APERC Workshop
The 48th APEC Energy Working Group and Associated Meetings
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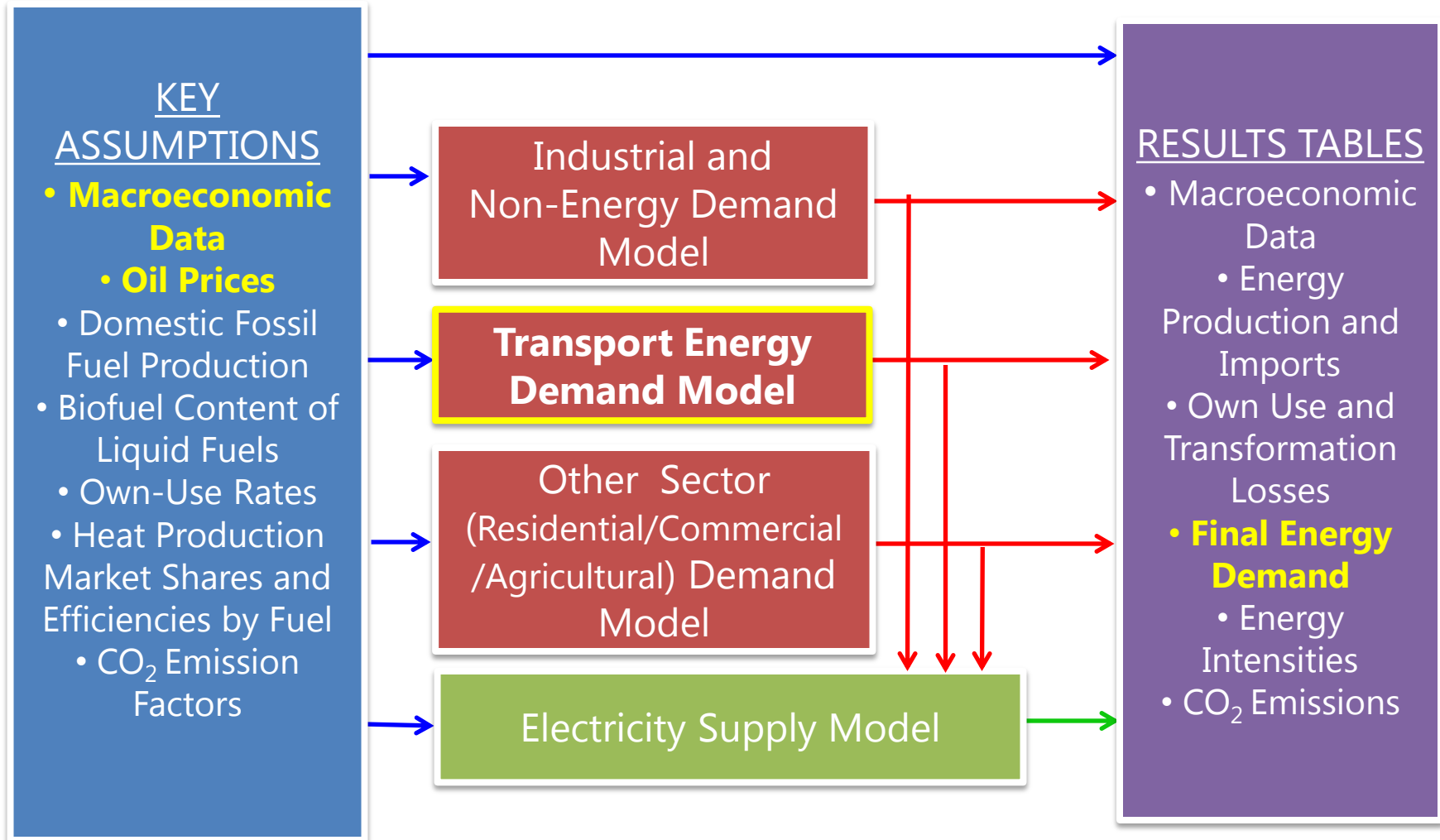# 2-2. Transportation Energy Demand Model

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KEY ASSUMPTIONS
- **Macroeconomic Data**
- **Oil Prices**
- Domestic Fossil Fuel Production
- Biofuel Content of Liquid Fuels
- Own-Use Rates
- Heat Production Market Shares and Efficiencies by Fuel
- CO_2 Emission Factors

Industrial and Non-Energy Demand Model

Transport Energy Demand Model

Other Sector (Residential/Commercial /Agricultural) Demand Model

Electricity Supply Model

RESULTS TABLES
- Macroeconomic Data
- Energy Production and Imports
- Own Use and Transformation Losses
- **Final Energy Demand**
- Energy Intensities
- CO_2 Emissions

Transport Energy Demand in APEC Region

APEC Final Energy Demand by Sector in 2010
(5th Ed. APEC Energy Outlook)
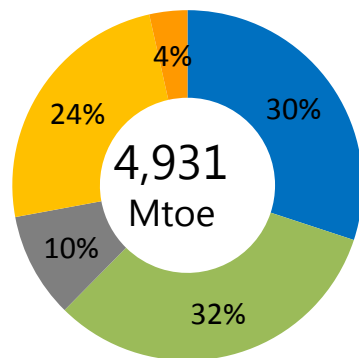
APEC Transport Final Energy Demand in 2011
(IEA Energy Data 2013)
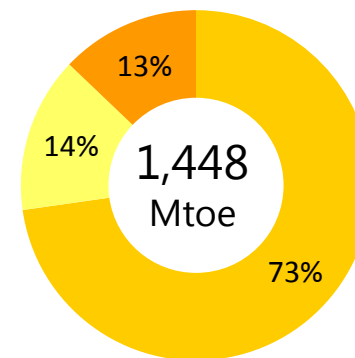
4,931 Mtoe

- Industry (30%)
- Other (32%)
- Non-Energy (10%)
- Domestic Transport (24%)
- International Transport (4%)

1,448 Mtoe

- Domestic Road Transport (73%)
- Domestic Non-Road Transport (14%)
- International Transport (13%)

Transport Energy Demand Modelling Methods

	Transport mode	Vehicle class	APEC Energy Demand in 2011 (Mtoe)	(Percent)	Model
Domestic (Road Transport)	-Road	-Light and Heavy vehicles -Motorcycles	1,053	73%	Vehicle Fleet Model
Domestic (Non-Road Transport)	-Rail -Pipeline -Water -Air -Non-specific		37 53 33 80 6	3% 4% 2% 6% 0.4%	Econometric Model
International (Non-Road Transport)	-Maritime -Aviation		109 78	8% 5%	Econometric Model

(Source: APERC, 2014)

APERC's Vehicle Fleet Model

(1980-2011)   **(2011-2040)**
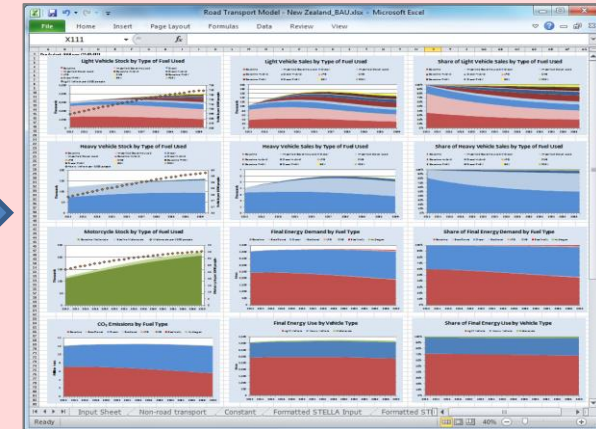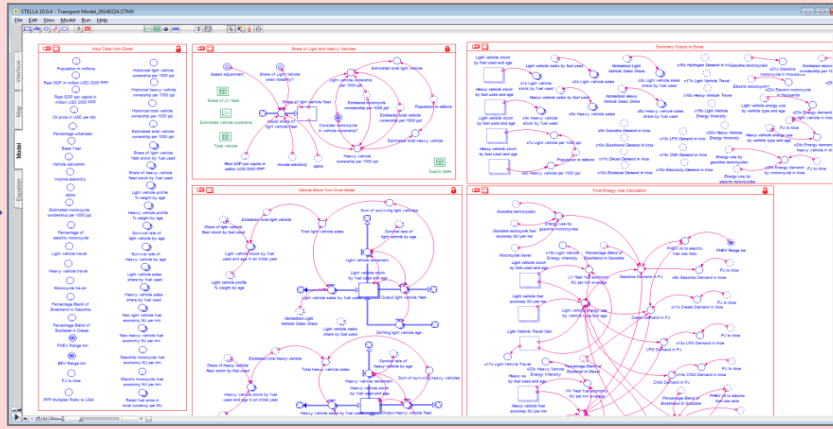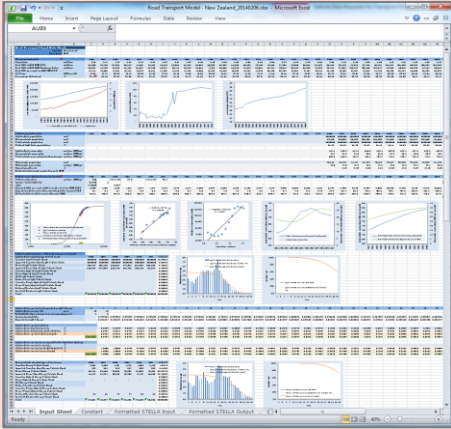
❖ **Macroeconomic data**
  - ✓ GDP & Population
  - ✓ Crude oil price
  - ✓ Urbanisation

❖ **Vehicle data**
  - ✓ Vehicle population
  - ✓ Vehicle age distribution
  - ✓ Vehicle sales
  - ✓ Vehicle fuel economy
  - ✓ Vehicle travel distance

❖ **Energy data**
  - ✓ Retail fuel prices
  - ✓ Blend ratio of biofuel
  - ✓ IEA road energy use

- **Vehicle ownership model** *-> vehicle stock*
  (GDP per capita, vehicle population, vehicle saturation)

- **Vehicle stock & flow model** *-> vehicle sales and vehicle retirement*
  (vehicle distribution by age, vehicle service life, survival rate)

- **Vehicle consumer choice model** *-> share of vehicle technologies*
  (fuel cost, purchase prices, driving range, refuelling infrastructure, etc..)

- **Vehicle travel model** *-> travel distance*
 *(fuel cost, income, vehicle ownership, efficiency improvement, urban density)*

❑ **Results**
  - ➢ Vehicle ownership
  - ➢ Vehicle stock by technology & fuel
  - ➢ Vehicle sales by technology & fuel
  - ➢ Energy demand by vehicle class
  - ➢ Energy demand by fuel type
  - ➢ Annual vehicle travel
  - ➢ Average energy intensity
  - ➢ etc.

Input	Main Model	Output
(Microsoft Excel)	(STELLA – System Dynamic Software)	(Microsoft Excel)
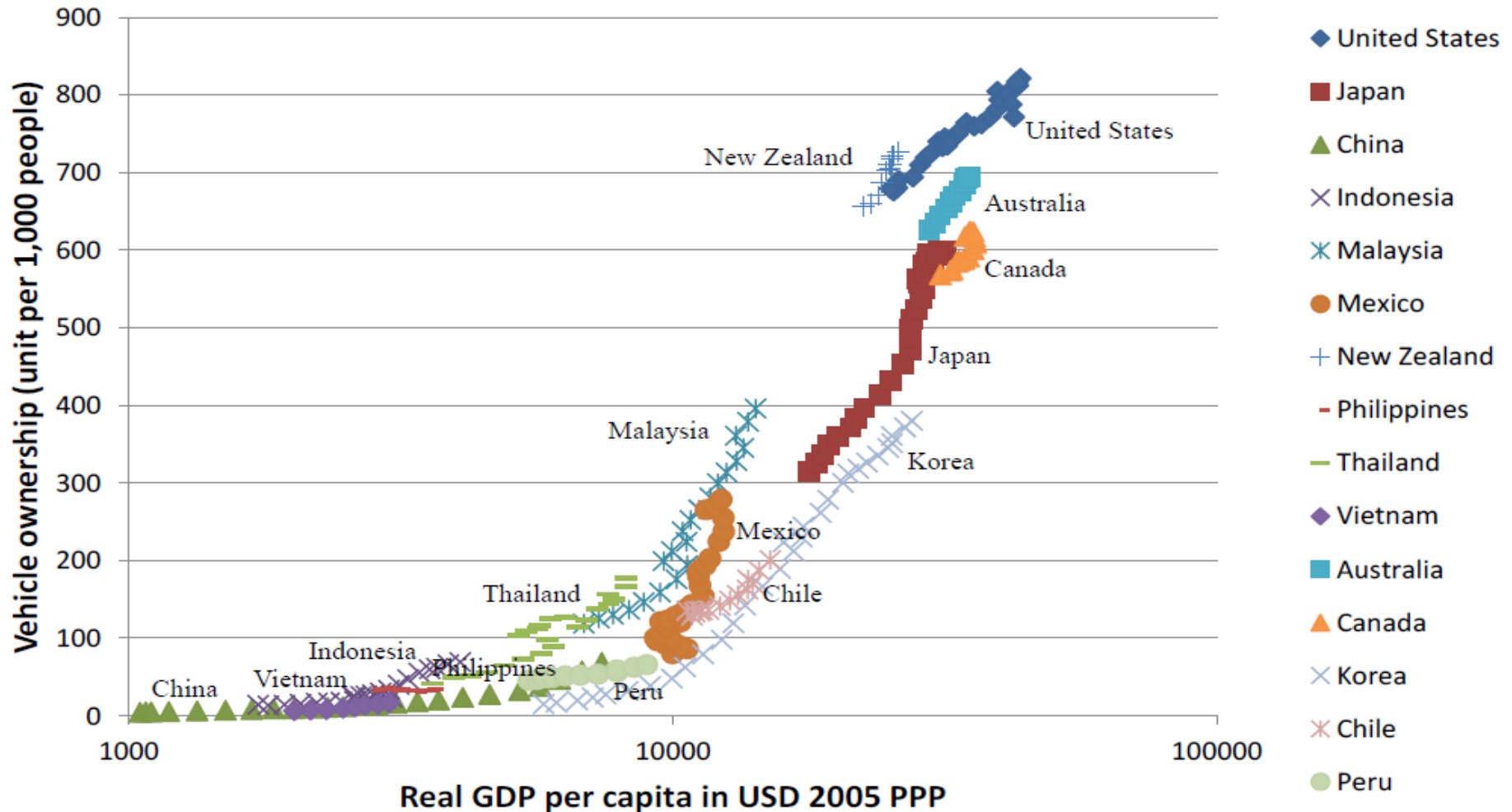
(Source: APERC, 2014)

	Vehicle per 1,000 Population				% Saturation		Saturation
	2011	2020	2030	2040	*2011*	*2040*	
Canada	623	664	702	735	79.9	94.3	780
United States	817	827	839	852	92.8	96.8	880
Mexico	253	369	452	481	51.9	98.5	488
Peru	67	147	264	356	15.9	84.8	420
Chile	193	304	403	463	38.3	92.0	503
Russia	299	393	480	536	49.8	89.4	600
Korea	387	438	462	473	80.6	98.5	480
Japan	594	611	618	620	95.8	99.9	620
China	62	205	374	460	12.4	92.2	499
Chinese Taipei	313	323	327	328	94.7	99.3	330
Hong Kong	84	85	86	86	93.2	95.9	90
Singapore	159	164	167	168	93.3	98.8	170
Thailand	164	291	421	492	31.7	95.0	518
Malaysia	365	492	570	602	59.1	97.6	617
Indonesia	47	99	201	339	9.9	72.0	470
Philippines	72	139	264	371	16.9	86.7	428
Vietnam	17	36	90	205	3.6	44.6	460
Brunei Darussalam	537	536	537	538	99.4	99.6	540
Papua New Guinea	9	16	35	83	1.3	11.9	700
Australia	694	732	756	769	89.0	98.6	780
New Zealand	718	741	760	773	92.1	99.1	780
APEC	*217*	*314*	*428*	*500*	*39.2*	*90.3*	*554*

(Source: APERC, 2014)

	Vehicle Stock (millions)				Compound Annual Growth Rates			
	2011	2020	2030	2040	2011-2020	2020-2030	2030-2040	2011-2040
Canada	21.41	24.69	27.98	30.80	1.6%	1.3%	1.0%	1.26%
United States	255.71	278.67	303.49	326.57	1.0%	0.9%	0.7%	0.85%
Mexico	29.10	46.48	61.21	68.01	5.3%	2.8%	1.1%	2.97%
Peru	1.97	4.78	9.39	13.41	10.4%	7.0%	3.6%	6.84%
Chile	3.33	5.63	7.88	9.26	6.0%	3.4%	1.6%	3.59%
Russia	42.70	55.44	65.46	70.39	2.9%	1.7%	0.7%	1.74%
Korea	18.71	21.80	23.26	23.33	1.7%	0.7%	0.0%	0.76%
Japan	75.16	76.28	74.34	70.85	0.2%	-0.3%	-0.5%	-0.20%
China	83.38	283.99	520.54	626.02	14.6%	6.2%	1.9%	7.20%
Chinese Taipei	7.26	7.63	7.70	7.44	0.6%	0.1%	-0.3%	0.09%
Hong Kong	0.60	0.66	0.73	0.77	1.2%	0.9%	0.6%	0.89%
Singapore	0.82	0.92	1.00	1.03	1.2%	0.8%	0.3%	0.78%
Thailand	11.40	20.95	30.86	35.91	7.0%	3.9%	1.5%	4.04%
Malaysia	10.53	16.24	21.24	24.58	4.9%	2.7%	1.5%	2.97%
Indonesia	11.28	25.93	56.19	98.27	9.7%	8.0%	5.7%	7.75%
Philippines	6.85	15.30	33.40	52.56	9.3%	8.1%	4.6%	7.28%
Vietnam	1.47	3.45	9.16	21.36	9.9%	10.3%	8.8%	9.67%
Brunei Darussalam	0.22	0.25	0.28	0.31	1.5%	1.2%	0.9%	1.17%
Papua New Guinea	0.06	0.13	0.36	0.99	8.4%	10.5%	10.6%	9.90%
Australia	15.70	18.48	21.00	22.91	1.8%	1.3%	0.9%	1.31%
New Zealand	3.17	3.58	3.96	4.24	1.3%	1.0%	0.7%	1.00%
APEC	600.8	911.3	1,279.4	1,509.0	4.7%	3.5%	1.7%	3.23%

(Source: APERC, 2014)

Vehicle Stock in 2011 and 2040 [Million Vehicles]

East Asia [except China]:

+0.6% CAGR

China:

+7.2% CAGR

APEC

+3.2% CAGR

Legend:
- FCEV
- BEV
- PHEV
- HEV
- CNG
- LPG
- ICE-Diesel
- ICE-Gasoline

North/Central America:

+1.1% CAGR

Southeast Asia:

+6.1% CAGR

Oceania:

+1.4% CAGR

South America:

+5.1% CAGR
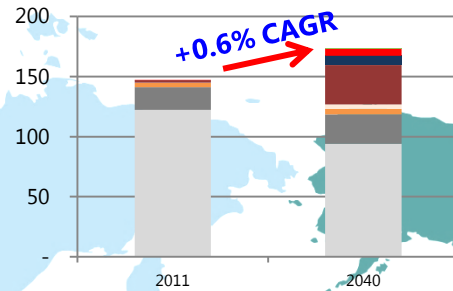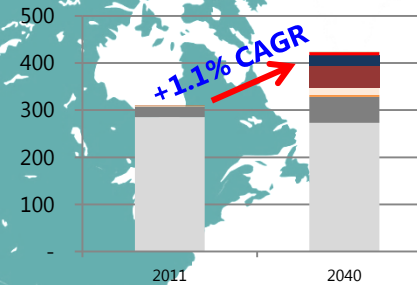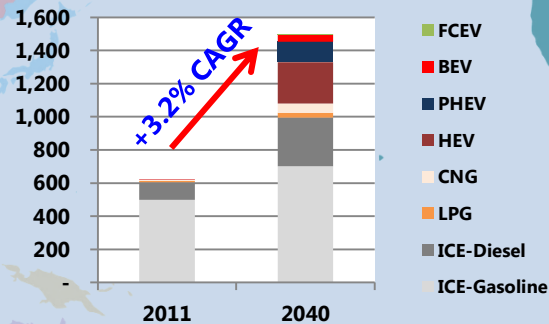
□ Vehicle stock will increase from 600 million in 2011 to 1,500 million in 2040; 2.5 times or 3.2% CAGR.

□ China's growth is the highest with 7.2% CAGR and will have 626 million vehicles in 2040, or 41.7% of the total APEC vehicle stock.

□ The share of electric-drive vehicles, HEV, PHEV, and EV in 2040 will be about 30% of the total APEC vehicle stock, and 40% of China's stock.
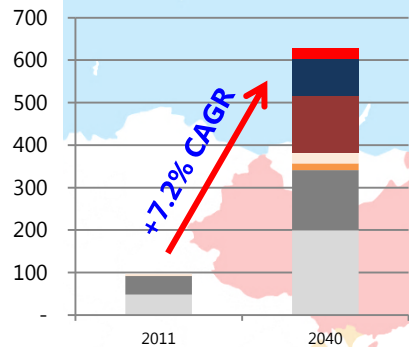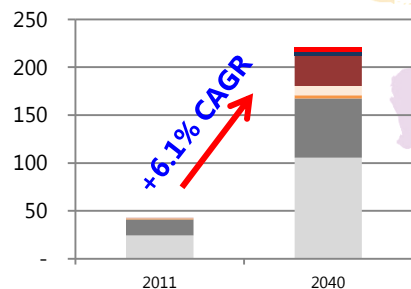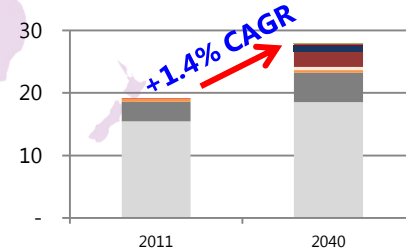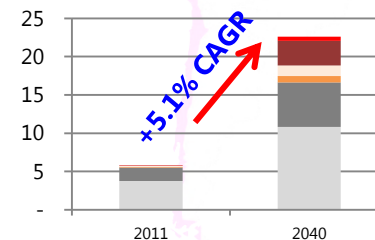
CAGR: Compound Annual Growth Rate

Please note that this is preliminary results.

Vehicle Sales by Technology by APEC Region

Vehicle Sales in 2011 and 2040 [Million Vehicles]

China:

+2.8% CAGR

East Asia [except China]:

-0.1% CAGR

North/Central America:

+1.0% CAGR

APEC

+1.9% CAGR

Legend:
- FCEV
- BEV
- PHEV
- HEV
- CNG
- LPG
- ICE-Diesel
- ICE-Gasoline

Southeast Asia:

+3.8% CAGR

Oceania:

+0.9% CAGR

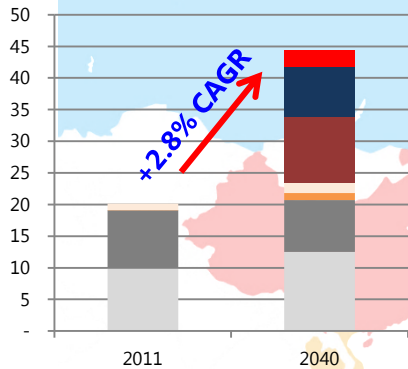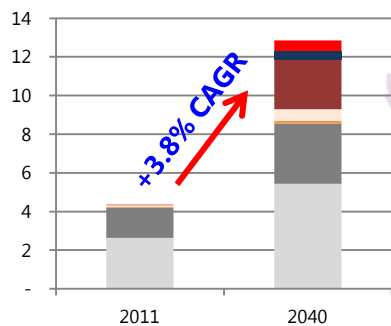**South America:**

+2.7% CAGR

- ❑ Vehicle sales will increase from 56 million in 2011 to 96 million in 2040, and about 45% of the APEC vehicle sales will be in China.

- ❑ Southeast Asia has the highest growth automobile market, increasingly 3.8% per year, equivalent to about 13 million vehicles sales in 2040.
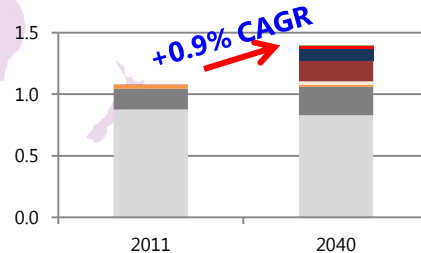
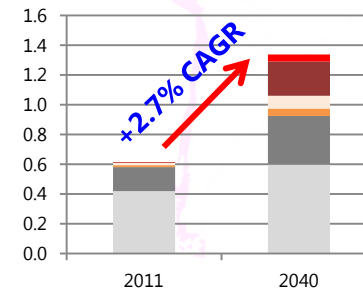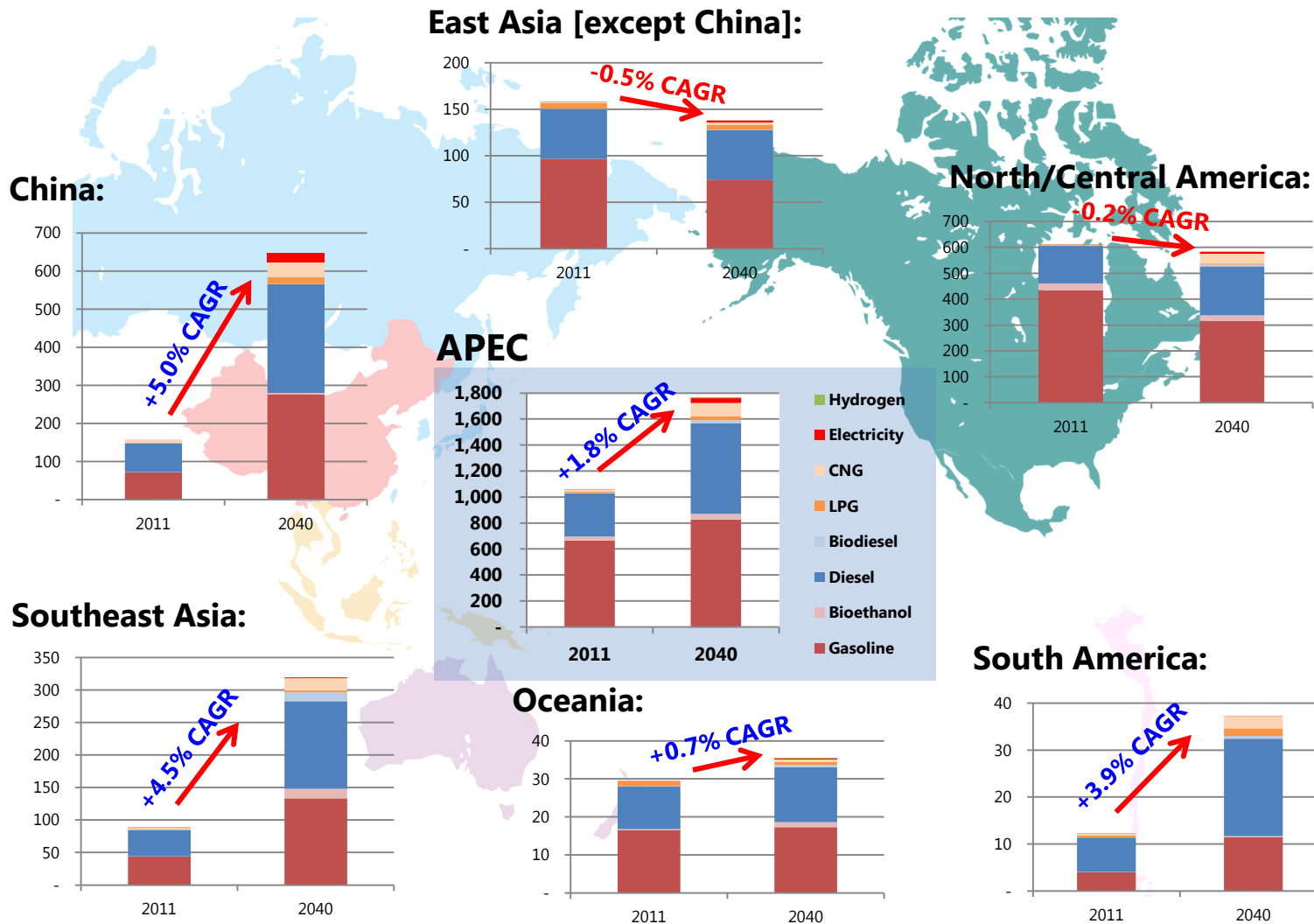*Please note that this is preliminary results.*

Road Energy Demand by Fuel Type

Road Energy Demand in 2011 and 2040 [Mtoe]

East Asia [except China]: -0.5% CAGR

China: +5.0% CAGR

North/Central America: -0.2% CAGR

APEC +1.8% CAGR

Legend:
- **Hydrogen**
- **Electricity**
- **CNG**
- **LPG**
- **Biodiesel**
- **Diesel**
- **Bioethanol**
- **Gasoline**

Southeast Asia: +4.5% CAGR

Oceania: +0.7% CAGR

South America: +3.9% CAGR

- ❑ Energy demand for road transport will increase from 1,060 Mtoe in 2011 to 1,760 Mtoe in 2040, or 1.8% CAGR.

- ❑ China has the highest growth at 5.0% per year, 650 Mtoe or 37% of the total energy demand in 2040.

- ❑ Oil (gasoline and diesel) remains the primary fuel used in the transport sector at about 87% of the total energy demand in 2040.

Please note that this is preliminary results.

Share of Road Energy Demand by Vehicle Type in 2011 (inner) and 2040 (outer)

- Light Vehicle
- Heavy Vehicle
- Motorcycle
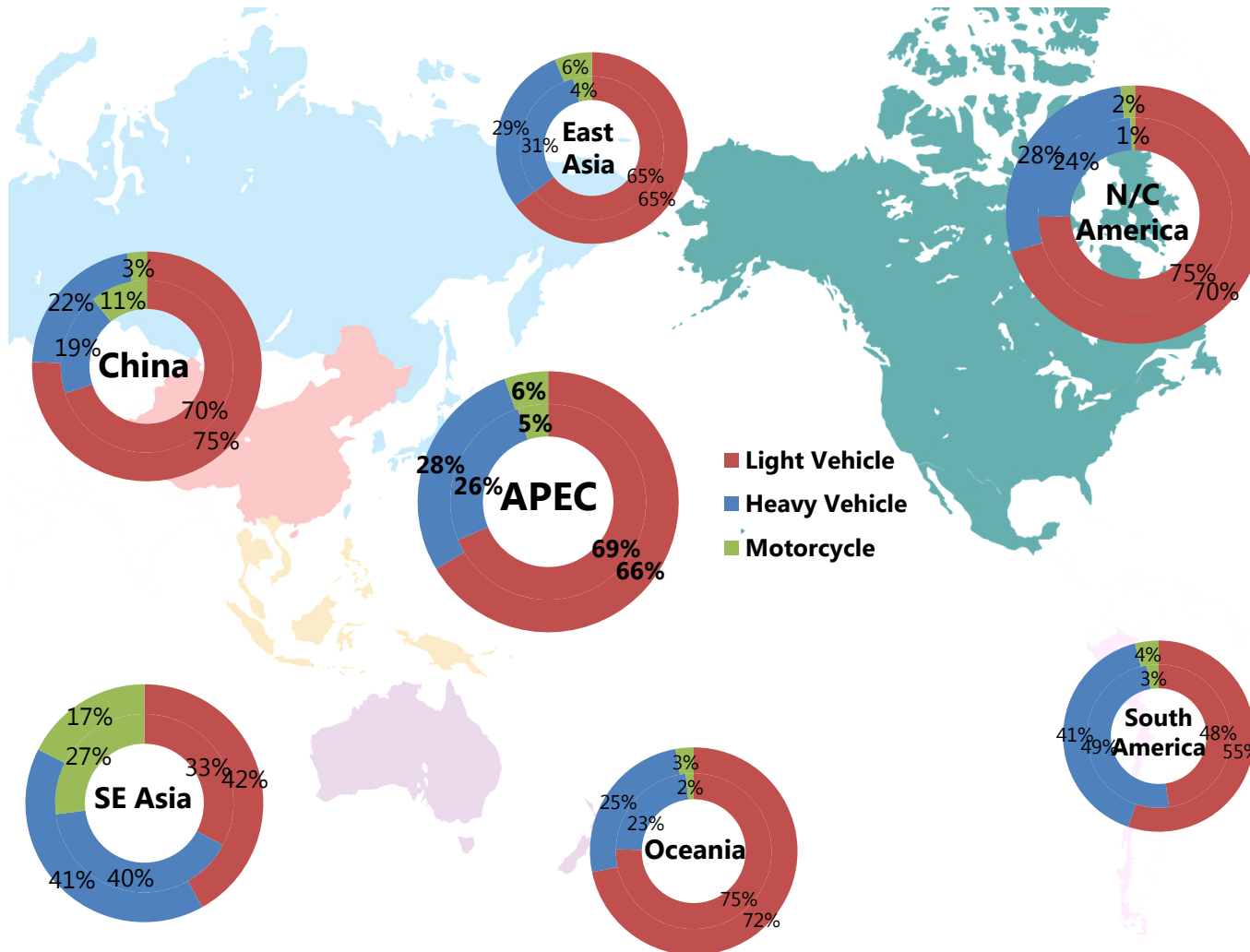
- ❑ **Light vehicles remain the biggest share of road energy demand in AEC region, 66% in 2040.**
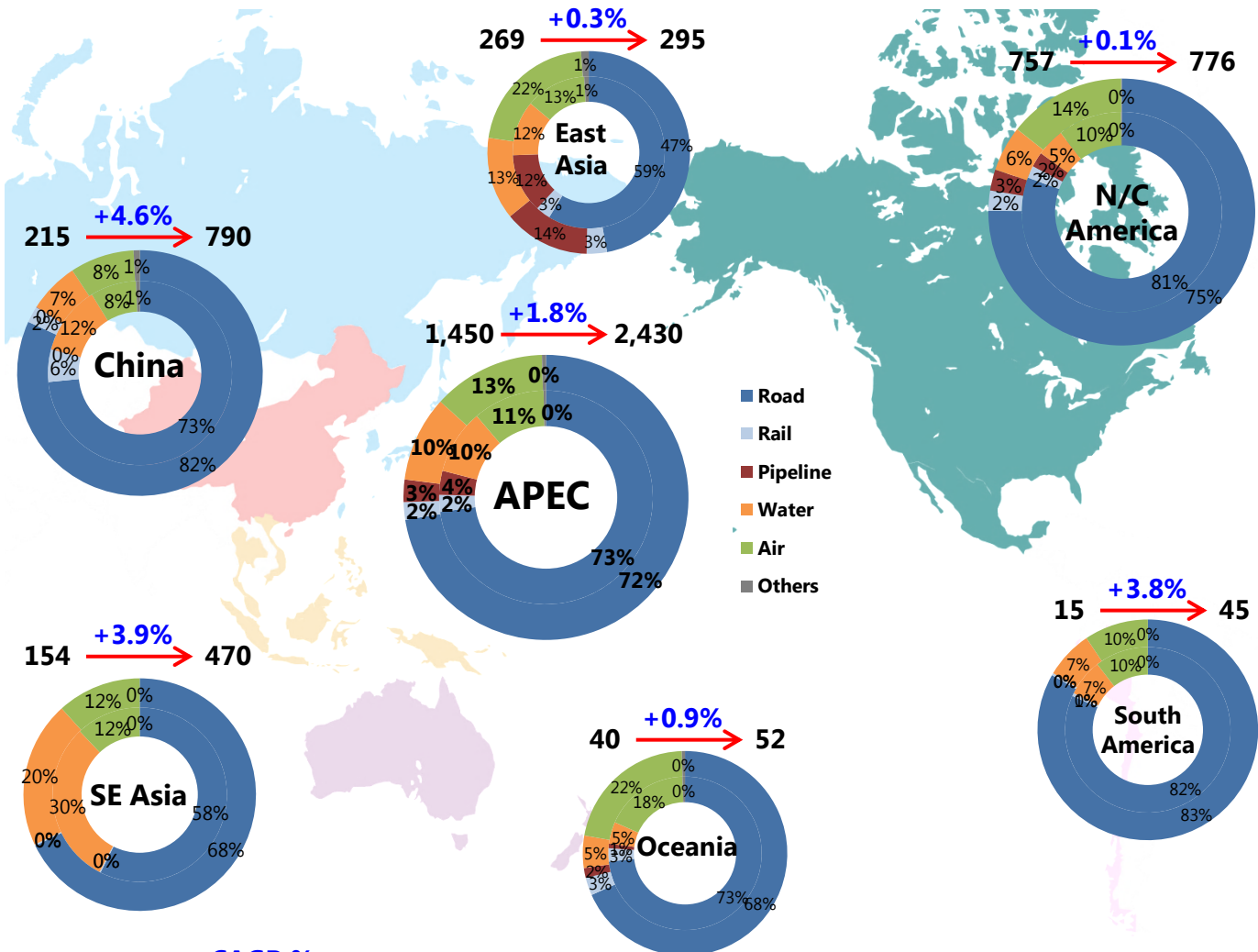
- ❑ **Heavy vehicles in SE Asia and South America have significant shares of energy demand, more than 40%.**

- ❑ **Motorcycles are a significant share of energy demand in SE Asia at 27% in 2011 and 17% in 2040.**

Please note that this is preliminary results.

Share of Transport Energy Demand by Mode in 2011 (inner) and 2040 (outer)

East Asia
269 **+0.3%** 295
1% / 13% / 1% / 22% / 12% / 13% / 12% / 3% / 14% / 3% / 47% / 59%

N/C America
757 **+0.1%** 776
0% / 14% / 10% / 0% / 6% / 5% / 3% / 2% / 2% / 81% / 75%

China
215 **+4.6%** 790
8% / 1% / 7% / 8% / 1% / 0% / 2% / 12% / 0% / 6% / 73% / 82%

APEC
1,450 **+1.8%** 2,430
13% / 0% / 11% / 0% / 10% / 10% / 3% / 4% / 2% / 2% / 73% / 72%

Legend:
- ■ Road
- ■ Rail
- ■ Pipeline
- ■ Water
- ■ Air
- ■ Others

SE Asia
154 **+3.9%** 470
12% / 0% / 12% / 0% / 20% / 30% / 0% / 58% / 0% / 68%

Oceania
40 **+0.9%** 52
0% / 22% / 0% / 18% / 5% / 3% / 5% / 2% / 3% / 73% / 68%

South America
15 **+3.8%** 45
10% / 0% / 10% / 0% / 7% / 7% / 0% / 0% / 82% / 83%

Mtoe **in 2011** → **CAGR %** → Mtoe **in 2040**

- ❑ **Road transport remains the biggest share of the total transport energy demand at more than 70%.**

- ❑ **Air and water transport are a significant share of energy demand in SE Asia, Oceania and East Asia, mostly due to international transport.**

- ❑ **Only small shares of railway and pipeline transport which are high energy efficiency modes.**

Please note that this is preliminary results.

❑ The developed vehicle fleet model can estimate road transport energy demand by fuel type and can capture the changes in vehicle stock and sales by technology.

❑ Energy demand in the transport sector is still increasing with the high growth, particularly the road transport, therefore, the new vehicle fuel economy needs to improve and high energy efficiency vehicles should be deployed faster.

❑ Next step, APERC's vehicle fleet model will be used to evaluate the impact of improving fuel economy and promoting high energy efficiency vehicles in the APEC region.

Thank you for your kind attention.

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