

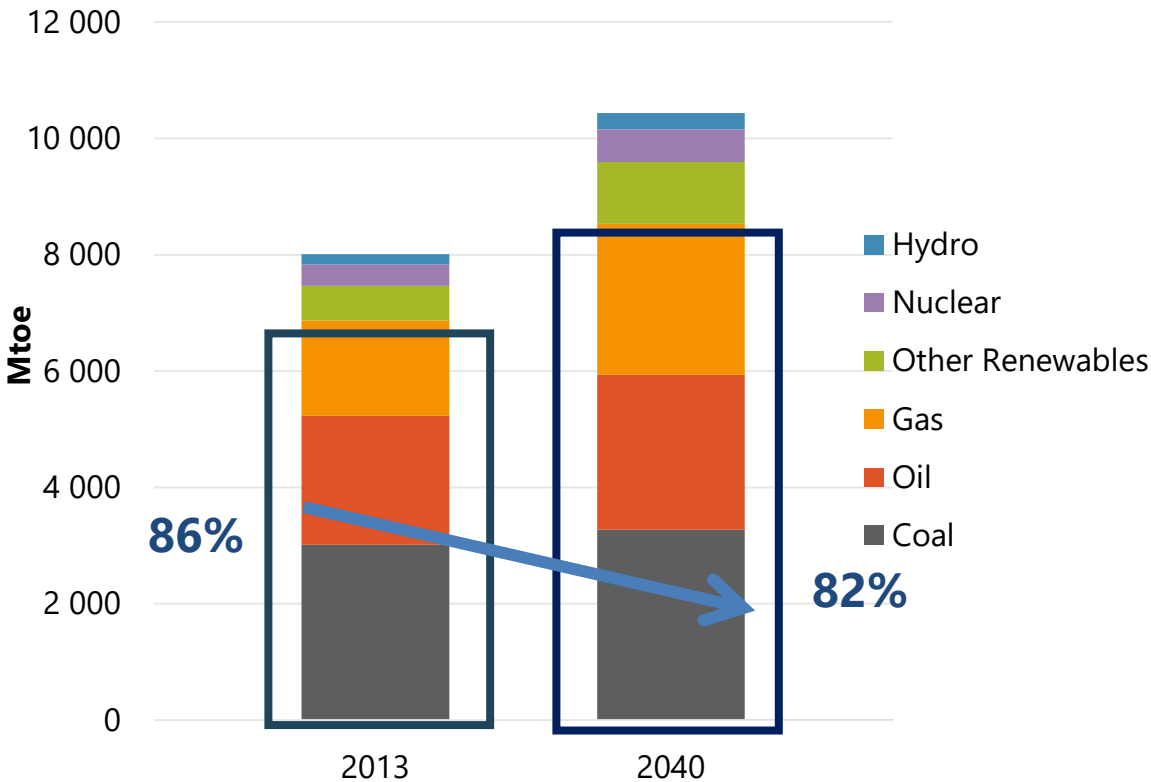
APEC RE Doubling Goal (Preview of High Renewables Scenario)

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Fossil Fuels Continue to Dominate

Preliminary Results

Energy Supply 30%



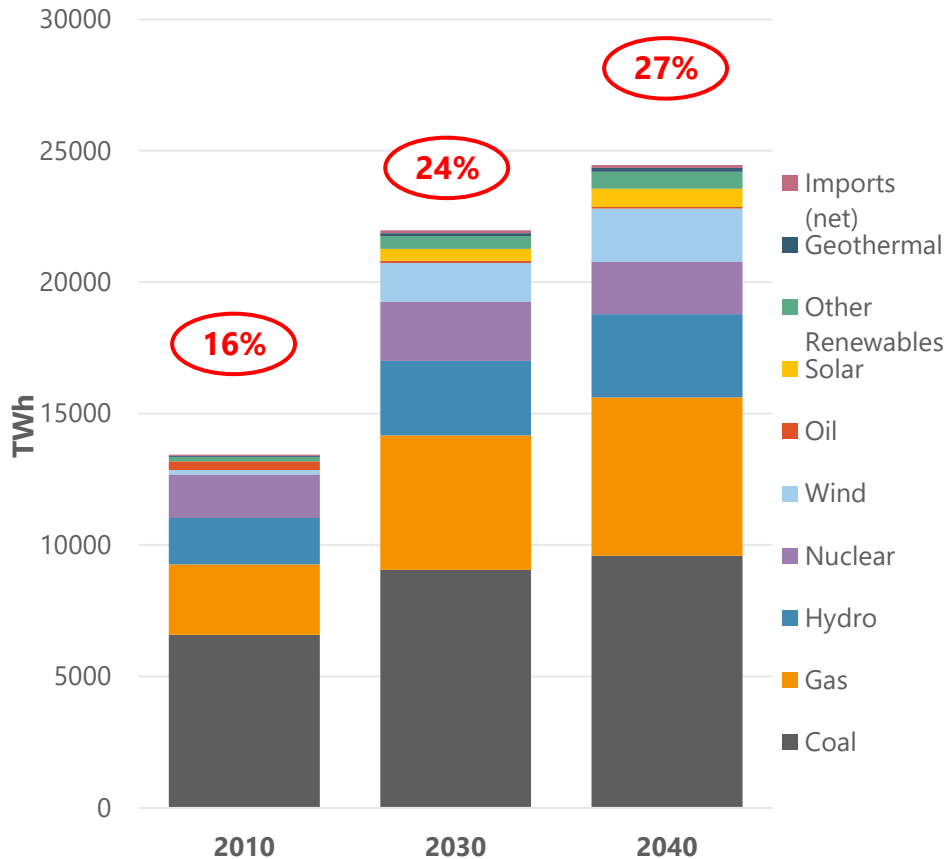
	Fuel Shares		
	1990	2013	2040
Coal	27.9%	37.6%	31.4%
Oil	35.7%	27.7%	25.5%
Gas	20.2%	20.5%	24.9%
Hydro	1.9%	2.2%	2.7%
Other Renewables	8.6%	7.4%	10.2%
Nuclear	5.8%	4.6%	5.2%

The Share of Fossil Fuel

Source: APERC Analysis

Renewables in Power and Transport

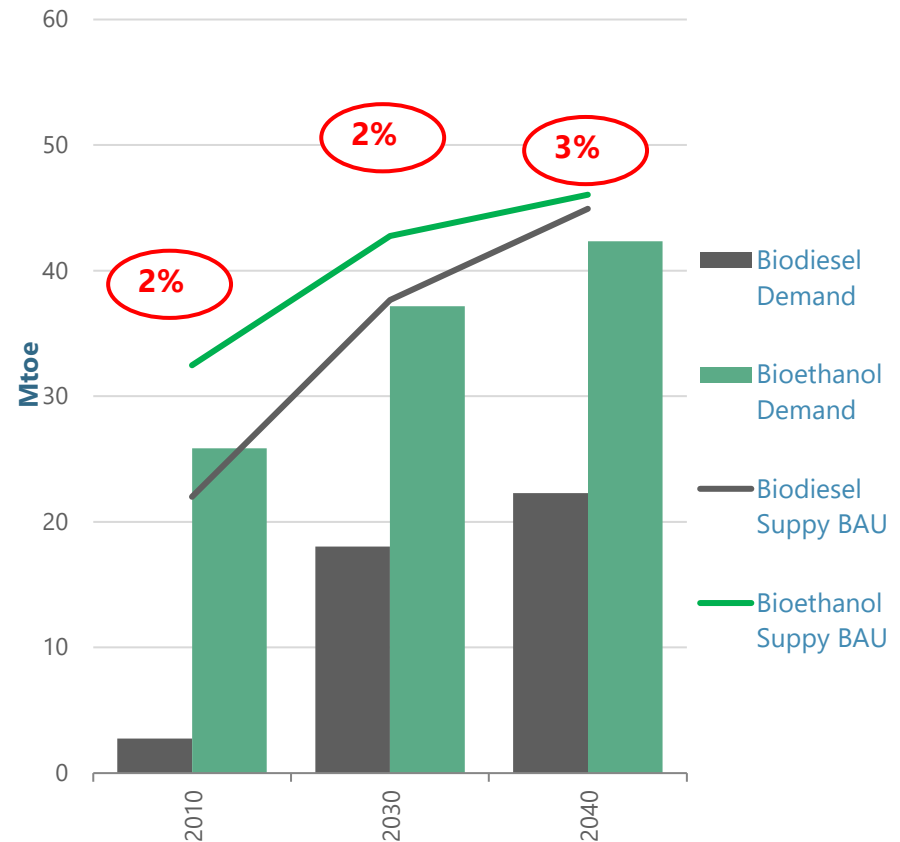
Total Power Generation Mix



Source: APERC Analysis

APEC's doubling goal in renewable is not achieved.

The Share of Biofuels in Transport Sector



Preliminary Results



High Renewables in Power Sector

Overview of Renewable Policies in APEC Region

< Renewable in Power Generation >

- Policies on RE development are anchored on enhancing energy security, sustaining socio-economic development, and addressing climate change.
- Setting targets, introducing FIT and/or RPS and providing incentives, subsidies, and taxation are the common approaches and strategies to encourage development and utilization of renewable.
- FIT scheme is mostly preferred policy instrument for RE promotion in the APEC region.

	Renewable energy policies framework							
	Renewable Energy Act	Other regulation or master plan related to renewables	Policy on renewable energy	Strategy for developing renewable energy	Renewable energy target		Feed-in- Tariff (FIT) or Renewable Portfolio Standard (RPS)	Incentives, subsidies, and taxation
					In general	In 2030		
Australia	√	√	√	√	√	X	X	√
Brunei Darussalam	X	√	√	√	√	X	X	X
Canada	X	√	√	√	√	X	F/R *)	√
Chile	√	√	√	√	√	X	X	√
China	√	√	√	√	√	X	F	√
Hong Kong, China	X	√	√	√	X	X	X	√
Indonesia	X	√	√	√	√	√	F	√
Japan	√	√	√	√	√	√	F	√
Korea	√	√	√	√	√	X	R	√
Malaysia	√	√	√	√	√	√	F	√
Mexico	√	√	√	√	√	X	X	√
New Zealand	X	√	√	√	√	X	X	√
Papua New Guinea	X	X	√	X	X	X	X	X
Peru	√	√	√	√	X	X	X	√
Philippines	√	√	√	√	√	√	F and R	√
Russia	X	√	√	√	√	√	F	√
Singapore	X	√	√	√	X	X	X	√
Chinese Taipei	√	√	√	√	√	√	F	√
Thailand	X	√	√	√	√	X	F	√
United States	X	√	√	√	√	X	F/R *)	√
Viet Nam	X	√	√	√	√	√	F	√

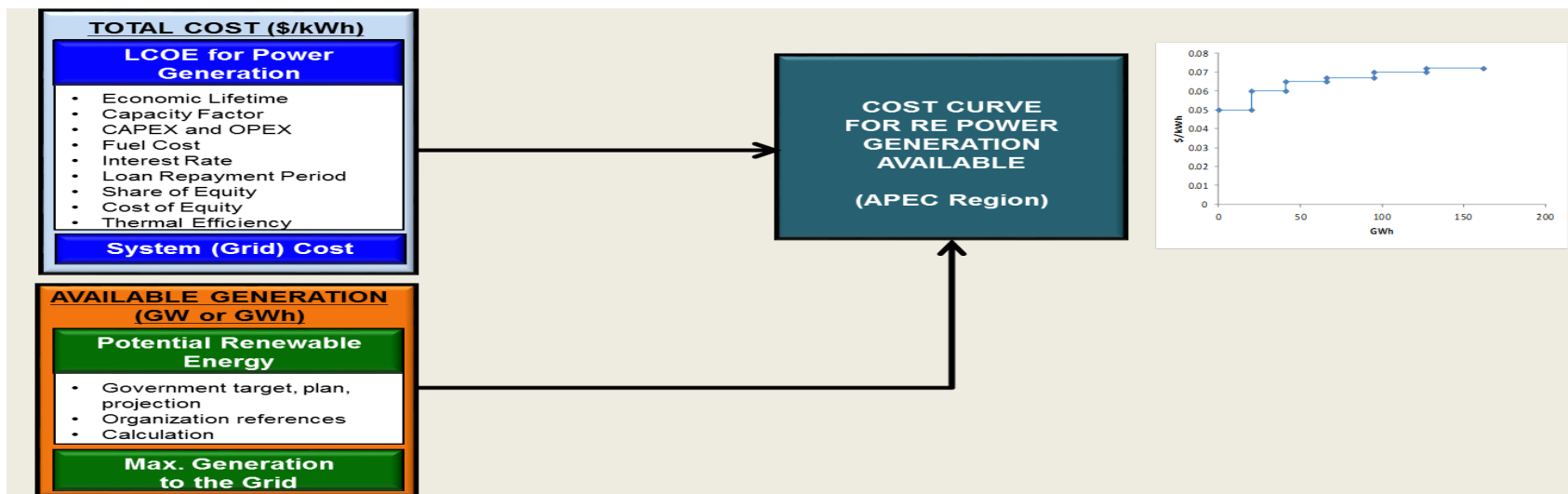
√ : Existing
 X : Not Existing currently
 F : Feed-in-Tariff
 R : Renewable Portfolio Standard
 *) : Applied in some local territories or states

Source: APERC Analysis

General Assumption and Methodology

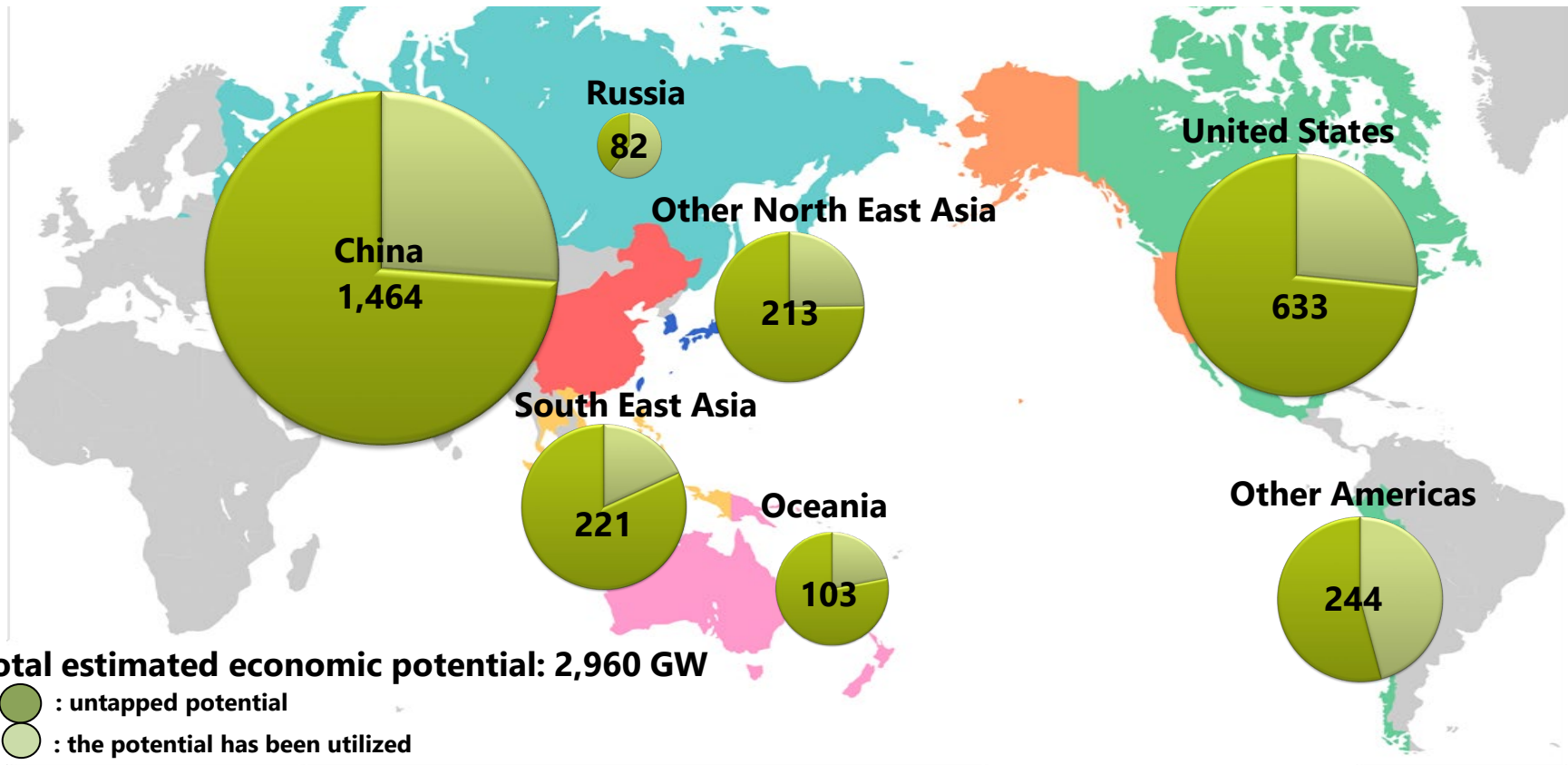
<High Renewable Scenario – Power Sector >

- Projection assumes government targets are fully met and the additional renewables capacity needed to meet the APEC doubling goal is developed based on a least cost approach for the APEC region. Additional renewable power is identified by considering the LCOE per technology and per economy, and the economic potential per technology and per economy.
- For macroeconomic and general assumptions, all data and information for inputs to LCOE are solicited from many sources and references (e.g. the economy data, report from international energy organizations, international financing institutions).



Estimated Potential of Renewable Energy

The potential is estimated by considering many factors, such as the government policies, targets, plans, and projections; and estimations using other pertinent sources or references with some data assumption



Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

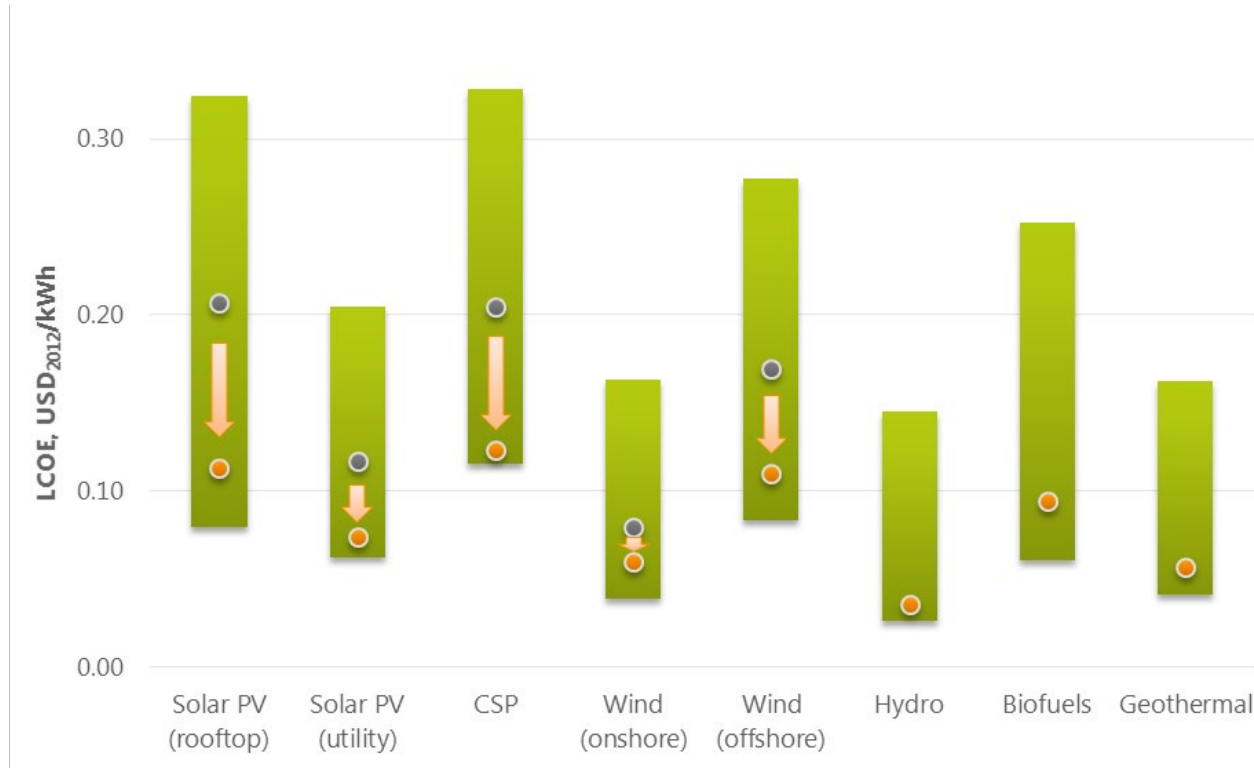
Source: APERC Analysis

Note: **Oceania** (Australia, New Zealand and PNG), **Other Americas** (Canada, Chile, Mexico and Peru), **Other North East Asia** (Hong Kong, Japan, Korea and Chinese Taipei), **South East Asia** (Brunei Barussalam, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam)

Declining Electricity Cost from Renewables

<Renewable in Power Generation>

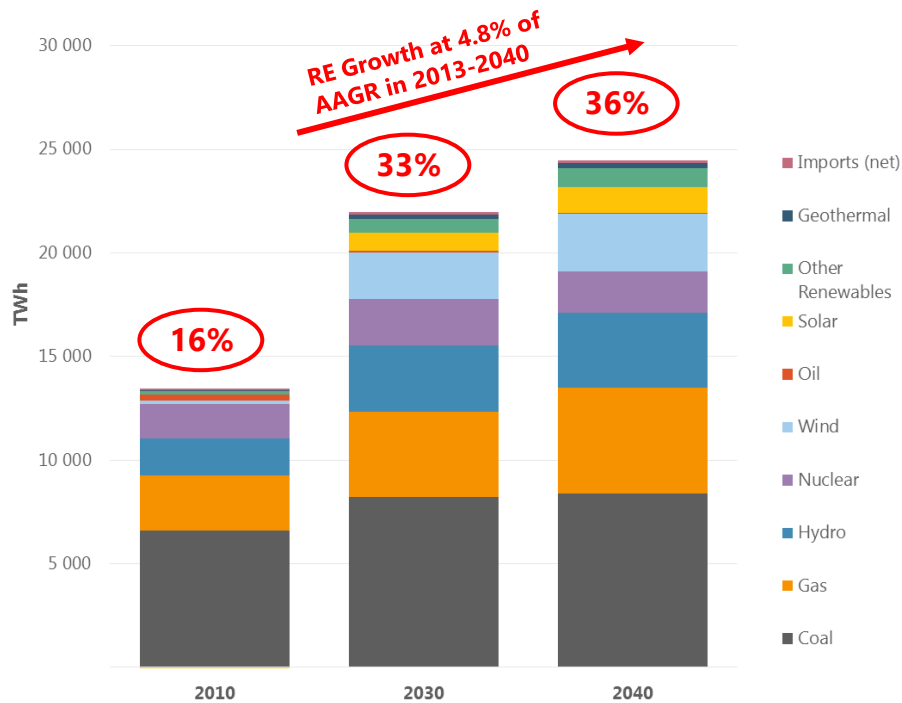
- Costs of RE technologies (solar and wind) have been declining from 2013 to 2040 in different economies where the lowest Levelised Cost of Electricity (LCOE) is hydro in Viet Nam and the highest is offshore wind in Peru.



Source: APERC Analysis

Solar and Wind Growing at the Fastest Rates

- Solar Photovoltaic and On-shore Wind will have the highest annual growth rates in installed capacity due to abundant untapped economic potential, declining and competitive costs of these technologies, and government targets in some economies.



Over the outlook period (2015-2040):

- Hydro is still the prominent technology to be developed, growing at 2.6% AAGR.
- Geothermal is growing at 6.4% of AAGR.
- Wind is growing at 8.7% AAGR in power generation to increase 1 946 TWh in 2030 and 2 539 TWh in 2040.
- Solar is growing at the fastest rates of 15% average annual in power generation to increase 856 TWh in 2030 and 1 200 TWh in 2040.
- Other Renewables are growing at 5.9% of AAGR.

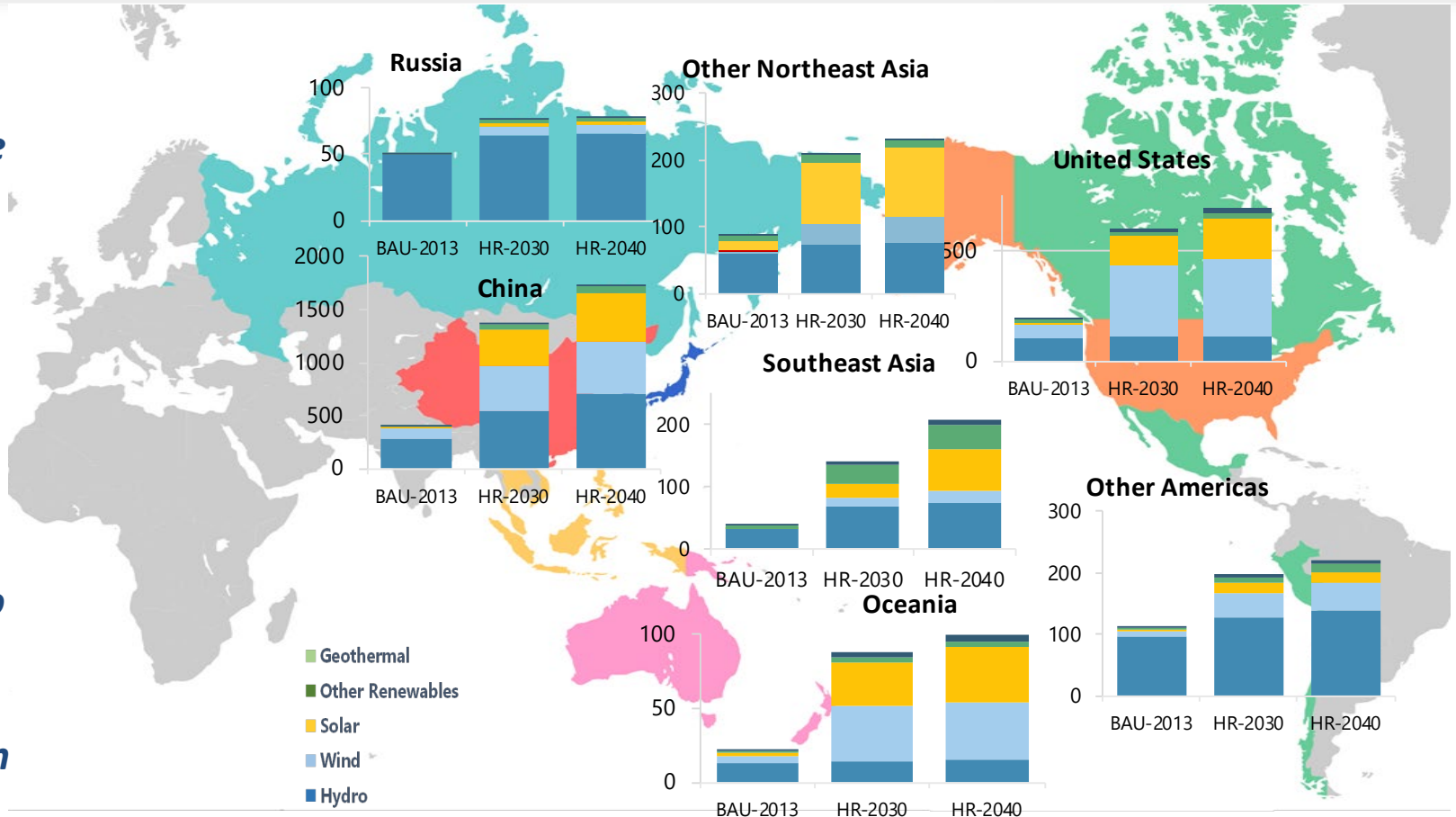
Preliminary Results

Source: APERC Analysis

Renewables Vary from Region to Region

Much of the increases in renewable capacity will come from solar and wind.

Other sub-regions also see significant contribution of hydro.



2013 BAU: 903 GW

2030 High Renewables (HR): 2,684 GW

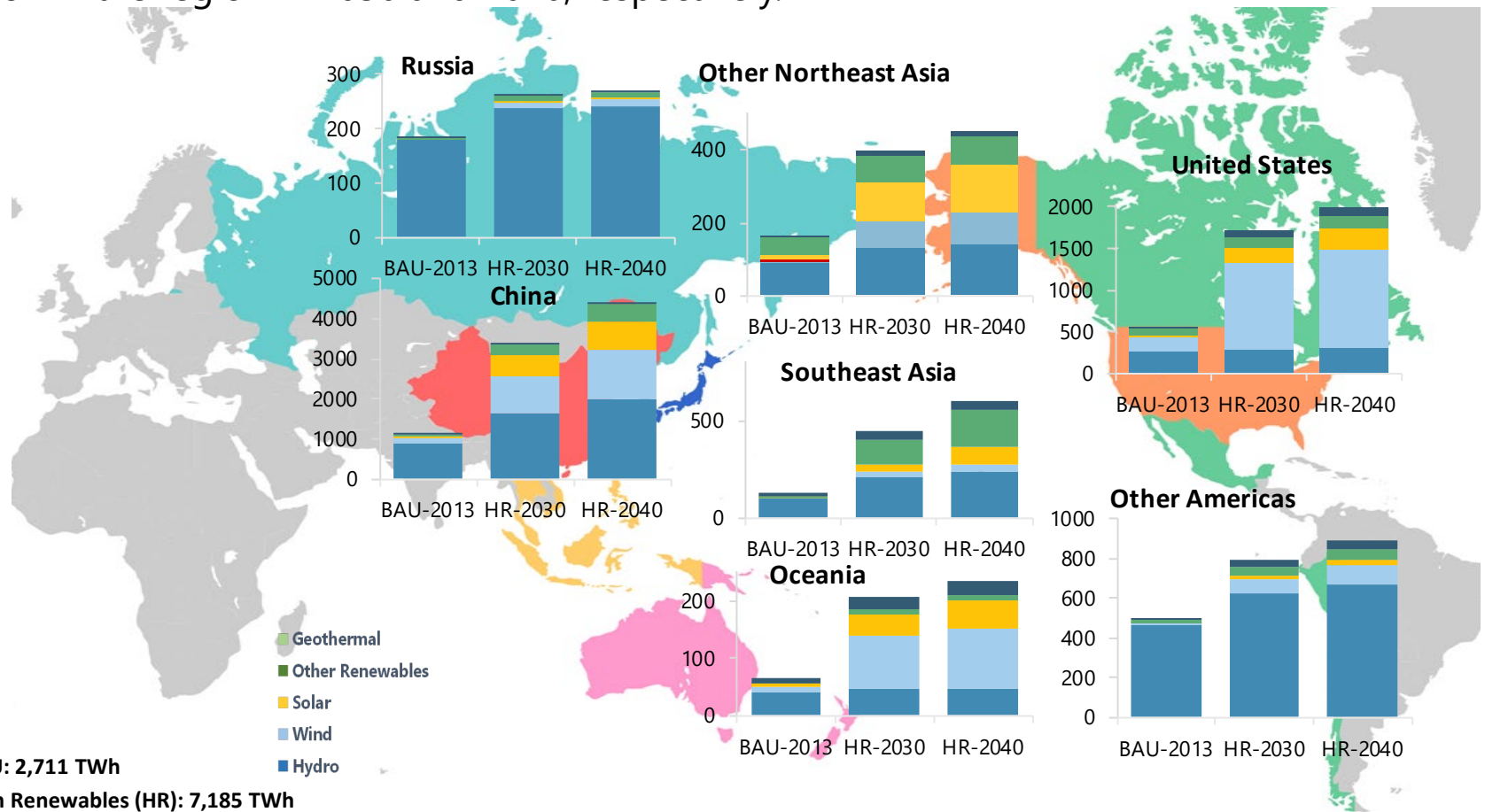
2040 High Renewables (HR): 3,257 GW

Preliminary Results

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China and US Lead Renewable Power Generation

Together, China and United States will provide about 70% and 71% of the total renewable generation in the region in 2030 and 2040, respectively.



2013 BAU: 2,711 TWh
 2030 High Renewables (HR): 7,185 TWh
 2040 High Renewables (HR): 8,812 TWh

Source: APERC Analysis

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Preliminary Results

Variable Renewable Integration

Economy	Share of Renewables in Power Generation in 2030		Share of Renewables in Power Generation in 2040	
	Total Share of Renewables including Hydropower	Share of Wind and Solar Power in Power Generation	Total Share of Renewables including Hydropower	Share of Wind and Solar Power in Power Generation
Australia	50%	40%	53%	43%
Brunei Darussalam	9%	8%	10%	8%
Canada	77%	7%	79%	9%
Chile	50%	5%	48%	6%
China	34%	14%	38%	17%
Hong Kong, China	1%	1%	1%	1%
Indonesia	41%	3%	48%	11%
Japan	25%	9%	28%	11%
Korea	11%	8%	13%	9%
Malaysia	21%	2%	20%	3%
Mexico	23%	8%	23%	9%
New Zealand	96%	22%	96%	24%
Papua New Guinea	57%	5%	54%	5%
Peru	73%	1%	65%	1%
Philippines	29%	7%	24%	5%
Russia	21%	1%	20%	1%
Singapore	3%	0%	3%	1%
Chinese Taipei	12%	6%	13%	7%
Thailand	14%	4%	11%	4%
United States	34%	24%	40%	29%
Viet Nam	31%	4%	23%	3%

<Variable Renewable Energy (VRE) Integration>

- Mostly APEC economies can be categorized as “Low Share”, except for several economies such as Australia and United States.
- According to IEA:
 - “Low Share” - No big technical challenge to operate a power system under categorized “Low Share” (IEA,2015).
 - “Large Share” - The system-wide integration needs to be transforming in order to increase flexibility.

Note:

- “Low Share” means that the share of VRE is 5-10% of annual generation.
- “High Share” means that the share of VRE is 20-45% of annual generation.

Source: APERC Analysis

Preliminary Results

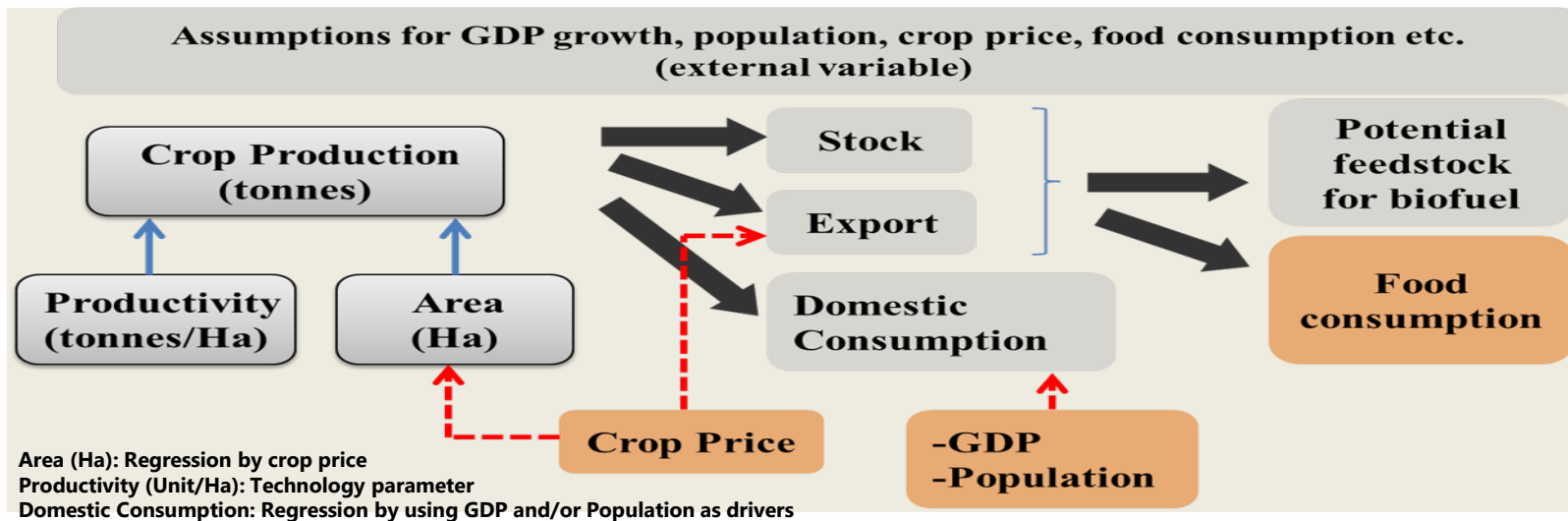


High Renewables in Transport Sector

General Assumption and Methodology

<HIREN Scenario – Transport Sector>

- **Supply Potential**- The projection is based on maximising the unutilized agricultural land and enhancing productivity per cultivated land. Expansion of agricultural land is considered through improvement in cultivation structure by crops (energy crops) and maximising arable land. Those economies with higher productivity levels per cultivated land will serve as benchmarks for increasing productivity of other economies on the assumption that such could be shared and transferred to others.
- **Demand** - The projection of blend rate is based on the minimum blend rate and/or target on biofuels by considering the biofuels supply potential availability.



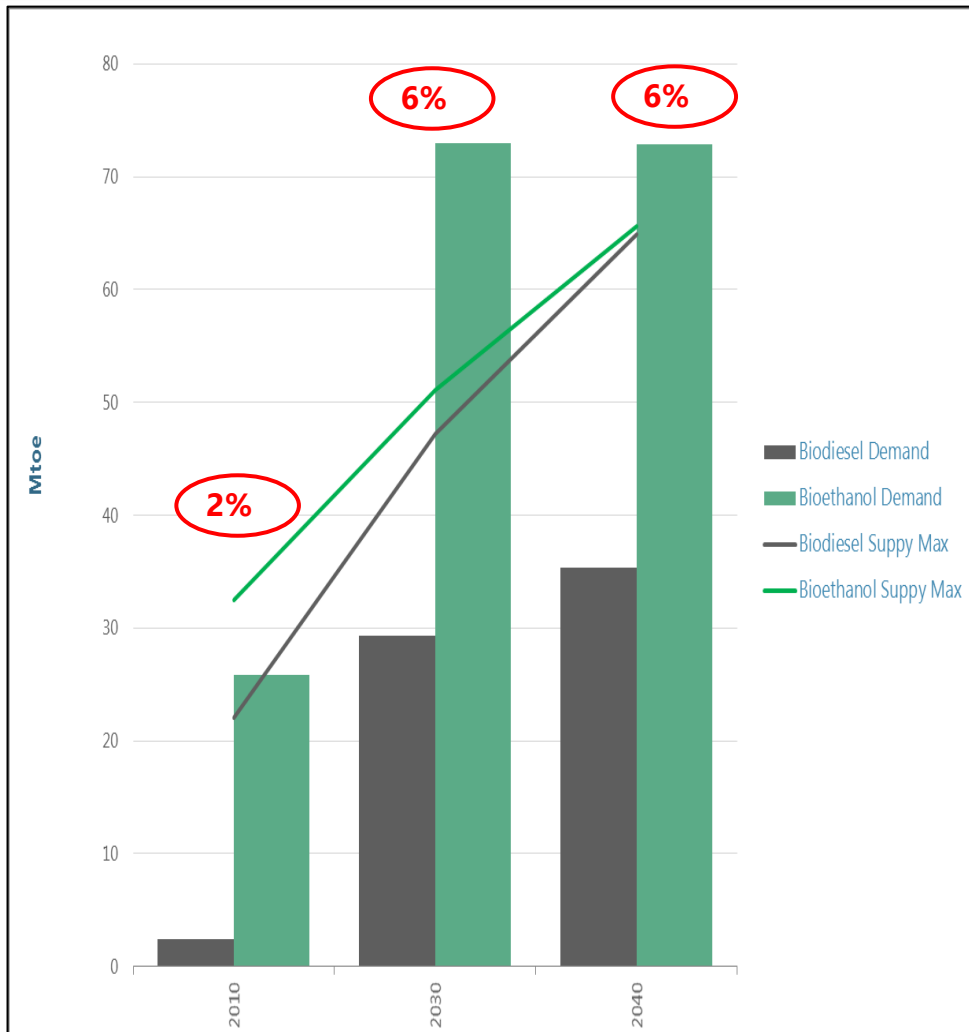
Biofuels Supply Potential

- Only 12 economies with bioethanol blend or with target blend in the future.
- 13 economies with supply potential for bioethanol.
- Only 12 economies with biodiesel blend or with target blend in the future.
- 11 economies with supply for bioediesel.

Economy	With Bioethanol Blend (Mandated/Target)	With Supply Potential (Bioethanol)	With Biodiesel Blend (Mandated/Target)	With Supply Potential (Biodiesel)
Australia (AUS)	√	√	√	Low
Brunei Darussalam (BD)	X	X	X	X
Canada (CDA)	√	Low	√	Low
Chile (CHL)	X	X	X	X
China (PRC)	√	Low	√	X
Chinese Taipei (CT)	√	X	√	X
Hong Kong, China (HKC)	X	X	√	X
Indonesia (INA)	√	Low	√	√
Japan (JPN)	√	Low	X	X
Korea (ROK)	X	Low	√	X
Malaysia (MAS)	X	X	√	√
Mexico (MEX)	√	Low	X	√
New Zealand (NZ)	X	X	X	√
Papua New Guinea (PNG)	X	Low	X	√
Peru (PE)	√	X	√	X
Philippines (RP)	√	Low	√	√
Russia (RUS)	X	√	X	Low
Singapore (SIN)	X	X	X	X
Thailand (THA)	√	√	√	Low
United States (US)	√	√	√	Low
Viet Nam (VN)	√	√	X	X

Source: APERC Analysis

Lack of Bioethanol Supply Potential



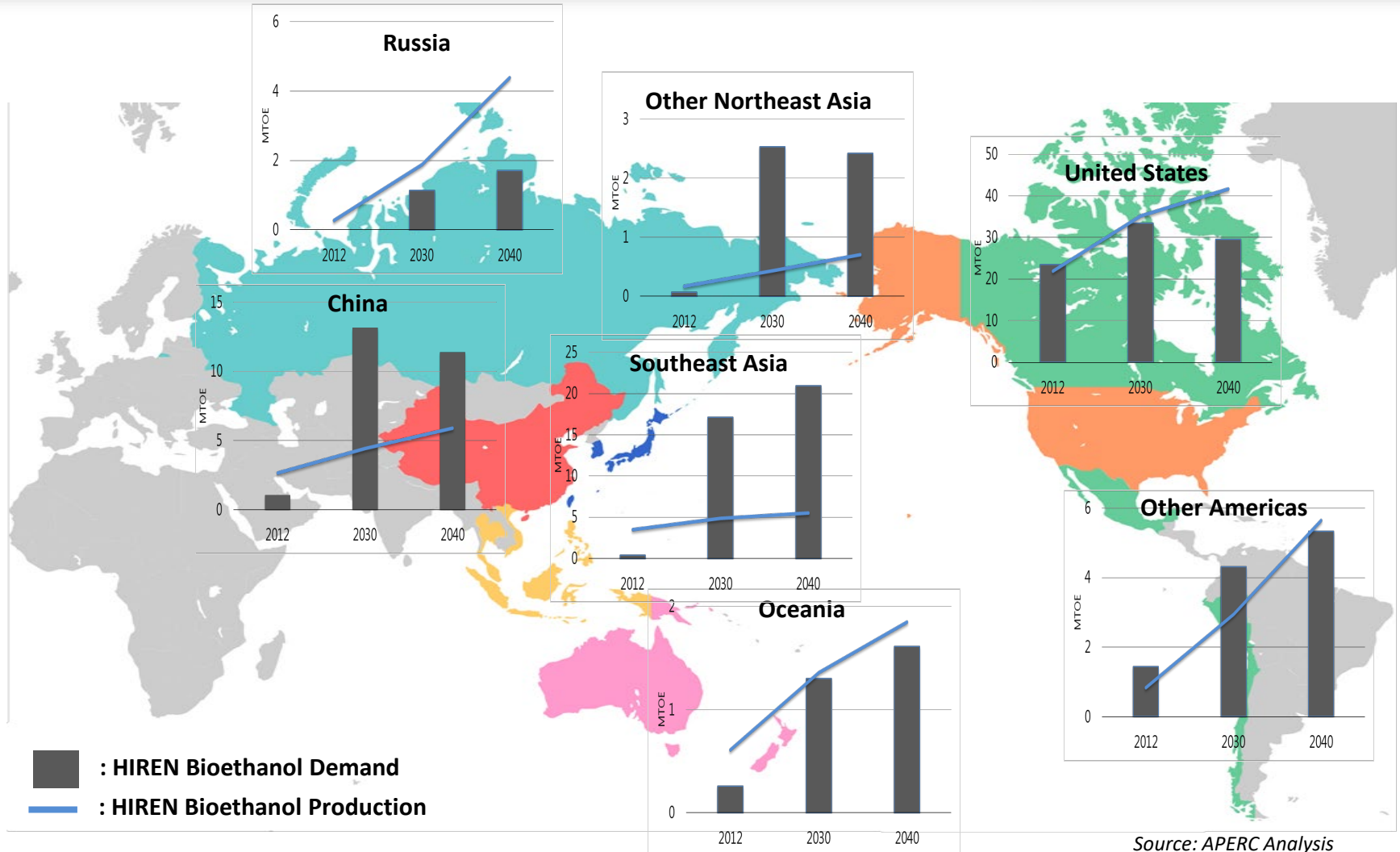
Source: APERC Analysis

Preliminary Results

<Renewable in Transport>

- Almost all economies will have possibilities of increasing biofuels use in the transport sector by maximizing unutilized agricultural lands and enhancing productivity per cultivated area without necessary affecting food production and supply.
- Bioethanol supply potential even in the High Supply Case will not meet higher demand in 2020 and onwards with only 1st generation biofuels is considered in the model.

US Leads APEC Bioethanol Production

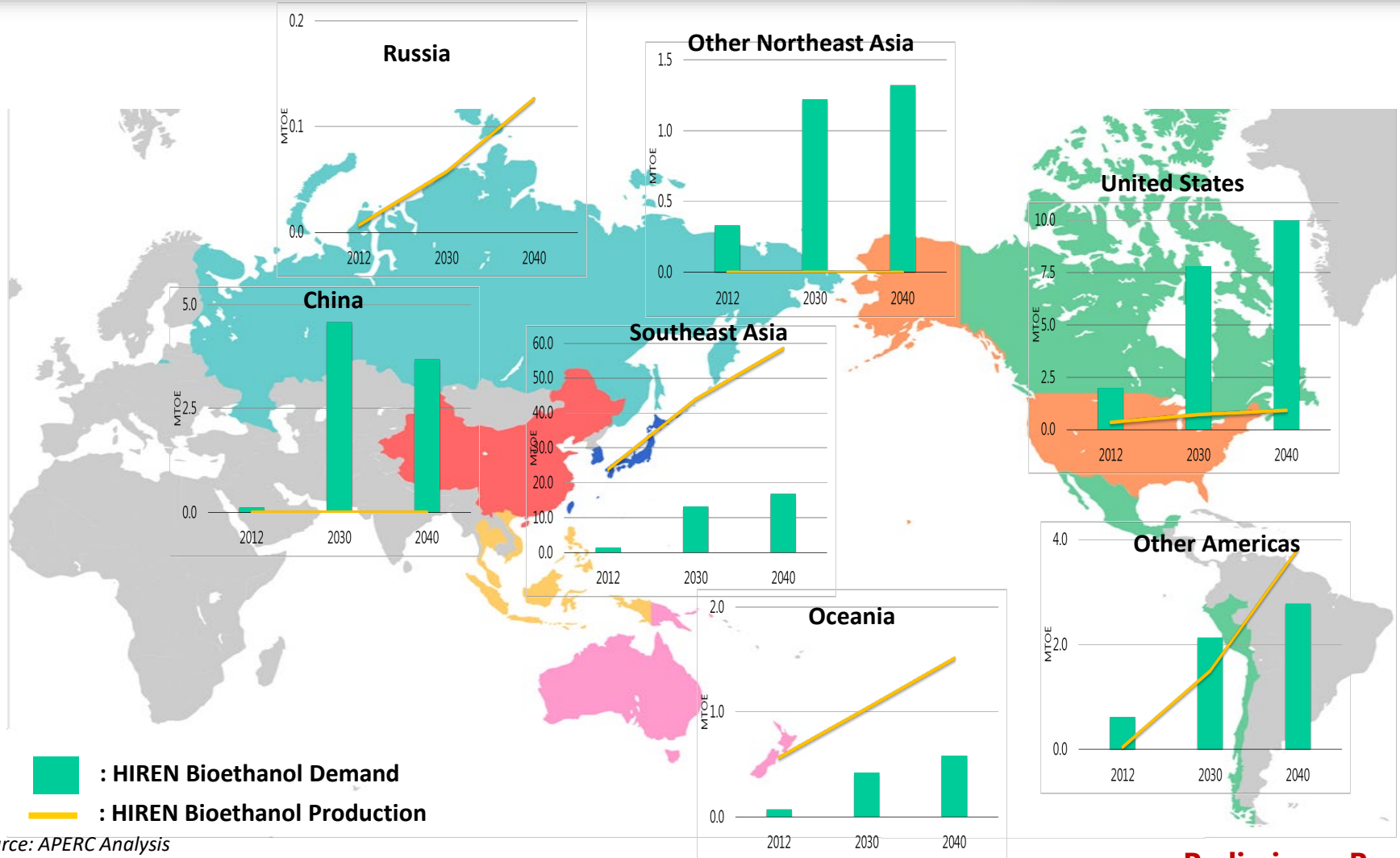


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Source: APERC Analysis

Preliminary Results

Southeast Asia Dominates Biodiesel Production



Source: APERC Analysis

Note: This map is for illustrative purposes and is without prejudice to the status of or sovereignty over any territory covered by this map.

Preliminary Results

Biofuels Trade Needed in Short- and Medium Term

<Biofuels Trade>

- There is a mismatch between biofuels demand and production in the APEC Region.
- Biofuels trade among APEC member for short- and medium-term period is one of solutions.
- Developing and deploying advanced biofuels technologies in the long-term period.

Economy	Biofuels Supply Potential in 2030		Biofuels Supply Potential in 2040	
	Remaining Bioethanol Supply (Ktoe)	Remaining Biodiesel Supply (Ktoe)	Remaining Bioethanol Supply (Ktoe)	Remaining Biodiesel Supply (Ktoe)
Australia	80	-157	262	-246
Brunei Darussalam	0	0	0	0
Canada	-324	-517	68	-541
Chile	0	0	0	0
China	-8730	-4580	-5489	-3679
Hong Kong, China	0	-38	0	-41
Indonesia	-11629	12558	-14048	19939
Japan	-2087	0	-1728	0
Korea	52	-1105	65	-1208
Malaysia	0	18944	0	22898
Mexico	-582	769	878	2645
New Zealand	-29	146	-37	126
Papua New Guinea	7	621	13	1044
Peru	-465	-882	-632	-1052
Philippines	-1317	-706	-2013	-1050
Russia	740	57	2694	126
Singapore	0	0	0	0
Chinese Taipei	-63	-80	-51	-75
Thailand	259	-80	321	-94
United States	1814	-7092	12128	-9268
Viet Nam	391	0	324	0

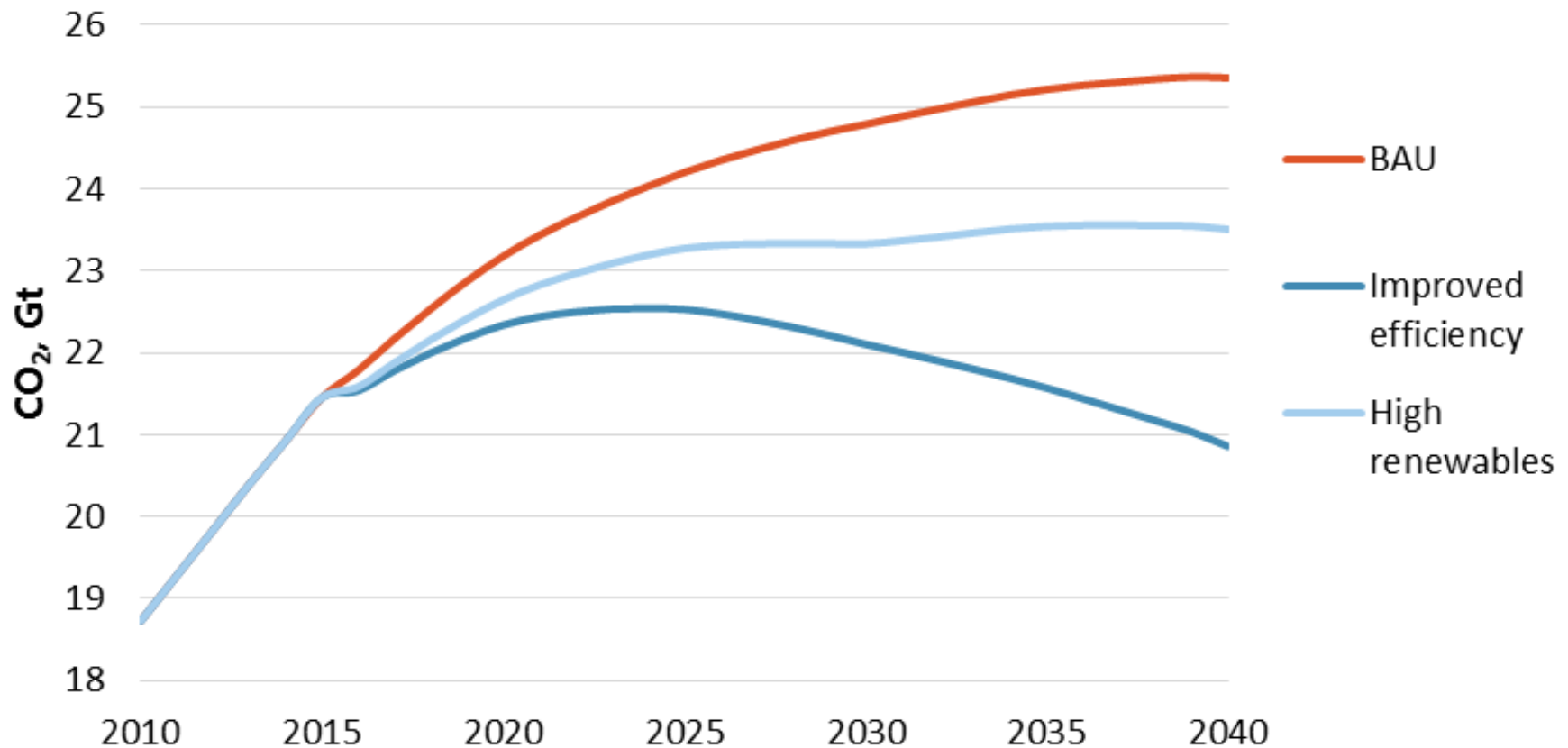
Note:

Remaining biofuels supply refers to the available biofuels supply volume after the domestic biofuels demand has been met.

Source: APERC Analysis

Preliminary Results

Total CO₂ Emissions in APERC Scenarios



Preliminary Results

Opportunities for Policy Action

<Renewable Power Generation>

- Continue to improve business environment for renewables development as “doing business” in some APEC economies are still cumbersome.
- Strengthen and improve the economy’s electricity system to facilitate greater VRE integration.

<Renewable Transport>

- For enhancing biofuels trade among APEC member economies:
 - Implement the guidelines for the development of biodiesel standard in the APEC region which was established in 2007 by EGNRET.
 - Establish similar standard for bioethanol.
 - Establish biofuels blend rate standard for vehicles which can meet the standard of auto-manufactures.
- Introduce the development and deployment of advanced biofuels to promote greater utilisation of biofuels.



Next Step

- ❑ **Finalize and publish the APEC Energy Demand and Supply Outlook (6th Edition) next year.**
- ❑ **The annual updating of the APEC Energy Overview (now 2015 update) will include discussion on RE share to total final energy demand and power generation to monitor overall APEC RE share.**

Thank you for your kind attention.

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