EGEDA 26, Bandar Seri Begawan, Brunei Darussalam
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APERC Research Activities

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Asia-Pacific
Economic Cooperation

Current APERC Projects

- APEC Energy Supply & Demand Outlook
- Independent Research Reports
  - Shale Gas Development
  - Geothermal Electricity Development
  - Grid Interconnection in Northeast Asia

APEC Energy Demand & Supply Outlook

- APERC has begun work on the 6th edition of *the Outlook* to be published in 2015
- A 28 year look ahead (2012-2040) assuming business-as-usual and several alternative cases
- Published in two volumes:
  - Volume 1: Sector/issue discussions
  - Volume 2: Individual economy discussions

Outlook Model Structure

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 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

Schedule for Outlook 6th Edition

- December 2014 – January 2015: Models results for BAU & alternative cases finalized
- February-April 215: Writing & editing process

- May 2015: External reviews begin
- October 2015: Outlook 6th Edition published

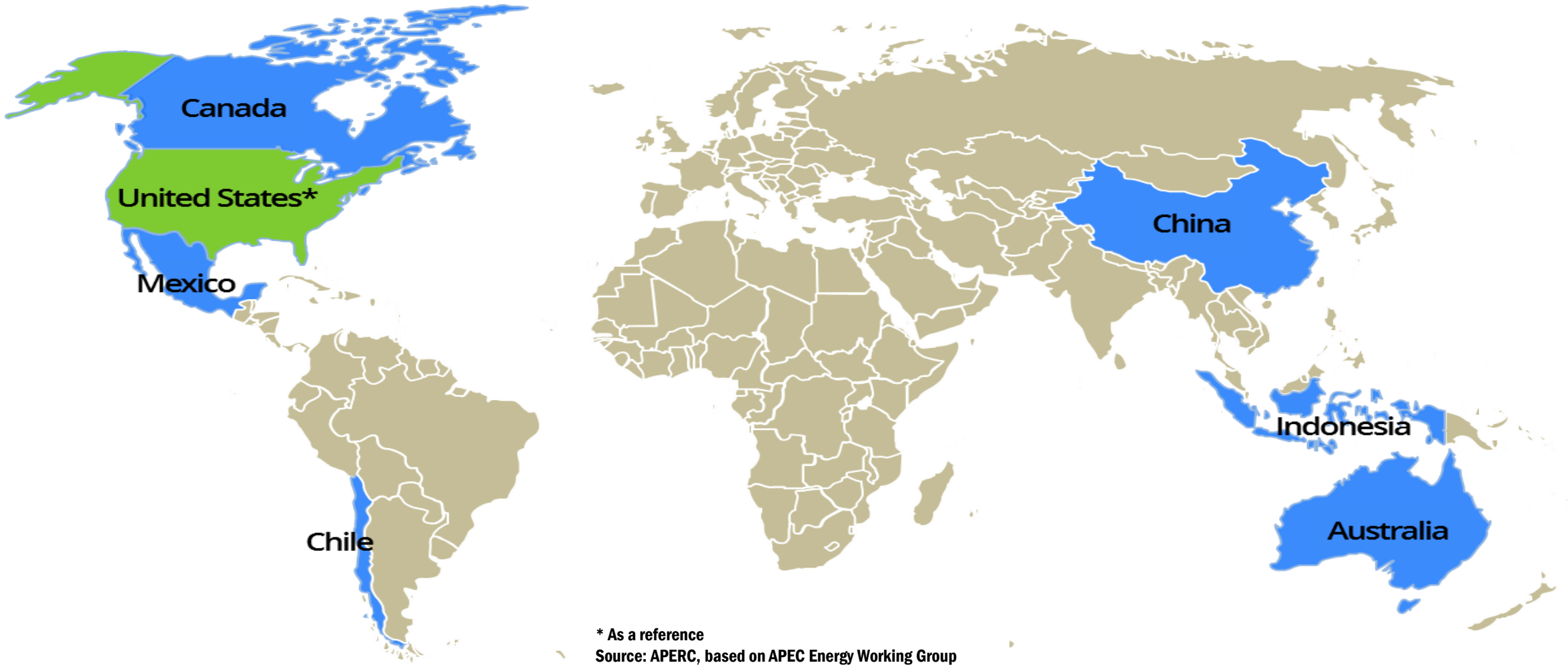
Pathways to shale gas development in APEC:

Progress and next steps

Roberto Lozano
Project Leader

APERC
Asia Pacific Energy Research Centre

Six APEC economies considered with potential to develop shale gas



* As a reference
Source: APERC, based on APEC Energy Working Group (2013) and EIA (2013).

Key factors to shale gas development (RIG)

Category	Label	Policy implication
Access to natural Resources	N1	Access to and quality of shale resources
	N2	Access to water
Infrastructure and technology	I1	Public access to geological information
	I2	Industry expertise adaptable to shale gas development
	I3	Developed markets and gas-to-market infrastructure
	I4	Oil and gas field services and auxiliary infrastructure
Governance	G1	Political support to shale gas development
	G2	Competitive market structure with access to capital markets
	G3	Unregulated natural gas prices
	G4	Open access to gas transmission infrastructure
	G5	Regulatory capacity, transparency and adaptability
	G6	Social license

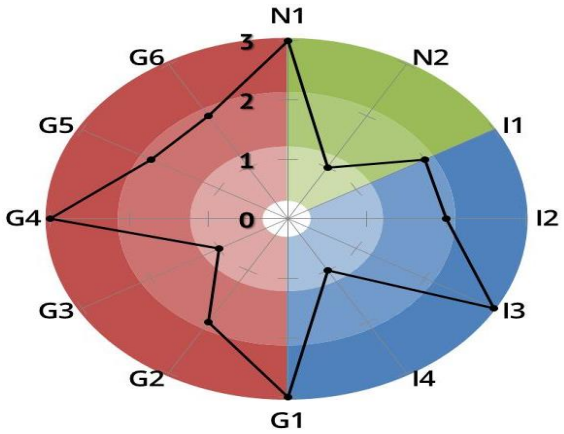
Determines the potential for shale gas development

Drives the economic productivity of shale gas resources

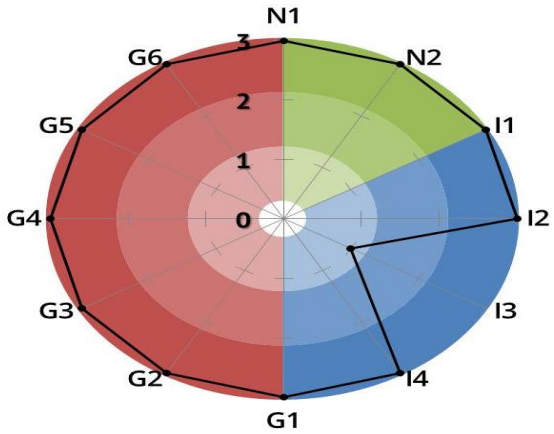
Achieves low and predictable transaction costs to align the interests of the different stakeholders involved

Source : APERC (2014)

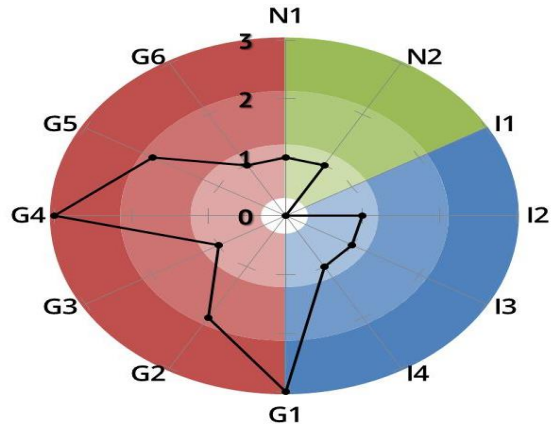
Findings by economy



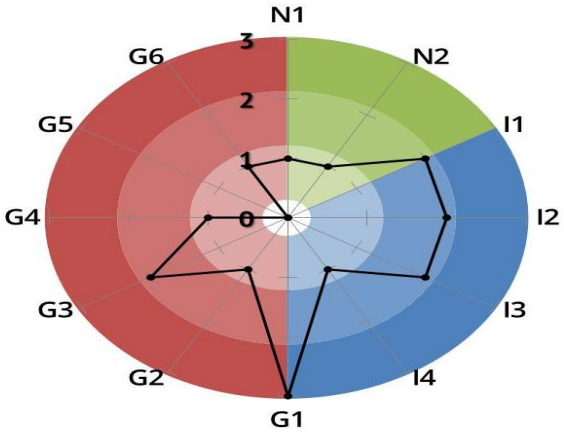
Australia



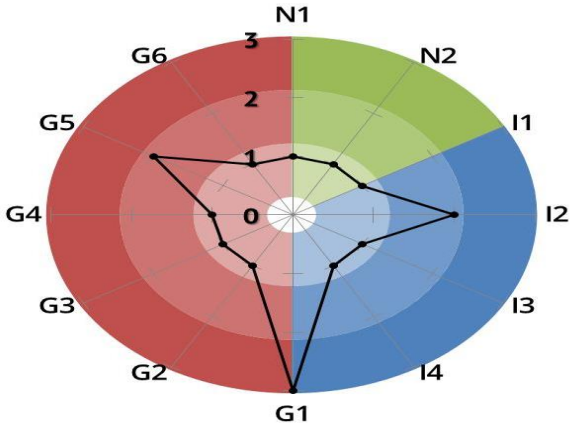
Canada



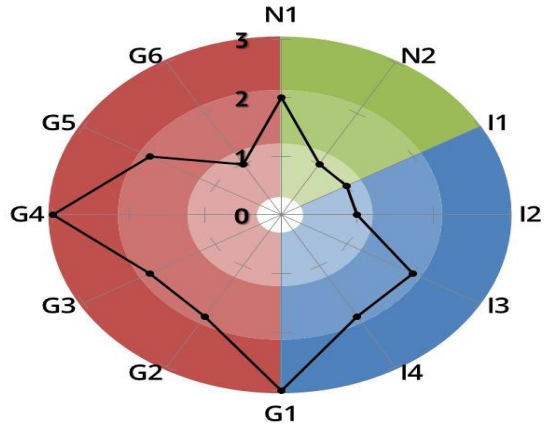
Chile



China



Indonesia



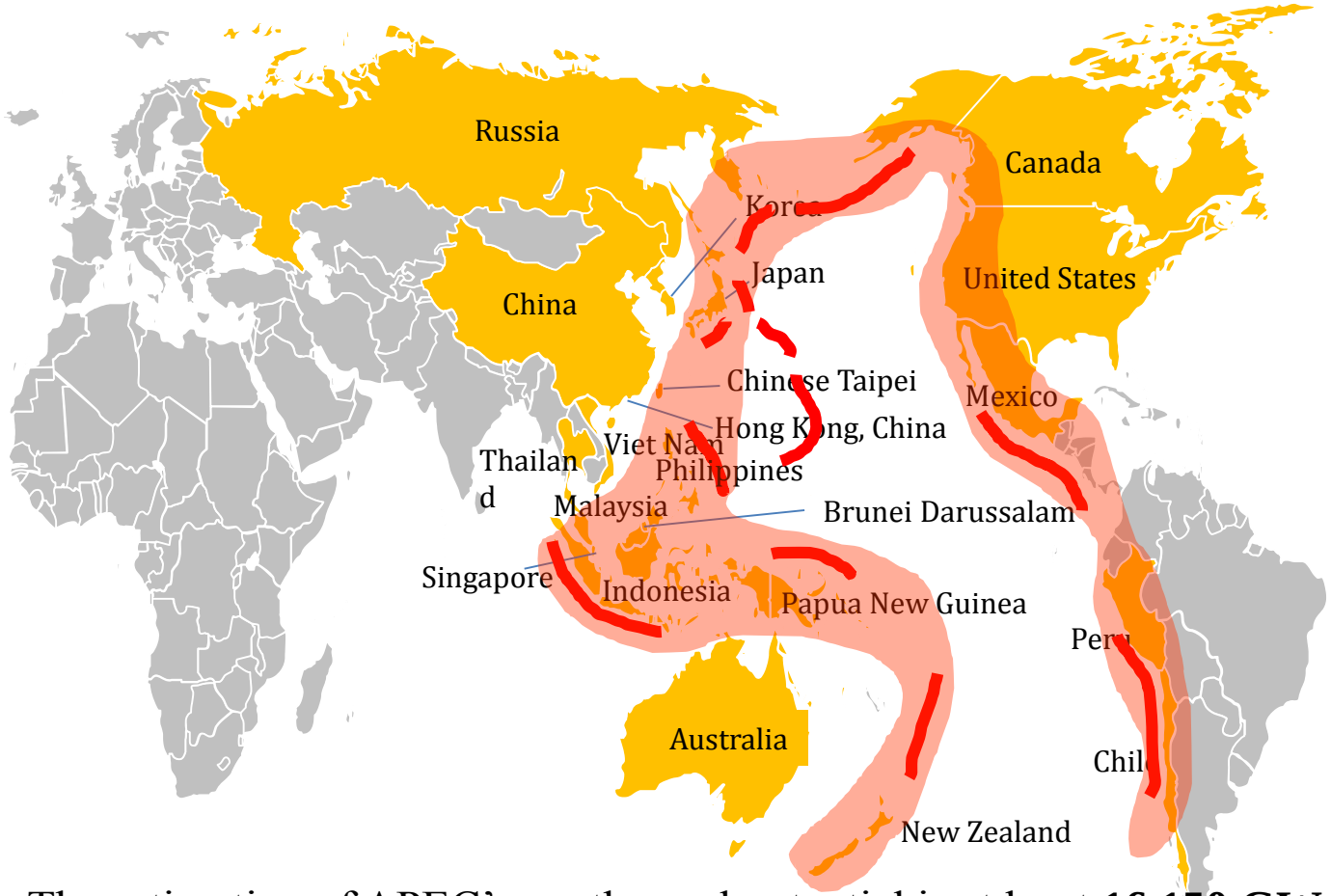
Mexico

Policy Success Factors for Geothermal Electricity Development in the APEC Region

Chrisnawan Anditya, Project Leader

Asia-Pacific
Economic Cooperation

Why Geothermal ?



The estimation of APEC's geothermal potential is at least **16,150 GW.**

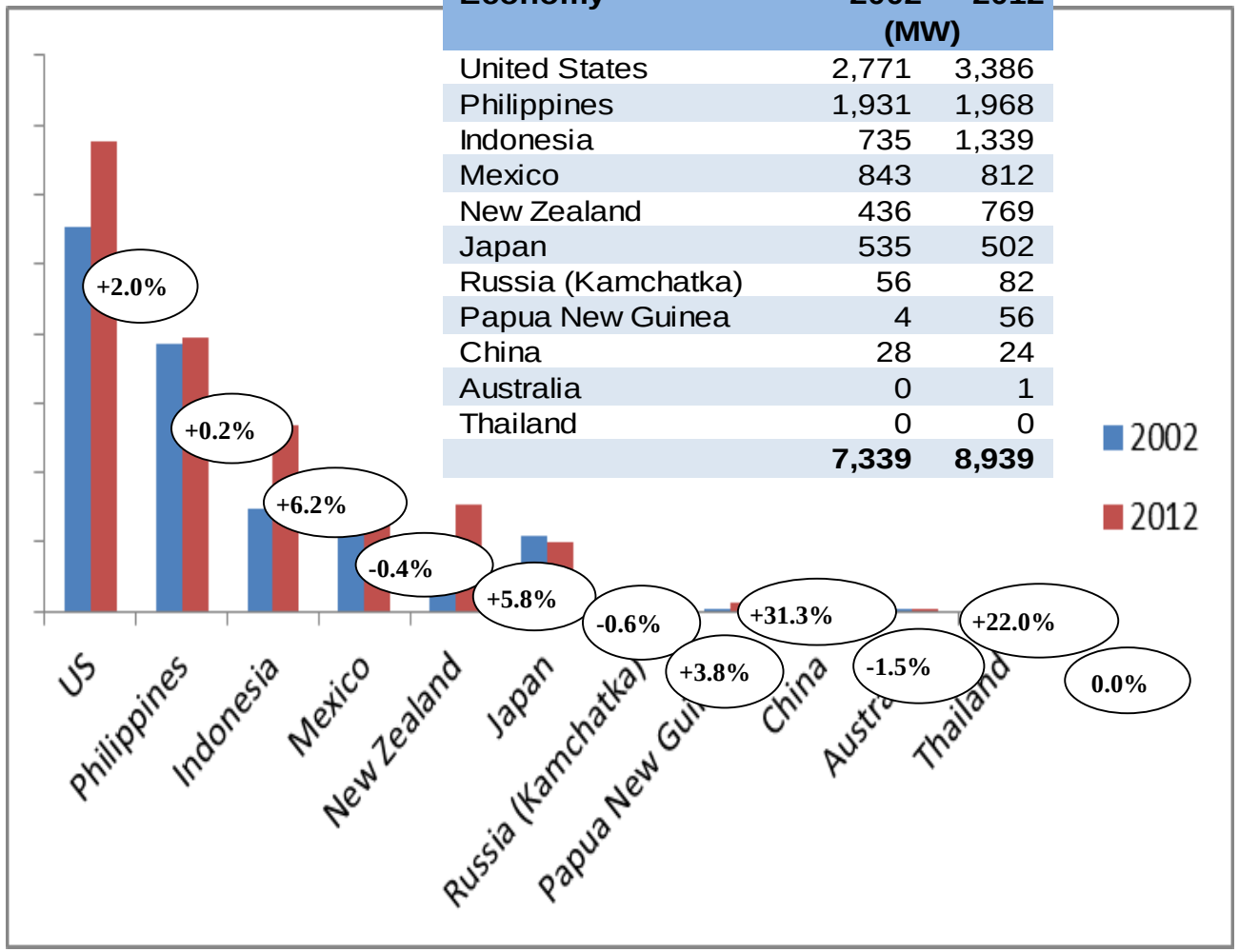
Source: APERC

- APEC region aligns almost perfectly with the 'Pacific Ring of Fire'
- APEC economies represent 78% of world's installed capacity

- Small land footprint
- Near-zero emissions
- Reliable power source

APEC's Installed Capacity Small Compared to Potential

Economy	2002 (MW)	2012
United States	2,771	3,386
Philippines	1,931	1,968
Indonesia	735	1,339
Mexico	843	812
New Zealand	436	769
Japan	535	502
Russia (Kamchatka)	56	82
Papua New Guinea	4	56
China	28	24
Australia	0	1
Thailand	0	0
	7,339	**8,939**



- Only 11 of 21 APEC economies have developed geothermal electricity
- Total installed capacity only 55% of potential
- Exploratory drilling very expensive
- Often located in remote areas
- Environmental impact needs mitigation
- Can conflict with other land uses
- Permitting process can be onerous

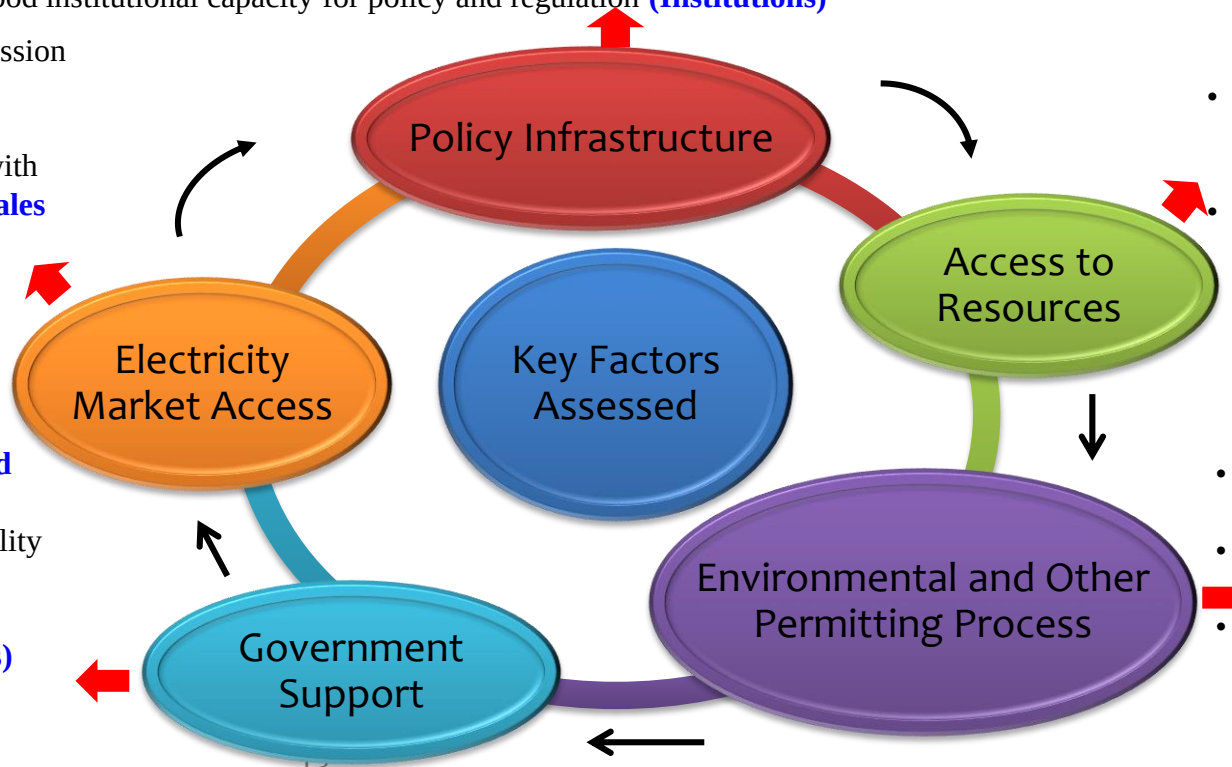
Source: BP Statistical Review of World Energy (June 2013)

What a Geothermal Developer Needs?

(Policies for Successful Geothermal Electricity Development)

- Clear and certain legislation and/or regulation **(Legal basis)**
- Well-defined strategy for promoting geothermal **(The government strategy)**
- Keeping previous commitments to investors **(The government commitment to investor)**
- Good institutional capacity for policy and regulation **(Institutions)**

- Streamlined procedures to access transmission networks without discrimination **(Transmission network)**
- Long-term contract for electricity price with reasonable price structures **(Electricity sales contracting)**



- Open and competitive basis for all players with reasonably simple procedure **(Access to geothermal resources)**
- Appropriately secure access to resources that developers have invested in **(Secure and exclusive rights to resources)**

- Good quality public database **(Database)**
- Adequate funding for R&D **(Research and development)**
- Sufficient of professional personnel in quality & quantity **(Human resources and development)**
- Financial incentives **(Financial incentives)**

- Reasonable time limits for permitting **(Permitting time limits)**
- Coordinate all aspects of permitting in one office **("One-stop shopping")**
- Good coordination among governmental agencies at all levels **(Inter-agency cooperation)**

Policy Success Factors for Geothermal Electricity Development in the APEC Region

Factor	The Expectation of Developers	Score-Card				
		1	2	3	4	5
1. Policy Infrastructure						
• Legal basis	Legislation and/or regulations governing the development of geothermal electricity must be established in clarity and certainty and these regulation should be harmonized with other related regulation.					
• Strategy	Strategy for promoting the development of geothermal electricity must be well-defined including strategy to decrease high risk in geothermal development in the early stage.					
• The government commitment to investor	Keeping previous commitments to existing geothermal developers are important.					
• Institutions	A specific institution/agency/organization with lead responsibility for geothermal policy and regulation must be established.					
2. Resources Access						
• Access to geothermal resources	At the pre-investment stage, access to geothermal resources must be open to all developers on an open and competitive basis with reasonably simple procedures.					
• Secure and exclusive rights to resources	Appropriately secure and exclusive rights to resources must be given to developers in which they have invested.					

Factor	The Expectation of Developers	Score-Card				
		1	2	3	4	5
3. Environmental and other development permitting						
• Permitting time limits	National geothermal guideline for permitting need to be provided with reasonable time limits within which permitting decisions must be reached.					
• "One-Stop Shopping"	Establishing one agency to coordinate all aspects of the geothermal permitting process as well as for monitoring the licenses should be estbalished.					
• Inter-agency cooperation	Good coordination between governmental agencies and at all levels of government to avoid duplication of responsibilities and policy conflicts must be conducted.					

Note for scorecard:

- *Getting 4-5 bars (blue colour) are considered to meet expectation of developers.*
- *Getting 0-3 bars (red colour) are considered improvement is needed.*

Policy Success Factors for Geothermal Electricity Development in the APEC Region

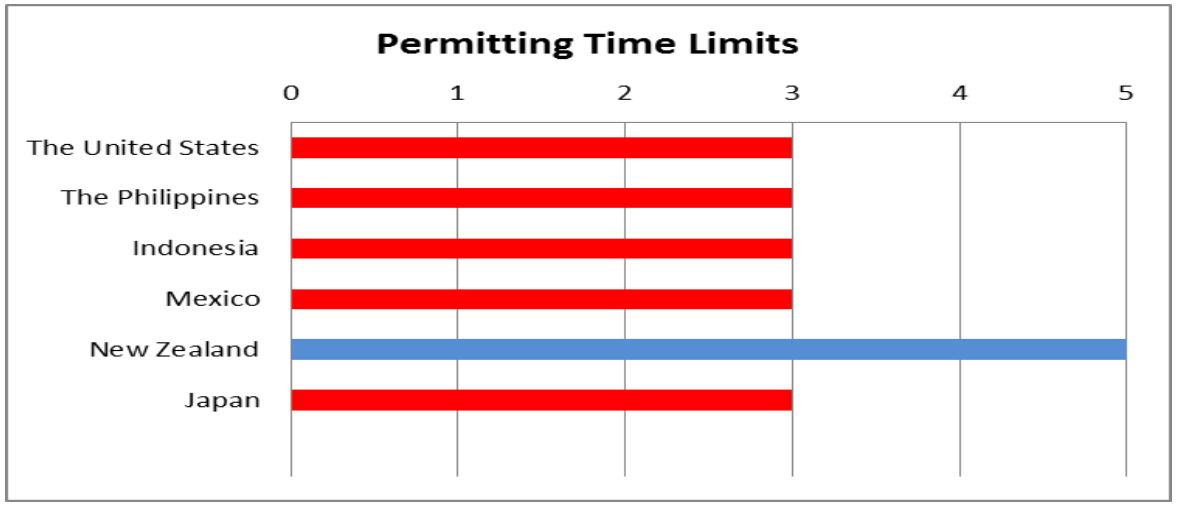
Factor	The Expectation of Developers	Score-Card				
		1	2	3	4	5
4. Government Support for Geothermal Industry						
• Database	Good quality of database regarding the geothermal resource potential must be established by the Government and this database must be easily accessed by the public					
• Research and development	Adequate funding for geothermal research and development on a continuing basis must be provided					
• Human resources and development	Professional training programs related to geothermal at the economy's universities and other institutions must be established in sufficient in quality and quantity to meet the developers need for trained geothermal personnel.					
• Financial incentives	Financial incentives for geothermal development reflective of its environmental benefits must be provided.					

Factor	The Expectation of Developers	Score-Card				
		1	2	3	4	5
5. Electricity Market Access						
• Transmission network	Standardized and reasonably simple procedures for geothermal developers to get access to the transmission system must be established.					
• Electricity sales contracting	Developers are able to enter into long-term contracts for sales of geothermal electricity at a reasonable price.					

Note for scorecard:

- *Getting 4-5 bars (blue colour) are considered to meet expectation of developers.*
- *Getting 0-3 bars (red colour) are considered improvement is needed.*

Environmental & Other Development Permitting (1)



- It is hard to predict the completion time for permits in all assessed economies, except for New Zealand, as the developers must obtain permits from various government agencies, both central and local.
- In New Zealand the permitting process to obtain ‘Resource Consent’ is closed with ‘One-Stop shopping’ which provides reasonable time limits within which a permitting decision must be made.

- Only New Zealand has ‘One-Stop shopping’, for permits out of the assessed economies. However, the United States is currently determining whether to establish a ‘Geothermal Coordinating Permit Office’.

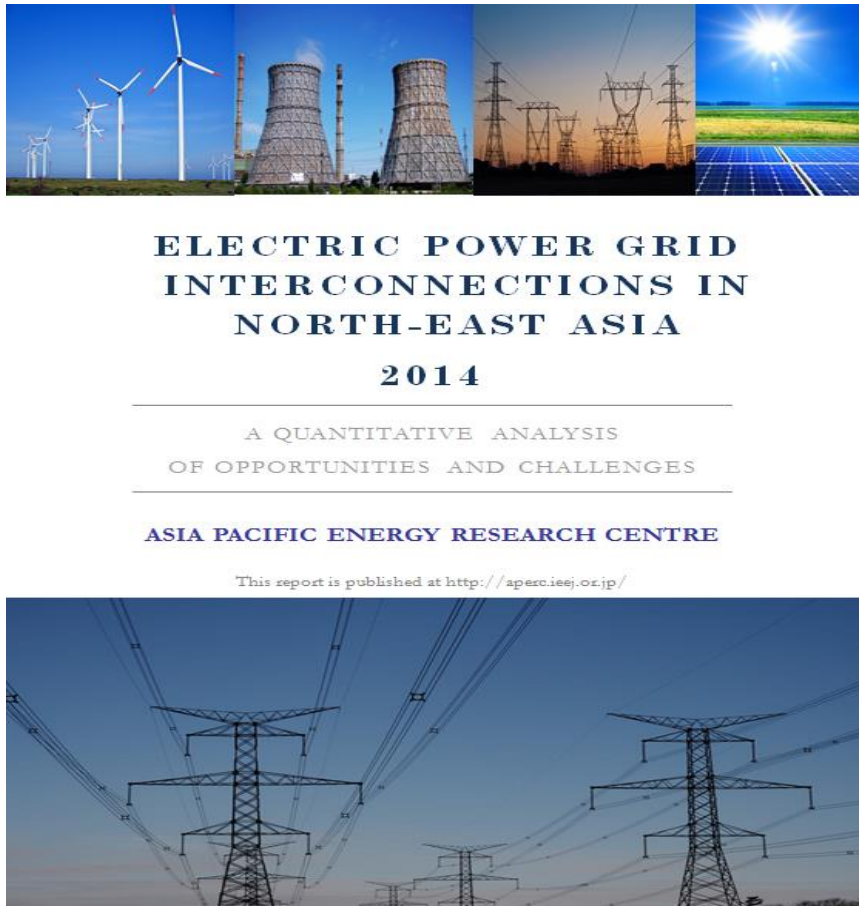
Success Factors in 5 APEC Economies (1)

US	The Philippines	Indonesia	Mexico	New Zealand	Japan
• Legal basis • The government strategy • The government commitment to investor • Institutions • Secure and exclusive rights to resources • Inter-agency cooperation • Database • Research and development	• Legal basis • The government strategy • Institutions • Secure and exclusive rights to resources • Database • Research and development	• Legal basis • The government strategy • Institutions • Secure and exclusive rights to resources	• Legal basis • Institutions • Research and development	• Legal basis • The government commitment to investor • Institutions • Permitting time limits • One-Stop Shopping • Inter-agency cooperation • Database • Research and development	• Legal basis • The government strategy • Inter-agency cooperation • Database • Research and development

Success Factors in 5 APEC Economies (2)

US	The Philippines	Indonesia	Mexico	New Zealand	Japan
• Human resources and development • Financial incentives • Transmission network • Electricity sales contracting	• Human resources and development • Financial incentives • Transmission network • Electricity sales contracting	• Financial incentives • Transmission network	• Human resources and development	• Human resources and development • Transmission network • Electricity sales contracting	• Financial incentives • Transmission network • Electricity sales contracting

Electric power grid interconnections in Northeast Asia: quantitative analysis of opportunities and challenges

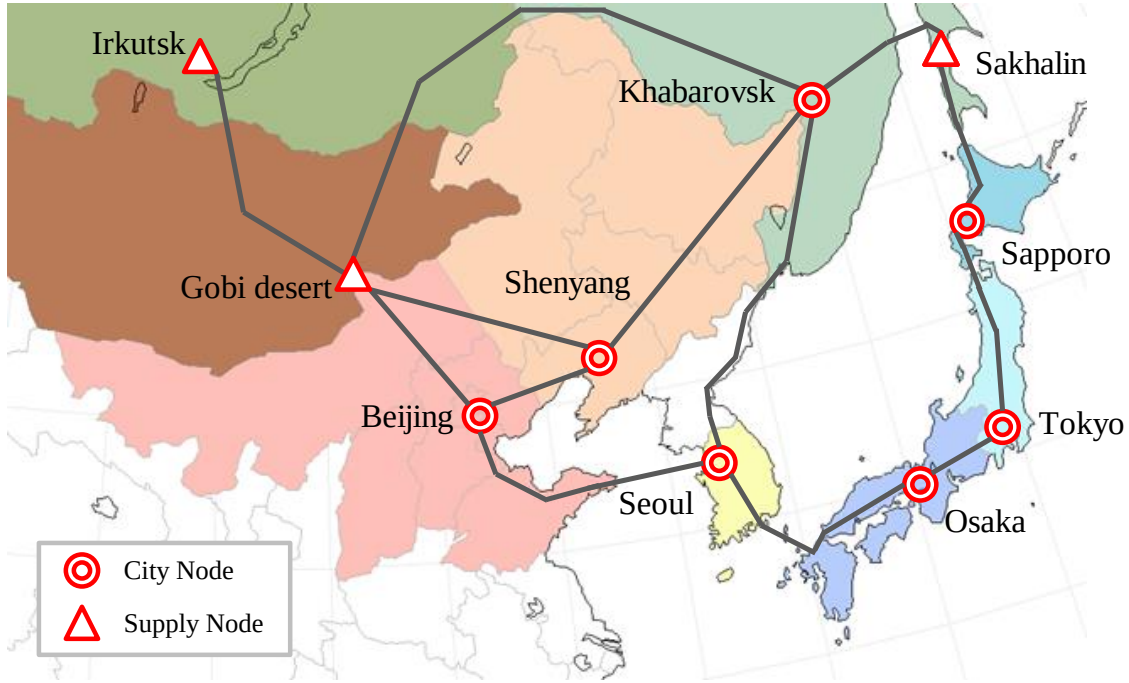


- APEC Northeast Asia Economies: China, Russia, Japan and Korea
- Quantitative model & policy analysis

- Takashi Otsuki, Lead Modeler
- Dmitry Sokolov, Team Member

Grid Interconnection Model

- Linear Programming Model
  - ✓Total system cost
  - ✓Power generation Mix
  - ✓Power flow in NEA region
  - ✓CO_2 emissions
- Single year, representative hourly load curve for five seasons (Summer-Peak, Summer-Average, Winter-Peak, Winter-Average, Intermediate)
- 4 APEC Economies, 2 transit economies, 10 nodes
- 7 Power Generation Technologies (Coal, Gas, Oil, Nuclear, Hydro, PV, Wind)



Simulation of NEA Grids in 2030: 4 scenarios

1. BAU scenario: No new grid interconnection.

2. OPT scenario: Grid interconnection allowed (Cost optimized).

3. ASG scenario: Proposed Gobitec/ASG transmission capacity + Cost optimized, 50 GW PV and 50 GW wind in Gobi region

4. RES scenario: ASG scenario condition + additional hydro potential in Russia.

<Upper bound constraint for power imports>

- In general, power importing economies need to be prepared for a sudden power supply interruption.
- In this study, net imports from other economies is limited to less than operating reserve level of the importing region.
- Simulations under different conditions (e.g. no upper bounds case) need to be investigated as a part of future work.

$$nimp_{r,s,t} \leq ORM_r \cdot ELD_{r,s,t}$$

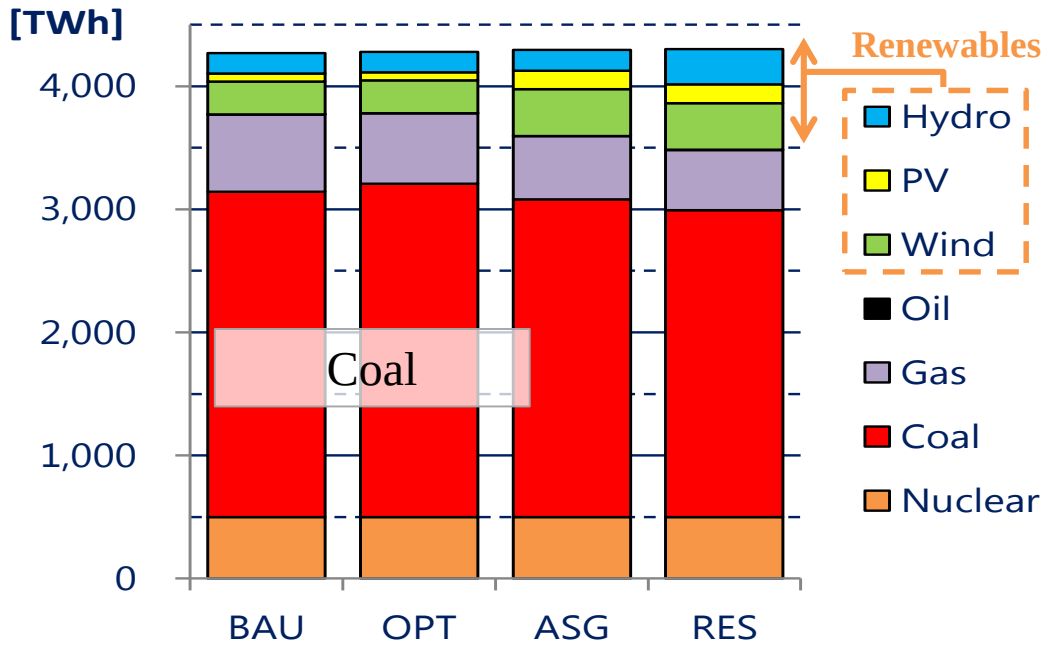
Net imports from other economy [MW]

Electric Load [MW]

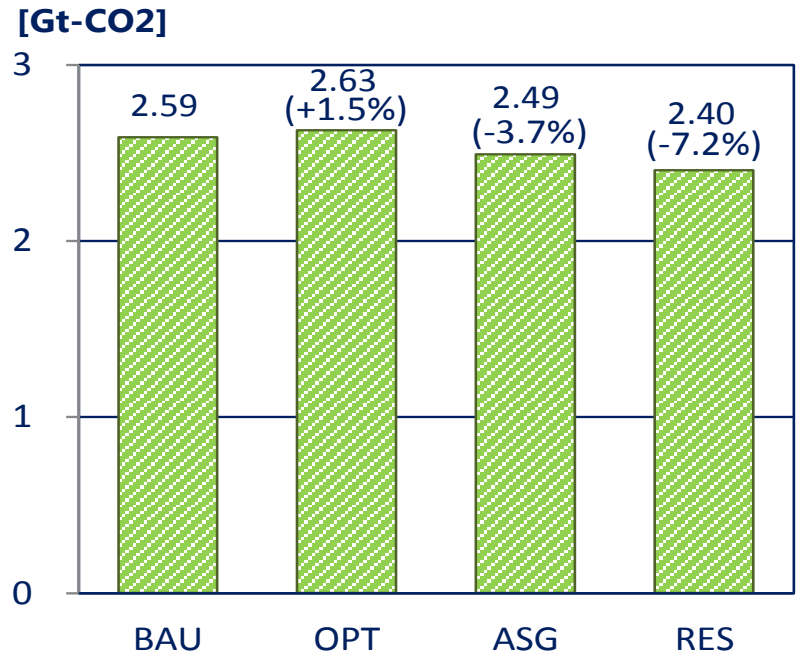
Operating Reserve (6%~10%)

Power Generation Mix and CO2 emissions

Power Generation Mix (2030)



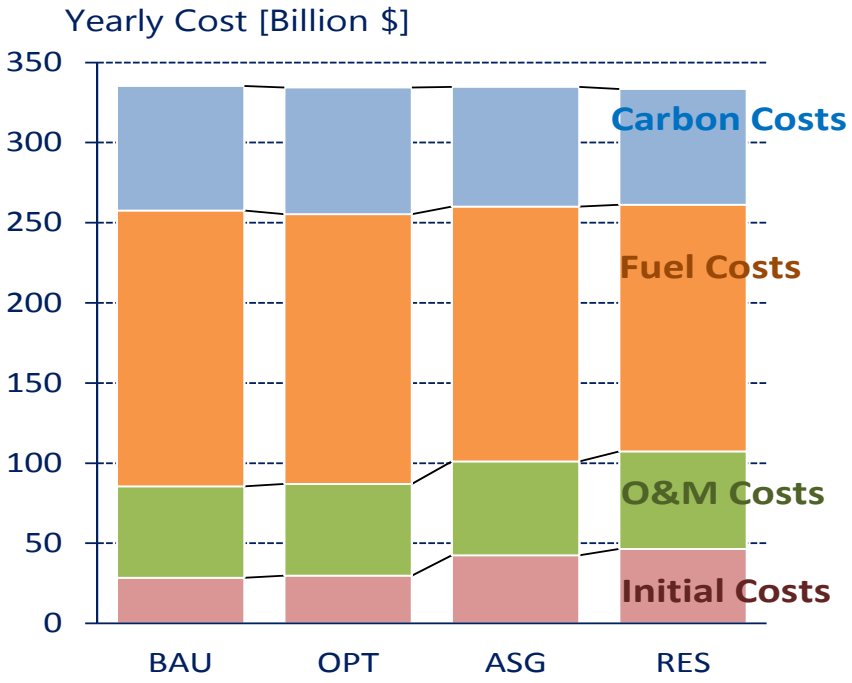
CO_2 emissions (2030)



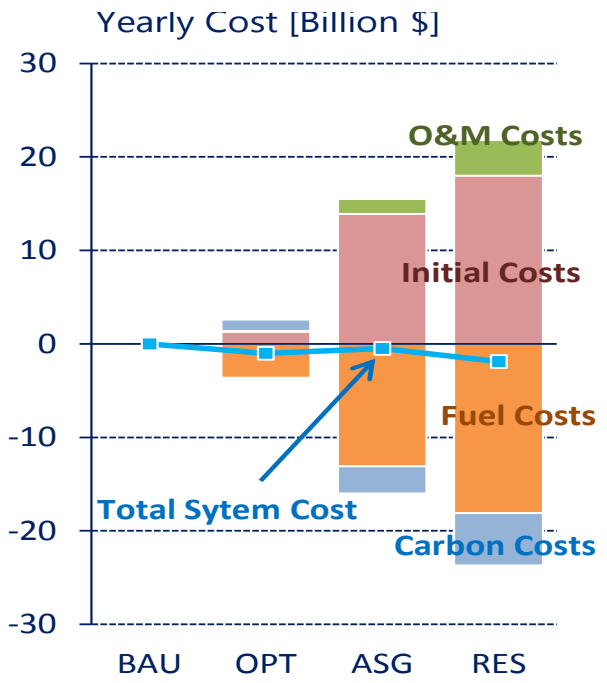
- In OPT, grid interconnections allow Japan/Korea to access cheaper coal electricity from China, and the share of coal-fired increases slightly, resulting in larger CO_2 emissions.
- The share of renewables in BAU is about 12%. In ASG and RES, renewables account for 16% and 19%, respectively, and contribute to CO_2 emissions reduction by 3.7% and 7.2%.

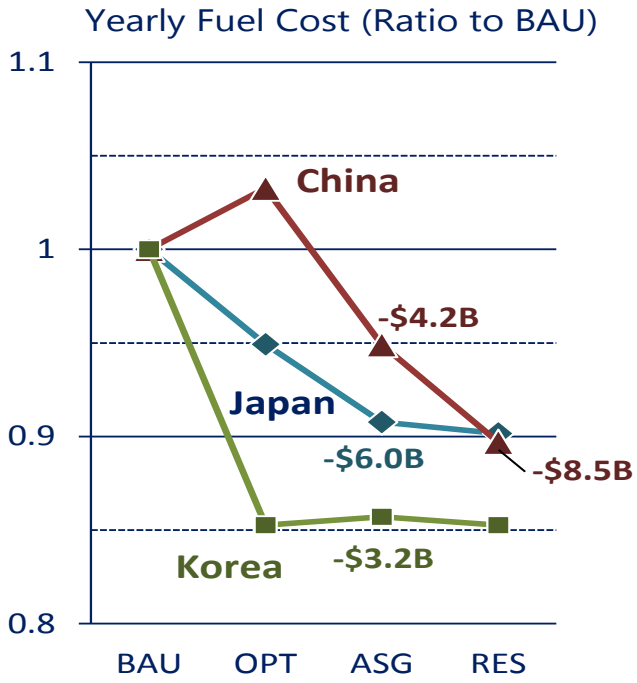
Costs and benefits

Total system cost



Changes from BAU





- Yearly total system costs decline by $1B/y, $0.5B/y and $1.9B/y in OPT, ASG and RES, respectively. Marginal impacts on the total system cost (-0.1% ~ -0.6%).
- In ASG and RES, although deployment of renewables and transmission lines pushes up initial costs and O&M costs, RE resource sharing contributes to fuel cost reduction by about 8% and 11%, respectively.

http://aperc.ieej.or.jp