



# Regional Trade Initiatives and Opportunities in Southeast Region

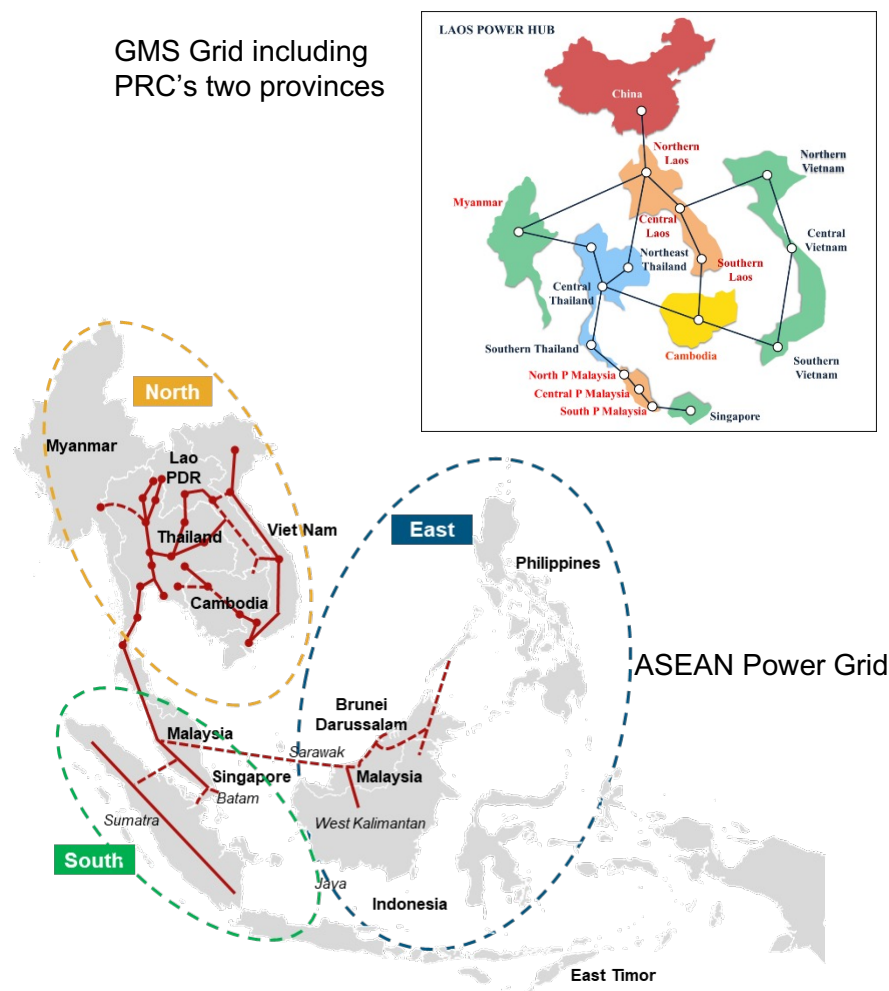
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# ASEAN Power Grid (since 1997) and GMS Energy Cooperation (since 2002)

## Current level of interconnection across ASEAN/GMS



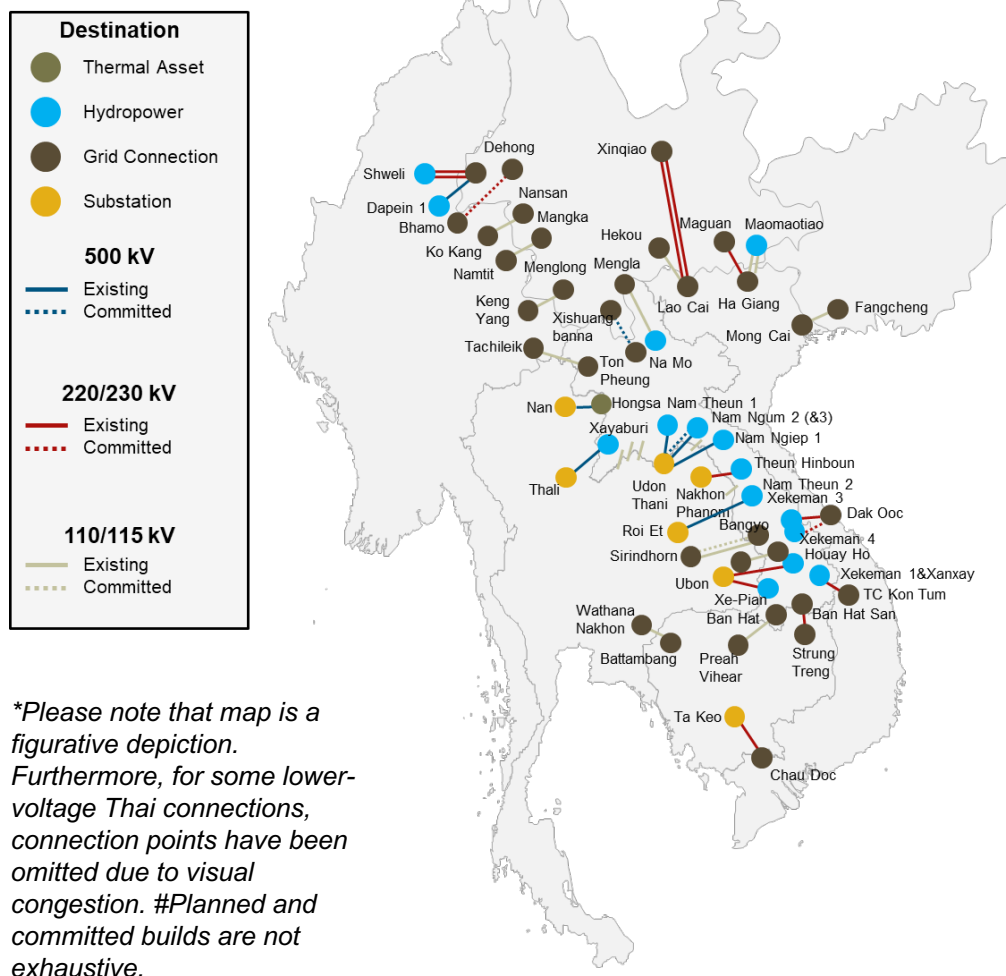
## Commentary

- The concept of an ASEAN Power Grid (APG) has existed for decades, but little substantive progress has been made and the grid remains underdeveloped.
- APG's existing transmission capacity stands at 7.8 GW, with ongoing additions (as of August 2020) ranging between 555-625 MW, aiming to achieve 18-22 GW in the future.
- The GMS has 24 high-voltage alternating current (HVAC) transmission connections across borders within the GMS.
- GMS's new interconnection capacity targets are between 19 GW and 22.4 GW although no clear timeline has been set.

## Overall levels of power exchange also remain low

- The highest levels of grid interconnectedness and active bilateral interconnections are largely confined to countries within the GMS and Peninsular Malaysia.
- The Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP) has increased power export. 260 GWh of power has been traded up to May 2023 since the inception of the project as of now since its operation in 2019.

# GMS power grid has been increasingly interconnected, **presenting significant opportunities for operating a regional power pool market using existing infrastructure**



The potential benefit and synergy of the regional power trade is huge through establishing a short-term power trading platform combined with enhancing bilateral and multilateral trading arrangements through increased interconnection capacity and harmonized interconnection rules and procedures and a transparent wheeling charge arrangement.

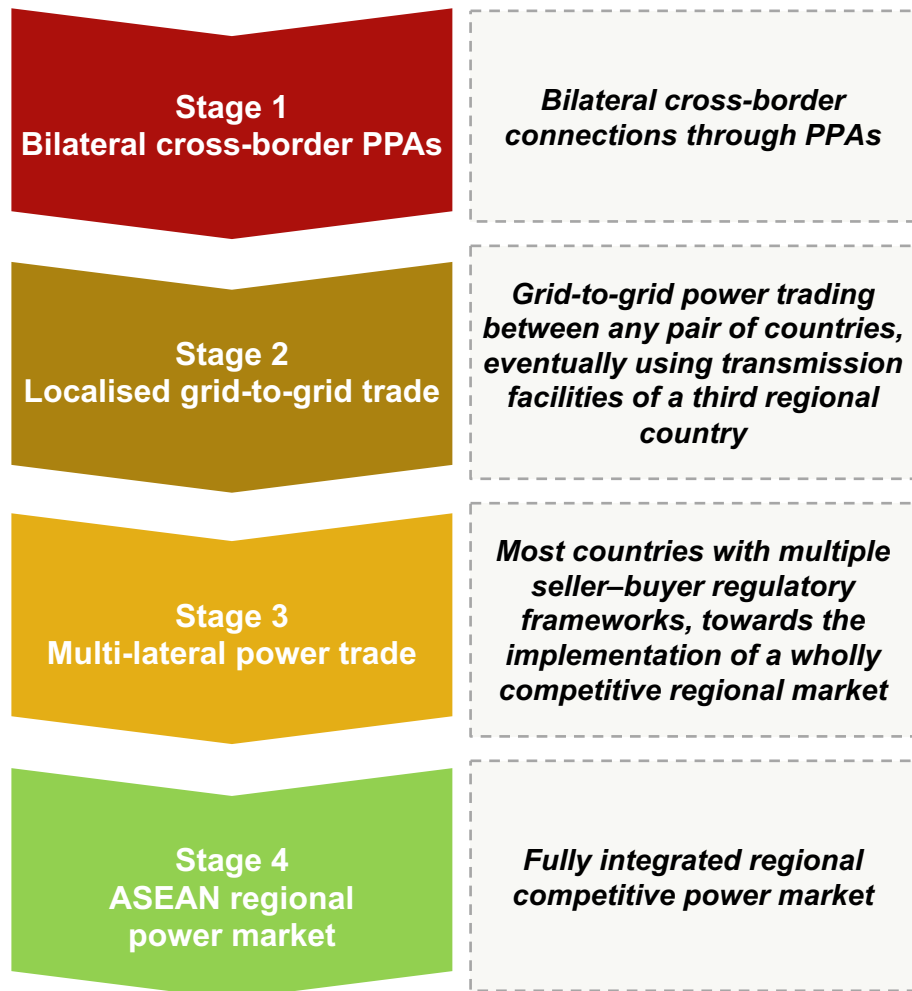
The existing and future portfolio of the regional power generation mix enables the optimization and least cost utilization of abundant RE resources in the region given the different resource availability based on resource location. The recent direction of power development plans of GMS countries has shown increased ambition to achieve carbon neutrality by 2050 or 2060. New developments should consider the following opportunities:

- Viet Nam's offshore wind potential
- All GMS countries' solar power – rooftop, floating solar PV, & grid-connected systems
- Laos floating solar combined with existing hydro, pumped storage hydro
- Acquire hydrogen and ammonia technology as clean fuel using RE resources
- Singapore 4 GW clean energy tender
- Undersea cable interconnections



# Benefits realized from cross-border power trading need to be at the heart of a **coherent and integrated approach toward power sector planning**

## Four key stages of regional power trade evolution



## Key points

### **Power sector planning in the region continues to be fragmented and primarily driven by individual member PDPs**

- At present, power sector development in Southeast Asia is mainly driven by individual member states own priorities around security of supply, affordability, and sustainability.

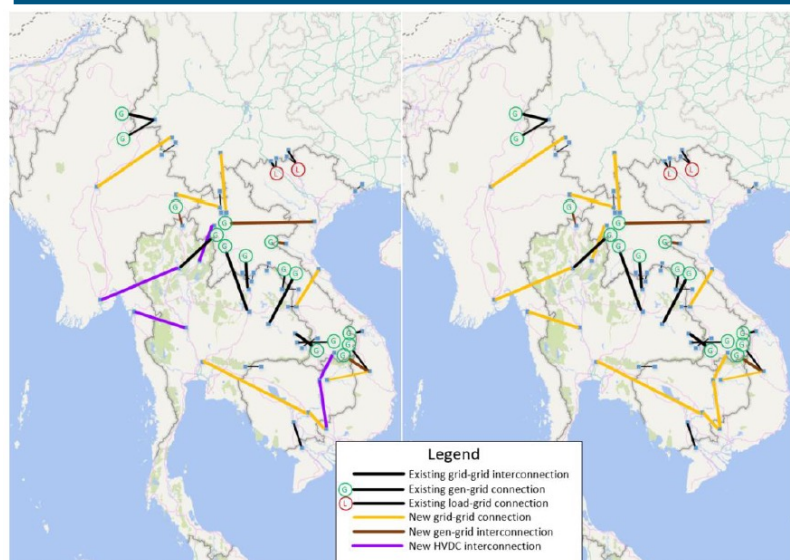
### **Thus far, power imports/exports have largely been considered on a standalone basis with localised benefits**

- Whilst there has been growing momentum with cross-border power trade in areas such as the GMS this has mostly been discrete cross-border PPAs and grid-to-grid projects with localized benefits.
- Unlocking the benefits of multi-lateral power trade will require a 'step change' in engagement among member states to form an integrated plan that sets out investment needs, drives alignment on technical and regulatory aspects, and promotes a framework for mutual economic benefits across the region.

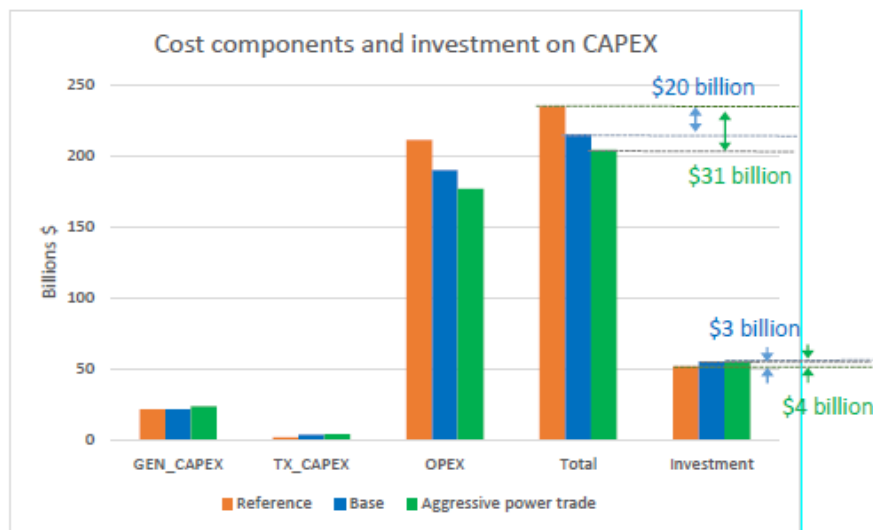
Source: Regional Grid Code Study; ADB

# Expanding Grid-Grid Interconnection in the GMS unlocks significant benefits

## Access to full interconnector capacity and a regional market are key prerequisites



- Cross-border interconnections to Cambodia facilitate power import from wider GMS initially
- Hydro generation in Lao N and S (3-5 GW) plus 0.5 GW wind – increased interconnection facilitates exports to all GMS countries
- Interconnections from Myanmar could provide access to markets in Thailand, PRC and Lao PDR for 8-12 GW of hydro generation and 1-3 GW of wind
- Increased interconnection between Thailand and Cambodia would increase potential for export from future thermal (6GW) and solar (7GW) generation to Vietnam and Cambodia
- Expanding interconnections Viet Nam from Lao PDR increases import potential for Viet Nam; interconnection to Cambodia could provide a market for significant generation from wind (6-7GW) and solar (5-9GW) export from south of Vietnam
- Exports from Lao PDR, Viet Nam and Thailand to Cambodia can also supply the 1GW potential export to Singapore via the proposed subsea cable connection



Source: Final Report – Regional Power Master Plan: Harmonizing the Greater Mekong Subregion (GMS) Power System to Facilitate Regional Power Trade

## The more cross-border interconnections will result in more benefits in the region

### A key set of regional interconnection emerges in most planning scenarios

Year	From	To	Connection Points	Type	Capacity (MW)	Investment Cost (\$ million of commission year)
2024	Myanmar	Thailand	Yangon area - Mae Moh	HVAC	1500	207
2024	Myanmar	Thailand	Mawlamyine - Tha Tako	HVAC	1500	184
2024	Lao PDR	Viet Nam	Ban Soc/Ban Hatxan - Tay Ninh via Stung Treng	HVAC	1000	238
2024	Lao PDR	Myanmar	Namo - Kenglatt - Tachileik - Kengtung	HVAC	800	250
2025	Lao PDR	Viet Nam	Luang Prabang HPP - Xam Nau (Lao PDR-N) - Nho Quan	HVAC	2500	432
2025	Thailand	Cambodia	Wangnoi - Banteay Mean Chey - Siem Reap - Kampong Cham	HVAC	300	524
2025	Myanmar	Thailand	Mae Khot TPP - Mae Chan	HVAC	370	84
2025	Lao PDR	PRC	Luang Prabang - Yunnan	HVAC	650	207
2025	Myanmar	PRC	Mandalay - Yunnan	HVAC	600	207
2026	Cambodia	Viet Nam	Kampong Cham - Tay Ninh	HVAC	300	154
2028	Cambodia	Viet Nam	Lower Se San 2 HPP - Pleiku	HVAC	200	247
2030	Lao PDR	Viet Nam	Xekaman 4 HPP - Ban Soc/Ban Hatxan - Pleiku	HVAC	1000	215
2030	Lao PDR	Viet Nam	Savannakhet - Ha Tihn	HVAC	600	137
2031	Lao PDR	Viet Nam	Nam Mo HPP - Ban Ve	HVAC	120	219

Lines with benefit greater than \$1 billion are highlighted **green**,  
lines with benefit between \$100 million and \$1 billion are highlighted light **orange**,  
and lines with benefit less than \$100 million are highlighted **dark orange**.

Source: Final Report – Regional Power Master Plan: Harmonizing the Greater Mekong Subregion (GMS) Power System to Facilitate Regional Power Trade – MHI for ADB 2021

The more cross-border interconnections will result in more benefits in the region

**Additional lines highlighted in “aggressive interconnection” scenario**

Year	From	To	Connection Points	Type	Capacity (MW)	Investment Cost (\$ million of commission year)
2024	Myanmar	Thailand	Yangon area - Mae Moh	HVAC	1500	207
2024	Myanmar	Thailand	Mawlamyine - Tha Tako	HVAC	1500	184
2024	Thailand	Cambodia	Thailand - Cambodia	HVAC	1500	290
2024	Lao PDR	Cambodia	Lao PDR - Cambodia	HVAC	1500	125
2025	Thailand	Cambodia	Thailand - Cambodia	HVAC	1500	290
2025	Thailand	Myanmar	Thailand - Myanmar	HVAC	1500	217
2025	Lao PDR	Cambodia	Lao PDR - Cambodia	HVAC	1500	125
2025	Lao PDR	Myanmar	Lao PDR - Myanmar	HVAC	1500	144
2026	Myanmar	Thailand	Mae Khot TPP - Mae Chan	HVAC	370	84
2026	Lao PDR	Viet Nam	Ban Soc/Ban Hatxan - Tay Ninh via Stung Treng	HVAC	1000	238
2026	Myanmar	PRC	Mandalay - Yunnan	HVAC	600	207
2026	Thailand	Cambodia	Thailand - Cambodia	HVAC	1500	290
2026	Thailand	Myanmar	Thailand - Myanmar	HVAC	1500	217
2026	Viet Nam	Cambodia	Viet Nam - Cambodia	HVAC	1500	125
2026	Lao PDR	Cambodia	Lao PDR - Cambodia	HVAC	1500	125
2026	Lao PDR	Myanmar	Lao PDR - Myanmar	HVAC	1500	144
2027	Viet Nam	Cambodia	Viet Nam - Cambodia	HVAC	1500	125
2027	Lao PDR	Myanmar	Lao PDR - Myanmar	HVAC	1500	144
2028	Viet Nam	Cambodia	Viet Nam - Cambodia	HVAC	1500	125
2028	Lao PDR	Viet Nam	Lao PDR - Viet Nam	HVAC	1500	242
2030	Lao PDR	Viet Nam	Lao PDR - Viet Nam	HVAC	1500	242
2031	Cambodia	Viet Nam	Kampong Cham - Tay Ninh	HVAC	300	154
2032	Thailand	Myanmar	Thailand - Myanmar	HVAC	1500	217
2032	Lao PDR	Viet Nam	Lao PDR - Viet Nam	HVAC	1500	242
2034	Cambodia	Viet Nam	Lower Se San 2 HPP - Pleiku	HVAC	200	247

# Expanding Grid-Grid Interconnection in the GMS unlocks significant benefits

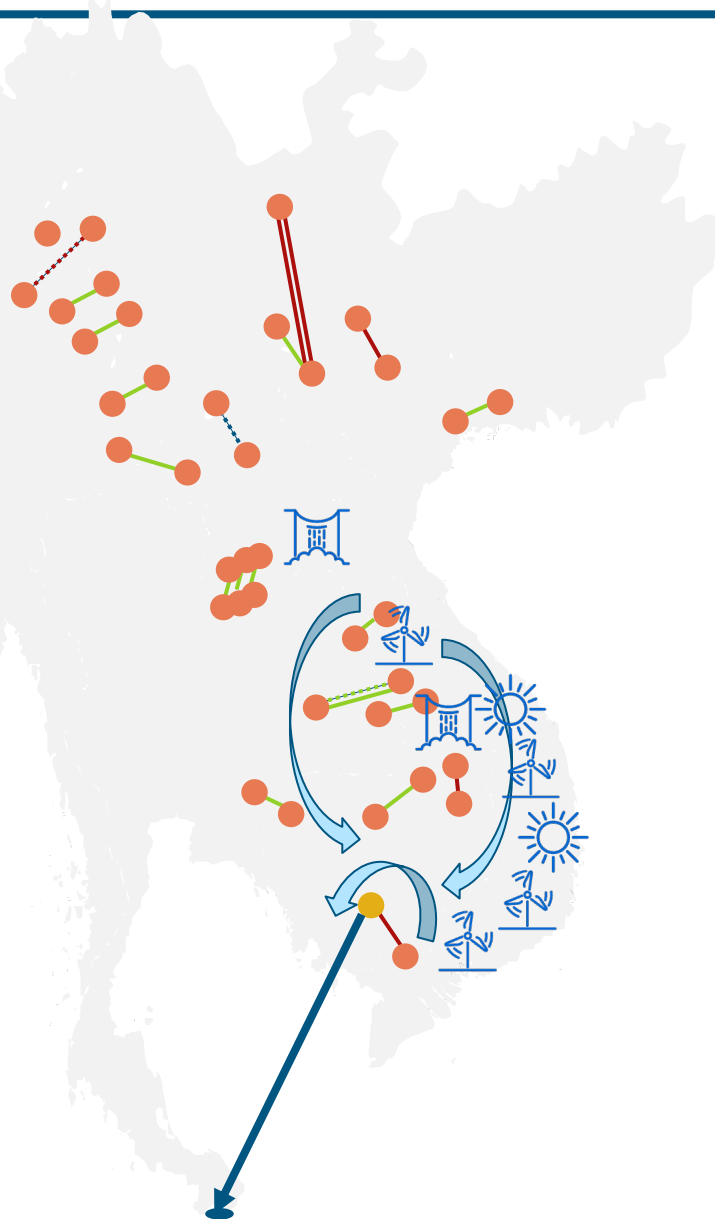
## Example: Opportunities for exporting curtailed renewable generation from VIE

$$\text{Cost of curtailment} = P_{\text{VIE}} * \text{Energy}_{\text{Curt}} = P_{\text{VIE}} * \text{GenMW}_{\text{Curt}} * \text{LF}$$

- Investment in/access to interconnectors **and the regional power market** would enable curtailed energy to be exported from VIE to CAM or SIN (with the new subsea cable) giving both parties benefits:
  - VIE: enabling recovery of lost revenue from curtailment + additional revenue for exports
  - CAM/SIE: will get access to cheap RES enabling both lower prices and meeting RES targets reducing internal investments.

$$\text{Congestion rent VIE-CAM} = (P_{\text{CAM}} - P_{\text{VIE}}) * \text{Energy}_{\text{Curt}}$$
$$\text{Congestion rent CAM-SIN} = (P_{\text{SIN}} - P_{\text{CAM}}) * \text{Energy}_{\text{Curt}}$$

- The regional power market will facilitate the short-term optimisation supporting welfare maximisation
- Regional power market will give visibility of zonal (national) prices
- Value of interconnectors can be calculated accordingly
- Developers of interconnectors remunerated via published wheeling tariff or using one of the standard models
  - Tariff Based Competitive Bidding
  - BOOT
  - Design-Finance-Build-Operate-Maintain





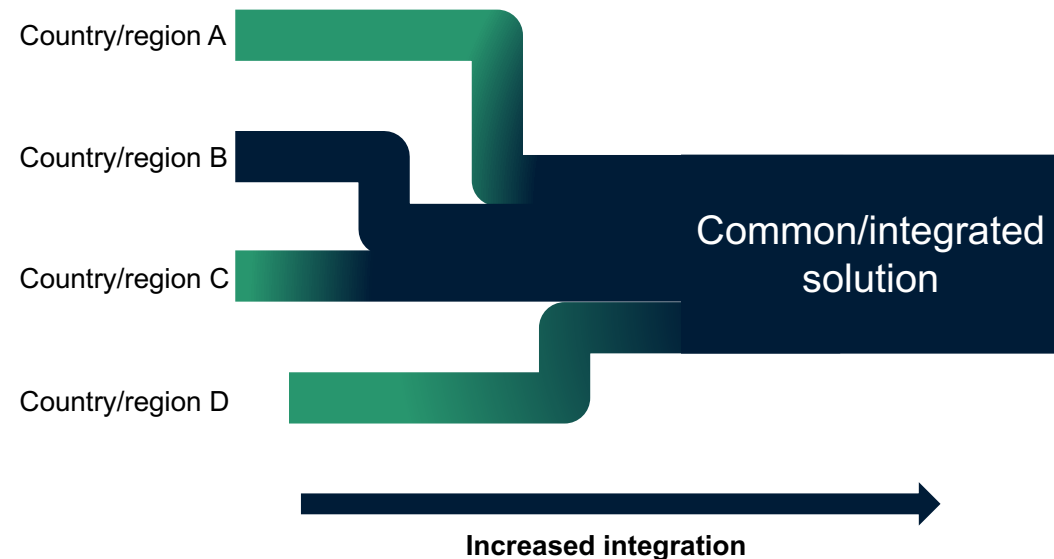
## Objective for regional markets

**Allowing for regional cooperation, but maintaining national control of the assets**

**A stepwise, flexible approach is needed, allowing new players to enter**

**Flexibility is needed in:**

- **Market design** – allowing future evolution of markets
- **Market Rules** – easy access to markets to new players
- **Market Platforms** – managing changes in the market framework
- **Legacy contracts** – respecting these
- **Market opening** – not a big bang where all join at the same time

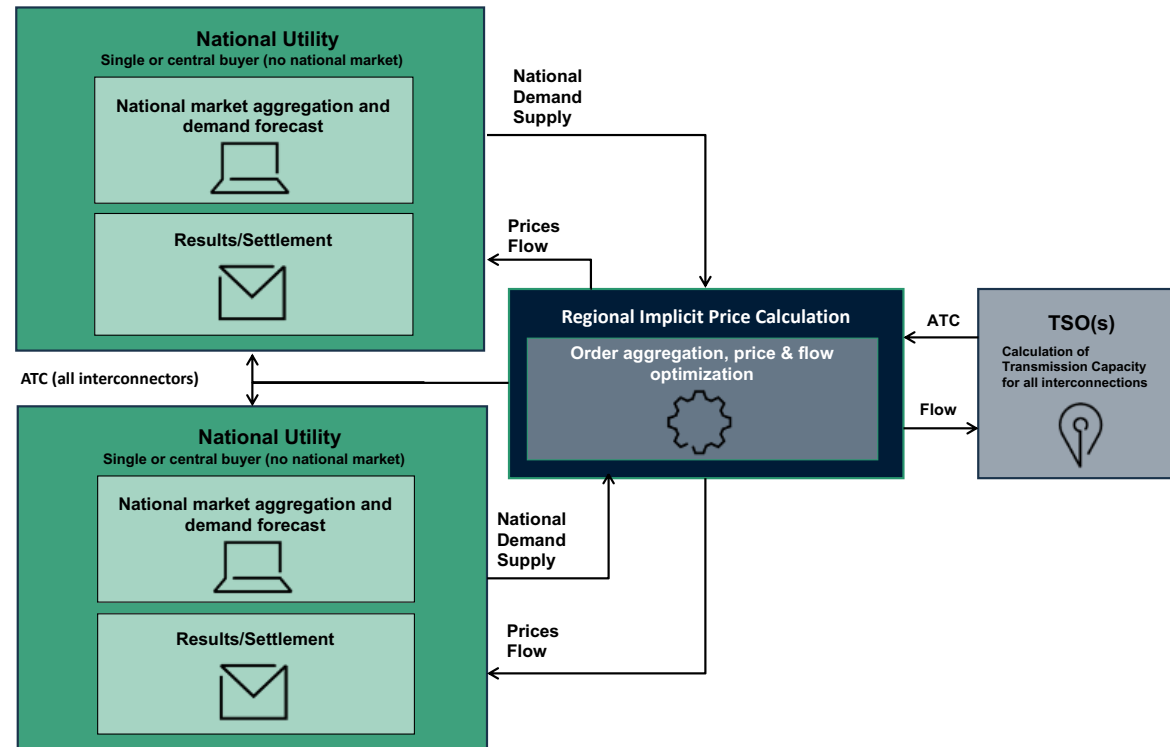


# A regional power market (day-ahead market) pilot operation proposed using existing interconnections in the ASEAN northern / GMS grid (2023-2025)

The starting point in a regional market is to establish a common methodology for the management of cross-border flows and prices

- **Harmonized rules for congestion management and transmission capacity allocation** – how to manage flows on the borders needs to be agreed upon, the national TSOs will play a vital role
- **Common market rules for regional trading** – flexible rules that cover the regional (not national) trading
- **Define the interfaces between the national and regional markets** – ensuring the same data is used in the regional market without requiring changes to the internal organization of the national power sector
- **Use of an Implicit auction** – meaning that the result shall optimize the utilization of the cross-border capacity as part of the price formation
- **Reporting** – important data for all participants available for all at the same time

Starting point



ATC - Available Transmission Capacity  
TSO - Transmission System Operator

**A cooperative setup between participating countries will be sufficient, not a new entity setup**

# .. then transitioning to a regional power market – natural evolution

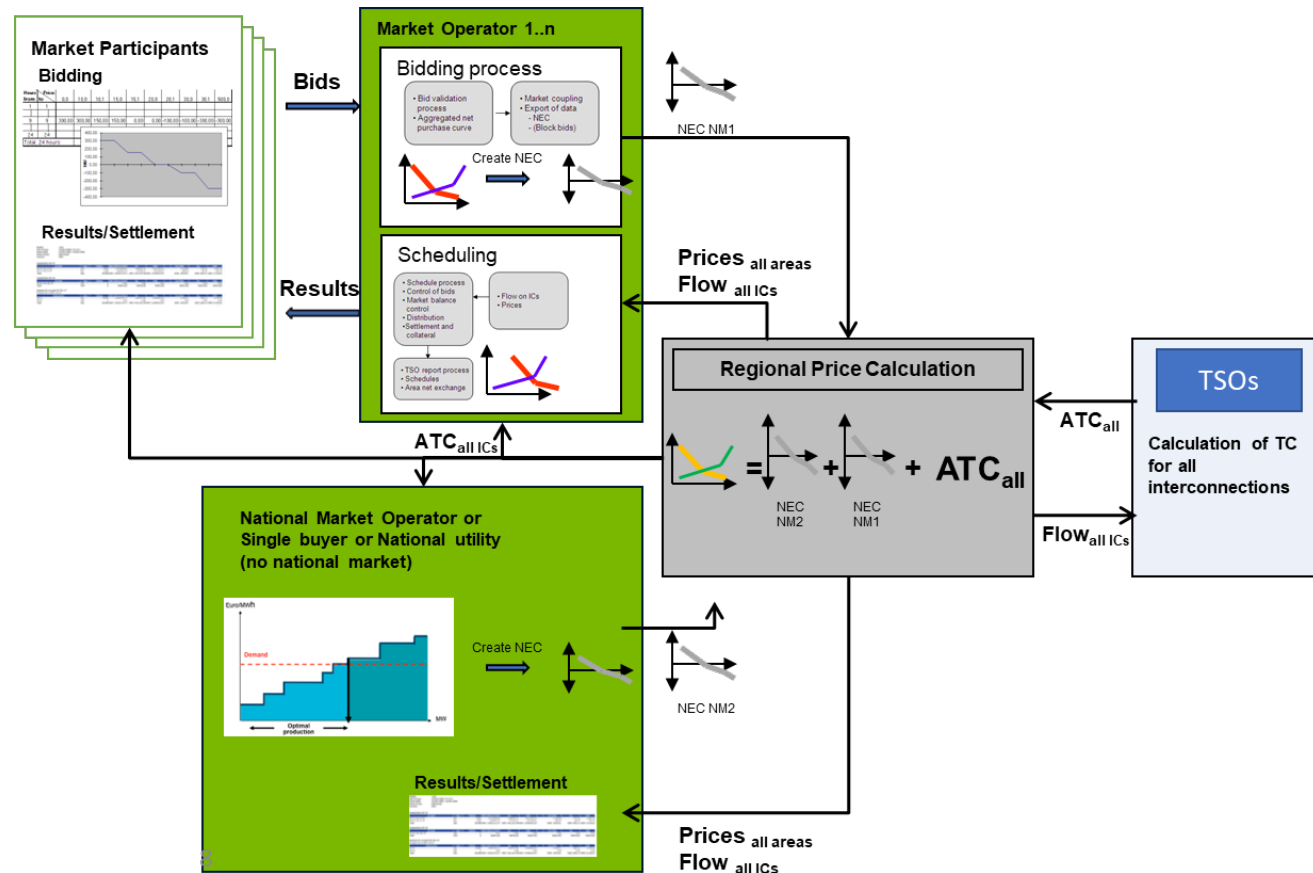
## Learning from a pilot operation, expanding capacity, and improving market design

The evolution of the regional market will be stepwise and shall allow for different developments in different countries/regions

**National market deregulation** – this will open for a different management of the national interface to the regional market but still the benefit and management of the regional market can remain. This can take different forms:

- The creation of national markets that will have an interface to the regional market
- Opening for national market players to directly participate in the market
- No new national market, just opening for national utilization of the regional market

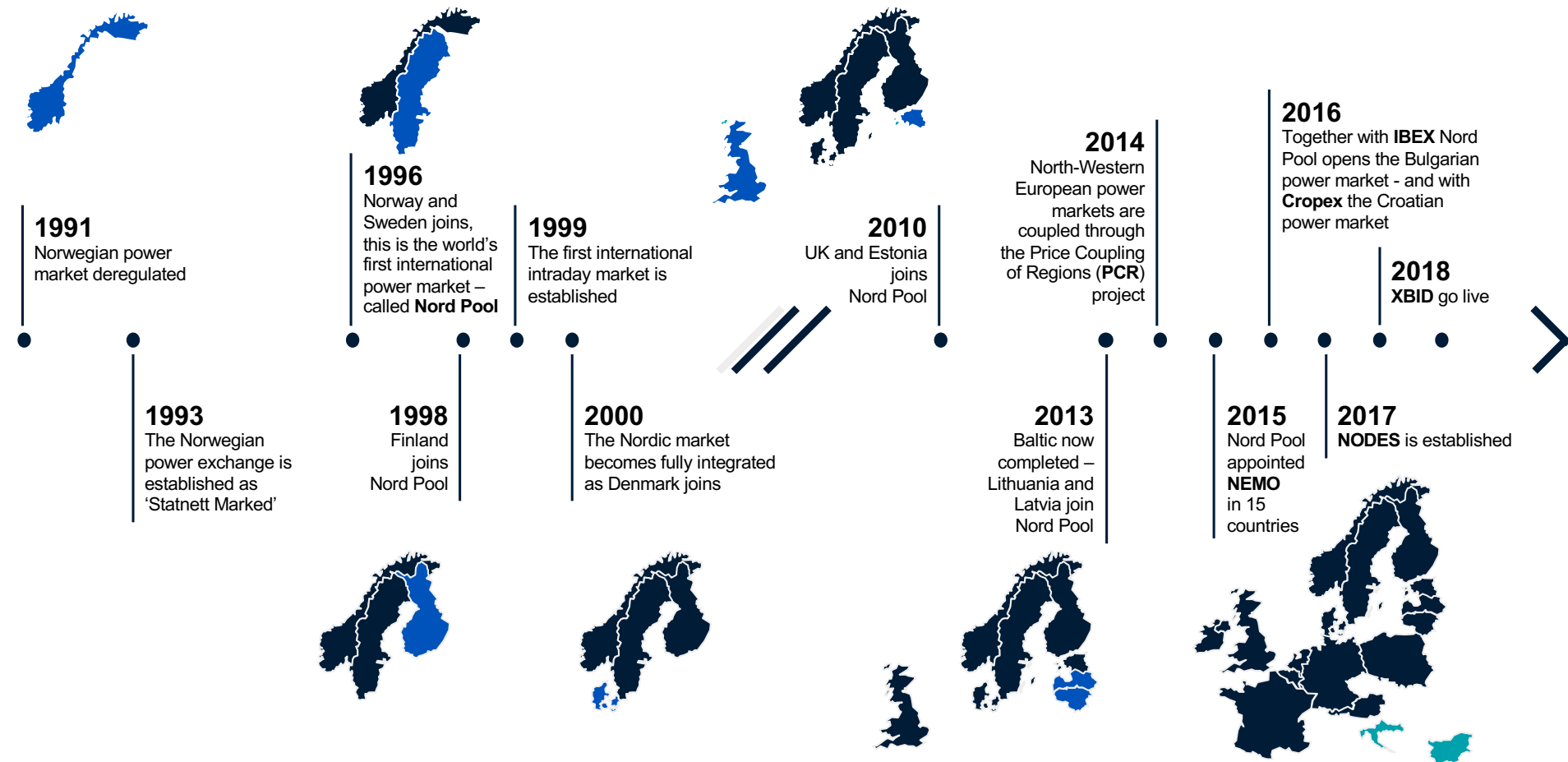
It is therefore imperative that the regional market has this flexibility in all aspects of its rules and regulations.



# A market-based and decentralized approach in Europe

**Nord Pool started in Norway in 1991 and evolved into a leading electricity market covering 16 European countries up to now**

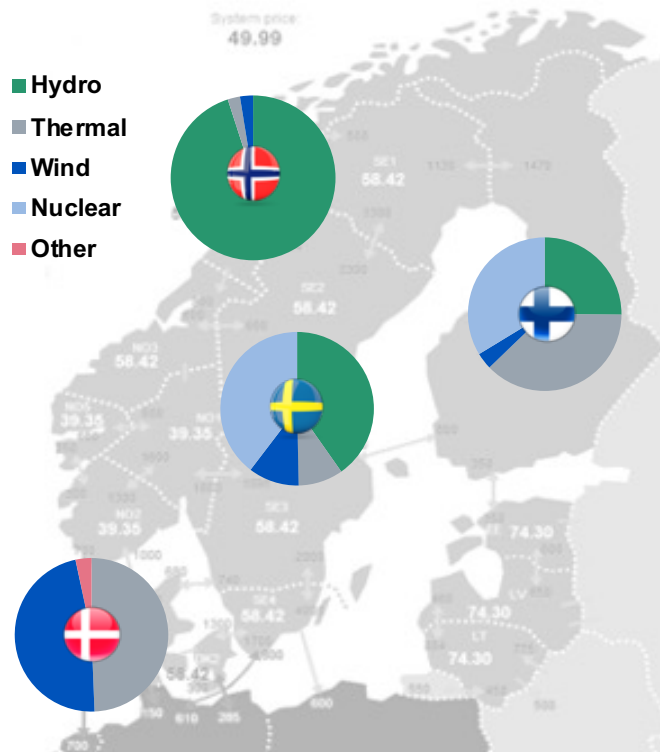
## The Nordic journey towards a European electricity market



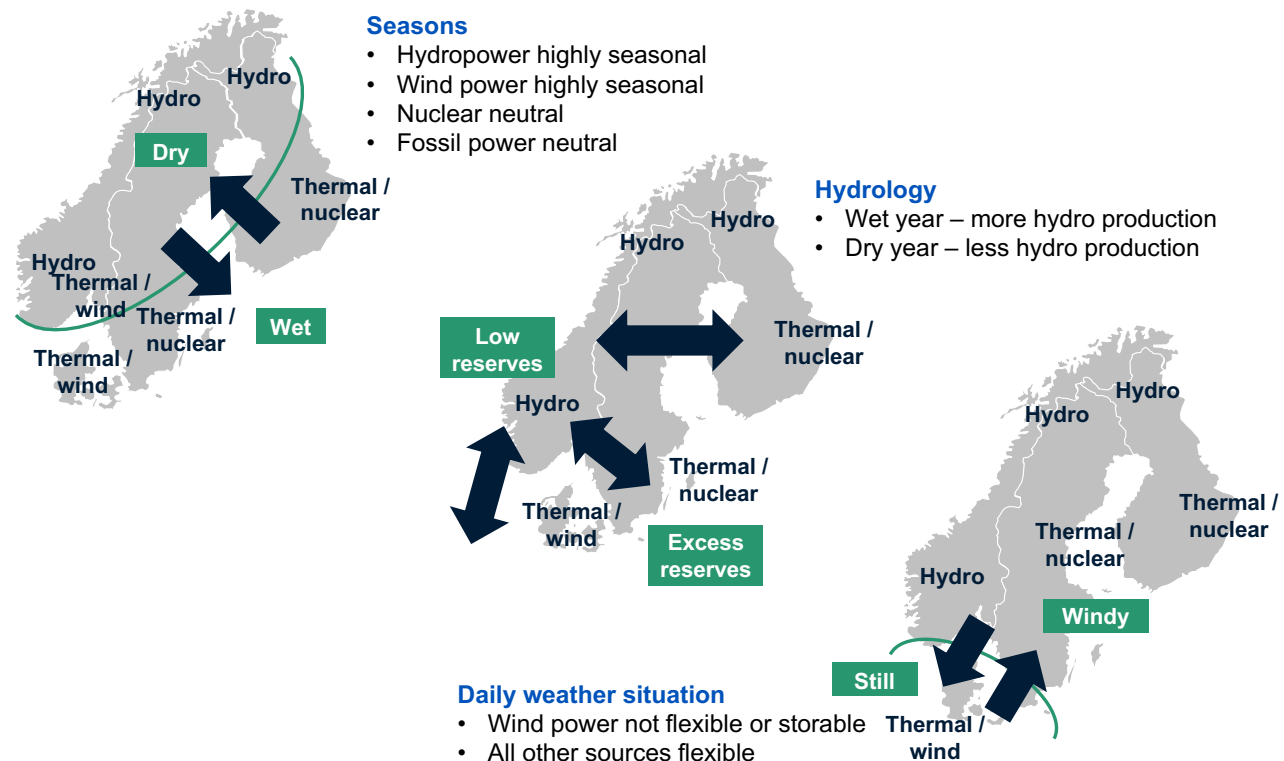


# Nordic Regional markets – Utilizing the value of differences to secure the optimal use of resources, resulting more stable and lower price and better RE integration

## Nordic power production capabilities

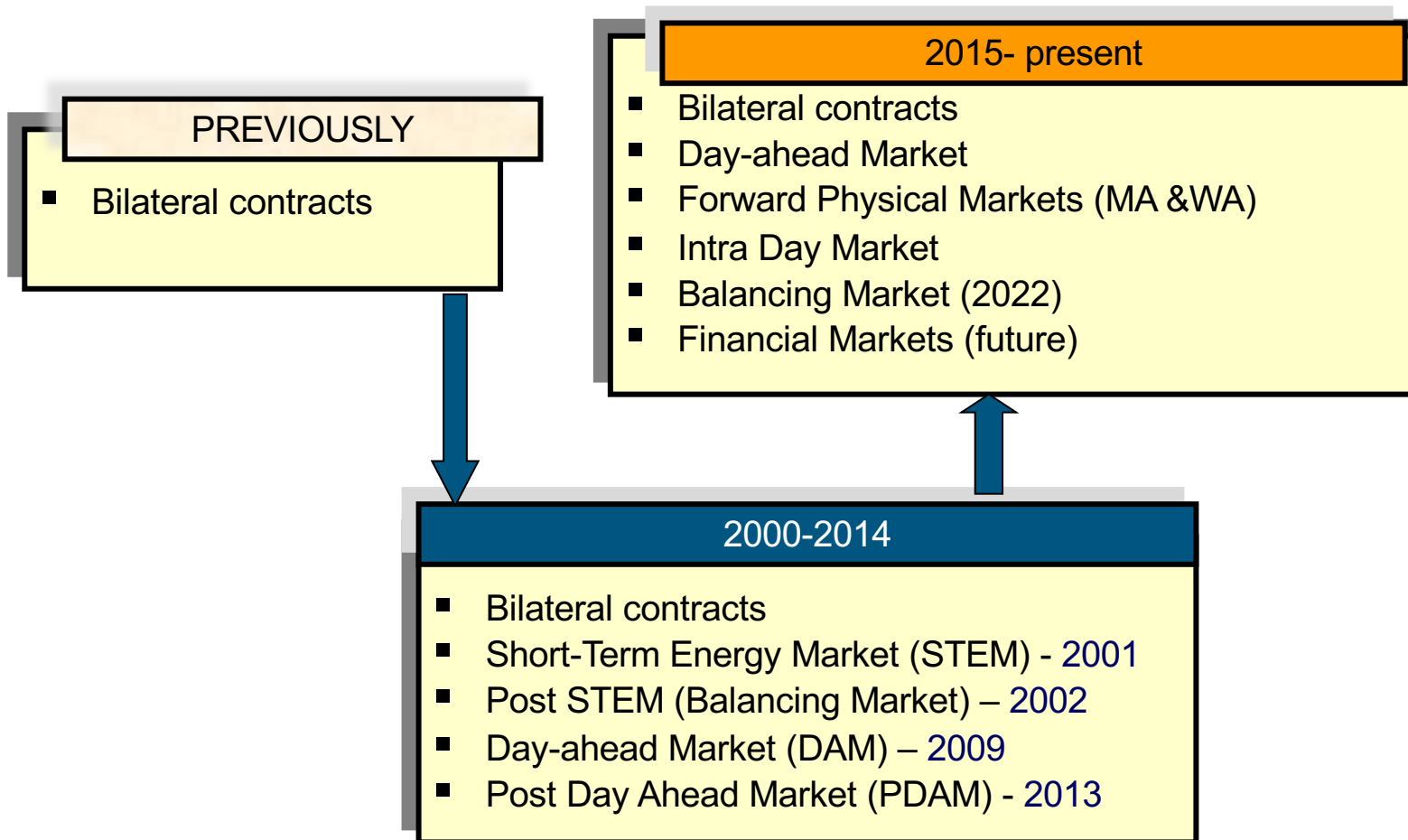


## Connecting markets with differing production profiles provides stability to the system



# The evolution of the Southern African Power Pool (SAPP)

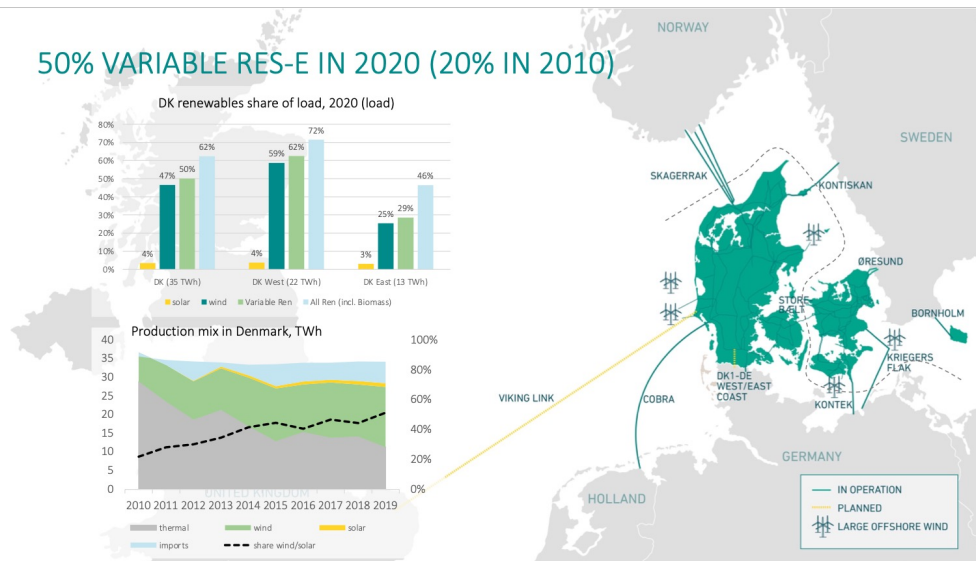
## Varying degrees of national market development but still utilizing regional power trade



# Demark Example – providing higher security of supply in RE-based power system

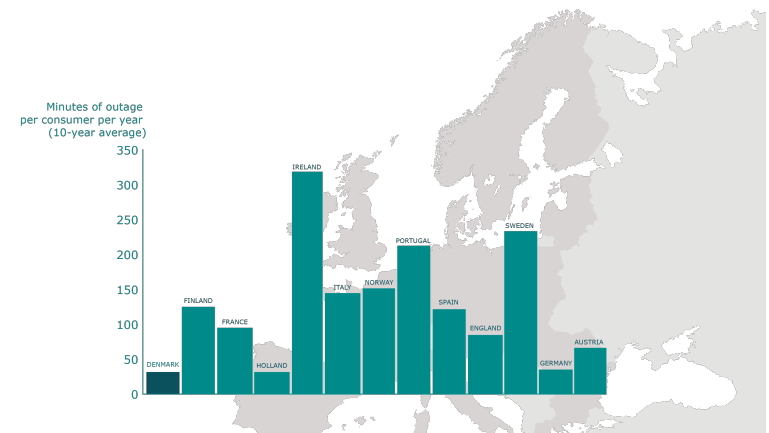
Example from Denmark – they rely on the well-integrated European regional market

50% VARIABLE RES-E IN 2020 (20% IN 2010)

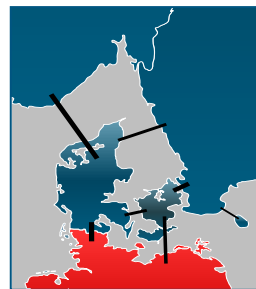


.....YET HIGH SECURITY OF SUPPLY

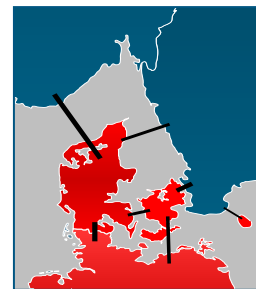
Danes have electricity 99.9% of the time



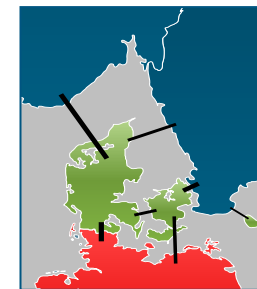
Common price 20% of time



Common with Nordics 50%



Common price with DE - 20%



Own price - only 10%

Source: **ENERGINET**

# US Western Energy Market Example – providing lower cost of supply in RE-based System

## Example from Western Imbalance Energy Market in the US



\*Avangrid office; generation-only BAA with distribution across multiple states.  
Map boundaries are approximate and for illustrative purposes only.

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Regional coordination in generating and delivering energy produces significant benefits in three main areas:

- Reduced costs for participants by lowering the amount of costly reserves utilities need to carry, and more efficient use of the regional transmission system.
- Reduced carbon emission and more efficient use and integration of renewable energy.
- Enhanced reliability by increasing operational visibility across electricity grids, and improving the ability to manage transmission line congestion across the region's high-voltage transmission system.

**\$418.82 million savings in Q1 2023**

**Total gross benefit since 2014:  
\$3.82 billion**



# GMS ETTF\_Regional Power Trade Working Group (RPTWG)

## Proposed work Plan (2023-2025) – Pilot Regional Power Market Development

Activity/Milestones – Pilot Regional Power Market Development	Indicative timeline
<b>Background/initial tasks</b>	
Formation of the RPTWG	Q3 2023
Appointment of international and national consultants for the design of a pilot regional power market and support for procurement of trading platform	Q3 2023
Review of existing bilateral trades, regional Master Plan and existing/high-priority regional interconnections projects	Q3 2023
Identification of available capacity on existing interconnectors and required steps to gain access to capacity for trading in pilot RPM	Q3 2023
Identification of countries to be included in the pilot RPM	Q4 2023
<b>High-level design for a pilot for a regional power market</b>	
Preparatory work on regulatory arrangements for pilot RPM involving 3+ countries	Q4 2023
Preliminary high-level design options for regional pilot power market (RPM) developed	Q4 2023
RPTWG workshop to discuss proposals for high-level RPM design options and a pilot RPM	Q4 2023
<b>Implementation of the pilot RPM</b>	
Negotiation of solutions for the utilization of current bilateral contracts and wheeling arrangements to support pilot RPM	Q4 2023 – Q1 2024
Development of detailed trading arrangements and procurement of platform for pilot RPM	Q4 2023 – Q2 2024
Commencement of pilot RPM including required trading platform	Q3 2024
GMS/ASEAN workshop to discuss the experiences from initial pilot RPM operations	Q4 2024
<b>Pilot trading period</b>	
Trading period (first only dry-runs and then with full financial/physical settlement)	Q4 2024 – Q4 2025
GMS/ASEAN workshop to discuss key findings, required changes to the design, and recommendations for expansion and scaling-up of the regular RPM (go-live)	Q4 2025

# GMS ETTF\_Regional Power Trade Working Group (RPTWG)

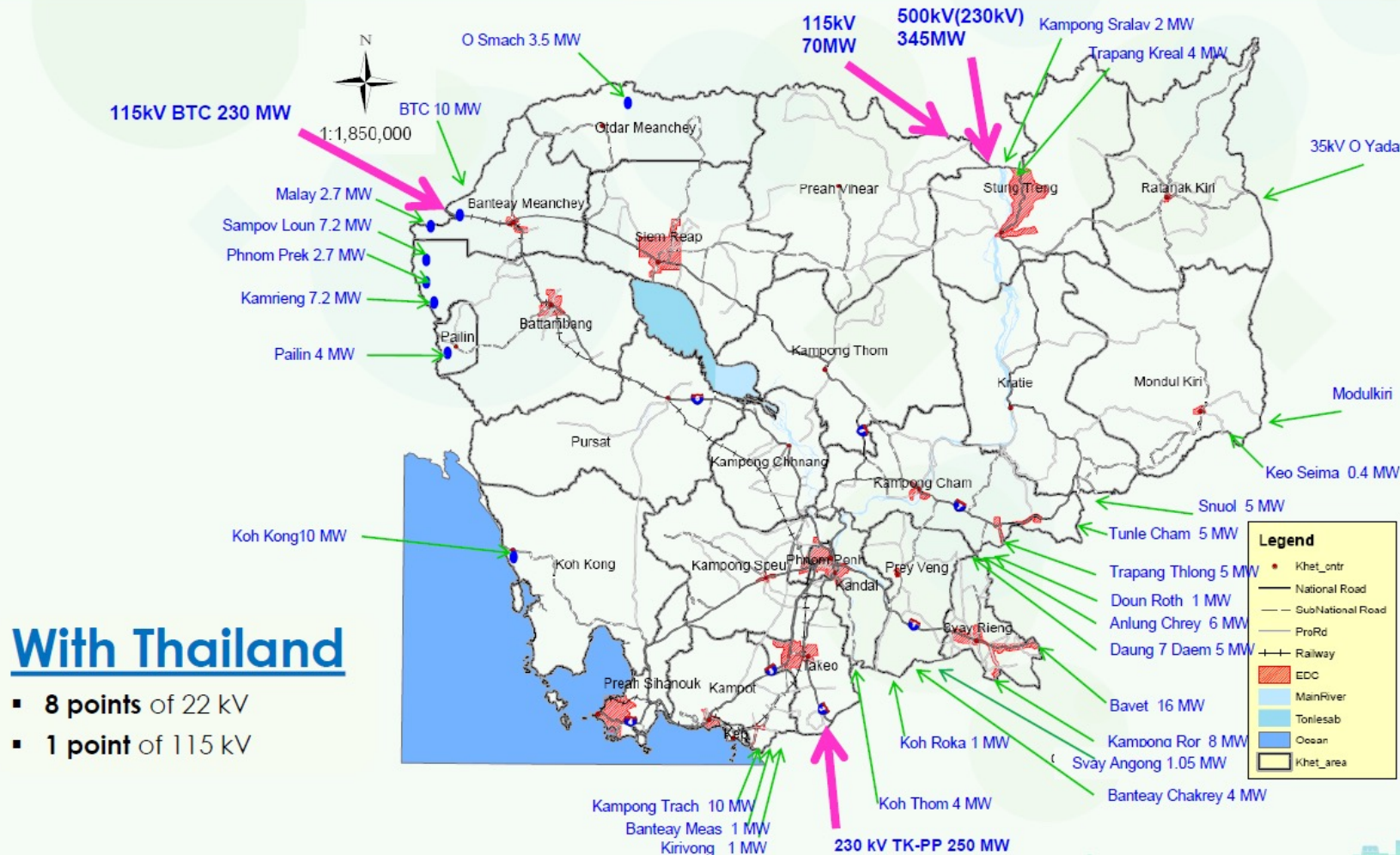
## Proposed Work Plan (2023-2025) – Assessment of Regional Interconnectivity

Activities/Milestones - Assessment of Regional Interconnectivity	Indicative timeline
Formulate terms of reference for international and national consultants to study the benefits of enhanced regional interconnection, prioritize interconnector projects, conduct high-level feasibility studies, and develop associated business models	Q3 2023
Appointment of international and national consultants	Q4 2023
Workshop to present initial findings to GMS/ASEAN stakeholders	Q1 2024
Develop regulations and charging arrangements to support regional transmission investments	Q1-Q2 2024
Conduct the feasibility studies of priority interconnection projects	Q2-Q3 2024
Workshop to present findings to GMS/ASEAN stakeholders	Q4 2024
Conduct actions to arrange the needed investment for the selected interconnection projects	Q1-Q3 2025
GMS/ASEAN workshop to share the key results	Q4 2025



**Thank you!**

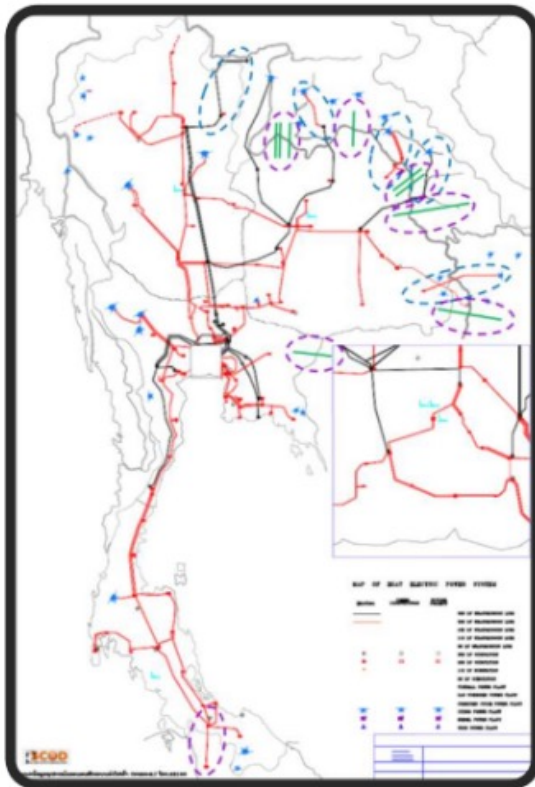
# Connection Points from Neighboring Countries





# Thailand Interconnection

## Status of Foreign Generation, Interconnection & Transmission



FIPP	Contract Capacity (MW)	Interconnection / Transmission Line	Circuits
Theun-Hinboun	434	230 kV Nakhon Phanom 2 – Thakhek	2
Houay Ho	126	230 kV Ubon Ratchathani 2 - Houay Ho	2
Nam Theun 2	948	500 kV Roi Et 2 - Nam Theun 2	2
Nam Ngum 2	596.6	500 kV Udon Thani 3 – Nabong	2
Hongsai Power	1,473	500 kV Nan – Hongsai	2
Nam Ngie 1	269	500 kV Udon Thani3 – Nabong	2
Xaiyaburi	1,220	500 kV Thali – Xaiyaburi	2
Xe-Pain Xe-Namnoy	354	230 kV Ubon Ratchathani 3 - Xe-Pain Xe-Namnoy	2
Nam Theun 1	514.3	500 kV Udon Thani 3 – Nabong	2

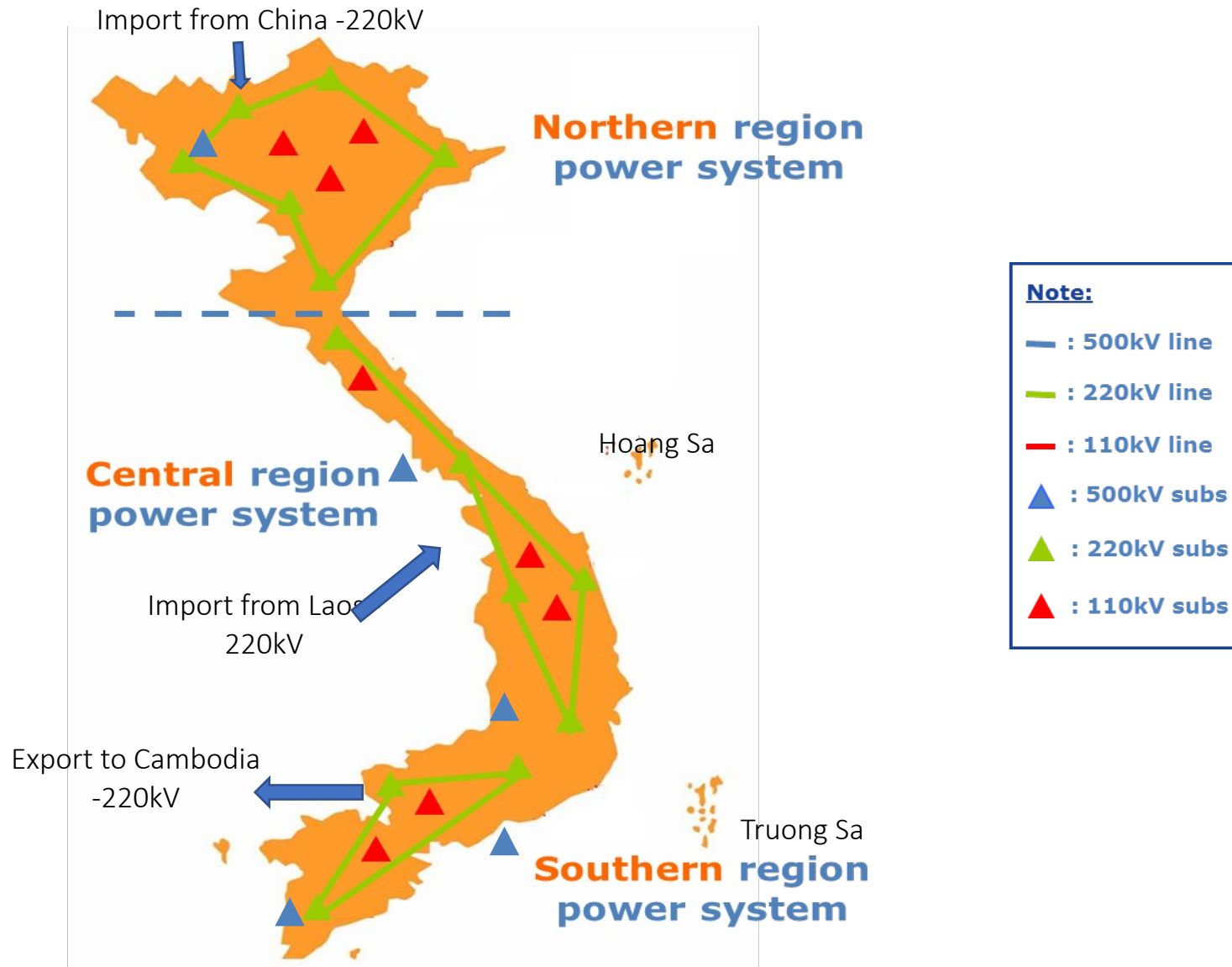
### Interconnection

TNB	300	300 kV HVDC Khlong Ngae – Gugun	1
EDL	-	115 kV Nong Khai – Tha Na Leng	1
		115 kV Nong Khai – Dong Phosy	2
		115 kV Bung Kan – Pak Xan	1
		115 kV Nakhon Phanom – Tha Khek	2
		115 kV Mukdahan 2 – Pak Bo	1
		115 kV Thali – Ken Thao	1
		115 kV Sirindhorn 2 – Bang Yo	2
EDC	-	115 kV Wathana Nakhon – Battambang	1

### Thailand System

North-Eastern Area	-	500 kV Roi Et 2 - Ubon Ratchathani 3	2
Southern Area		500 kV Bang Saphan 2 - Surat Thani 2	2
		500 kV Surat Thani 2 - Phuket 3	2

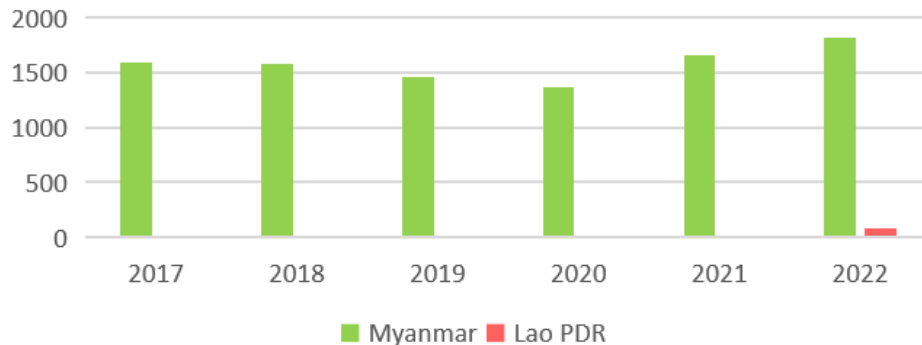
# Viet Nam Interconnection



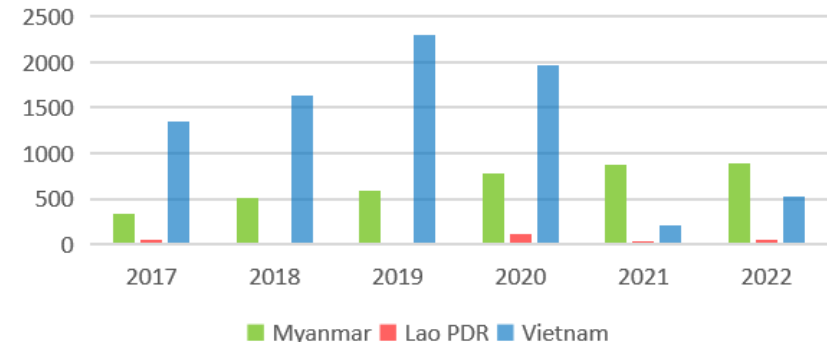
# Power Trade Between China and GMS Countries

- **The restore of China(Guangxi)-Vietnam power trade.** The power trade from China(Guangxi) to Vietnam is restored since May 2023 with monthly amount of 30GWh. Since 2004, China has interconnected with Myanmar, Lao PDR and Vietnam through power transmission lines at voltages of 110 kV and above, with the cumulative trade electricity of over 65.5 billion kWh.
- **Cooperation from one-way power trade to two-way power transmission.** In June 2022, the power station in northern Laos successfully sent electricity to Yunnan province in Southwest China. China and Lao PDR for the first time achieved the two-way transmission of electricity.

China's power import from Myanmar and Lao PDR  
2017-2022 (GWh)



China's power export to Myanmar, Lao PDR, Vietnam  
2017-2022 (GWh)



Source: General Administration of Customs of China

## In progress :

1. **500kV China-Laos Interconnection** : FS completed, Framework agreement was signed between CSG & EDL in November 2022
2. **China-Myanmar Interconnection** : Phase 1: 230kV interconnection.