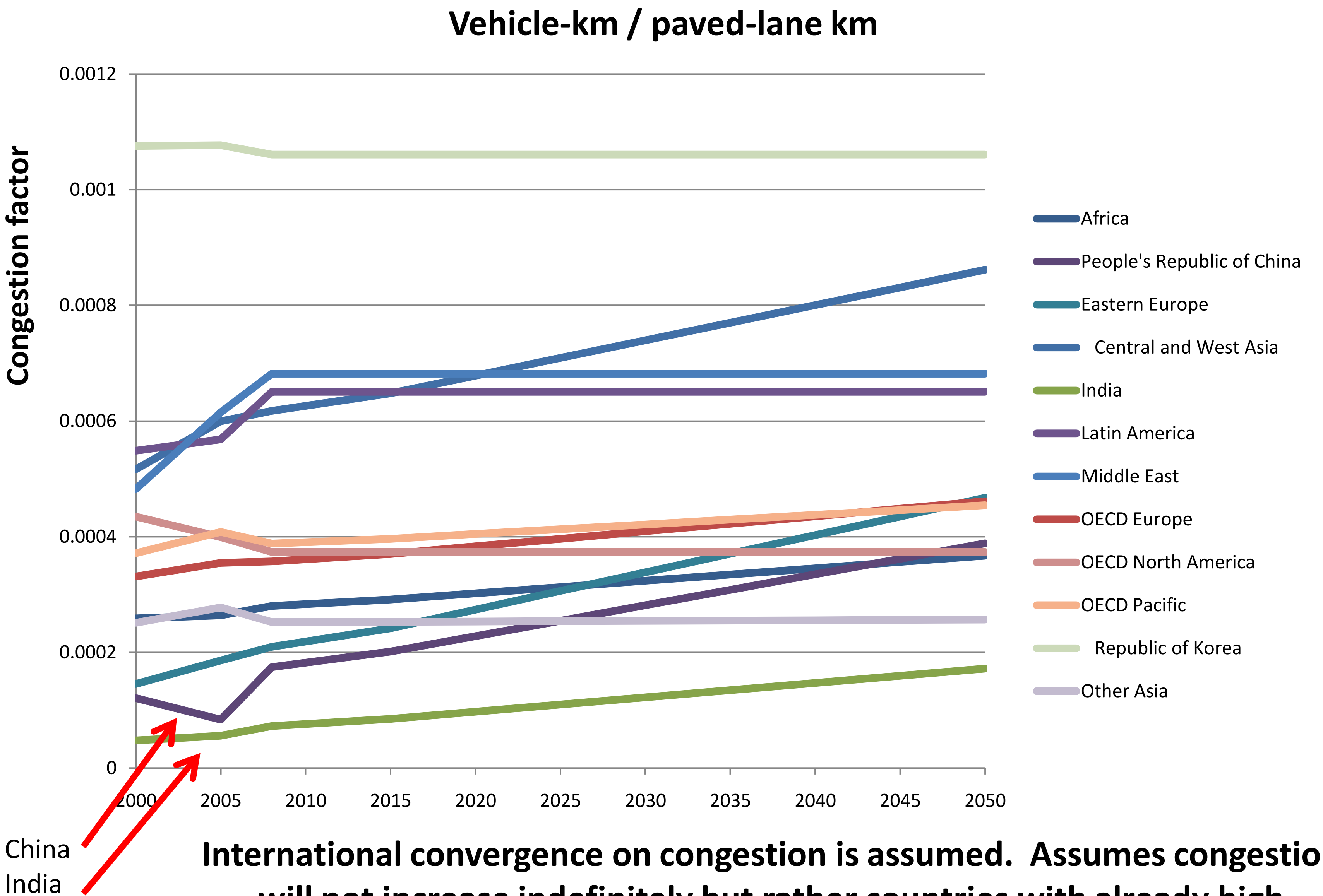


China
India

	Average Ratio
Africa	0.00026767
Other Africa	0.00023648
South Africa	0.0006832
People's Republic of China	**0.00012635**
Eastern Europe	0.00018021
FSU	0.00022863
Central and West Asia	0.00057786
Russia	8.0124E-05
India	**5.8694E-05**
Latin America	0.00058911
Brazil	0.00080377
Other Latin America	0.00049352
Middle East	0.00059309
OECD Europe	0.00034772
France	0.00026087
Germany	0.00101229
Italy	0.00043729
Other OECD Europe	0.00025216
UK	0.0005108
OECD North America	0.00040247
Canada	0.0002626
Mexico	0.00079536
USA	0.00040748
OECD Pacific	0.00038922
Australia and NZ	0.00024666
Japan	0.00039557
Republic of Korea	0.00107109
Other Asia	0.00026037
World Annual Average	**0.00031287**

China and India have two of the lowest average congestion factors, and thus their paved-lane km projections (based on a fixed average historic ratio) are exceptionally high with few vehicles per lane-km

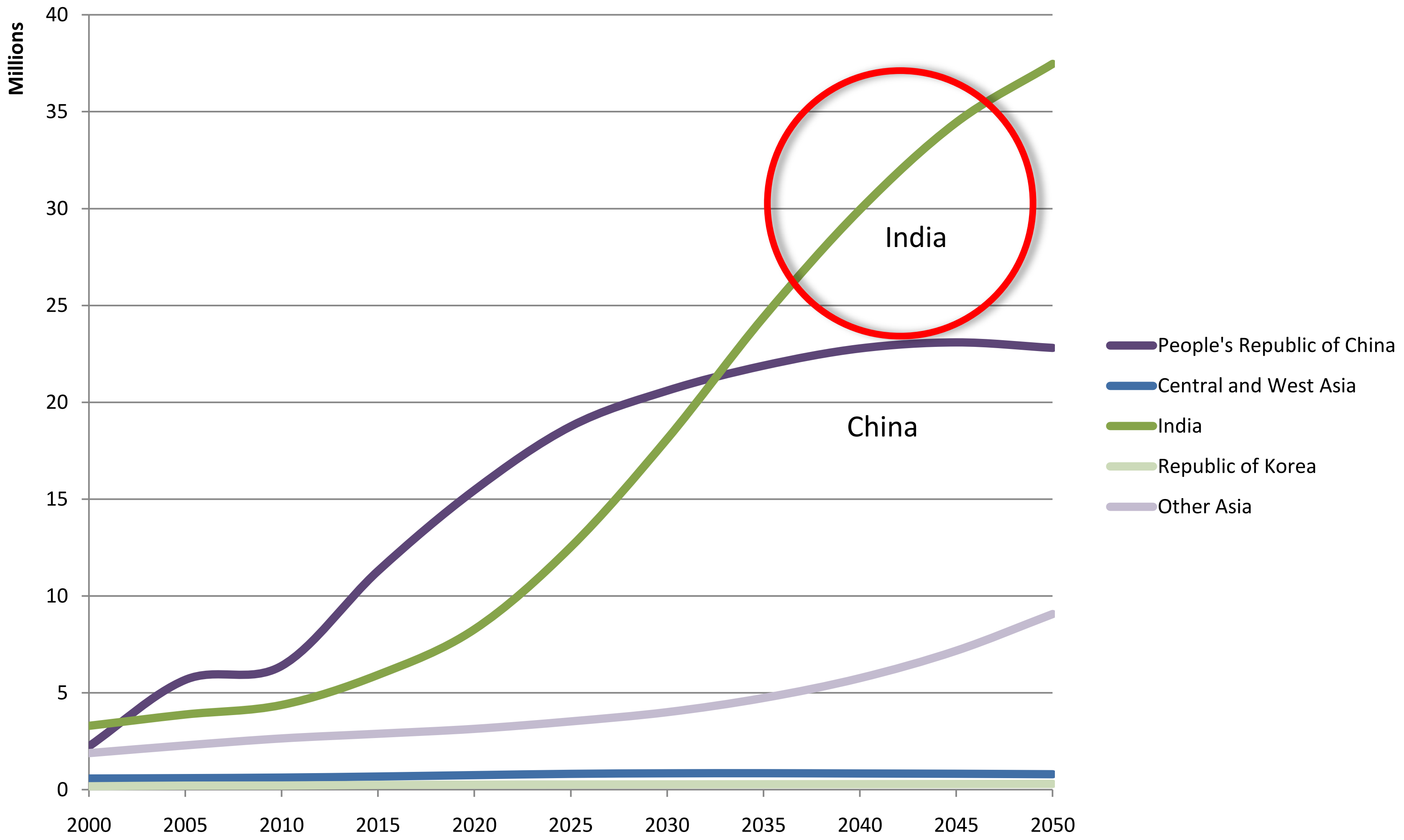
Projection of congestion factors



International convergence on congestion is assumed. Assumes congestion will not increase indefinitely but rather countries with already high congestion levels (e.g. Japan and Korea) will instead find more efficient ways of accommodating increases in vehicle-km.

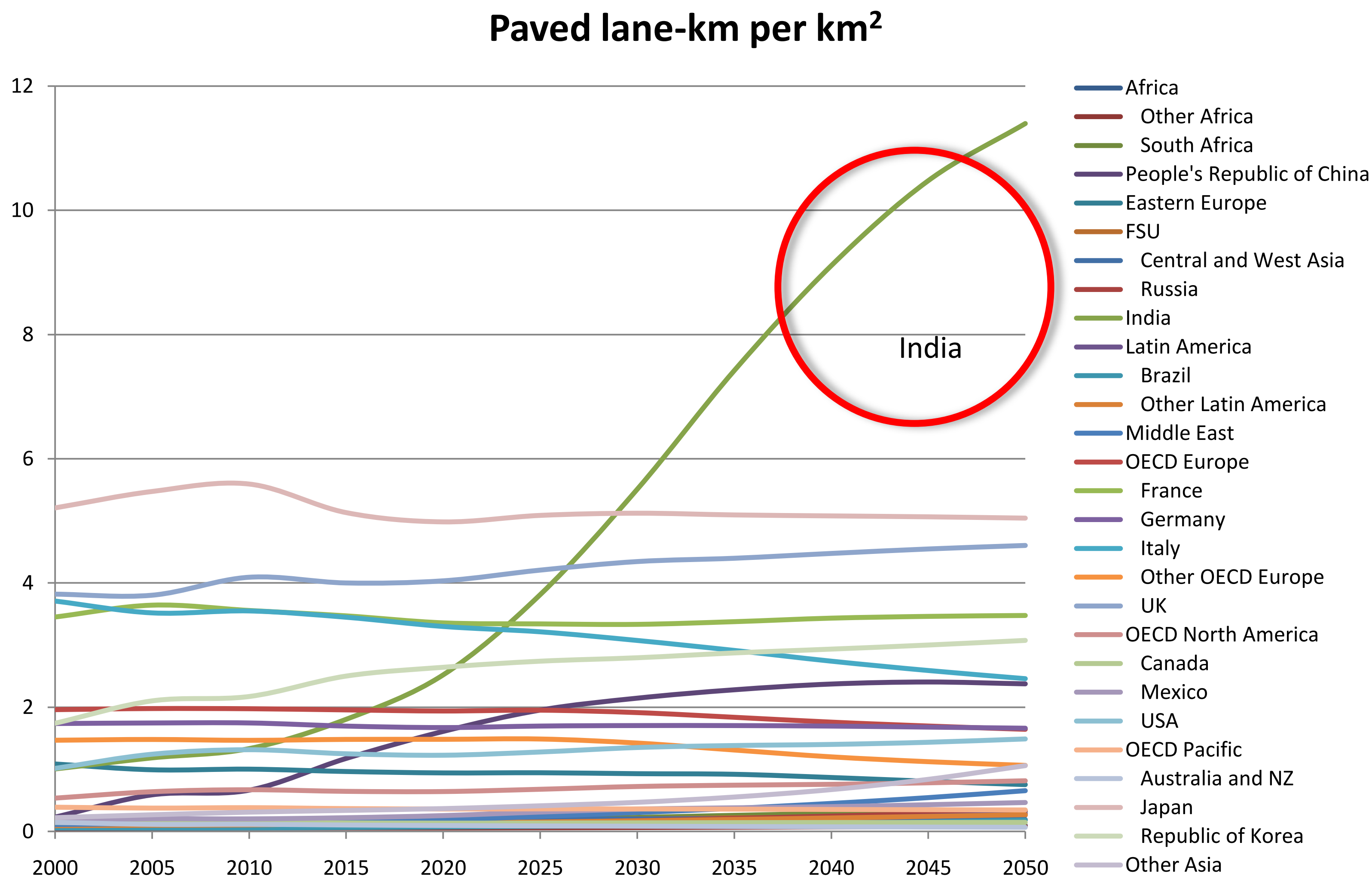
Projections of paved lane-km

Using the internationally convergent congestion factors (i.e. applying limits to paved lane-km growth)



While China's infrastructure projections might be feasible, India's infrastructure projections appear too high, indicating that congestion factors need to be adjusted.

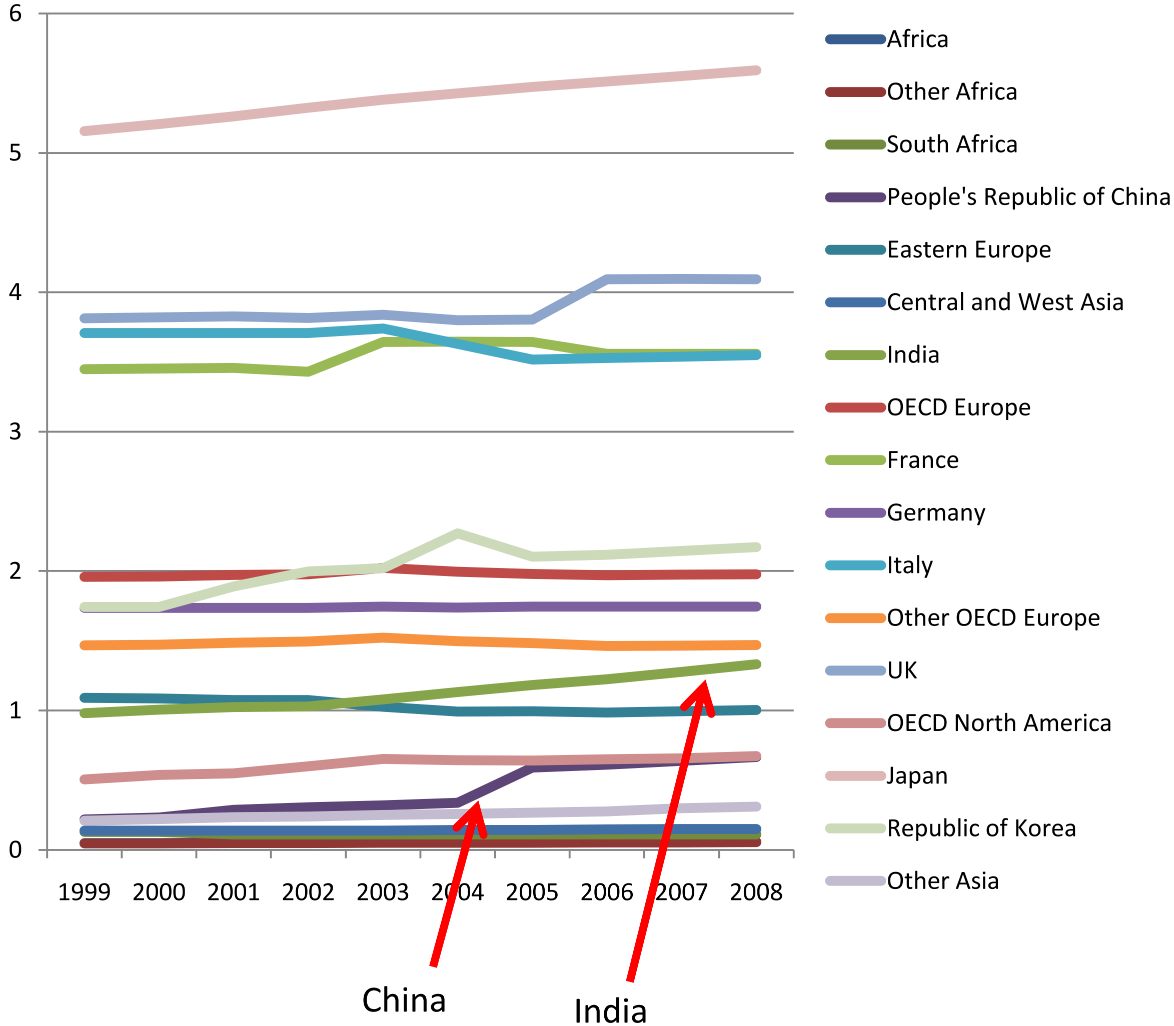
Resulting roadway density



India's roadway density calculates to 11.4 paved lane-km per km^2 by 2050, twice Japan's current value, which is the highest density value in the word today.

Historic roadway densities

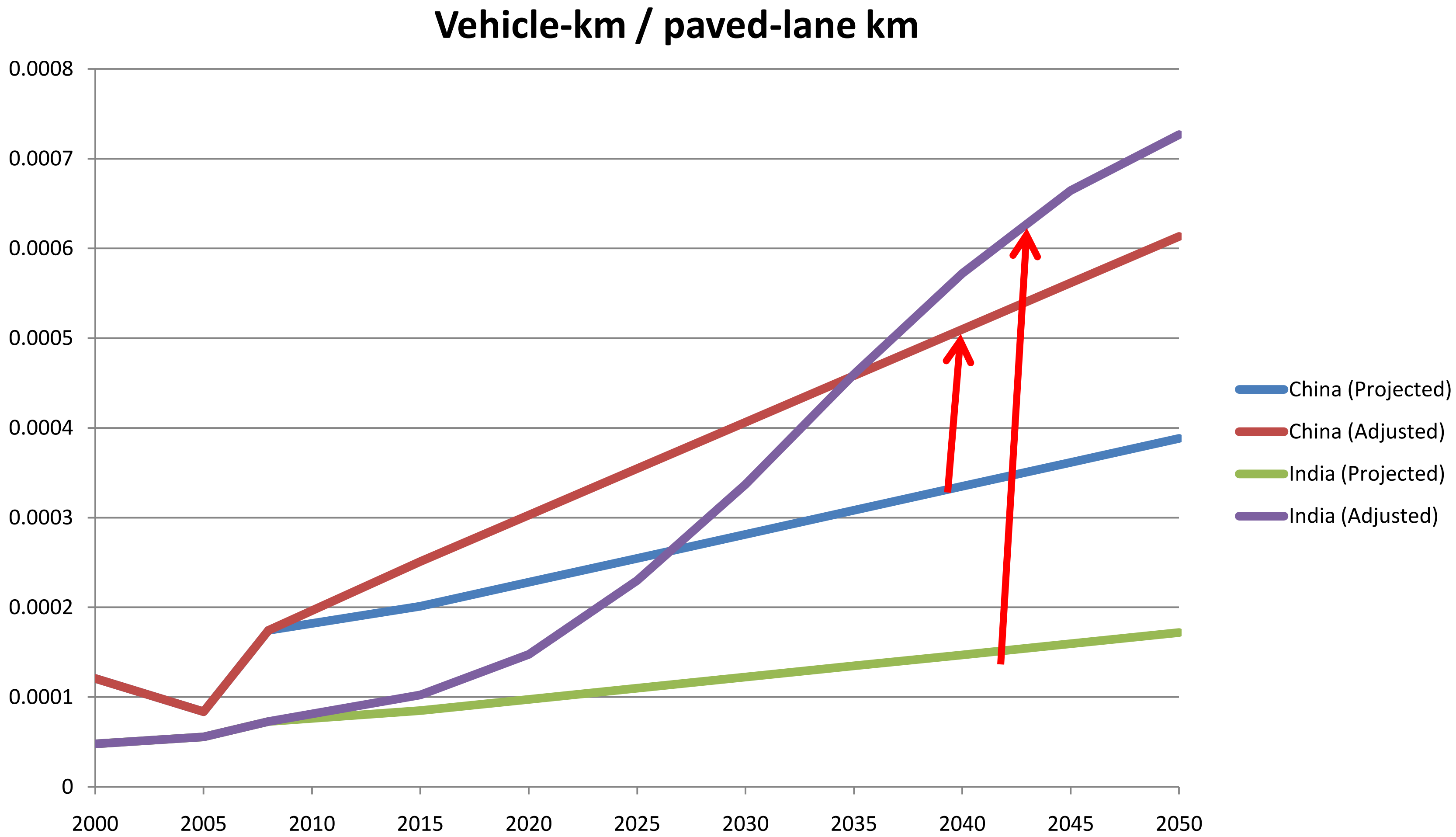
Paved lane-km per km^2



	Applied Paved Lane-Km Density Limits
Africa	1
Other Africa	1
South Africa	1
People's Republic of China	**2**
Eastern Europe	2
FSU	1
Central and West Asia	1
Russia	1
India	**3**
Latin America	1
Brazil	1
Other Latin America	1
Middle East	1
OECD Europe	3
France	5
Germany	3
Italy	5
Other OECD Europe	2
UK	5
OECD North America	2
Canada	1
Mexico	1
USA	2
OECD Pacific	1
Australia and NZ	1
Japan	5.7
Republic of Korea	4
Other Asia	2

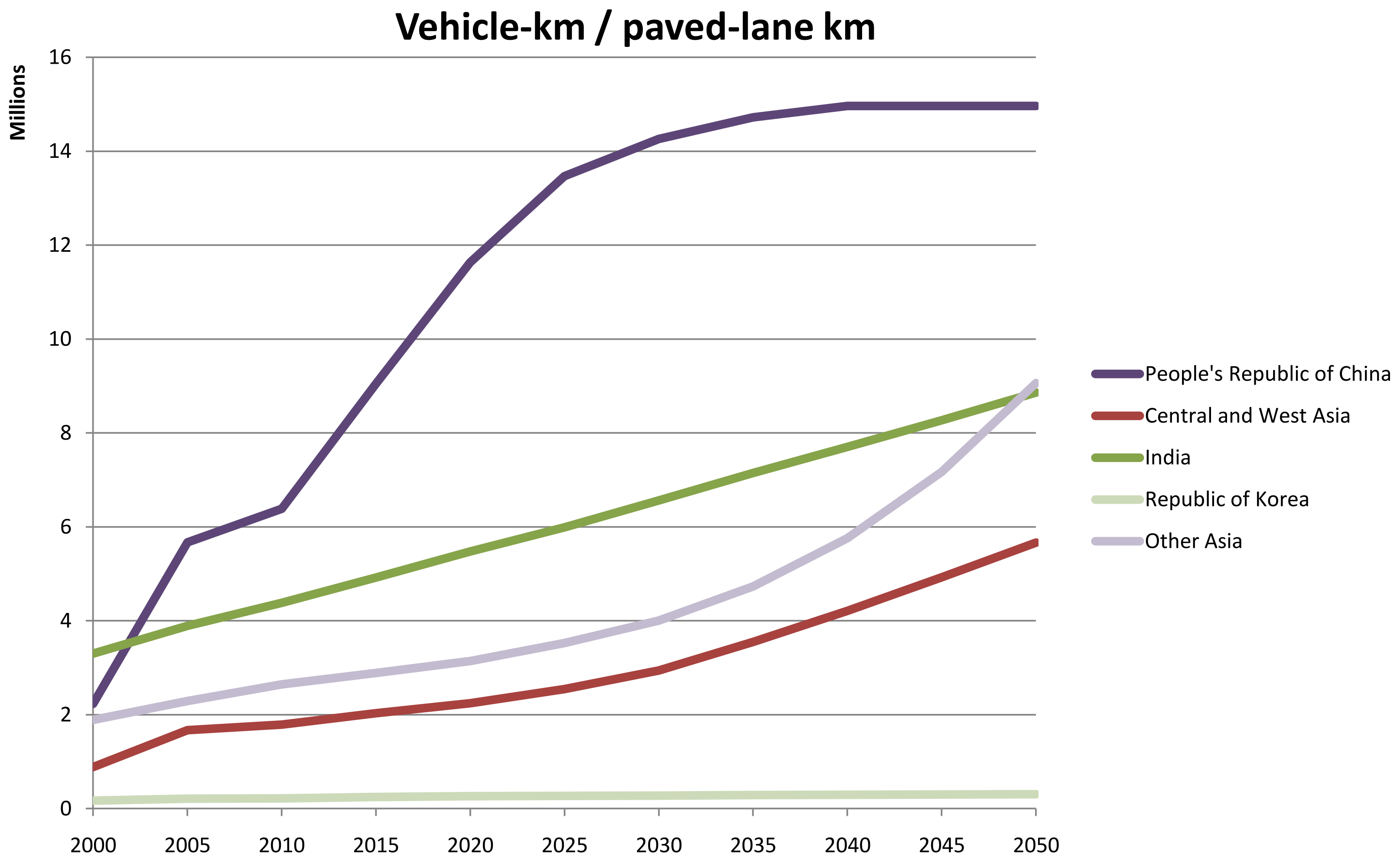
Density limits therefore are applied to ensure that roadways are not constructed further after reaching certain density thresholds: 1. China: 2 paved lane km per km^2; and, 2. India: 3 paved lane-km per km^2.

Adjusted congestion factors



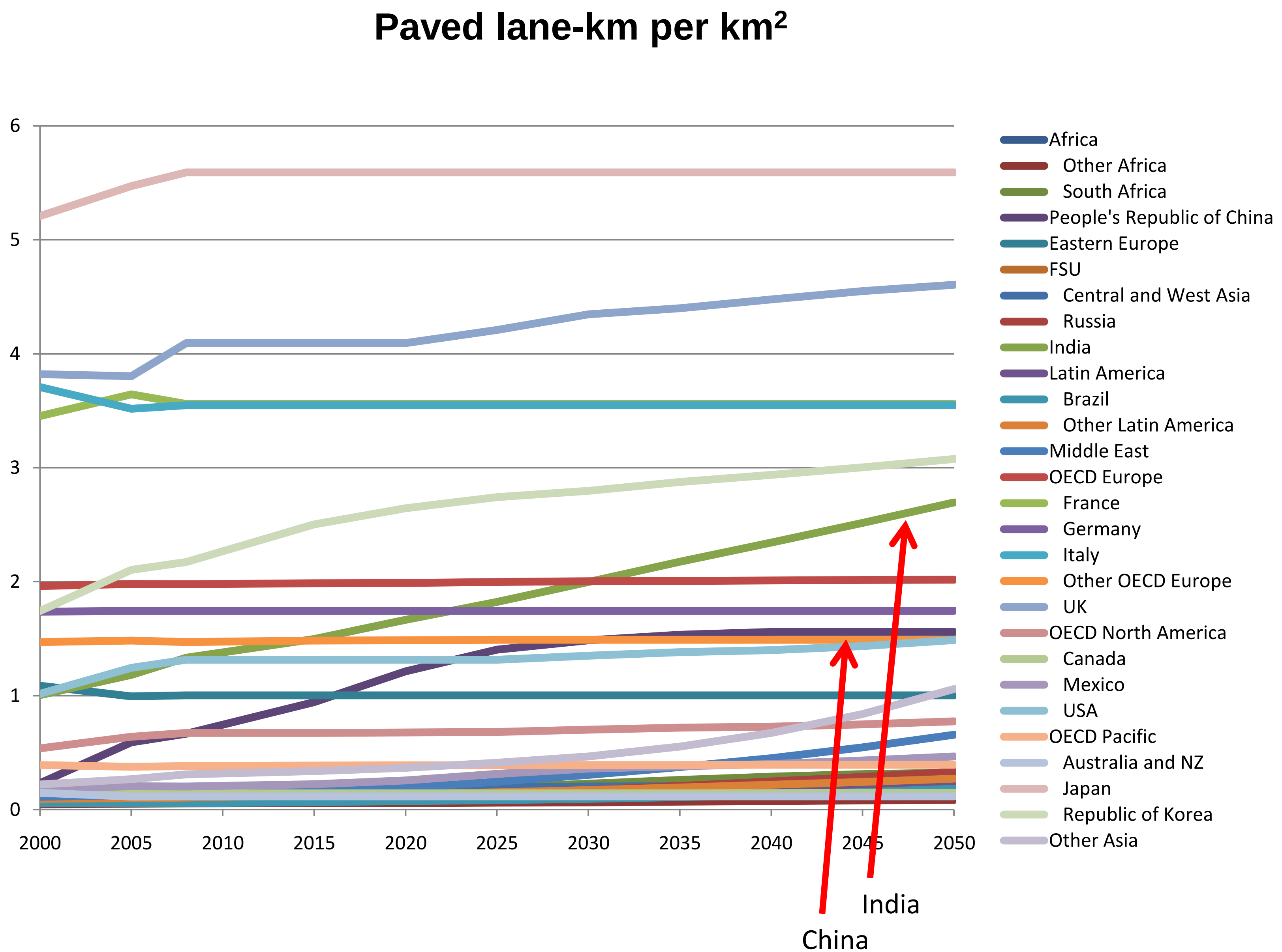
Further adjustment made to ensure annual infrastructure additions do not exceed the historic national capacity for road construction. China has never built more than an average 700k paved lane-km per year. India has not built more than 120k paved lane-km per year.

Adjusted paved lane-km

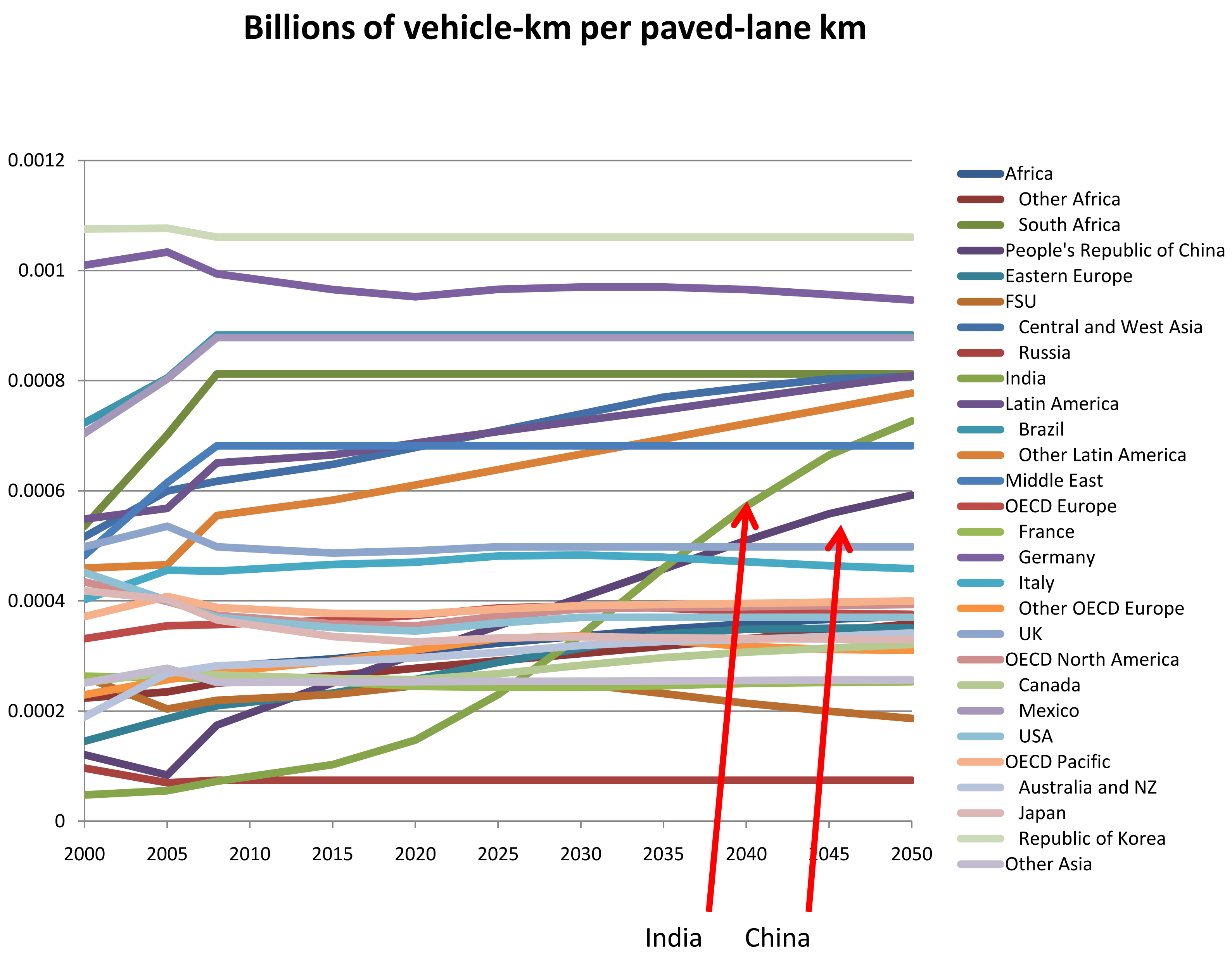


Application of limits on congestion and road construction capacity

Resulting roadway density



Resulting roadway congestion



Cost assumptions

Millions US$ per paved lane-km

	Construction			Reconstruction/Upgrade		
	Capital	Planning / Admin / Consulting	O&M	Capital	Planning / Admin / Consulting	O&M
People's Republic of China	1.309	0.0449	0.022	0.524	0.0245	0.0093
Central and West Asia	0.976	0.169	0.0723	0.045	0.0101	0.0185
India	0.338	0.007	0.0028	0.113	0.0034	0.0019
Republic of Korea	1.309	0.169	0.0217	0.524	0.025	0.0093
Other Asia	1.721	0.177	0.1101	0.138	0.0116	0.0093

Based on actual data from ADB funded roadway development (51 projects).

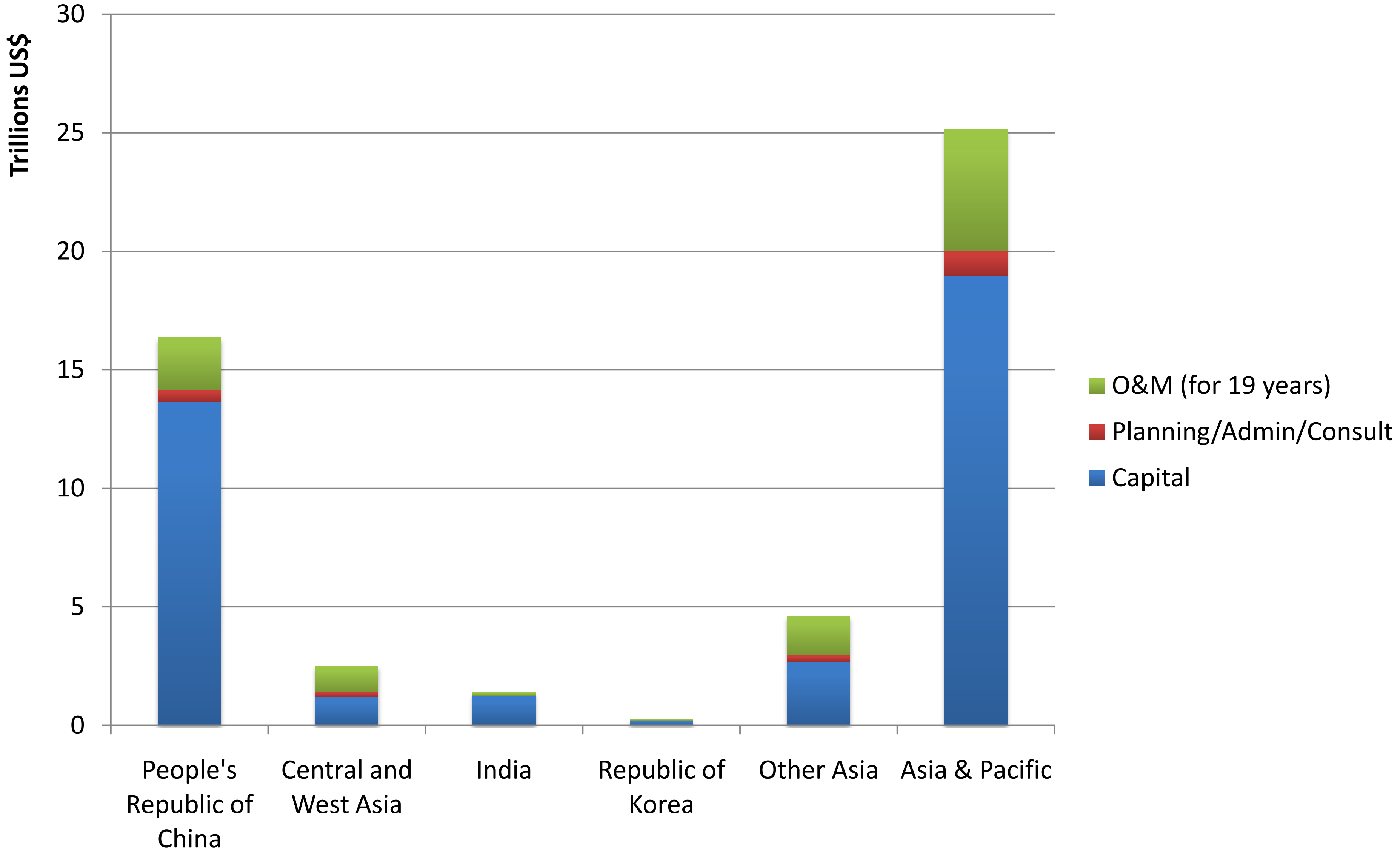
Note that India's costs are considerably lower than other parts of the region.

Roadway construction, reconstruction, and O&M Costs to 2030

Billions US$

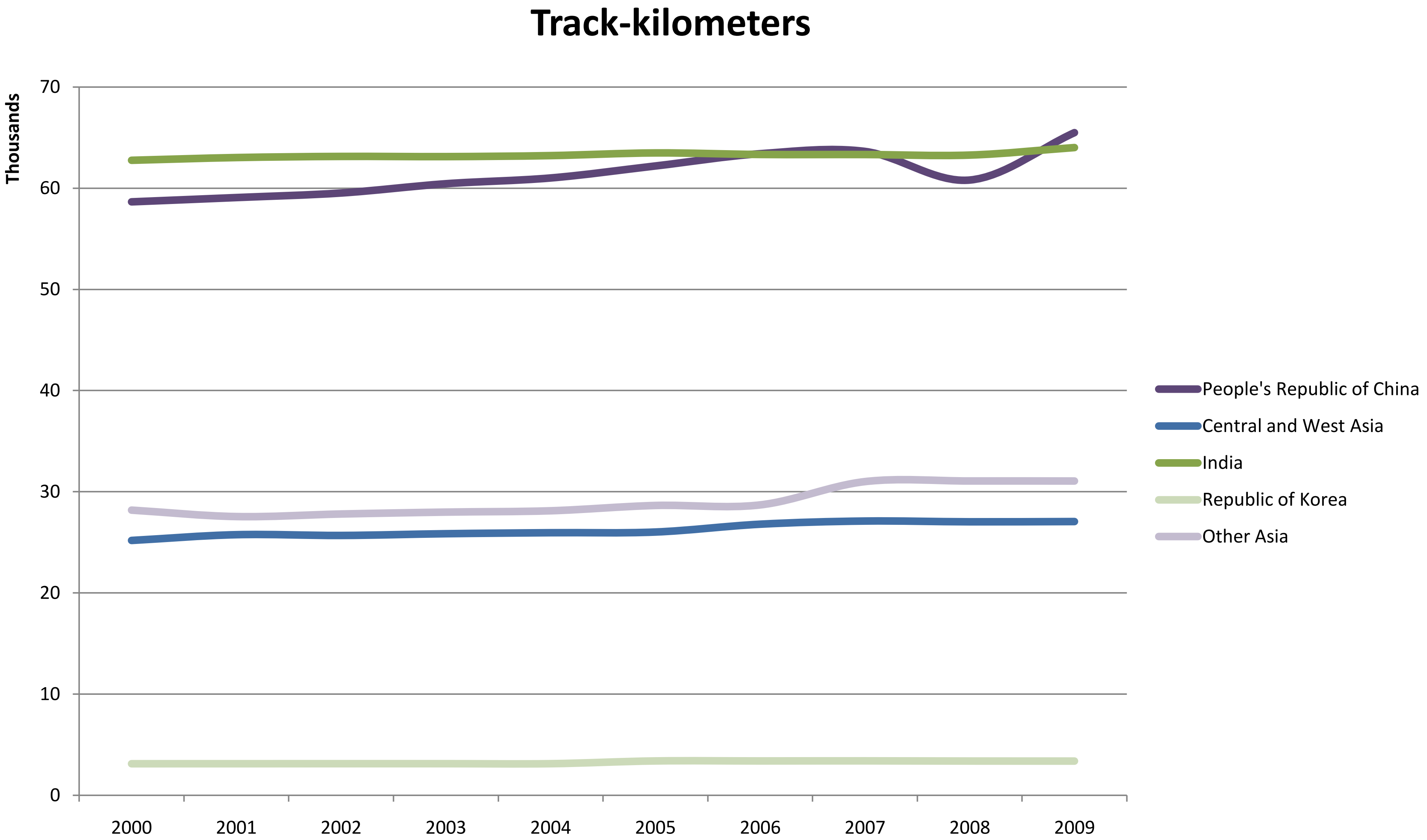
	Capital	Planning / Admin / Consulting	O&M (for 19 years)	Total	Average per year (20 year period)
People's Republic of China	13,656	513	2,188	16,357	**818**
Central and West Asia	1,202	212	1,104	2,519	**126**
India	1,226	30.2	138.4	1,394	**69.7**
Republic of Korea	194	15.9	31.8	242	**12.1**
Other Asia	2,695	271	1,650	4,615	**231**
Asia & Pacific	**18,974**	**1,042**	**5,112**	**25,127**	**1,256**

Net infrastructure costs to 2030 (trillions)



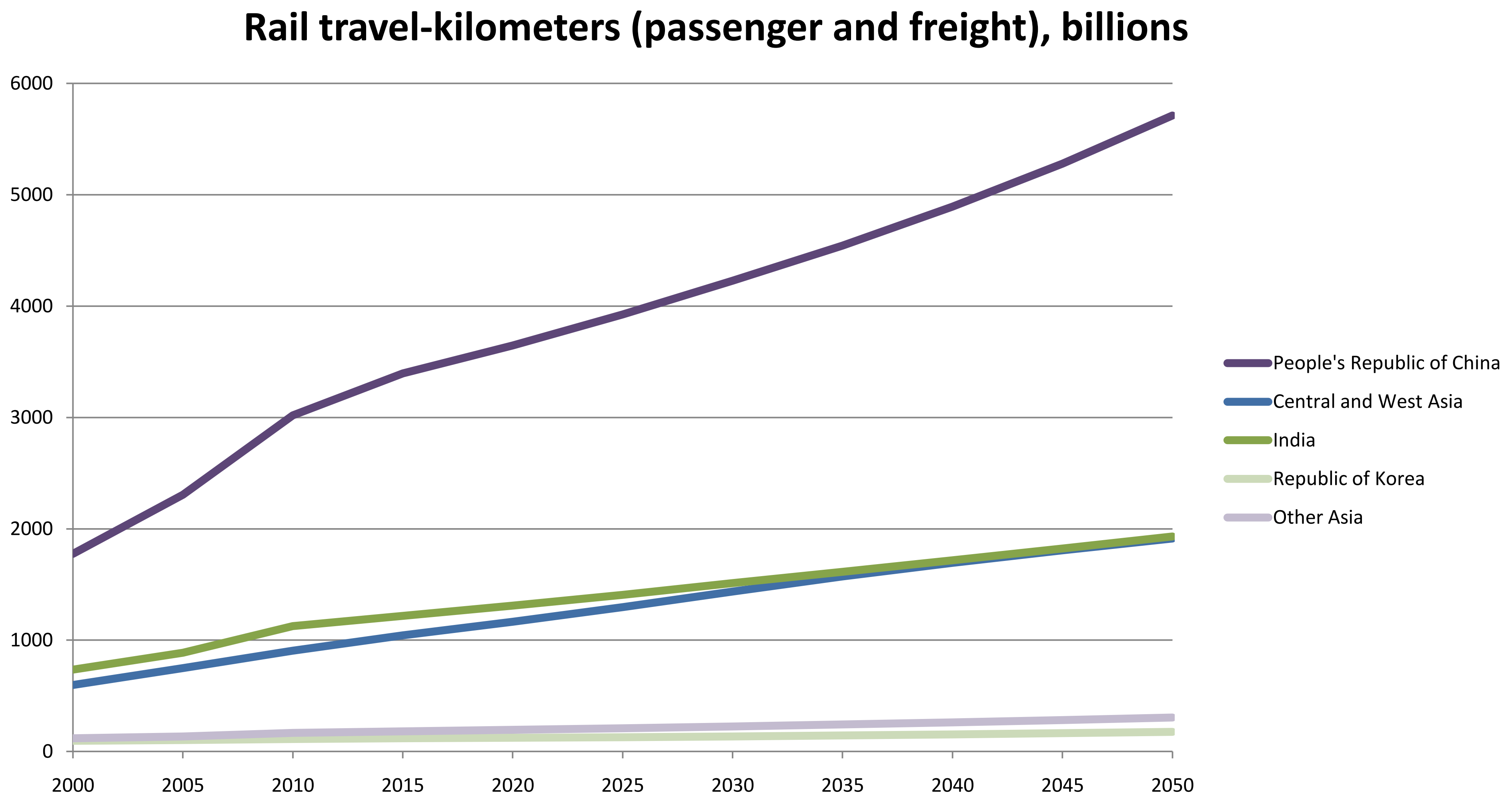
Railway infrastructure cost projections

Existing railway infrastructure



Source: UIC, IEA

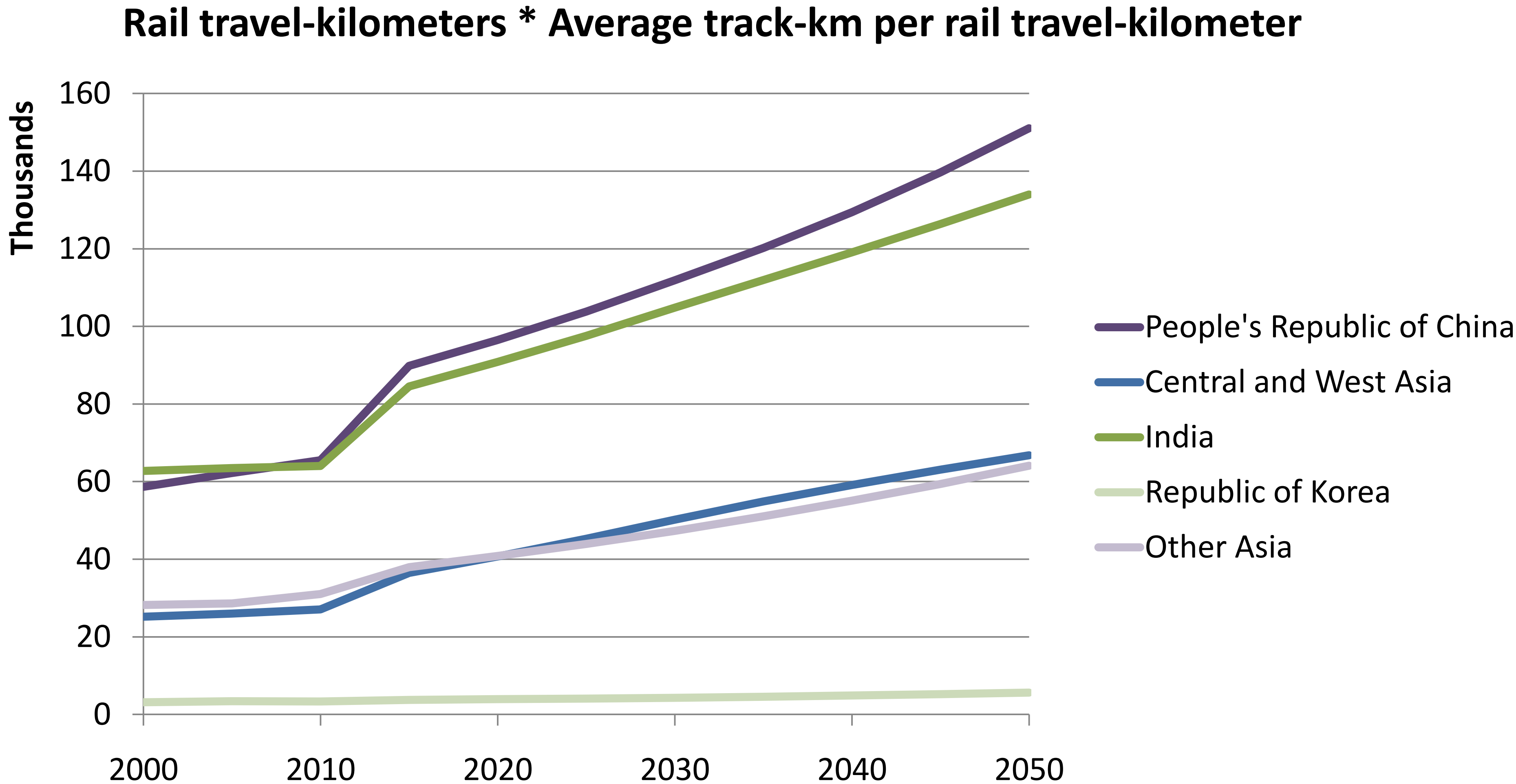
Projections of rail travel-kilometers to 2050



Source: IEA

Asia and Pacific's share of global rail travel increases from 49% in 2010 to 53% in 2050.

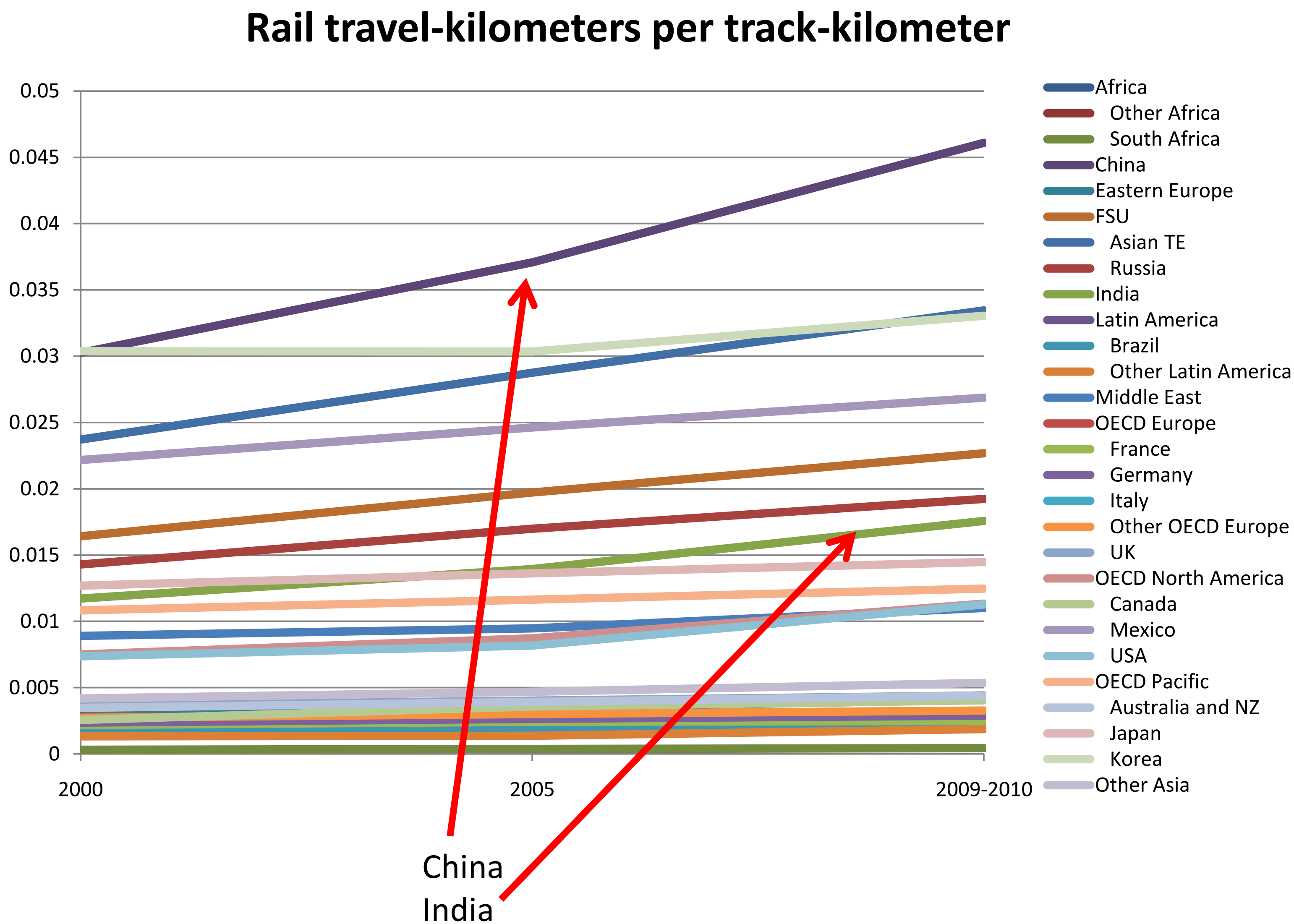
Rail track-km projections (No limits applied)



Results in more than doubling the 2010 infrastructure network size. Realistic?

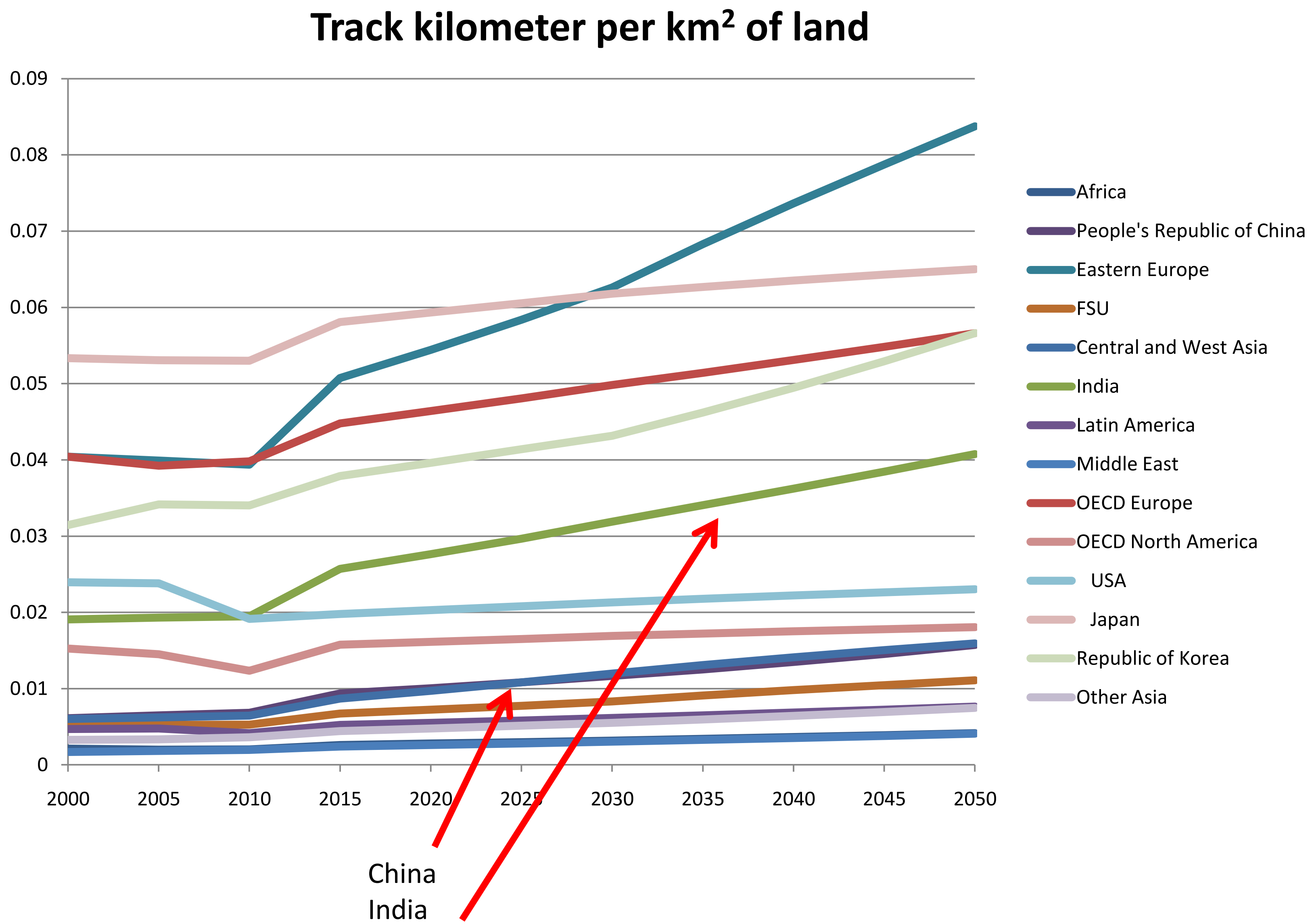
Note: Does note include high-speed rail.

Historic ratio of utilization factor



Unlike the situation with road infrastructure, China's and India's utilization factor are already relatively high. Thus, for rail, rail density per km^2 of land and construction capacity are more likely to be limiting factors.

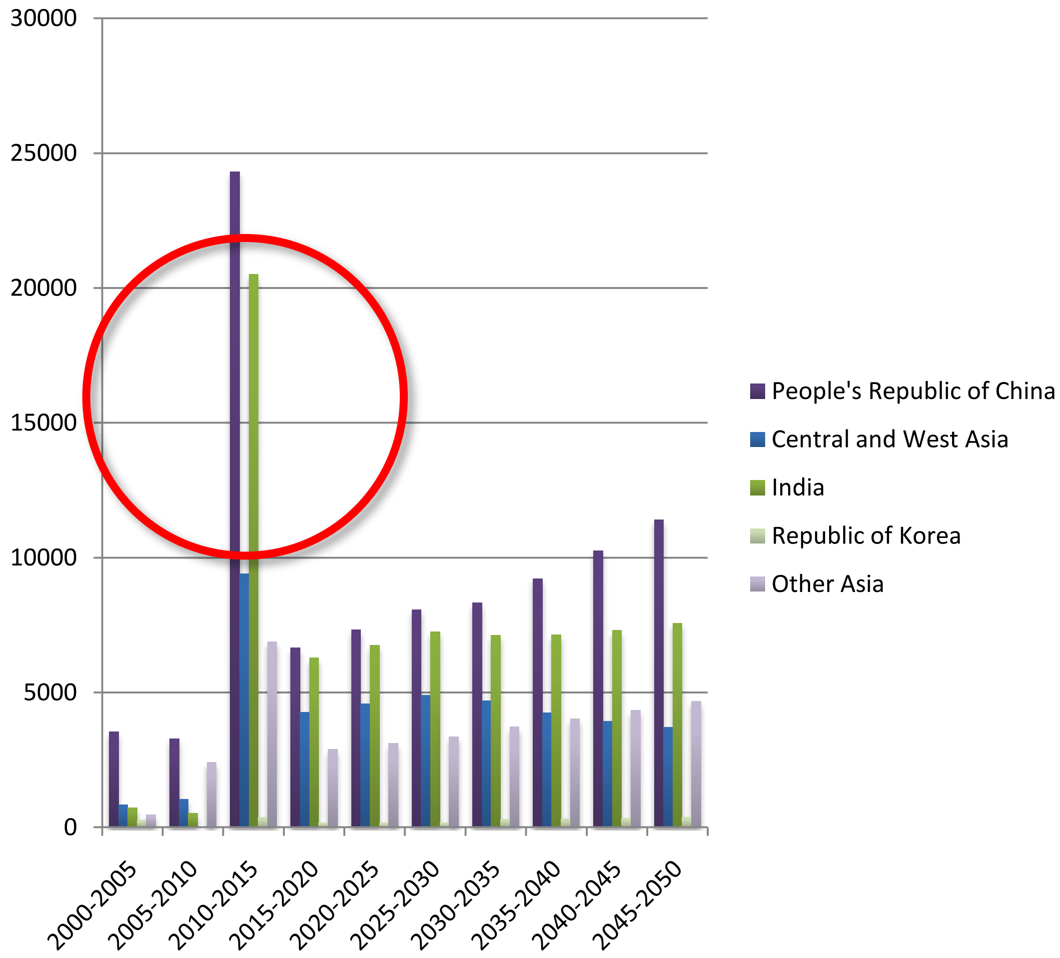
Consequent rail track density (Track-km per Km^2)



Land availability does not appear to be a limiting factor.

Projected added track-kilometers

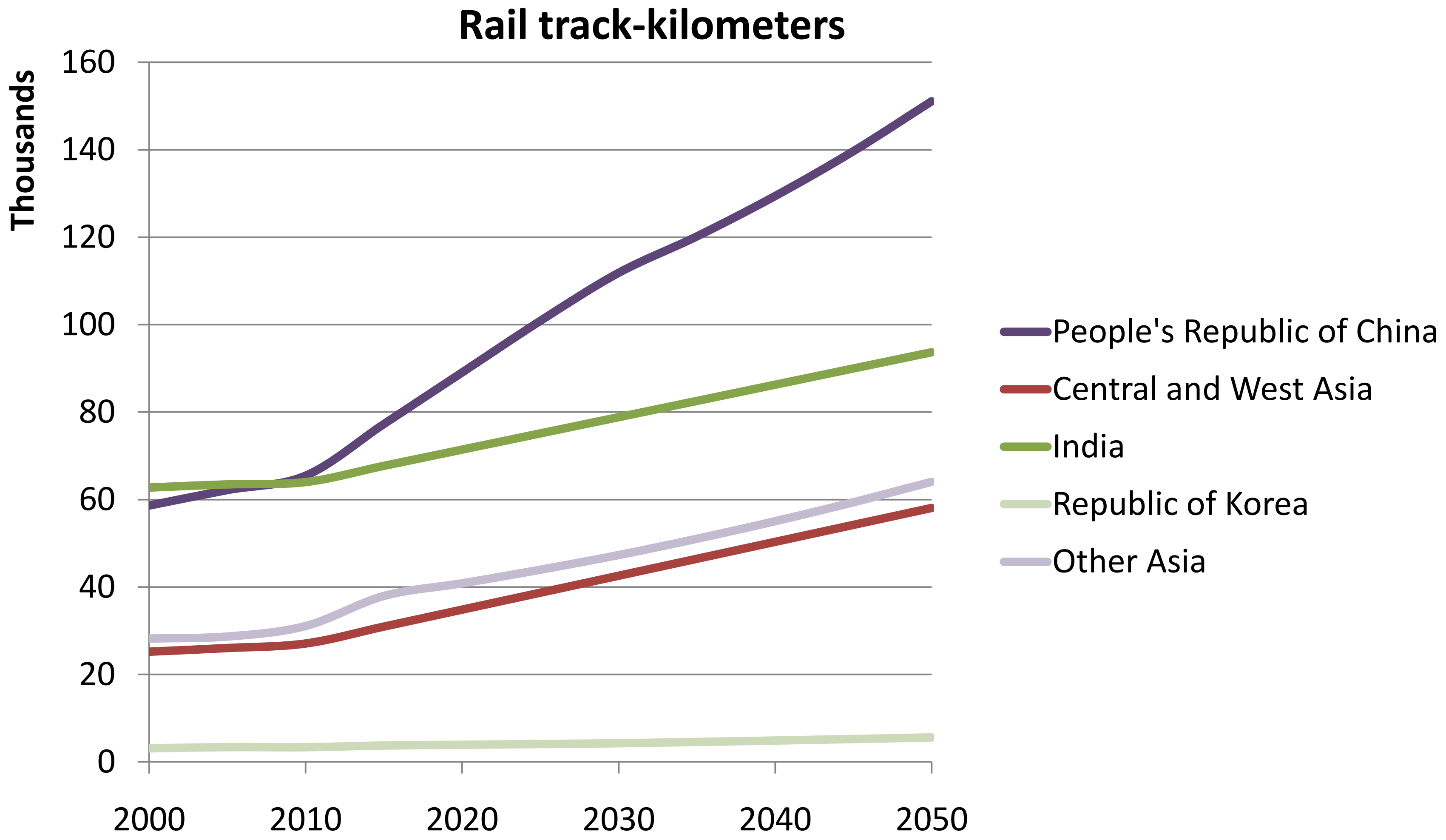
Track-kilometers added over each 5-year period



	Applied Limits (5 Year Construction Capacity)
People's Republic of China	11,798
Central and West Asia	3,880
India	3,710
Republic of Korea	1,315
Other Asia	11,495

Rate of track additions in the post-2010 period significantly exceeds historical rate, especially from 2010 to 2015.

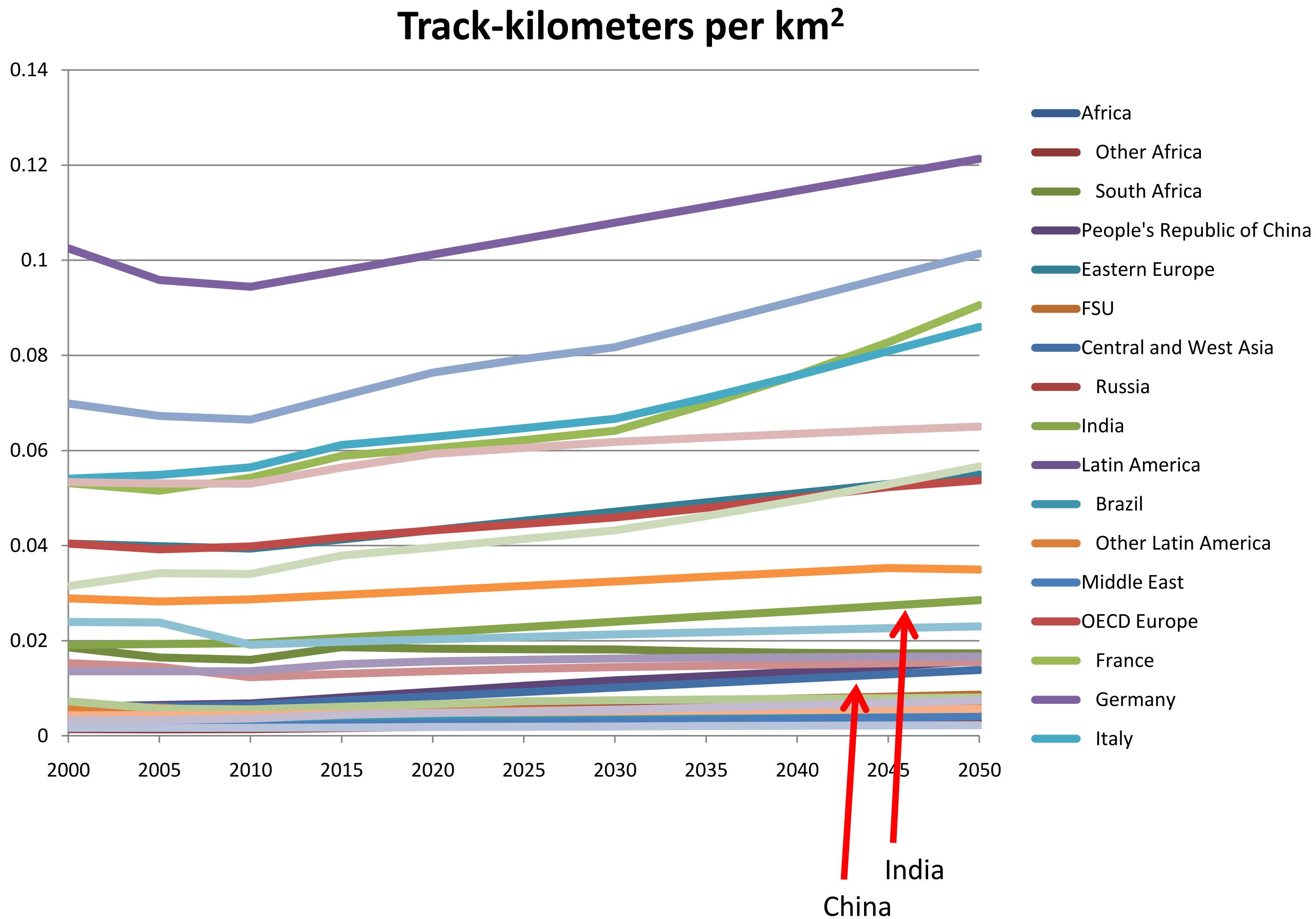
Rail track-km projections with construction-capacity limits applied



Steady growth is applied to China while historic construction capacities are applied elsewhere.

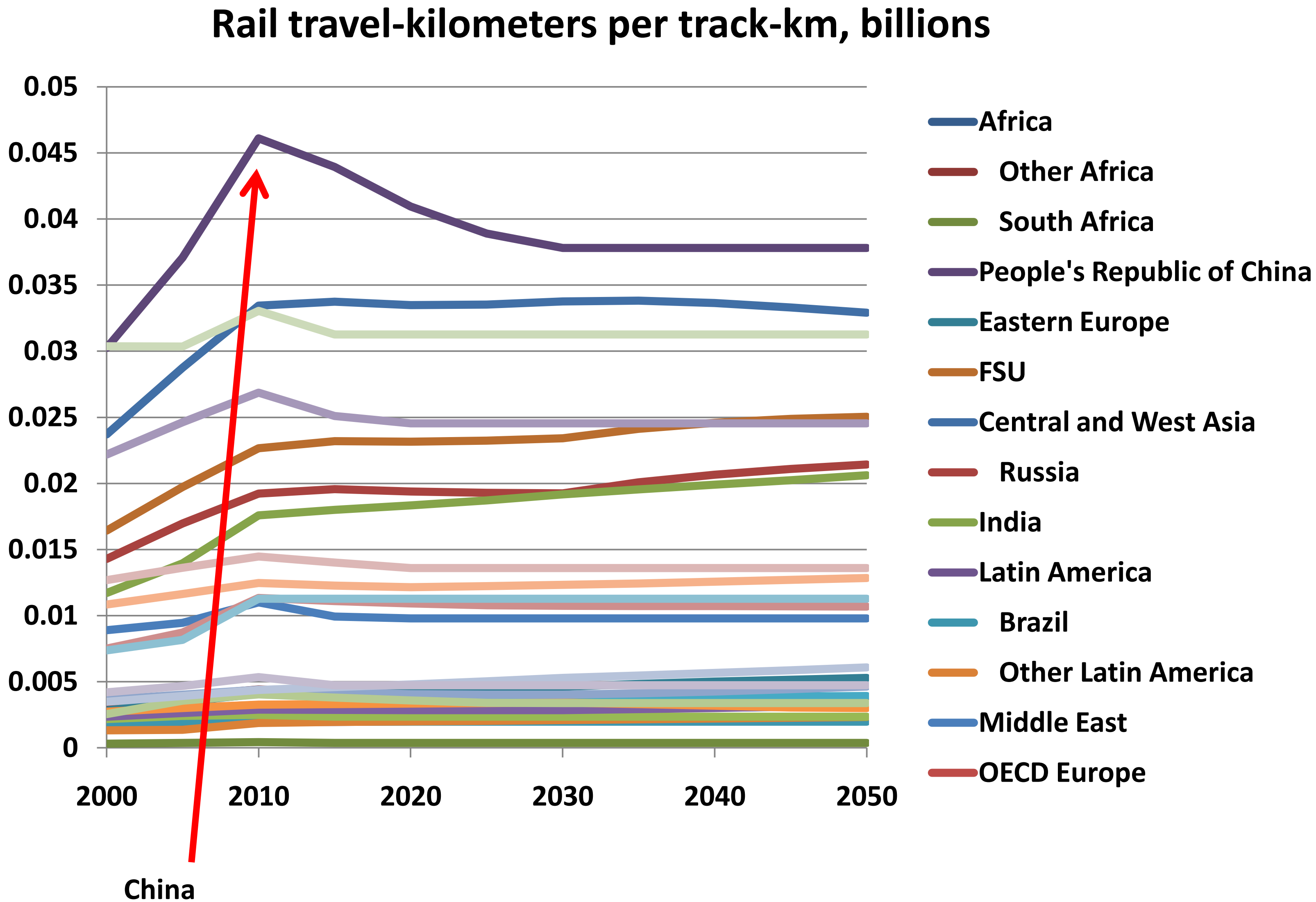
The global share of track-km for Asia and Pacific increase from 20% in 2010 to 25% in 2050 (excluding High-Speed Rail).

Resulting railway density



When construction capacity limits are applied, the rail density of the Asia and Pacific region falls within global levels.

Resulting railway utilization



China's utilization rate spikes in 2010, but then becomes stable through to 2050.

Cost assumptions

Million US$ per track-kilometer

	Capital	Planning / Administration / Consulting	Operations & Maintenance
People's Republic of China	2.8714	0.219747	0.82037
Central and West Asia	1.95	0.13	0.82
India	2.8714	0.219747	0.82037
Republic of Korea	2.8714	0.219747	0.82037
Other Asia	2.8714	0.219747	0.82037

Based on ADB rail development cost data.

In the case of rail, O&M costs are approximately one-third of original capital costs.

Note: Data does not include High-Speed Rail.

Construction, reconstruction, and O&M costs to 2030

Millions US$

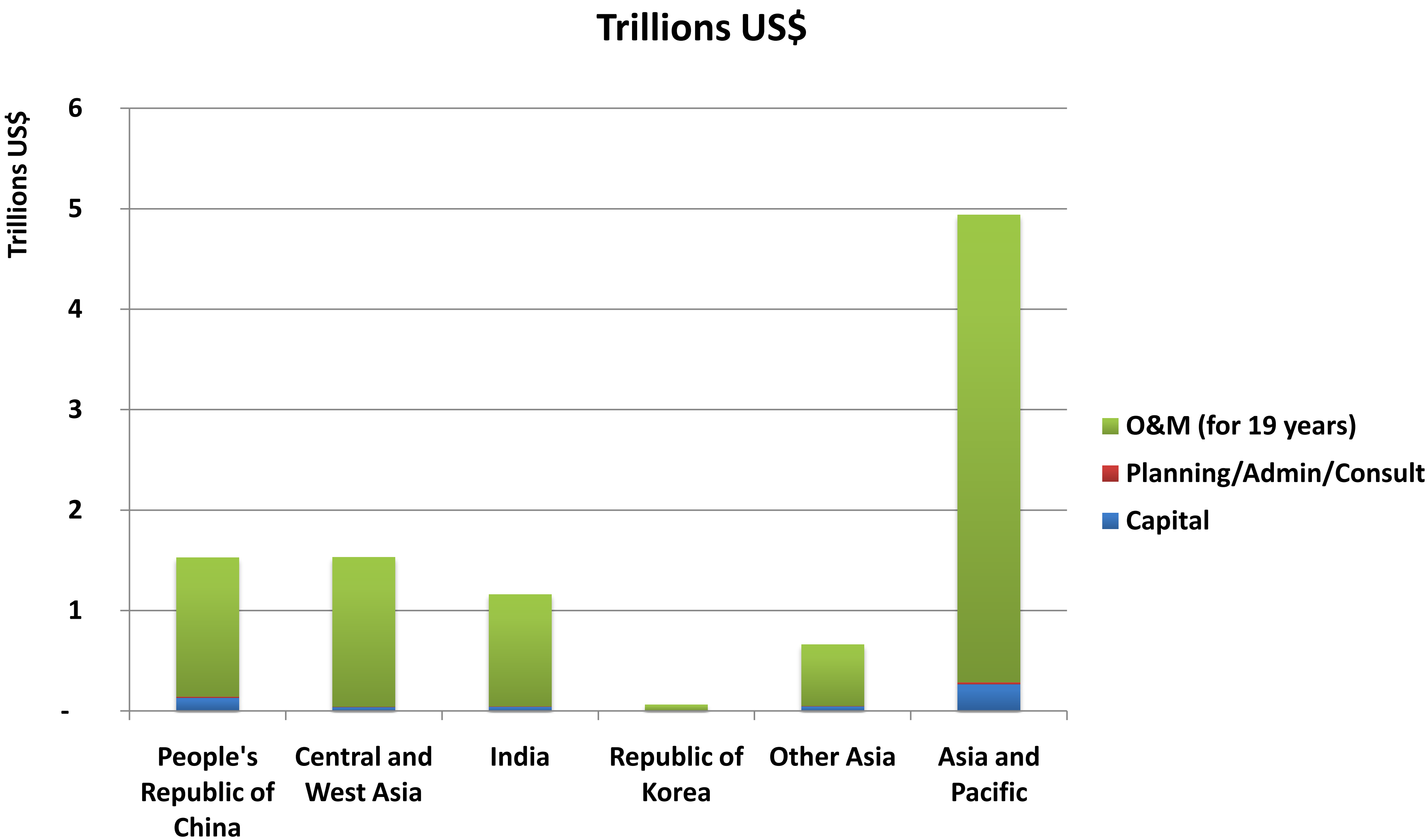
	Capital	Planning / Admin / Consulting	O&M (for 19 years)	Total	Average per year (20 year period)
People's Republic of China	133,132	10,189	1,382,156	**1,525,476**	**76,274**
Central and West Asia	40,404	2,694	1,487,016	**1,530,113**	**76,506**
India	42,612	3,261	1,113,459	**1,159,332**	**57,967**
Republic of Korea	2,605	199	59,724	**62,528**	**3,126**
Other Asia	46,665	3,571	610,713	**660,950**	**33,047**
Asia and Pacific	265,418	19,914	4,653,068	**4,938,400**	**246,920**

Assumes that recently reconstructed/upgraded rail will have a lifetime of roughly 50 years.

Note that the bulk of the costs for rail are related to Operations & Maintenance.

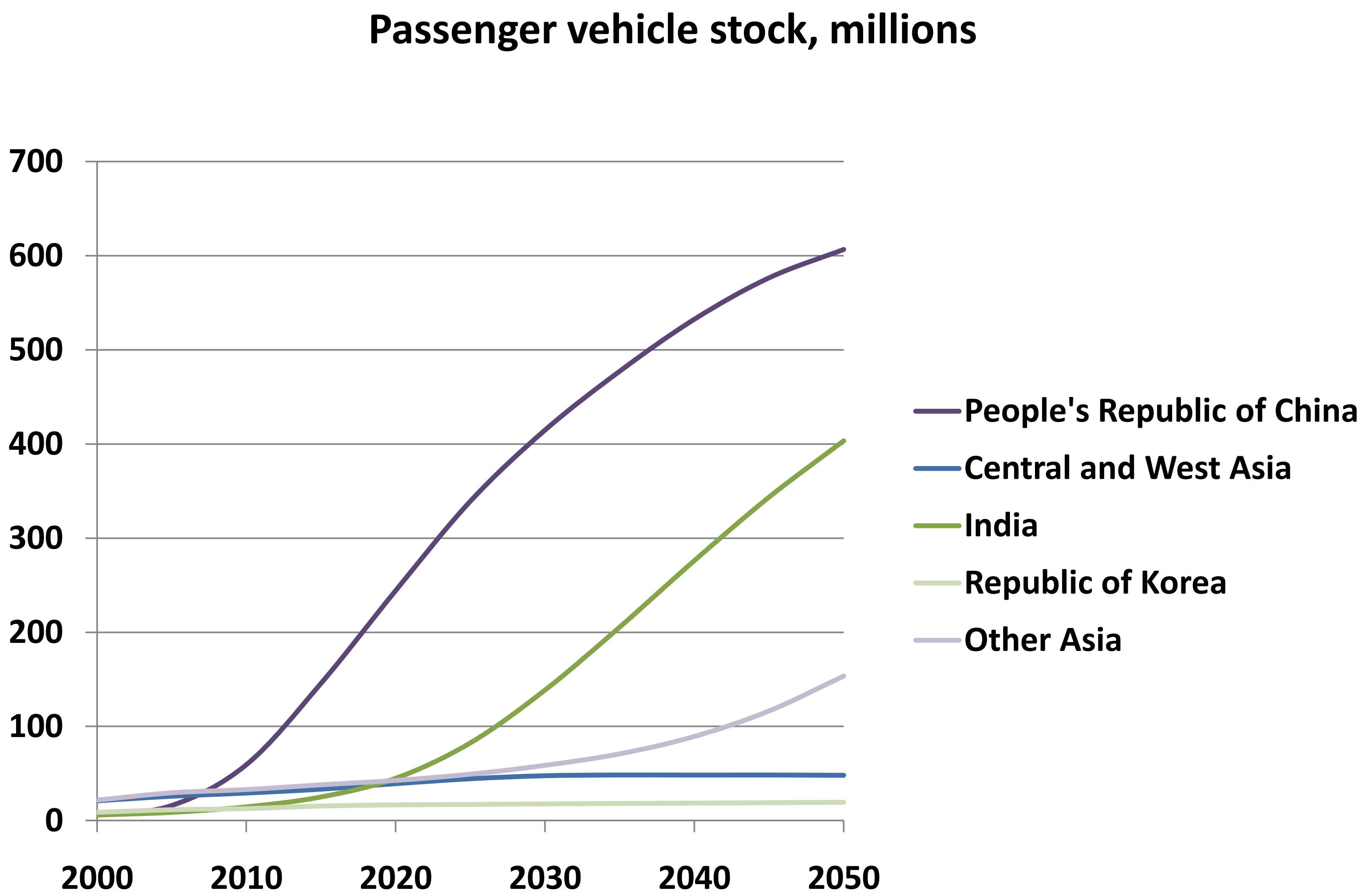
Note that data does not include High-Speed Rail.

Net infrastructure costs to 2030

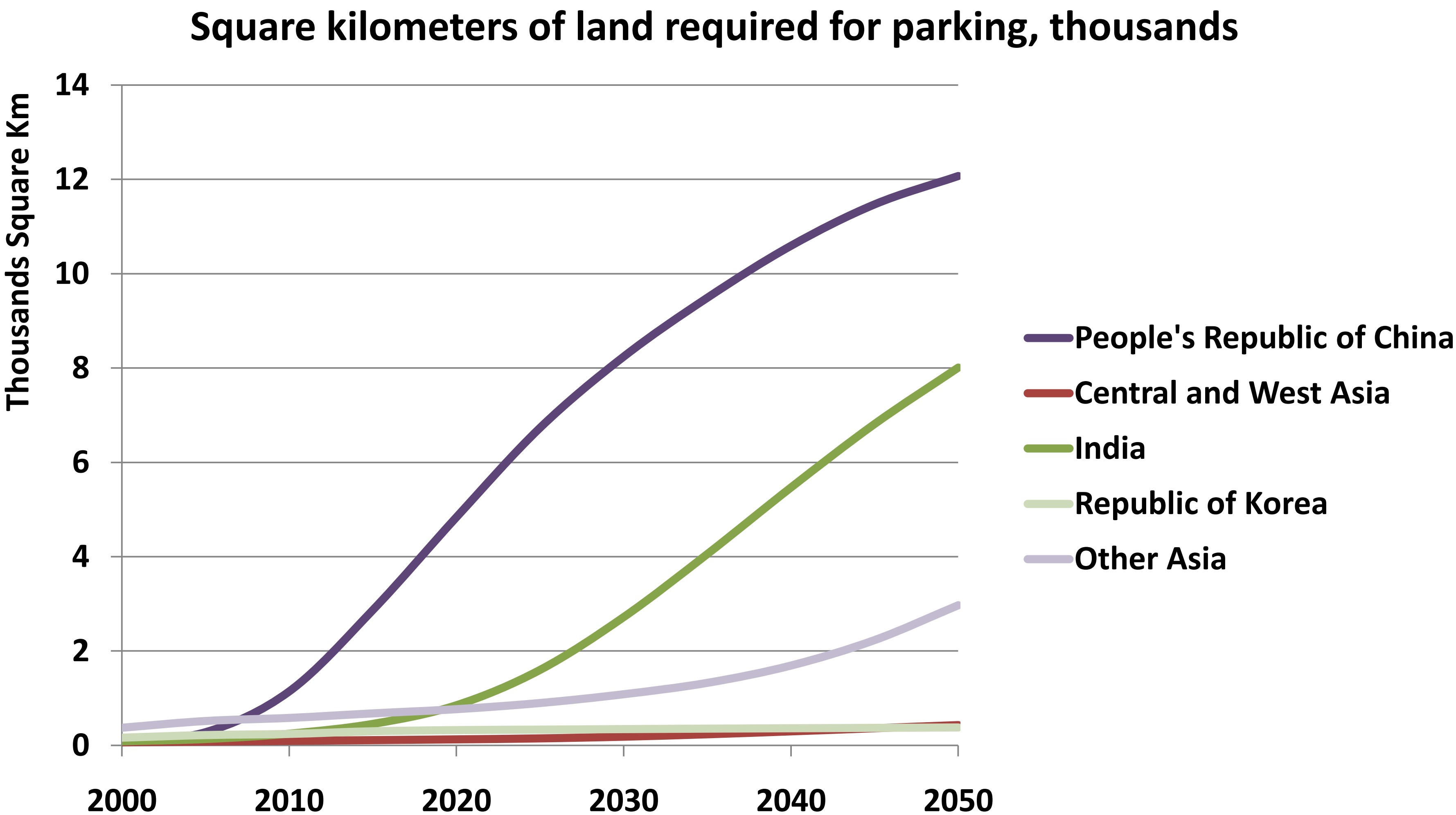


Parking infrastructure projections

IEA projected vehicle stock

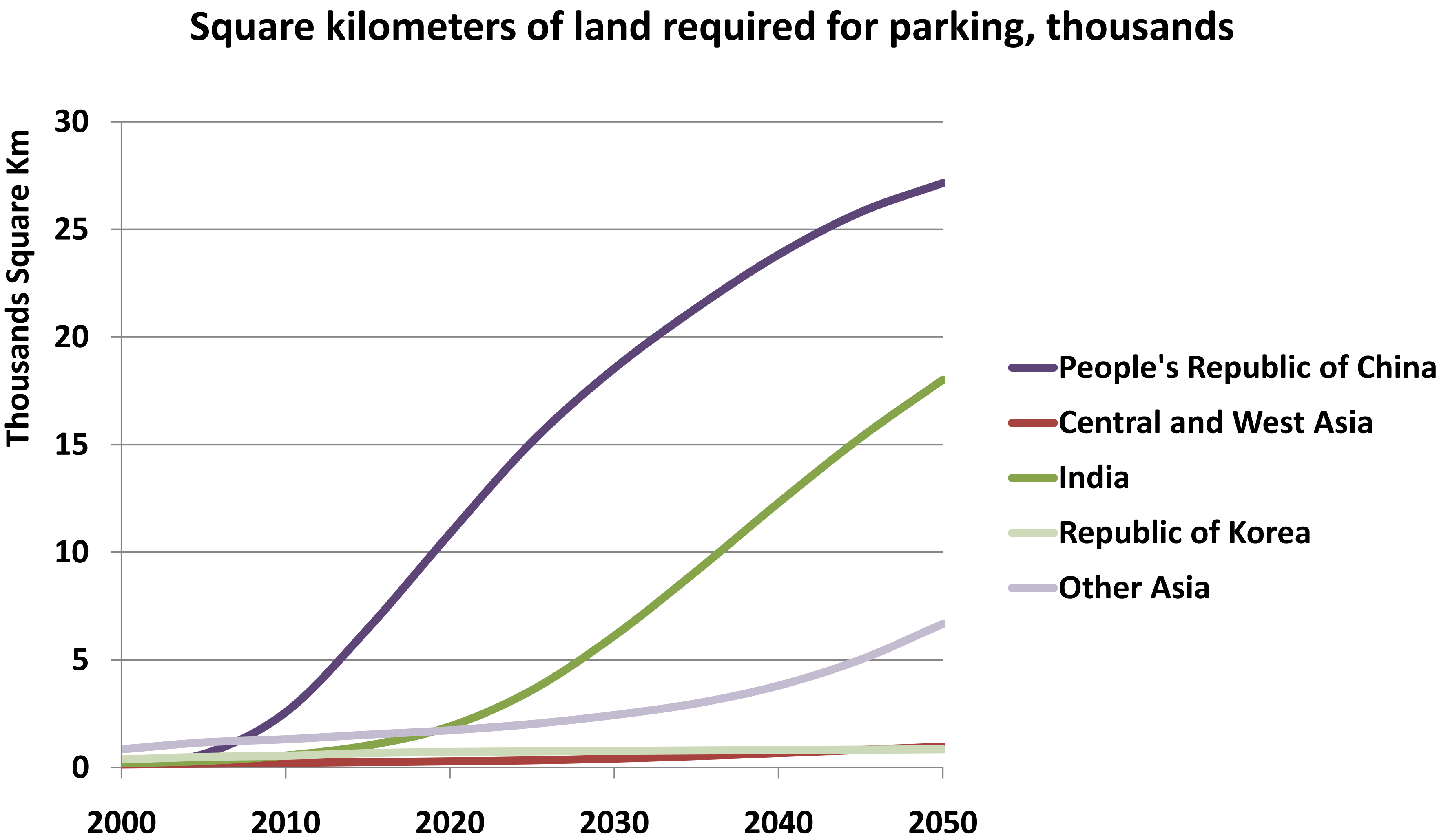


Low scenario (Two $10m^2$ paved spaces per vehicle)



Under the low scenario, the Asia and Pacific region will require 22,000 km^2 of new parking spaces during the period of 2010 to 2050.

High scenario (Three 15m² paved spaces per vehicle)



Under the low scenario, the Asia and Pacific region will require 48,000 km² of new parking spaces during the period of 2010 to 2050.

Cost assumptions

Millions US$ per square kilometer

	Construction		
	Capital	Land	O&M
People's Republic of China	40.5529	6.147	4.05529
Central and West Asia	40.5529	31.9	4.05529
India	40.5529	4.987	4.05529
Republic of Korea	40.5529	6.147	4.05529
Other Asia	40.5529	4.987	4.05529

Capital costs are based on a single CDIA study from Indonesia for a surface-level parking area. To the extent underground and multi-story parking facilities are developed, cost will be more.

Land values are an average of land costs from ADB transport projects (170 projects).

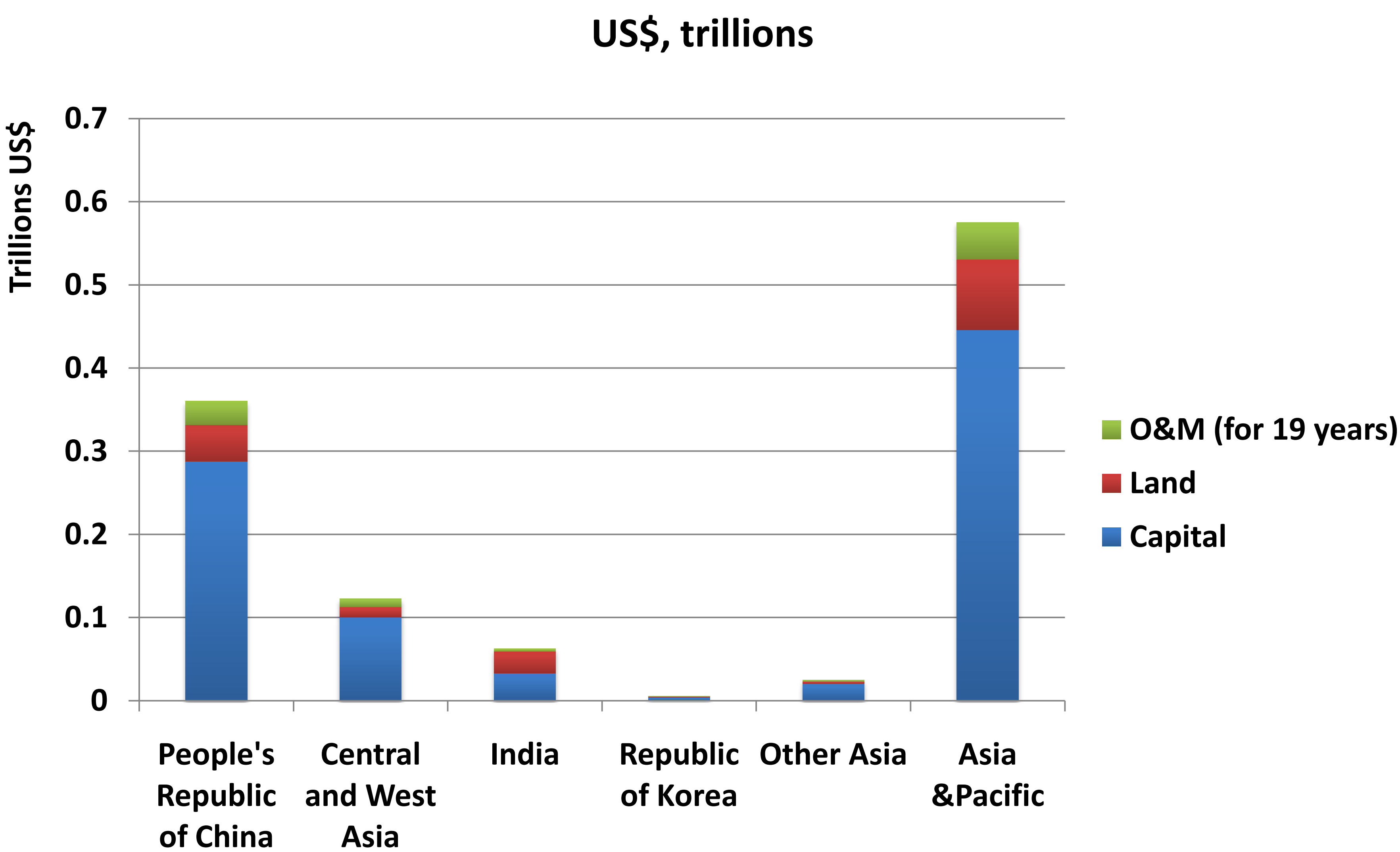
Annual operation and maintenance costs are estimated as 10% of original capital costs.

Construction, maintenance & operation costs to 2030

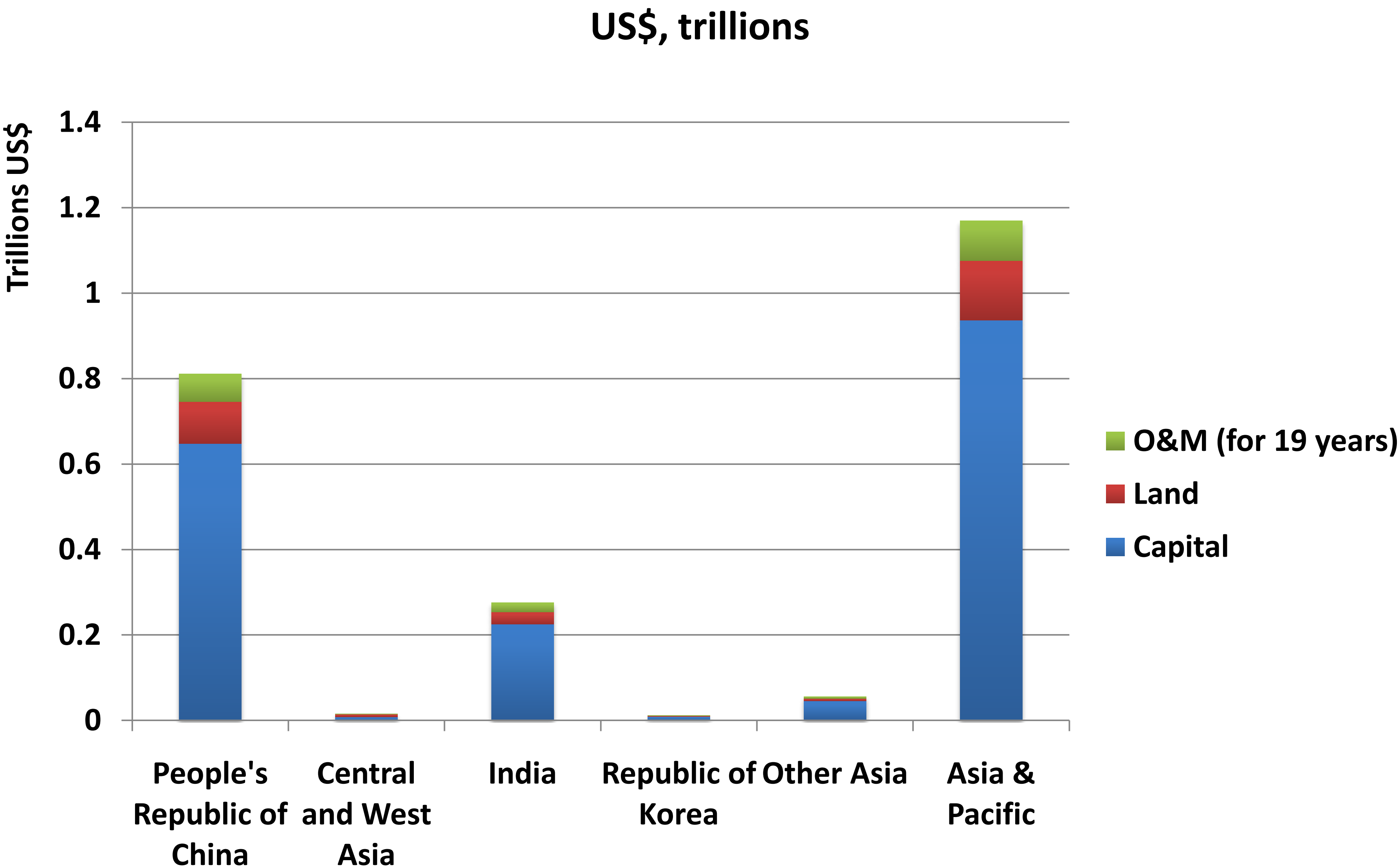
US$, millions

		Capital	Land	O&M (for 19 years)	Lifetime Cost per year (20 year period)
Low	People's Republic of China	287,885	43,638	28,789	**18,016**
	Central and West Asia	100,290	12,333	10,029	**6,133**
	India	33,043	25,993	3,304	**3,117**
	Republic of Korea	4,056	615	406	**254**
	Other Asia	20,338	2,501	2,034	**1,244**
	Asia &Pacific	**445,613**	**85,079**	**44,561**	**28,763**
High	People's Republic of China	647,742	98,185	64,774	**40,535**
	Central and West Asia	8,066	6,345	807	**761**
	India	225,653	27,750	22,565	**13,798**
	Republic of Korea	9,125	1,383	913	**571**
	Other Asia	45,761	5,628	4,576	**2,798**
	Asia & Pacific	**936,348**	**139,290**	**93,635**	**58,464**

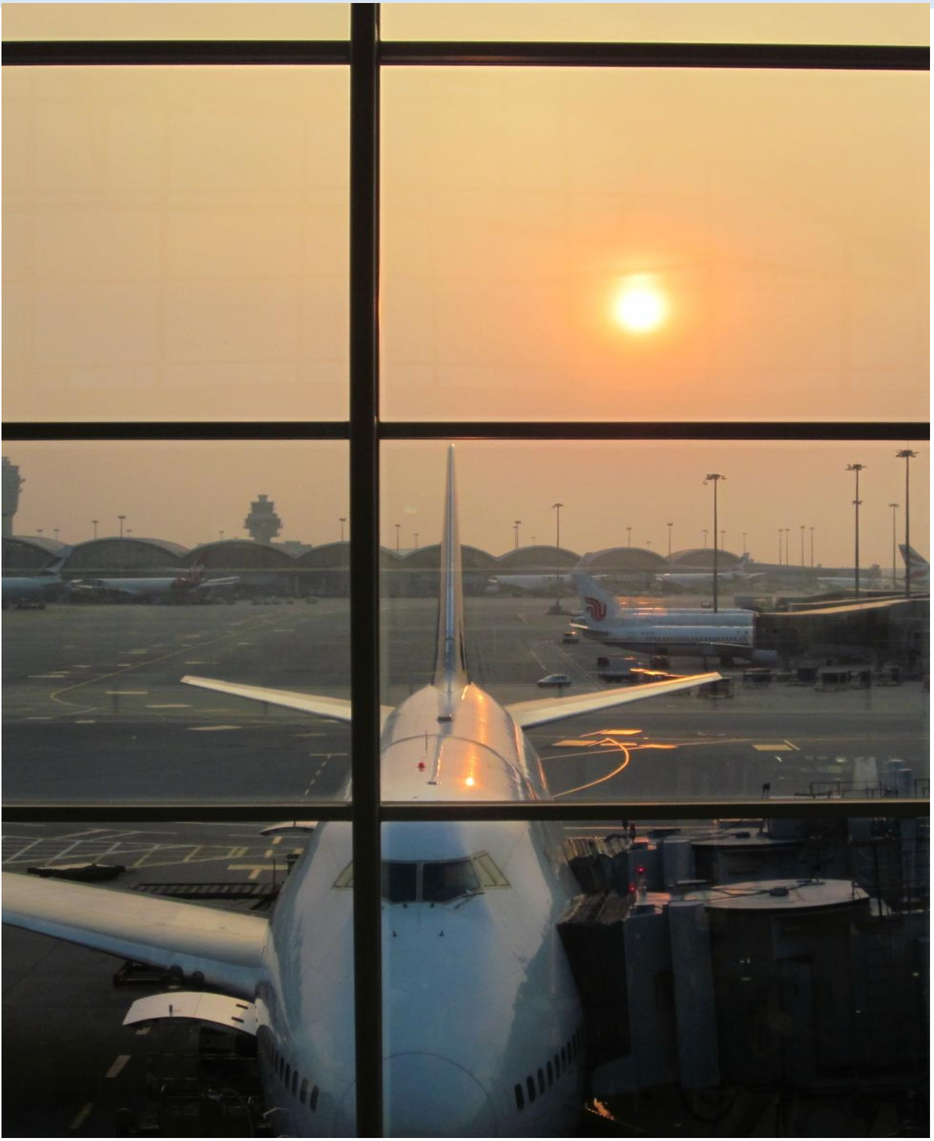
Net parking costs to 2030 (low scenario)



Net parking costs to 2030 (high scenario)



Additional transport sector costs



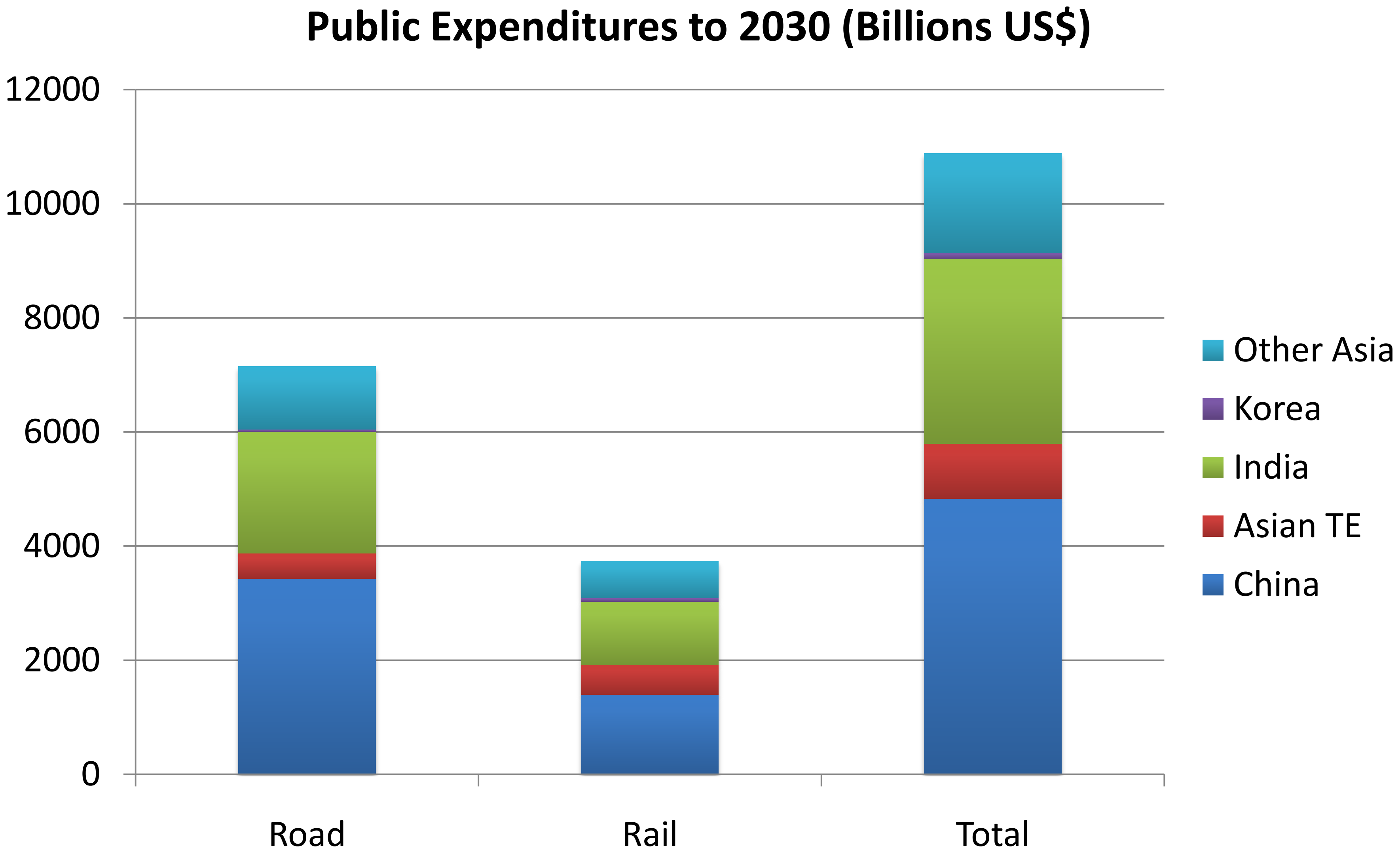
Air travel infrastructure

Freight infrastructure

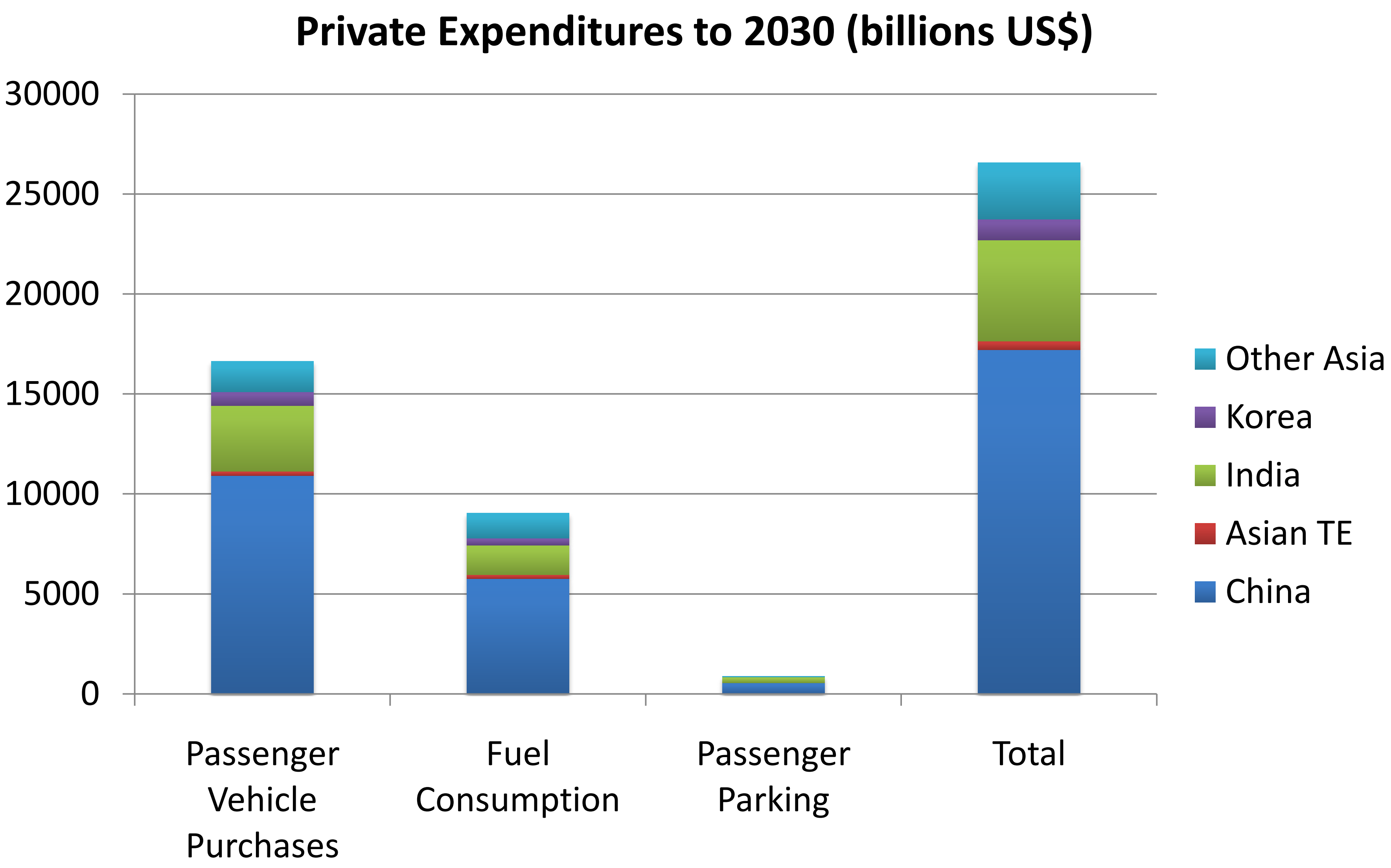
Projected expenditures for business-as-usual baseline to 2030

<table>
<tr><th></th><th></th><th></th><th colspan="2">Net Expenditures to 2030 (Billion US$)</th><th colspan="2">Expenditure as a Percent of Annual GDP by 2030</th></tr>
<tr><td rowspan="5">Public</td><td rowspan="3">Road Infrastructure</td><td>Capital Construction</td><td>15,392.8</td><td rowspan="3">25,127.5</td><td>1.17%</td><td rowspan="3">1.92%</td></tr>
<tr><td>Reconstruction / Upgrading</td><td>4,622.8</td><td>0.35%</td></tr>
<tr><td>Operation & Maintenance (All Road)</td><td>5,111.9</td><td>0.39%</td></tr>
<tr><td rowspan="2">Rail Infrastructure</td><td>Capital Construction</td><td>285.3</td><td rowspan="2">4,938.4</td><td>0.02%</td><td rowspan="2">0.38%</td></tr>
<tr><td>Operation & Maintenance (All Rail)</td><td>4,653.1</td><td>0.35%</td></tr>
<tr><td rowspan="5">Private</td><td rowspan="2">Passenger Vehicles (IEA Estimates)</td><td>Purchases</td><td>16,639.4</td><td rowspan="2">25,690.6</td><td>1.27%</td><td rowspan="2">1.96%</td></tr>
<tr><td>Fuel</td><td>9,051.3</td><td>0.69%</td></tr>
<tr><td rowspan="3">Parking Infrastructure (Low)</td><td>Capital Construction (Surface)</td><td>445.6</td><td rowspan="3">575.3</td><td>0.03%</td><td rowspan="3">0.04%</td></tr>
<tr><td>Land</td><td>85.1</td><td>0.01%</td></tr>
<tr><td>Operation & Maintenance (New Spaces Only)</td><td>44.6</td><td>0.00%</td></tr>
<tr><td colspan="3">Total</td><td colspan="2">56,331.8</td><td colspan="2">4.30%</td></tr>
</table>

Public sector infrastructure expenditures (baseline)



Private sector expenditure (baseline)



Cost of alternative interventions

1. Planning costs
2. Capital costs
3. Operations and maintenance costs

ADB project data

- ❑ Telecommuting (2 examples)
- ❑ BRT (37 projects)
- ❑ Underground Metro (17 projects)
- ❑ Elevated Metro (12 projects)
- ❑ Pedestrianization (14 projects)
- ❑ Bicycles (4 projects)
- ❑ Pedicabs (2 examples)
- ❑ Congestion Pricing (14 examples)
- ❑ Parking Levies (2 examples)
- ❑ HSR (71 projects)
- ❑ Alternative Fuels (30 examples)
- ❑ Fuel Economy Standards (1 example)

	Millions of US$ (Unless indicated)			Central and West Asia	East Asia	China	Korea	Pacific	South Asia	India	Southeast Asia
TC/TW	Implementation	Capital Cost (+ Interest)	$/worker	2635	2635	2635	2635	2635	2635	2635	2635
		Planning/Admin/Consult		700	700	700	700	700	700	700	700
		O&M		1800	1800	1800	1800	1800	1800	1800	1800
BRT	Construction	Capital Cost (+ Interest)	km	1.41025	1.44175	1.6835	1.2	1.410	1.758	1.758	1
		Planning/Admin/Consult		0.141	0.1297	0.36	0.108	0.282	0.1406	0.088	0.09
		O&M		0.155	0.1572	0.2044	0.131	0.169	0.1898	0.185	0.109
UM	Construction	Capital Cost (+ Interest)	km	59.259	100.782	61.04	100.8	120.4	120.4	120.4	106.3
		Planning/Admin/Consult		7.5	9.07038	3.052	9.07	24.09	9.63	6.02	9.56
		O&M		6.6759	10.985	6.409	10.99	14.45	13.01	12.65	11.58
EM	Construction	Capital Cost (+ Interest)	km	37.63	37.63	37.63	37.63	37.63	37.63	37.63	37.63
		Planning/Admin/Consult		3.763	3.3867	1.8815	3.39	7.53	3.01	1.88	3.39
		O&M		4.1393	4.10167	3.95115	4.10	4.52	4.06	3.95	4.10
PED	Construction	Capital Cost (+ Interest)	km	0.0406	0.0406	0.0406	0.0406	0.0406	0.06	0.007	0.026
		Planning/Admin/Consult		0.00406	0.00365	0.00203	0.004	0.008	0.005	0.000	0.002
		O&M		0.0045	0.00443	0.00426	0.004	0.005	0.006	0.001	0.003
BIK	Construction	Capital Cost (+ Interest)	km	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.069
		Planning/Admin/Consult		0.0067	0.00603	0.00335	0.006	0.013	0.005	0.003	0.006
		O&M		0.0074	0.0073	0.007	0.007	0.008	0.007	0.007	0.007
PED/BIK	Construction	Capital Cost (+ Interest)	km	0.5095	0.475	0.475	0.475	0.5095	0.544	0.544	0.5095
		Planning/Admin/Consult		0.051	0.0428	0.0238	0.043	0.102	0.044	0.027	0.046
		O&M		0.056	0.0518	0.0499	0.052	0.061	0.059	0.057	0.056
P-Cab	Implementation	Capital Cost (+ Interest)	cab	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
		Planning/Admin/Consult		0.0001	0.00009	0.00005	0.0001	0.0002	0.0001	0.0001	0.0001
		O&M		0.00011	0.000109	0.000105	0.0001	0.0001	0.0001	0.0001	0.0001
CongPr	Implementation	Capital Cost (+ Interest)	program	220	220	220	220	220	220	220	130
		Planning/Admin/Consult		22	19.8	11	19.8	44	17.6	11	11.7
		O&M		24.2	23.98	23.1	23.98	26.4	23.76	23.1	14.17
PrkLev	Implementation	Capital Cost (+ Interest)	program	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065	0.00065
		Planning/Admin/Consult		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
		O&M		0.150065	0.150065	0.150065	0.1501	0.1501	0.1501	0.1501	0.1501
HSR	Construction	Capital Cost (+ Interest)	km	22.96	22.96	14.65	22.96	22.96	22.96	22.96	22.96
		Planning/Admin/Consult		2.296	2.0664	0.7325	2.066	4.592	1.837	1.148	2.066
		O&M		24.3376	24.3376	15.529	24.338	24.338	24.338	24.338	24.338

Abatement cost results

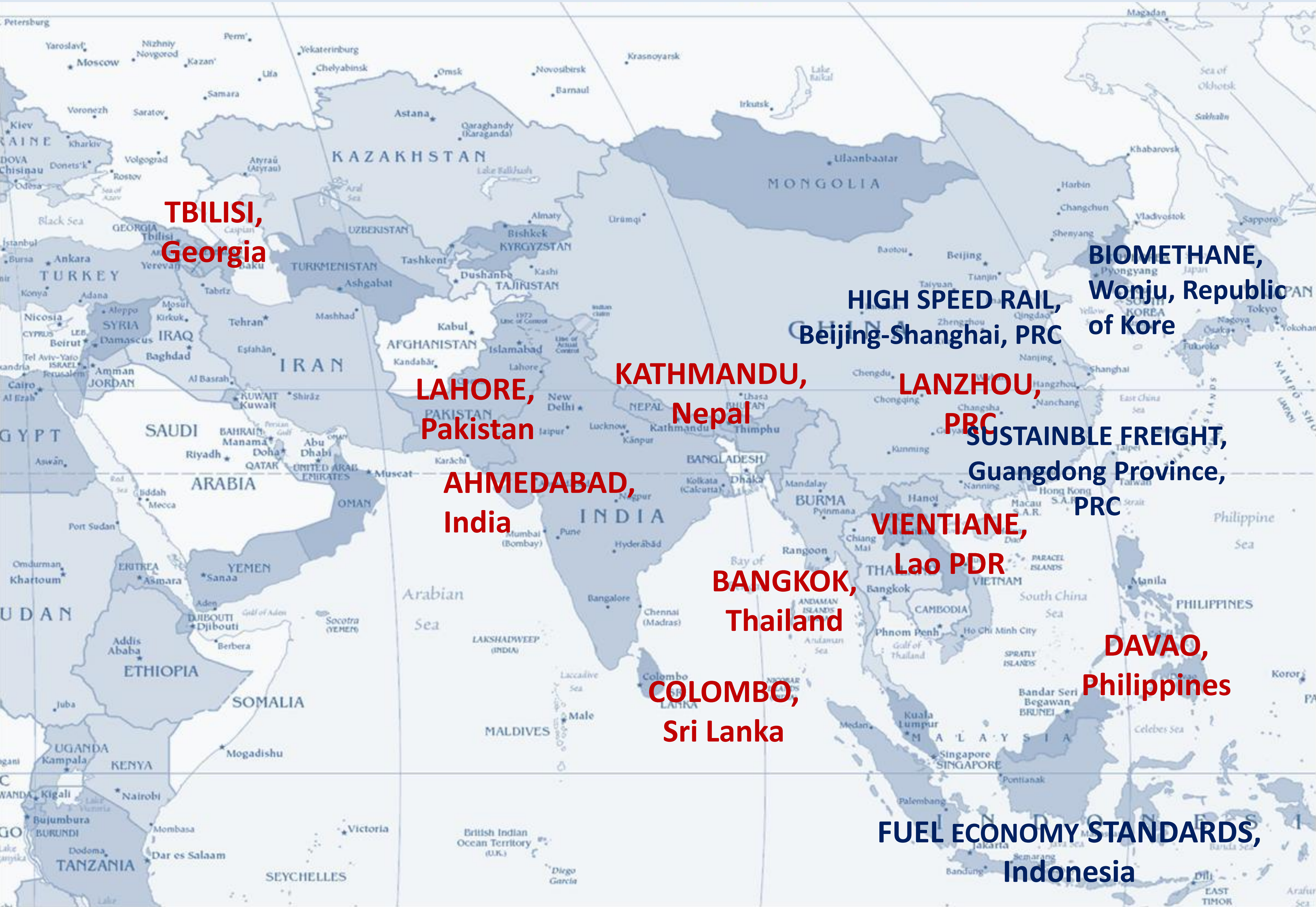
	2010-2030 US$ per barrel of oil-equivalent offset	2010-2050 US$ per barrel of oil-equivalent offset
Transit-Oriented Development	$ 6.48	$ 1.89
Bus Rapid Transit (BRT)	$ 12.45	$ 4.38
Underground Metro	$ 323.70	$ 78.84
Elevated Urban Rail	$ 149.40	$ 35.04
Pedestrian Facilities	$ 4.27	$ 0.98
NMT Vehicles	$ 2.91	$ 0.63
Congestion Pricing	$ 9.34	$ 3.35
Parking Levy	-$ 0.52	-$ 2.41

Case Studies
(13h45 – 14h45)

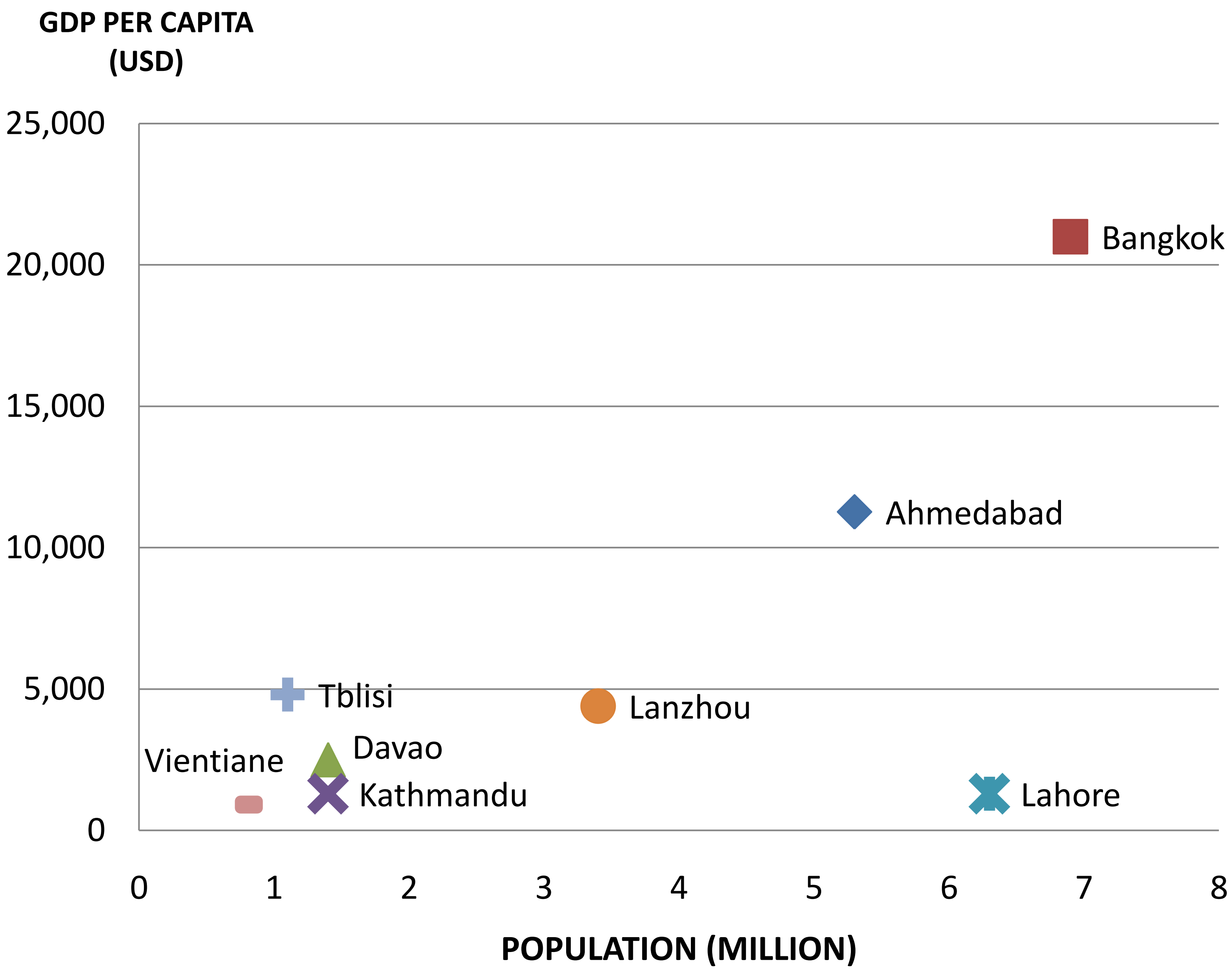
Objectives of Case Studies

- Evaluate ease of data collection for key variables
- Determine BAU fuel use projections at a city level
- Understand relative oil reduction impact of alternative scenarios
- Estimate abatement costs
- Simulate a hypothetical market mechanism
- Develop calculation toolkit
- Estimate co-benefits

Case Studies: 9 cities 4 single interventions



Diversity of Cities



Base Data Collection

Existing Data

Key Parameter	COLOMBO	KATHMANDU	LAHORE	TBILISI	AHMEDABAD	BANGKOK	DAVAO	LANZHOU	VIENTIANE
Population	●	●	◑	◑	●	●	◑	●	●
GDP	–	–	–	–	–	●	–	●	●
Fuel consumption	–	–	–	–	◑	●	–	–	–
Vehicle numbers	●	●	●	●	◇◑	●	◇◑	◇◑	◇◑
Average vehicle km	–	–	–	–	–	◇◑	–	–	–
Fuel economy of vehicles	–	–	–	–	◇◑	◇◑	–	–	–
Load factors	–	–	–	–	–	–	–	–	–
NMT passenger km	–	–	–	–	–	◇◑	–	–	–
Numbers of trips	◑	–	–	–	–	◑	–	◑	◑
Average trip distances	◑	–	–	–	–	–	–	–	–

Collected and Calculated Data

Key Parameter	COLOMBO	KATHMANDU	LAHORE	TBILISI	AHMEDABAD	BANGKOK	DAVAO	LANGZHOU	VIENTIANE
Population	●	●	●	●	●	●	©	●	●
GDP	●	©	©	©	©	●	©	●	●
Fuel consumption	©	©	©	©	©	●	©	©	©
Vehicle numbers	●	●	●	●	●	●	©	©	©
Average vehicle km	–	–	–	–	©	©	©	©	©
Fuel economy of vehicles	◐	©	©	©	©	©	©	©	©
Load factors	–	–	–	–	©	©	©	©	©
NMT passenger km	©	–	–	–	©	◐	©	©	©
Numbers of trips	◐	©	©	©	–	◐	–	◐	◐
Average trip distances	◐	©	©	©	–	–	–	–	–

Methodology
for
BAU and Alternative Scenarios

City Case Study Approaches

< ADB’s City Cases>

Fuel Consumption = No. of Vehicles X Aver. Vehicle Km X Fuel economy

Total Passenger km = No. of Vehicle X Aver. Vehicle Km X Load Factor

Population and GDP are key factors to project the growth of vehicle numbers

<PADECO’s City Cases>

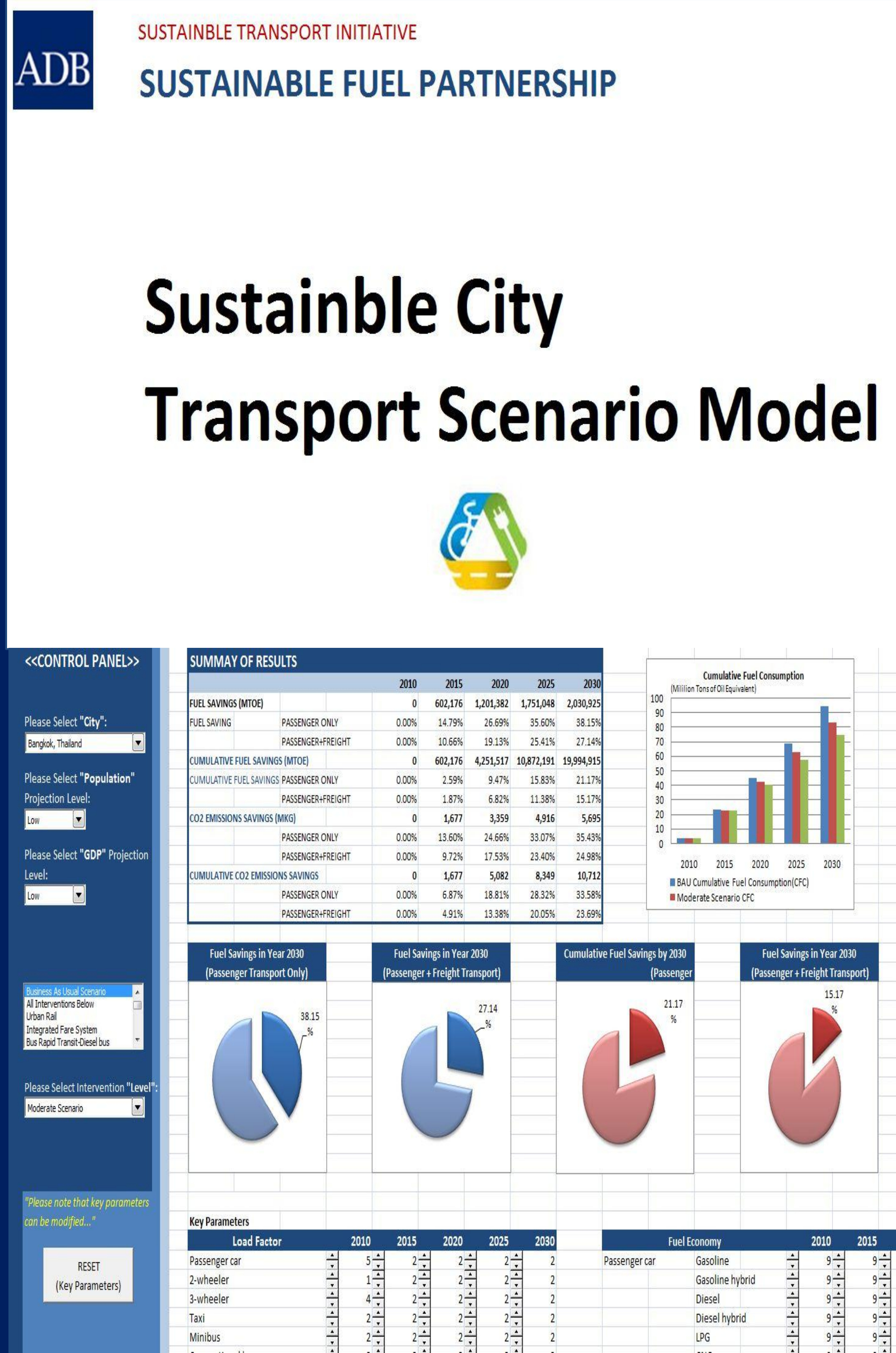
Fuel Consumption = No. of Trips X Aver. Trip Distance X Fuel economy

Total Trip Numbers, Mode Share in No. of Trips

Population is a key factor to project the increase of trip numbers.

Methodological Approach for ADB City Case Studies:

Ahmedabad, Bangkok, Davao, Lanzhou, and Vientiane



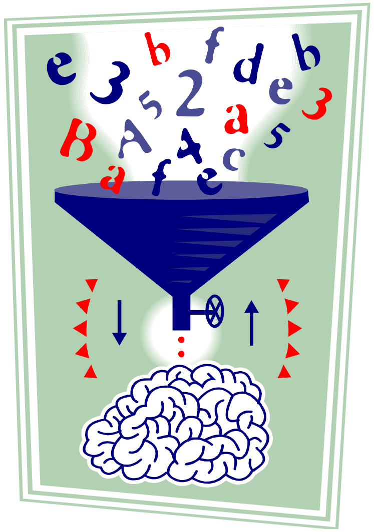
Base Data

- Base data collection:
  - Sub-contracted consultants at each city
  - 10 year historical data are requested
  - Reality check on data availability at a city level

- Data gap and calculation:
  - Various methods
  - A mix of top-down and bottom-up approaches for calculation and verification
  - A Range of references, including national/regional data, including IEA Mobility Model data

BAU Scenario Development

- The availability of historical data support and shape BAU scenario development



- Population and GDP projections
  - Low and high projections on population
  - Low and high projections GDP
  - 4 baselines for each city
- Vehicle growth projections
- Other parameters...

Population and GDP Projections

- Population and GDP determine vehicle growth patterns

- Testing various statistical projection measures
  - Linear projection using a range of measures:
    - 5-10 year “GROWTH”; “TREND”; “FORECAST”; moving rates, compound annual growth rates
  - Other measures: national growth rate (mainly from IEA data), other study references

Vehicle Projections

- **Vehicle Group One:**
  - Sensitive to GDP
  - Passenger cars (PLDVs), Motorcycles, Trucks
  - Per capita GDP sensitivity per vehicle

- **Vehicle Group Two:**
  - Sensitive to Population
  - Three-wheelers, Taxis, Minibuses, Conventional buses, BRT buses
  - 20-year compound annual growth rate on population

Transport Scenario Model

ADB

SUSTAINBLE TRANSPORT INITIATIVE

SUSTAINABLE FUEL PARTNERSHIP

Sustainble City

T

<<CONTROL PANEL>>

Please Select **"City"**:
Bangkok, Thailand

Please Select **"Population"** Projection Level:
Low

Please Select **"GDP"** Projection Level:
Low

Business As Usual Scenario
All Interventions Below
Urban Rail
Integrated Fare System
Bus Rapid Transit-Diesel bus

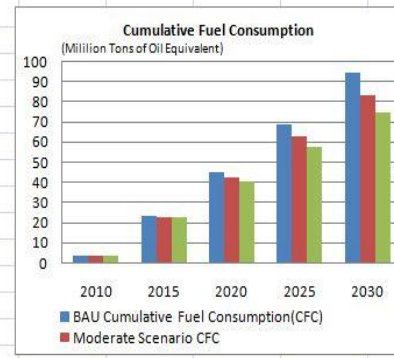
Please Select Intervention **"Level"**:
Moderate Scenario

"Please note that key parameters can be modified..."

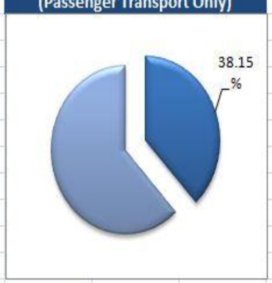
RESET
(Key Parameters)

SUMMAY OF RESULTS

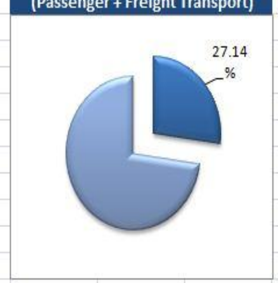
		2010	2015	2020	2025	2030
FUEL SAVINGS (MTOE)		0	602,176	1,201,382	1,751,048	2,030,925
FUEL SAVING	PASSENGER ONLY	0.00%	14.79%	26.69%	35.60%	38.15%
	PASSENGER+FREIGHT	0.00%	10.66%	19.13%	25.41%	27.14%
CUMULATIVE FUEL SAVINGS (MTOE)		0	602,176	4,251,517	10,872,191	19,994,915
CUMULATIVE FUEL SAVINGS	PASSENGER ONLY	0.00%	2.59%	9.47%	15.83%	21.17%
	PASSENGER+FREIGHT	0.00%	1.87%	6.82%	11.38%	15.17%
CO2 EMISSIONS SAVINGS (MKG)		0	1,677	3,359	4,916	5,695
	PASSENGER ONLY	0.00%	13.60%	24.66%	33.07%	35.43%
	PASSENGER+FREIGHT	0.00%	9.72%	17.53%	23.40%	24.98%
CUMULATIVE CO2 EMISSIONS SAVINGS		0	1,677	5,082	8,349	10,712
	PASSENGER ONLY	0.00%	6.87%	18.81%	28.32%	33.58%
	PASSENGER+FREIGHT	0.00%	4.91%	13.38%	20.05%	23.69%



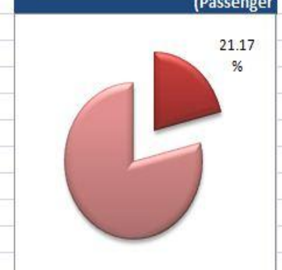
Fuel Savings in Year 2030 (Passenger Transport Only)



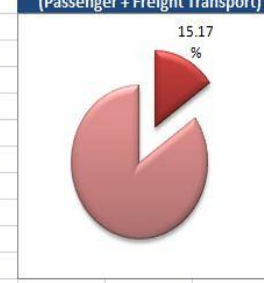
Fuel Savings in Year 2030 (Passenger + Freight Transport)



Cumulative Fuel Savings by 2030 (Passenger



Fuel Savings in Year 2030 (Passenger + Freight Transport)



Key Parameters

Load Factor	2010	2015	2020	2025	2030
Passenger car	5	2	2	2	2
2-wheeler	1	2	2	2	2
3-wheeler	4	2	2	2	2
Taxi	2	2	2	2	2
Minibus	2	2	2	2	2

Fuel Economy		2010	2015
Passenger car	Gasoline	9	9
	Gasoline hybrid	9	9
	Diesel	9	9
	Diesel hybrid	9	9
	LPG	9	9

Methodological Approach for PADECO City Case Studies:

Colombo,
Kathmandu,
Lahore,
Tbilisi

Fuel Consumption data

Top-Down Approach	
Colombo	FUEL STATION SURVEY was conducted. 10 stations out of 70 stations
Kathmandu	FUEL STATION SURVEY was conducted. 16 stations out of 120 stations
Lahore	SALE FIGURES of all the fuel stations were available
Bottom-up Approach	
Tbilisi	Fuel consumption was CALCULATED based on numbers of vehicles with assumptions on average trip distance and fuel economies of vehicles

BAU Trip Calculation Methodology (1)

<Type One: Colombo Case>

- JICA Strada Model
  - “Inter-district” travel: the Model provides the 2010, 2020, and 2030 trip numbers
  - “Intra-district” travel: the Model provides only 2010 trip numbers.
    - Passenger car: 5% annual trip growth rate was applied.
    - Bus: 2% annual trip growth rate was applied.

BAU Trip Calculation Methodology (2)

<Type Two: Kathmandu, Lahore and Tbilisi Cases>

- "Population" serves as a base...

  Total no. of Trips = Population X Average no. of Trips per person

- PADECO population projection in Kathmandu

PADECO's Population Projection	2011	2020	2030
Kathmandu	1,500,000	3,000,000	6,000,000
Lahore	10,000,000	13,000,000	16,000,000
Tbilisi	1,100,000	1,300,000	1,700,000

BAU Fuel Consumption

Unit: Tons of Oil Equivalent	2010	2015	2020	2015	2030
Colombo	283,482	514,877	659,731	951,785	1,338,145
Cumulative FC	283,482	900,729	1,289,601	1,736,111	2,597,309
Kathmandu	124,143	-	376,416	-	1,512,255
Cumulative FC		-	-	-	-
Lahore	525,163	1,326,400	2,771,948	4,707,665	7,409,053
Cumulative FC	525,163	2,446,072	5,194,871	8,975,811	14,201,347
Tbilisi	118,479	-	188,322	-	496,399
Cumulative FC	118,479	-	-	-	-

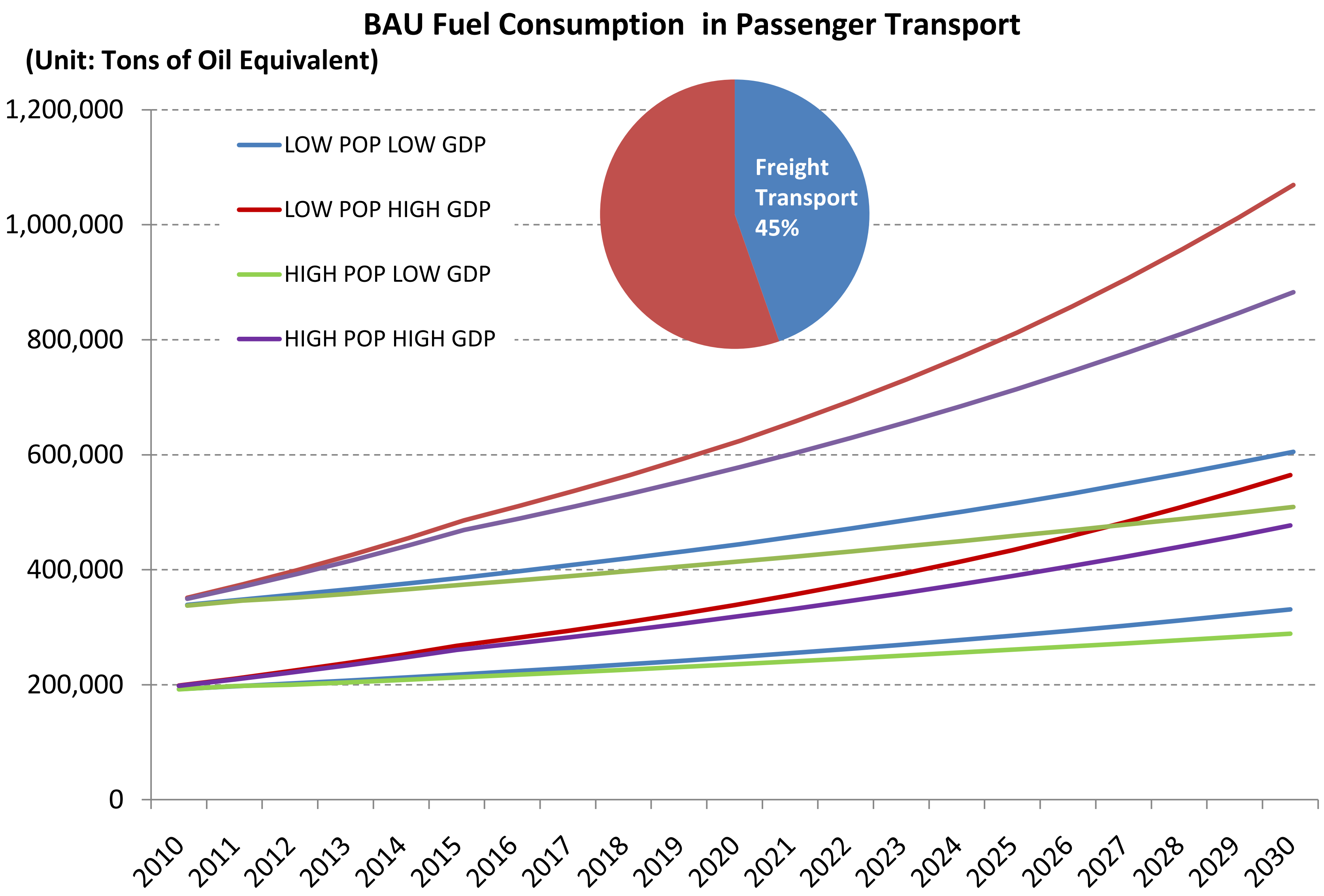
ADB City Case Results:

Ahmedabad, Bangkok, Davao, Lanzhou, Vientiane

Ahmedabad, India

- 6.9 million population in 1,569 km^2
- GDP per capita in 2009: 11,125 USD
- Passenger car ownership: 487/1000 population in 2009
- Motorcycle ownership: 358 /1000 population in 2009
- Diversified transport modes, but limited provision of NMT

Ahmedabad BAU Fuel Consumption



Ahmedabad Results: Package of Interventions

<LOW Population LOW GDP Projection>

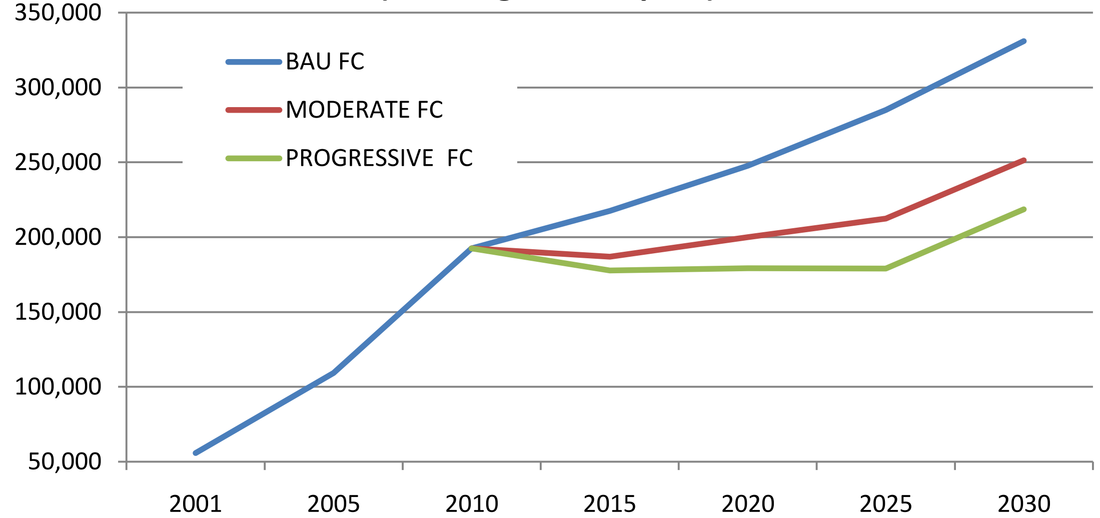
Passenger Transport	2010	2015	2020	2025	2030
BAU Fuel Consumption	192,516	217,481	247,823	285,042	331,036
Fuel Savings for Year…	0	30,497 ~ 39,810	47,842 ~ 68,571	72,651 ~ 105,970	79,744 ~ 112,444
Fuel Savings %	0%	14.0% ~ 18.3%	19.3% ~ 27.7%	25.5% ~ 37.2%	24.1% ~ 34.0%
BAU **Cumulative** Fuel Consumption	192,516	1,228,665	2,405,370	3,753,880	5,314,092
Cumulative Fuel Savings for Year…	0	30,497 ~ 39,810	206,083 ~ 273,843	478,951 ~ 663,447	863,115 ~ 1,212,490
Cumulative Fuel Savings %	**0%**	**2.5% ~ 3.2%**	**8.6% ~ 11.4%**	**12.8% ~ 17.7%**	**16.2% ~ 22.8%**

(Unit: Tons of Oil Equivalent)

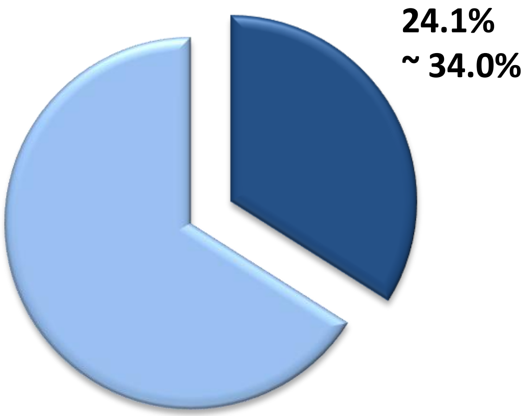
Ahmedabad Results: Package of Interventions

<LOW Population LOW GDP Projection>

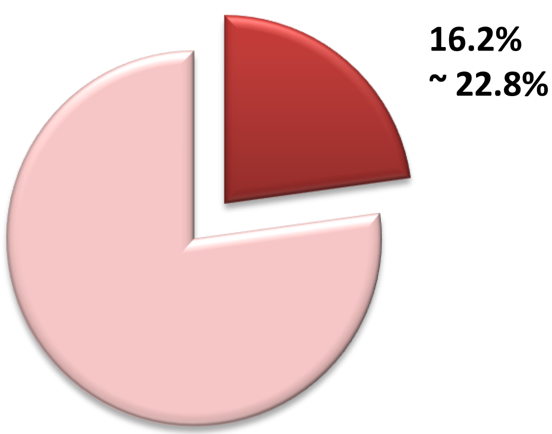
Fuel Consumption Comparison (Passenger Transport)



Fuel Savings in 2030 (Passenger Transport)



Cumulative Fuel Savings by 2030 (Passenger Transport)

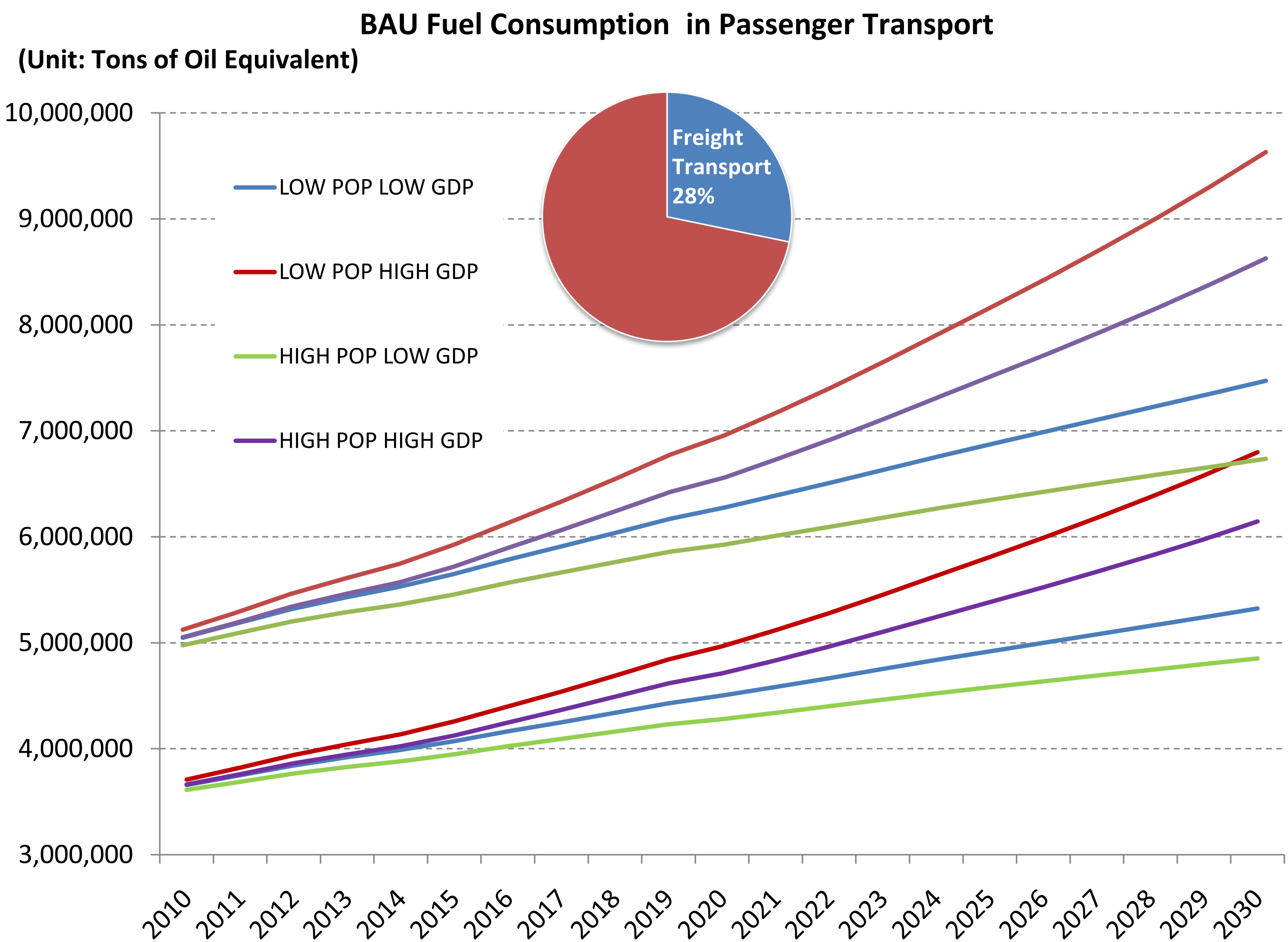


(Unit: Tons of Oil Equivalent)

Bangkok, Thailand

- 6.9 million population in 1,569 km^2
- GDP per capita in 2009: 11,125 USD
- Passenger car ownership: 487/1000 population in 2009
- Motorcycle ownership: 358 /1000 population in 2009
- Diversified transport modes, but limited provision of NMT

Bangkok BAU Fuel Consumption



Bangkok Results: Package of Interventions

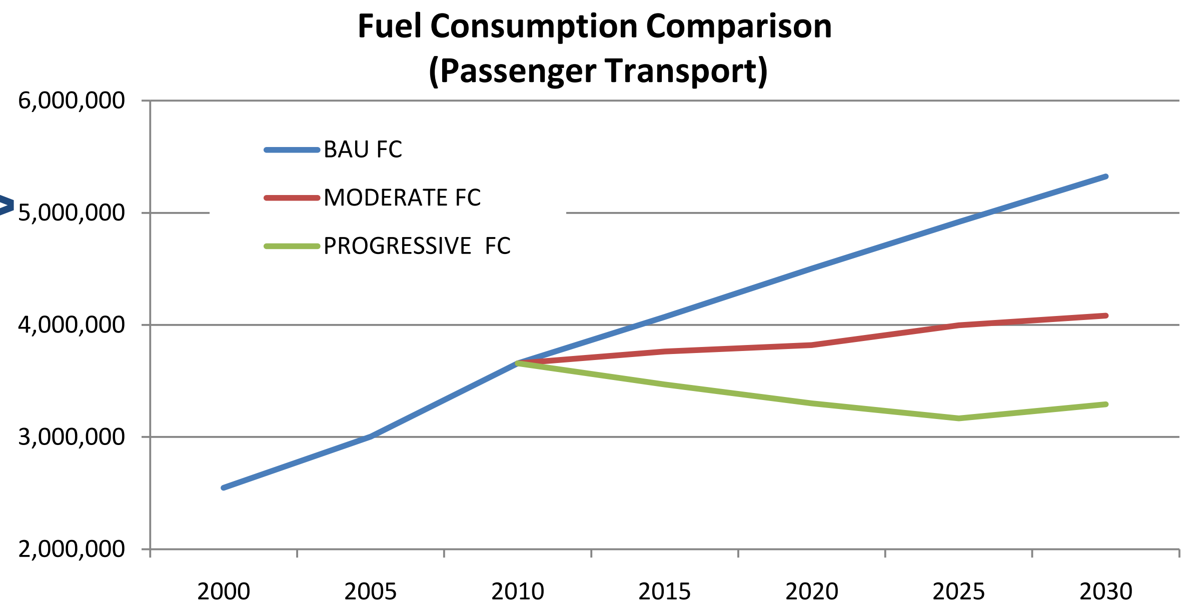
<LOW Population LOW GDP Projection>

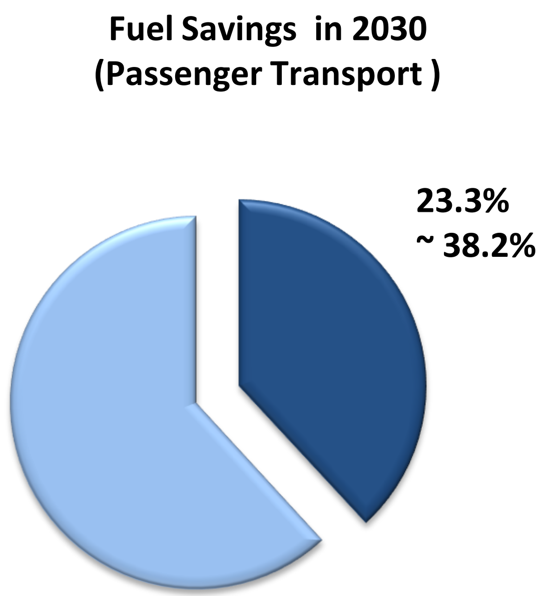
Passenger Transport	2010	2015	2020	2025	2030
BAU Fuel Consumption	3,657,275	4,070,793	4,501,225	4,918,946	5,323,385
Fuel Savings for Year…	0	308,892 ~ 602,176	681,054 ~ 1,201,382	922,556 ~ 1,751,048	1,239,224 ~ 2,030,925
Fuel Savings %	0%	7.6% ~ 14.8%	15.1% ~ 26.7%	18.8% ~ 35.6%	23.3% ~ 38.2%
BAU **Cumulative** Fuel Consumption	3,657,275	23,227,680	44,910,063	68,667,247	94,471,216
Cumulative Fuel Savings for Year…	0	308,892 ~ 602,176	2,257,064 ~ 4,251,517	5,955,849~ 10,872,191	10,954,733~ 19,994,915
Cumulative Fuel Savings %	**0%**	**1.3% ~ 2.6%**	**5.0% ~ 9.5%**	**8.7% ~ 15.8%**	**11.6% ~ 21.2%**

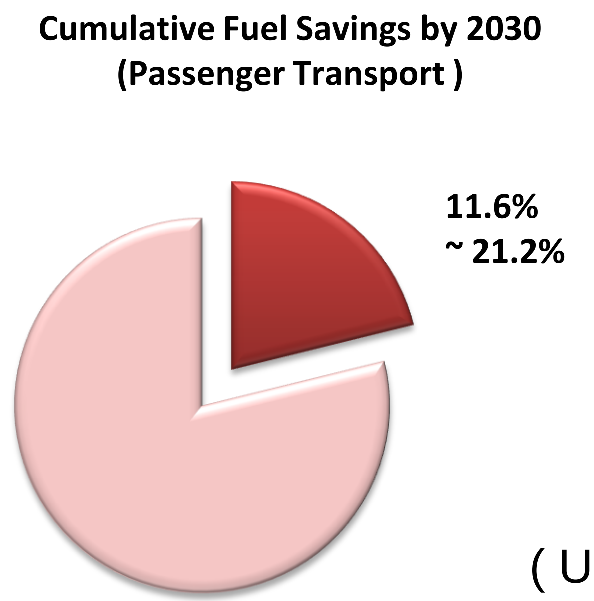
(Unit: Tons of Oil Equivalent)

Bangkok Results: Package of Interventions

<LOW Population LOW GDP Projection>



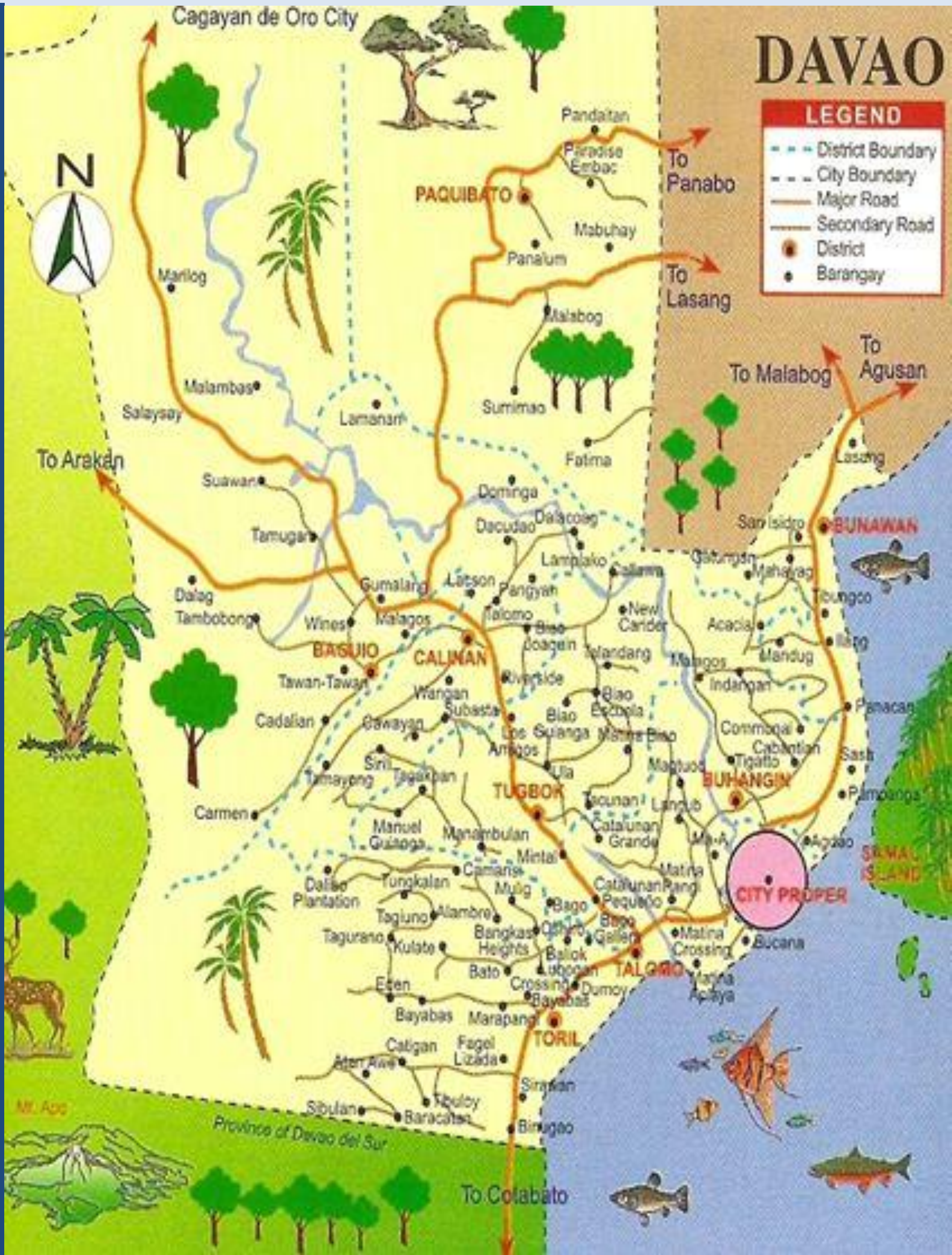




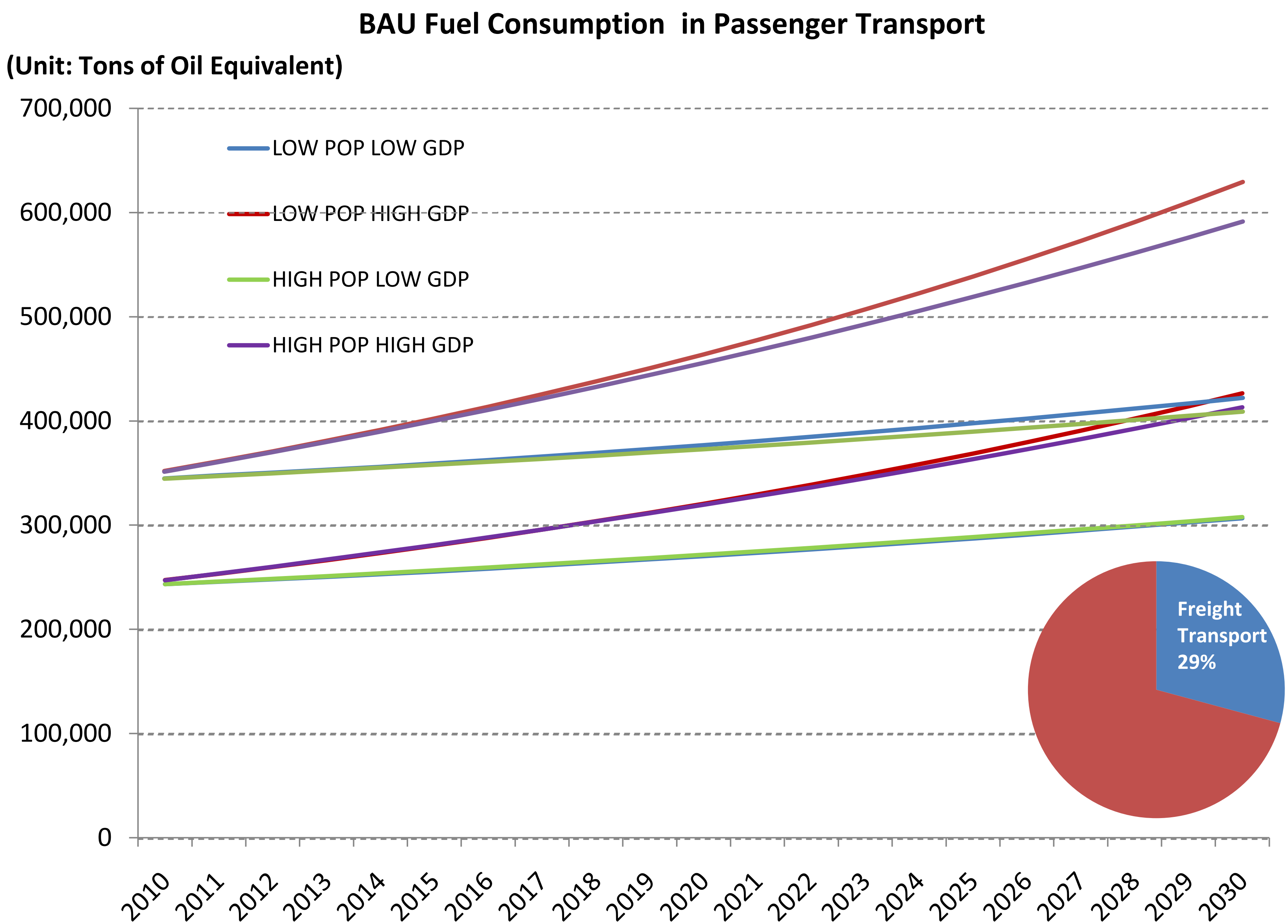
(Unit: Tons of Oil Equivalent)

Davao, Philippines

- 6.9 million population in 1,569 km^2
- GDP per capita in 2009: 11,125 USD
- Passenger car ownership: 487/1000 population in 2009
- Motorcycle ownership: 358 /1000 population in 2009
- Diversified transport modes, but limited provision of NMT



Davao Fuel Consumption



Davao Results: Package of Interventions

<LOW Population LOW GDP Projection>

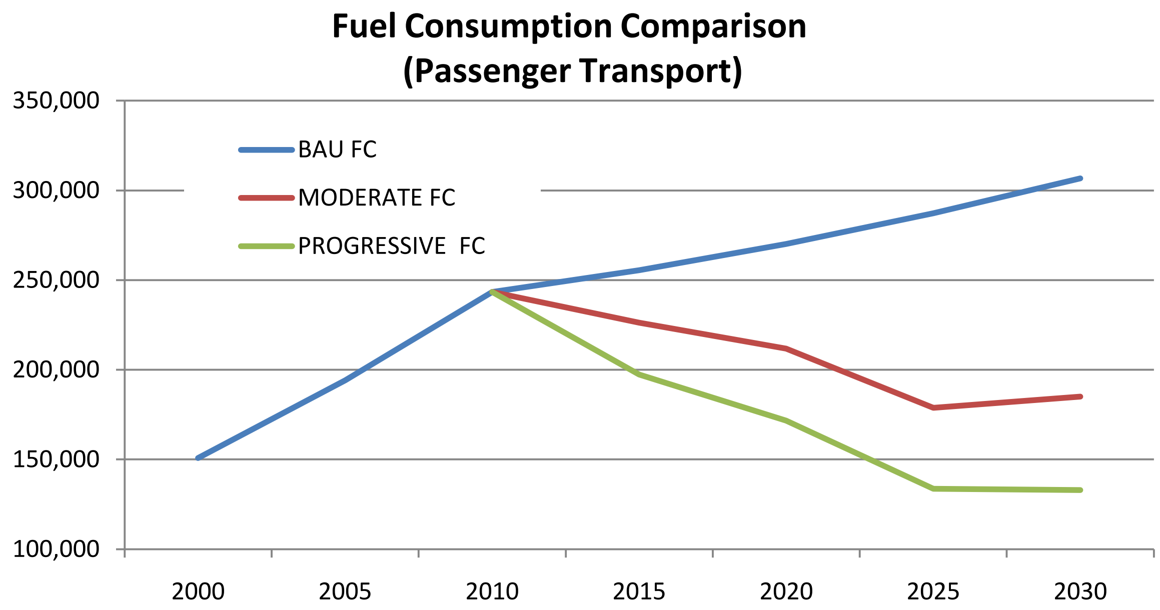
Passenger Transport	2010	2015	2020	2025	2030
BAU Fuel Consumption	243,416	255,458	270,139	287,212	306,647
Fuel Savings for Year…	0	29,252 ~ 58,026	58,402 ~ 98,564	108,428 ~ 153,621	121,646 ~ 173,773
Fuel Savings %	0%	11.5% ~ 22.7%	21.6% ~ 36.5%	37.8% ~ 53.5%	39.7% ~ 56.7%

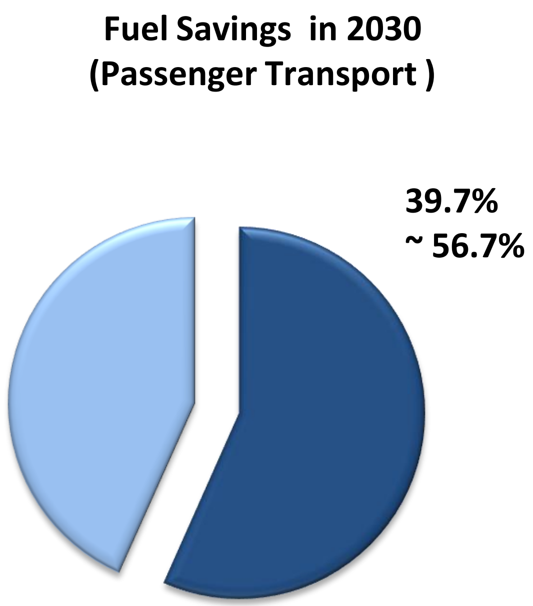
BAU **Cumulative** Fuel Consumption	243,416	1,495,496	2,816,067	4,217,059	5,710,413
Cumulative Fuel Savings for Year…	0	29,252 ~ 58,026	198,622 ~ 414,939	588,764 ~ 994,461	1,140,074 ~ 1,822,413
Cumulative Fuel Savings %	**0%**	**2.5% ~ 3.9%**	**8.6% ~ 14.7%**	**12.8% ~ 23.6%**	**16.2% ~ 31.9%**

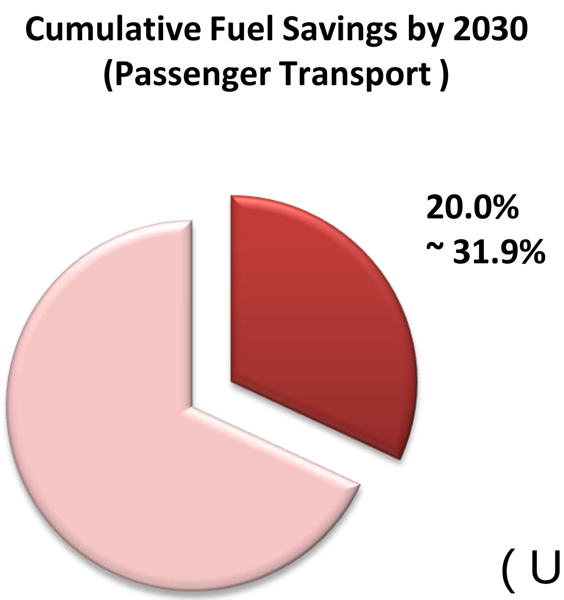
(Unit: Tons of Oil Equivalent)

Davao Results: Package of Interventions

<LOW Population LOW GDP Projection>





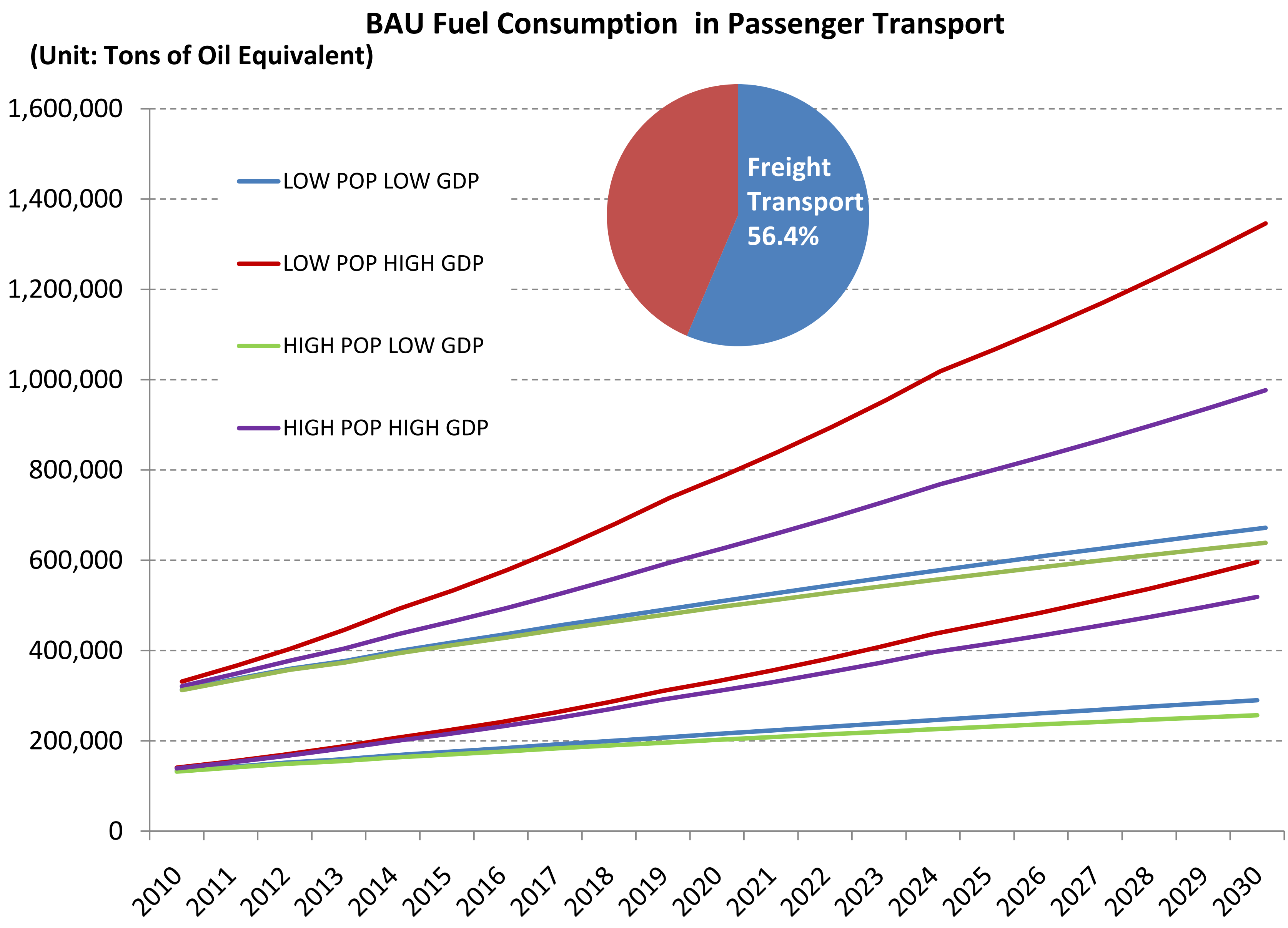


(Unit: Tons of Oil Equivalent)

Lanzhou, PRC

- 6.9 million population in 1,569 km^2
- GDP per capita in 2009: 11,125 USD
- Passenger car ownership: 487/1000 population in 2009
- Motorcycle ownership: 358 /1000 population in 2009
- Diversified transport modes, but limited provision of NMT

Lanzhou BAU Fuel Consumption



Lanzhou Results: Package of Interventions

<LOW Population LOW GDP Projection>

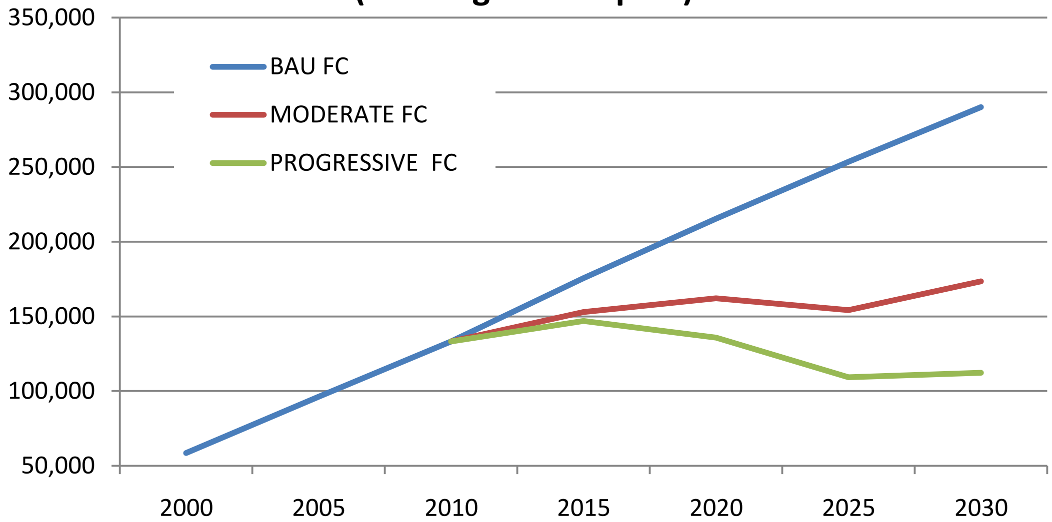
Passenger Transport	2010	2015	2020	2025	2030
BAU Fuel Consumption	243,416	255,458	270,139	287,212	306,647
Fuel Savings for Year…	0	29,252 ~ 58,026	58,402 ~ 98,564	108,428 ~ 153,621	121,646 ~ 173,773
Fuel Savings %	0%	11.5% ~ 22.7%	21.6% ~ 36.5%	37.8% ~ 53.5%	39.7% ~ 56.7%
BAU **Cumulative** Fuel Consumption	243,416	1,495,496	2,816,067	4,217,059	5,710,413
Cumulative Fuel Savings for Year…	0	29,252 ~ 58,026	198,622 ~ 414,939	588,764 ~ 994,461	1,140,074 ~ 1,822,413
Cumulative Fuel Savings %	**0%**	**2.5% ~ 3.9%**	**8.6% ~ 14.7%**	**12.8% ~ 23.6%**	**16.2% ~ 31.9%**

(Unit: Tons of Oil Equivalent)

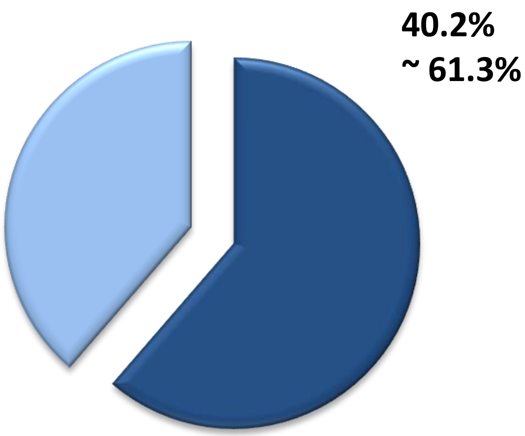
Lanzhou Results: Package of Interventions

<LOW Population LOW GDP Projection>

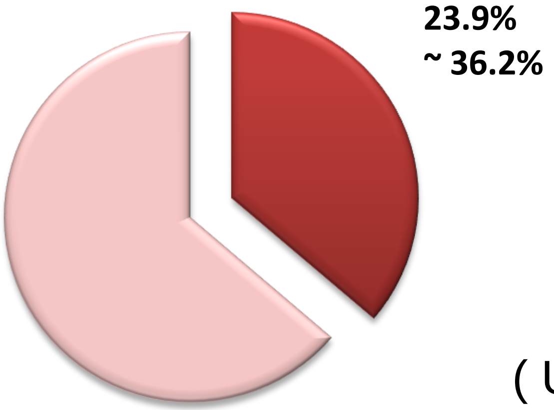
Fuel Consumption Comparison (Passenger Transport)



Fuel Savings in 2030 (Passenger Transport)



Cumulative Fuel Savings by 2030 (Passenger Transport)

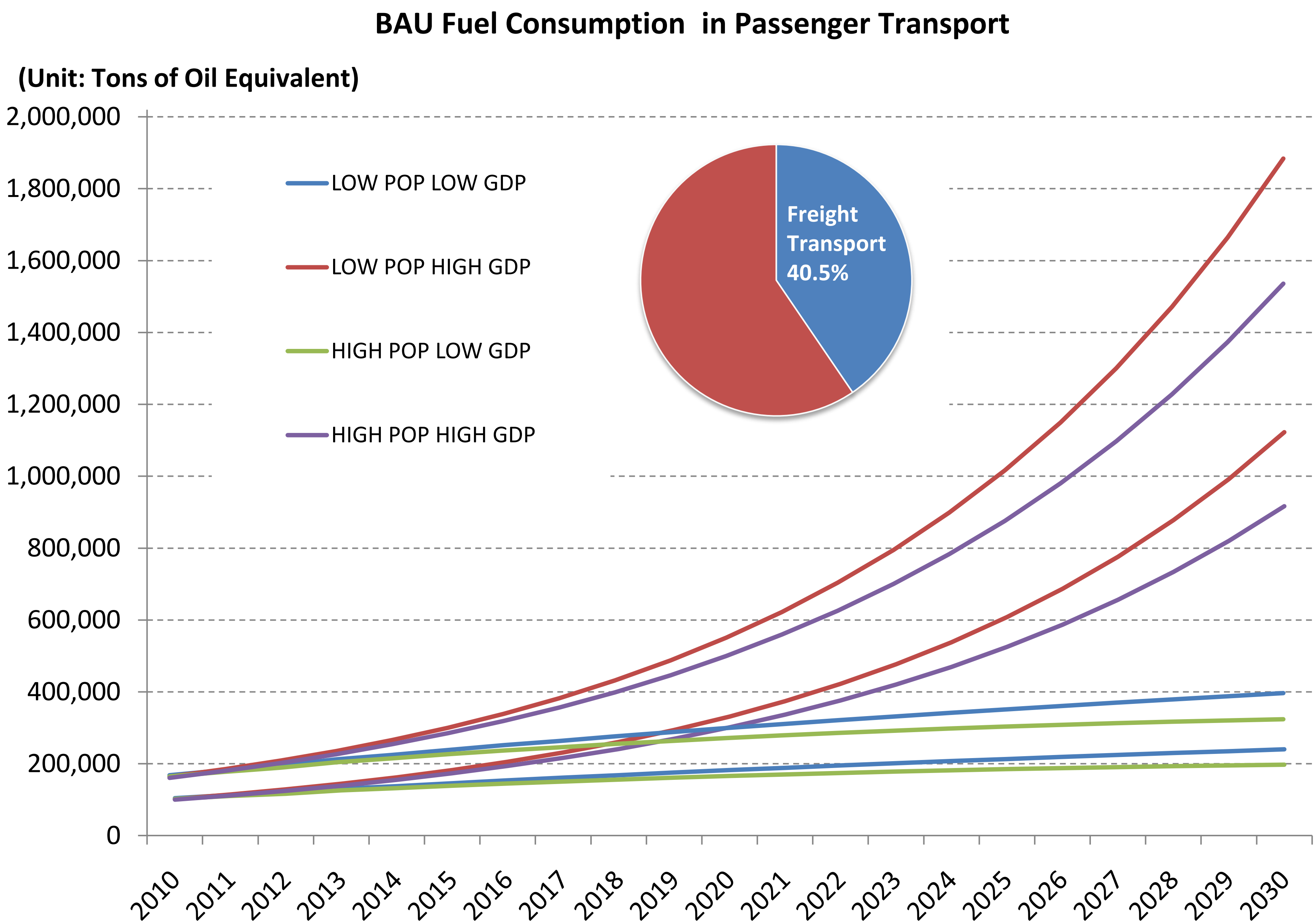


(Unit: Tons of Oil Equivalent)

Vientiane, Lao PDR

- Population: 754,000 in 3,920km^2
- GDP per capita: 914 USD
- Passenger car ownership: 105 /1000 population
- Motorcycle ownership: 361 /1000 population

Vientiane BAU Fuel Consumption



Vientiane Results: Package of Interventions

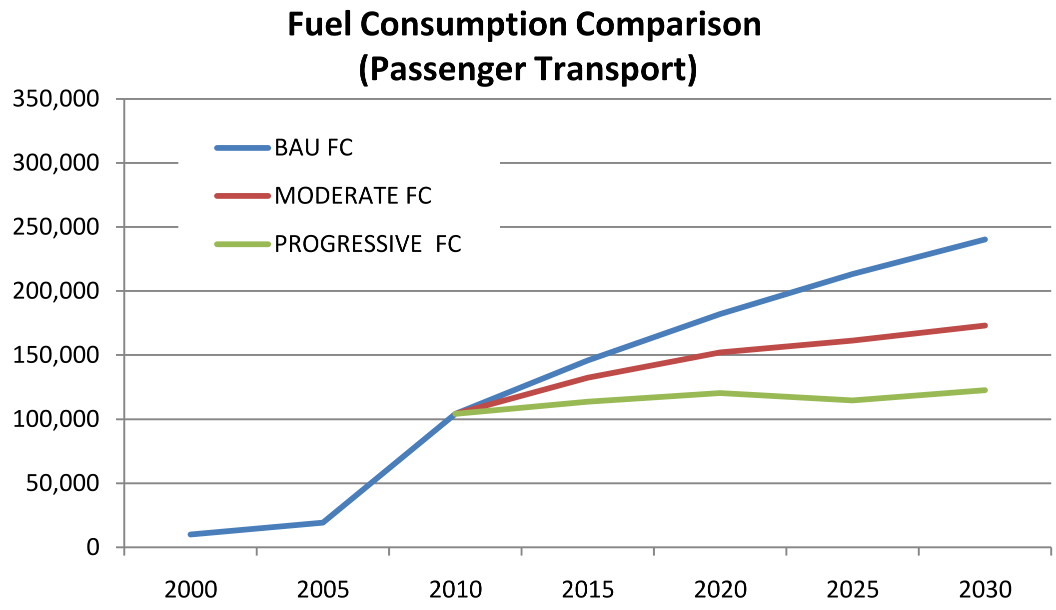
<LOW Population LOW GDP Projection>

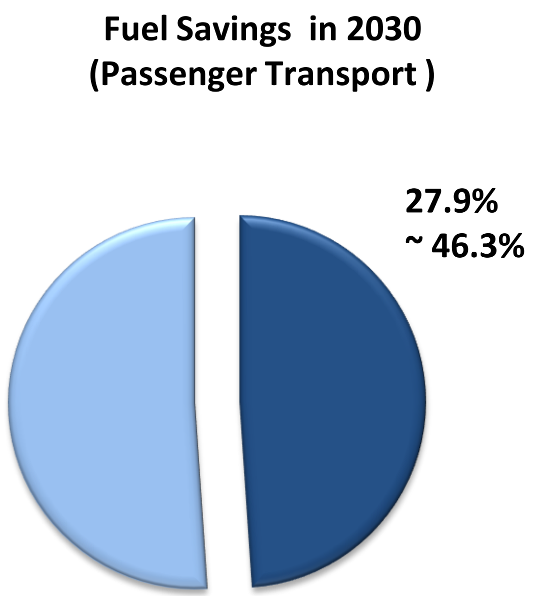
Passenger Transport	2010	2015	2020	2025	2030
BAU Fuel Consumption	104,181	145,931	182,182	213,252	240,177
Fuel Savings for Year…	0	13,510 ~ 32,227	30,011 ~ 61,713	51,839 ~ 98,677	67,044 ~ 117,533
Fuel Savings %	0%	9.3% ~ 22.1%	16.5% ~ 33.9%	24.3% ~ 46.3%	27.9% ~ 48.9%
BAU **Cumulative** Fuel Consumption	104,181	751,655	1,592,823	2,598,918	3,747,444
Cumulative Fuel Savings for Year…	0	13,510~ 58,026	117,283 ~ 414,939	314,545 ~ 994,461	618,749~ 1,822,413
Cumulative Fuel Savings %	**0%**	**1.8% ~ 4.3%**	**7.4% ~ 16.3%**	**12.1% ~ 25.1%**	**16.5% ~ 32.1%**

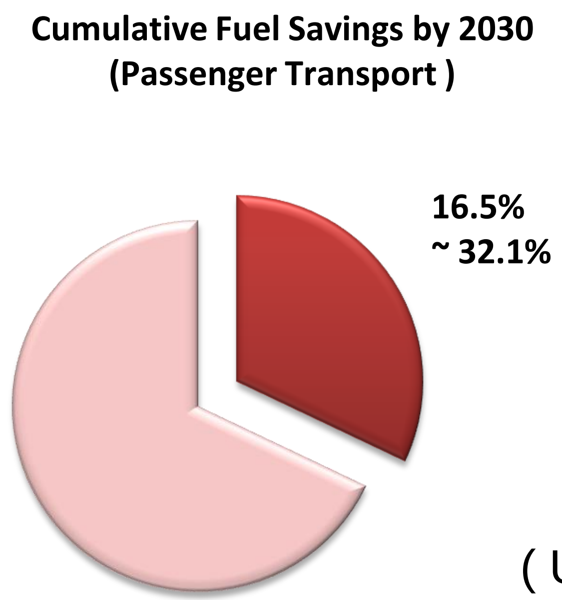
(Unit: Tons of Oil Equivalent)

Vientiane Results: Package of Interventions

<LOW Population LOW GDP Projection>







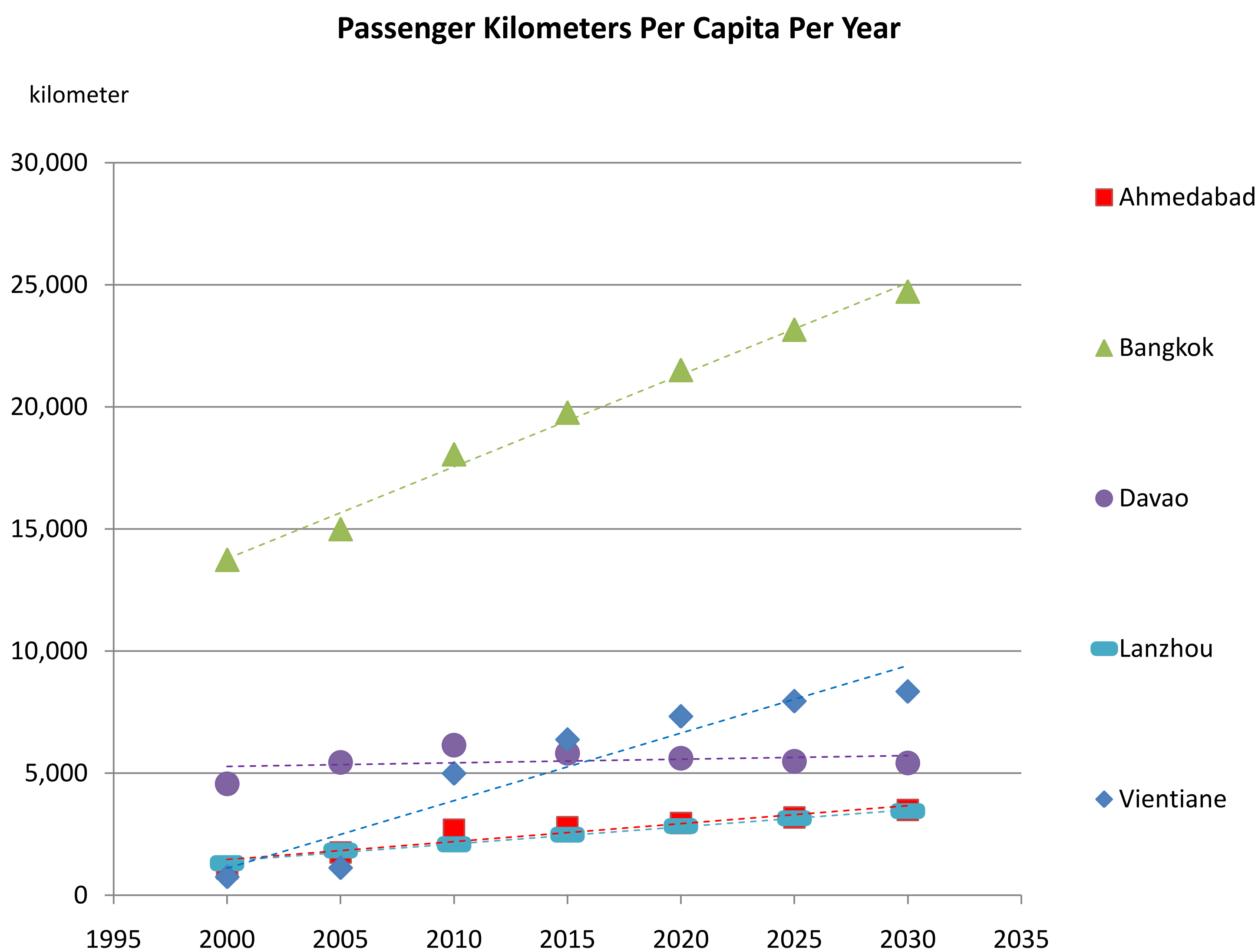
(Unit: Tons of Oil Equivalent)

Comparative Analysis:

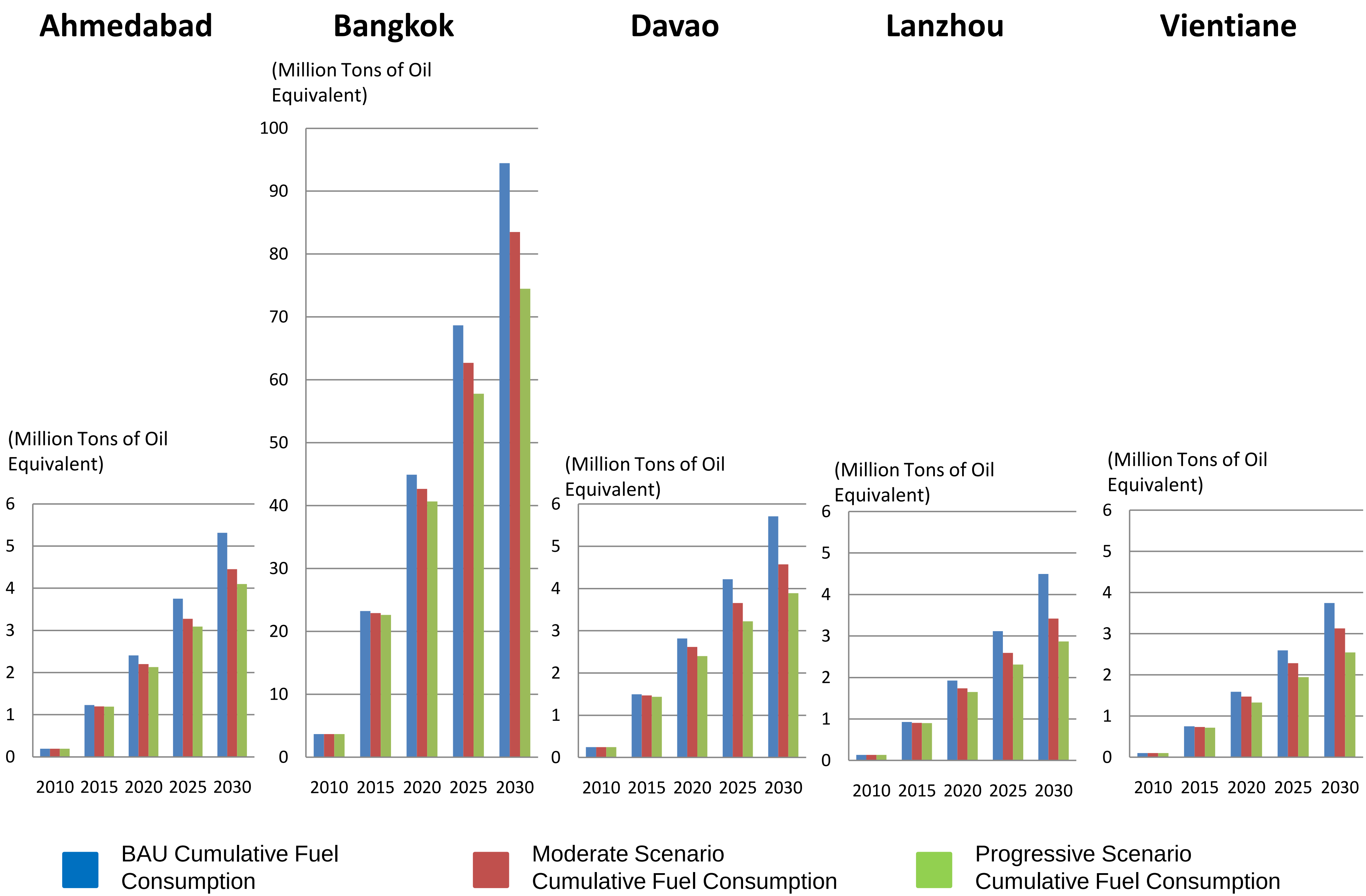
Ahmedabad
Bangkok
Davao
Lanzhou
Vientiane

< example in Low Population & Low GDP growth projections>

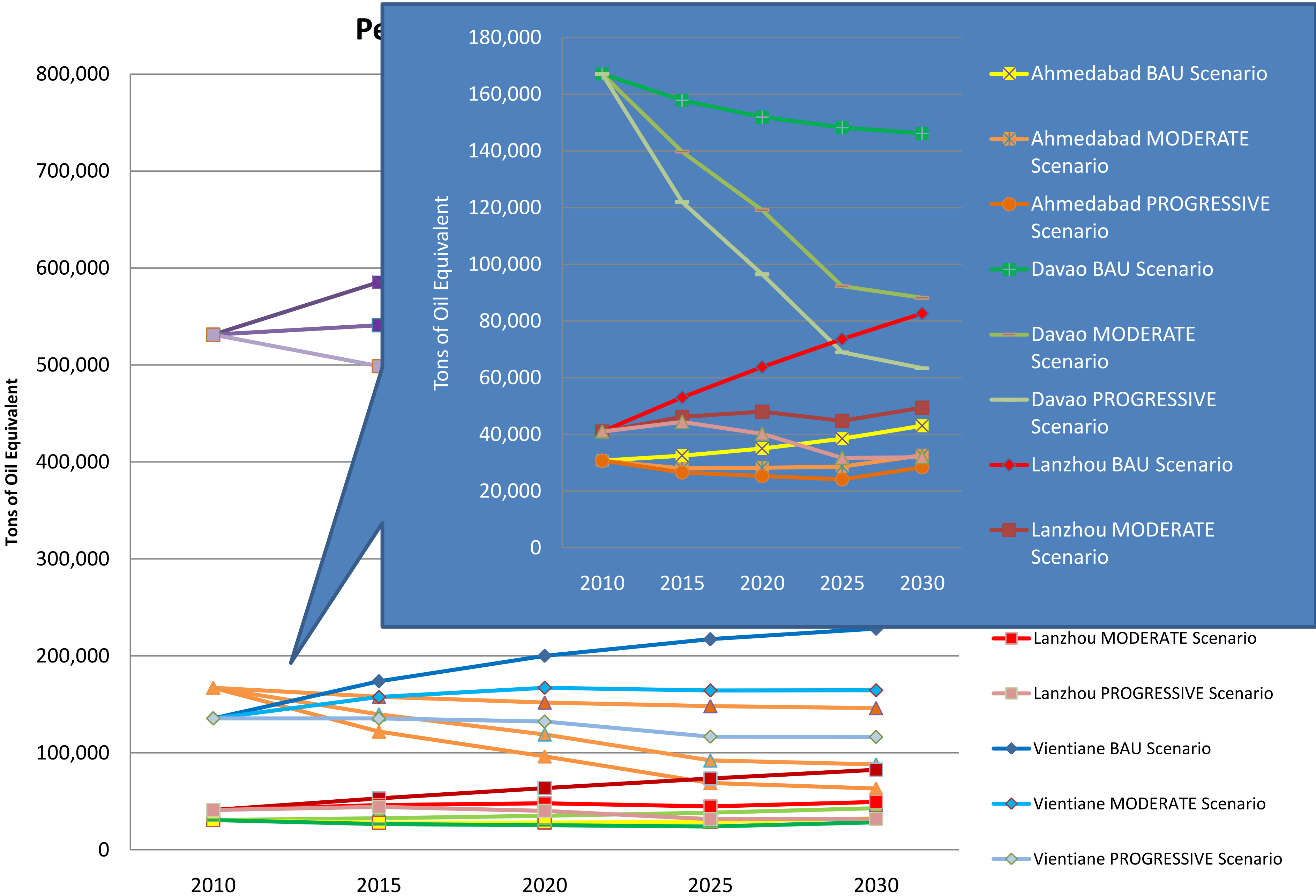
Per Capita Passenger Km (BAU Scenario)



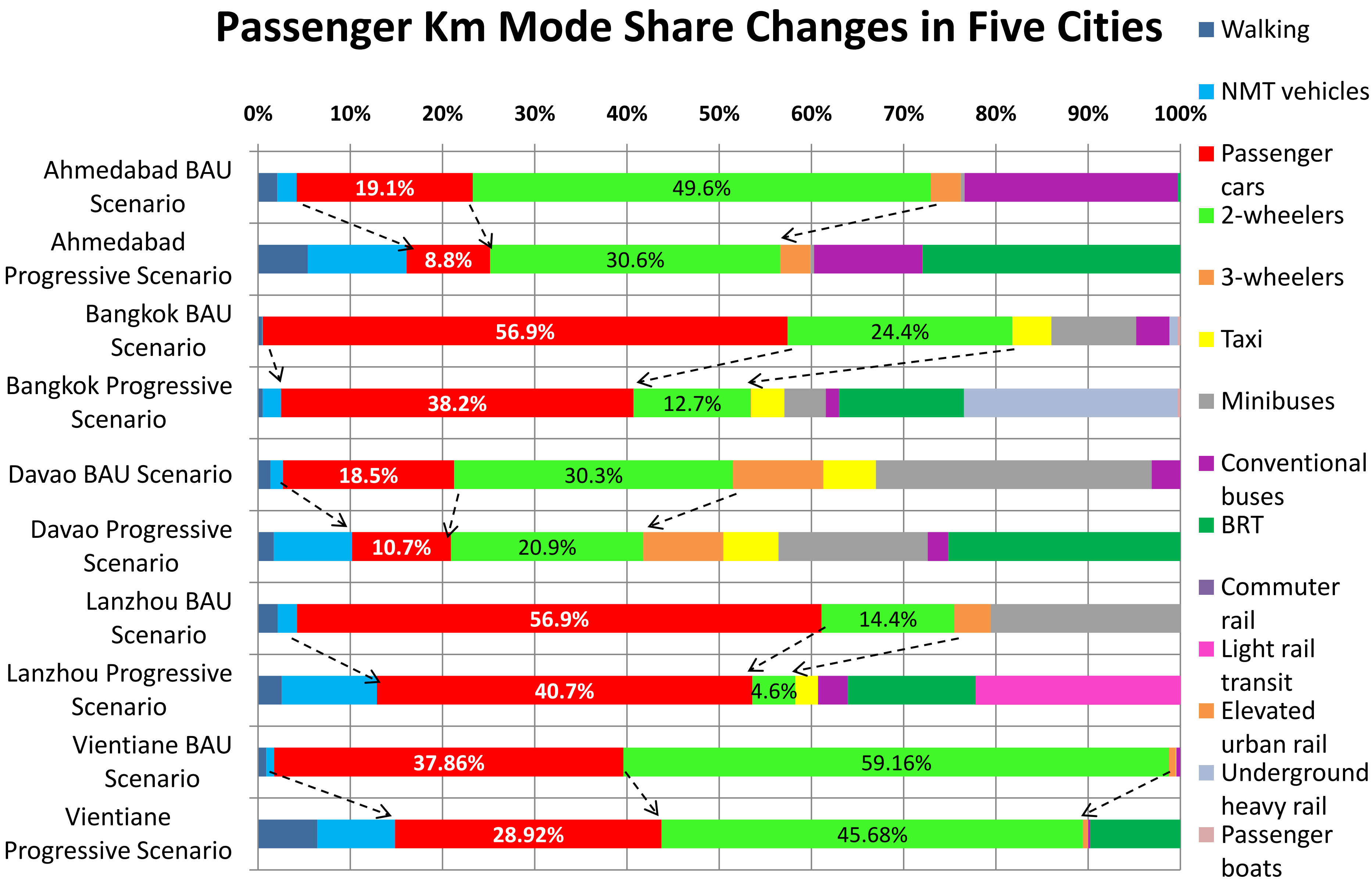
Cumulative Fuel Consumptions



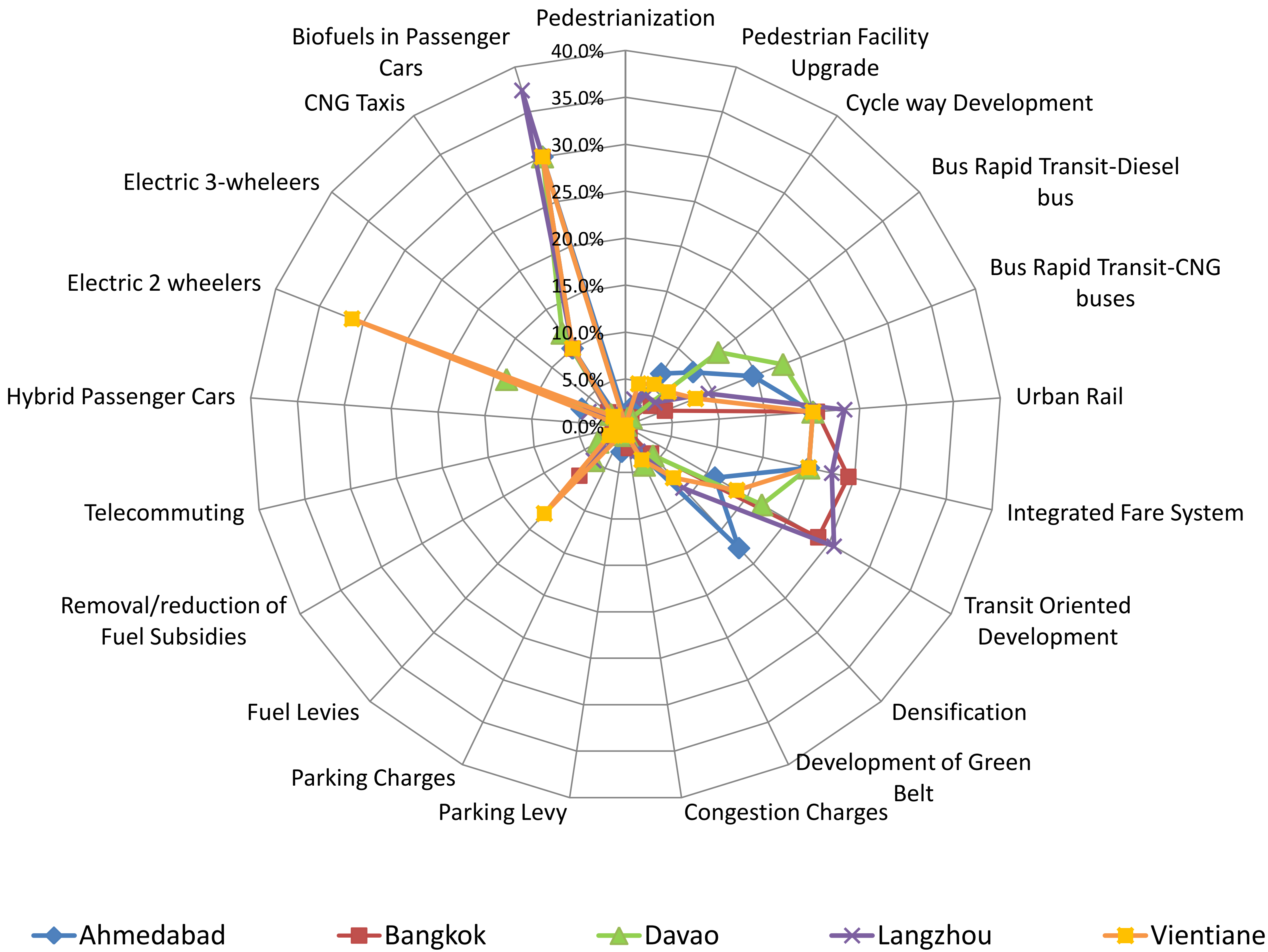
Per Capita Fuel Consumption



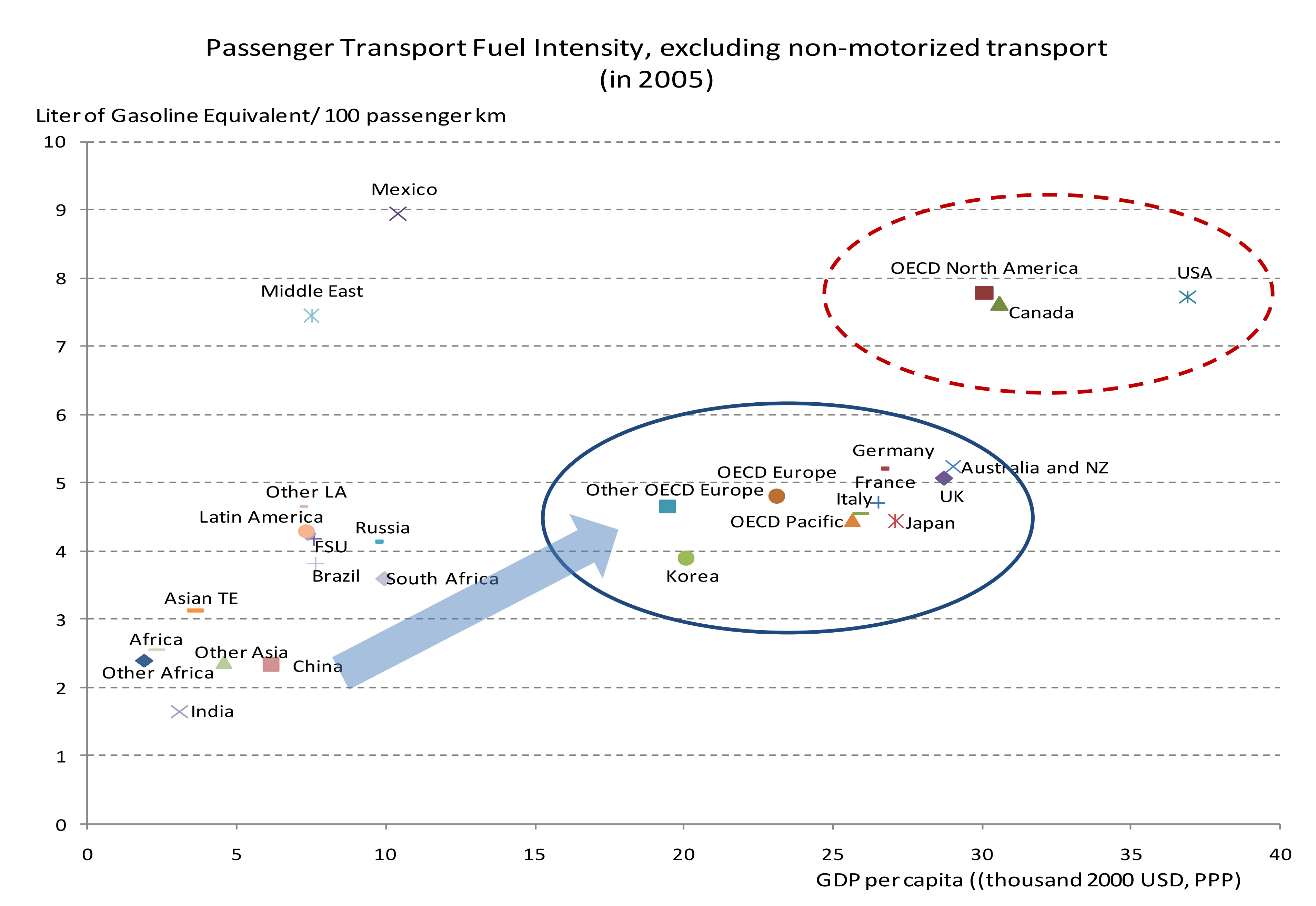
Mode Share Changes (in passenger km)



Fuel Savings of Each Intervention

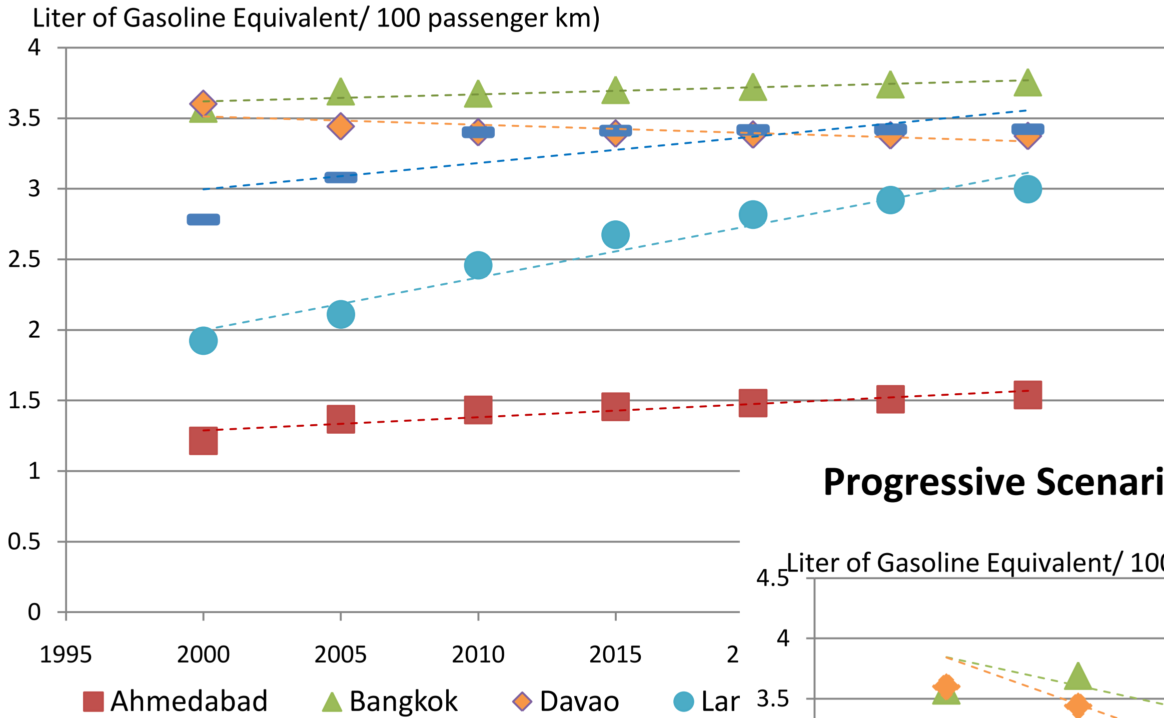


Passenger Transport Fuel Intensity



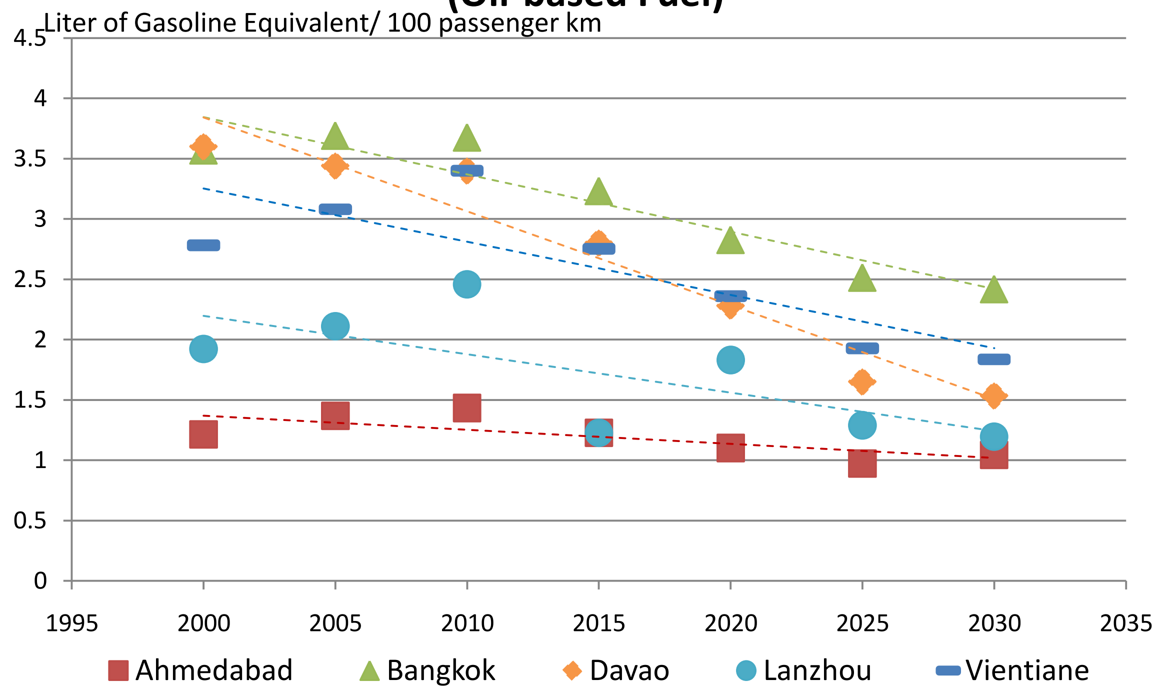
Transport Fuel Intensity

BAU Scenario: Passenger Transport Fuel Efficiency (Oil-based Fuel)

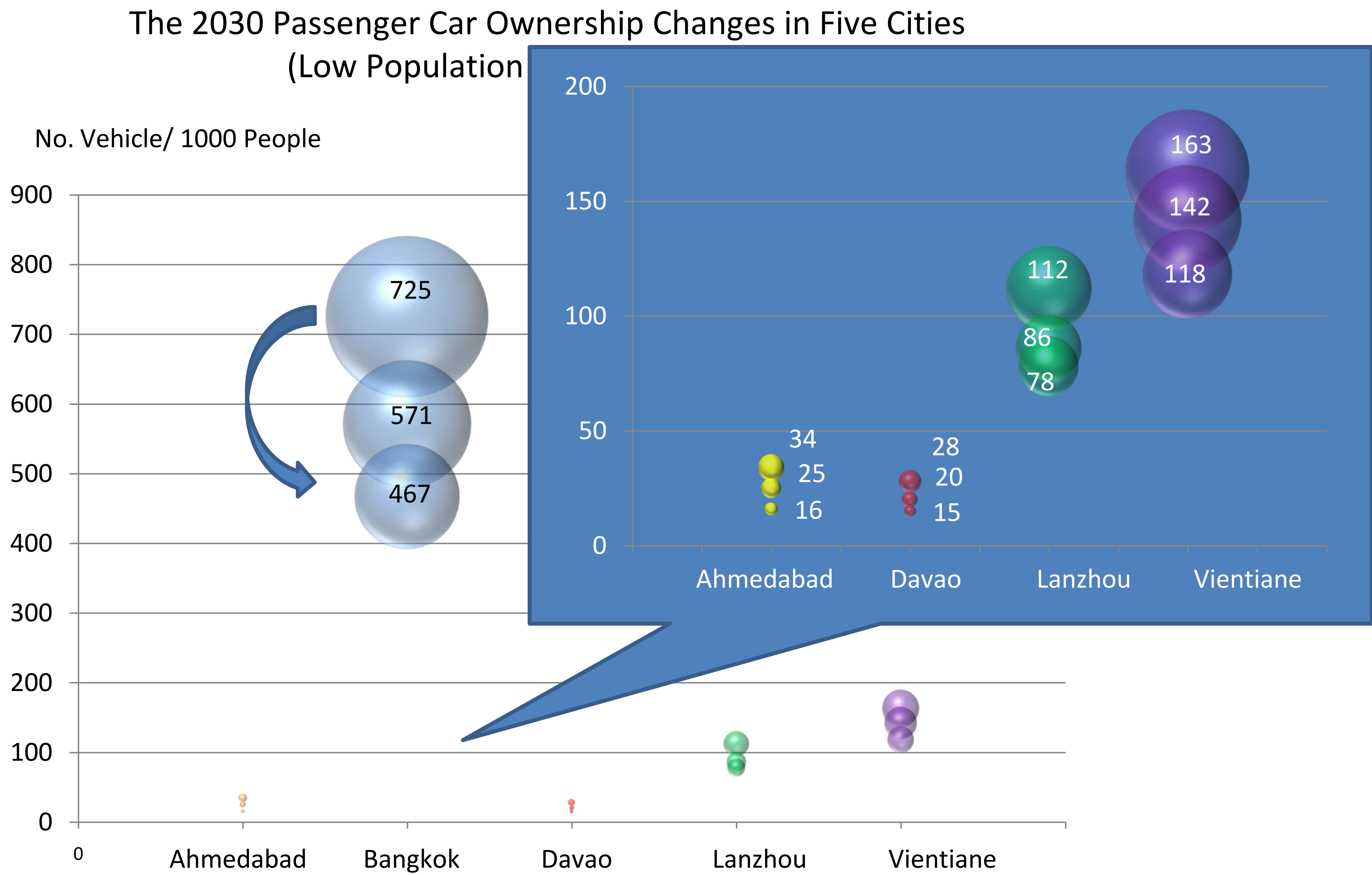


<Low Population Low GDP Projection>

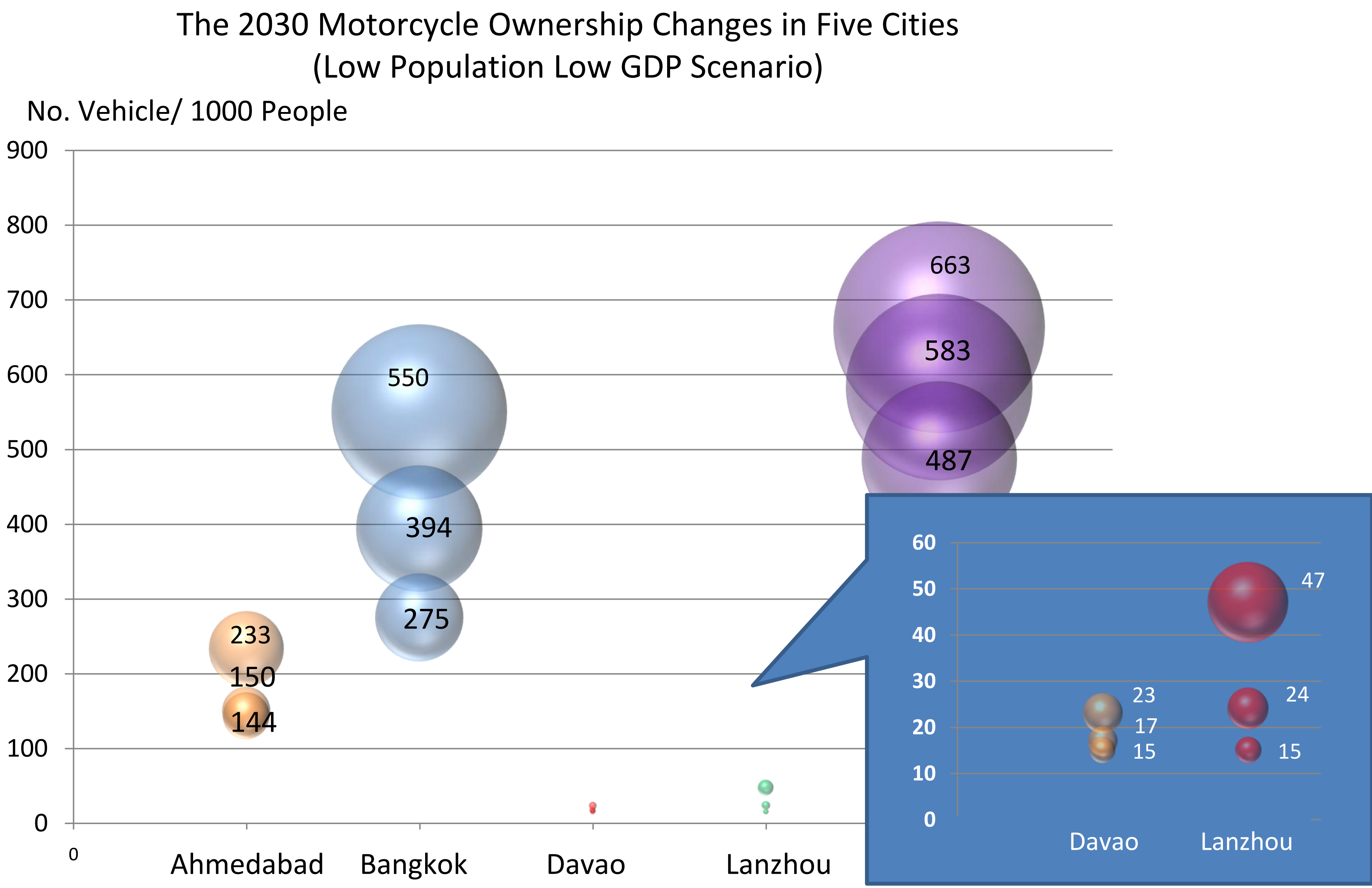
Progressive Scenario: Passenger Transport Fuel Efficiency (Oil-based Fuel)



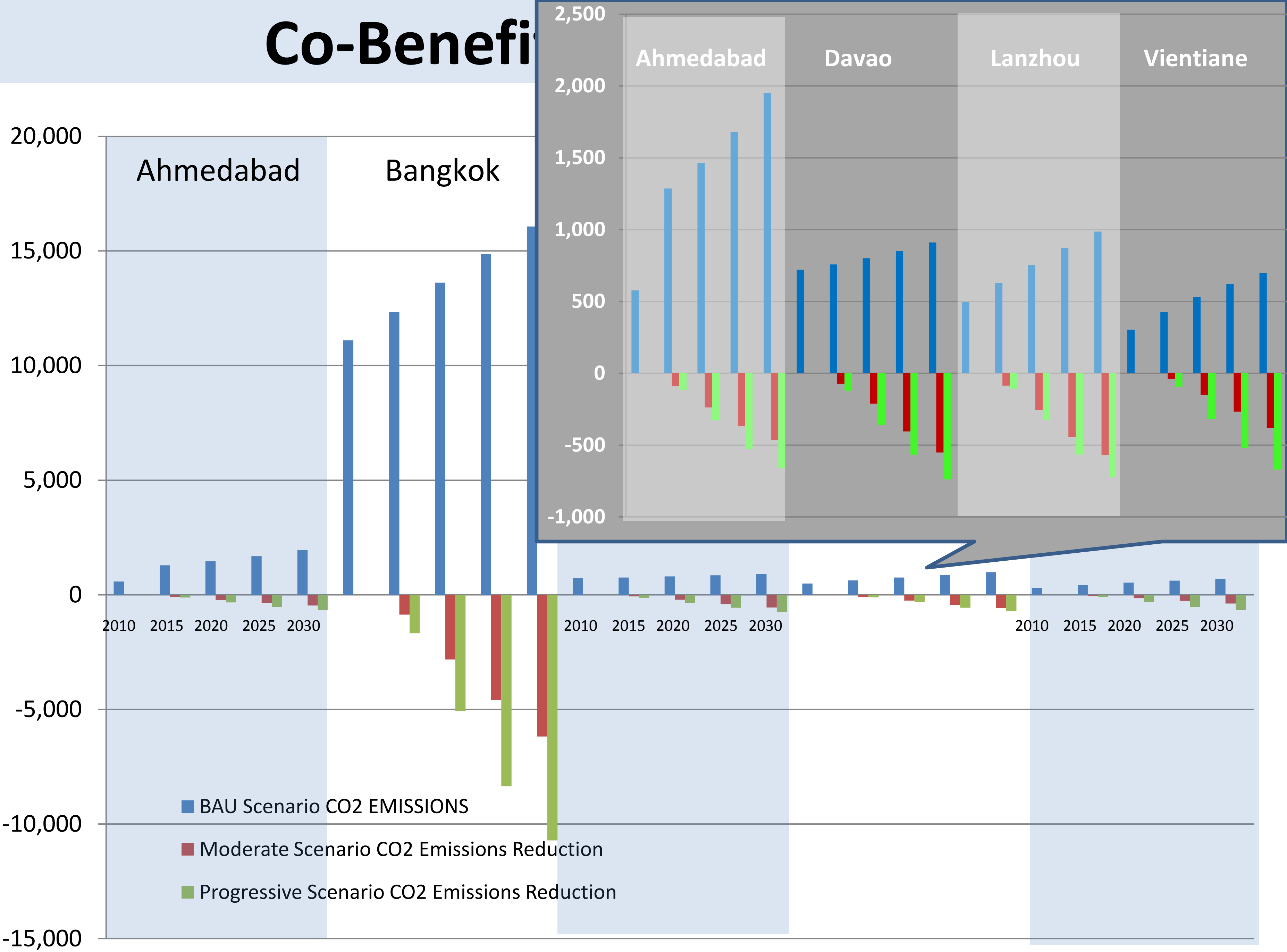
Passenger Car Ownership



Motorcycle Ownership



Co-Benefi



20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Ahmedabad
Bangkok
2010
2015
2020
2025
2030
BAU Scenario CO2 EMISSIONS
Moderate Scenario CO2 Emissions Reduction
Progressive Scenario CO2 Emissions Reduction
2,500
2,000
1,500
1,000
500
0
-500
-1,000
Ahmedabad
Davao
Lanzhou
Vientiane

Single Intervention
Case Studies

Wonju, Republic of Korea

- Mid-East of the Korean peninsula, located at the south western part of Kangwon Province
- The total area of Wonju City is 867.3 km^2
- 87.1 % occupied by forests and agricultural lands
- In 2008, the total population was 306,350 (growth rate at 1.7%)
- "Waste to Biomethane" project: 5.5 million m^3 in 2011/12

Biomethane Result

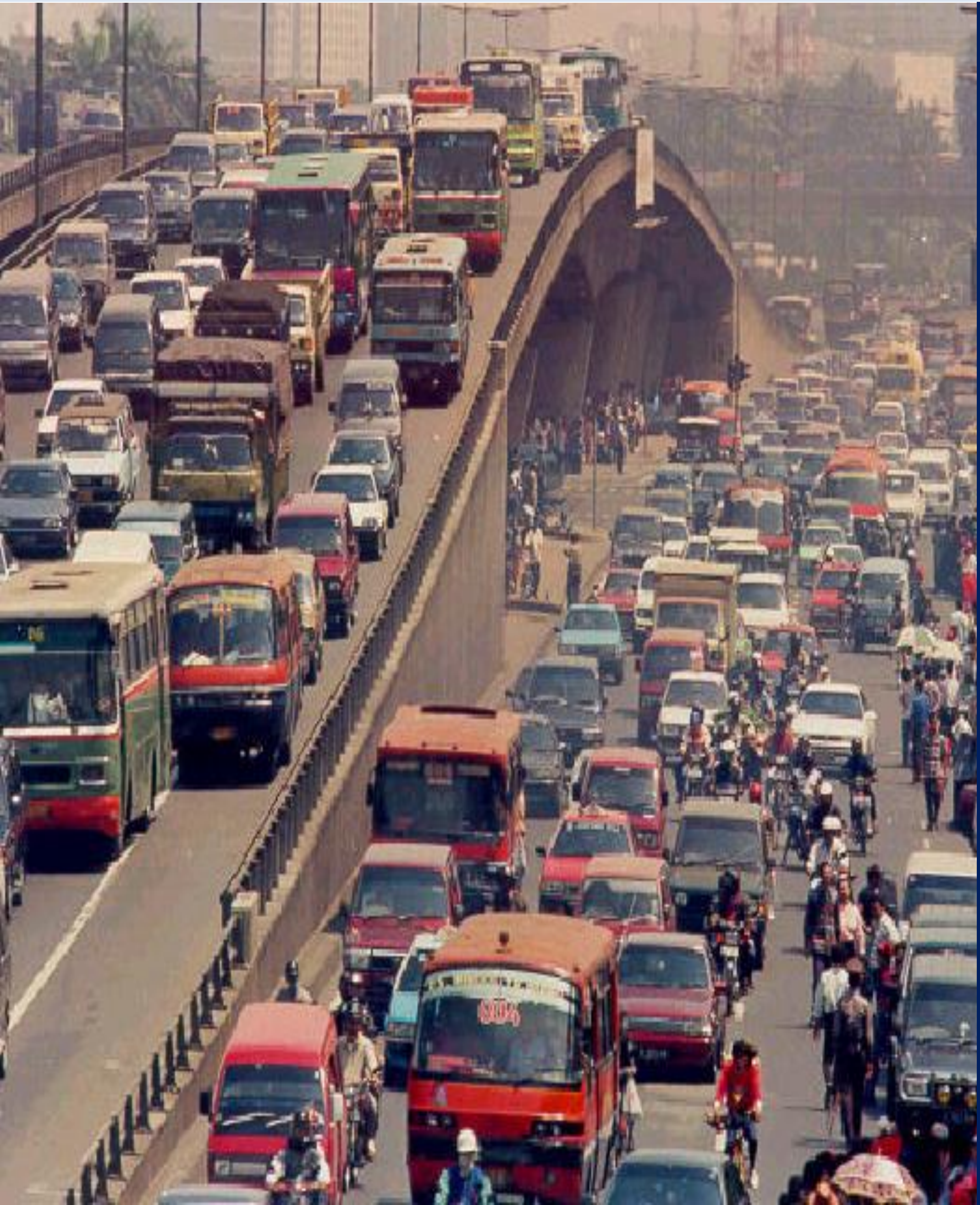
CONSERVATIVE SCENARIO:

- 11.3 Million M3 Biomethane from waste
- Cumulative Savings: **0.15 MTOE**

PROGRESSIVE SCENARIO:

- 14. 1 Million M3 Biomethane from waste
- Cumulative Savings: **0.17 MTOE**

Indonesia (fuel economy standards)



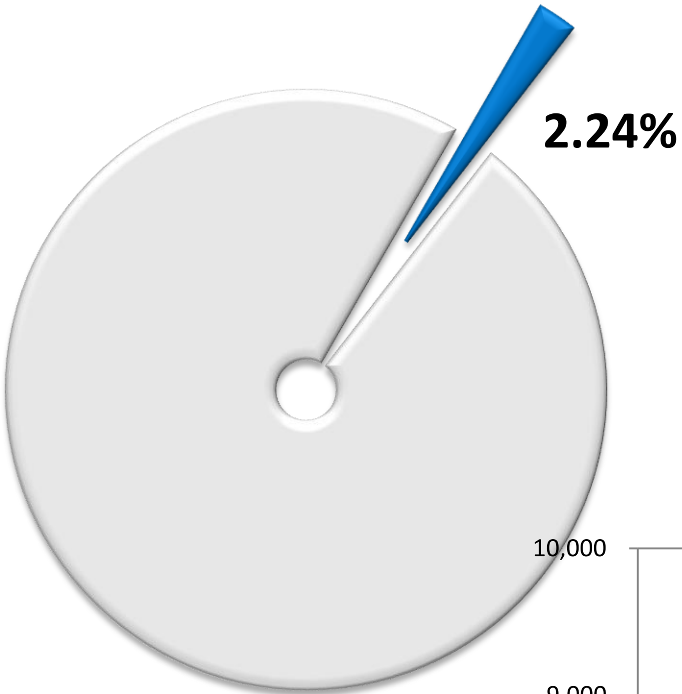
- Transport sector takes up almost 52% of the total energy consumption
- The fuel demand increased around 5-6% annually in the last 20 years
- 23% of CO_2 emissions; Road transport accounts for more than 85% of total CO_2 emissions

Indonesia FES Scenarios

2008 Average Fuel Economy of Passenger Cars: 7.89 L/100 km

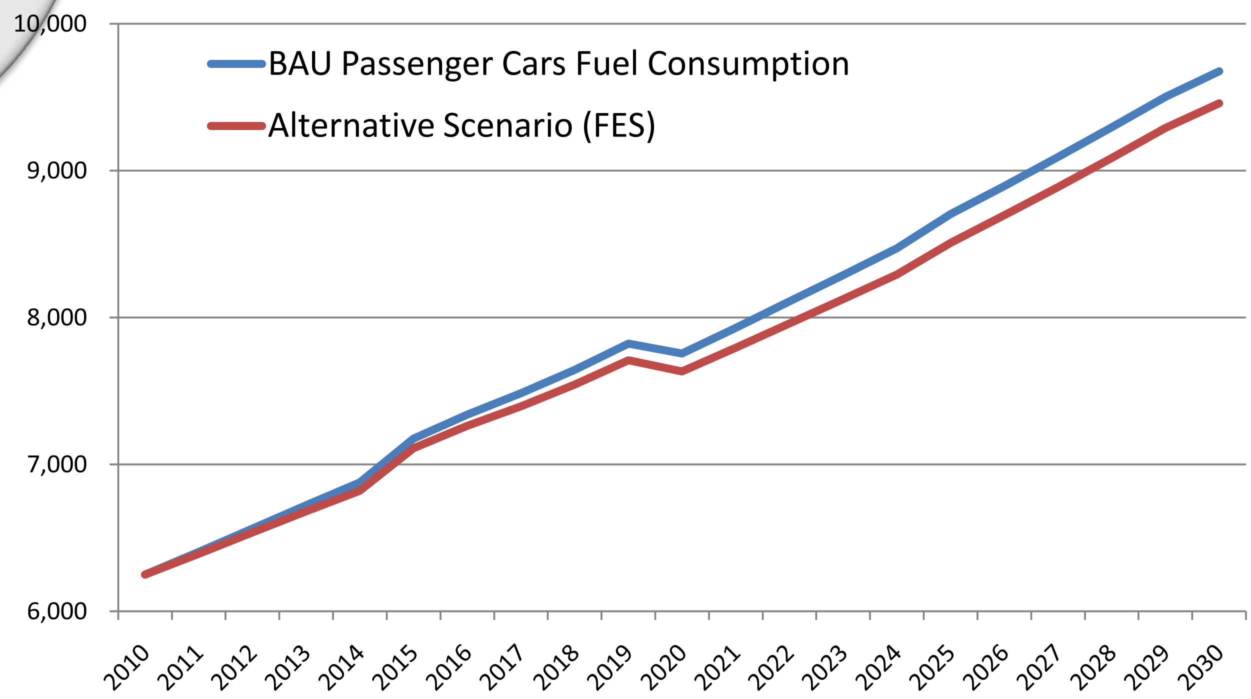
Fuel Economy Standards	Average Fuel Economy	Targeted Timeframe
(Chinese FES Phase 3- 7.23L/100 km)+	6 L/100km	2015
Chinese FES Phase 4 / Japanese 2020 FES target	5 L/100km	2020
European 2020 FES target	4 L/100 km	2030

Indonesia Fuel Economy Standards Result



Cumulative Savings: **2.1 MTOE**

(BAU Passenger Car fuel consumption)

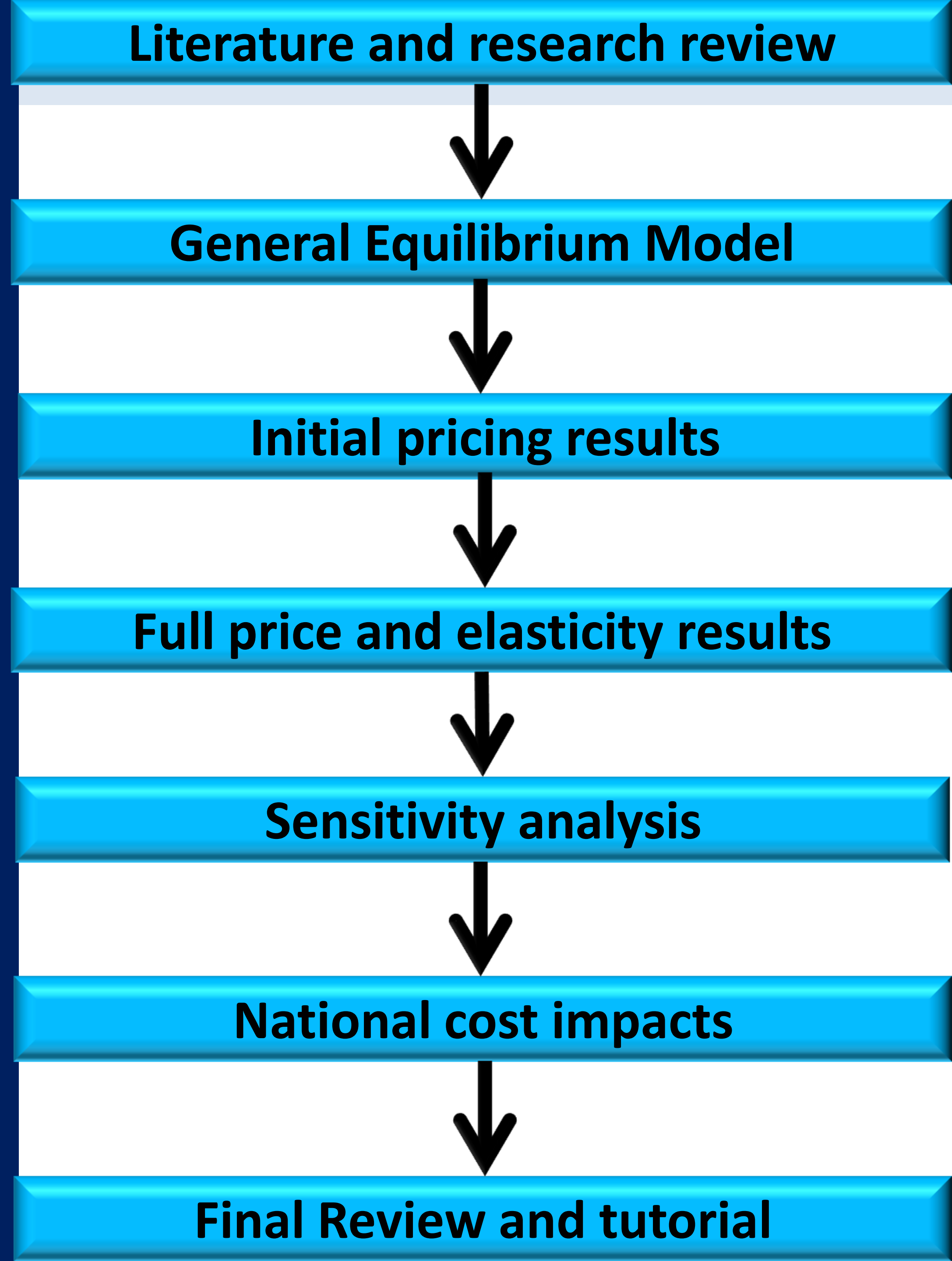


Economic Modeling

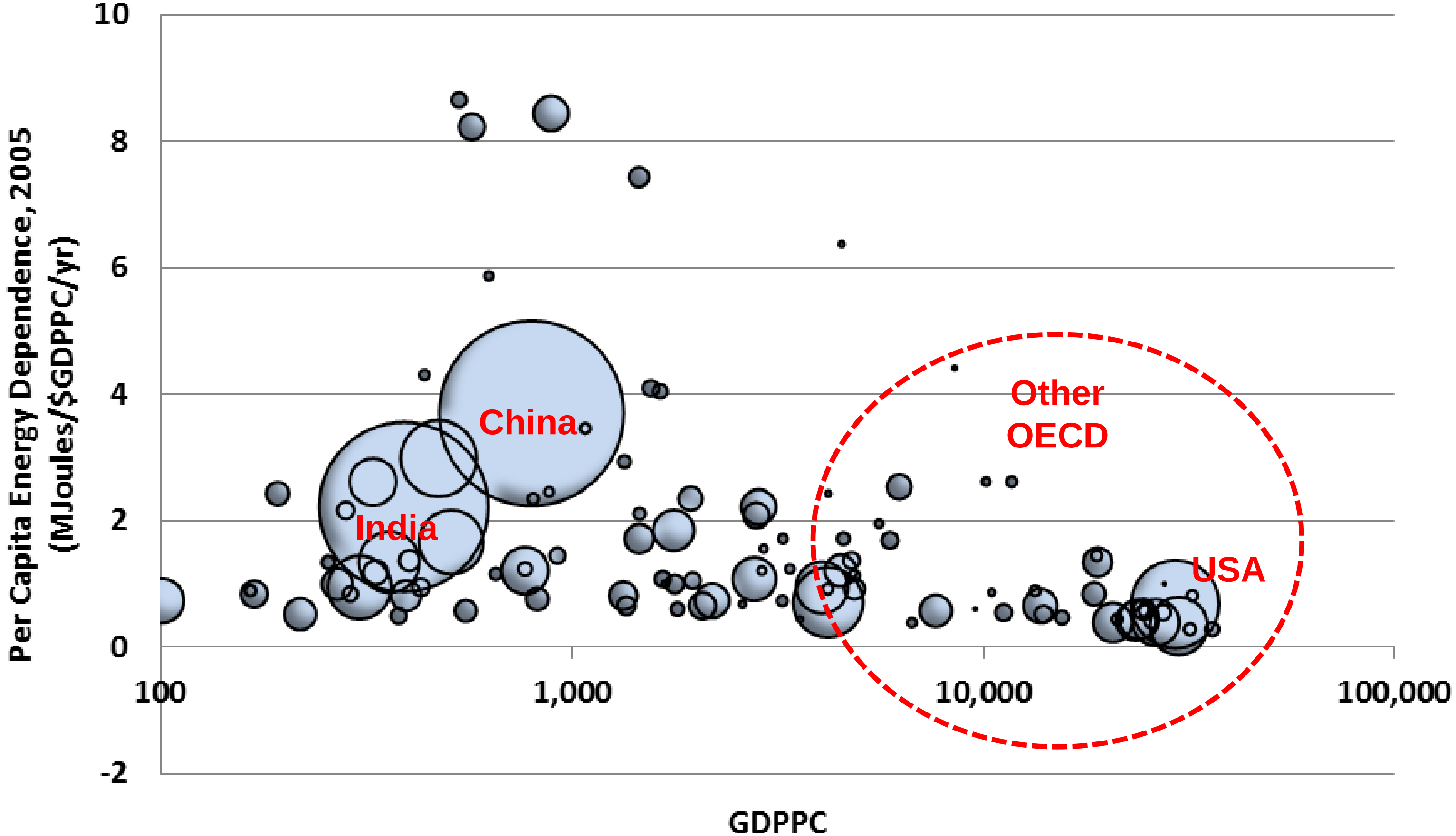
(11h00 – 12h45)

Economic Modeling

- Berkeley Economic Advising and Research (BEAR)
- Initial results produced in June 2011
- Full report by 31 July 2011

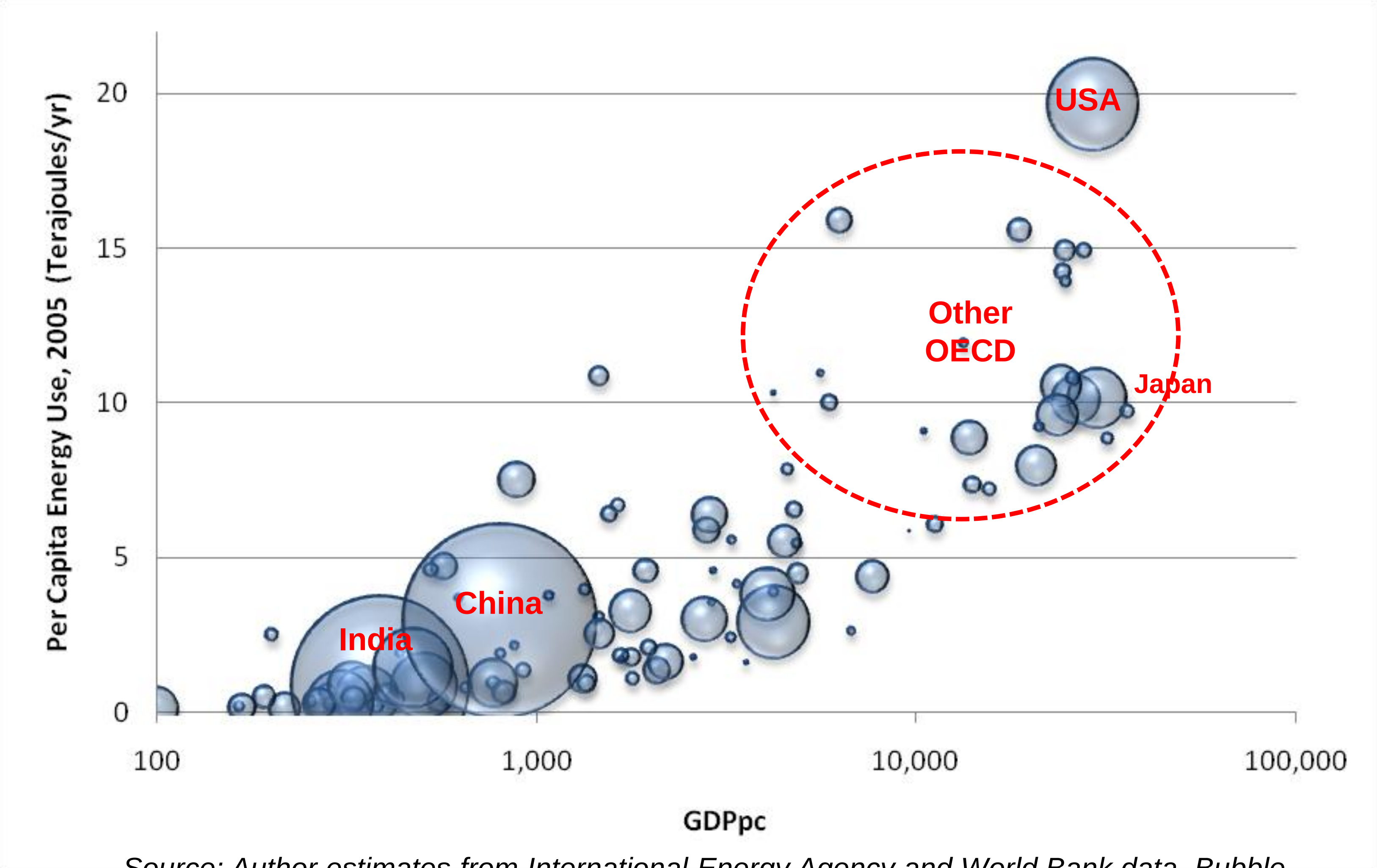


Looking Good: Energy Intensity by Country, Income, and Population



Source: Author estimates from International Energy Agency and World Bank data. Bubble diameter is proportional to population, 2005

Look Out: Energy and Income, by Country, Income, and Population

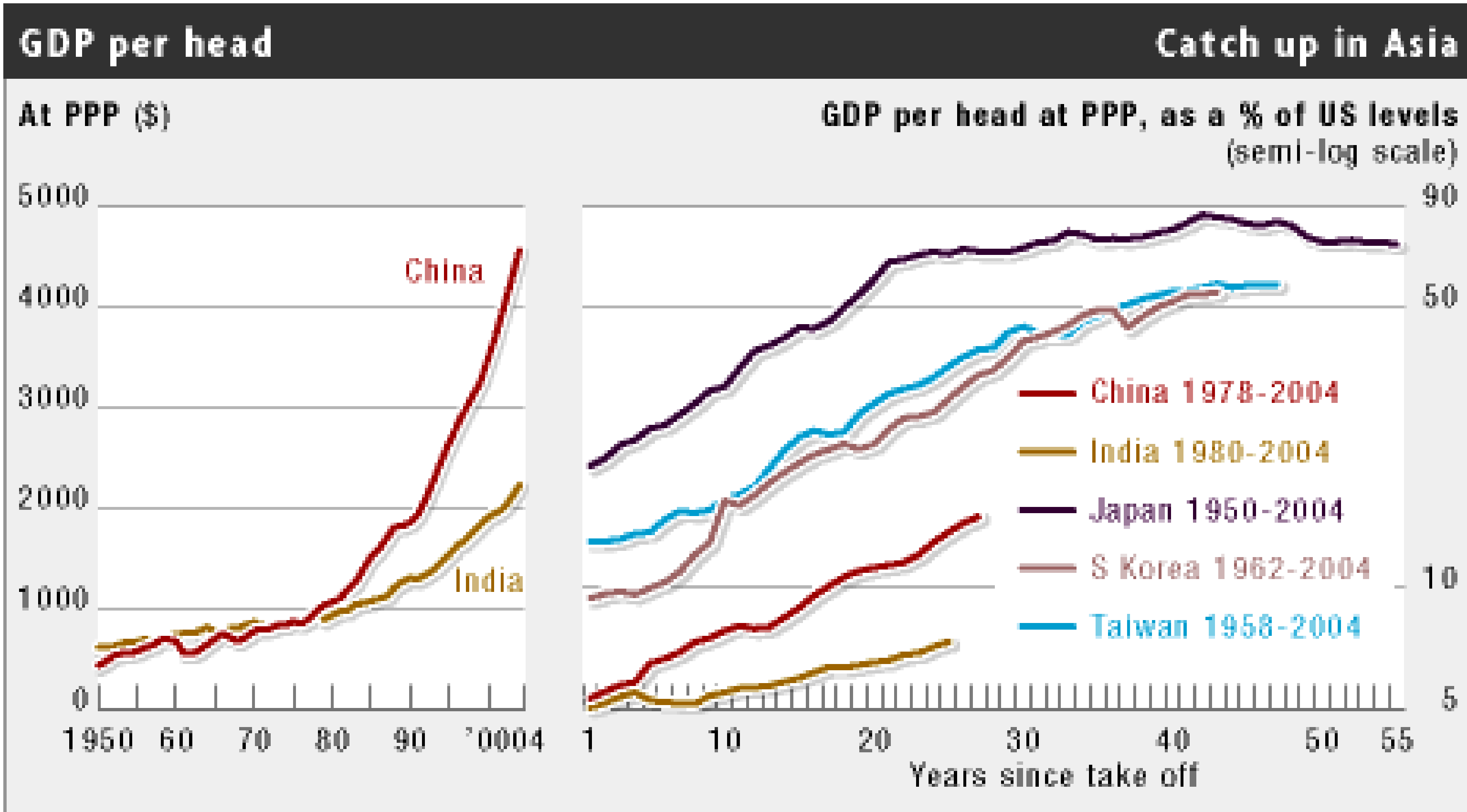


Source: Author estimates from International Energy Agency and World Bank data. Bubble diameter is proportional to population (2005)

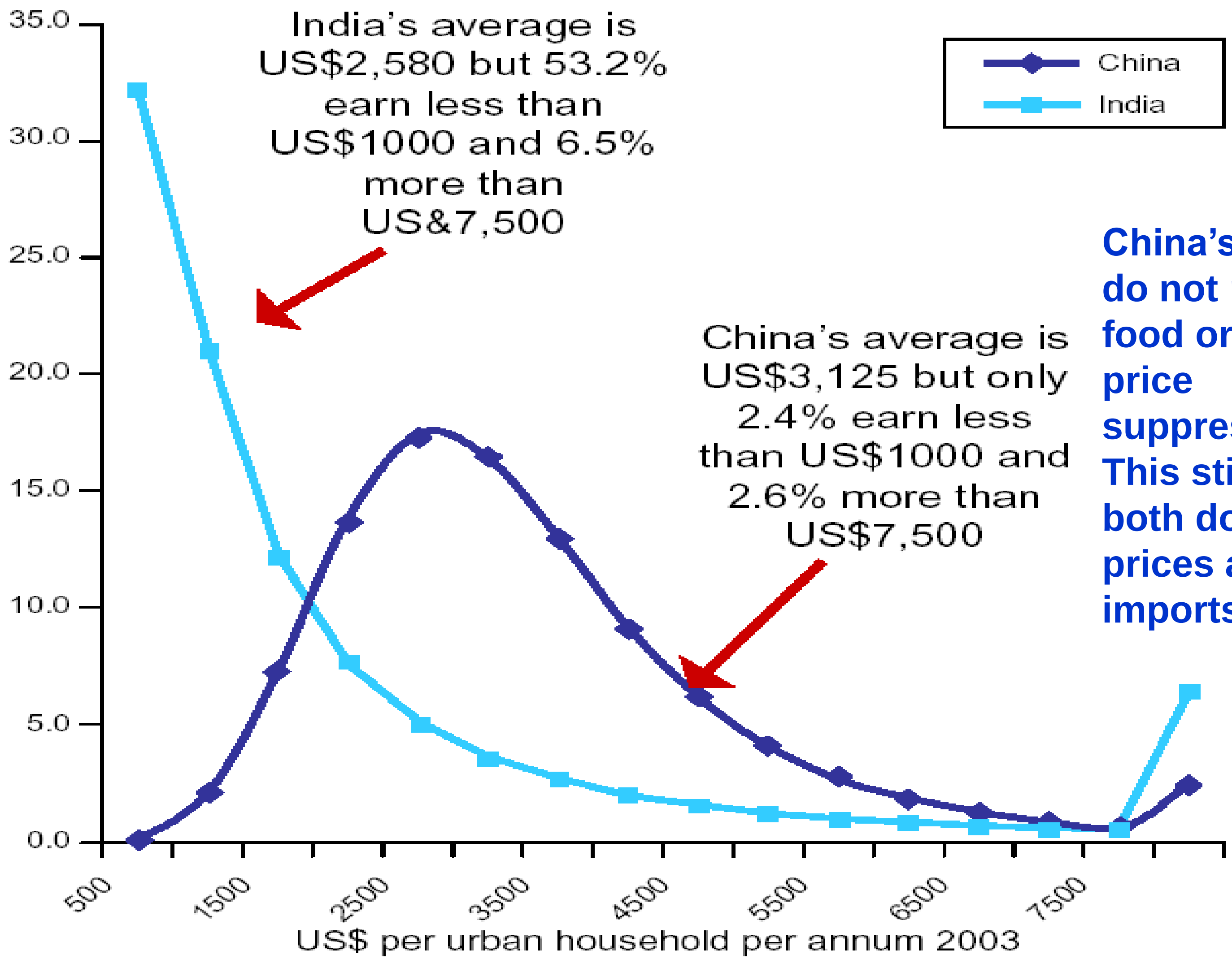
Asian Emergence and Fuel Demand

- Asia's economic emergence has fundamentally altered the trends and composition of global resource allocation, demand, and supply
- This process remains in its early stages, but the implications for essential commodities, including energy and food, are already far-reaching
- China and India are also rapidly emerging GHG sources, and their fuel needs will eventually exceed the developed countries

Room to grow – but on a different scale

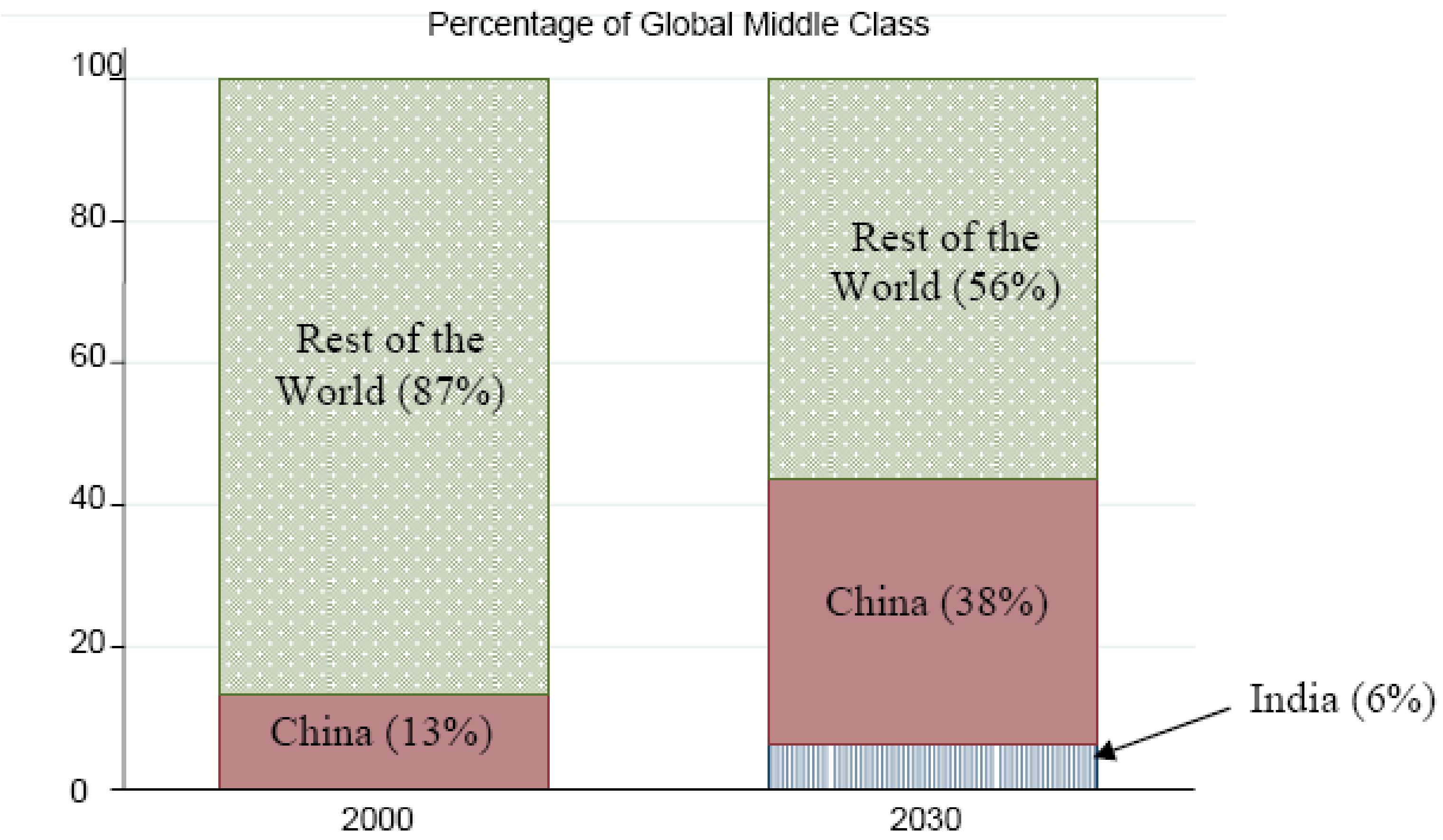


China's Urban Population will Accelerate Resource-intensive Regional Demand



China's urbanites do not really need food or energy price suppression. This stimulates both domestic prices and imports.

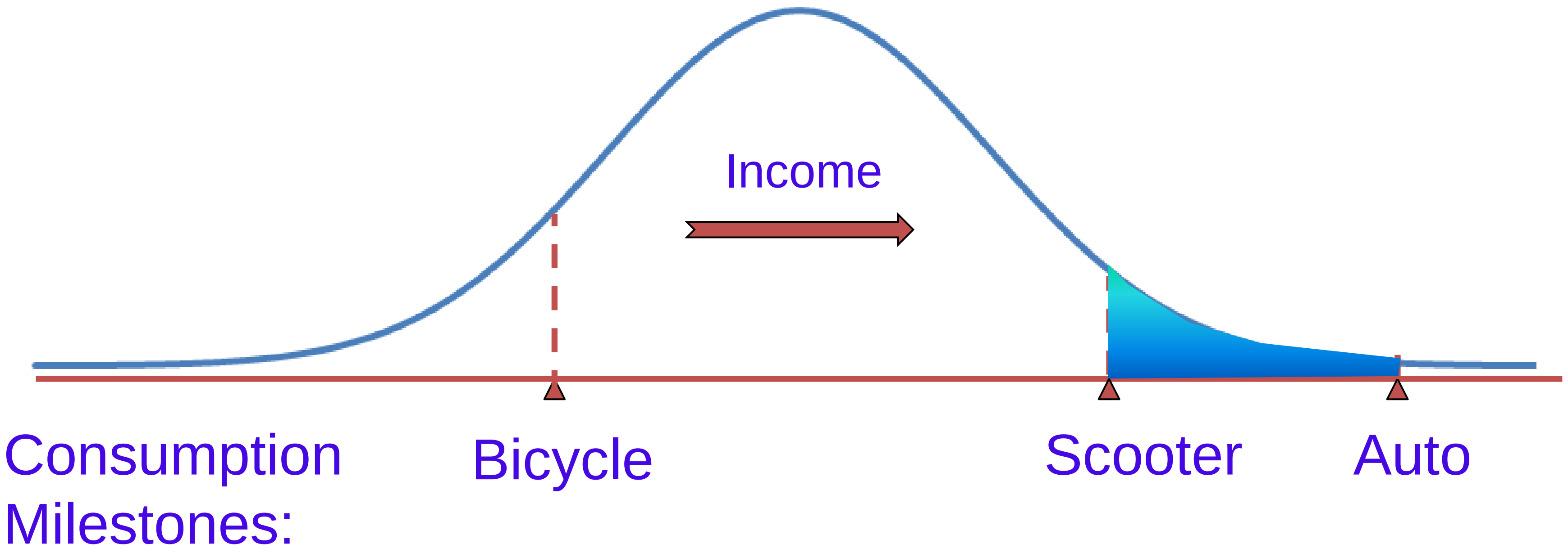
Middle Class Emergence



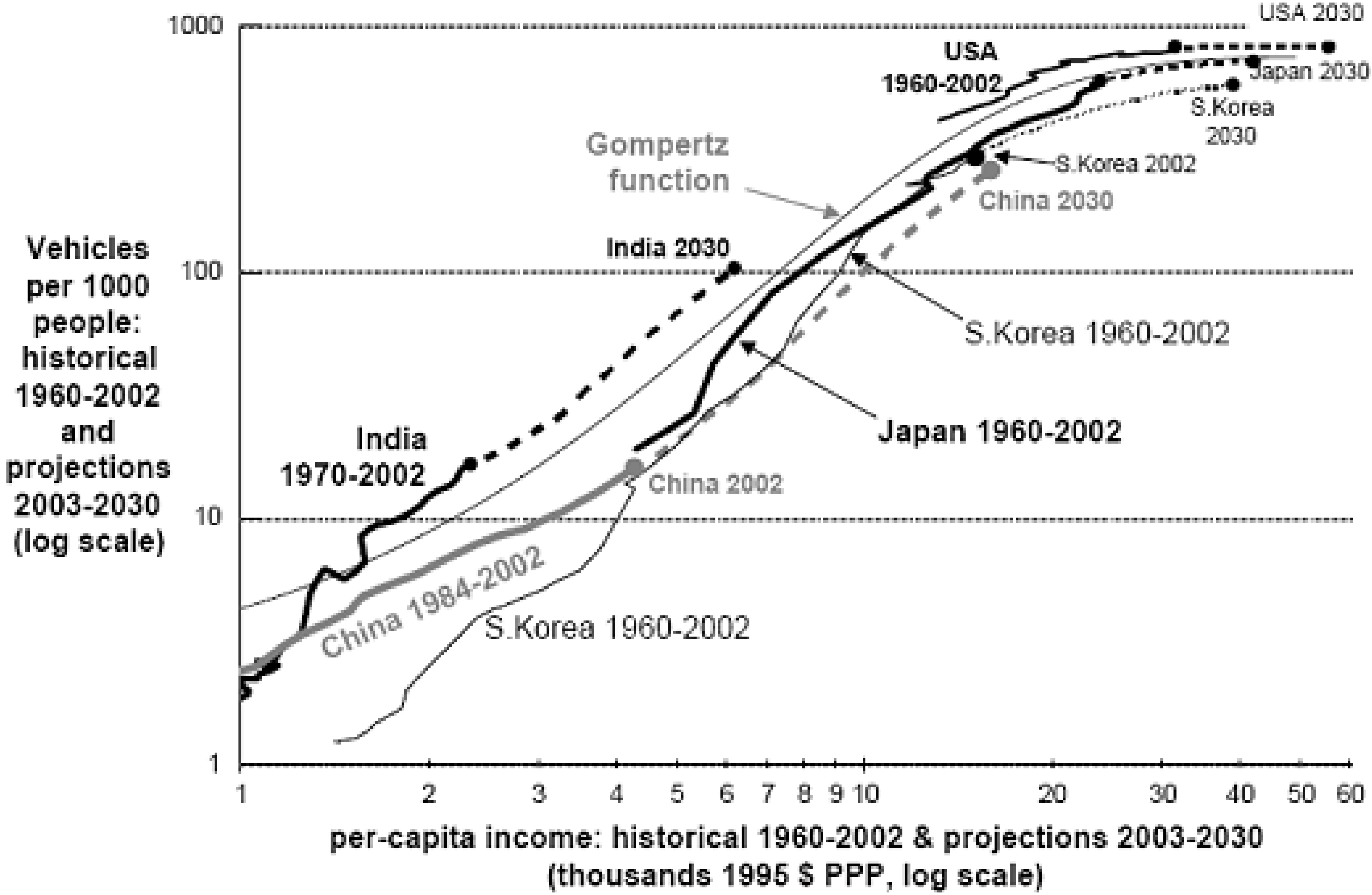
Source: World Bank

Growth of Consumer Durables... Explosive

Durable Goods: Linear Growth of Average Income
Induces Exponential Growth of New Demand

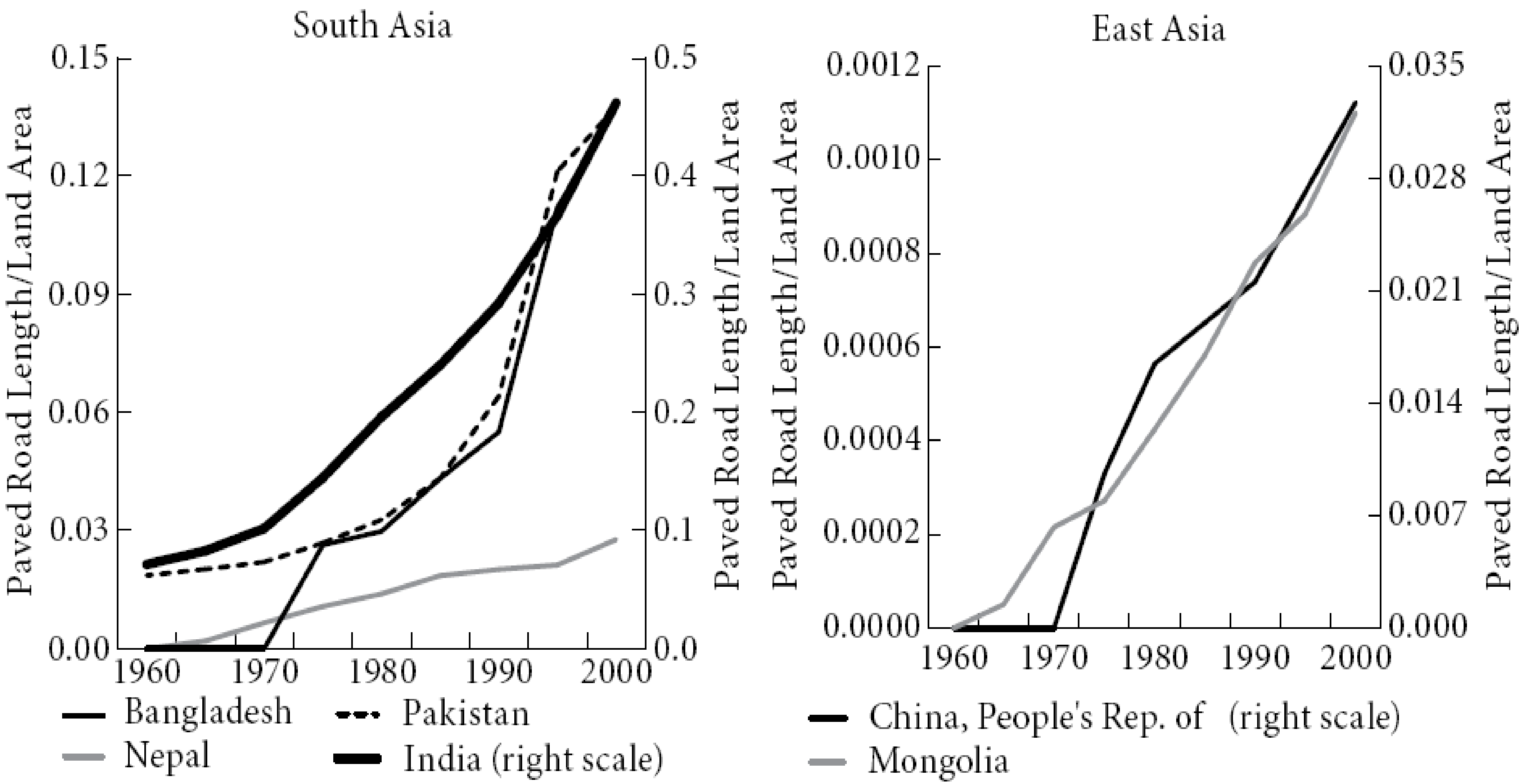


Vehicles: A sentinel commodity 1960-2030



Source: Dargay, Gately and Sommer: 2008

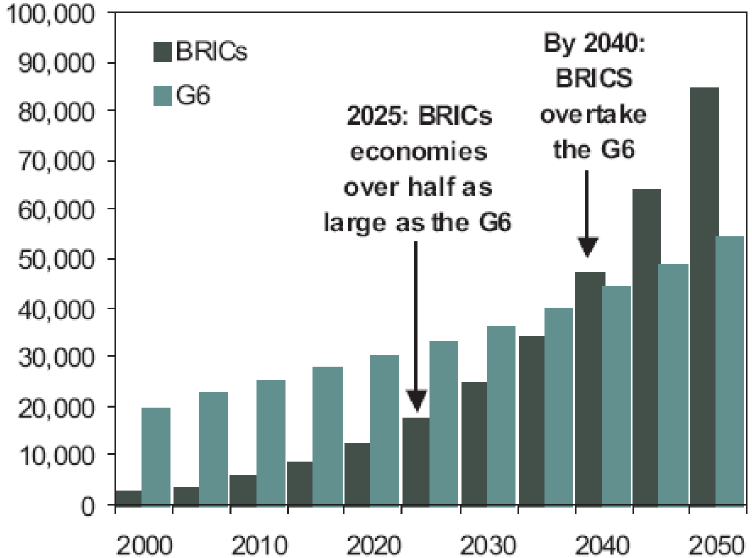
Policy Facilitation: Paved Road Systems



Source: Fay and Yepes (2003).

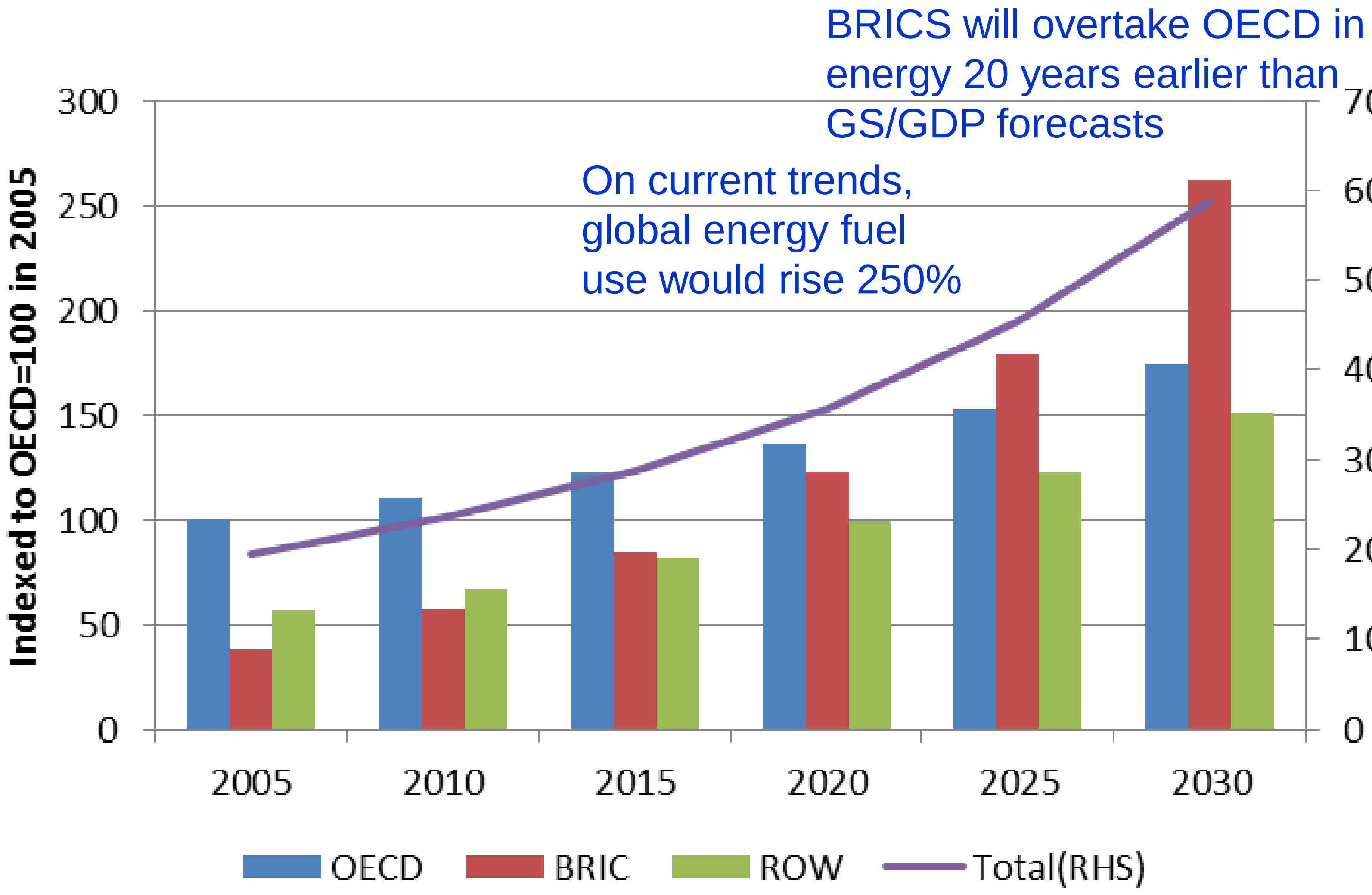
Where this all leads:
Emerging Markets and Global Energy

- The BRICS story from an energy perspective
- The Goldman-Sachs (GS) projections show aggregate growth,
- but the composition of demand and technology will have decisive impacts on energy intensity, energy choice, and emissions



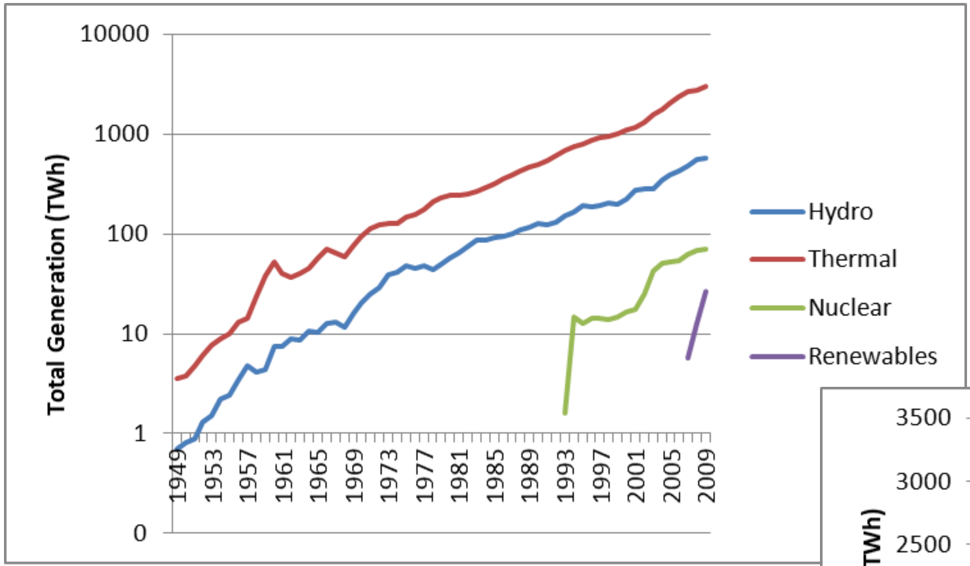
GS BRICs Model Projections. See text for details and assumptions.

Emerging Markets are Redefining Global Energy Use



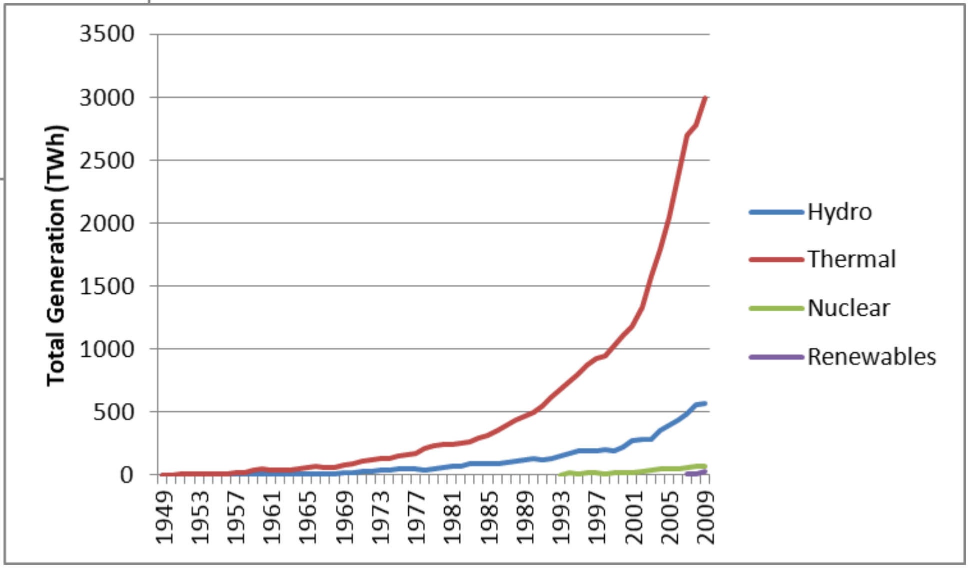
Source: Roland-Holst:2010.

Supply Side Solutions: China's Electric Power by Energy Source



Yes, renewables are growing very fast.

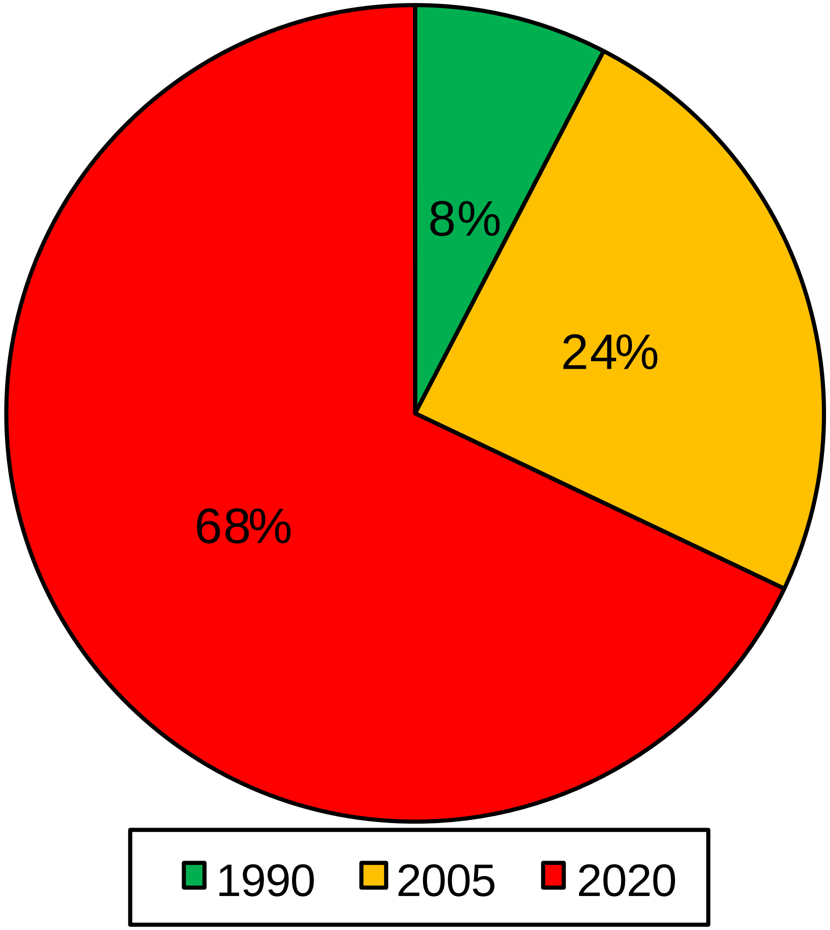
Their overall contribution, however, remains negligible.



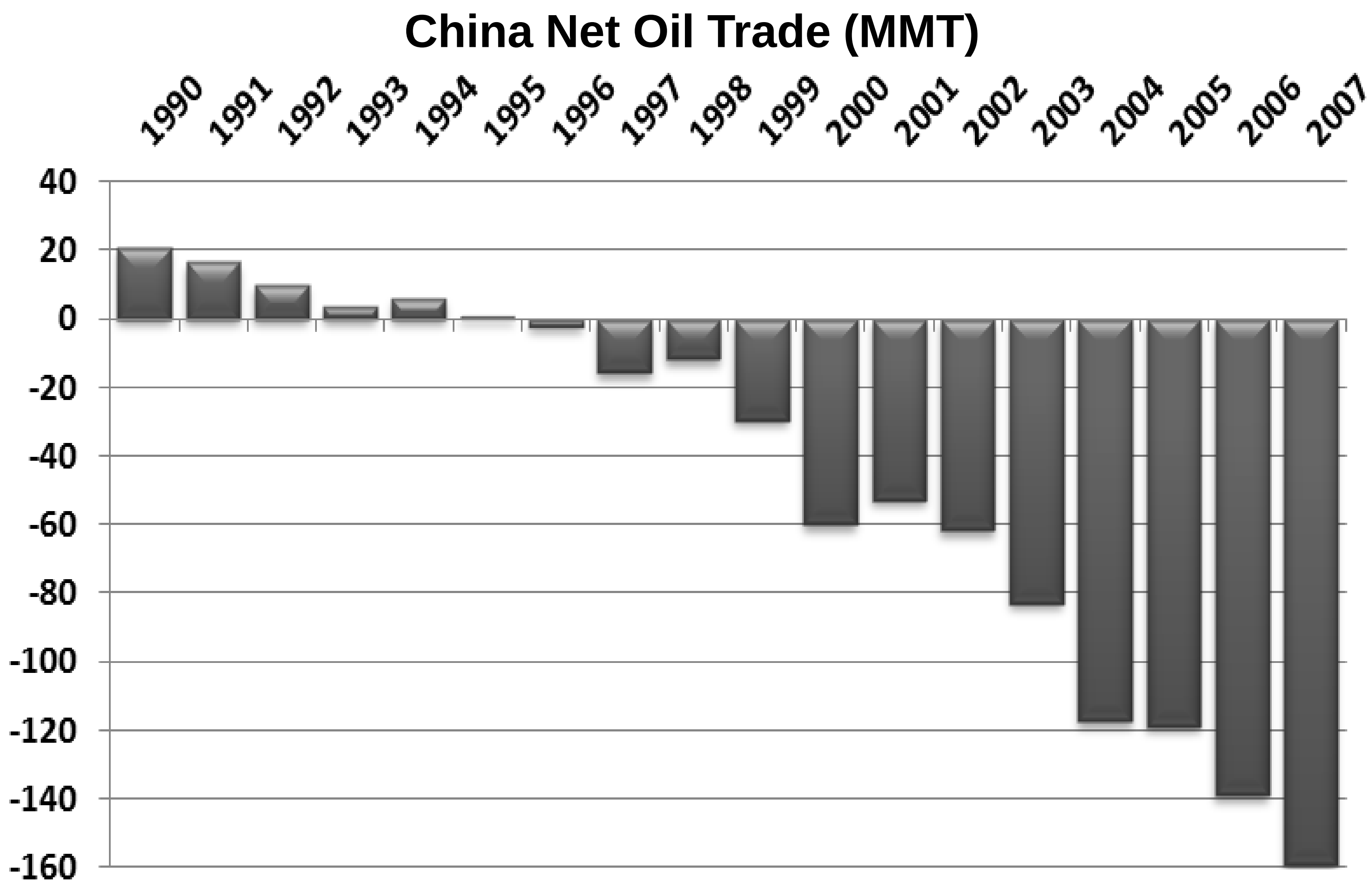
Source: NDRC, PRC.

China's Electric Power Capacity

- 1.8TW by 2020
- Between now and 2020, more new capacity will be added than the entire installed capacity of the EU
- 74% coal-fired
- 30-40 year useful life



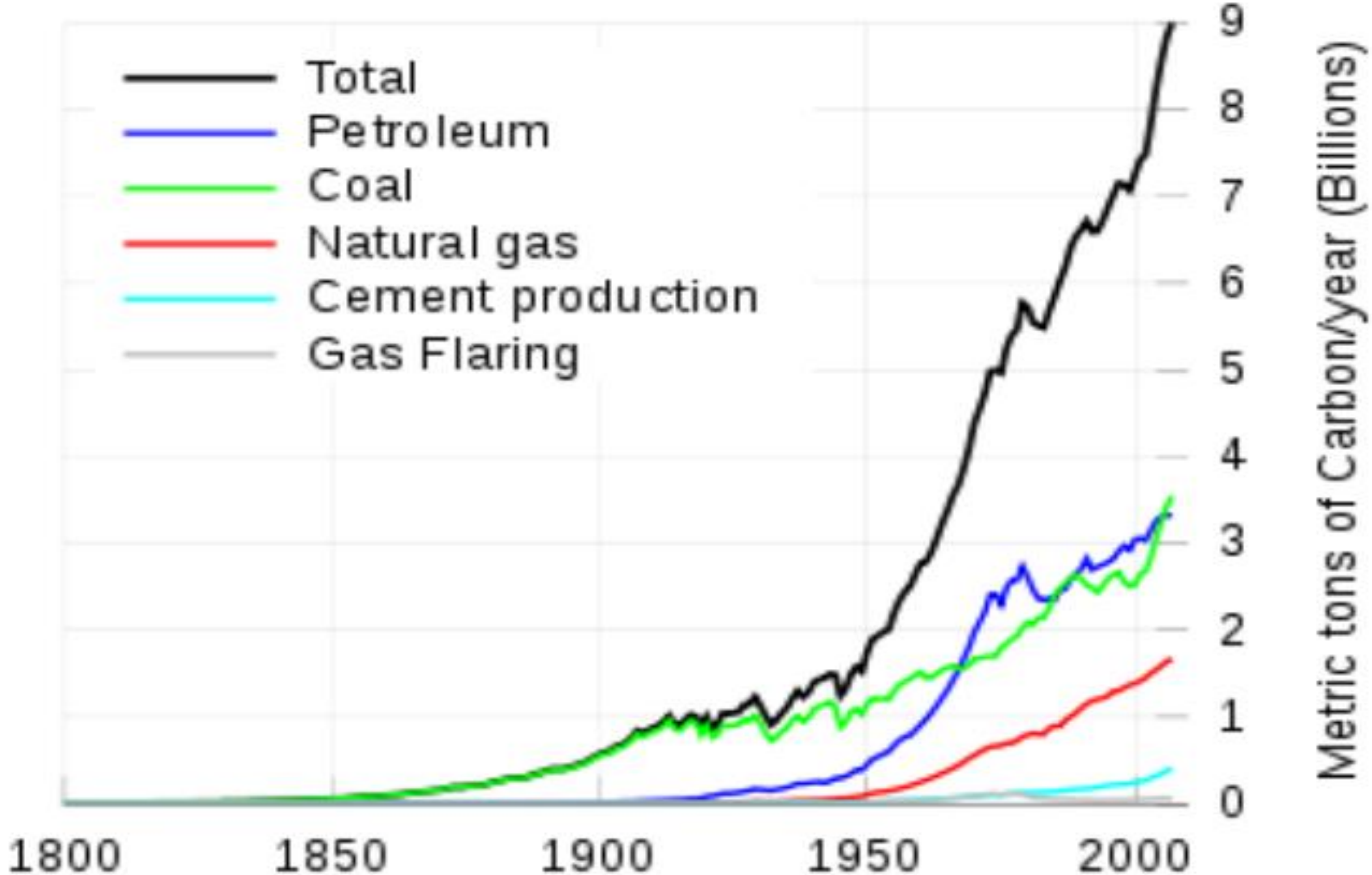
China’s Petroleum Tsunami



Source: UN/COMTRADE

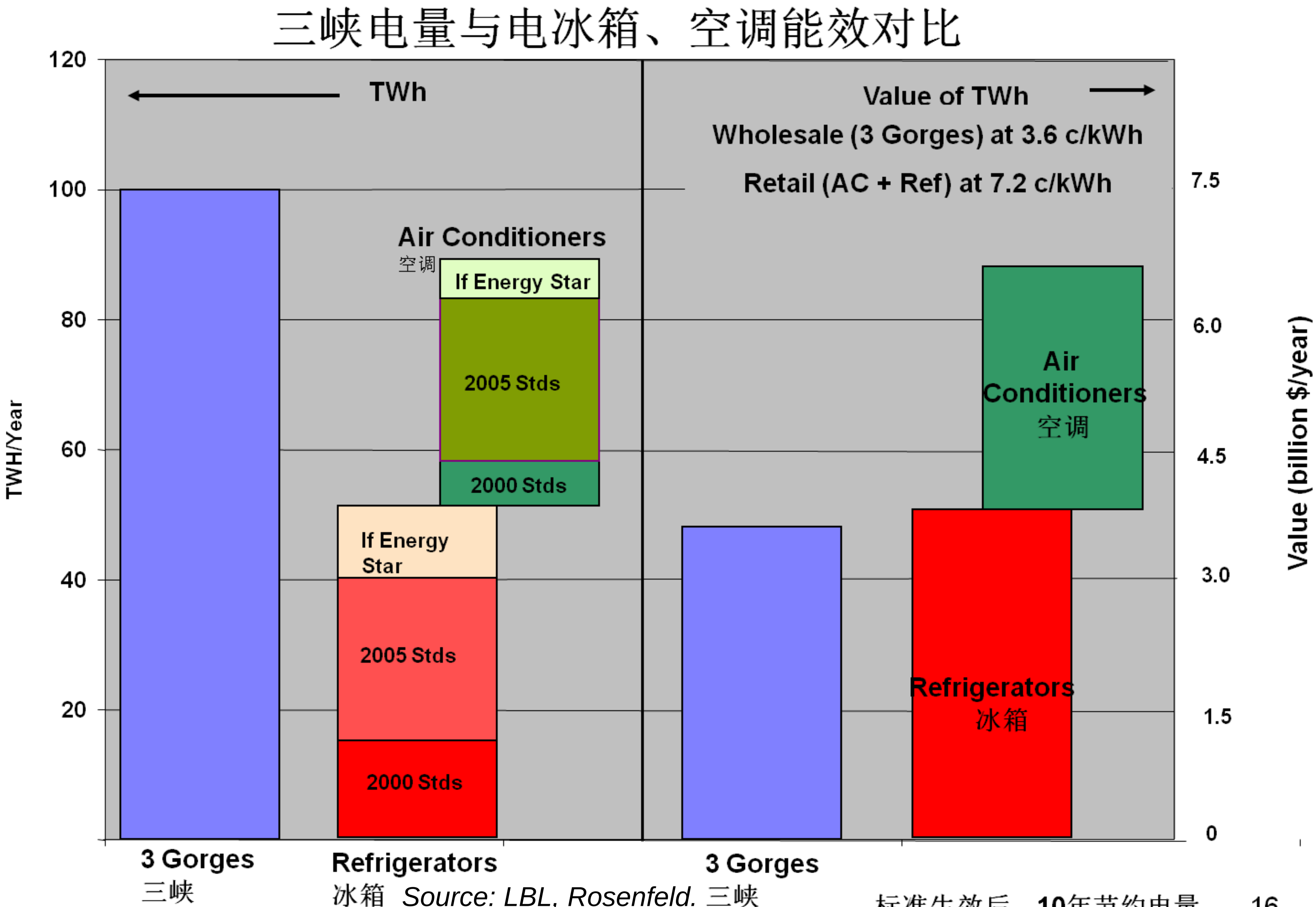
Can we really keep this up?

Global fossil carbon emissions flow by fuel type



NB: Carbon represents only 27% of the mass of CO_2

Demand Side Solutions: Electric Power in China

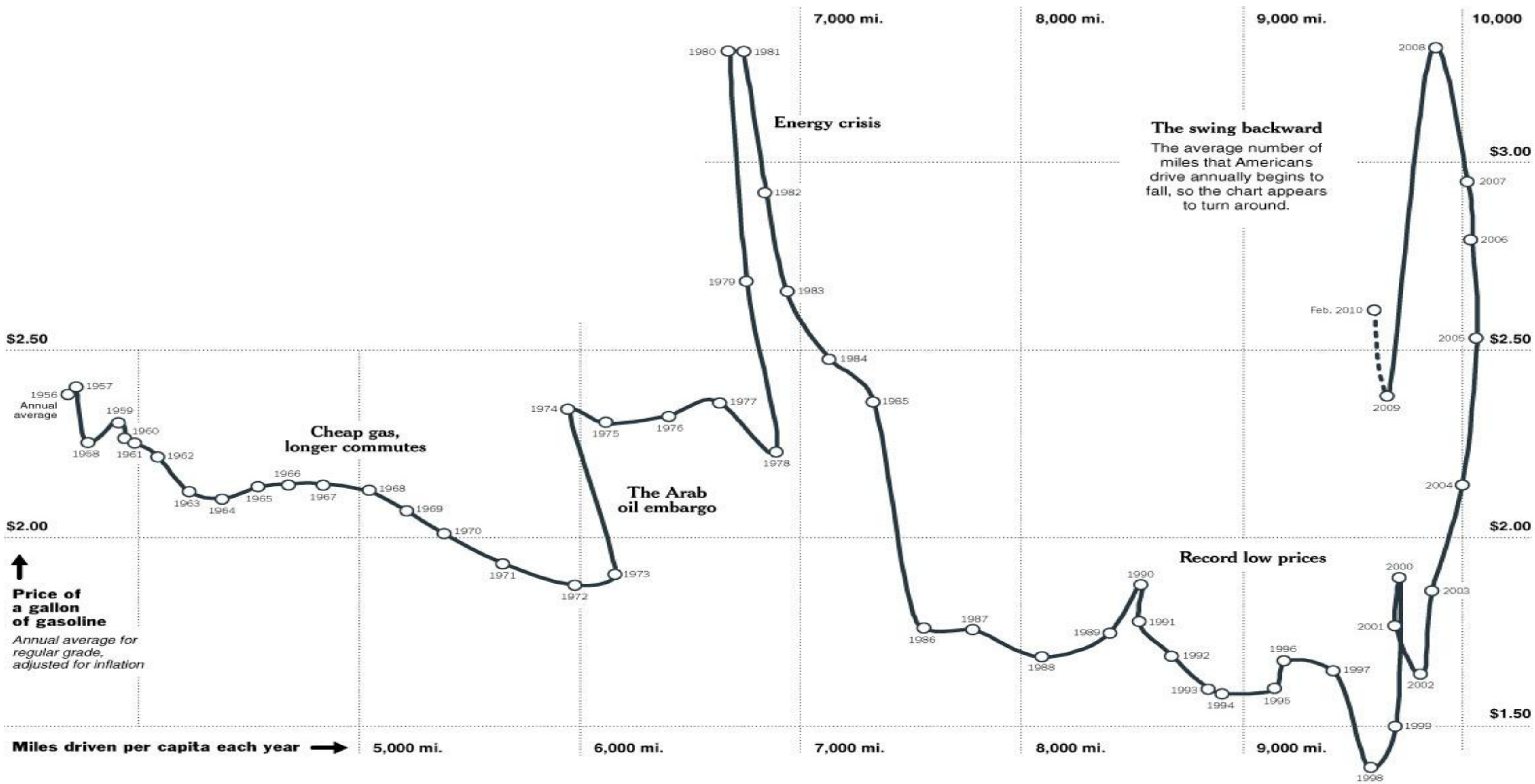


Source: LBL, Rosenfeld.

标准生效后，10年节约电量

Hitting the Wall?
Prices/taxes/fees can also do the work

U.S. VMT and Gasoline Prices



Source: NY Times

Emerging markets will have more adaptable demand patterns for fuels

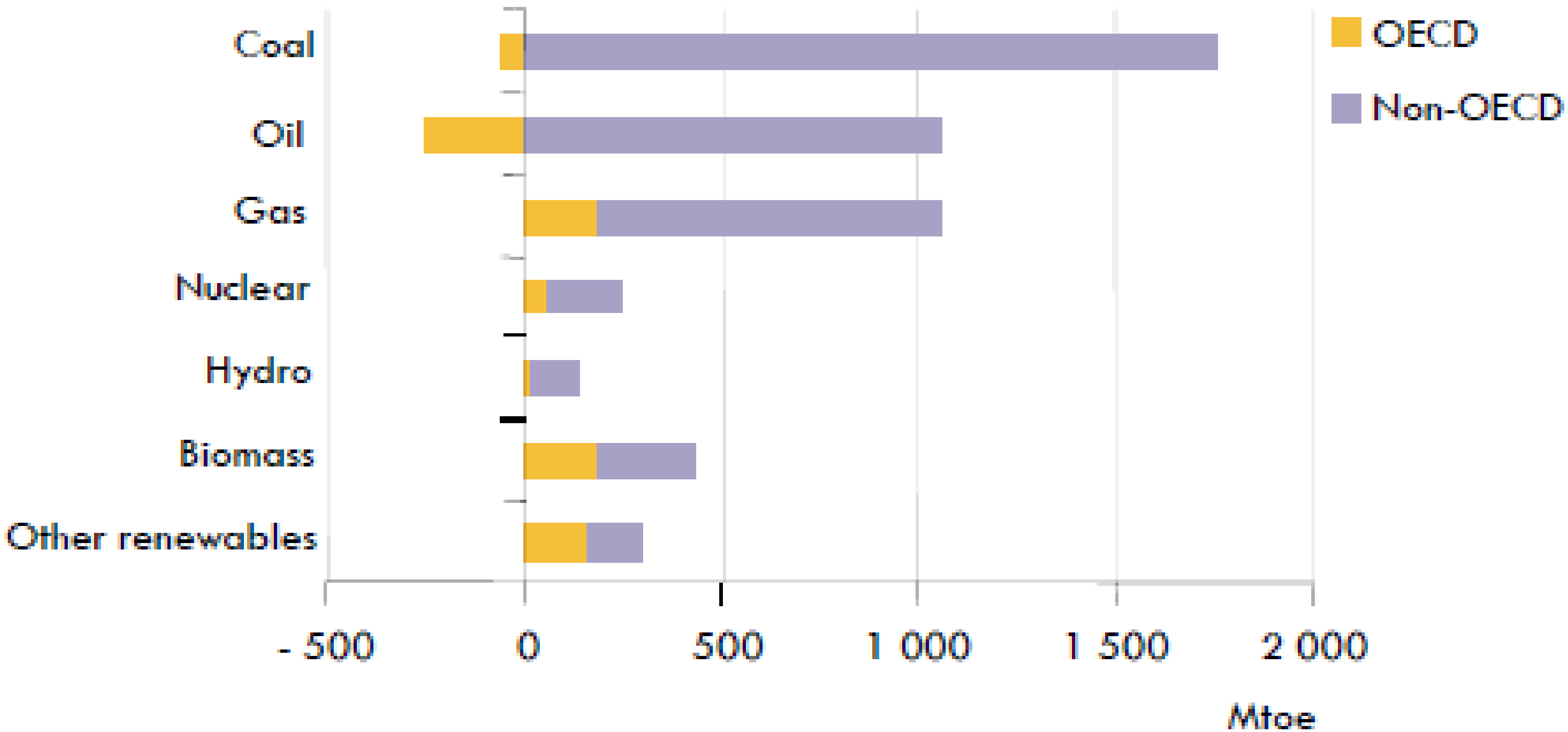
- Malleable consumer preferences and low levels of legacy infrastructure promise a more ready market for alternative vehicles and fuels
- China will play a major role in the EV industry future….It is already the largest EV market in the world, with 17 million electric bikes sold in 2008, and many of these companies are planning to move up and sell small electric vehicles.

How the State can Help

- Change Behavior
  - Standards
  - Incentives, disincentives
  - Information, education
- Reduce Innovation Costs
  - Traditional R&D Finance
  - Leadership: Infrastructure investments (grid, etc.)
  - Loans, guarantees, and contracts

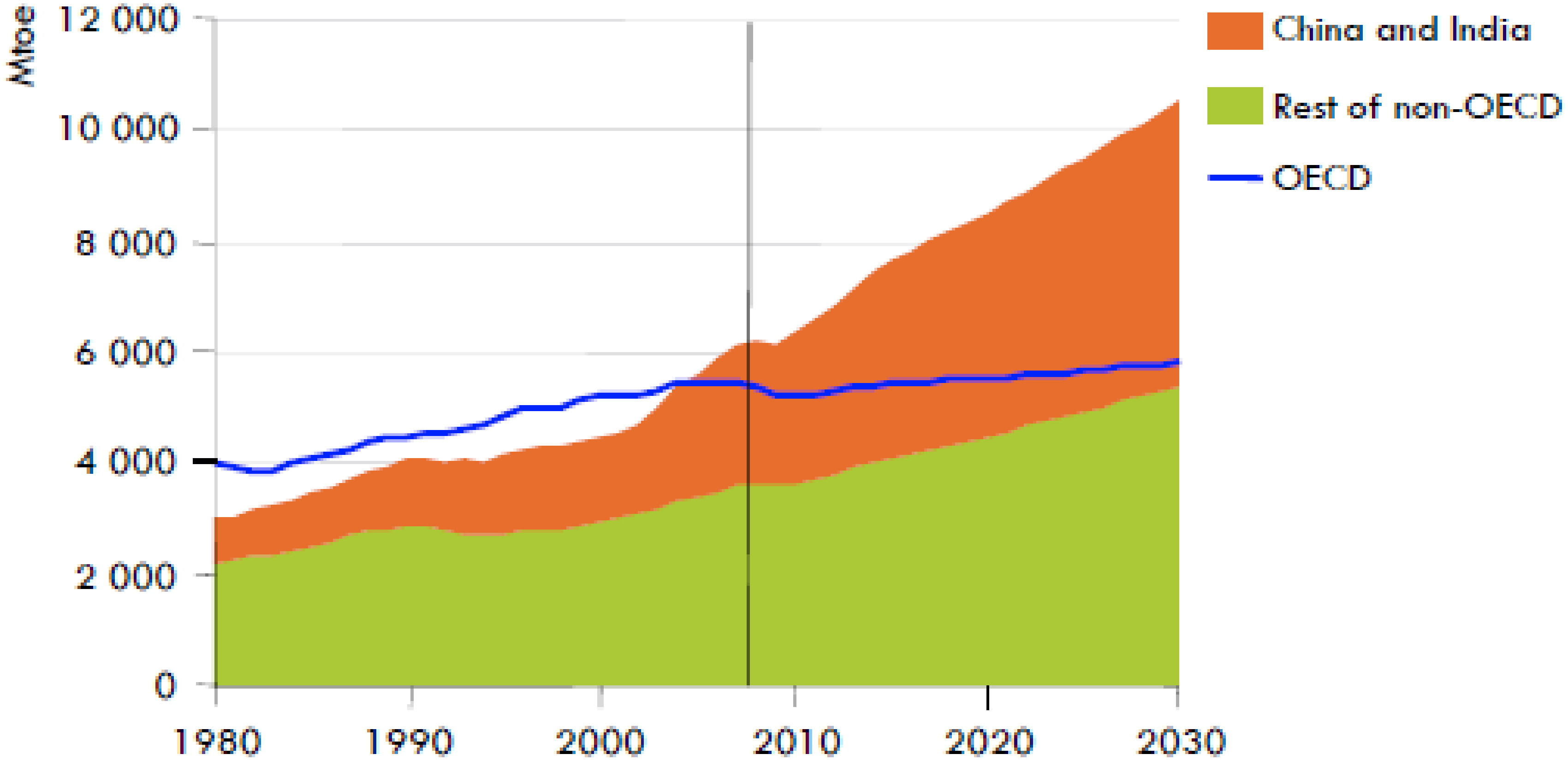
Whither Energy Prices?

Market Prospects to 2030
Fuel Composition of New Energy Demand



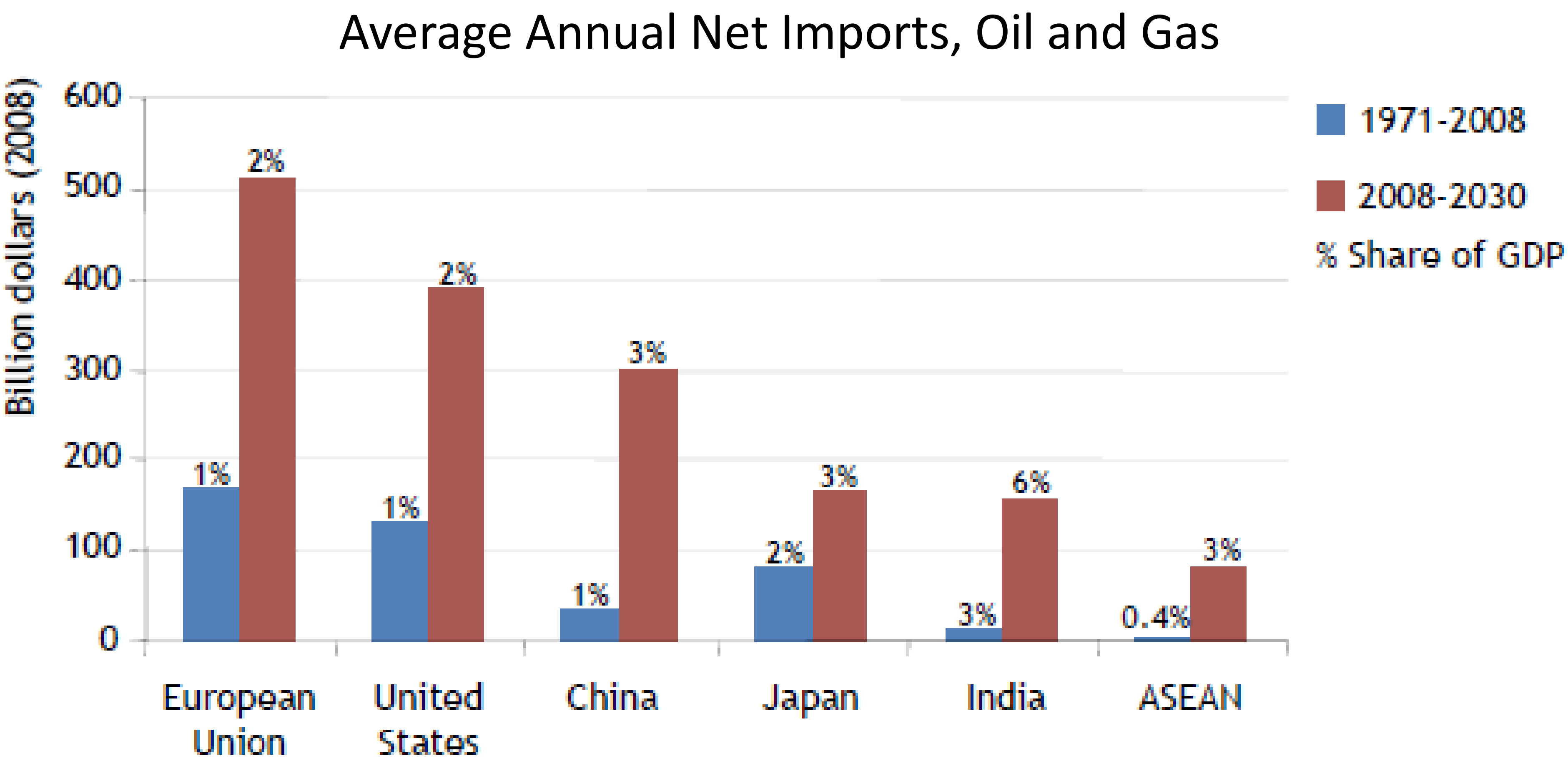
Source: IEA

Global Primary Energy Demand



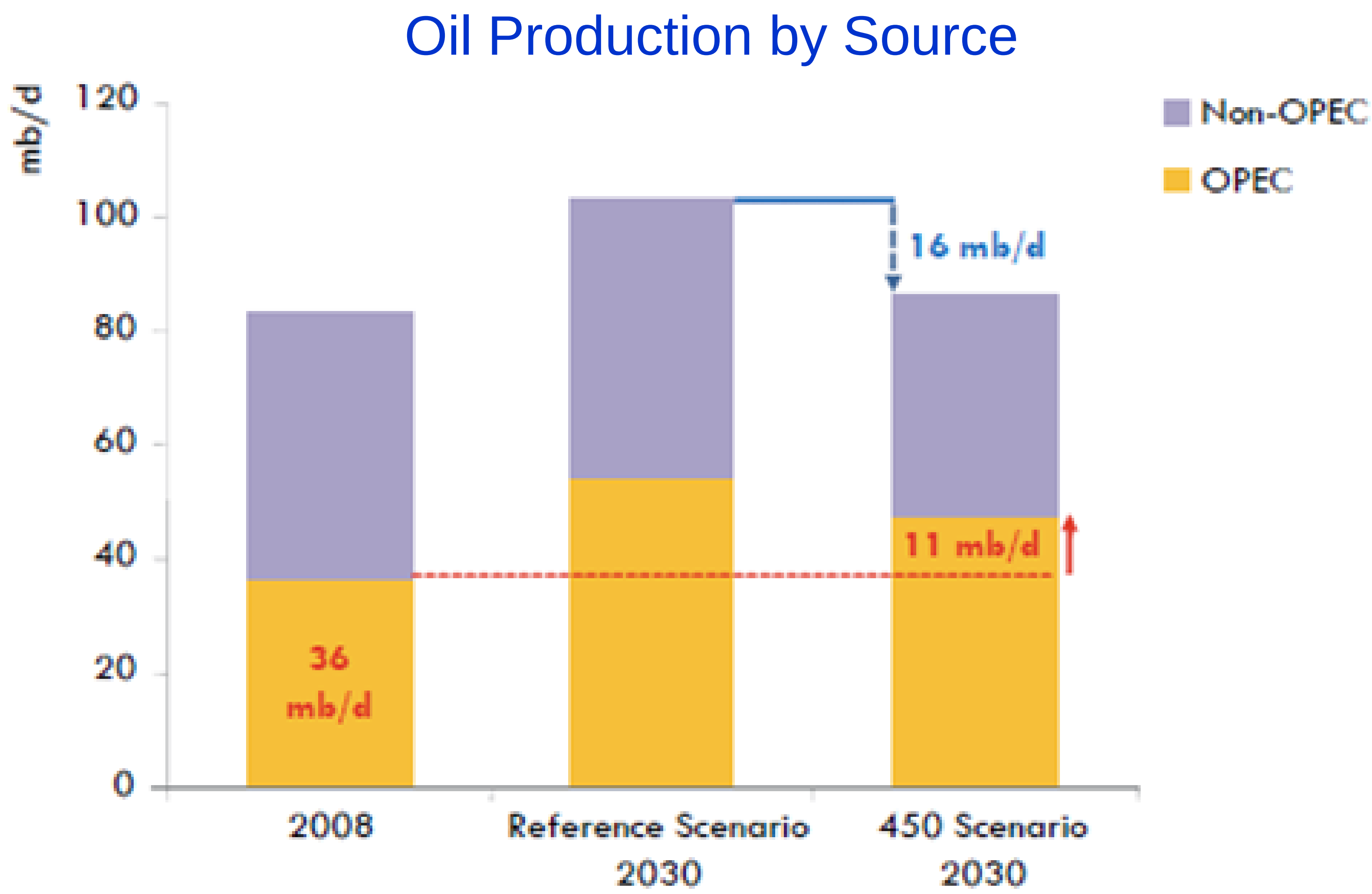
Source: IEA

Rising Import Dependence



Source: IEA

Supply Side Consolidation



Source: IEA

Trade-Integrated Global Energy and Resource (TIGER) Model

- A global database for assessing economic linkages, policy and market outcomes, energy flows, and environmental factors
- A state-of-the-art, forward looking economic scenario tool
- Information capacity
  - Up to 113 countries/regions
  - Up to 57 sectors/commodities
  - Annual projections to 2050

GTAP-B(erkeley)

A new global database including:

- GTAP-7 complete, 113 countries, 57 sectors
- Energy disaggregation – 13 sources
- Emissions data – 14 categories
- Demographic data – population by country and age (young, working, retired)

GTAP Comprises over 90 percent of relevant Asian economic activity

Country	Population in millions (2010)	GDP in billions USD with PPP (2010)	GDP in billions USD (2010)	GDP per capita with PPP (2010)	Oil consumption in 2009 (bbl/day)	Oil consumption per capita (bbl/day per 1000 people)
Afghanistan	30	30	17	1000	5,000	0.168
Armenia	3	17	9	5800	49,000	16.498
Azerbaijan	8	90	52	11000	136,000	16.249
Bangladesh	159	259	100	1700	82,340	0.519
Bhutan	7	4	1	5000	1,000	0.141
Cambodia	15	30	11	2000	4,000	0.272
China, People's Republic of	1,337	9,872	5,745	7400	8,200,000	6.134
Hong Kong, China	7	327	224	45600	418,200	58.736
India	1,189	4,046	1,430	3400	2,980,000	2.506
Indonesia	246	1,033	695	4300	1,115,000	4.540
Kazakhstan	16	198	131	12800	241,000	15.528
Korea, Republic of	49	1,467	986	30200	2,185,000	44.821
Kyrgyz Republic	6	12	4	2200	15,000	2.683
Lao PDR	6	16	6	2400	1,918	0.296
Malaysia	29	417	219	14700	536,000	18.656
Maldives	0	2	1	4600	6,000	15.385
Mongolia	3	10	6	3300	16,000	5.112
Myanmar	54	60	36	1100	42,000	0.778
Nepal	29	35	15	1200	18,000	0.612
Pakistan	187	451	175	2400	373,000	1.991
Philippines	102	353	189	3500	307,200	3.017
Singapore	5	292	234	57200	927,000	195.570
Sri Lanka	21	105	48	4900	90,000	4.229
Taipei,China	23	824	427	35800	834,000	36.151
Tajikistan	8	15	6	2000	38,000	4.980
Thailand	67	580	313	8700	356,000	5.336
Timor-Leste	1	3	616	2600	2,500	2.119
Turkmenistan	5	37	28	7400	120,000	24.000
Uzbekistan	28	86	38	3100	145,000	5.155
Viet Nam	91	278	102	3100	311,400	3.439
Total Asia	3,730	20,918	11,848		19,555,558	
GTAP Countries	3,524	19,724	10,069		18,128,058	
Percent Asian Coverage	94	94	90		93	

Energy Disaggregation

1. Coal
2. Oil
3. Gas
4. Biodiesel
5. Ethanol1 - Sugar based
6. Ethanol2 - Starch based
7. Nuclear
8. Hydro
9. Biomass and Waste
10. Wind
11. Geothermal
12. Solar
13. Tide and Wave

Emission Categories

Air Pollutants

1.	Carbon Dioxide	CO2
2.	Suspended particulates	PART
3.	Sulfur dioxide	SO2
4.	Nitrogen dioxide	NO2
5.	Volatile organic compounds	VOC
6.	Carbon monoxide	CO
7.	Toxic air index	TOXAIR
8.	Biological air index	BIOAIR

Water Pollutants

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

Land Pollutants

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

Uses of the TIGER Scenario Framework

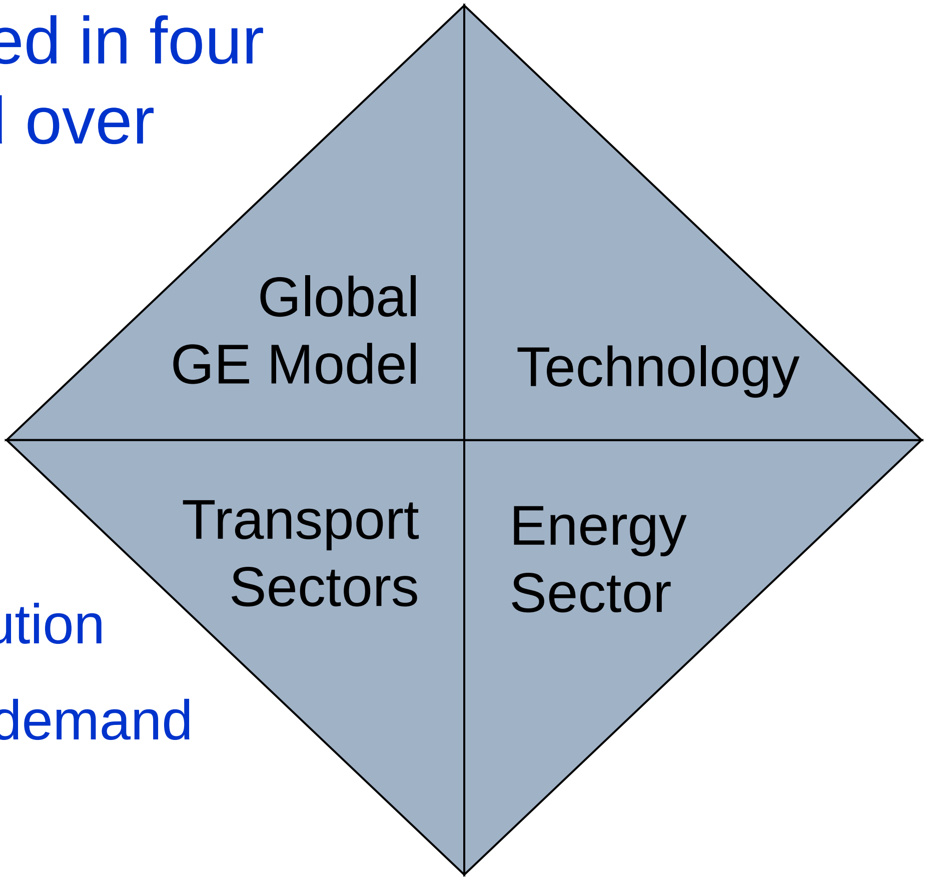
- Scenario work on long term energy trends
  - Demand and regulatory scenarios
  - Pricing trends with emergent technologies
  - Emergent supply-side energy trends (biofuel, other renewables, nuclear, etc.)
- Research on climate/energy policy
- Food-fuel trends and interactions
  - Integrating food and fuel capacity and demand scenarios for detailed economic impact assessment
- Geographic analysis
  - Identification of emergent demand
  - Integration with other GIS-based research on emergent supply
- Integration platform for the conceptual work
  - From qualitative to quantitative answers

How we Forecast

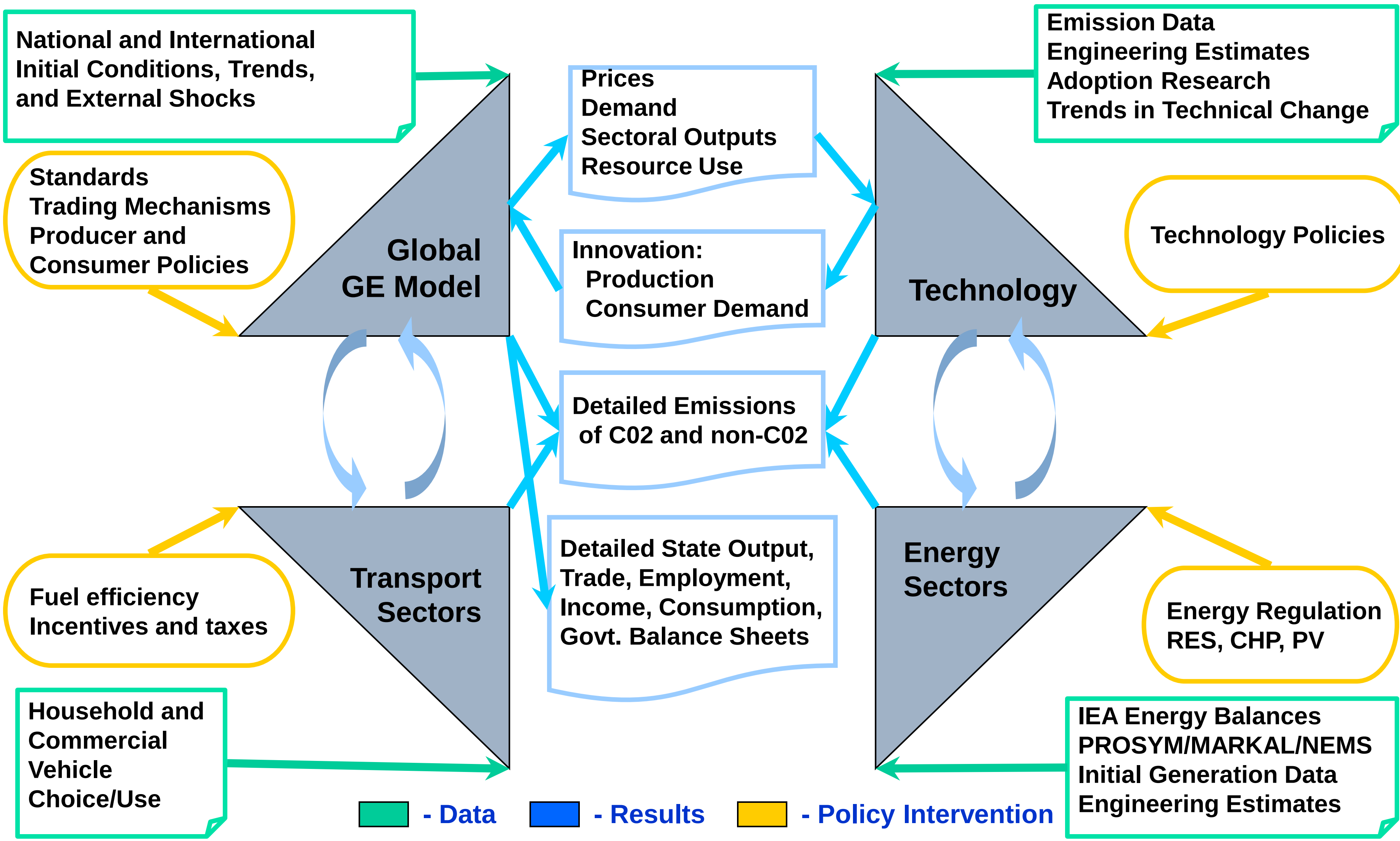
TIGER has been developed in four areas and implemented over two time horizons.

Components:

1. Core GE model
2. Technology module
3. Energy production/distribution
4. Transportation services/demand



Detailed Framework



Time Horizons

TIGER is being developed for scenario analysis over two time horizons:

1. **Policy horizon**: 2010-2030 (IEA, DOE, etc.)

   Detailed structural change – emphasis on energy markets, food-fuel, and policy choices to shift growth trajectories

2. **Climate horizon**: 2010-2050 (IEA, Shell)

   More aggregated – emphasis on technological change, climate impacts

Three Primary Research Areas

Energy Innovation & Price Reform
Energy, economic, GHG implications of:
- Renewables innovation, w/ and w/o biofuels
- CCS deployment, at different cost levels
- Large-scale removal of energy subsidies
- Oil sand and shale

Emerging Markets
Energy, economic, resource, and GHG implications:
- higher/lower GDP growth
- changes in economic structure
- emerging demand patterns

Carbon Constraints
Energy, economic, GHG implications of:
- emissions trading systems
-International emissions tax harmonization
- bilateral emissions agreements

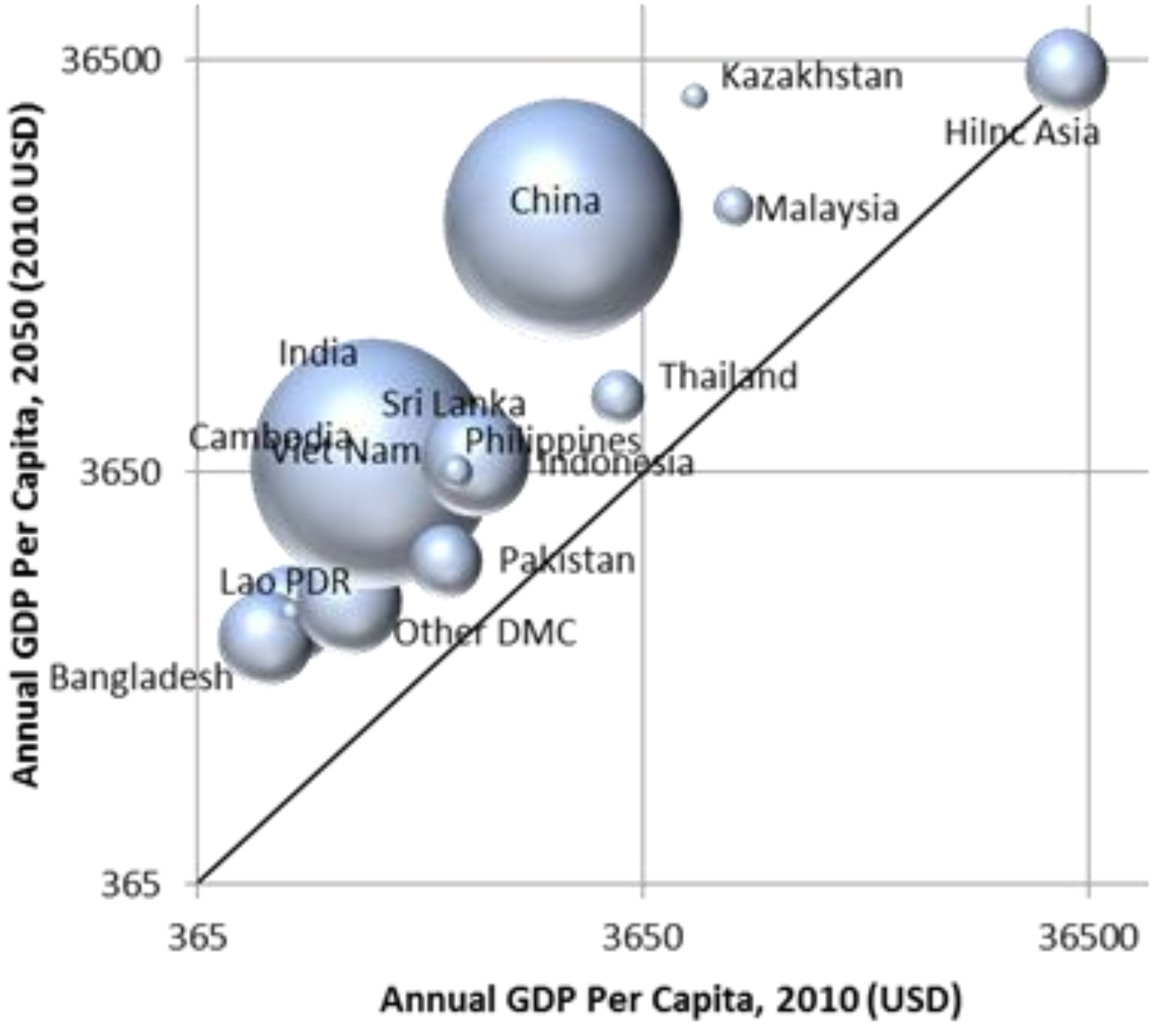
Preliminary Forecasting Results

- For this Sustainable Fuel Partnership project, we applied TIGER to examine Asian regional economic responses to alternative oil price trends
- Our results reveal a very diverse and adaptable economic region, with ample opportunities for policy intervention

Scenarios

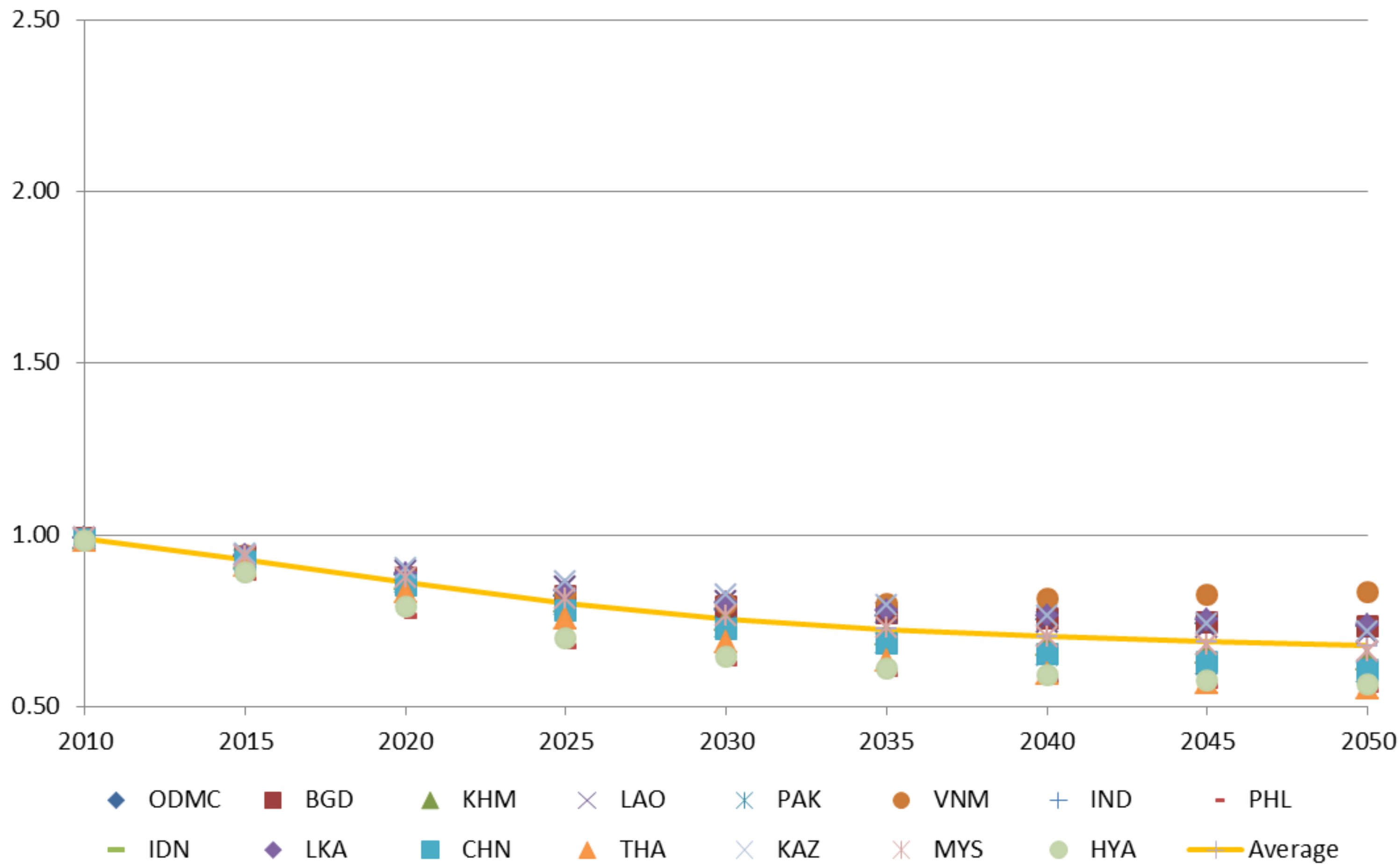
Scenario	Name	Description
1	Baseline	The global economy grows at consensus Business as Usual rates.
2	Oil Prices Below Baseline	Assume global oil supply capacity grows up to 20% faster than the Baseline by 2050.
3	Oil Prices Above Baseline	Assume global oil supply capacity grows up to 20% more slowly than the Baseline by 2050.

Baseline Growth of Real GDP



Source: Authors' estimates.
NB: Bubble diameter proportional to population.

Domestic and Regional (average) Oil Prices – Low Scenario

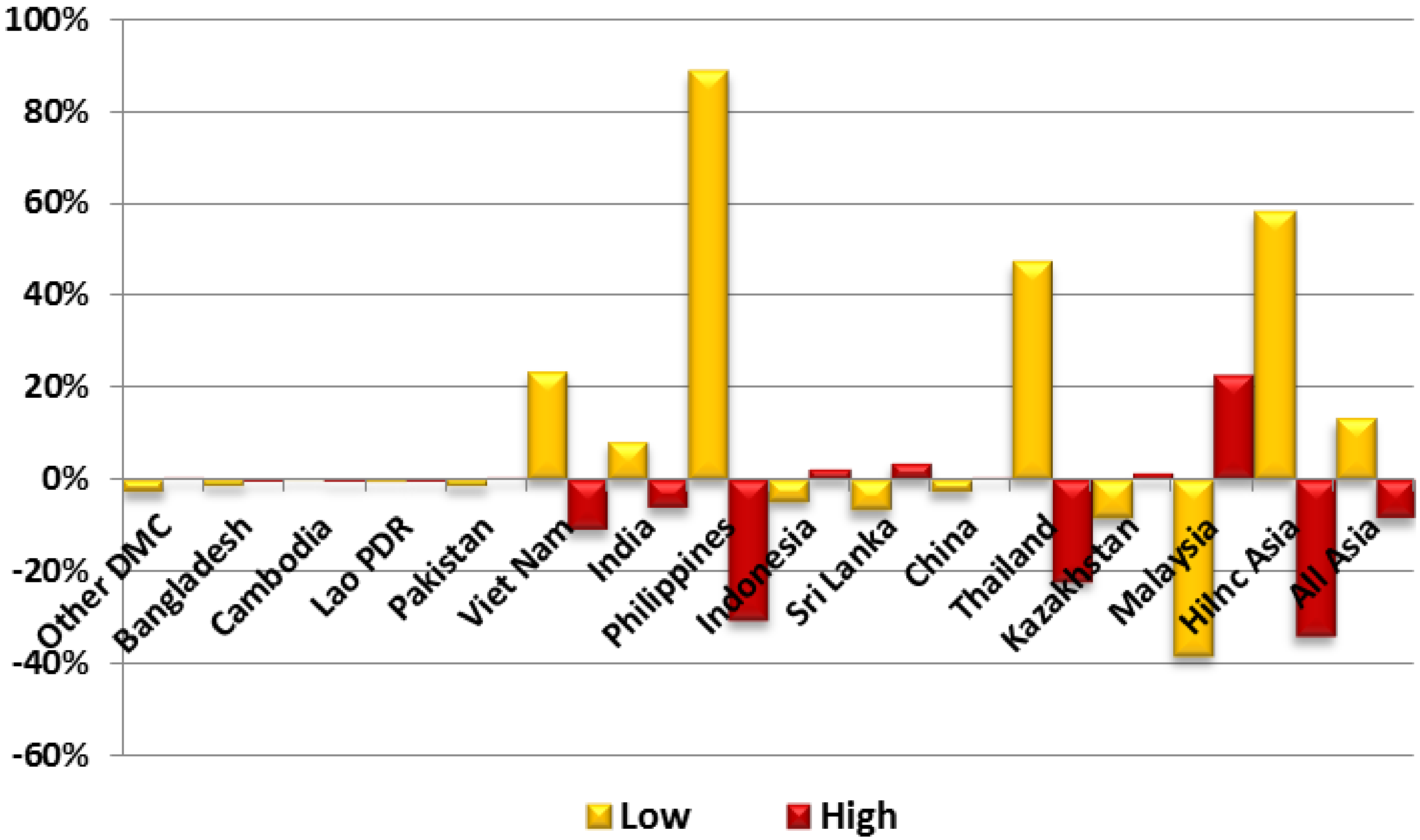


Source: Authors' estimates.
NB: Values are ratios to Baseline prices for each year.

Domestic and Regional (average) Oil Prices – High Scenario

Source: Authors' estimates.
NB: Values are ratios to Baseline prices for each year.

Real GDP Impacts of Alternative Oil Price Trends



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

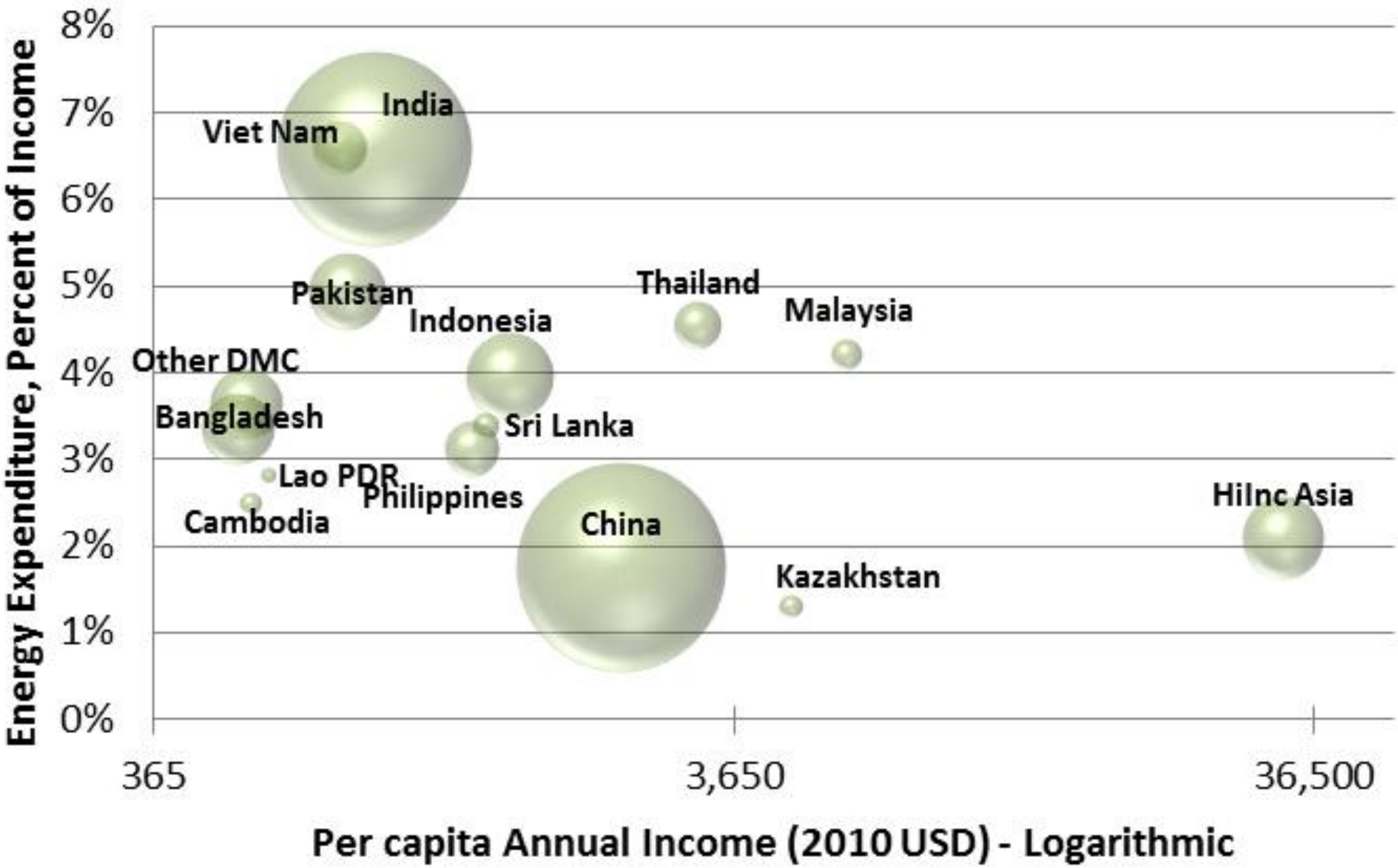
Real GDP Impacts of Alternative Oil Price Trends

	Low	High
Other DMC	-2.8%	0.1%
Bangladesh	-1.3%	0.0%
Cambodia	0.2%	-0.6%
Lao PDR	-0.5%	-0.5%
Pakistan	-1.6%	0.2%
Viet Nam	23.2%	-11.0%
India	8.2%	-6.3%
Philippines	88.5%	-30.7%
Indonesia	-4.8%	2.1%
Sri Lanka	-6.8%	3.5%
China	-2.7%	0.1%
Thailand	47.2%	-22.2%
Kazakhstan	-8.5%	1.0%
Malaysia	-38.5%	22.5%
HiInc Asia	58.3%	-34.2%
All Asia	13.3%	-8.6%

Source: Authors' estimates.

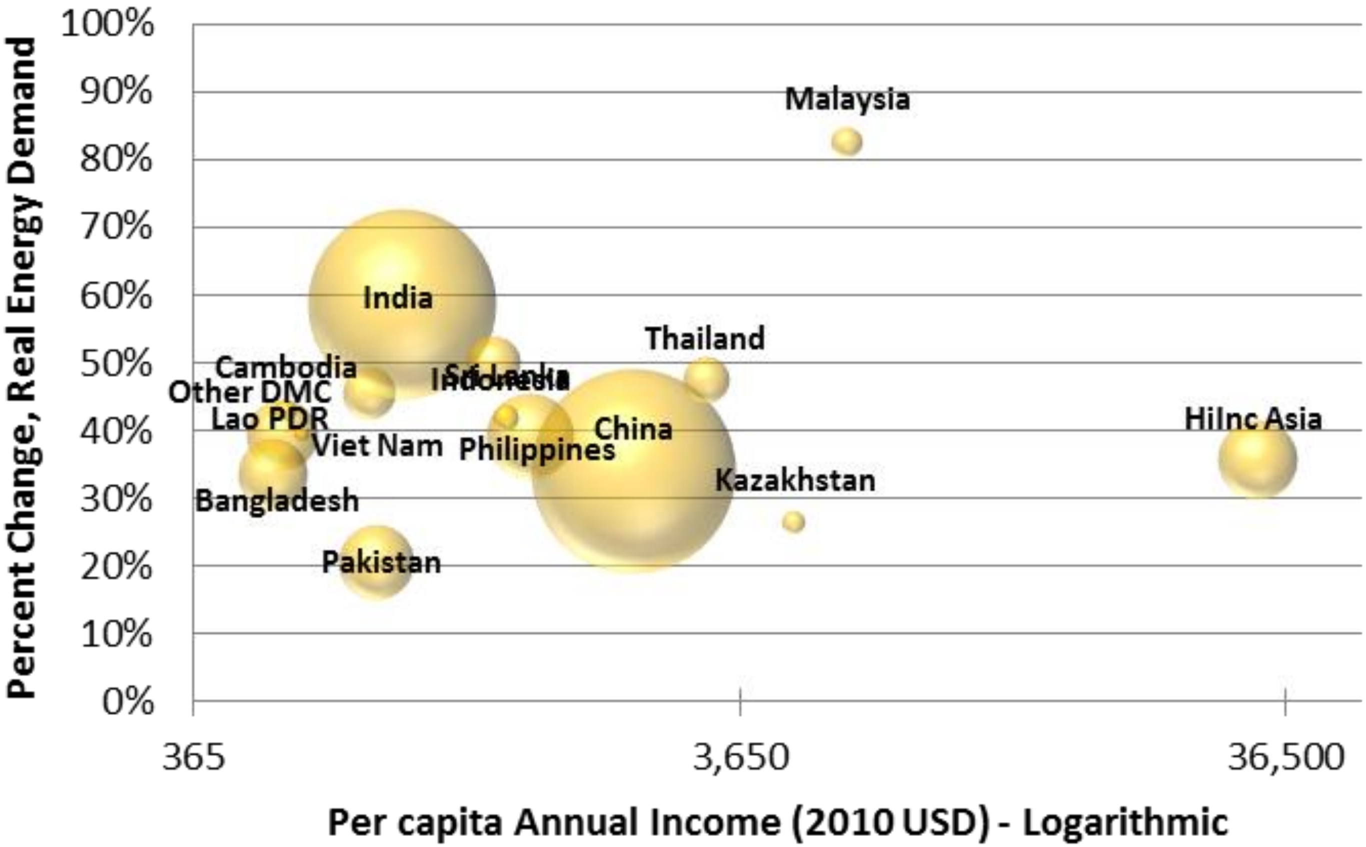
NB: Values are percentage change from Baseline in 2030.

Household Energy Expenditure as a Percent of GDP (2010)



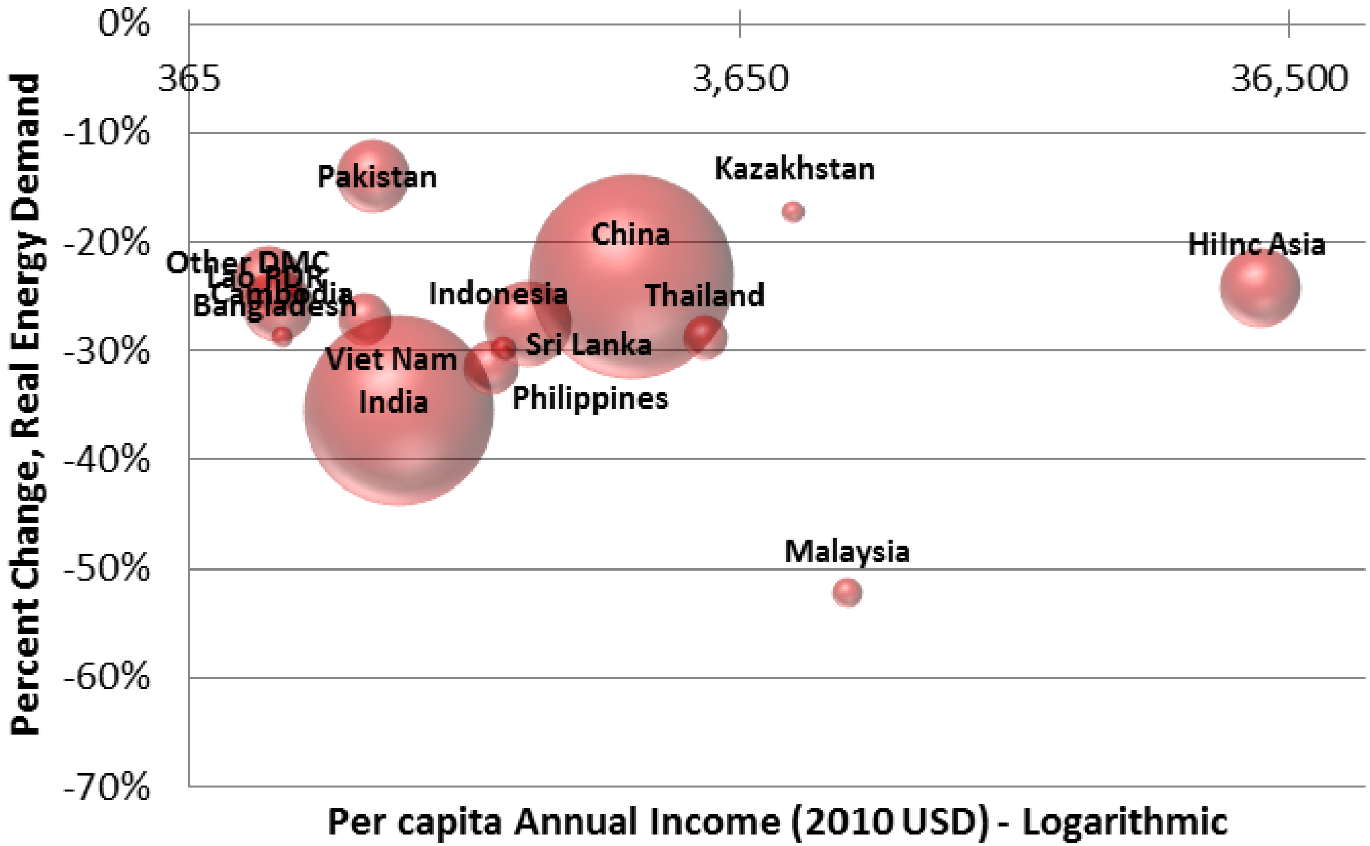
Source: Authors' estimates.
NB: Bubble diameter proportional to population.

Change in Real Cumulative Domestic Energy Demand – Low Oil Prices



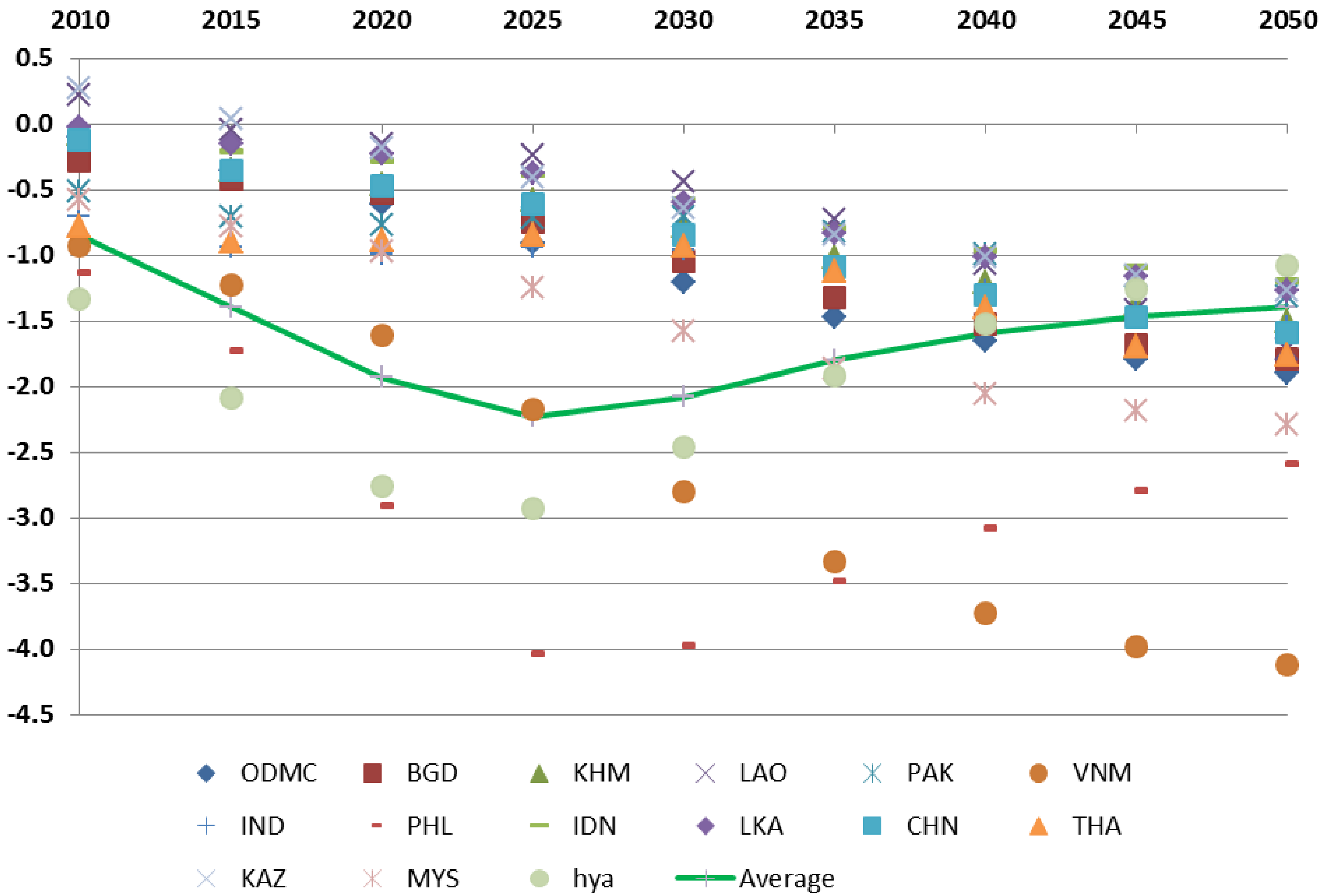
Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Change in Real Cumulative Domestic Energy Demand – High Oil Prices



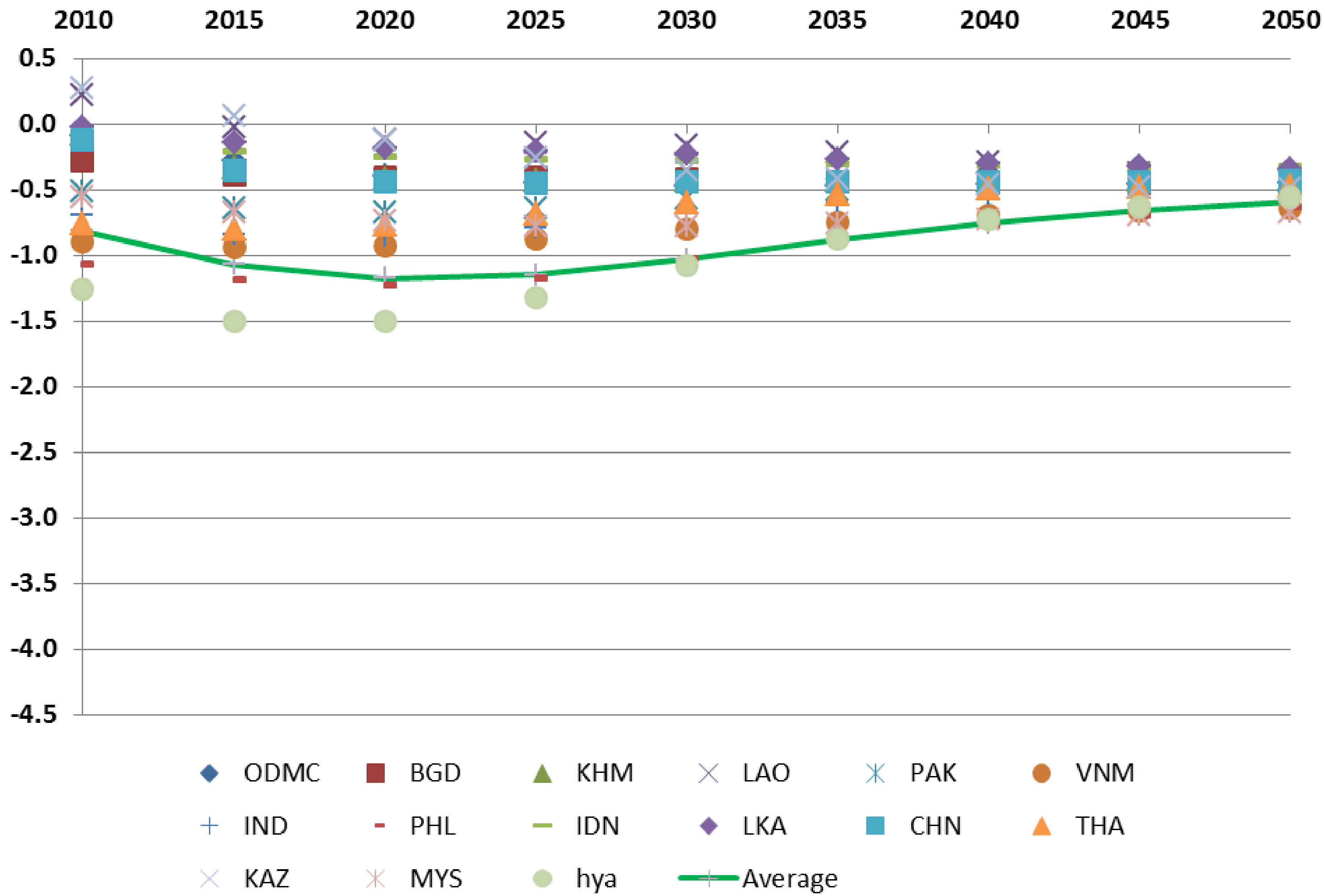
Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Elasticity of National Oil Demand – Low Oil Prices



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Elasticity of National Oil Demand – High Oil Prices



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Fuel Security

Definition and measurement

- Energy and fuel security are easy concepts to motivate, and thus play a prominent role in policy dialog.
- Unfortunately, they can be difficult to measure, depending not only on definitions of energy need but myriad of ways in which such needs can be met.

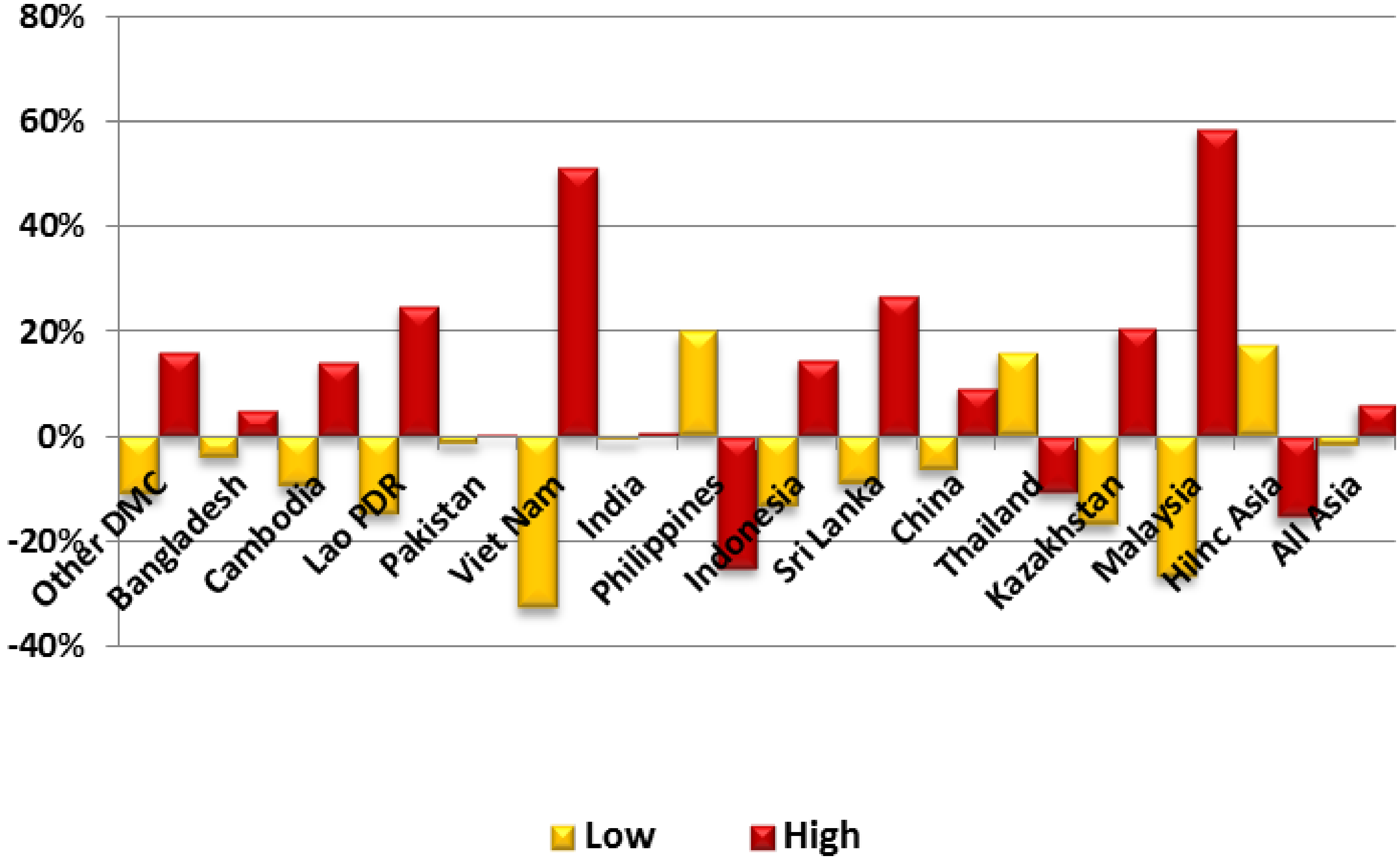
Fuel Production Security

In accordance with the classical notion of national energy self-sufficiency, we can defined for country *r*

$$PS_r = \frac{\sum_e PA_{re} XP_{re}}{\sum_e PA_{re} XA_{re}}$$

For energy sectors e, output XP, and aggregate demand XA=XD+XM, comprised of domestic goods and imports.

National Energy Production Security (PS)



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

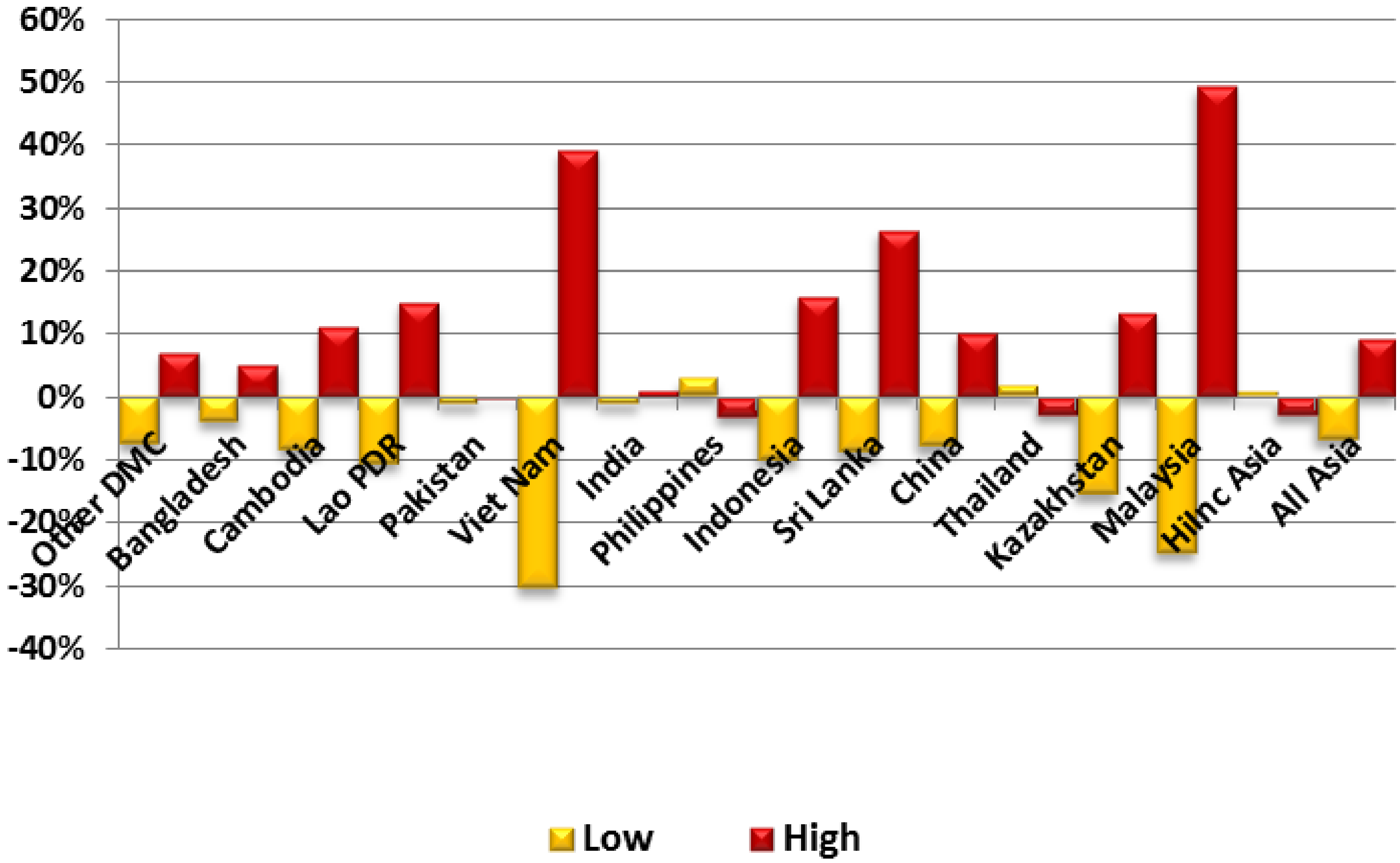
Domestic Fuel Security

For a narrower definition of fuel security that excludes trade, we define Domestic Security

$$DS_r = \frac{\sum_e PA_{re} XA_{re} - \sum_e PM_{re} XM_{re}}{\sum_e PA_{re} XA_{re}} = \frac{\sum_e PA_{re} XP_{re} - \sum_e PE_{re} XE_{re}}{\sum_e PA_{re} XA_{re}}$$

which measures the proportion of domestic demand that is currently met by domestic production. This measure, demand net of imports or supply net of exports, shows the extent to which a country currently meets its own needs, beyond current trade commitments in energy commodities.

National Domestic Fuel Security (DS)



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Fuel Trade Security

Perhaps the broadest notion of fuel security allows for countries to rely partially or even completely on global markets, assuming they can barter exports to meet domestic needs, i.e.

$$TS_r = \frac{\sum_e PA_{re} XP_{re} + \sum_b PE_{rb} XE_{rb}}{\sum_e PA_{re} XA_{re}}$$

where the subscript *b* denotes sectors other than energy (to avoid double counting their exports in *XP*). Of course a country might need to reduce imports of other kinds to cover energy import needs, but in any case this index measures the country r's domestic and international purchasing power relative to domestic energy demand.

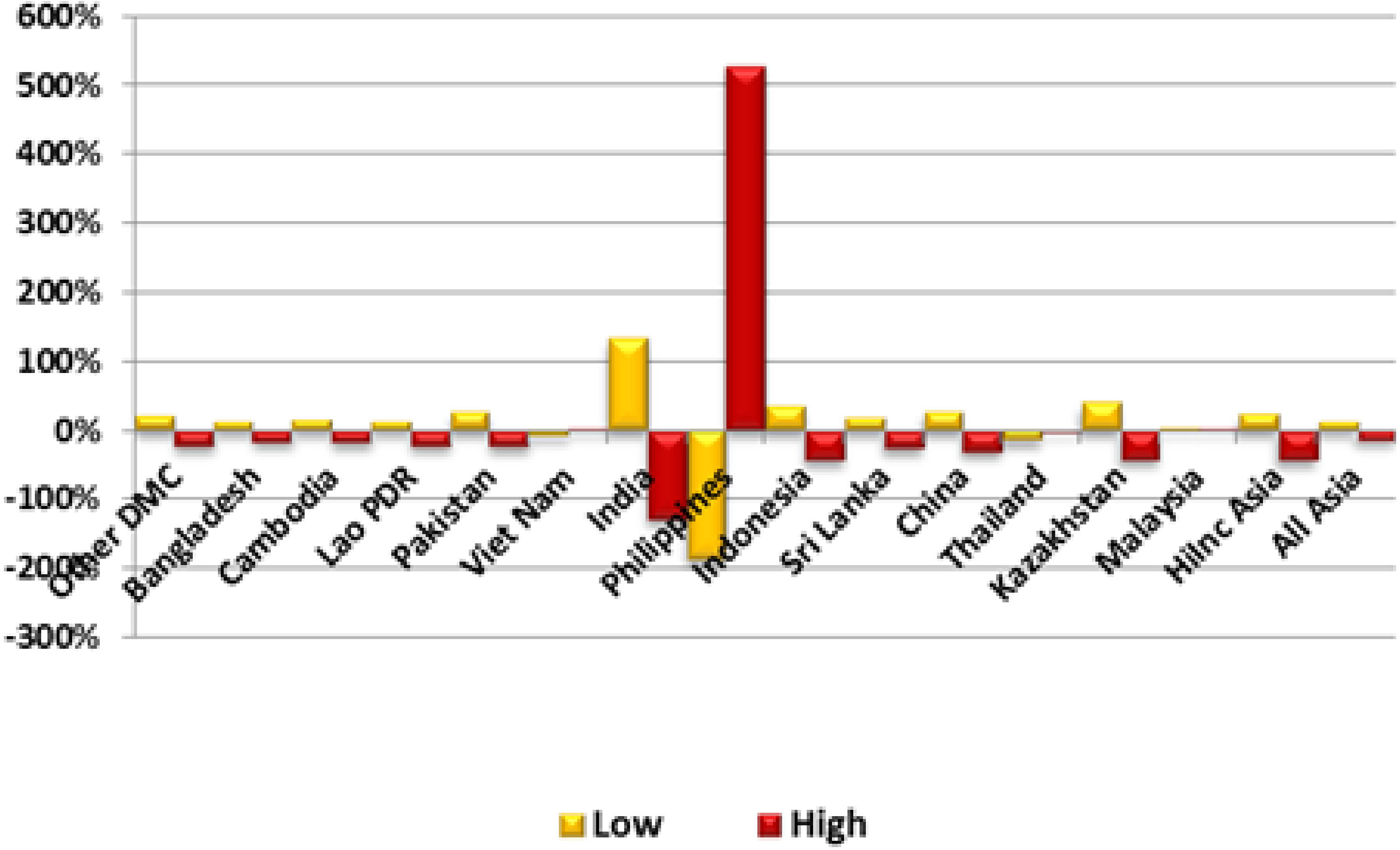
Fuel Consumption Security

A final measure relates not to total energy output and use across the economy, but to final household consumption, defined as energy Consumption Security

$$CS_r = \frac{\sum_i PC_{ri} XC_{ri}}{\sum_e PC_{re} XC_{re}}$$

which measures the total consumption expenditure as a multiple of the cost of energy consumption. This measure represents a traditional household energy affordability metric that is most likely to inform domestic energy price policy.

National Fuel Consumption Security (CS)



Source: Authors' estimates.
NB: Values are percentage change from Baseline in 2030.

Measuring Energy/Fuel Risk

How should policy makers assess risk relative to fuel security metrics? We propose a set of indicators that support regional comparison, standard setting, and targeting. Assume any one of these four security metrics (call it S) has a policy target level T. Then for a group of countries r=1,2,…,R, with total population P and individual populations P-$_r$, we can define an index of regional fuel security as follows:

$$\Sigma_{\alpha}(T) = \sum_{r=1} \frac{P_r}{P}\left(\frac{S_r - T}{T}\right)^{\alpha} = \sum_{r=1} \pi_r \left(\frac{S_r - T}{T}\right)^{\alpha}$$

For α=1, this index measures average regional per capita fuel security with respect to the given metric (S) and target (T). If the index is greater than zero, then the region as a whole can meet its energy needs through trade, if negative it will have to import from the rest of the world. For α=2 the indicator measures the variance or regional inequality of fuel security.

Measuring Risk, Continued

To assess energy risk for individual or groups of nations within the Asian region, we can order countries by the fuel security index under consideration (Figure A3.1), and evaluate all countries below the target security level T with the index

$$\sigma_{\alpha}(T) = \sum_{r=1}^{q} \frac{P_r}{P}\left(\frac{S_r - T}{T}\right)^{\alpha}$$

Where q identifies the last of the set of countries below the fuel security target T. From this formulation, we see that

1) If *a* = 0, $\Sigma_0 = \sum_{r=1}^{q} \pi_r$

This is the *share of Asia's population with national energy risk,* the simplest measure of region energy vulnerability.

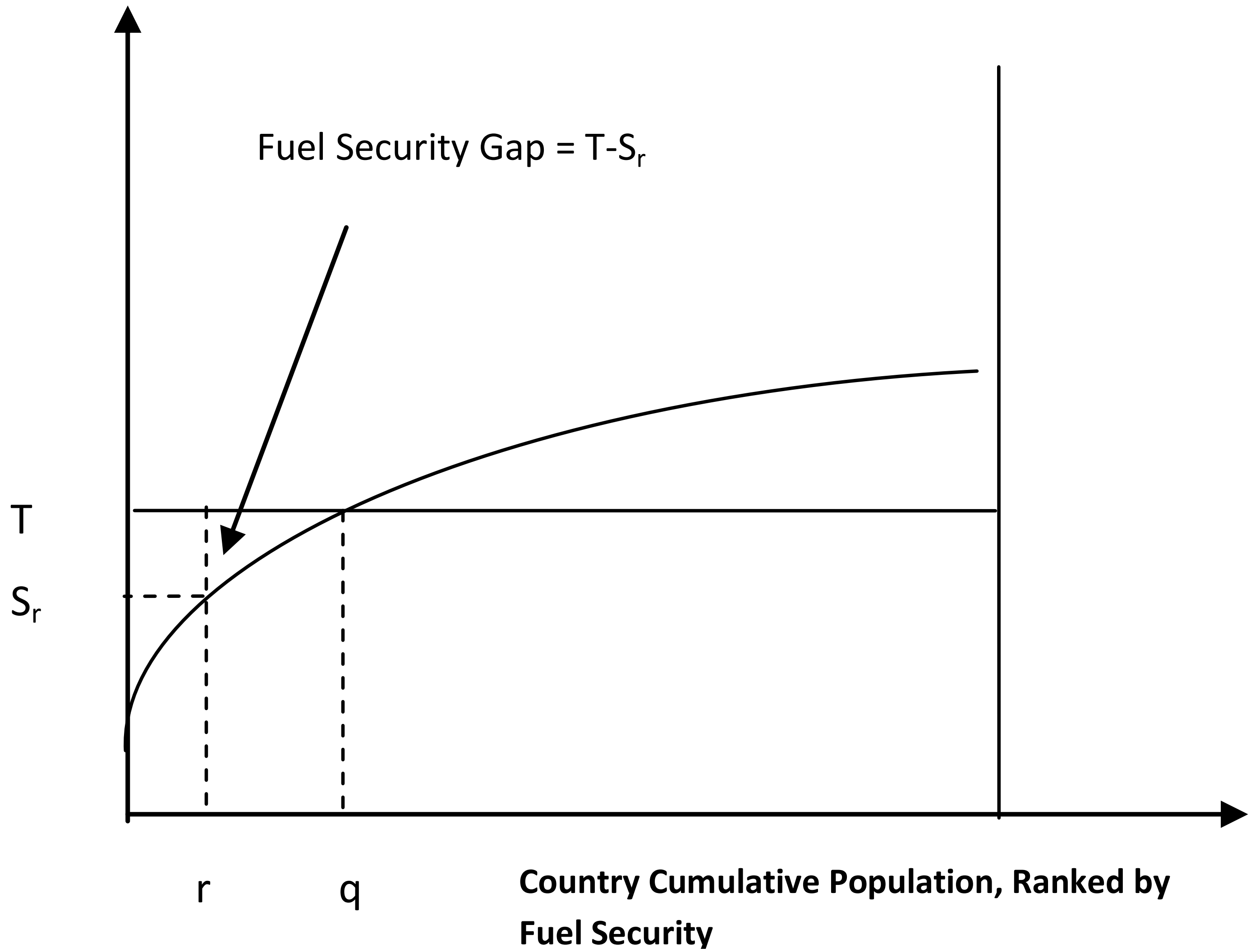
2) If *a* = 1, then $\Sigma_1 = \sum_{r=1}^{q} \pi_r \left(\frac{S_r - T}{T}\right)$

This is the *energy risk gap index* or the *depth of energy risk*, where: $\sum_{1}^{q} (S_r - T)$ measures the energy vulnerability deficit of an individual country, or its fuel security gap.

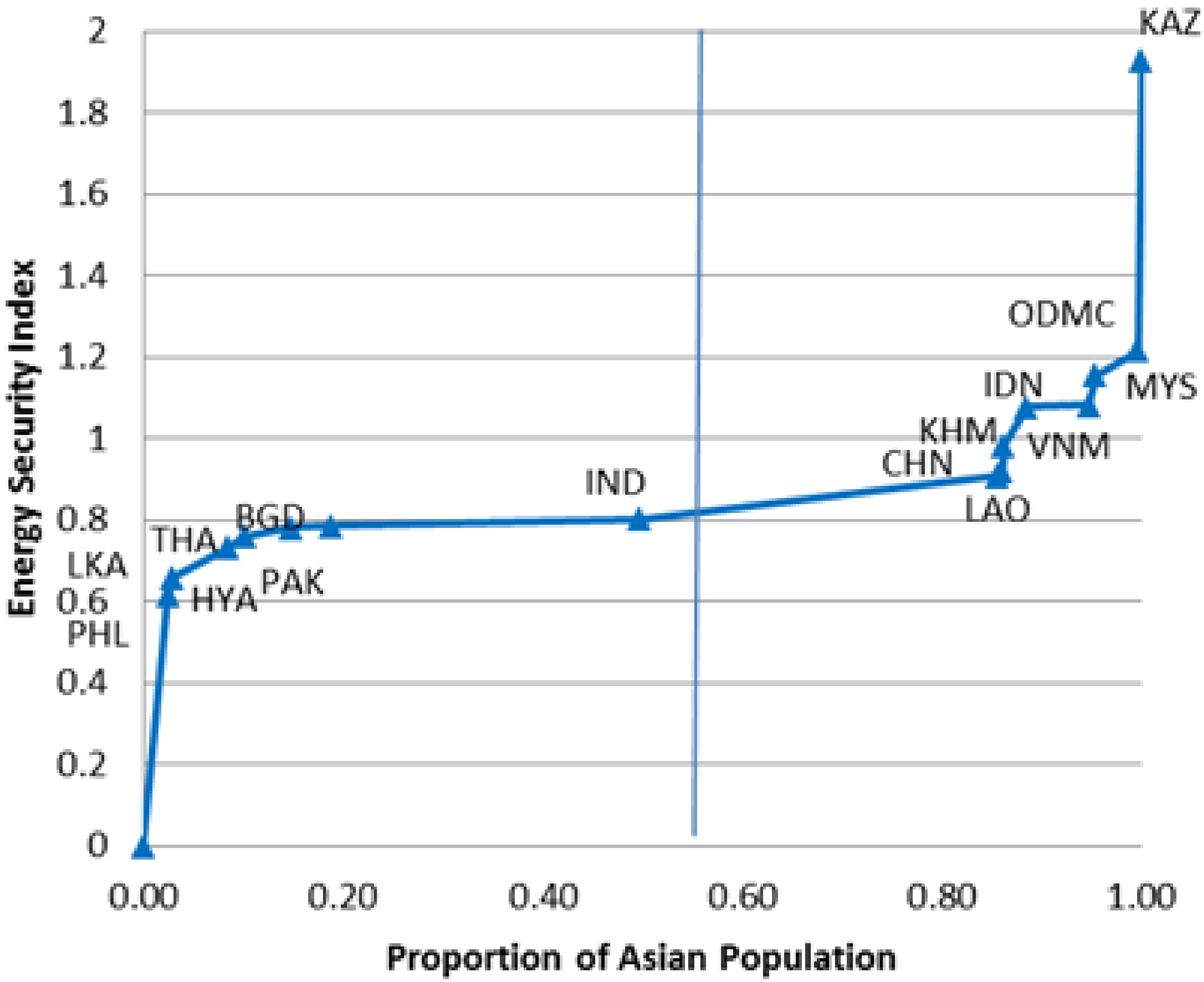
3) If *a* = 2, $\Sigma_2 = \frac{1}{n}\sum_{1}^{q}\left(\frac{S_r - T}{T}\right)^2$

This is the *severity of energy risk* index.

Fuel/Energy Risk Assessment

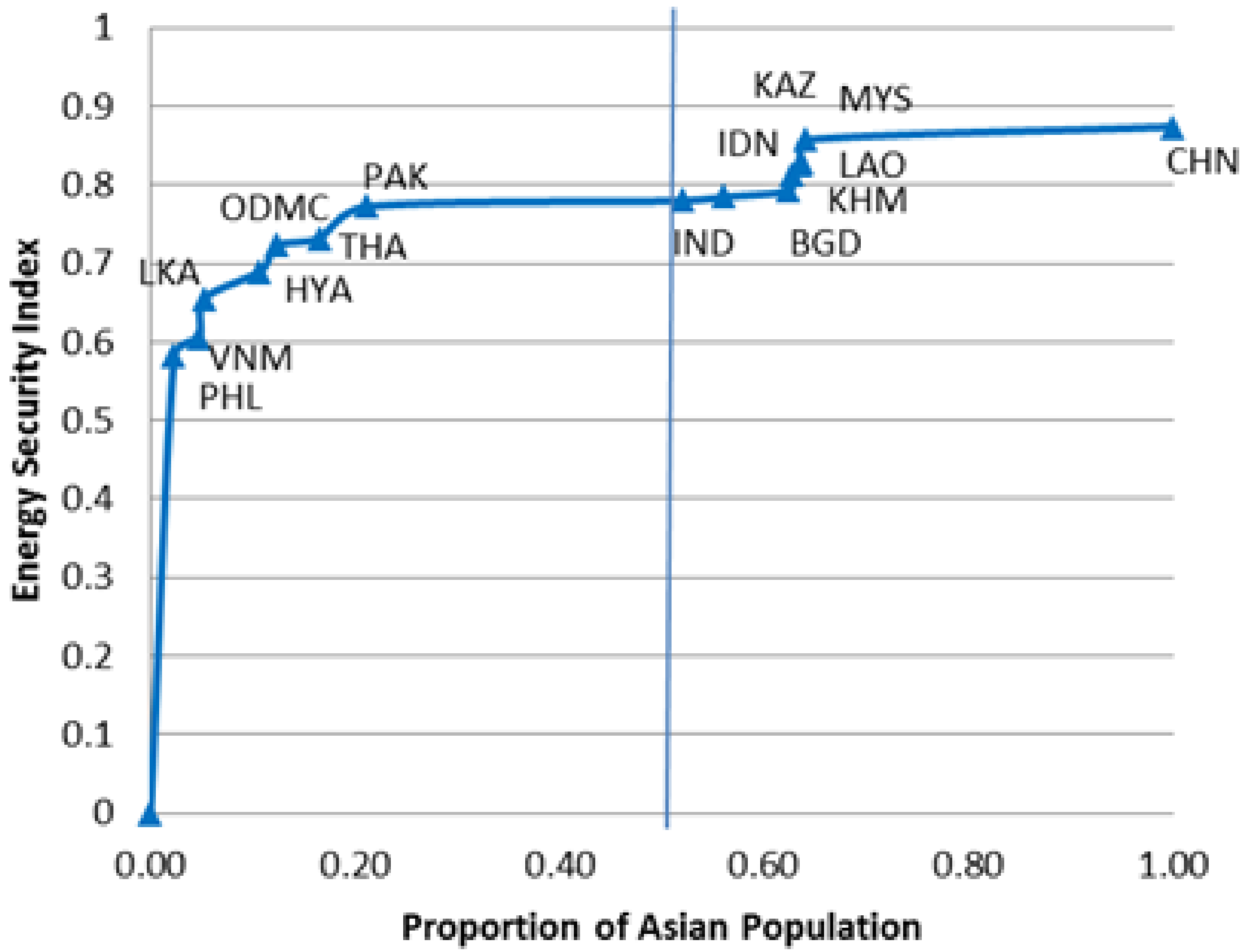


Example: Energy Production Security (PS) Index by Country, Baseline 2050



Source: Authors' estimates.

Energy Demand Security (DS) Index by Country, Baseline 2050



Source: Authors' estimates.

Pilot Fund Study

(14h45 – 15h00)

Project phasing

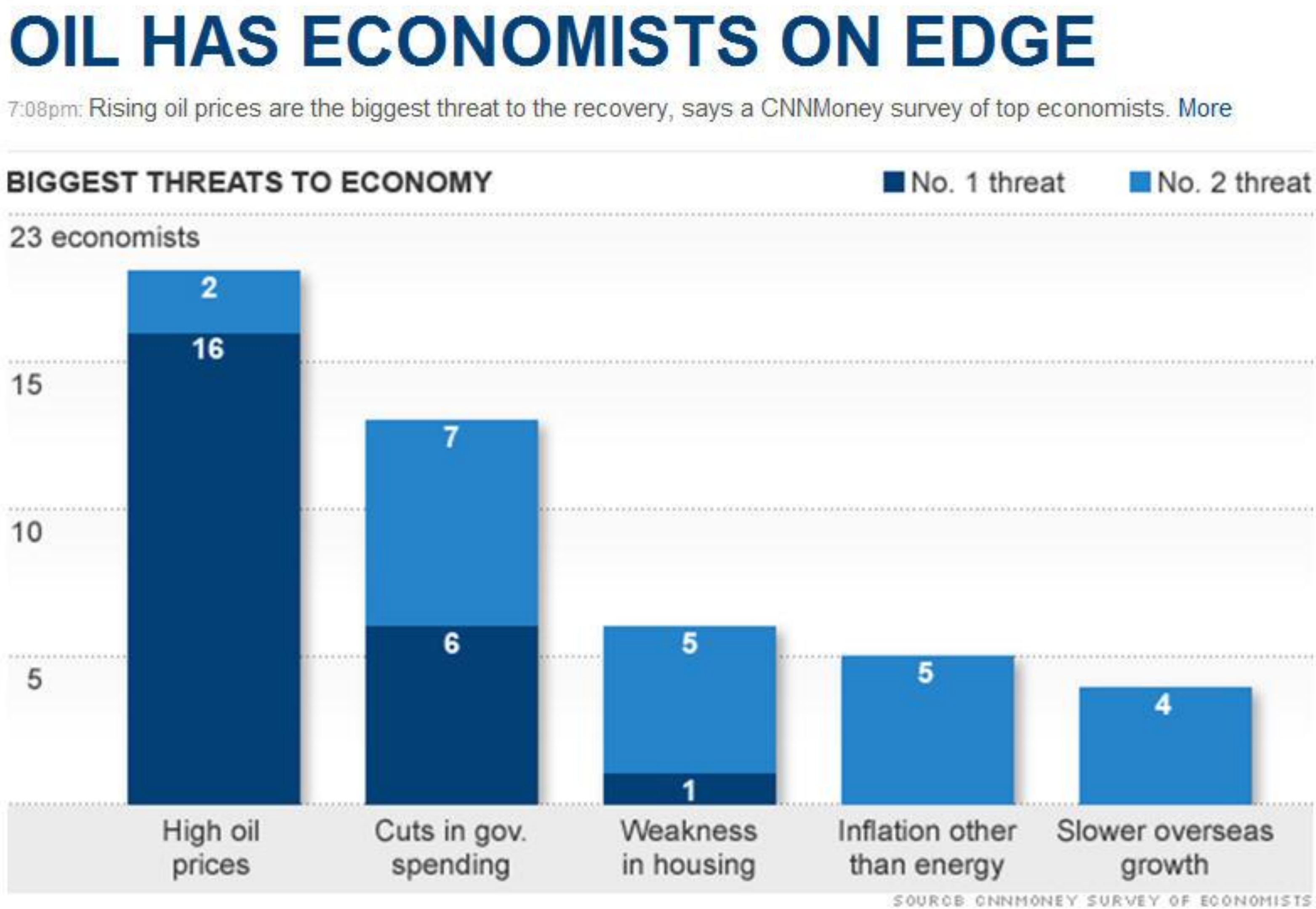
Phase I
- Research Phase (2009-2011)

Phase II
- Pilot Fund (2012-2014)

Phase III
- Market Phase (2015-2017)

Timing of project and world events

Fuel security as an increasing concern



Pilot Fund Proposal

- ❑ ADB team developing the proposal

- ❑ Focus upon initializing an effective demonstration of Fuel Security Credits by 2012

- ❑ Targeted completion date of Proposal: 15 July 2011

Initial concept

Mechanism type:
Offset

Target fund size:
US$ 50 - 100 million

No. of cities to be awarded:
2 – 4 cities

Process and disbursements

City proposals

Accepted proposals

Starter disbursement

Results-based payment

Pilot Fund Study

Review of existing pilot funds

- Prototype Carbon Fund
- Other World Bank Carbon Funds
- Asia Pacific Carbon Fund
- Future Carbon Fund

↓

Conceptual implementation plan

- Core design principles
- Administrative plan
- City application process
- Baseline methodologies
- Measurement, reporting, and verification
- Legal issues
- Communications
- Risk assessment

↓

Funder package

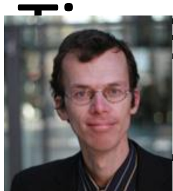
- Rationale Study
- Pilot Fund Study

Market Mechanism Study

(15h15 – 16h15)

Objectives of the scoping study

- Overall objective: develop a concept for a Fuel Security Market Mechanism
- Major components:
  - Review of existing mechanisms
  - Expert Forum
  - Market Mechanism Study (concept development)
  - Conceptual implementation plan
- Ti…elines: … early … draf… …cept by … July, fi… oncep… …eser… …n by end of August 2011




Dr. Axel Michaelowa & Sonja Butzengeiger, PCC

Mario Keller, INFRAS

Dr. Maike Sippel

Consider lesson‘s learnt from existing systems

- EU Emissions Trading Scheme (EU ETS)
- Kyoto Mechanisms: CDM and JI
- Tokyo Cap-and-Trade Program, JP
- RECLAIM - Regional Clean Air Incentives Market, USA
- Acid Rain Programme, USA
- ERMS - Emission Reduction Market System, USA
- Taiyuan Emissions Permit Trading, China
- Regional Greenhouse Gas Initiative (RGGI), USA
- Japanese Voluntary Emissions Trading Scheme (JVETS)
- Greenhouse Gas Reduction Scheme (GGAS), AUS
- Green certificate schemes in the NL, Sweden, USA (voluntary)
- White certificates/Energy efficiency credits in Italy, France, UK, AUS
- Urban transport - Road pricing in EU, Singapore, Hong Kong
- Performance-related Heavy Vehicle Fee (HVF), CH
- Green car tax in EU, CHN

Standardised presentation of findings

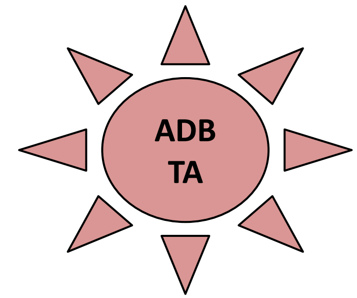
RECLAIM – Regional Clean Air Incentives Market		United States
Target substance: SO_x, NO_x	Reduction Unit: 1 t SO_x/NO_x → RTC (RECLAIM Trading Unit)	Type: Emissions Trading
Start of operation: 1994	Status: fully operational	Regulatory status: mandatory
Allowance allocation: Grandfathering based on XXX	Downstream/upstream: downstream	
Scale: provincial (4 counties in Los Angeles Basin, California)	Administration: South Coast Air Quality Management District (SCAQMD), team of 15	
Description	Longest history and practical experience of any locally designed and implemented air emissions cap and trade program. Motivated by state and federal ambient air quality standards (Clean Air Act).	
Flexibility and Diversity		
Participants – covered entities	Large point sources (>4t/a) → electricity generators, large industry (e.g. glass melters, facilities using industrial boilers)	
	284 facilities (2010) NOx: 286 participants (65% of emissions from stationary sources, 17% of total emissions)) SOx: 32 participants (85% of emissions from stationary sources, 31% of total emissions)	
Participants – demand for certificates	Participating facilities, investors (involved in 66% of NO_x trades and 86% of SO_x trades in 2010) Demand generated through absolute targets	
Including fuel / transport options? All kinds of?	Program exclusively targets stationary sources. Conversion of Mobile Source Credits envisioned, but not operational.	
How are end-use markets addressed?	Not addressed	
Linkages with other policies / mechanisms	Prior to RECLAIM: regulatory environment dominated by Command-and-Control regulations (that would have become effective and were perceived by industry to be more costly than a cap-and-trade)	
For ETS: Offsets?	Available when a price cap is reached (since 2000 electricity crisis)	
Methodological approach		
Monitoring & verification requirements	Monitoring by facility, verification/auditing by SCAQMD staff (incl. field inspections); More advanced monitoring requirements for large sources	
Base line definition (dealing with leakage, rebound effects, secondary impacts, double counting, lack of permanence, lack of additionality)	Not applicable	
For Offsets: Duration of crediting?	Not applicable	
For ETS: borrowing or banking?	Not allowed	
Enforcement	Monetary penalty and deduction from next year's allocation	
Environmental and economic effectiveness		
Amount of emission reductions / target	NO_x: -71% (1994-2009); SO_x: -59%	
Share of emissions covered	NO_x: 65% of emissions from stationary sources, 17% of total emissions; SO_x: 85% of emissions from stationary sources, 31% of total emissions (all: 1994)	
Volume of trading	NO_x: \$17.3 million; SO_x: \$30.3 million (2010)	
Credit / certificate price	NO_x: 741-8,052\$/t; SO_x: 451-1,286\$/t (2010)	
Lessons learnt		
Evaluation of the mechanism	• Significant resource requirements (time, funds, staff) – for design, implementation, monitoring • Engaged stakeholders: early and frequent stakeholder involvement is critical • Rule development / improvement process throughout implementation (role of evaluation)	

Analyse:

- Design features
- Lesson's learnt
- Relevance for FSC

- Plus review of academic proposals

Expert Forum



- Side event Carbon Expo
- Private lunch with selected experts
- Closed session with selected experts in afternoon

- Present idea of FSC MM and selected design options in detail
  - Scope of MM (cap-and-trade, baseline-and-credit, mandatory/voluntary, regional/City Bubbles/national/international)
  - Demand for FSCs
- Interactice discussion, guided by questions

- Objectives: get expert‘s opinion on tricky issues, gather additional ideas for structuring the FSC MM (scope)

FSC MM design concept

- Core design principles: Credibility, Simplicity, Clarity, Flexibility, Inclusivity, Diversity and Incentives for investment towards local government initiatives

- FSC MM design features
  - Scope
  - Recipient of credits
  - Type of mechanism (voluntary, mandatory)
  - Definition of Energy Security units
  - Type of target (voluntary, mandatory)
  - "Allocation" principles (grandfathering, future baselines etc)
  - Compliance & awarding scheme
  - Crediting/compliance periods
  - MRV
  - Selected institutional issues
  - Avoidance of negative effects

Suggest
1 package

Further elements of work

- Risk assessment of package
  - Risk registry in table format
  - E.g. political acceptability, lobby groups, enviornmental/social side effects
- Communications plan
- Recommendations next steps
- Conceptual implementation plan
  - macro level, i.e. will only identify crunchy issues
  - Includes institutional plan, financial plan, baseline calculation issues, MRV, legal issues, communications, risk assessment and timelines

Making a FSC Market Mechanism work – selected aspects

Objectives of a FSC Market Mechanism

- Fuel security: harness regional, national & global benefits from increased energy security

FSC Market Mechanism:

- Incentivise fuel savings (focus on oil)
- Switch from imported fuels to domestic fuels
  - → Must go hand-in-hand with fuel savings to avoid problematic side effects (earlier depletion of domestic resources)
- Generate funds that can be used for financing fuel savings / energy security projects
- Create a market with many actors looking for

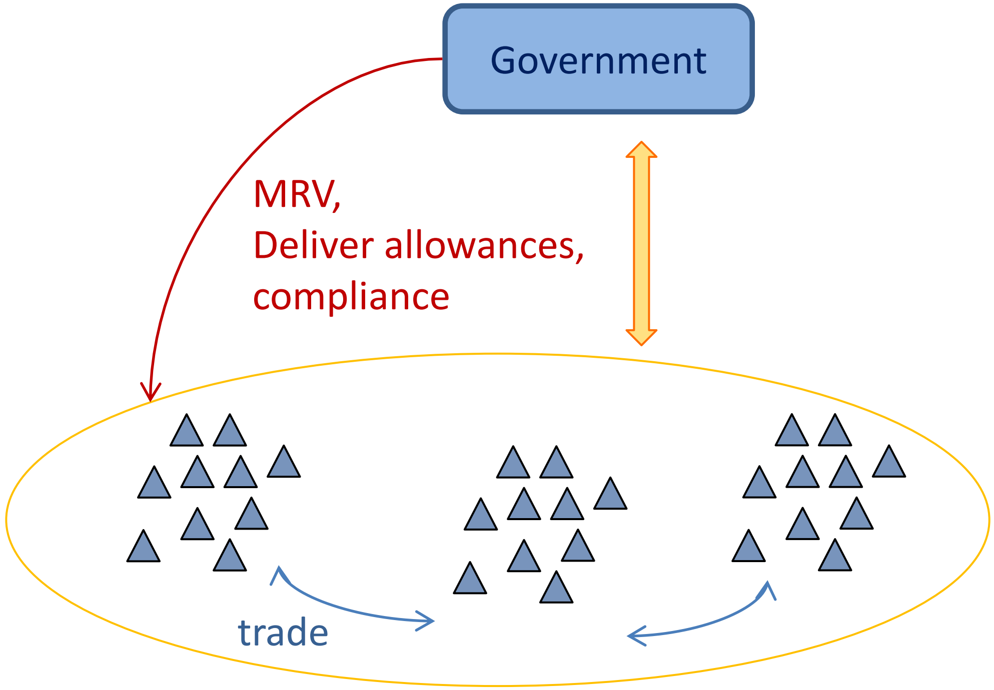
Market mechanisms can have very different faces

- Major options:
  - Voluntary or mandatory participation
  - Local or regional or national or international scale
  - Cap-and-trade or baseline-and-credit/offsets or „add-on-certificates“ (e.g. green/white certificate)
  - Absolute targets or intensity/relative targets
  - Coverage of fuel consumers: all within defined „scope“ or only selected ones
  - Origin of demand
- Choice of design influences effectiveness, efficiency and practicability (e.g. MRV) of system
- Questions: how to optimize the puzzle pieces against each other? → *example of scopes*

ADB

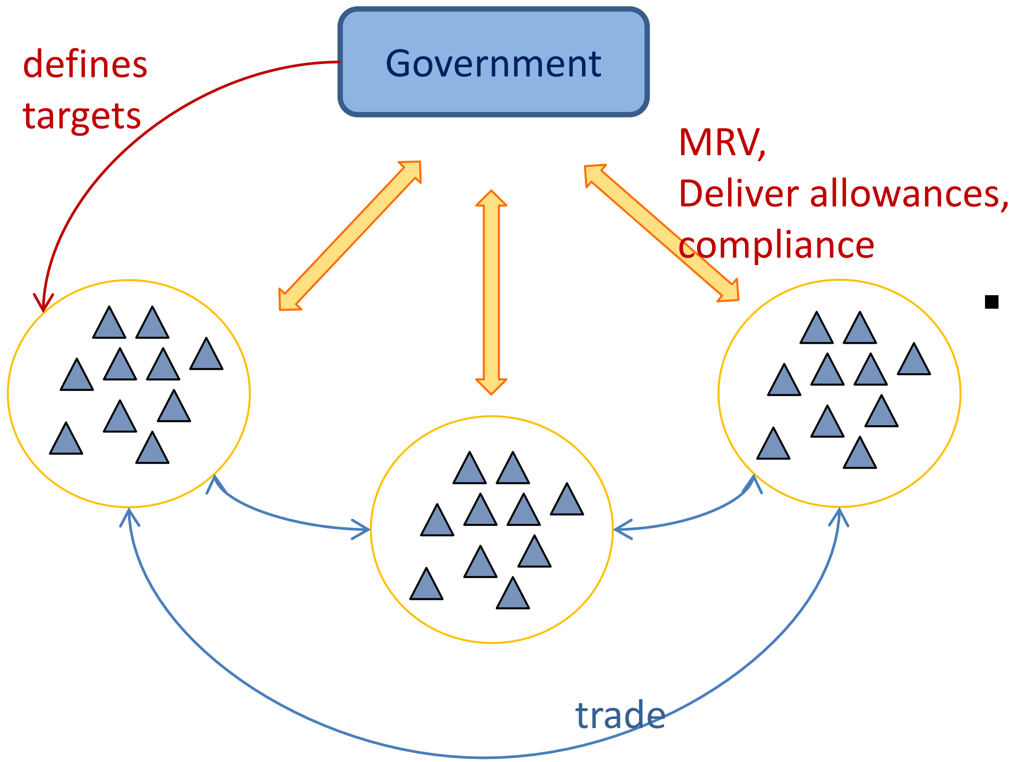
Option: regional/national cap-and-trade scheme

- All (major) fuel consumers in a specified region participate on mandatory basis
  - Can be very effective (comprehensive coverage)
  - Challenges:
    - MRV of small fuel consumers. Possible solution: upstream approach
    - Political acceptability?



Option: „City bubble“

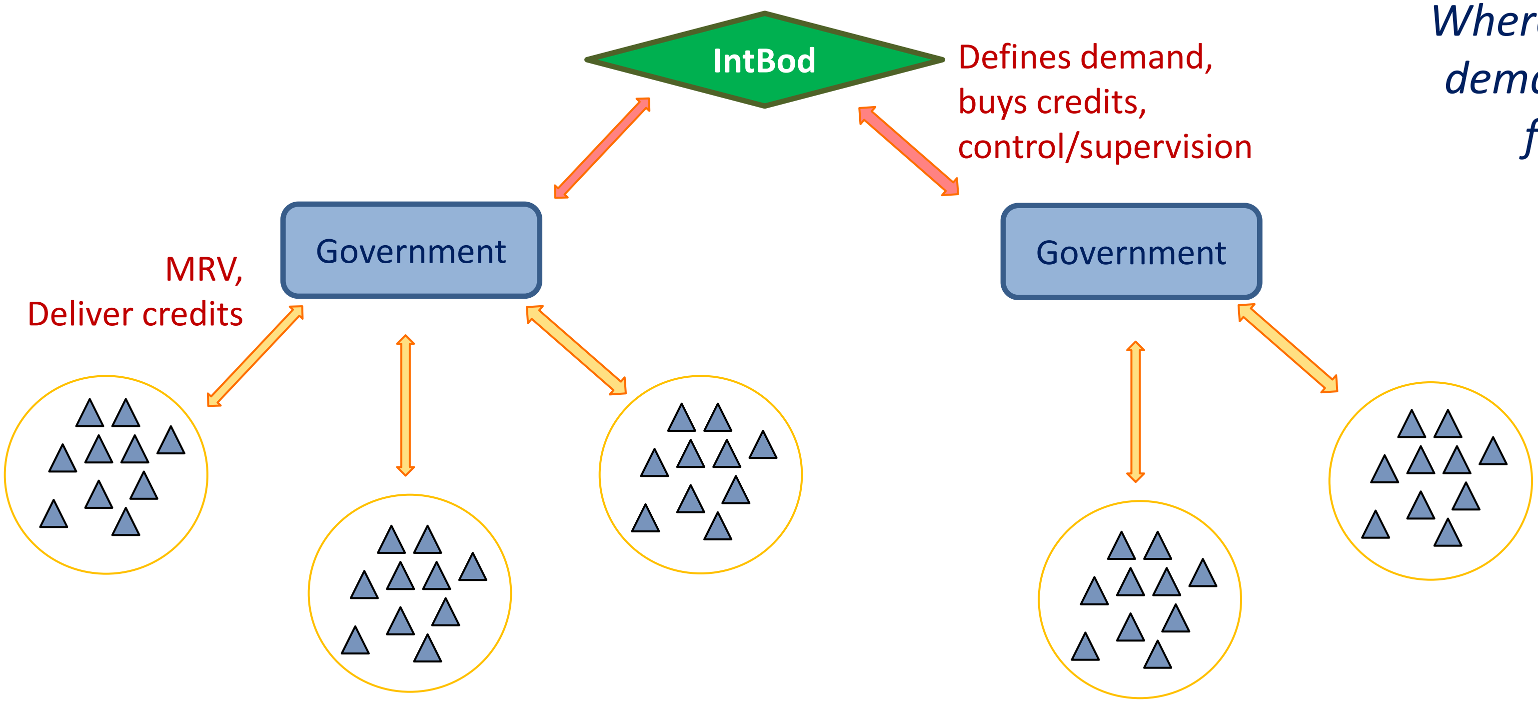
- If a city participates, all fuel consumers in that city are included
- Avoids leakage within city, but cannot avoid leakage between cities
- Covers all fuel consumers in city → effective but might need complex MRV. Up-/midstream MRV approach for simplification
- Can be baseline and credit- or cap-and-trade approach



- Mandatory participation of „all“ fuel consumers in city
  - Transport (midstream)
  - Public buildings (midstream)
  - Private households (midstream)
  - Industry (downstream)
  - Services (midstream)

Option: International schemes

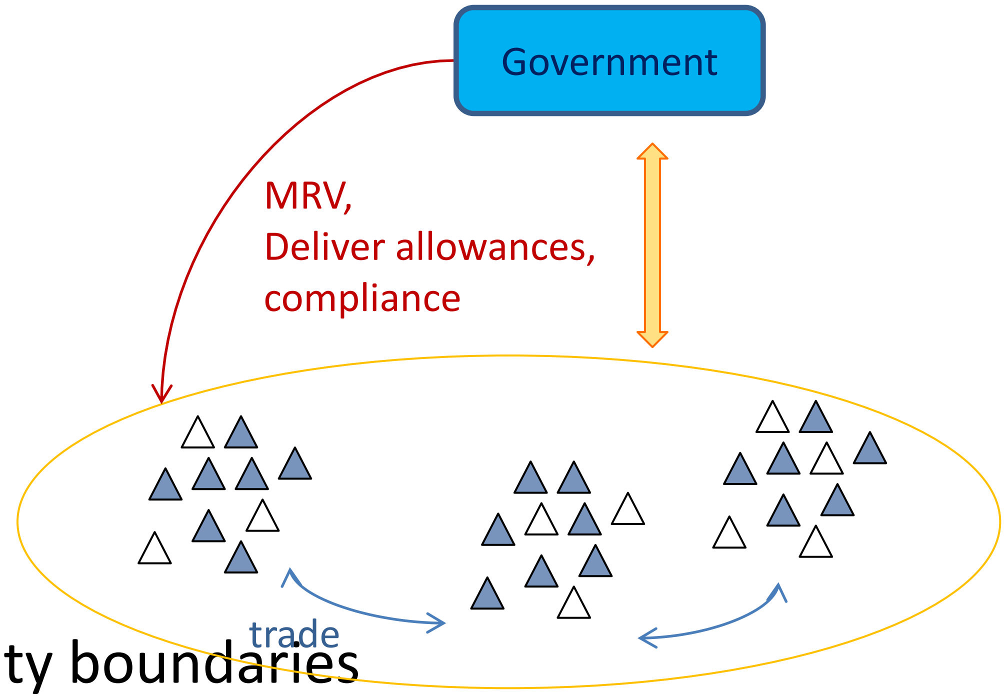
- International body defines demand or target
- Countries can chose to opt-in
- If a country participates, then all cities with certain characteristics participate on mandatory basis to avoid leakage
- Can be baseline and credit- or cap-and-trade approach



Where does the demand come from?

Option: Sectoral approach

- Not city as a whole is included, but „subsectors“, e.g.:
  - public transport
  - private transport
  - public buildings
  - private buildings
  - industry
  - service sector ...

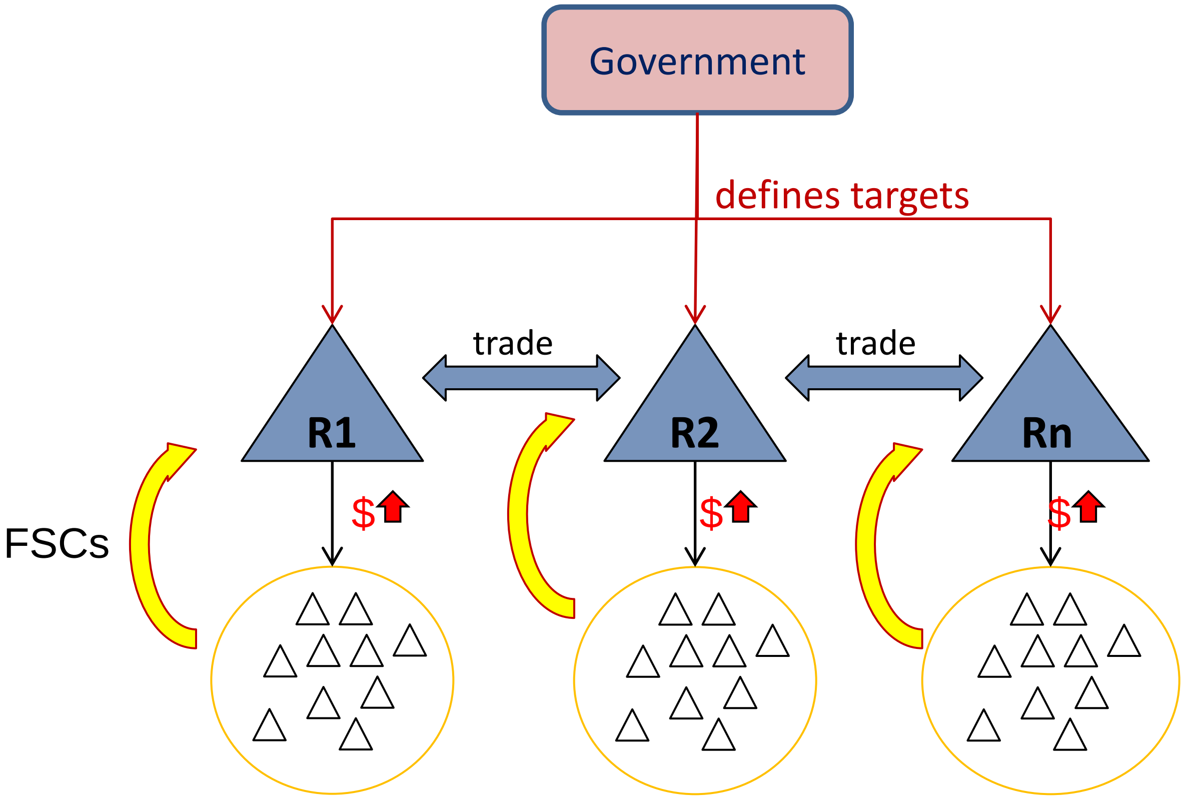


- Avoids leakage outside city boundaries
- Allows starting with less complex fuel users, and expand over time

Options: National cap-and-trade, baseline & credit, international schemes

Creating demand for FSCs (I)

1. National cap-and-trade scheme (upstream)



Fuel Importers/Refineries:

- No own mitigation options,
- Need to buy offsets (= demand)
- Price increase fuels

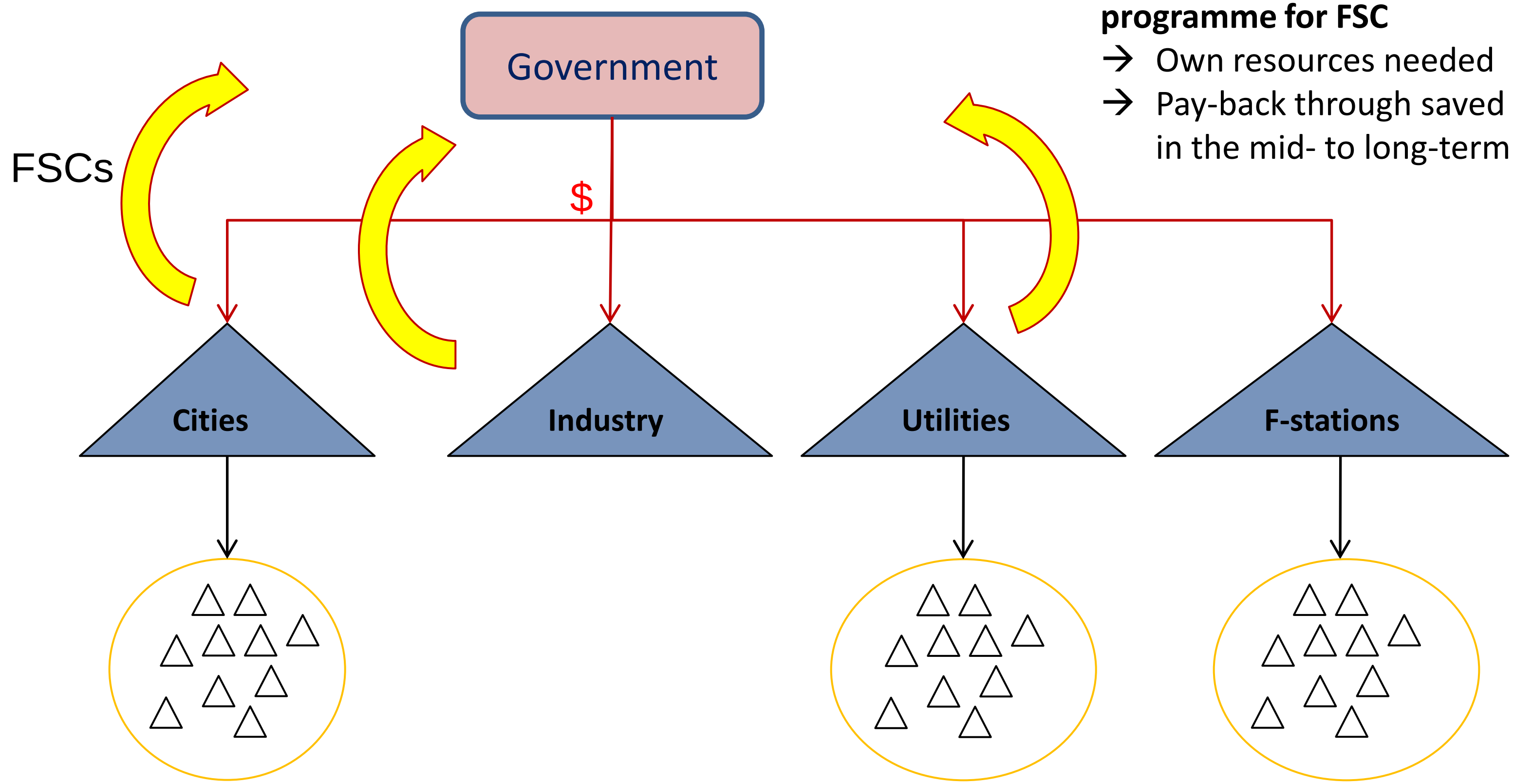
Fuel Consumers:

- Don't participate in trading
- Search for reduction options :
  - Higher fuel price
  - Create FSCs
- Questionable: can people afford price increases?

→ Might need to increase energy subsidies (not wanted!)

Creating demand for FSCs (II)

2. Domestic voluntary offset-scheme



Government sets up procurement programme for FSC

→ Own resources needed

→ Pay-back through saved subsidies only in the mid- to long-term

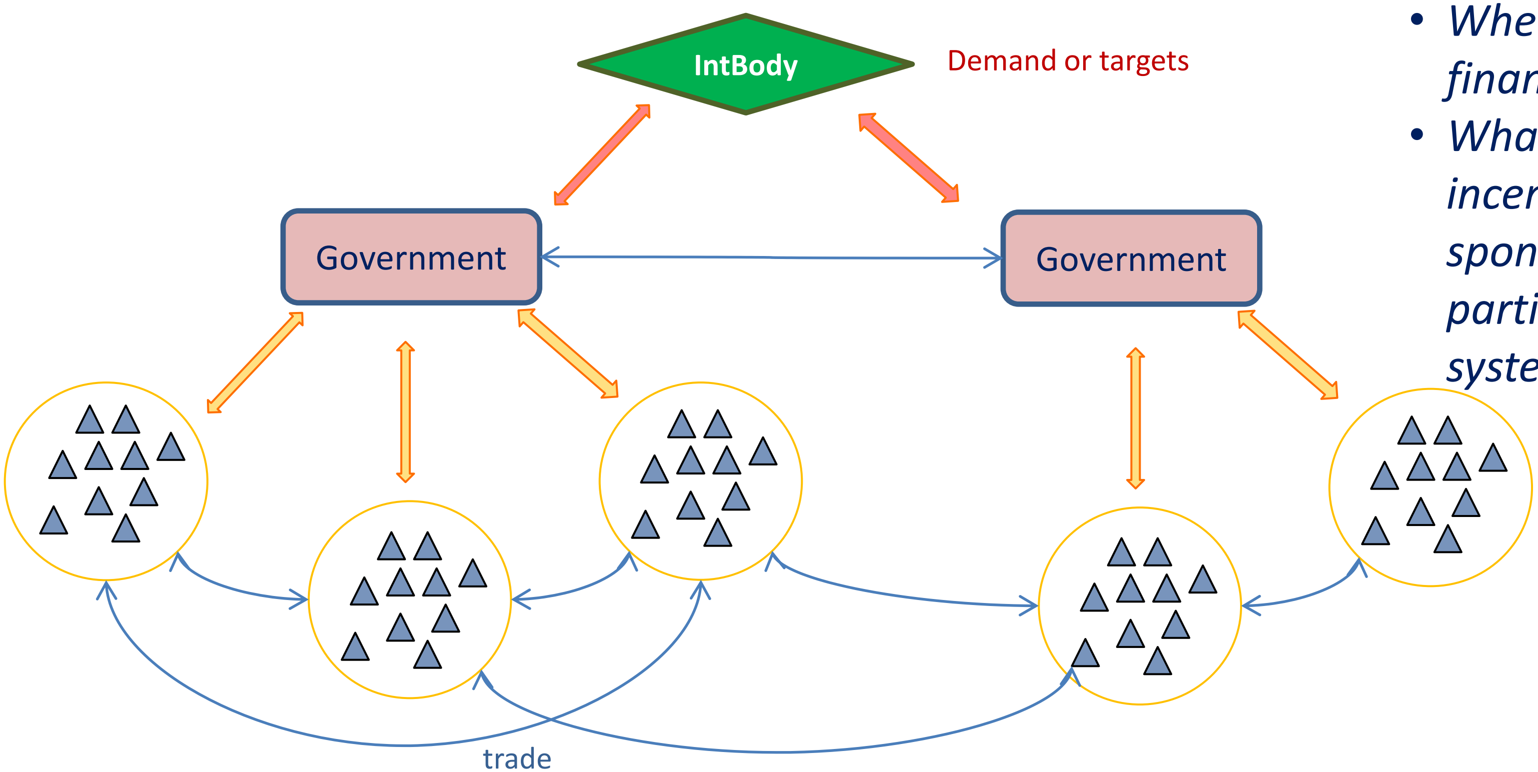
→All domestic models imply re-alloction of financial resources in the short-term

→ One would need to carefully evaluate distributional effects

Creating demand for FSCs (III)

3. International schemes

- International body defines target or otherwise generates demand (e.g. through an procurement programme)



- *Where does the finance come from?*
- *What would be incentives for sponsoring or particating the system?*

Demand for a FSC MM - Conclusions

- Creating demand through **mandatory reduction targets:**
  - Any cap-and-trade scheme on fuels/fuel security will result in higher energy prices (of covered fuels) for end consumers
  - Depending on how money is invested in projects, there might be a mismatch between those who pay and those who benefit
  - Higher fuel prices are an incentive to reduce consumption, but there might be cases where governments already subsidise fuels in order to promote economic growth. Compensation necessary?

- Creating demand through **offsets**:
  - National procurement programmes: result in additional short-term costs for governments, return only in mid- to long-term
  - International procurement programmes: who would be willing to make financial contributions?

    → ESCO model to attract institutional investors?

Next steps

(16h15 – 16h30)

Major activities and completion dates

1. Final Rationale Study: 1 July

2. Pilot Fund Proposal: 15 July

3. Final Rationale Study: 31 July

    - Oil demand and costing analysis
    - Case studies
    - Economic modeling

4. Market Mechanism Study: 3 August

5. Final Review: 12 September

6. Final Report: October

Final review

12 September 2011 (Tentative)

Manila

Final partner and funder session of the Research Phase

Closing Remarks

(16h30 – 17h00)

Thank you