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Energy & Environment

World Bank: GMS Power Market Development

Presentation to RPTCC-25 on Task 1
Prepared by: Intelligent Energy Systems

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Task 1: Business Cases for Greater Power Market Integration in the GMS

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TOPICS

1. Focus of today's presentation
2. Objectives of "Task 1"
3. Candidate Cross-border Interconnection Projects
4. Modelling and Approach
5. Modelling Results – Main Findings
6. Integrated case regional transmission expansion
7. Interconnection strategy for the GMS
8. Next steps and conclusion

1. Focus of today's presentation

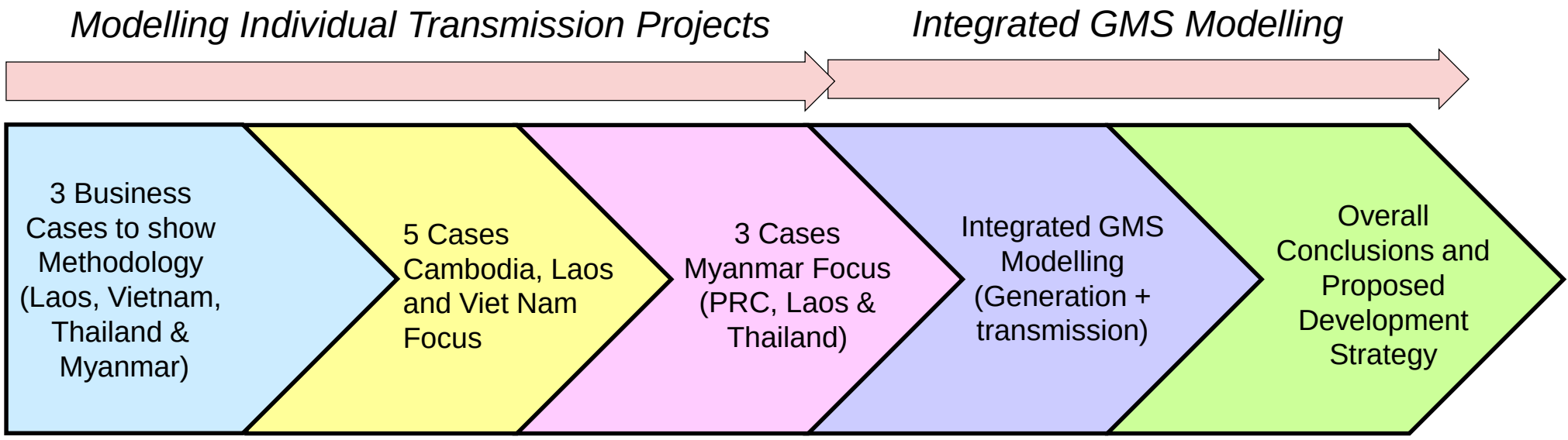
- Brief synopsis on the modelling results of business cases for Greater Power Market Integration in the GMS, with particular focus on the Integrated Case

2. Overview

Task 1 Objectives: Assessment of Business Cases to Support GMS Power Market Integration

- Objective was to assess a number of **business cases (cross-border transmission projects)** that will enhance power market integration in the Greater Mekong Sub-region (GMS)
- The business cases studied were transmission projects that appeared to offer the greatest potential for accelerating electricity trade
- The business cases were subsequently ranked and prioritised to arrive at an **integrated case** which could form the basis of an interconnection strategy for the region, where business cases are prioritised based on:
  - potential to accelerate electricity trade in the GMS
  - those that offer the greatest benefit to the region
- Each **business case** has been presented and discussed in previous RPTCC meetings
- This presentation is intended to provide a recap of the business cases and present the main conclusions of the study

Study Stages



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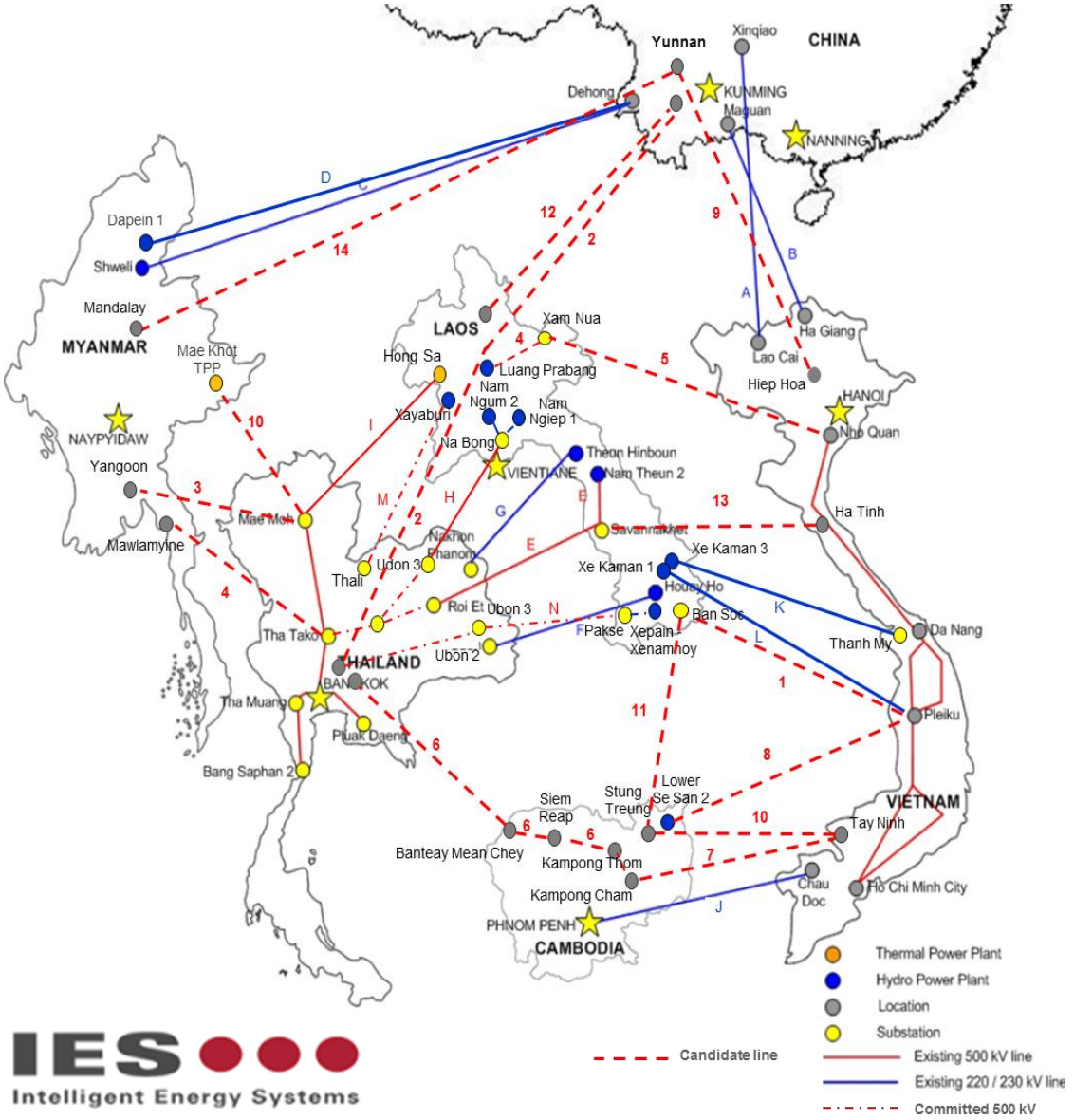
3. Candidate Cross-border Interconnection Projects

GMS Interconnection: Candidate Cross-Border (CB) Projects



- Compiled candidate CB projects based on studies conducted by ADB, APERC, IEA, others + our own understanding
- Many CB projects are about leveraging large-scale hydro potential

* ADB RIF: ADB Regional Investment Framework Implementation Plan
* APERC: Asia Pacific Energy Research Center

Reference:
14 Candidate Cross-Border GMS Projects (1)

No.	From	To	Connection Points (From – To)	Type	Length (km)	Capacity (MW)	Source(s)
1	Lao PDR - South	Viet Nam - Central	Ban Soc/Ban Hatxan – Pleiku	500 kV double circuit	190	1,000	ADB RIF, APERC
2	PRC (Yunnan)	Thailand - Central	Gan Lan Ba – Tha Wung via Lao-N	600 kV HVDC	1,300	3,000	ADB RIF, APERC
3	Myanmar - Central	Thailand - North	Yangon area – Mae Moh	500 kV	350	1,500	ADB, APERC, IEA
4	Myanmar - Central	Thailand - Central	Mawlamyine – Tha Tako	500 kV	300	1,500	ADB RIF, IEA
5	Lao - North	Viet Nam - North	Luang Prabang HPP - Xam Nau (Lao-N) – Nho Quan	500 kV double circuit	400	2,500	ADB, APERC
6	Thailand - Central	Cambodia	Wangnoi – Banteay Mean Chey – Siem Reap – Kampong Cham	500 kV double circuit	500	300	ADB, APERC
7	Cambodia	Viet Nam - South	Kampong Cham – Tay Ninh	500 kV double circuit	100	300	ADB

* ADB RIF: ADB Regional Investment Framework Implementation Plan
* APERC: Asia Pacific Energy Research Center

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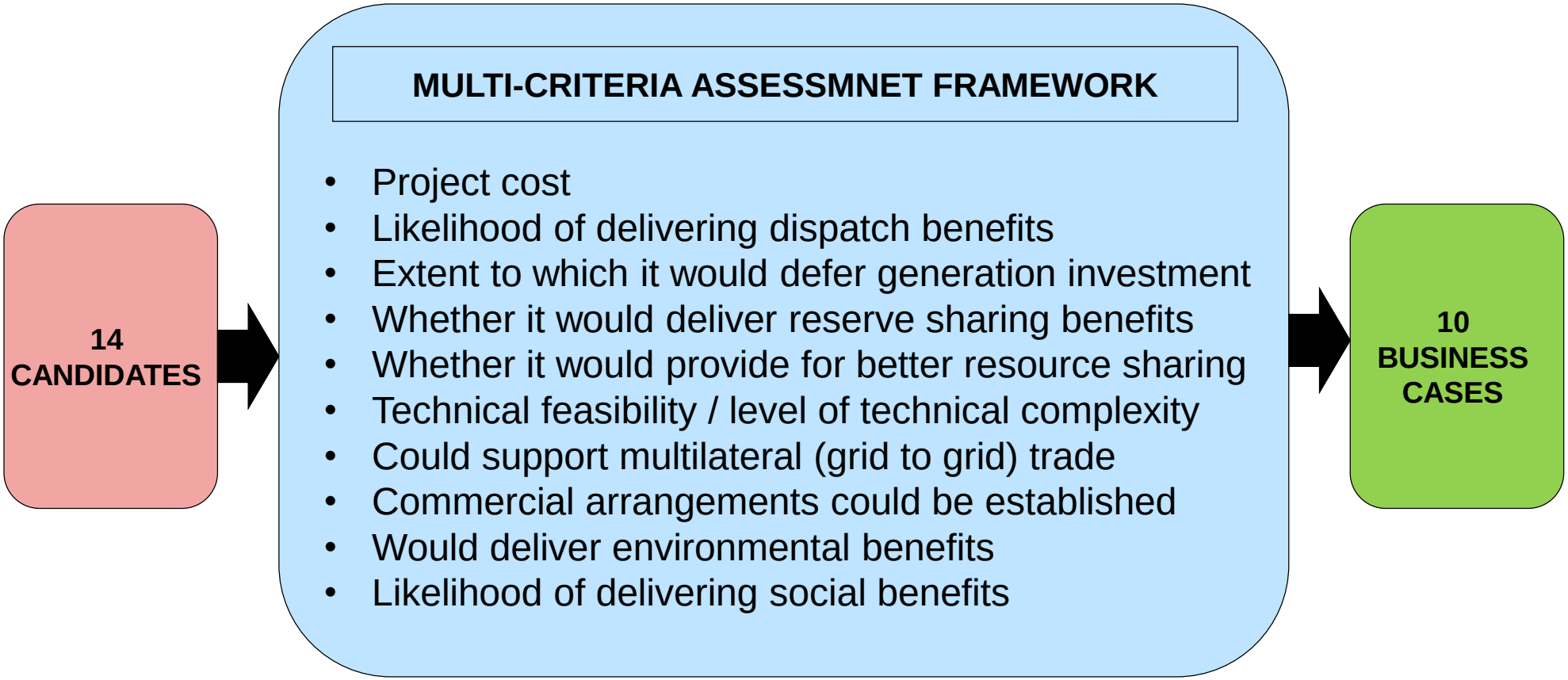
Reference:
14 Candidate Cross-Border GMS Projects (2)

No.	From	To	Connection Points (From – To)	Type	Length (km)	Capacity (MW)	Source(s)
8	Cambodia	Viet Nam - Central	Lower Se San 2 HPP – Pleiku	230 kV double circuit	230 km	200	ADB
9	PRC	Viet Nam - North	Yunnan – Hiep Hoa	500 kV DC	1,200 km	3,000	ADB
10	Myanmar - North	Thailand - North	Mae Khot TPP – Mae Chan	230 kV	115 km	370	ADB
11	Lao PDR - South	Viet Nam - South	Ban Soc/ Ban Hatxan – Tay Ninh via Stung Treng	500 kV	320 km	1,000	ADB, World Bank
12	Lao - North	PRC	Luang Prabang - Yunnan	500 kV	350 km	650	ADB
13	Lao PDR - South	Viet Nam - Central	Savannaket – Ha Tihn	500 kV	200 km	600	ADB
14	Myanmar - North	PRC	Mandalay - Yunnan	500 kV	350 km	600	ADB

We acknowledge that others are possible & interested in RPTCC perspectives on any alternatives that we may consider…

Filtering 14 Candidate Projects to Arrive at 10 Business Cases for Further Analysis



Summary of all Business Cases and the Integrated Case

No.	Region (From)	Region (To)	Connection Points (From – To)	Assumed Length (km)	Sizing Options (MW)	Project Cost (US $m)
1	Lao PDR (South)	Viet Nam (Central)	Ban Soc / Ban Hatxan ⇔ Pleiku	190	500, 1000, 2000	162, 207, 266
2	Myanmar	Thailand (North)	Yangon area ⇔ Moe Moh	350	500, 1000, 2000	298, 382, 490
3	Lao PDR (South)	Viet Nam (South)	Ban Soc / Ban Hatxan ⇔ Tay Ninh via Stung Treng	320	500, 1000, 2000	272, 349, 448
4	Thailand (Central)	Cambodia	Wangnoi ⇔ Banteay Mean Chey ⇔Siem Reap ⇔ Kampong Cham	500	200, 400, 800	187, 374, 480
5	Cambodia	Viet Nam (South)	Kampong Cham ⇔ Tay Ninh	100	200, 400, 600	68, 78, 87
6	Cambodia	Viet Nam (Central)	Lower Se San 2 (HPP) ⇔ Pleiku	230	200. 400, 800	78, 156, 201
7	Lao PDR (North)	Myanmar	Luang Namtha ⇔ Northern Myanmar	150	500, 1000, 2000	510, 654, 840
8a	Myanmar	PRC	Mandalay ⇔ Yunnan	500	Only 1000	872
8b	Myanmar	PRC	Yangon ⇔ Yunnan	350	Only 1000	327
9	Lao PDR (North)	Viet Nam (North)	Luang Prabang (HPP) ⇔ Xam Nau (Lao-N) ⇔ Nho Quan	400	1500, 2500, 3500	420, 640, 896
10	Integrated case: Optimised timing and sizing of all business cases 1-9				Dynamic	As per above

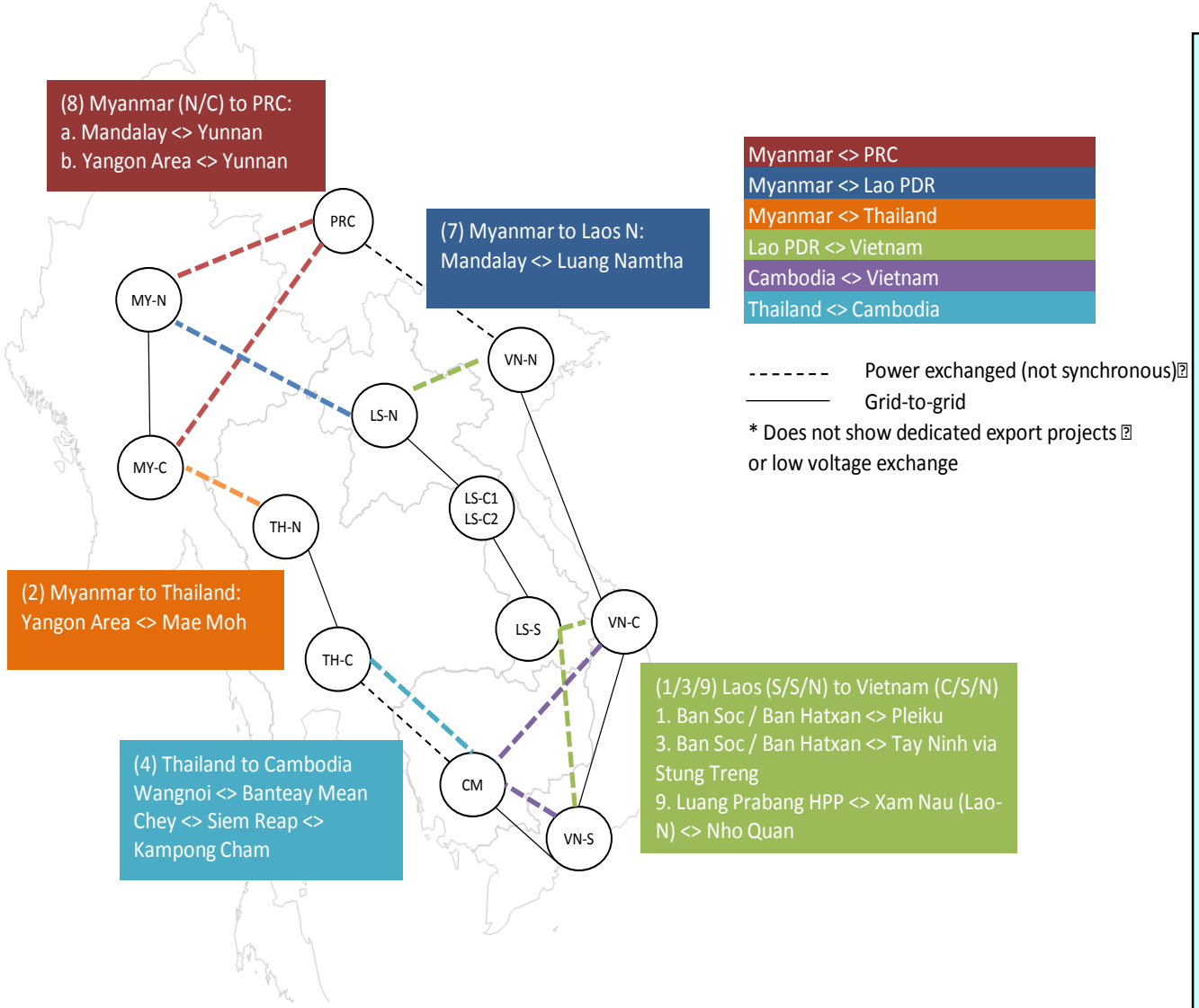
Studied in Integrated Case Only

Laos ⇔ Viet Nam

Cambodia ⇔ Viet Nam or Thailand

Myanmar ⇔ Lao PDR, PRC or Thailand

Illustration of All Business Cases Studied



- Many businesses cases are focused on supporting hydro exports in the region
- Opens up export opportunities for Laos to develop hydro resource
- Connections between Viet Nam and Thailand
  - Via Lao PDR and/or Cambodia
  - Integral in establishing regional power market given they are two of the largest grids in the GMS (besides the CSG in PRC)
- Benefits from avoided costs of capacity and generation cost savings
- Potential for supply diversification and reserve sharing between countries:
  - Hedges against low inflow years for hydro
  - Allows for higher renewable penetration

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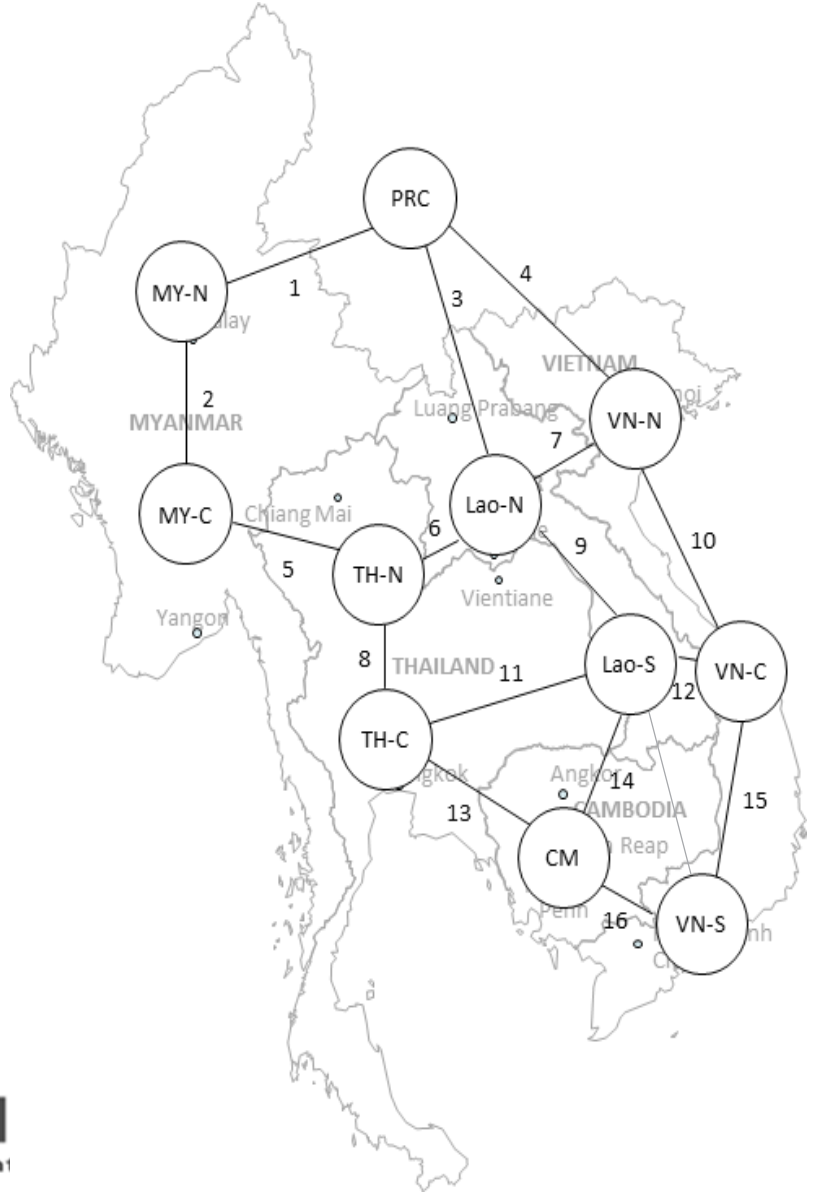
4. Modelling and Approach

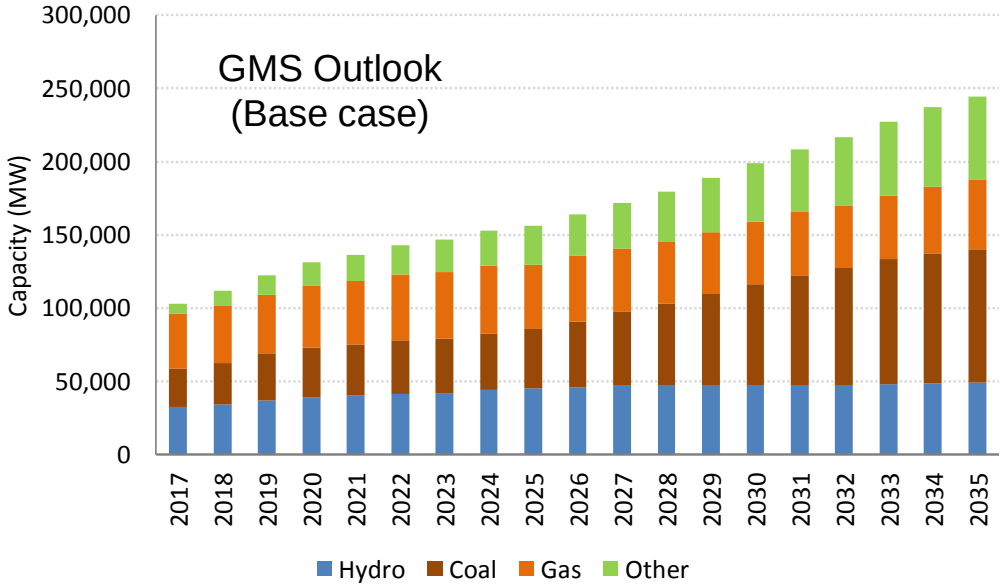
Regional Transmission Model for Economic Cost-Benefit Assessment



- Regions chosen to correspond to major load and generation centers and/or to coincide with connection points of interest
  - For some business cases we may need to disaggregate some regions further
- HV connections + some MV connections that are important
- Suitable for high-level economic cost-benefit analysis and understanding general patterns in power flows over a variety of scenarios:
  - Different hydrological conditions
  - Demand growth scenarios
  - Renewable energy expansion
  - Emissions constraints
  - Allow different possible technology mixes
- Power system modelled from 2016 to 2035

Step 1: Base Case Outlook

- The Base case sets out a baseline from which to compare costs and benefits associated with developing the various Business Case links (at country and GMS level)
- Base case assumes GMS countries continue developing projects as per stand-alone power development plans and medium demand growth outlook (i.e. no Business case link in place)
- Intra-country network allowed to be augmented in model on a least-cost basis
  - includes Myanmar, Vietnam and Laos national transmission system
  - provides an understanding on how national power systems may need to be expanded in support of cross-border power trade



Base case has minimal cross-border trading and the increasing demands across the GMS is predominantly met by coal and gas over the long-term (Vietnam, Thailand, Myanmar, Cambodia)

Chart depicts minimal hydro development

Step 2: Individual Business Case Assessments

For each individual Business case, we assess the GMS outlook:

- Include Business Case project when modelling the GMS outlook. This is done separately for each transmission size option
- Business Case projects are assumed to be operational from year 2020
- Analyse the following costs and benefits associated with the outlook to 2035 (non-financial impacts are also quantified) and compare to Base Case:
  - Investment cost of developing Business case link (Project cost)
  - Differences in generation ⇔ fuel cost and variable opex savings
  - Differences in generation capacity build ⇔ deferred / avoided capex + fixed opex
    - Or sometimes capacity that needs is developed earlier (less common)
  - Differences in national transmission expansions (cost of supporting of cross-border power trade)

Step 3: Integrated Case

- **Integrated GMS Case**:
  - Put all **candidate** cross-border transmission projects as options that the model could develop and let it decide which business case projects (**regional transmission projects**) to build
  - Allow **national transmission links** to be upgraded as required to support regional trade
  - All cross-border transmission projects are modelled as continuous i.e. no lumpy investment – this is to understand the "optimal" sizes
  - The model will optimise the GMS development outlook (least-cost) with respect to which Business case to prioritise (sizing and timing) and where to build generation and what type
- Similar to previous step, compare Base case to Integrated Case with benefits (and costs) over period from 2017-35 mainly defined by:
  - Differences in generation capacity build ⇔ deferred / avoided capacity or possibly capacity that needs to be developed earlier (not so common)
  - Differences in generation costs ⇔ fuel cost savings
  - Differences in national transmission expansions ⇔ deferred / avoided transmission upgrades or possibly transmission upgrades that need to come earlier (quite common)
  - Cost of cross-border transmission projects
- Gain insight into "big picture" implications for national grids, and priority projects for the GMS

Business Case (Transmission Project) Assessment Framework – Filter the List

Economic	• Evaluation of costs and benefits • Avoided fuel costs and deferred investment • What country / countries benefit?
Technical	• Reserve sharing • Improved use of existing resources (G & T) • Implications for national grids (synchronization, operations, congestion & stability)
Commercial	• Compatibility with multi-lateral trade • Existing regulatory arrangements pose minimal barriers
Environmental	• Avoided emissions and other externalities • Better use of existing infrastructure • Well-matched to Renewable Energy (RE) potential

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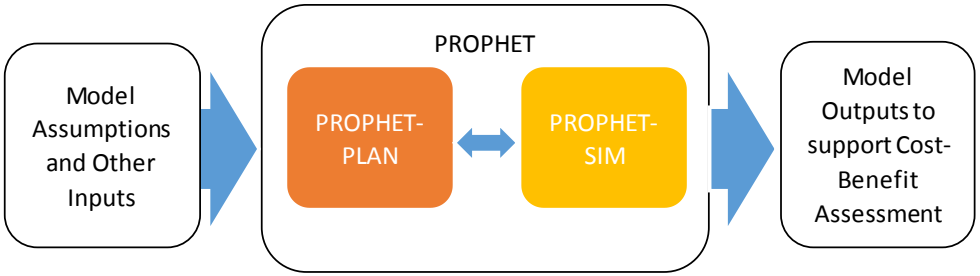
Reference: Modelling Platform

Key Inputs:

- Generators + existing (regional) transmission system
- Demand
- Fuel prices and cost structures of generators
- Hydro availabilities based on wet and dry seasons
- Renewable resource seasonality across the year based on analysis of monthly GMS irradiance and wind speed measurements converted to generation profiles
- Transmission cases being studied



Scenarios:

- Base Case based on existing PDPs
- Business case scenarios for different transfer capabilities – e.g. 500 MW, 1000 MW, 2000 MW
- Possible scenarios to stress test the business case:
  - Low hydro availability (to analyse the benefits of reserve sharing)
  - Higher RE cases to understand whether the business case is complementary to higher RE development in the GMS
- Model period: 2017-2035
- Model typical days (hourly) per month in each year to reflect: seasonality and daily profiles

Key Outputs:

- Capacity development and capital costs
- Generator dispatch
  - Fuel costs
  - Operational costs
- Transmission flows and direction (at the regional and intra-country level)
- Emissions

PROPHET:

- PROPHET-PLAN is a least cost generation expansion planning tool
- PROPHET-SIM is a Monte Carlo economic dispatch simulation model

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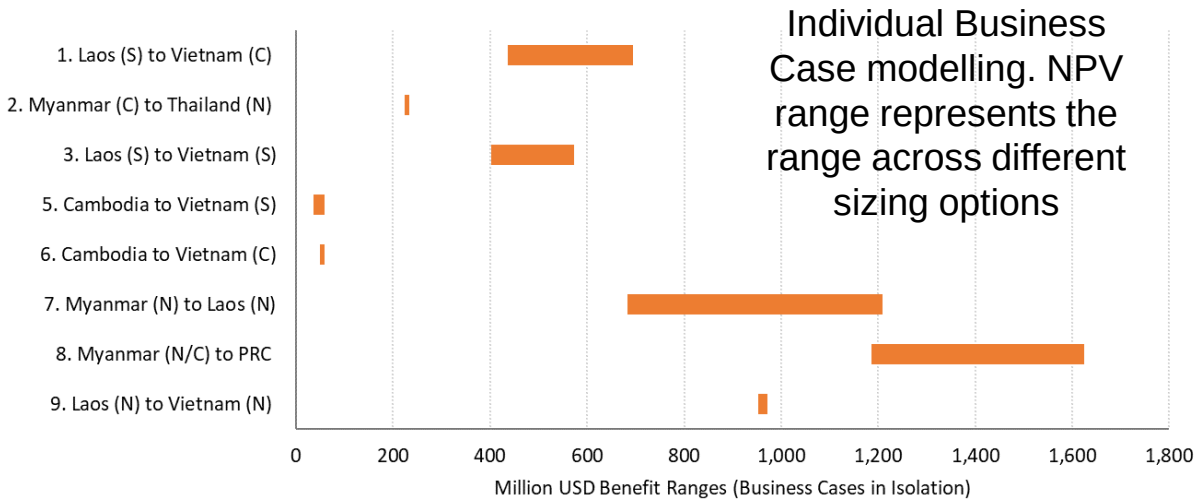
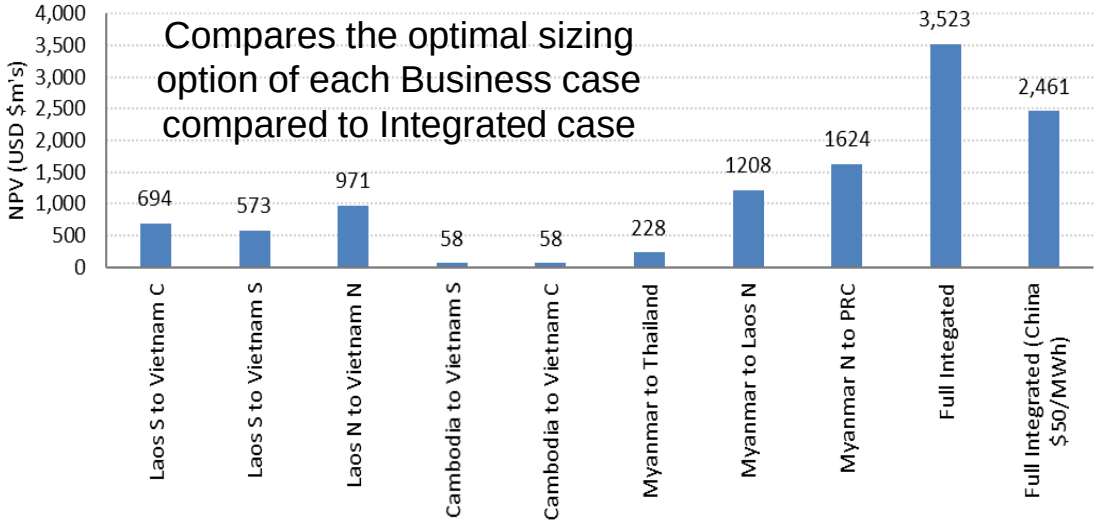
5. Modelling Results – Main Findings

Costs and Benefits of Integration

- Significant benefits and opportunities arising from cross-border trading across the GMS:
  - avoiding additional generation investments (demand and supply diversification, better utilisation and reserve sharing)
  - deferring the need for national transmission upgrades (but need to strengthening the Laos grid)
  - avoiding higher power generation costs as individual countries have different LCOE's
  - Lower emissions across the GMS and ability to integrate higher renewables
- The modelling carried out in this study also shows that there are significant benefits from greater integration of Laos with its neighbouring countries.
- In the near-term, Laos could play a role in terms of providing additional power supplies to Myanmar and Vietnam with immediate short-term cost reductions, and over the longer-term for Thailand.
- Most of the benefits associated with the Integrated Case are the result of alleviation of Myanmar's short to medium term tightness in supply, use of surplus power from PRC, and use of hydro resources in Laos for exports to Vietnam and Myanmar.
- These benefits arise from only a limited number of interconnections that were studied, specifically the Myanmar to PRC and Laos, and Laos to Vietnam business cases.

Business Case NPV Ranges





- Each business case resulted in positive net present values (NPV) ranging from US$36 million to US$1.6 billion) arising from a deferral or avoidance of generation investment, and highly significant reductions in power generation costs
- Results show that there is a subset of the individual business cases that show significantly higher benefits as a consequence of hydro displacing coal and gas generation.
- In general, power systems with dominant hydro or relatively low-cost exports (particularly Laos and PRC) are able to offset more expensive generation sources and reduce the system costs in Myanmar, Thailand and Vietnam.

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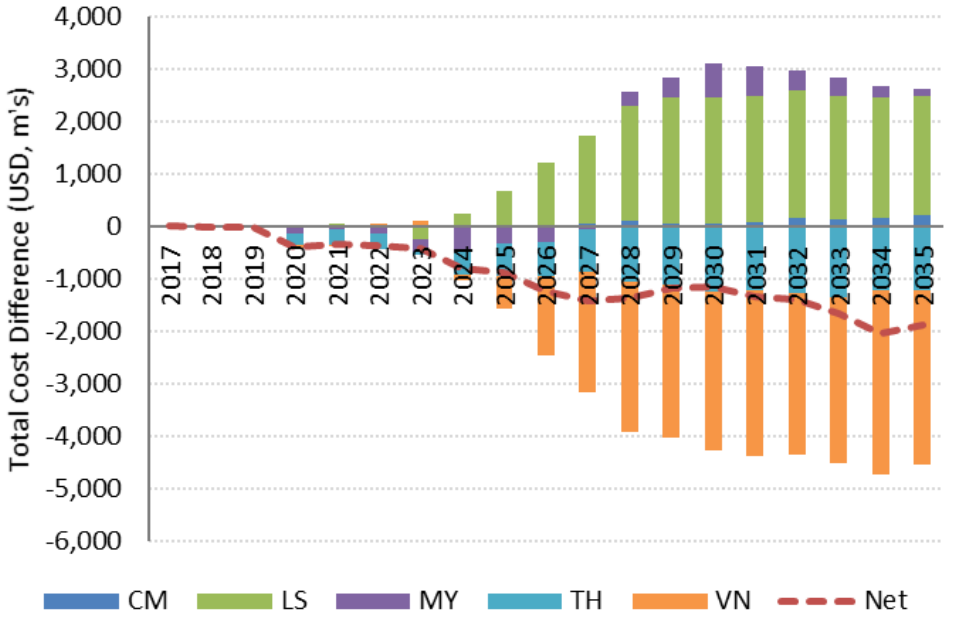
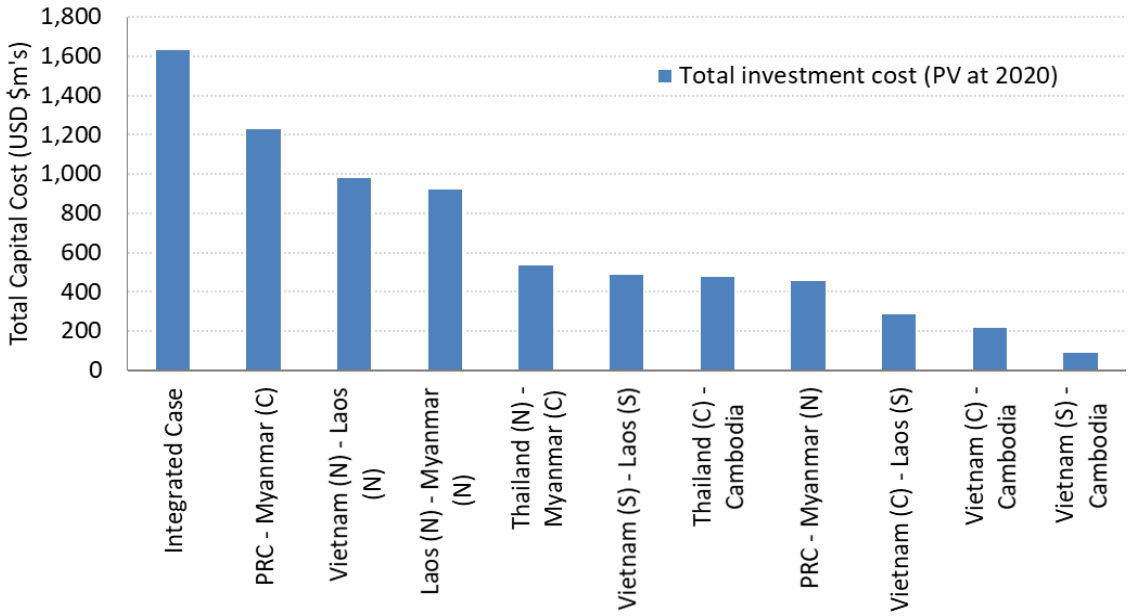
Total Generation Cost Difference by Country (Integrated Case)

- Below chart shows significant developments (investments) in Lao PDR drive a lot of the generation cost reductions (benefits) in Vietnam and Thailand.
- Cost of national grid transmission augmentations
  - Relieve total investment required to augment the Myanmar and Vietnam grids
  - Increase the importance of the Laos network in connecting the region
- Net benefit is approximately $440m by 2035



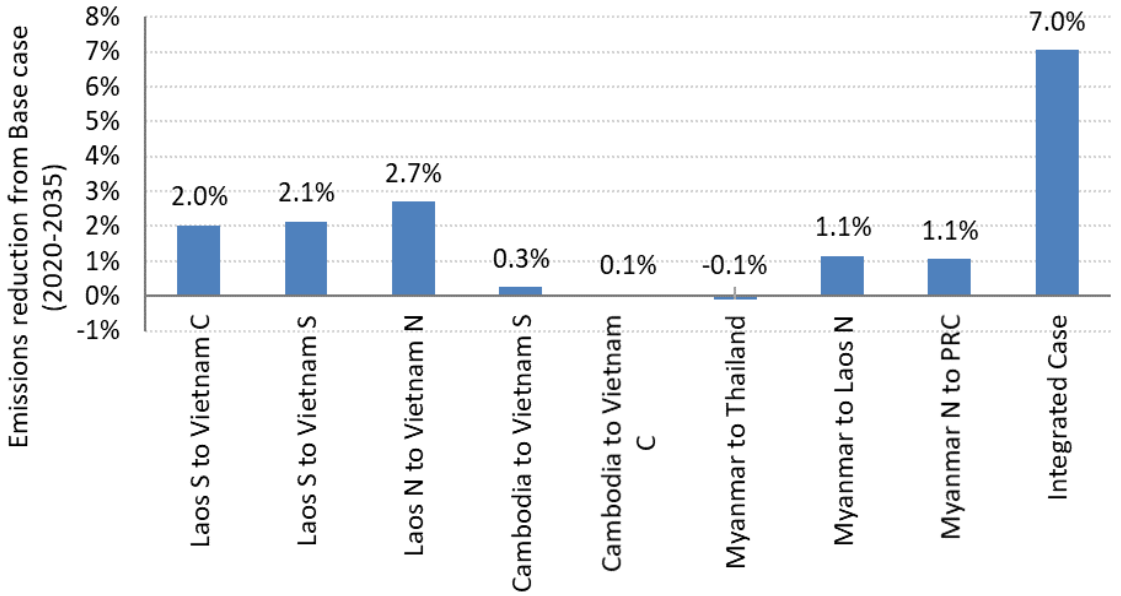
Total Transmission Investment Cost (Ordered)

- Comparing total transmission investment cost (excluding national transmission augmentations) across the individual business case links and the Integrated case on a present value basis.
  - the cost of the Integrated case is much smaller than the sum of the individual business case link investment costs, supporting the notion that prioritisation will be key in maximising the benefit across the GMS.
- The Integrated case is based on developing the optimal business case link capacities incrementally over time compared to the individual cases which were assumed to be in place at their full sizing at 2020



Carbon Emissions Reduction (Optimal Business Cases and Integrated Case against Base Case)

- Carbon emissions are lower than that of the Base case by approximately 7% from 2020 to 2035 with a reduction in coal fired generation across the GMS.
- By 2035, Integrated case results in 60 million tons of CO2 emissions reduction from Base case
- On a standalone basis individual business cases reduce carbon emissions by up to 2.7% between 2020 and 2035



- Most of the emissions reductions in the Integrated case arise from Laos hydro displacing thermal generation located in Vietnam
  - Benefits have not been quantified in addition to the reduction in generation costs.

Benefit Summary

GMS Integration

- Avoid additional generation investments
- Defer the need for national transmission upgrades
- Avoid higher power generation
- Diversification benefits in providing relief to countries from under-investment in generation
- Ability to integrate higher renewables
- Better utilisation of hydro resources from diversification in:
- hydrological conditions
- demand profiles of the interconnected countries

Laos supporting the GMS

- Provide additional power supplies to Myanmar and Vietnam
  - Improvement in Myanmar's short to medium term tightness in supply
  - Use of hydro resources in Laos for exports to Vietnam and Myanmar
- Immediate short-term cost reductions in above countries
  - Long-term cost reductions in Thailand
  - Use of surplus power from PRC
- Benefits resulted from studying only limited number of business case interconnections:
  - Myanmar to PRC
  - Myanmar to Laos
  - Laos to Vietnam

6. Integrated Case Regional Transmission Expansion

Business Case Link Timing and Expansion Summary (Integrated Case)

- Integrated Case modelling results in least-cost business case expansions + national transmission network augmentations that would support them
- We take the results and formulate a more concise set of investments for the region

BC No.	Region (From)	Region (To)	Regional Transmission Expansion	Earliest Year Allowed
1	Lao PDR (South)	Viet Nam (Central)	• 1200 MW developed in 2022 • 1200 MW => 1400 MW by 2030 • 1400 MW => 2000 MW by 2035	2022
2	Myanmar	Thailand (North)	• 550 MW in 2025 • 1550 MW developed by 2030 • 2000 MW developed by 2035	2025
3	Lao PDR (South)	Viet Nam (South)	• 800 MW in 2025 • 800 MW => 2000 by 2028	2025
4	Thailand (Central)	Cambodia	• 100 MW => 300 MW in 2027 • 300 MW => 700 MW in 2032	2025
5	Cambodia	Viet Nam (South)	• 200 MW => 470 MW in 2023 • 470 MW => 600 MW by 2033	2022
6	Cambodia	Viet Nam (Central)	• 250 MW by 2026/27	2025
7	Lao PDR (North)	Myanmar (North)	• 1100 MW in 2023 • 1100 MW => 2000 MW by 2033	2022
8a	Myanmar (Mandalay)	PRC	• 800 MW developed from 2025 • Expanded to 1000 MW in the longer-term	2025
8b	Myanmar (Yangon)	PRC	• 8a is the preferred option	2025
9	Lao PDR (North)	Viet Nam (North)	• 570 MW developed in 2025 • 2500 MW in place by 2029	2025

Proposed Development Strategy for Cross-Border Expansions

- Rearranged cross-border expansions by chronological order to form a possible strategy for enhancing cross-border trade over time
- Priority projects and augmentation timings, based on:
  - size of the business case augmentation
  - estimated augmentation costs
  - greatest economic benefits to the region.

Period	Priority Business Case Augmentation	From Region	To Region	Expansion From (MW)	Expansion To (MW)	Estimated Cost ($m)
2022-24	✓	Lao PDR (South)	Viet Nam (Central)	0	1200	154
		Cambodia	Viet Nam (South)	200	470	29
	✓	Lao PDR (North)	Myanmar (North)	0	1100	466
2025-27	✓	Lao PDR (North)	Viet Nam (North)	0	1400	365
	✓	Myanmar (Mandalay)	PRC	0	800	168
	✓	Myanmar	Thailand	0	670	163
	✓	Lao PDR (South)	Viet Nam (South)	0	1700	385
		Cambodia	Viet Nam (Central)	0	250	63
		Thailand (Central)	Cambodia	80	270	101
2028-30	✓	Myanmar	Thailand (North)	670	1550	215
		Lao PDR (South)	Viet Nam (Central)	1200	1400	31
		Lao PDR (South)	Viet Nam (South)	1700	2000	62
	✓	Lao PDR (North)	Viet Nam (North)	1400	2400	255
Beyond 2030	✓	Lao PDR (South)	Viet Nam (Central)	1400	2000	79
	✓	Myanmar	Thailand (North)	1550	2000	111
	✓	Lao PDR (North)	Myanmar (North)	1100	2000	373
	✓	Myanmar (Mandalay)	PRC	800	1000	30
		Thailand (Central)	Cambodia	270	730	252
		Cambodia	Viet Nam (South)	470	600	14

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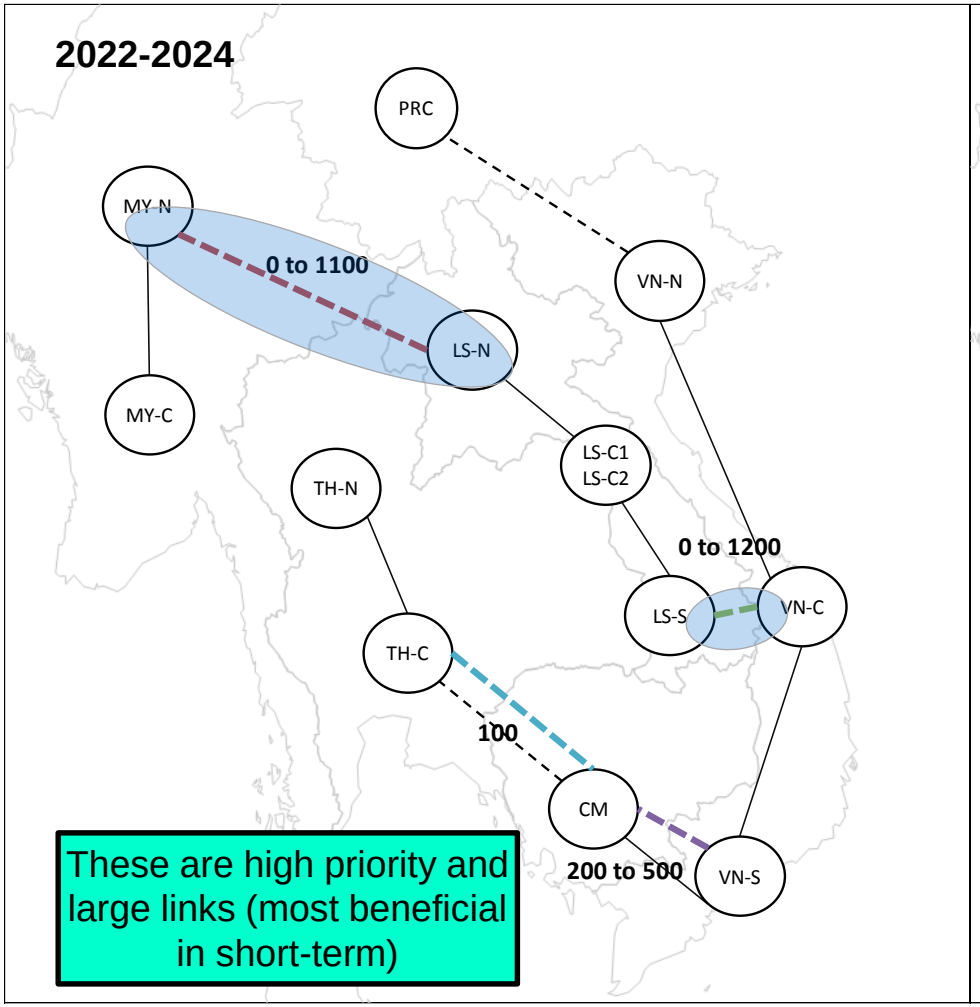
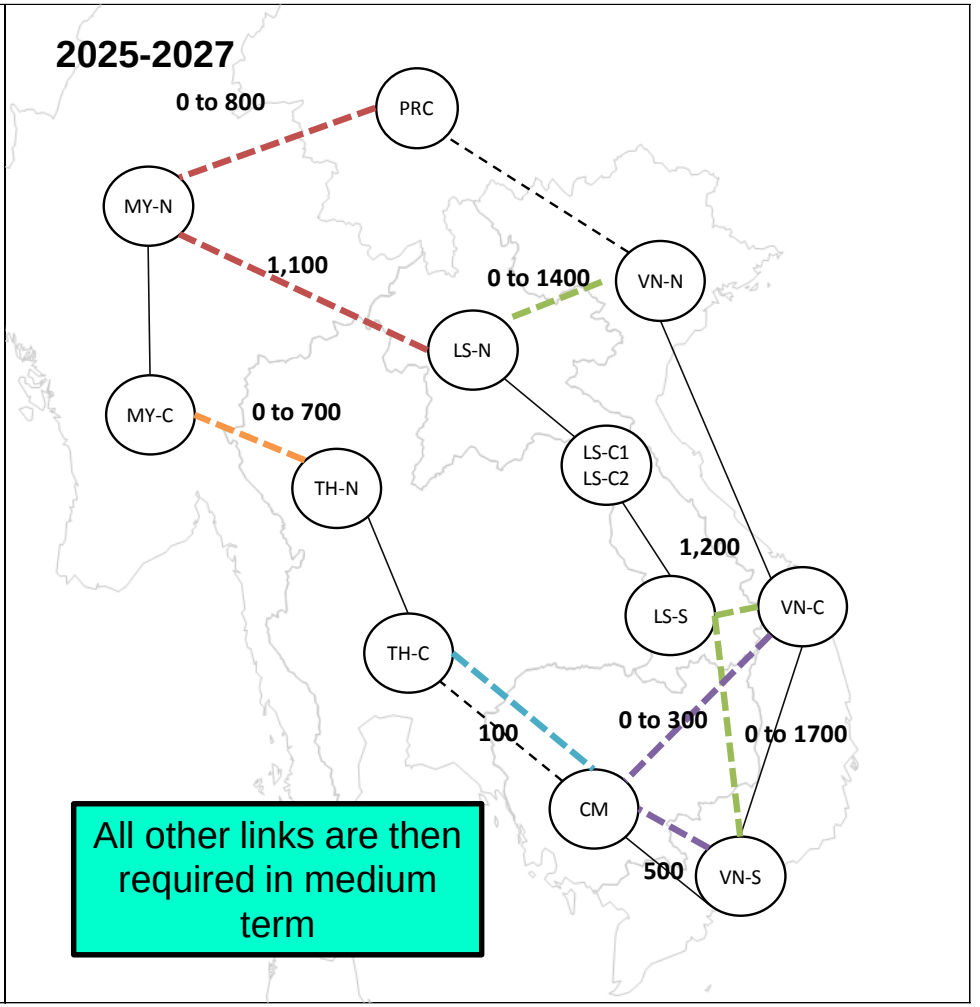
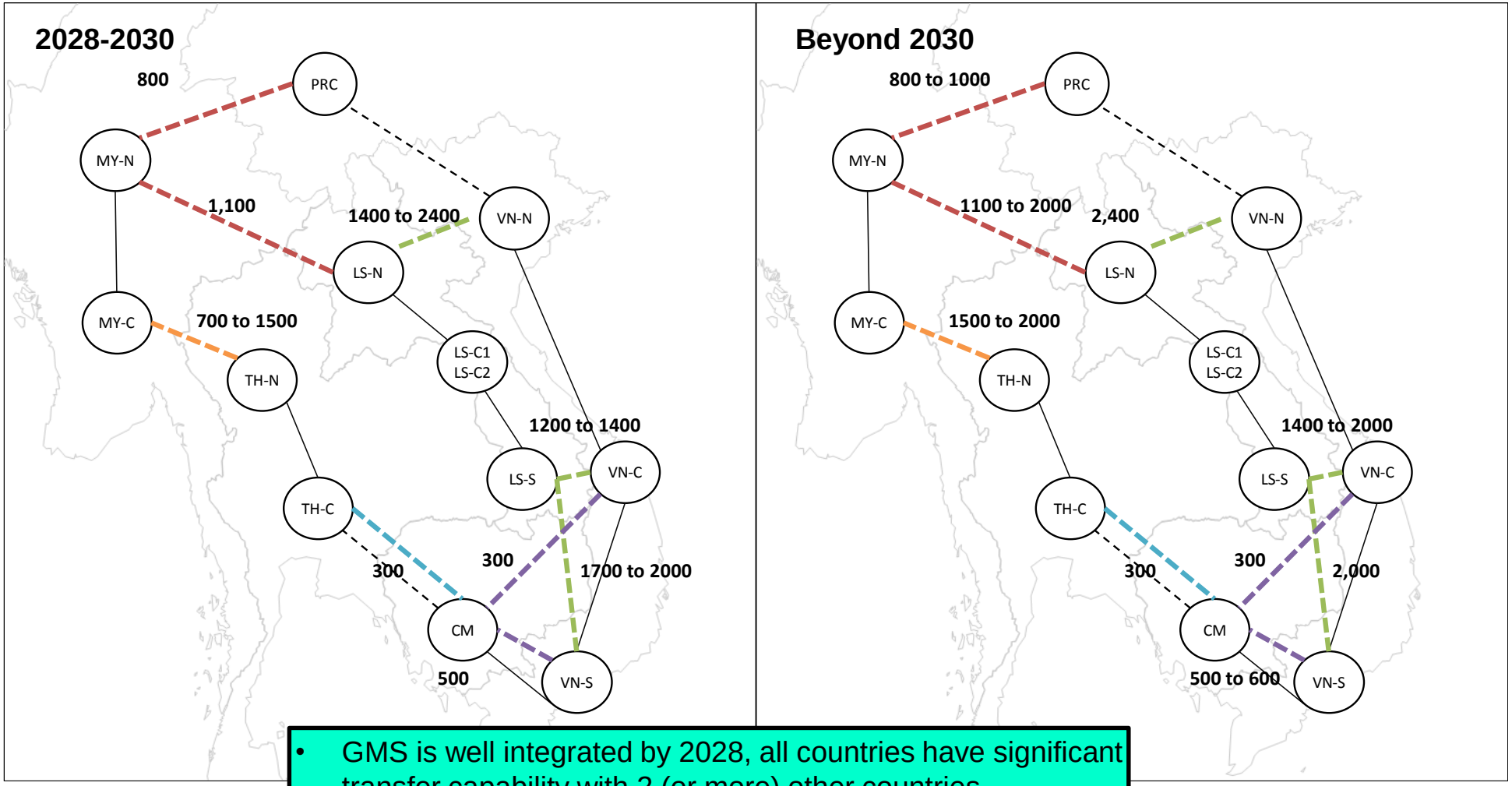
Total Transmission Investment Requirements over Time





Total Transmission Investment Requirements over Time



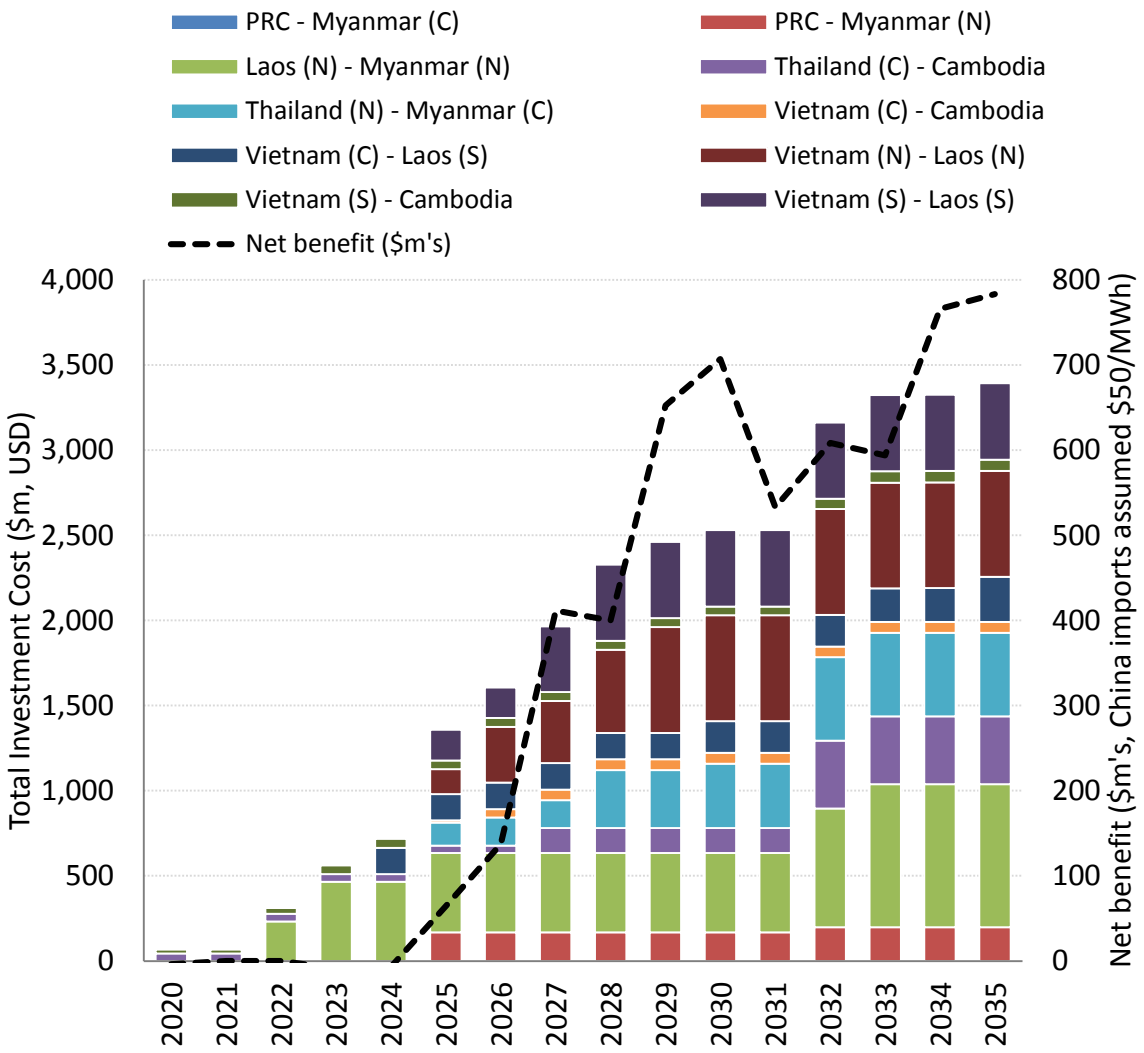
- GMS is well integrated by 2028, all countries have significant transfer capability with 2 (or more) other countries
- Post-2030, augmentations on all of the Business case links are fully developed up to the maximum sizing option.

Total Transmission Investment Requirements over Time (Excludes National Grid Augmentations)

- Integrated GMS
  - Allow greater potential for further cross-border trading opportunities
  - Benefit and open up power planning options.
  - Potential for reducing overall reserve requirements in the region through the utilisation of interconnector capacity and demand diversification

  - Lao PDR plays a very vital role in integrating the GMS
    - counterparty to all of the GMS countries (including dedicated exports),
    - coordination is required in relation to grid-to-grid operations between country networks and in delivering a national transmission grid to support cross-border trading.

Total Transmission Investment Requirements over Time (Excludes National Grid Augmentations)



- Chart showing investment cost requirements for prioritised interconnection projects in the Integrated case and the corresponding total benefit
  - Investment cost of transmission projects gradually increases to $3.4 billion by 2035
  - Driven by interconnection projects involving Laos and Myanmar
- Annual benefits increase in line with transmission projects
  - The level of benefits are significant given the investment cost represents the upfront cost of a +30 year asset

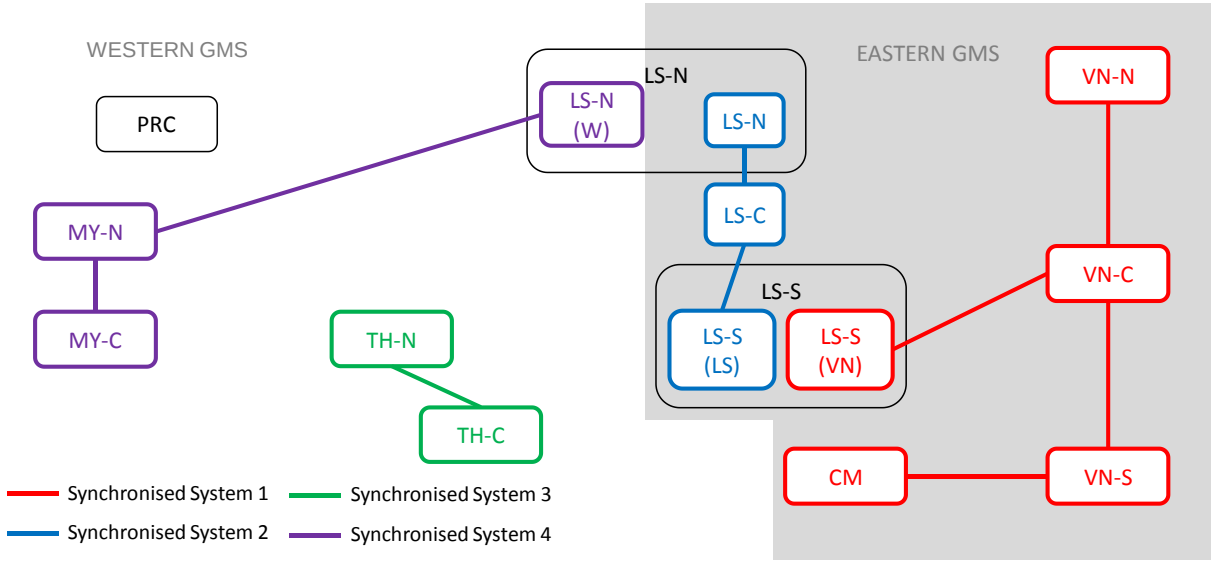
7. Interconnection Strategy for the GMS

Interconnection Strategy for the GMS

- To realise the identified benefits of each cross-border expansions in the GMS an interconnection strategy is required
- We have looked at gradual steps towards implementing the prioritized projects
- We did not consider low voltage / distribution network level connections and, with the exception of cross-border links involving PRC, considered only AC (synchronous) interconnections of the transmission networks in the region
- Note that we have not done more detailed technical modelling to support this and the plan is conceptual and strategic
- This strategy would need to additionally consider :
  - supporting investments in control schemes
  - building in N-1 redundancy
  - automatic control schemes
  - rules of power system dispatching
- Which are issues beyond the scope of this project

Interconnection Strategy for the GMS: Stage 1 (2022-24)

- Strengthening Cambodia, Laos and Vietnam and Northern Laos to Myanmar
- Expand synchronous connection between Vietnam and Cambodia to provide added security to Cambodia
- Lao PDR south is suggested by the Integrated Case to be interconnected to Viet Nam. However, interconnectivity between the south of Lao PDR's national grid and the rest of the country is very weak
  - proposed exports from Lao PDR to Viet Nam in the south are planned to be done by connecting enclaves of hydro generators to Vietnam's power system, which is a first step towards synchronisation.
  - A possible approach therefore would be to synchronise the enclaves and expand a subset of the southern power system of Lao PDR to synchronise with Viet Nam.
- Similar to Laos > Vietnam, Laos > Myanmar could also adopt a similar approach (form isolated enclaves first then work towards synchronisation)



Based on the Integrated Case, the GMS does not have any other cross-border interconnections during this period, so we do not consider synchronisation outside of this initial stage.

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Interconnection Strategy for the GMS: Stage 2 (2025-27)

(WEST)

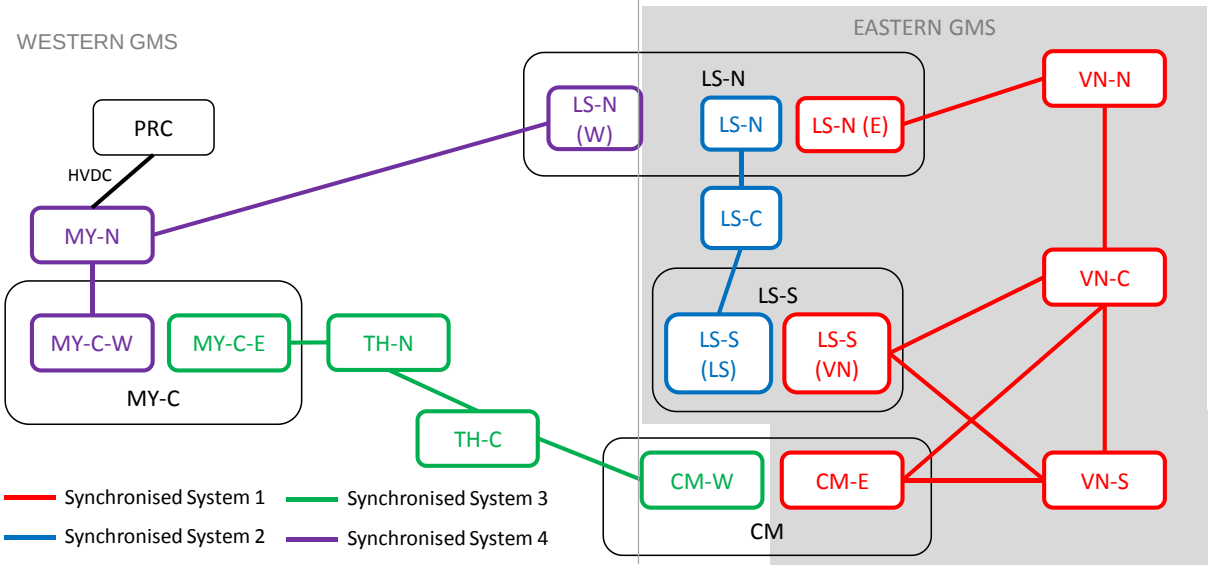
- Myanmar (Mandalay) to PRC
- Thailand (central) to Cambodia (northwest)
- Myanmar to Thailand

- PRC connects to Myanmar via HVDC, so there are no significant issues with respect to staging synchronisation between grids;
- Split Cambodia into west and east sub-zones as first step in synchronisation to Thailand; and
- Similarly, split Myanmar central (Yangon) into west and east zones for synchronisation to Thailand.

(EAST)

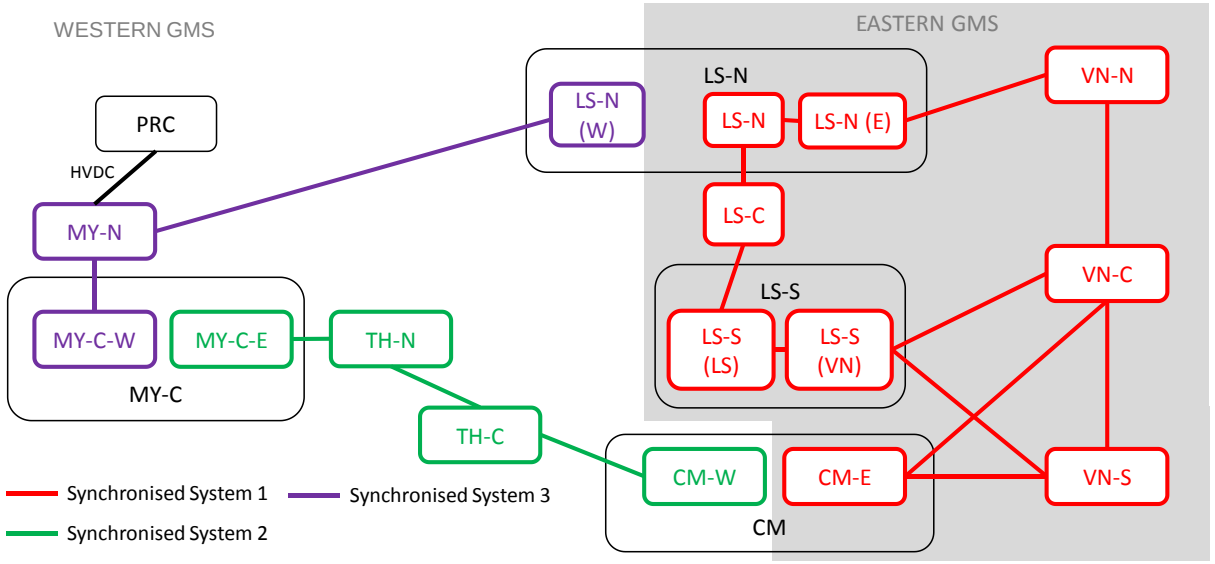
- Laos (North) to Vietnam (North)
- Cambodia to Vietnam (Central)
- Lao PDR (South) to Vietnam (South)

- Southern Laos network and Vietnamese network is strengthened and synchronised;
- Cambodian power system cross-border connections to Vietnam are strengthened; and
- Northern Laos split into two sub-regions with portion synchronised to Vietnamese north power system.



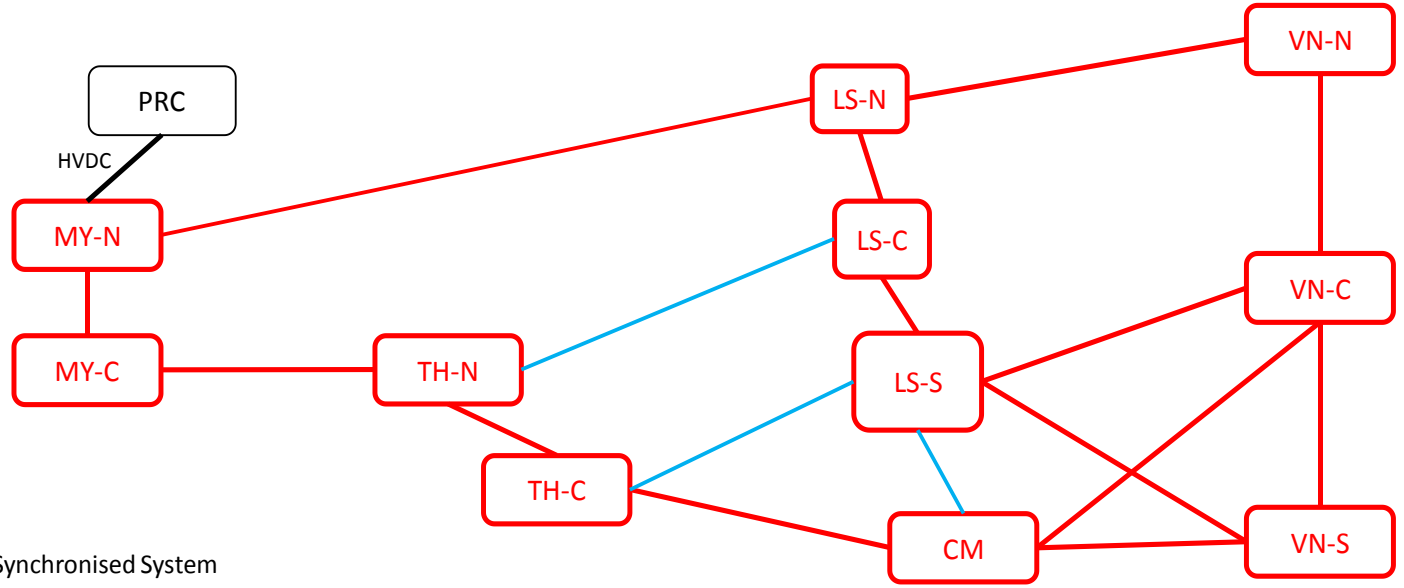
Interconnection Strategy for the GMS: Stage 3 (2028-30)

- Covers the further expansion of existing connections that have been proposed for development during Stage 2
  - Myanmar to Thailand
  - Laos PDR (South) to Vietnam Central and South
  - Laos PDR (North) to Vietnam (North)
- Suggest that within this period that the western GMS region and the eastern GMS regions be internally synchronised
  - Two separate but largely synchronised grids. The main justification is that the Thailand and Vietnamese systems are relatively large; therefore, we are interconnected and synchronising the smaller systems of Myanmar, Cambodia and Laos to their larger neighbours initially, before considering interconnection of the western and eastern systems.

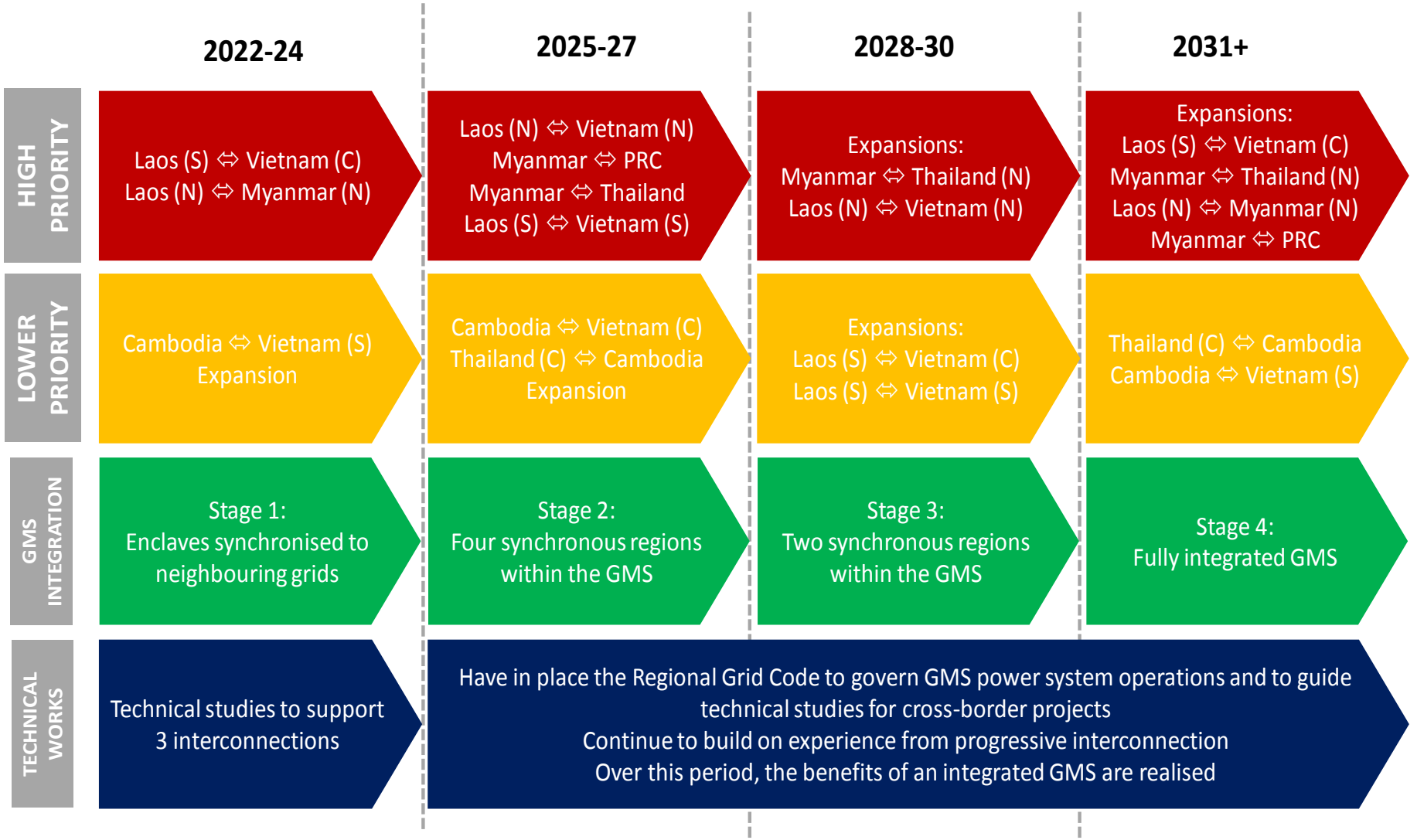


Interconnection Strategy for the GMS: Stage 4 (2031 and beyond)

- Stage 4 (final) covers:
  - Lao PDR (South) to Vietnam (Central)
  - Myanmar to Thailand (Norther)
  - Thailand (Central) to Cambodia
  - Cambodia to Vietnam (South)
  - Lao PDR (North) to Myanmar (North)
  - Myanmar (North) to PRC
- Chart below shows the overall integrated and synchronised regional power system based on the suggested strategy for synchronisation
- We have included a number of connections that we did not explicitly consider or study within this project.
  - Role of these interconnections should be investigated and considered within a synchronisation strategy and to better balance power flows in the region.



Conceptual 10-year Roadmap for Regional Integration



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Proposed Strategy for Integration of Synchronous Interconnections

- Interconnection strategy across four stages of regional integration
  - beginning with the present state of the GMS
  - progressively moving towards a fully integrated and synchronised GMS by year 2031.

Stage	Period	Preconditions	Key Actions	Purpose
1	2022-24	Technical feasibility studies for the proposed cross-border projects within this period.	Synchronisation of a portion of the southern Laos power system to Vietnam central and building upon the existing synchronous connection between Vietnam south and Cambodia and synchronising a portion of Las North grid to Myanmar.	Build on the limited number of existing synchronised interconnections and take initial steps towards interconnecting high priority cross-border interconnections with minimal implications for synchronised grid operations.
2	2025-27	Regional Grid Code in place to guide technical studies and identify supporting transmission network investments to enable synchronous interconnections to operate appropriately.	Form four synchronous interconnections within the region, with the synchronous interconnections being: (1) Vietnam and parts of Cambodia and Laos, (2) Laos and connections to Thailand, (3) Cambodia, Thailand and a portion of Myanmar's southern power system, and (4) Myanmar and PRC.	Build on the experience of stage 1 by expanding synchronous interconnections and subsequently managing power system operations under the Regional Grid Code. Continue to realise a significant fraction of the economic benefits of the high priority cross-border projects.
3	2028-30	Successful implementation of stage 2, and completion of technical studies to support further cross-border connections in the region.	Formation of eastern and western GMS synchronous interconnections through integration of Laos, Cambodia and Vietnam to form the eastern system, and integration / synchronisation of PRC, Myanmar, Thailand and Cambodia to form the western system.	Establish two significant synchronous regions within the GMS and have them operated under the Regional Grid Code. Most of the "low hanging fruit" benefits of the Integrated case are realised within this period.
4	2031 & beyond	Successful implementation of Stage 3, and completion of technical studies to support further cross-border connections in the region.	integration of western and eastern GMS synchronous interconnections to have a fully integrated and synchronised regional power system	Gain the full benefits of an integrated GMS.

8. Next steps and conclusion

Next steps

- Study has demonstrated the benefits of greater integration of the GMS region
  - Identified the cross-border interconnections that will lead to the greatest benefits in the region
- 10-year roadmap prioritising investments in cross-border connections based on those that deliver the greatest benefits to the region
- Roadmap has identified
  - high level strategy for interconnection
  - important preconditions that need to be implemented as part of progressing the GMS towards a fully interconnected region
- Important next steps

Next steps

Next steps	Notes
1. Detailed technical studies to support individual business cases	To identify additional investments that may be required in order to ensure power system operations will be reasonable
2. Economic viability of HVDC interconnection in the region	This would be an alternative to the AC interconnections studies
3. Regional Grid Code to be agreed and established	Adoption of the regional Code by each of the GMS countries and the agreement of a minimum set of requirements for interconnection will be key facilitating steps
4. Planning frameworks within the member countries to be adjusted	To incorporate cross-border transmission projects
5. Rigorous approach for development and implementation of regional transmission wheeling charges	To give a clear path for the remuneration of major transmission investments
6. Country-by-country of specific policies and regulatory reforms	To ensure open access to the national power networks and underpin the transparency with which the regional power systems are planned and operated
7. Further consideration should be given by the RPTCC and possible successor or subsidiary groups to the trading rules and balancing arrangements	Should be implemented in parallel with the technical expansion of the power systems to ensure that a sound basis for power trading is created.

Issues

- GMS member countries are at different stages both at policy level and in terms of practical implementation regarding issues as below:

Power sector unbundling and ensuring the independence of transmission function and guarantee of third-party access to facilitate increased power trading

Defining roles and responsibilities of government ministries and other agencies responsible for power sector regulation

Creating regulations and licences needed to enable a combination of incumbent power utilities and new private sector developers of transmission infrastructure to work together in an integrated way

Identifying capacity building needs in areas required to enhance technical, project management and financial/economic capabilities of power sector stakeholders

Addressing challenges posed particularly in Lao PDR by existence of IPPs exporting power across borders over dedicated interconnectors constructed on a BOT basis (utilisation of which is defined under terms of PPAs but which will need to form part of the synchronised regional network)

Conclusion

- Achieving highest level of regional cooperation is essential
- Recognise the importance of the continued role of the RPTCC and the potential evolution of this body into the RPCC in future as being critical to the future evolution of the GMS power sector

THANK YOU – QUESTIONS & ANSWERS