Lao People's Democratic Republic
Ministry of Energy and Mines
Electricité du Laos

The Study on Power Network System Master Plan in Lao People's Democratic Republic ADB GMS RPTCC-26

Japan International Cooperation Agency (JICA)
Tokyo Electric Power Company Holdings, Inc.
TEPCO Power Grid, Inc.
NIPPON KOEI CO., LTD.
Tokyo Electric Power Services Co., Ltd.
Hanoi

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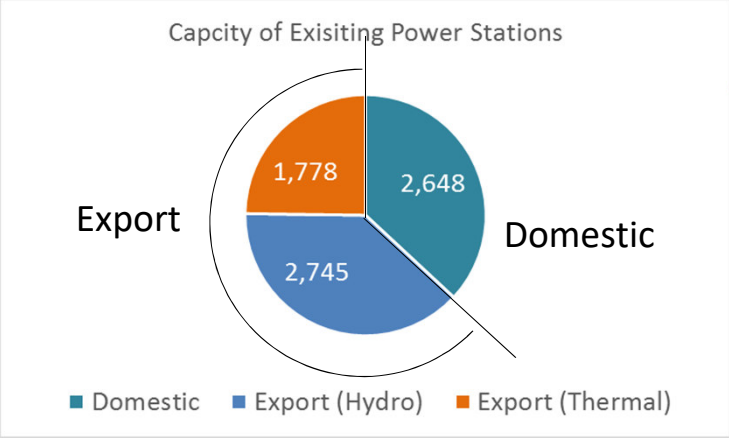
Schedule of JICA Laos MP Study

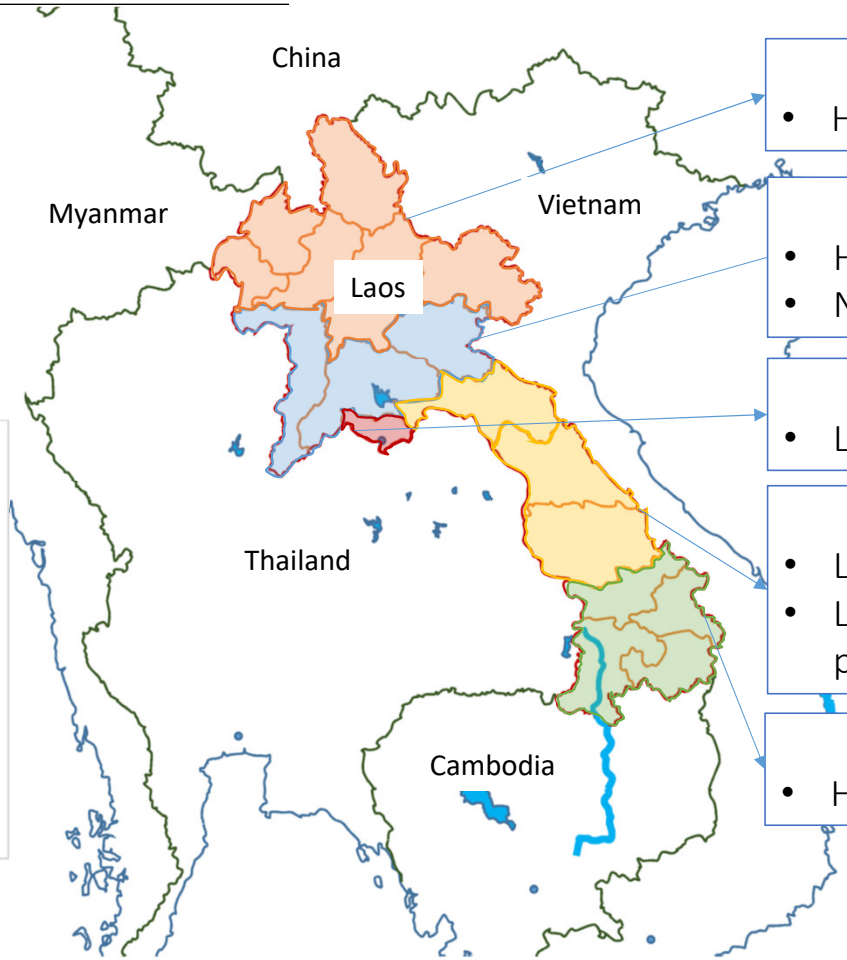
Sep. 2017	Beginning
	Stage 1 Power Trade Expansion Scenario
	Stage 2 Power Network System Development Plan
Oct. 2019	F/R Stage 2
	Stage 3 GMS Interregional Power Trade
	Overall Picture and Issues of Interregional Power Trade
	Issues and Their Countermeasures regarding Grid Code for Expansion of GMS Interregional Power Trade
	Revision of Optimal Power Generation Plan of GMS
	Proposal of Cooperation Projects
Dec. 2019	DF/R Stage 3
Feb. 2019	F/R

Regional Features of Electric Power in Laos

Laos

- Located in the center of Indochinese Peninsula
- It has harnessed its potential for hydraulic power for economic growth.





North
- High hydropower potential

Central North
- High hydropower potential
- Near Vientiane Capital

Vientiane Capital
- Large power demand

Borikhamxai & Central
- Low hydropower potential
- Large industry and mining power demand

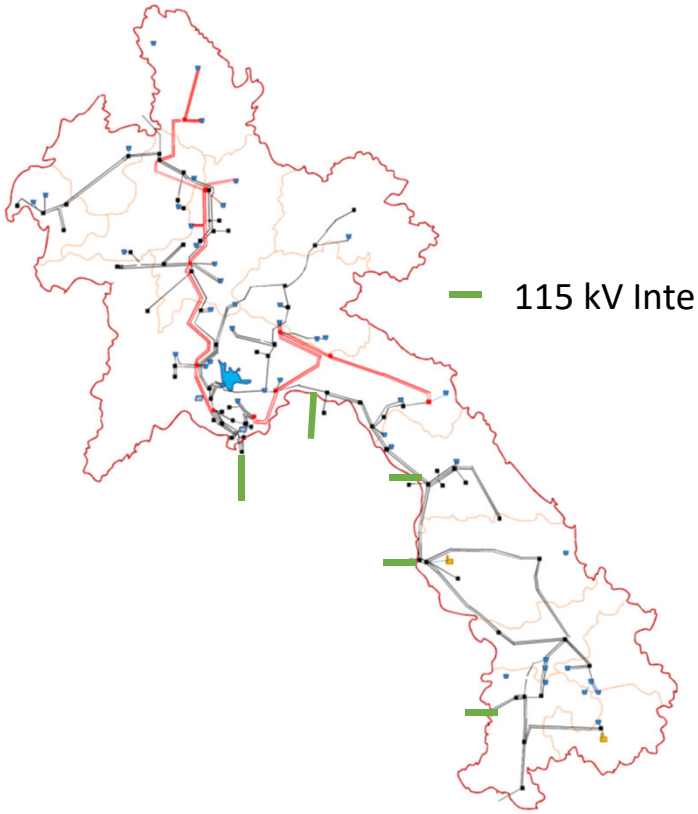
South
- High hydropower potential

Current Power System in Laos

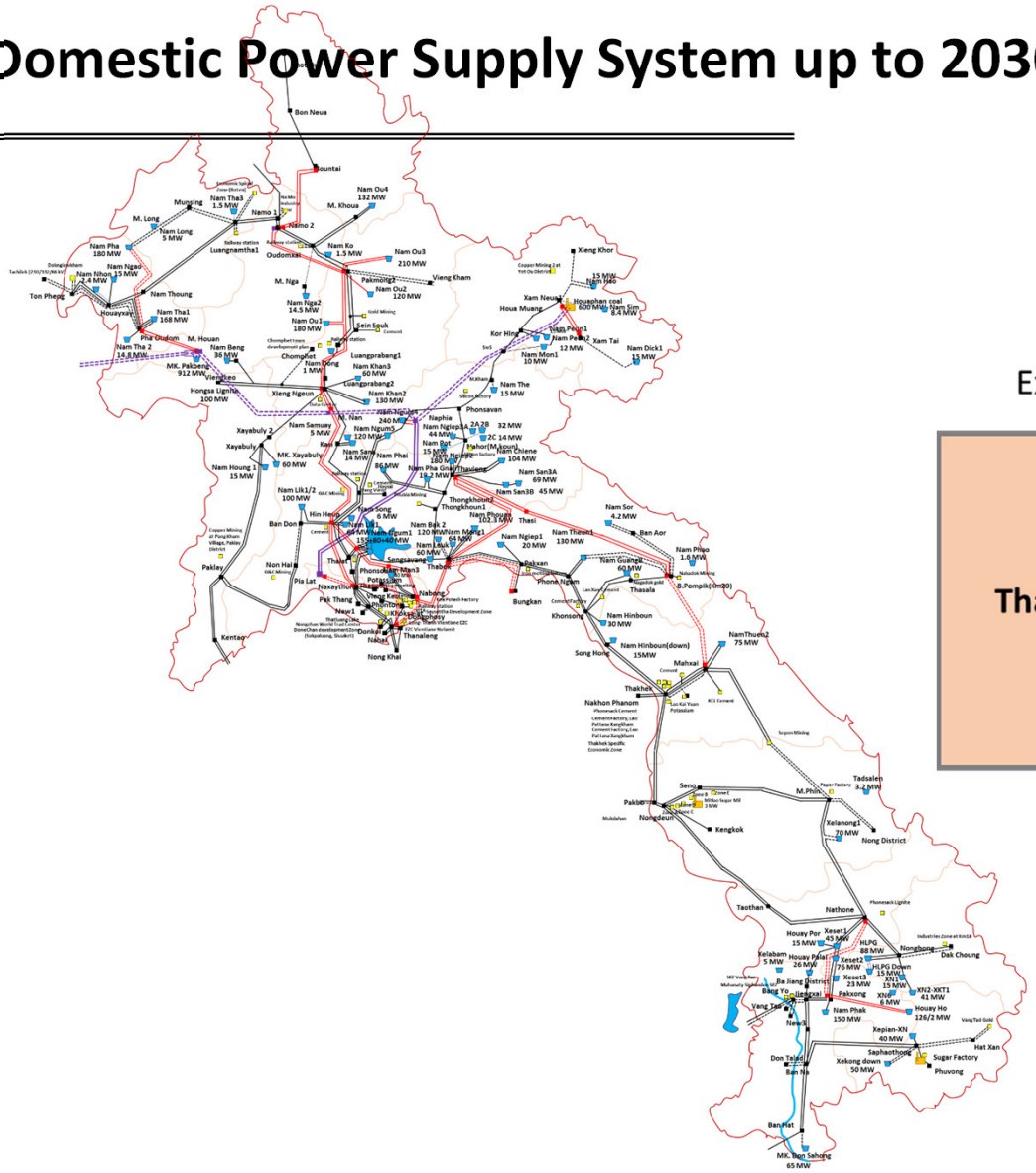
- Export-dedicated Transmission Lines and Domestic Power Supply System
- Domestic Power Supply System connected to EGAT by 115 kV interconnections

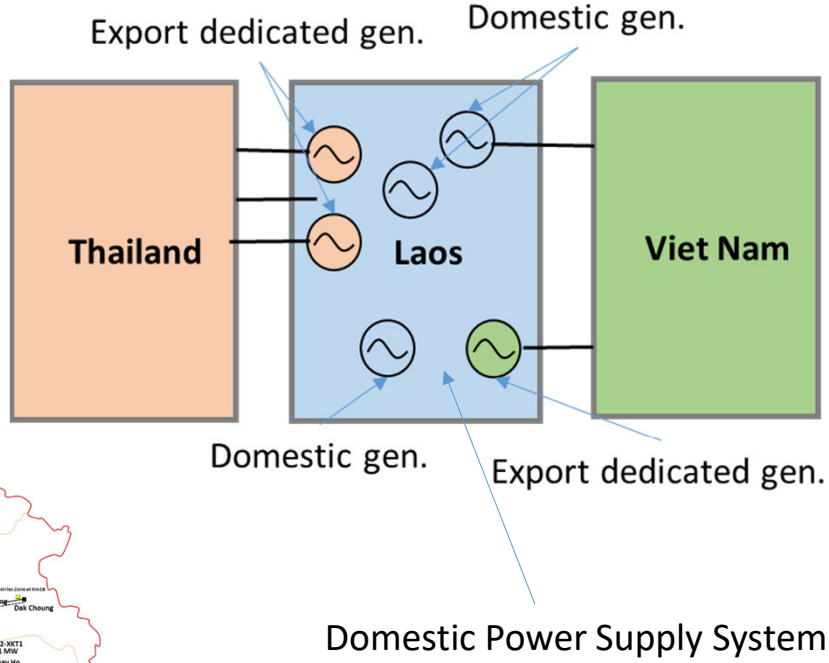
Existing Export-dedicated Transmission Lines

Existing Domestic Power Supply System



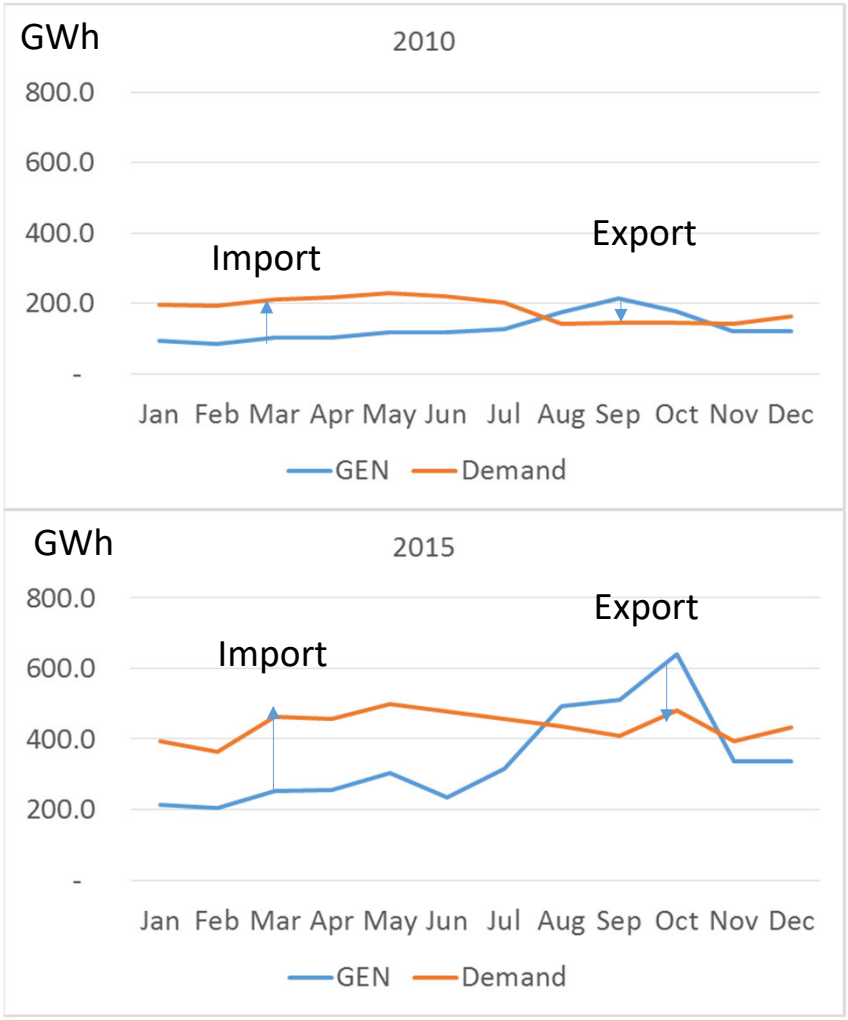
Plan of Domestic Power Supply System up to 2030



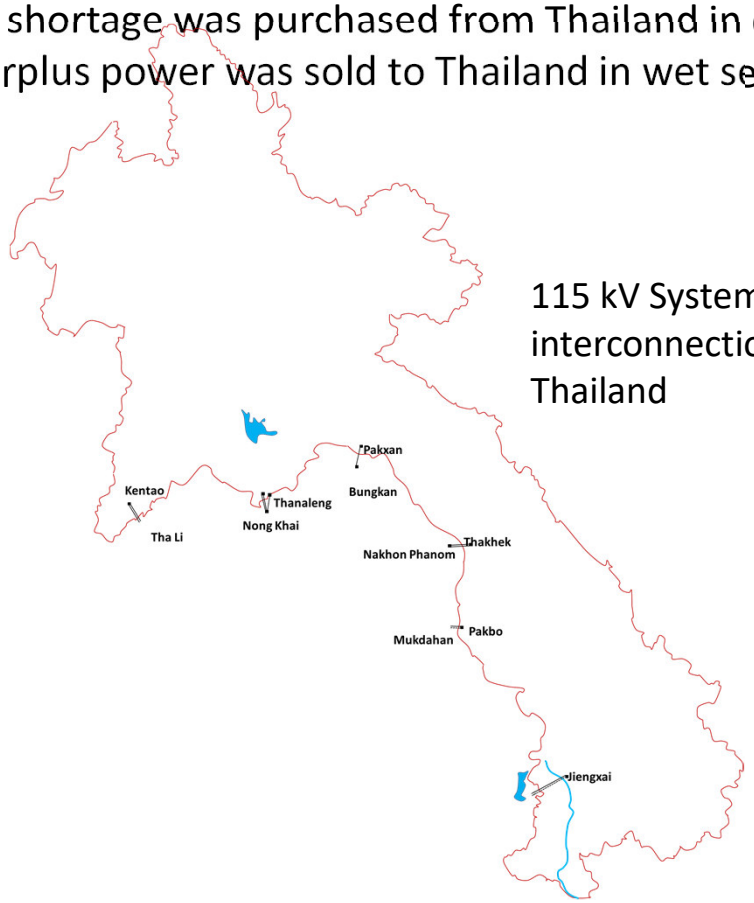


Domestic Power Supply System

Power Supply / Demand Balance in Domestic System Before 2015



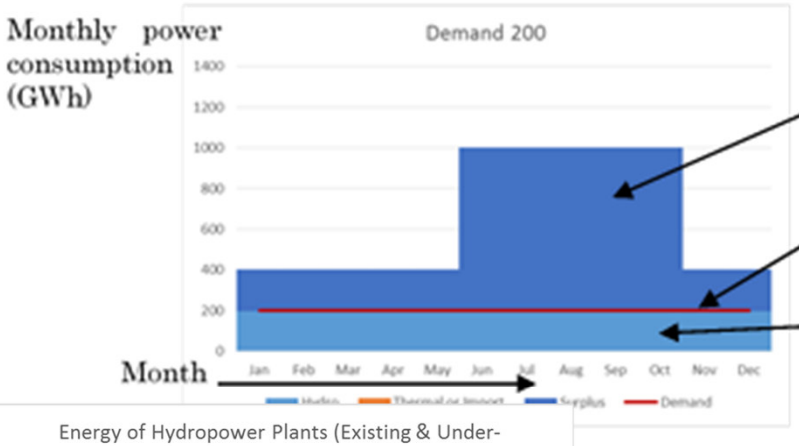
- Before 2015, annual generated energy in domestic system of Laos was approximately balanced.
- Power shortage was purchased from Thailand in dry seasons and surplus power was sold to Thailand in wet seasons.

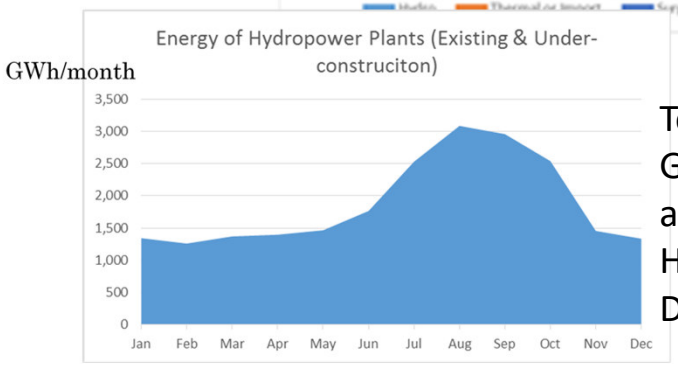


115 kV System to System interconnections with Thailand

Current/Future Power Supply / Demand Balance in Domestic Power Supply System of Laos

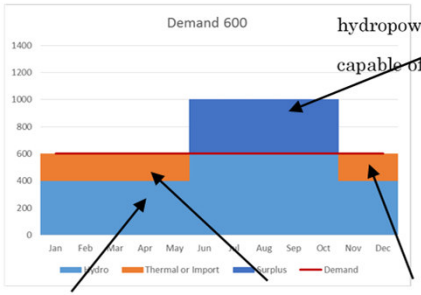
Surplus power occurs in both wet and dry seasons and can be exported to Thailand because of much development of hydropower stations.





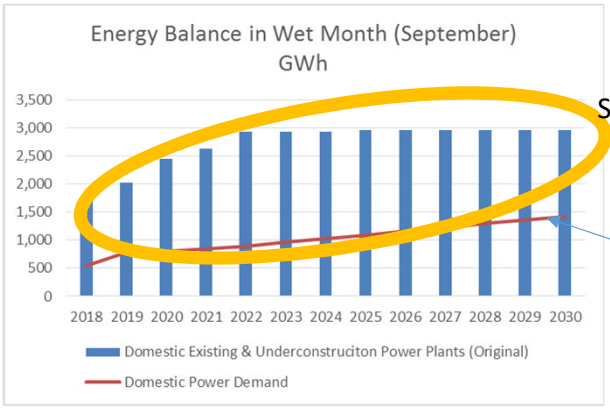
Total Monthly Power Generation Energy of Existing and Under-construction Hydropower Plants for Domestic Power Supply in Laos

Future



Securing Supply Capacity by Thermal Power Plants

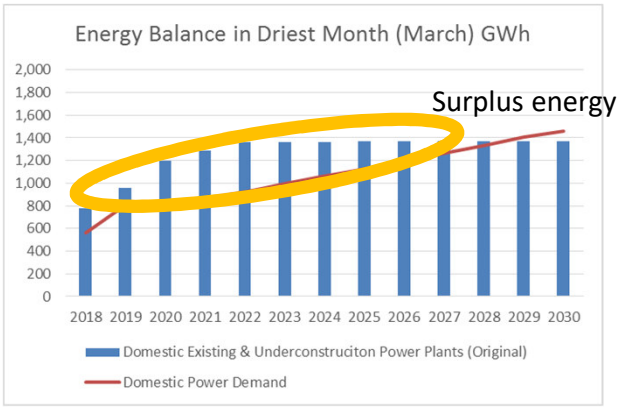
Domestic Power Supply and Demand Balance by Existing and Under-construction Power Stations



Surplus energy

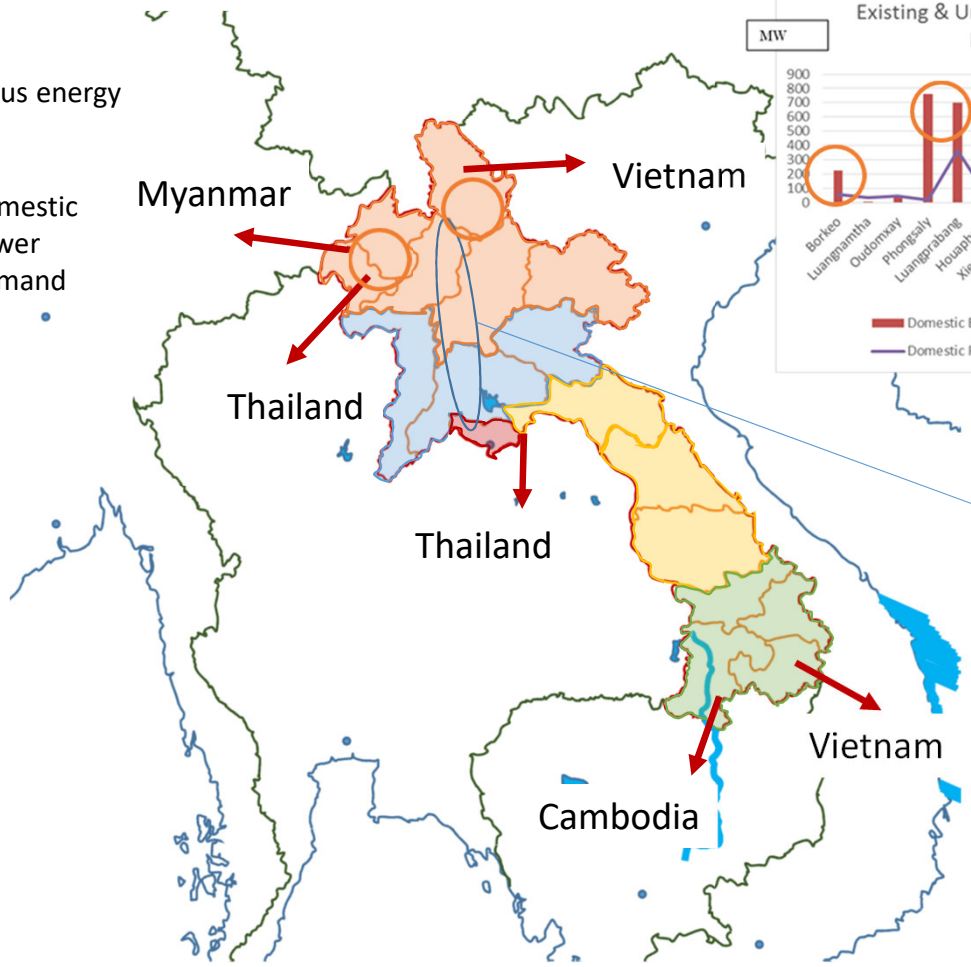
Domestic Power Demand

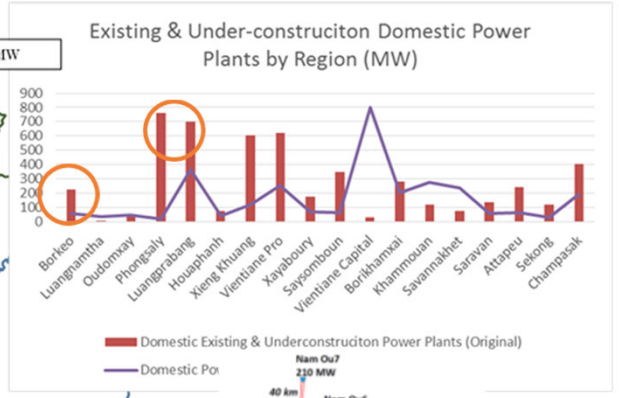
Energy in Wet Month for each year

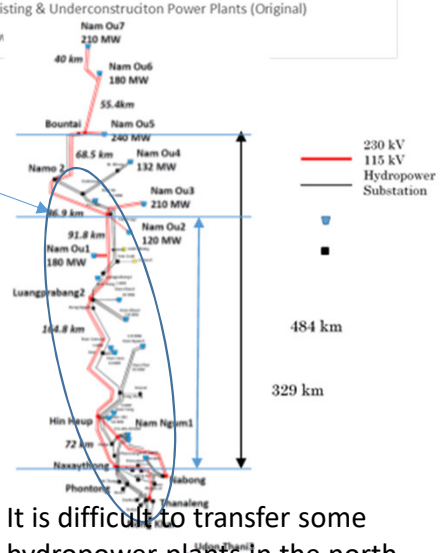


Surplus energy

Energy in Dry Month for each year

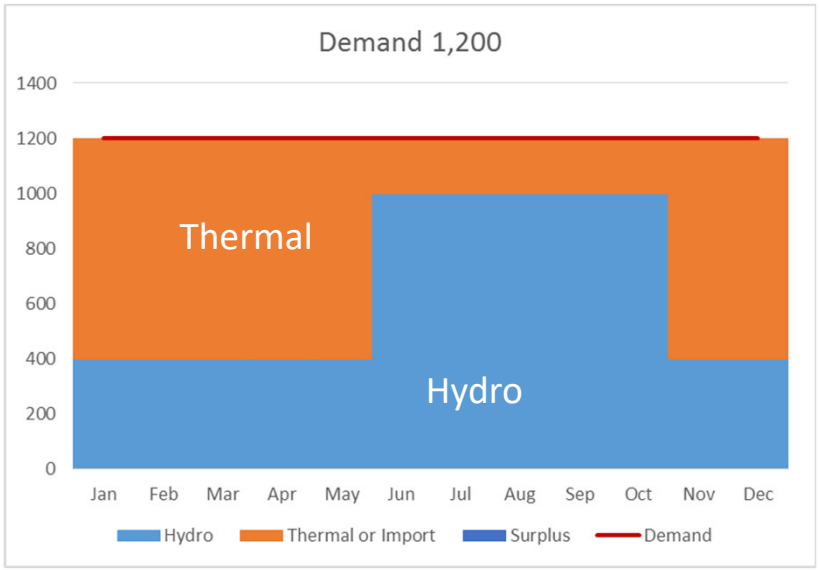






It is difficult to transfer some hydropower plants in the north to Vientiane via existing transmission lines due to the constraints by system stability.

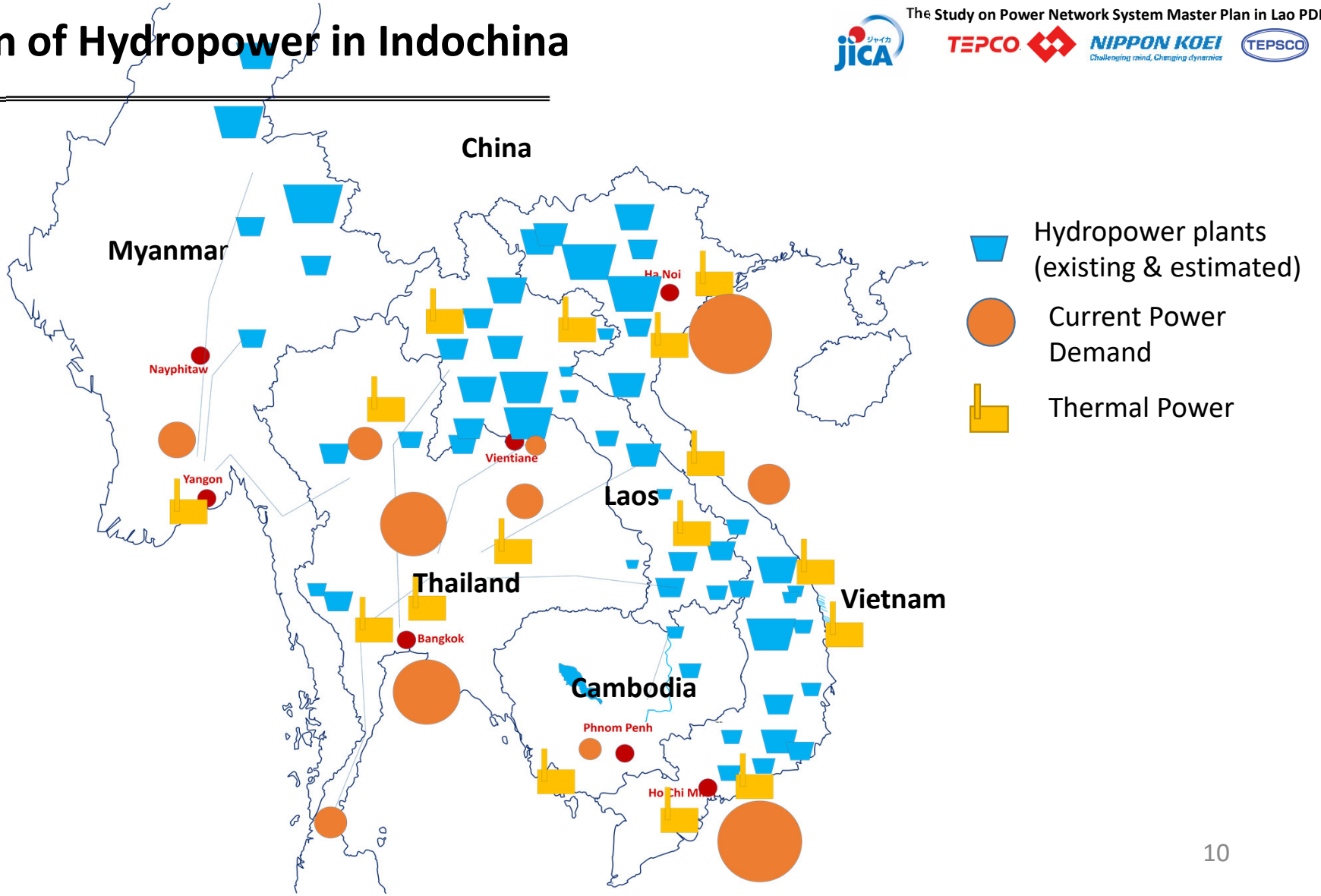
Ideal System Configuration Composed of Hydro-Thermal Generation



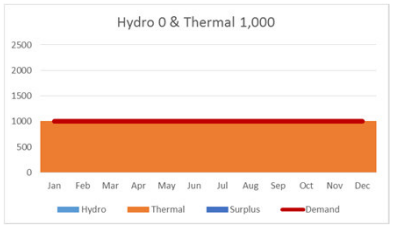
Power demand in combined system of Laos and neighboring countries

Realized by interconnected system of Laos and neighboring countries with enough interconnecting capacity.

Distribution of Hydropower in Indochina

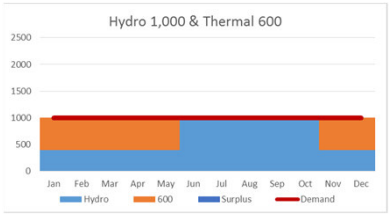


Change in Power Generation Cost Mixed by Hydropower and Thermal Power (Example)

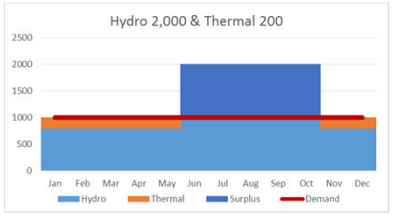


Usc/kWh

8.45



6.93



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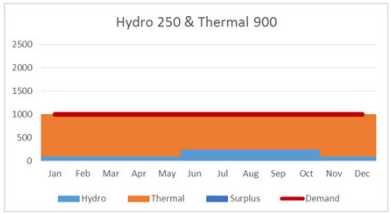

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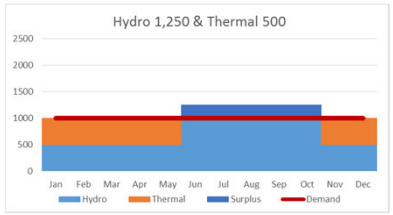

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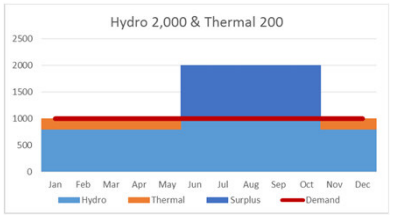

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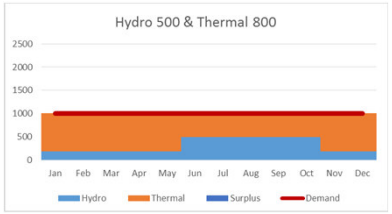

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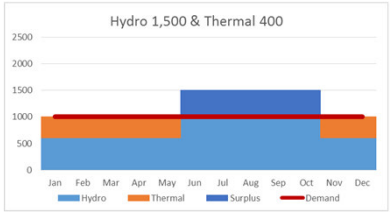
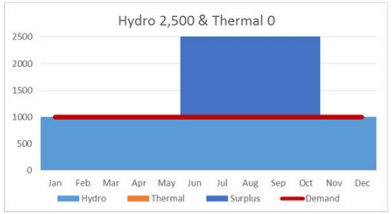
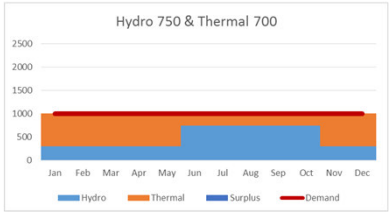


7.64



9.04



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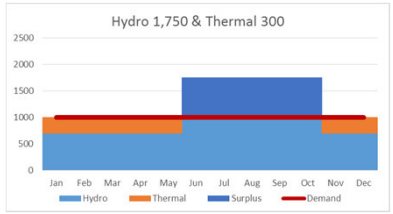
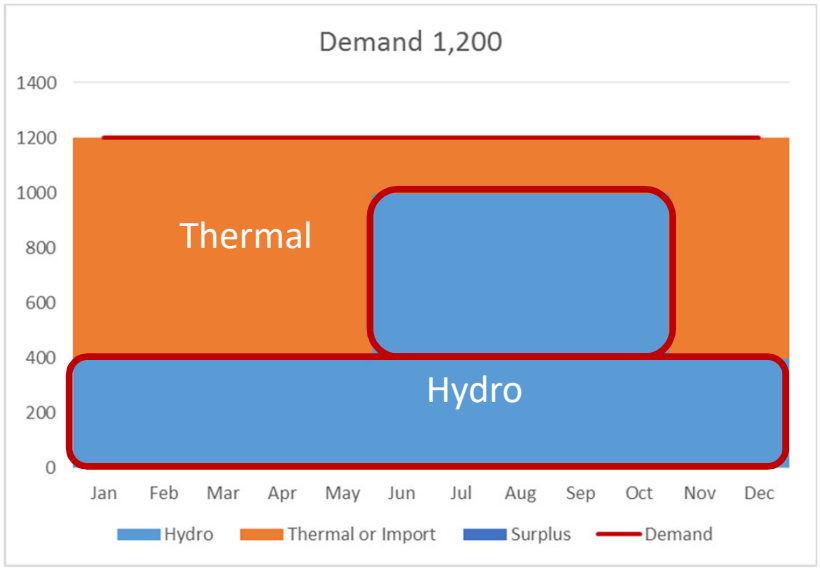


7.99

Fuel	0.07	USD/kWh
Hydro Capacity Cost		2.5million USD/MW
Thermal Capacity Cost		1.0million USD/MW

(Capacity Factor 80% in maximum MW)
(Annual Depreciation Rate 10%)
Hydro Energy: Jan-May, Nov & Dec 2.5times of Jun-Oct

Cost Saving by Alternating Thermal Power to Hydropower



Dry Season | Wet Season | Dry Season

Cost Saving of Thermal Power

- Fuel Cost

- Fuel Cost - Fixed Cost

Cost-up by Hydropower

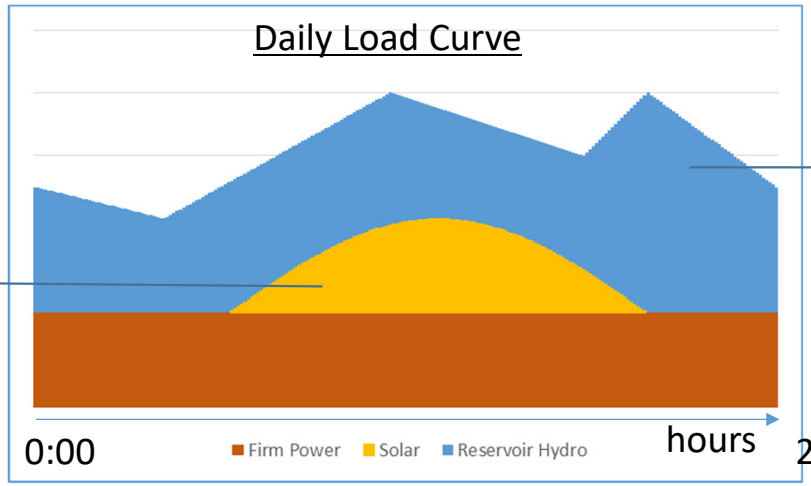
+ Fixed Cost

Benefit → Cost

Payment

Mixing of Hydropower and Other Power Sources

- Power generation cost can be reduced by adequate mixing of hydropower and thermal power by interconnections.
- Seasonal changes in hydropower have to be compensated by the seasonal changes of thermal power. It is preferable for some thermal power plants to make PPA including variable cost part and fixed cost part for seasonal changes in power outputs.
- Reservoir type hydropower easily follow daily changes in renewable power outputs.



Renewable energy (solar power)

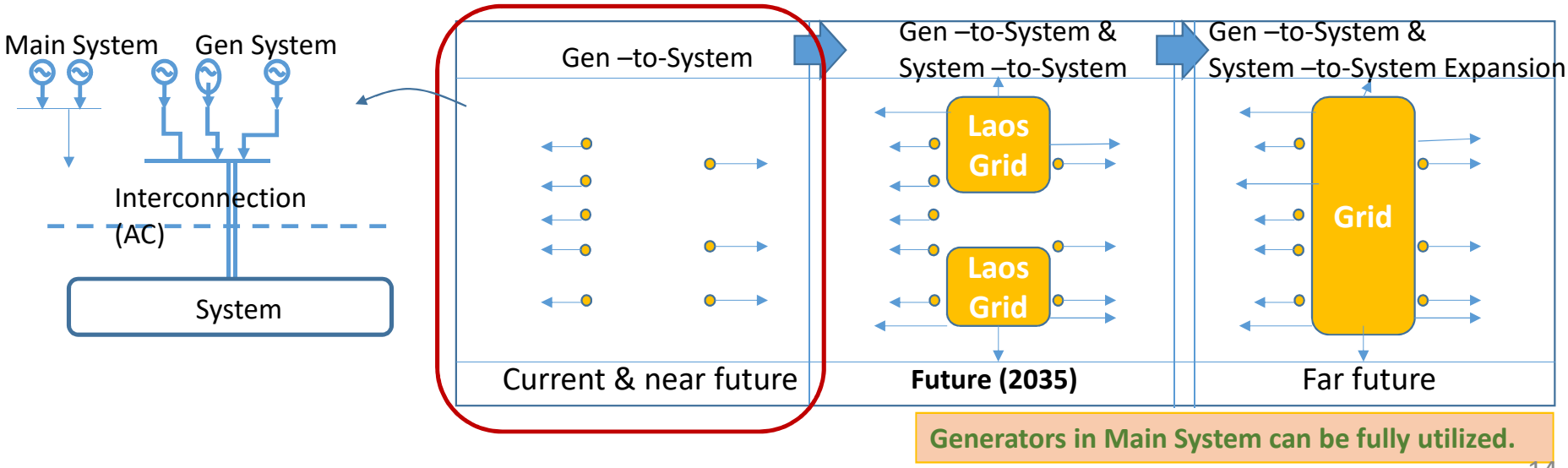
Reservoir hydropower

- To make power supply-demand balancing filling the gap caused by renewable energy in daily load curves
- To respond quickly to control system frequency

Future Interconnections

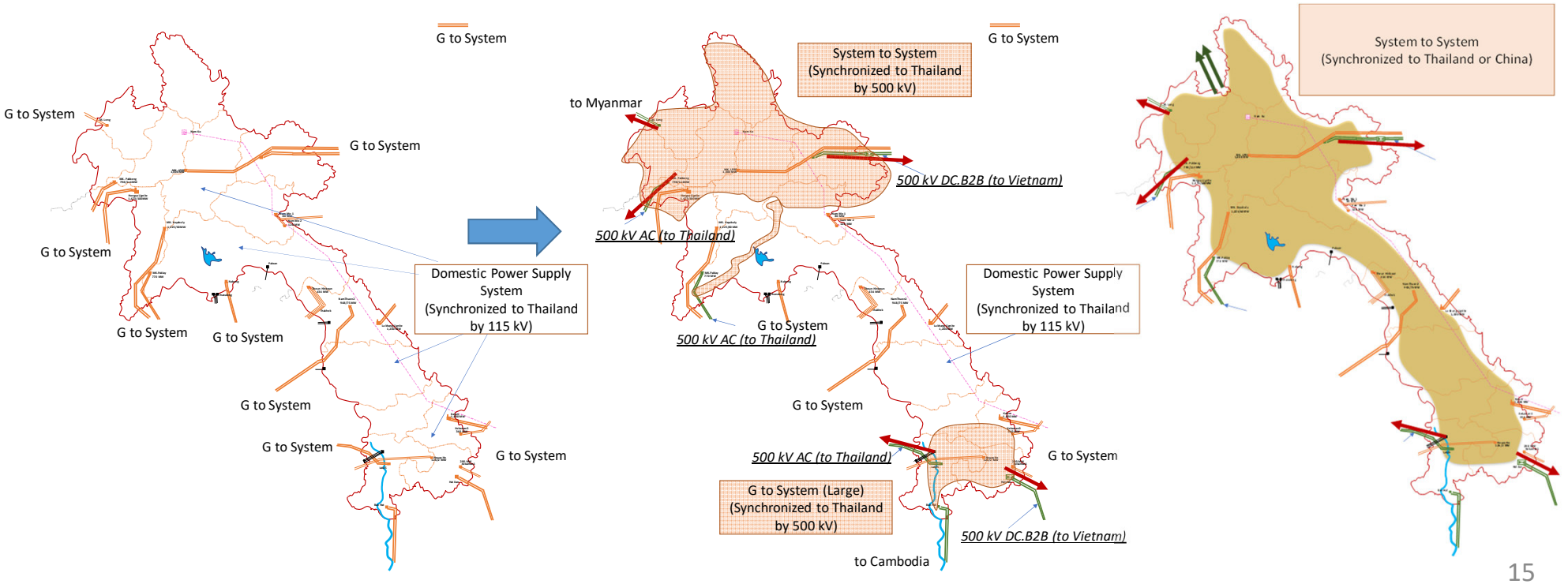
- "System to System"

1. Expansion from "Gen to System" to "System to System" to improve economic efficiency and power supply reliability
2. "System to System" make it possible to realize GMS power trade with fully utilizing the power generation of Laos in future.



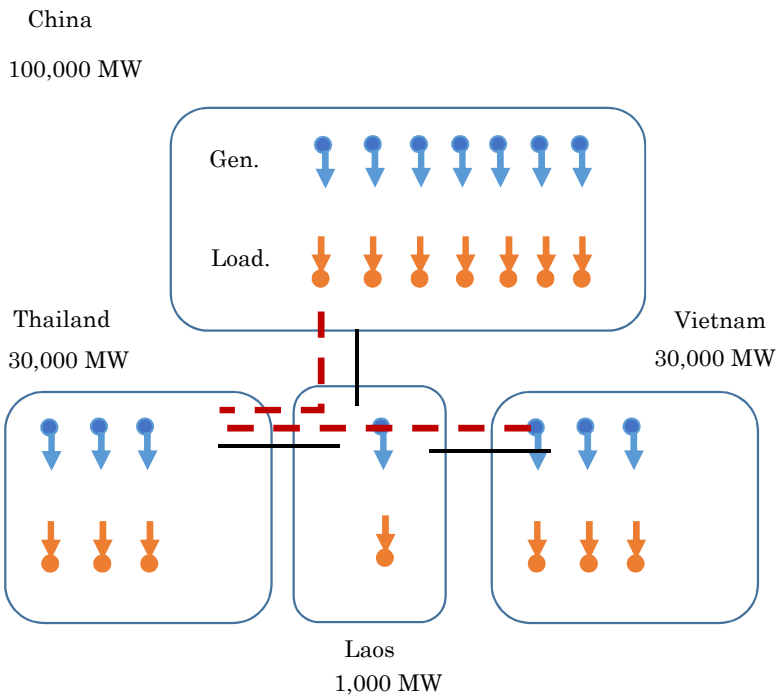
System Configuration for Power Export in Future

-2020	-2025	-2030
Gen-to-System		Gen-to-system System-to-System



Issues for synchronous interconnections around Laos

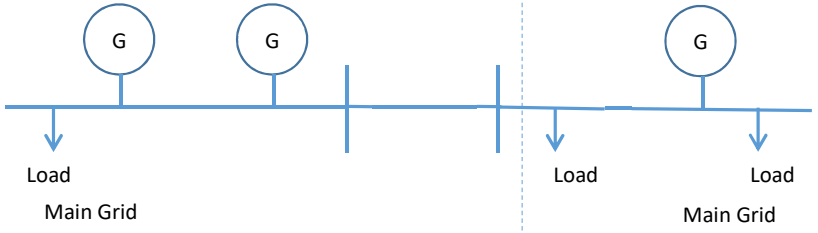
- Domestic power system of Laos is currently synchronously connected to Thailand only by 115 kV interconnections.
- If current domestic power system of Laos is synchronously connected to China or Vietnam, it may cause problems. Because all the generators at synchronous operation are forced to respond the deviation of loads and power outputs in this connected system, large power is going through weak system.(by governors)
- Interconnections may require 500 kV and supporting generators in Laos.



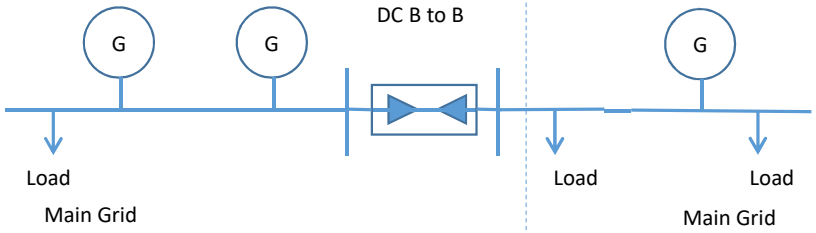
L

Interconnection Method

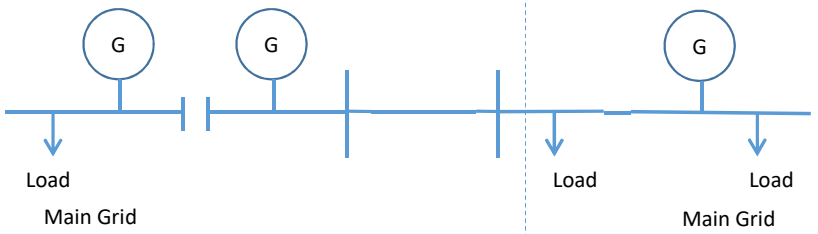
System-to-system (AC)



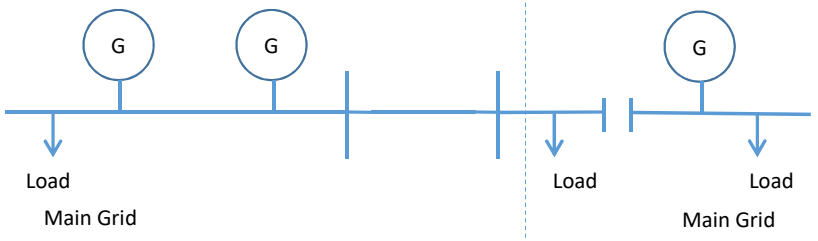
System-to-system (DC)



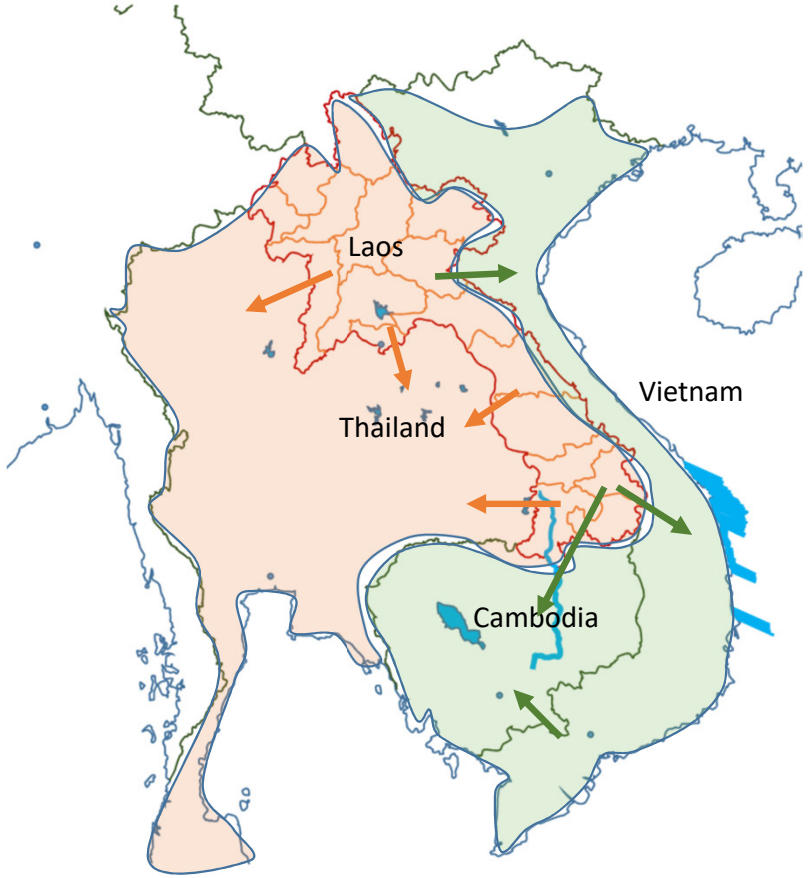
G-to-system (AC)



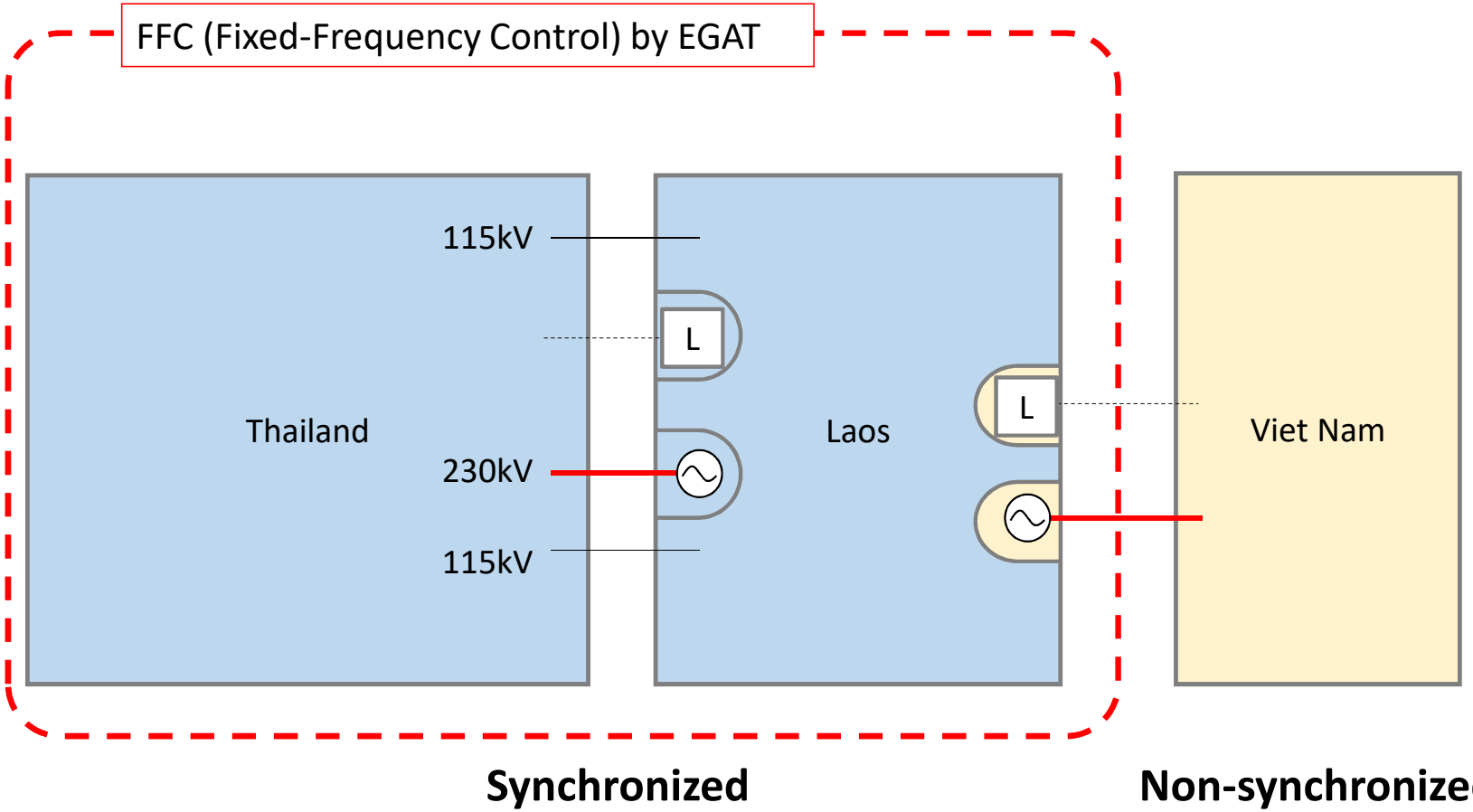
System-to-L (AC)



Current Synchronized Areas

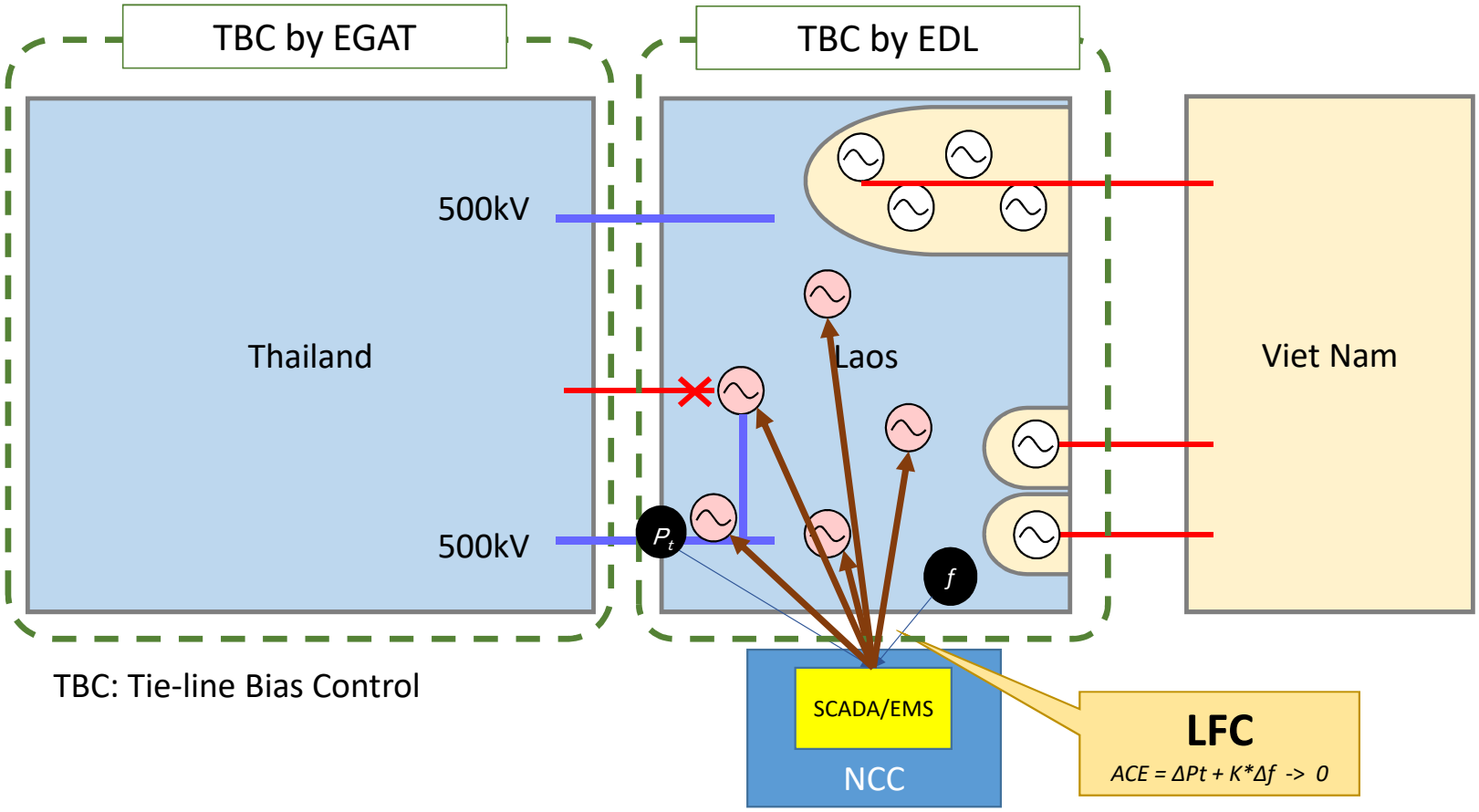


Roadmap for System-to-system – Current Situation



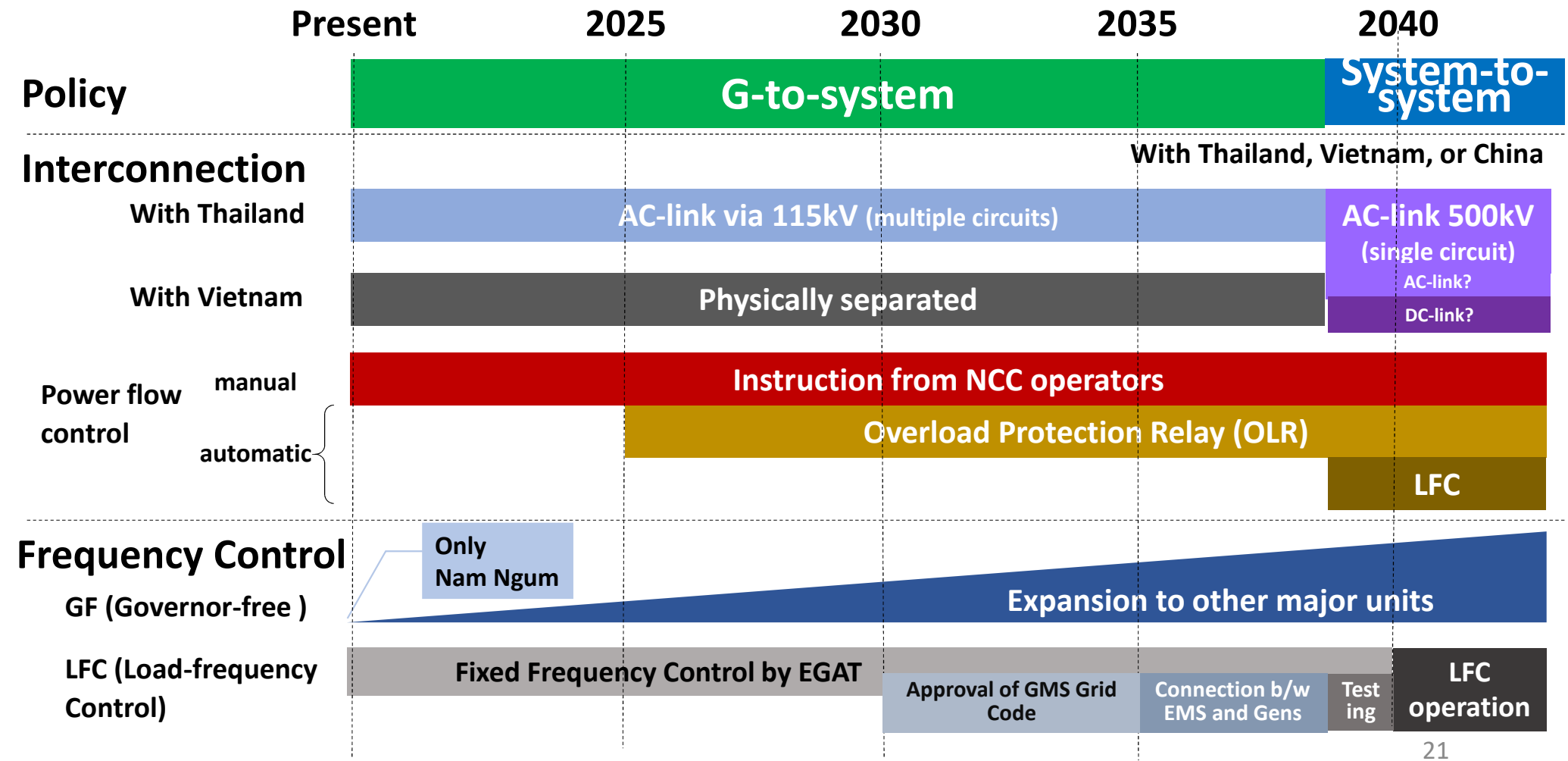
Roadmap for System-to-system

Commencement of LFC

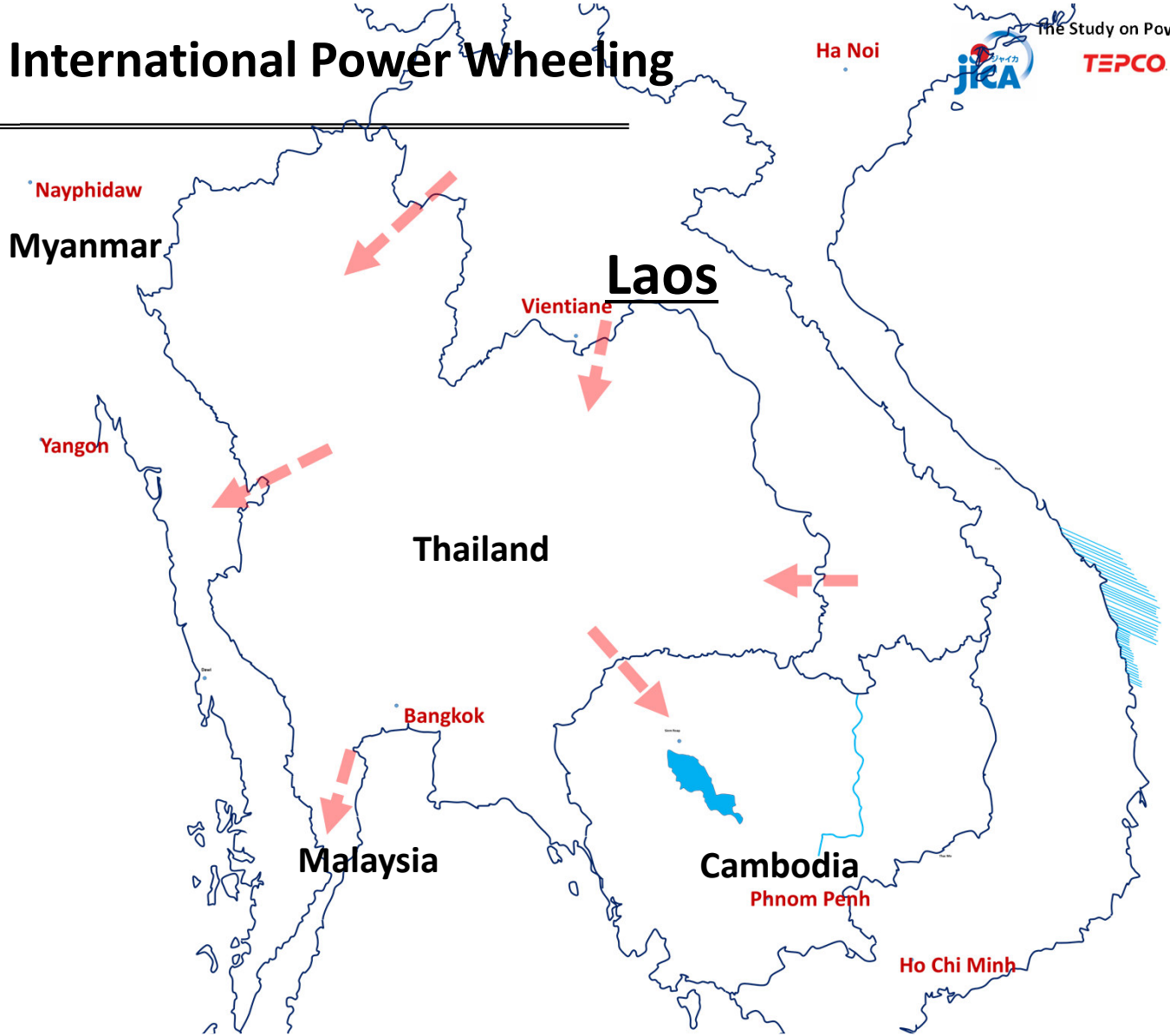


TBC: Tie-line Bias Control

Roadmap for System-to-system – Overview



Concept of International Power Wheeling



Thank you!