東京大学政策ビジョン研究センター
Policy Alternatives Research Institute
RAEL | Renewable & Appropriate Energy Laboratory
Professor Daniel Kammen, UC Berkeley
ERIA Economic Research Institute for ASEAN and East Asia

Energy Connectivity: from Myanmar to GMS

Kensuke Yamaguchi*, Noah Kittner**,
Daniel del Barrio*, Hisashi Yoshikawa*, Daniel Kammen**
(*U Tokyo; **UC Berkeley)

Mekong Forum 2017
Khon Kaen, 14 July 2017

Global Energy Policy and East Asia Research Unit
Policy Alternatives Research Institute (PARI) - University of Tokyo

Mission

- Analyze the regional structure of energy supply and demand as well as energy policies in East Asia; discuss from an international viewpoint, and raise awareness of the issues.
- Prepare policy recommendations based on latest energy policy research.
- Supported by ERIA Economic Research Institute for ASEAN and East Asia

Featured Collaborations

Chulalongkorn University

YTU Yangon Technological University

National University of Laos

PARI THE UNIVERSITY OF TOKYO

Renewable & Appropriate Energy Laboratory RAEL

PARI-RAEL Collaborative Research: “Energy for Peace” initiative with NLD

Kick-off Meeting with Central Economic Commission of NLD
(May18, Rose Hall, Yangon)

- ✓ Before the Myanmar general election in 2020, we will craft the energy strategy in the era of national reconciliation.
- ✓ Dialogue with ethnic groups are surely important. At the same time, dialogue with neighboring countries (eg China) is most critical.
- ✓ We are collaborating with China to include their perspective.
  - ✓ One Belt One Road Center, Yunnan University.

Key Publications: Realizing Connectivity

- Del Barrio-Alvarez and Horii "Energy security and regional power sector cooperation in the Greater Mekong Sub-region: past developments and near term challenges" Asian Journal of Public Affairs (2017)
- Kittner, N., Yamaguchi, K. (2017). Hydropower threatens peace in Myanmar – but it doesn't have to. Nikkei Asian Review.
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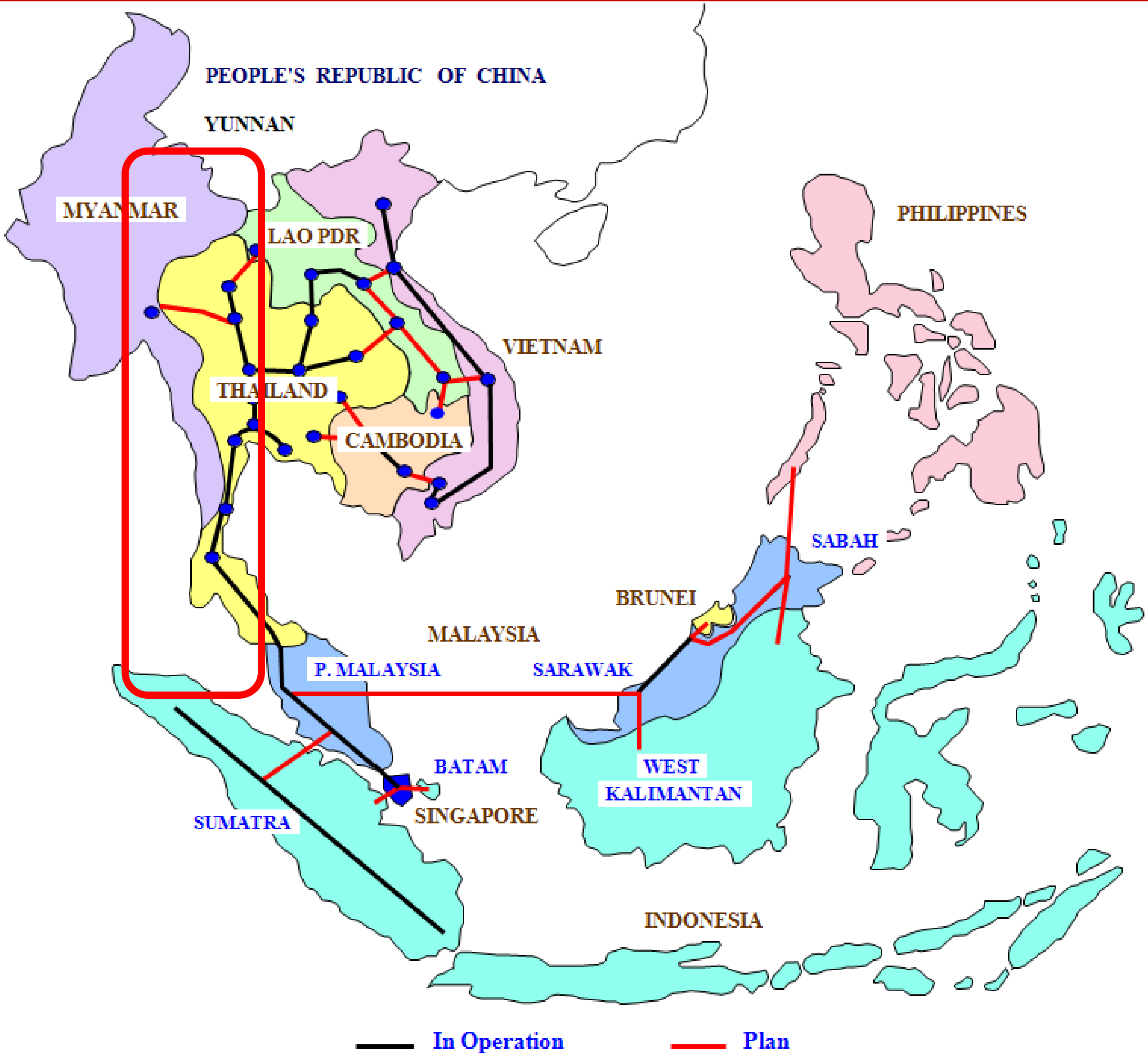
Increasing Importance of Energy Connectivity: from the point of GMS, Japan and USA

- Japan-Mekong Connectivity Initiative (July 2016) led by Ministry of Foreign Affairs in Japan
  - "Japan-Mekong Connectivity Initiative" by utilizing Japan's contribution of 750 billion yen in three years from 2016 to realize *a vibrant and effective connectivity* in GMS.

Foreign Minister Fumio Kishida in Chulalongkorn U in 2016

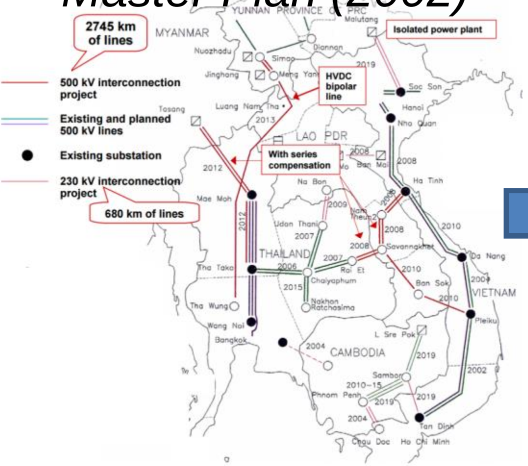
- Friends of the Lower Mekong (FLM) Conference jointly hosted by the U.S. and the Lao PDR (Feb 4, 2015)
  - Representatives agreed on the importance of an *integrated regional power grid* to support equitable, basin-scale nexus tradeoffs and the need to assist Mekong countries in harmonizing technical and performance standards.

Connectivity Focus: From Myanmar to GMS

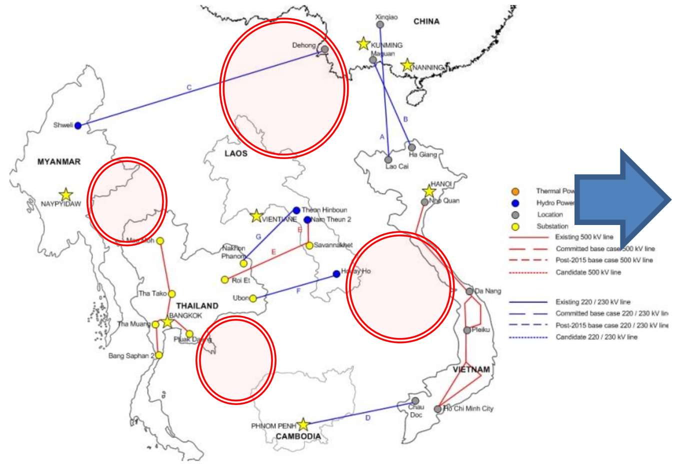


Recent studies on GMS connectivity: How to make pathways?

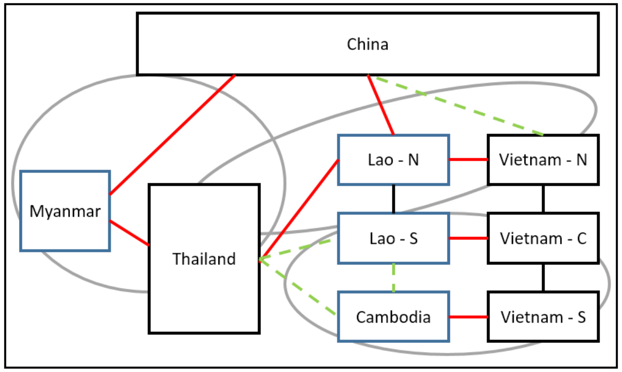
Regional Indicative Master Plan (2002)



Existing interconnections (by 2009)



RETA 6440 (2010)



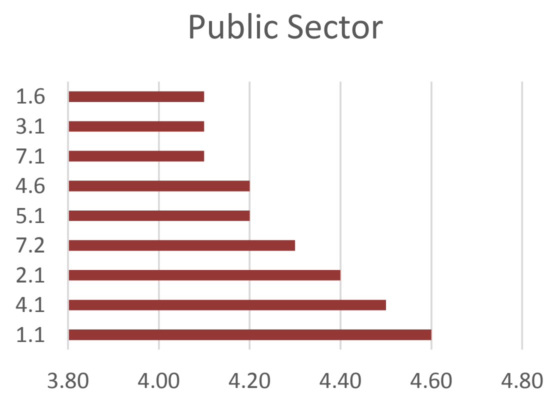
Regional Power Trade Coordination Committee (RPTCC) facilitated by ADB		
#1	Guilin, PRC	Jul, 2004
#2	Bangkok, Thailand	Dec, 2004
	…	
#22	Chengdu, PRC	Jun, 2017
#23	TBC, Lao PDR	Dec, 2017

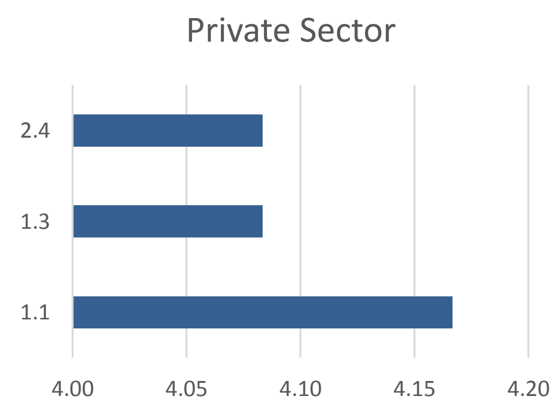
Basing the past discussions in RPTCC…
How we can make pathways for realizing power interconnections?

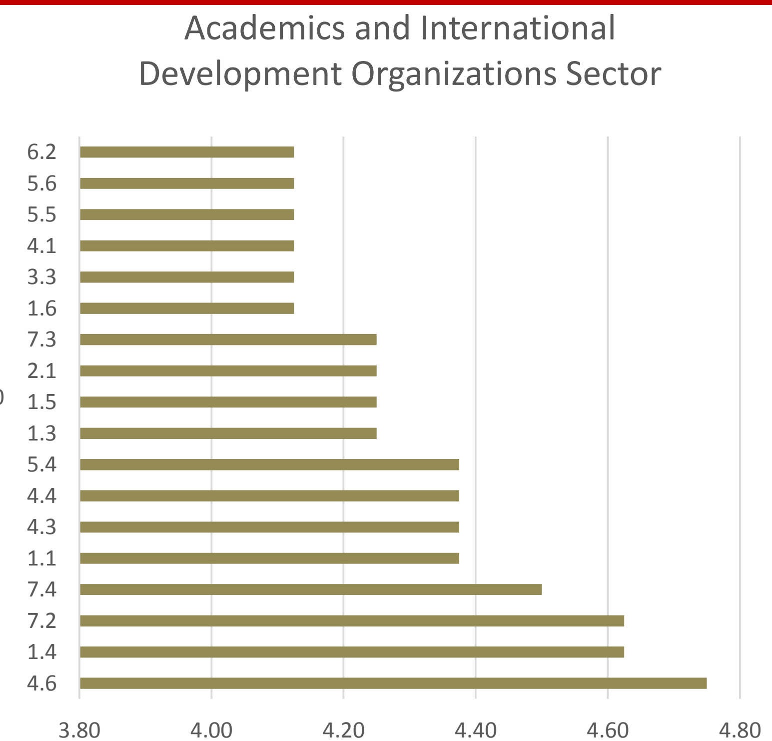
Our Approach:
Energy connectivity in GMS

1. Exploratory Stage (2017/18)
   - Aim: to gather suggestions for improving and selecting scenarios, that were considered relevant and interesting in this region.
   - Participants: Policy Arena, Business, Civil Society
2. Forecasting Stage (2018/19)
   - SWITCH Model: Capacity expansion linear program
   - Minimizes total power system cost:
     - ✓ Generation investment and operation
     - ✓ Transmission investment and operation
3. Outreach Stage (2019/20)
   - Collective Policy Implications in GMS
     - ✓ Eg: Power trilemma among availability, sustainability, and affordability.
   - Capacity Bulding program for each country
     - ✓ Strengthen the planning capacity of power trade in each PDP

Exploratory Stage:
Result of Social Survey on Energy Connectivity



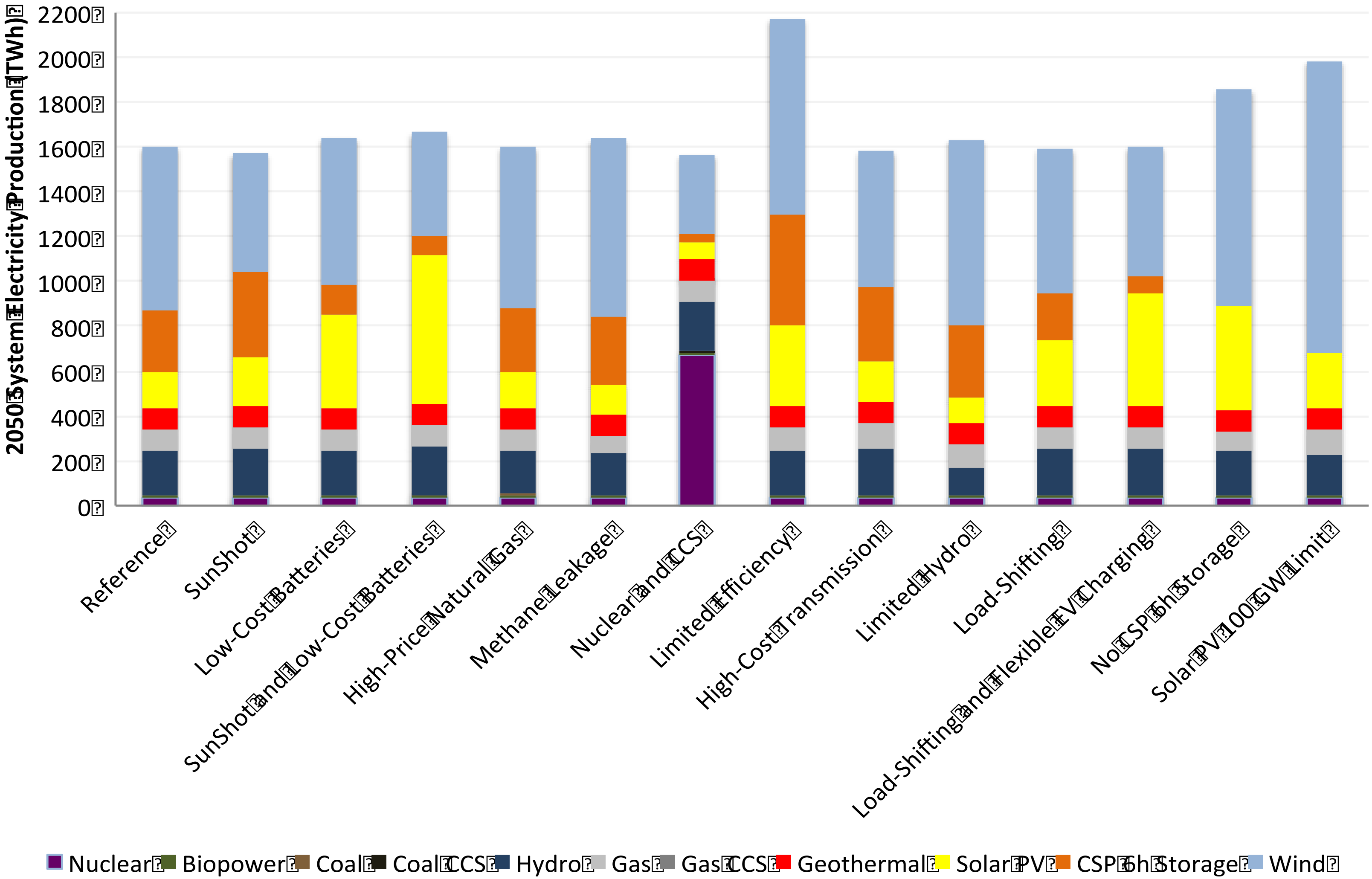




Outstanding factors for each stakeholder category (>4)

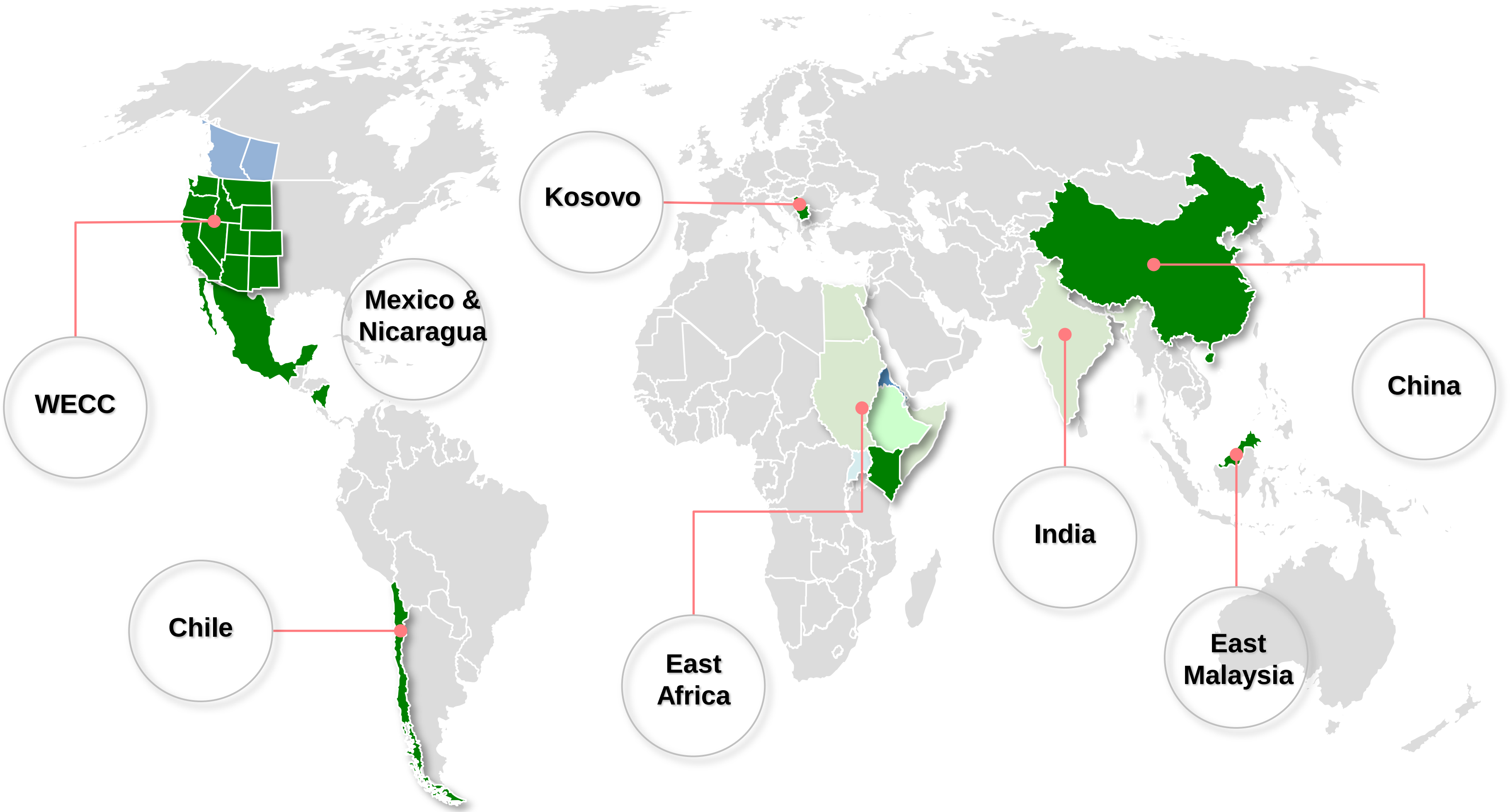
- ✓ Social result shows the different perspective on energy connectivity among stakeholders
- ✓ Based on each perspective, we will develop multiple energy connectivity scenarios in GMS
- ✓ This regional scenario will give the assumptions for forecasting model in the next stage

Forecasting Stage:
Output image of SWITCH model



- ✓ Western North America: Electricity production mix varies widely across scenarios in 2050 *(All of which meet the 450 ppm target)*

Reference: SWITCH modeling efforts

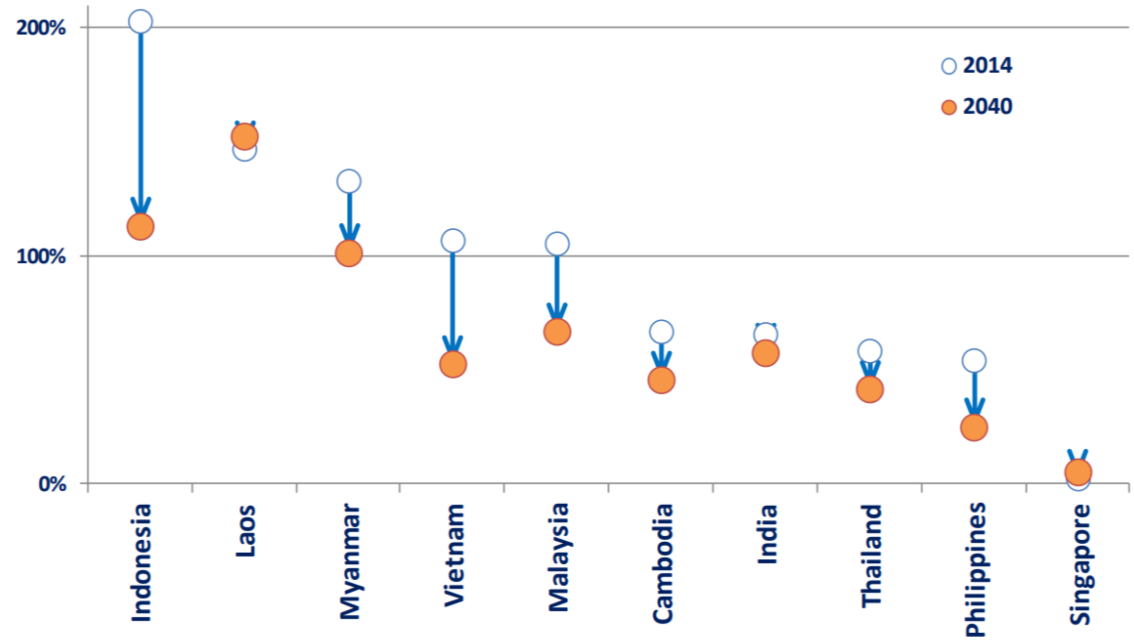


https://rael.berkeley.edu/project/switch-a-modeling-tool-for-the-electricity-sector/

Outreach Stage: Impact of connectivity of Self Sufficiency

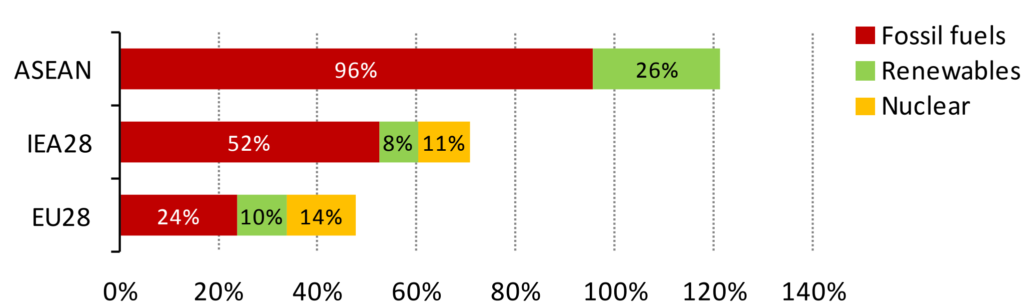
- ✓ In ASEAN, domestic energy resources are abundant.
- ✓ If utilizing resources in the region, energy independence from middle east will be progressed.
- ✓ Yet, without connectivity infrastructure, self sufficiency rate is to be declined.
- ✓ How could power interconnections contribute to the domestic use of resources?

Declining self-sufficiency rate



Source: Asia/World Energy Outlook (IEEJ, 2016)

Regional Demand / Regional Supply



Source: Energy Data Center, IEA.

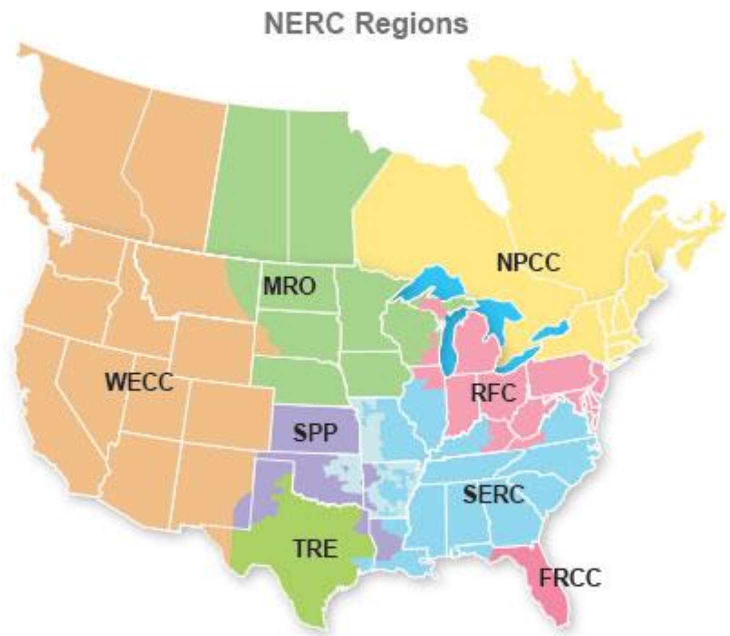
Step Forward: New collaboration with Mekong Institute

- Starting collaborations with Mekong Institute, we will progress the exploratory stage through scenario making in 2017.
- Upcoming Event: Special Session at GMSarn (November 28-30 2017, Danan, Vietnam) hosted by RAEL, MI and PARI.
  - Please contact to: Dr. Jirawadee Polprasert < jirawadeep@nu.ac.th >

Thank you very much!

K. Yamaguchi <yamaguchi@pari.u-tokyo.ac.jp>; N. Kittner < nrkittner@berkeley.edu >

Example: SWITCH WECC model



- Capacity expansion linear program

- Minimizes total power system cost:
  - Generation investment and operation
  - Transmission investment and operation
- Geographic:
  - –Western North American Power System (the WECC)
  - – 50 load areas
- Temporal:
  - –4 investment periods: 2016-2025 (“2020”); 2026-2035 (“2030”); 2036-2045 (“2040”); 2046-2055 (“2050”);
  - –144 distinct hours simulated per period
    - Dispatch simulated simultaneously with investment decisions

Key Publications

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I Exploratory Stage						
2017	1	2	3	4	5	6
	Methodology		(Inner) Kick-off workshop	Social Survey		(Inner) Stakeholders workshop I
2017	7	8	9	10	11	12
	Mekong Forum in Khon Kaen	PTIT's Training Session		Greater Mekong Forum in Yangon	**GMSarn in Danan**	
II Forecasting Stage with Mekong Institute						
2018	1	2	3	4	5	6
	Scenario-Making		Capacity Building (SWITCH)			ADB's Clean Energy Forum in Manila
2018	7	8	9	10	11	12
	SWITCH model running				GMSarn	
III Implication Stage						
2019						

Upcoming Event: GMSarn (November 28-30, Danan, Vietnam)

If you are interested, please contact to:

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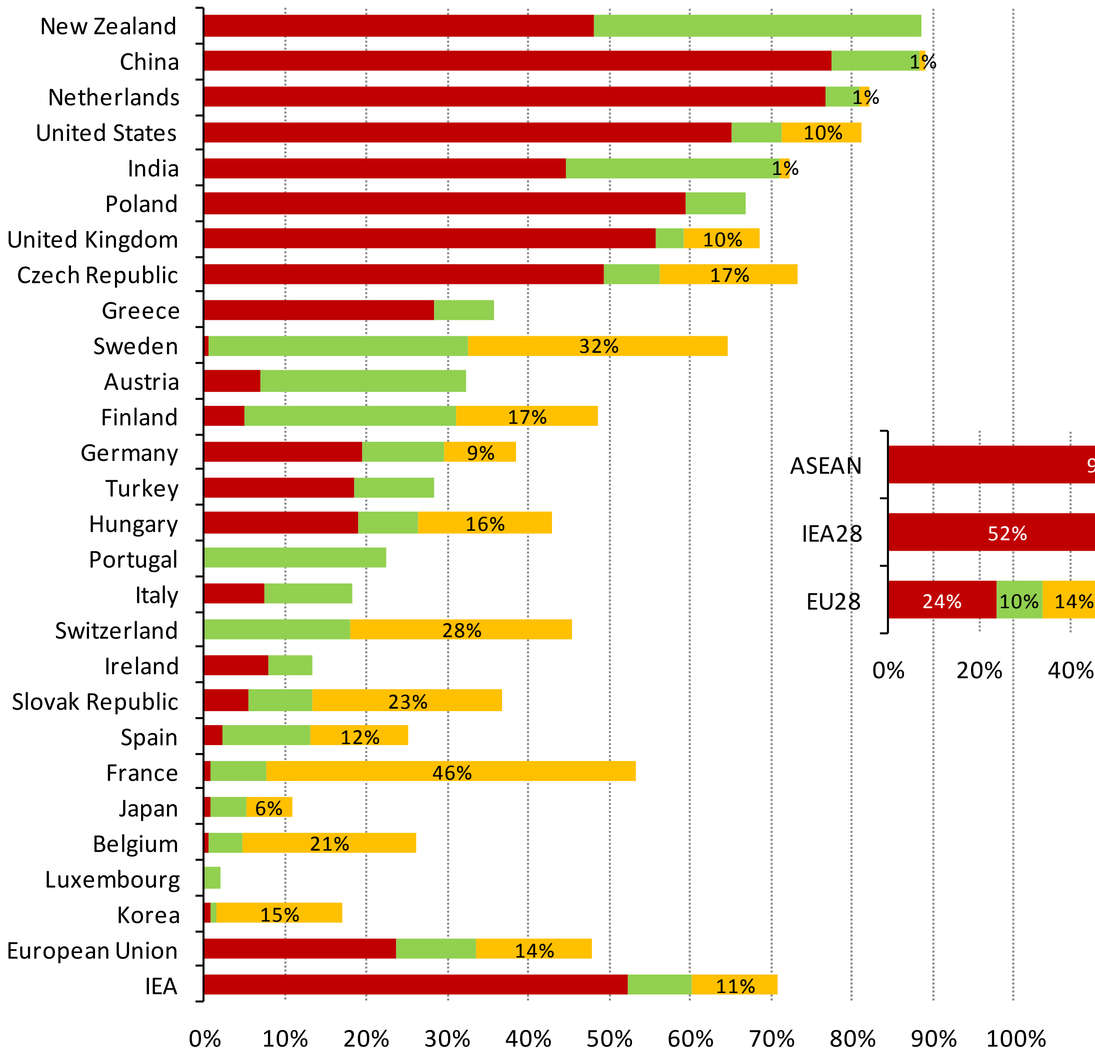
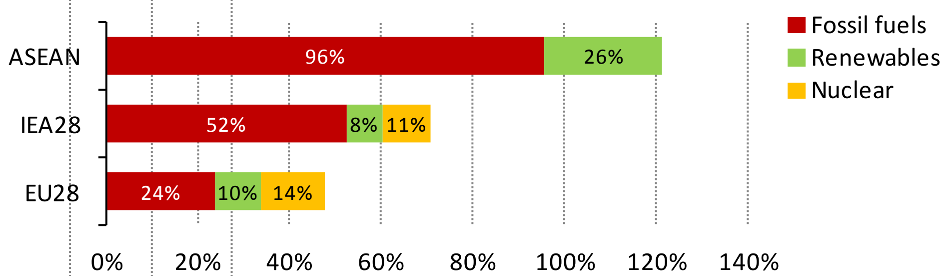
Thank you very much!

Collective Energy Security

Energy self-sufficiency* by fuel in 2011



WEO 2013 basis



* Self-sufficiency = domestic production / total primary energy supply

Source: Energy Data Center, IEA.

Note: Does not include fuels not in the fossil fuels, renewables and nuclear categories.

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Activities

- “Energy Efficiency Road Mapping Study in Lao PDR” Report (2011-13)
- Organized International Symposiums such as “Energy Policy Roundtable” (2012-)
- Hosted a series of joint workshops with the universities and research institutes such as Chulalongkorn University of Thailand and U.C. Berkeley & created an ASEAN energy research network (2013-)
- Research on rural electrification in Myanmar resulting in policy recommendations and human resource development (2013-)

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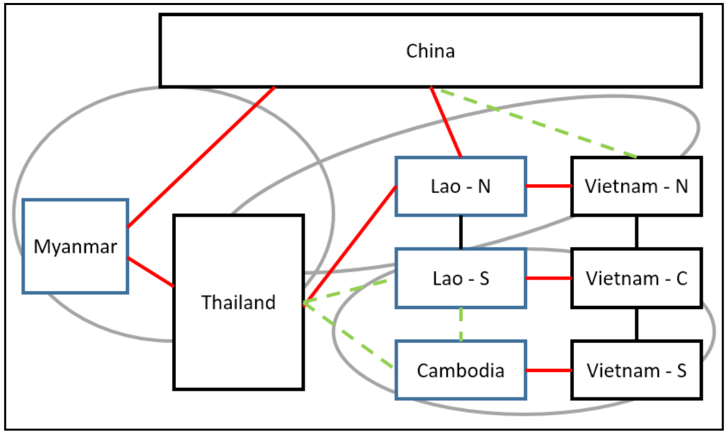
- Energy Policy
- Nikkei Asian Review

- The importance of Energy Connectivity

Recent studies on GMS connectivity

- RETA 6440, Update of GMS Regional Master Plan (2008 – 2010)
  - Simulations considering different degrees on interconnectivity
    - Base case, case 2000 MW, High export, and No expansion
  - Three poles for regional power trade
  - Recommendation for creation of RPCC

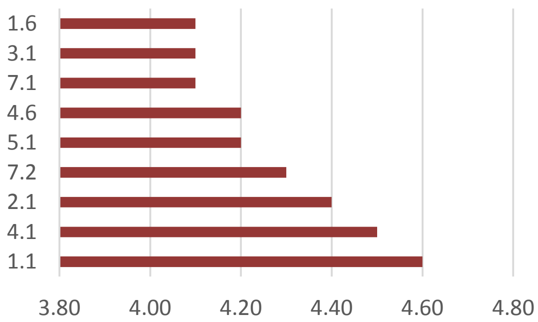


North West pole	East West Northern link	Southern grid
28 GW hydro pot. Myanmar Myan. - China: 20,000 MW Myanmar - Thai: 5,800 MW Between 2015-2028	10 GW hydro pot. Lao N Thai – Lao N: 1,500 MW Lao N – NV: 2,400 MW New interconnection cap.	7 GW hydro potential in Lao-S and Cambodia

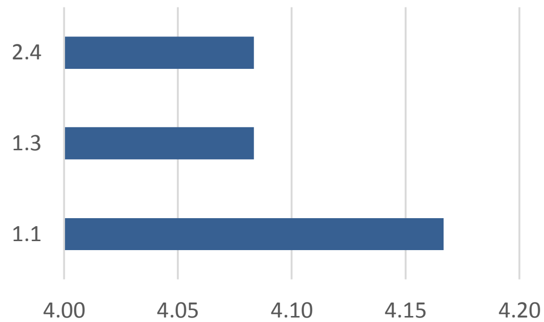
Studies for enabling further connectivity being conducted

Result of Social Survey

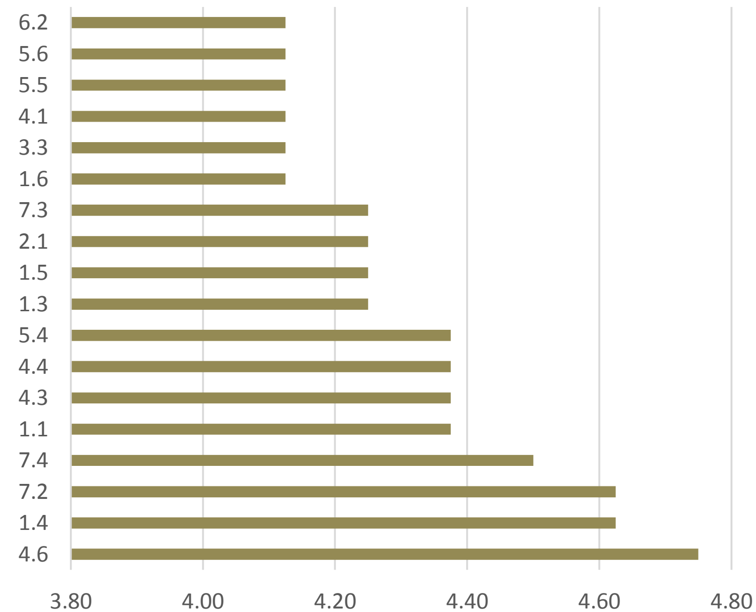
Public Sector



Private Sector



Academics and International Development Organizations Sector



Outstanding factors for each stakeholder category (>4)

1. Power Inter-Connectivity
   - To what extent, cross-border transmission will be developed? Renewable Energy
2. Decentralized Grid Systems
   - To what extent, renewable energy will be diffused?
3. Main river Development of Mekong
   - To what extent, decentralized power systems will be integrated into centralized systems?
4. Renewable Energy
   - To what extent, main river development will be proceeded in Mekong?

Energy connectivity in GMS

1. Exploratory Stage (2016/17)
   - Aim: to gather suggestions for improving and selecting scenarios, that were considered relevant and interesting in this region.
   - Participants: Policy Arena, Business, Civil Society
   - Descriptive Scenarios: Branching Point, Critical Uncertainty,
     - ✓ Trans-border Connectivity / Low Carbon Power Systems / Mekong River Development / Centralized vs Decentralized Systems
2. Forecasting Stage (2017/18)
   - SWITCH Model by RAEL, UC Berkeley
   - Minimizes total power system cost:
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     - ✓ Eg: Power trilemma among availability, sustainability, and affordability.

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Way forwards

- Starting collaborations on connectivity
  - Mekong Institute
  - PTIT
- Upcoming Event
  - GMSarn

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2017	1	2	3	4	5	6
	Interview		(Inner) Stakeholder WSII	Writing Report		(Open) Suggestion for Policy Arena
II Forecasting Stage						
2017	7	8	9	10	11	12
	Collaboration with the SWITCH modeler (RAEL)					
2018	1	2	3	4	5	6
	Collaboration with the SWITCH modeler (RAEL)					
III Implication Stage						
2018	7	8	9	10	11	12
	Collaboration with Research Network (eg ERIN)					
2019	1	2	3	4	5	6
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4 Key Points in GMS Energy Scenarios

1. Power Inter-Connectivity
   – To what extent, cross-border transmission will be developed?
2. Renewable Energy
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SWITCH Training Workshop by PTIT

Thank you very much!

Possible Collaborations

- Scenario development in GMS,
- SWITCH modeling by RAEL,
- Modeling training by PTIT

…

- If you are interested, please contact to:

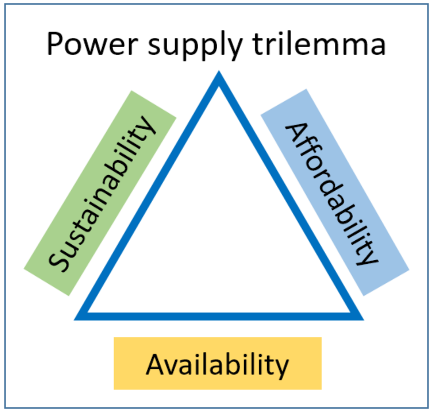
normanvu@outlook.com (Mr. Norman) /

kyamaguchi@pp.u-tokyo.ac.jp

Xin cảm ơn

Energy security & GMS power trilemma

- Energy security relies on three pillars:
  - Adequacy and reliability of physical energy supply
  - Environmental sustainability
  - Affordable access



Source: IEA, 2015

Demand to nearly double by 2035

	mtoe				AAGR [%]
	2009	2015	2020	2035	2009/35
Cambodia	5	6	7	11	3.0
Lao PDR	3	5	5	9	4.5
Myanmar	15	17	21	35	3.3
Thailand	103	121	140	215	2.9
Viet Nam	64	83	99	185	4.2
PRC	2,257	2,798	3,156	4,034	2.3
Total	2,447	3,030	3,429	4,489	2.4
Total /PRC	190	232	273	455	3.4

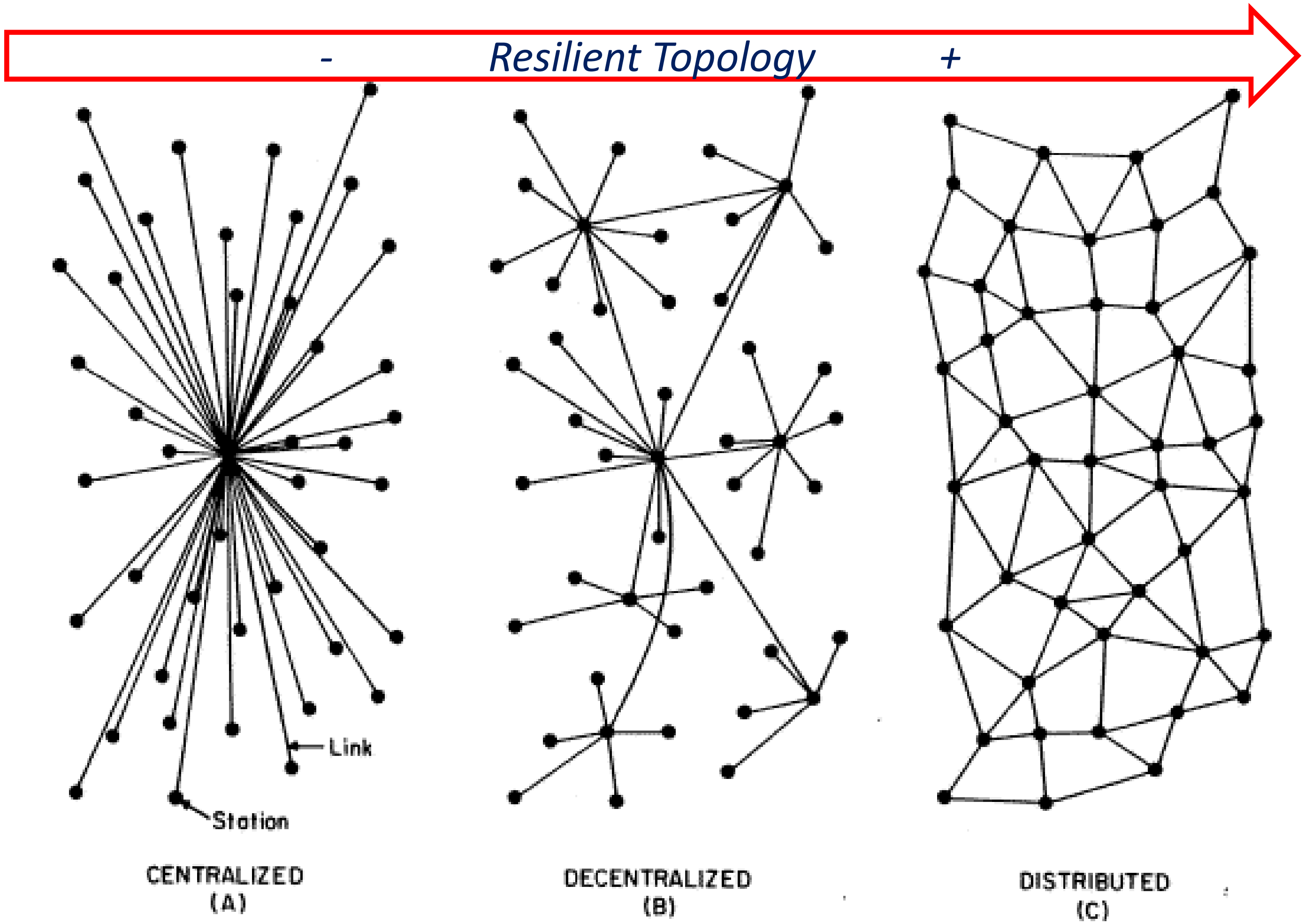
Countries pledges at Paris Agreements

Intended Nationally Determined Contributions (INDCs) by 2030	
Cambodia	To reduce CO2 emissions by 27% compared to BAU
Lao PDR	To increase forest area (70%), support neighbouring countries, increase small scale to 30% of total
Myanmar	To continue being a GHG sink
Thailand	To reduce GHG emissions by 20-25 % comp. to BAU
Viet Nam	To reduce GHG emission by 8 – 25% comp. to BAU
PRC	To lower CO2 emissions per unit of GDP by 60-65%

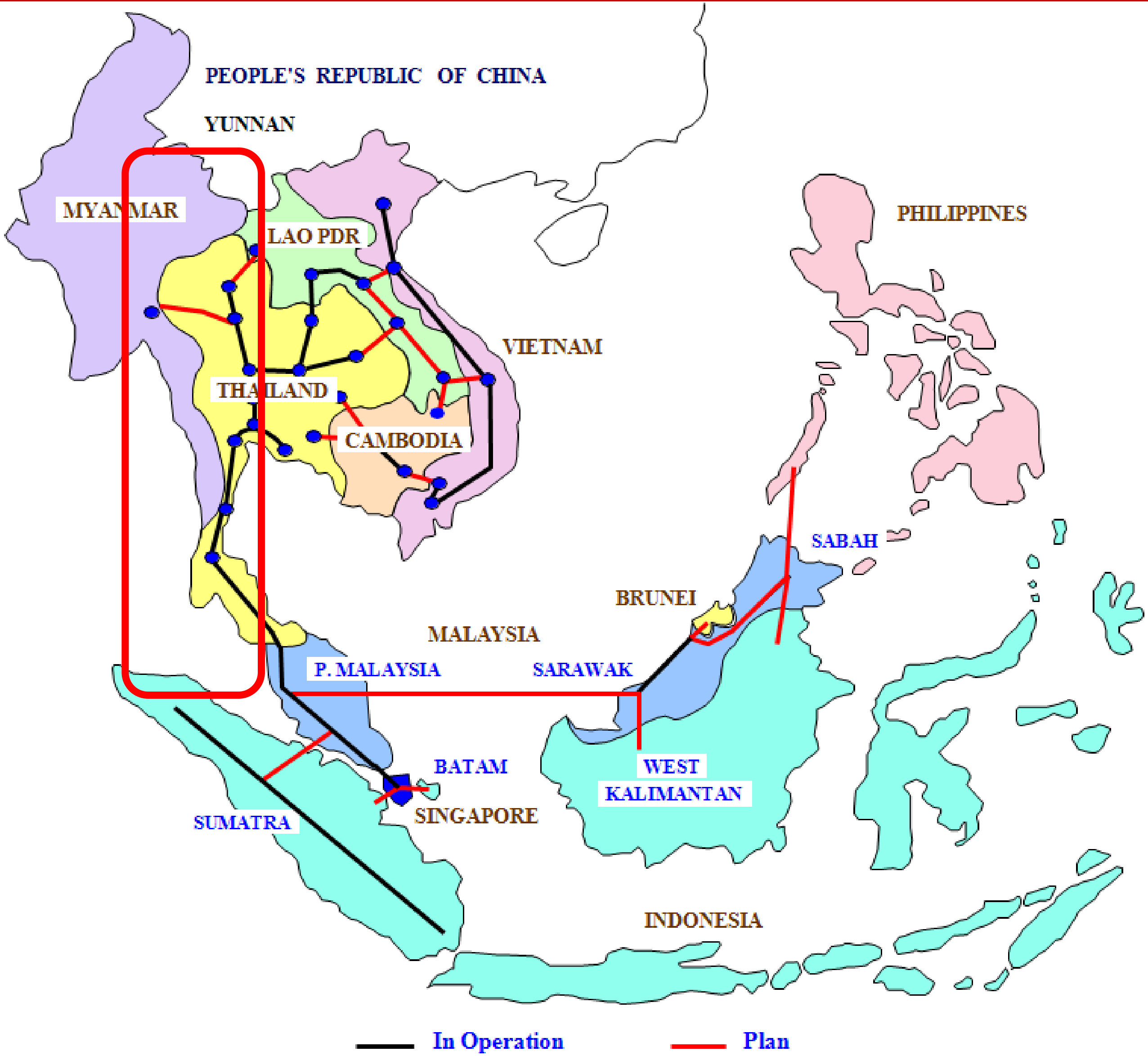
Social and environmental sustainable vision for increasing demand

Variations of Connectivity

APEC Energy Ministers ministers affirm the importance of energy resiliency and energy security in the energy trade and investment framework. (Philippines, 2015)



Focusing on Myanmar-Thai



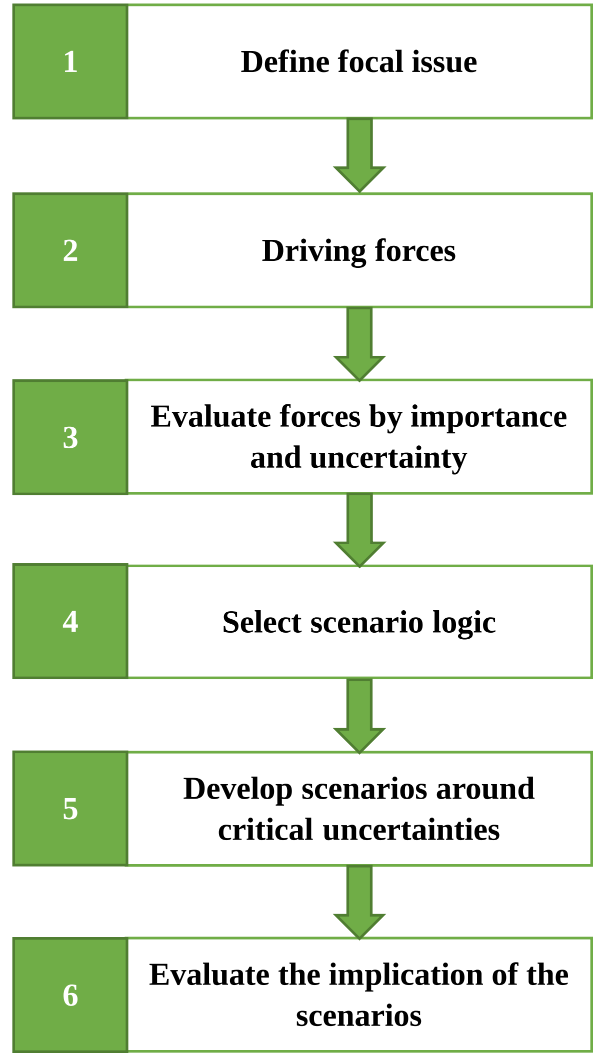
Chula-U Tokyo Collaborations

- Research Institutes
  - Energy Research Institute (ERI), Chulalongkorn University
  - Prof. Bundhit => Prof. Tharapon => Prof. Dawan => Prof. Veerapong
- Phase
  - [I] :1OCT 2013 ~ 30JUN 2014
  - [II] : 1JUL 2014 ~ 30JUN 2015
  - [III] : 1JUL 2015 ~ 30JUN 2016
  - <u>[IV] : 1JUL 2016 ~</u>
- Stakeholder's Meeting ([I]-[II])
  - Understanding barriers of IPPs in Myanmar to draw implications for their removal. (Int. J. Public Policy forthcoming)
- Fieldwork in Myanmar ([III])
  - People's perception on huge hydro-dams. (バンコク商工会議所報 2016)
- Chinese Perspective ([III])
  - Policy Process: Oil/Gas pipeline between China/Myanmar (アジ研ワールドトレンド 2015)

The 2nd Workshop on Rural Electrification in Myanmar
Jointly Organized by
Ministry of Livestock, Fisheries and Rural Development and
UTokyo Policy Alternatives Research Institute of
The University of Tokyo supported by ERIA
2015
Nay Pyi Taw
မြန်မာနိုင်ငံအင်ဂျင်နီယာအသင်း
International Symposium

Scenario development

- The process starts by identifying the key point
- Driving forces are noted down in step 2
- In step 3, the most important and highly uncertain driving forces are selected
- Different scenarios are created in step 4.
- Step 5 describes how future may unfold by composing storyline for each scenario.
- Final step in developing scenarios is to evaluate by quantitative analysis and assessing the implications of scenarios



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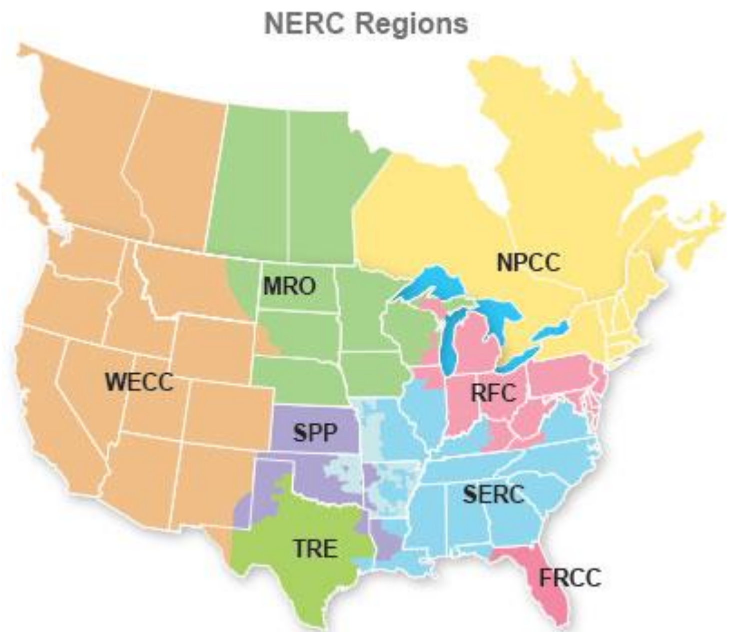
     - ✓ Eg: Power trilemma among availability, sustainability, and affordability.

Example: SWITCH WECC model



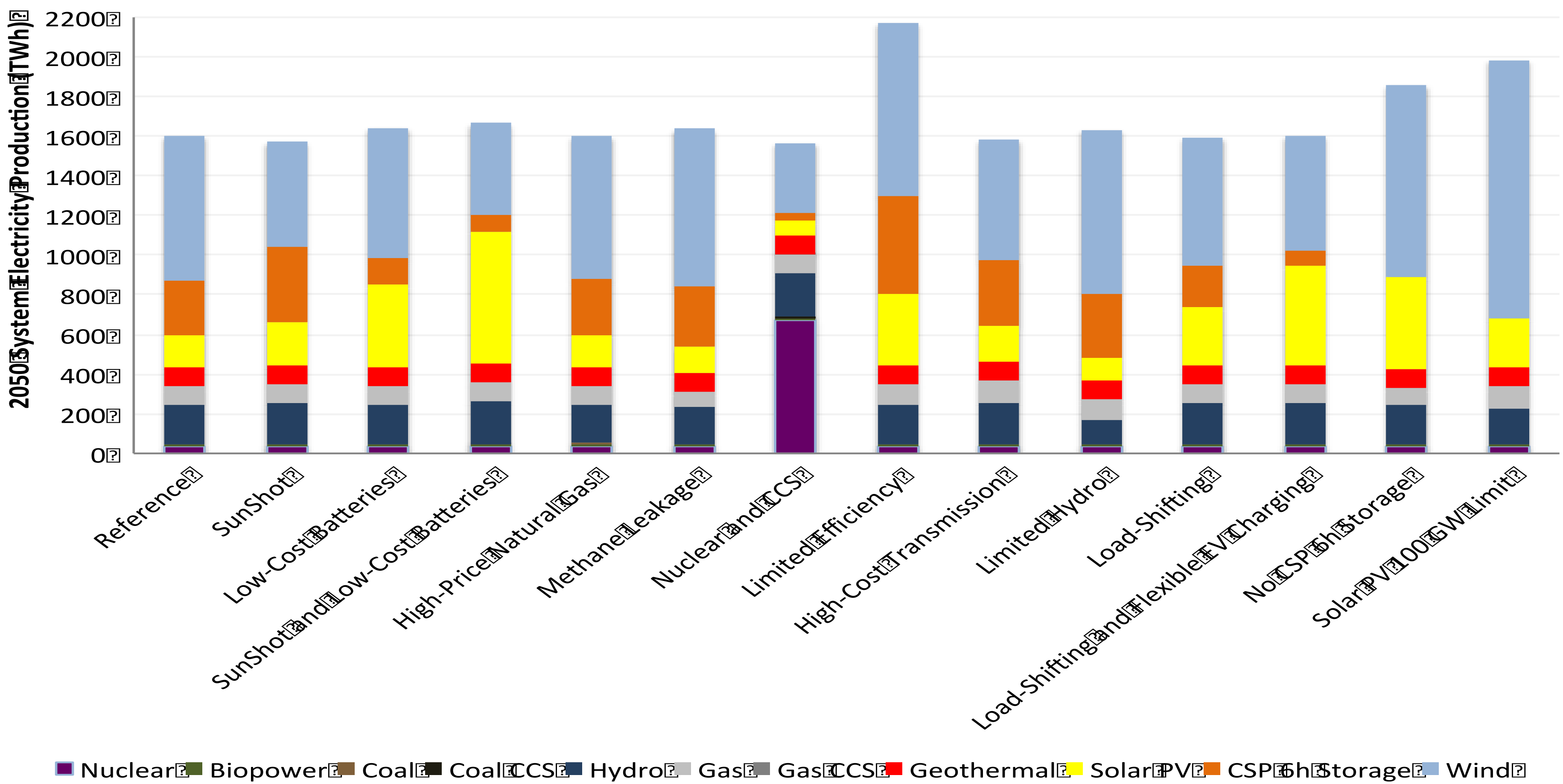
- Capacity expansion linear program

- Minimizes total power system cost:
    - Generation investment and operation
    - Transmission investment and operation
- Geographic:
    - –Western North American Power System (the WECC)
    - – 50 load areas
- Temporal:
    - –4 investment periods: 2016-2025 (“2020”); 2026-2035 (“2030”); 2036-2045 (“2040”); 2046-2055 (“2050”);
    - –144 distinct hours simulated per period
        - Dispatch simulated simultaneously with investment decisions

Output Image: SWITCH WECC model

Western North America: Electricity production mix varies widely across scenarios in 2050

All of which meet the 450 ppmv target

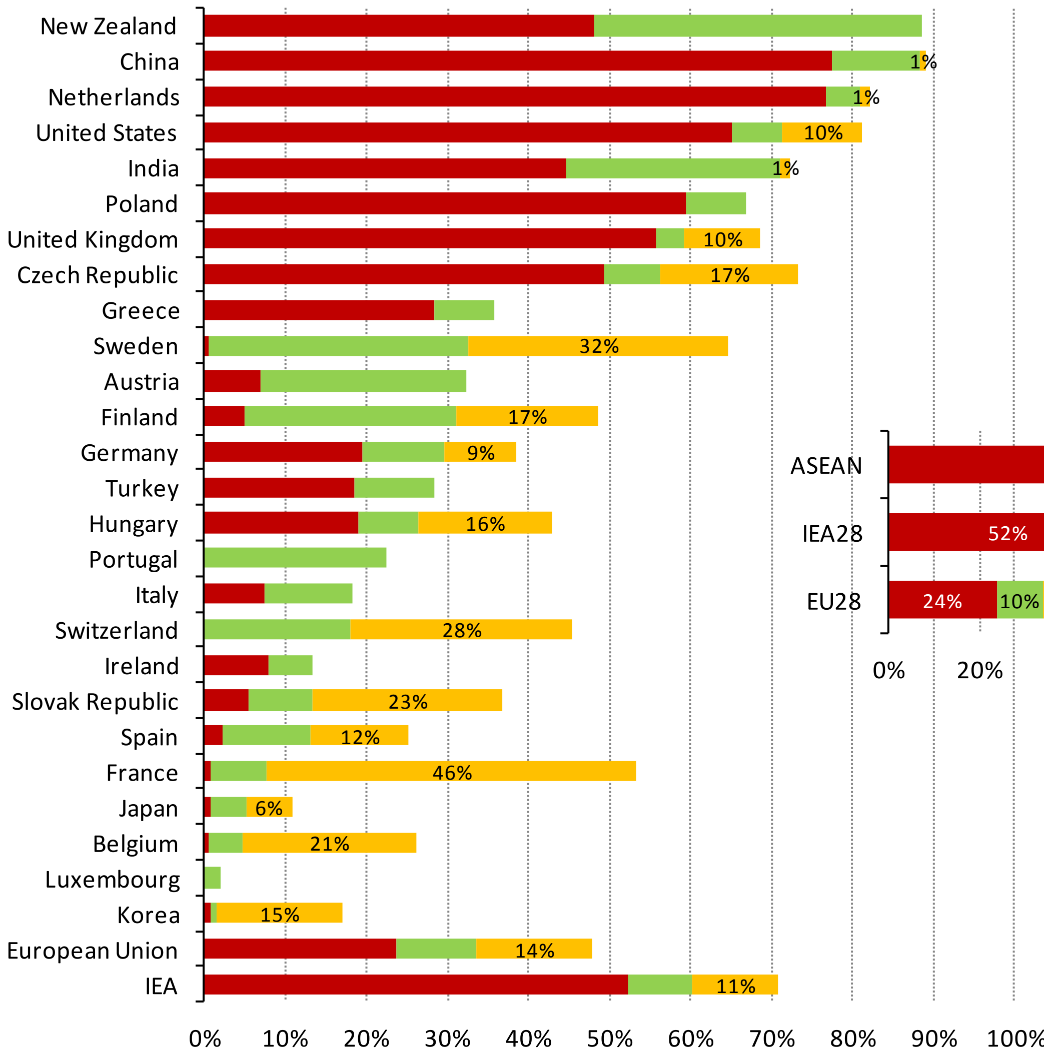


Energy connectivity in GMS

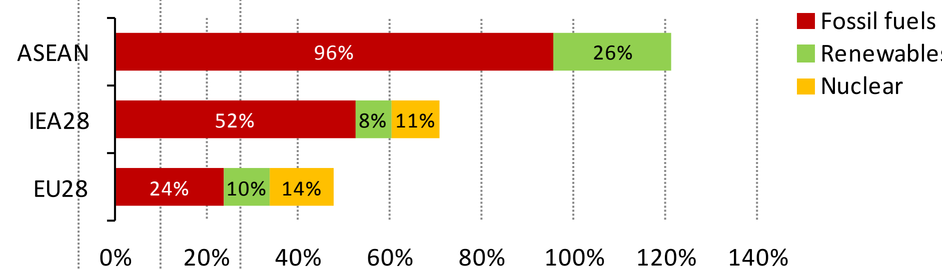
1. Exploratory Stage (2016/17)
   - Aim: to gather suggestions for improving and selecting scenarios, that were considered relevant and interesting in this region.
   - Participants: Policy Arena, Business, Civil Society
   - Descriptive Scenarios: Branching Point, Critical Uncertainty,
     - ✓ Trans-border Connectivity / Low Carbon Power Systems / Mekong River Development / Centralized vs Decentralized Systems
2. Forecasting Stage (2017/18)
   - SWITCH Model
   - Minimizes total power system cost:
     - ✓ Generation investment and operation
     - ✓ Transmission investment and operation
3. Implication Stage (2018/19)
   - Collective Policy Implications in GMS
     - ✓ Eg: Power trilemma among availability, sustainability, and affordability.

Collective Energy Security

Energy self-sufficiency* by fuel in 2011



WEO 2013 basis



* Self-sufficiency =
domestic production /
total primary energy supply

Source: Energy Data Center, IEA.

Note: Does not include fuels not in the fossil fuels, renewables and nuclear categories.

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I Exploratory Stage						
2016	7	8	9	10	11	12
	Methodology		(Inner) Kick-off workshop	Data Collection		(Inner) Stakeholders workshop I
2017	1	2	3	4	5	6
	Interview		(Inner) Stakeholder WSII	Writing Report		(Open) Suggestion for Policy Arena
II Forecasting Stage						
2017	7	8	9	10	11	12
	Collaboration with the SWITCH modeler (RAEL)					
2018	1	2	3	4	5	6
	Collaboration with the SWITCH modeler (RAEL)					
III Implication Stage						
2018	7	8	9	10	11	12
	Collaboration with Research Network (eg ERIN)					
2019	1	2	3	4	5	6
	Collaboration with Research Network (eg ERIN)					

SWITCH Training Workshop by PTIT

Thank you very much!

Possible Collaborations

- Scenario development in GMS,
- SWITCH modeling by RAEL,
- Modeling training by PTIT

…

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Xin cảm ơn