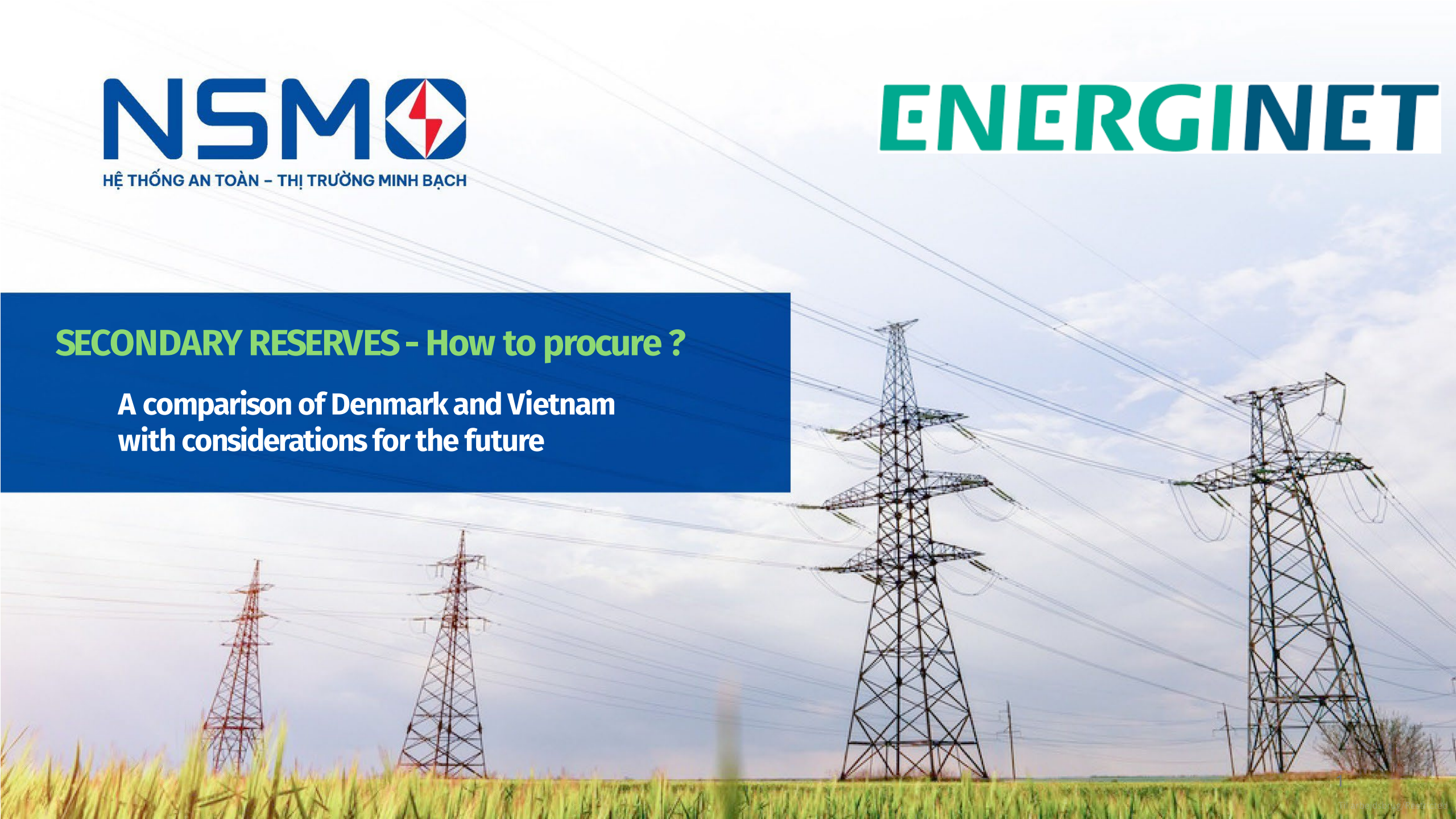


SECONDARY RESERVES - How to procure ?

A comparison of Denmark and Vietnam
with considerations for the future





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Background

Mr. Ulrik has specialized in power system economics, and for the past 20 years he has been working intensively with energy market design and energy policy. He has extensive knowledge of the energy sector and the Nordic and European power systems, from employment at the Danish TSO and the Danish economic consultancy, Copenhagen Economics. At Copenhagen Economics he was responsible for clients within the energy sector. Currently Ulrik works with different market design projects and with market design training, e.g. Nordic TSOs on improved grid utilization through better grid representation in the market operation model (so-called Flow Based Market Coupling). Ulrik has been responsible for the power market training activities towards Energinet's global collaborators (TSOs, utilities and energy regulators). Ulrik headed the sub project on training in power market design and launching a short-term power market in East Africa. From 2013 to 2022 Ulrik has done teaching in micro economics and power system economics as external associate professor at Southern Danish University.



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Background

Mr. Nguyen Ba Hoai has been working for the National Power System and Market Operator (NSMO, formerly EVNNLDC) for more than 10 years. He is currently the Deputy Manager (in charge) of the Renewable Energy Management Department. He received both his Bachelor's and Master's degrees in Electrical Power System from Universiti Tenaga Nasional (UNITEN), Malaysia. His responsibilities include the application of science and technology in developing tools for renewable energy operations, such as monitoring, forecasting, and management renewable energy. He also serves as the key focal point for international cooperation with other system operators around the world. Prior to this role, he gained extensive experience in the field of SCADA/EMS, particularly with AGC and state estimation.



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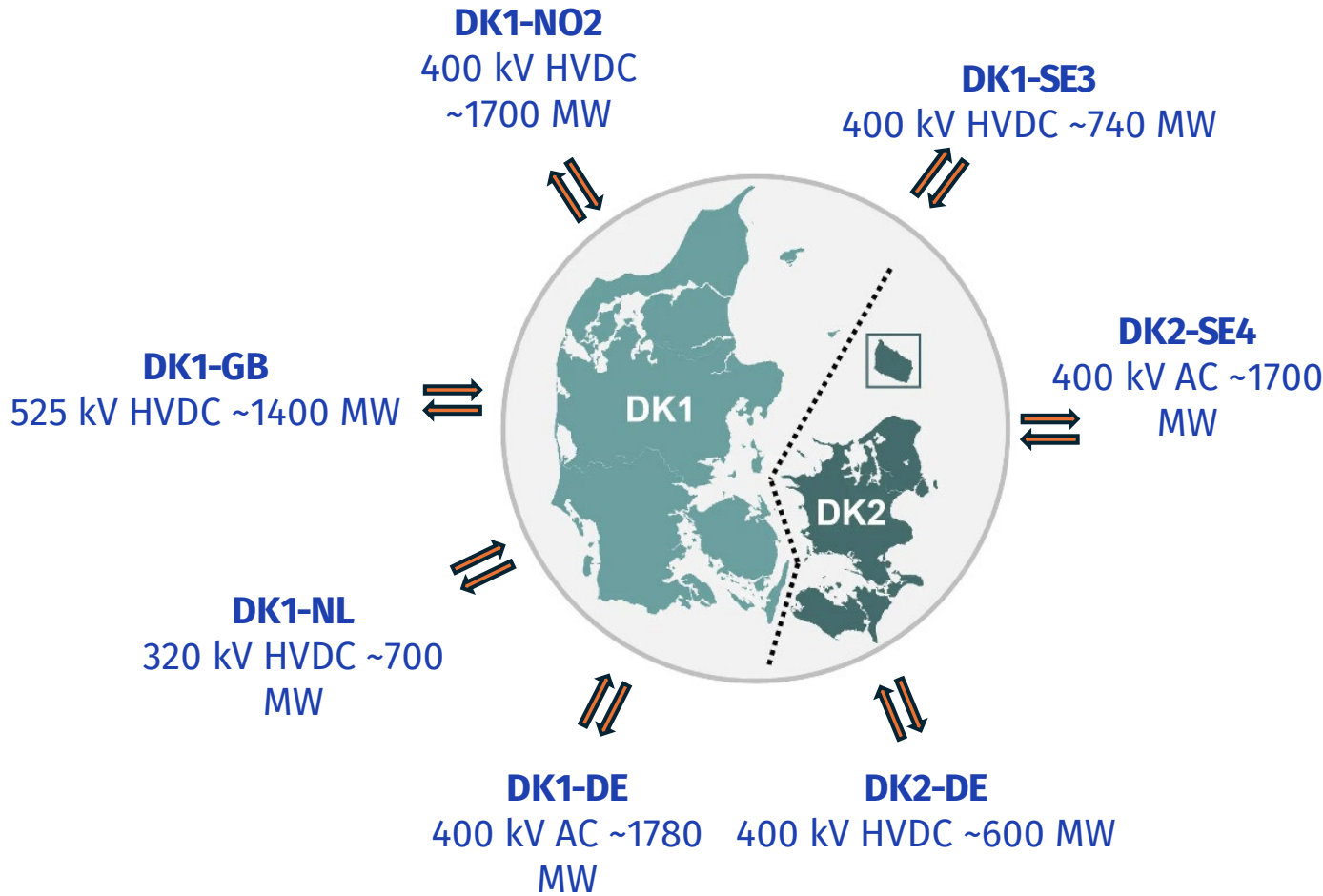
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POWER SYSTEM COMPARISON

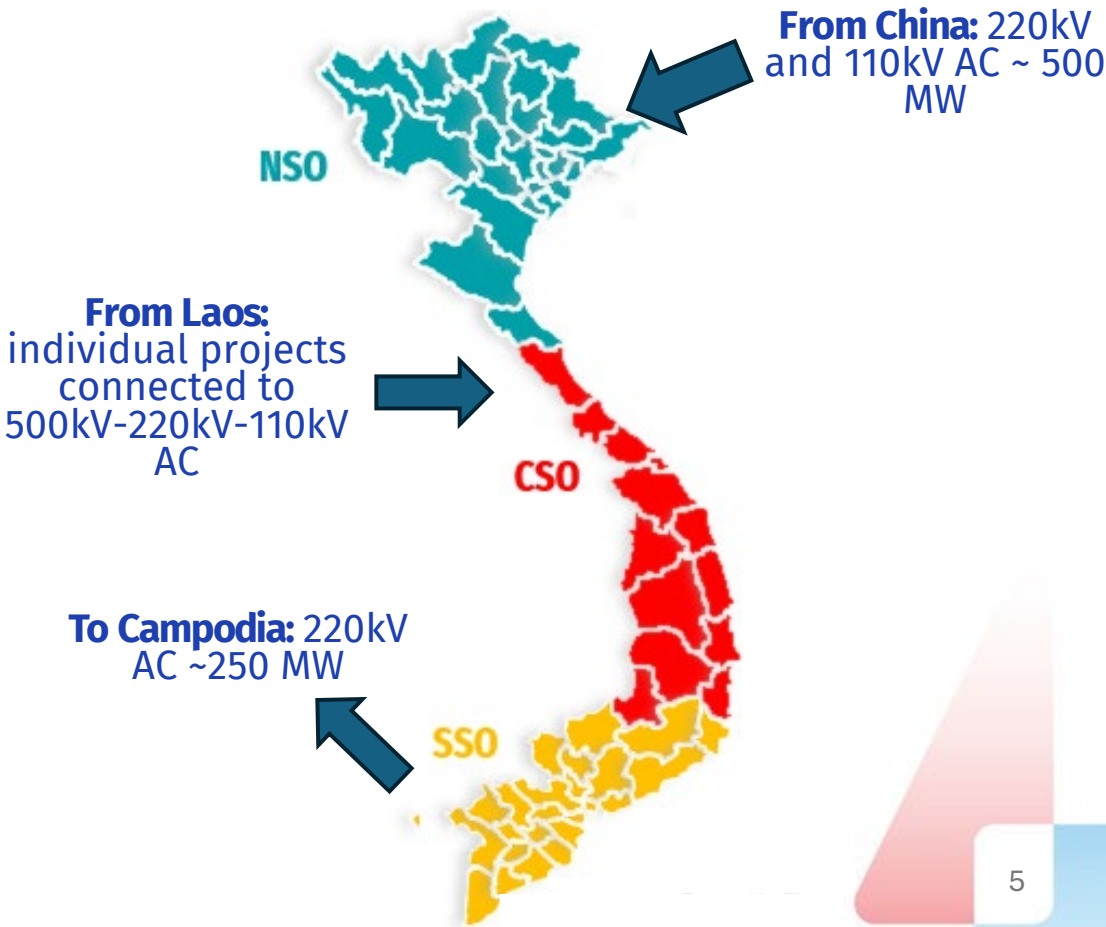
Vietnam - Denmark

POWER SYSTEM STRUCTURE

Danish power system



Vietnam power system



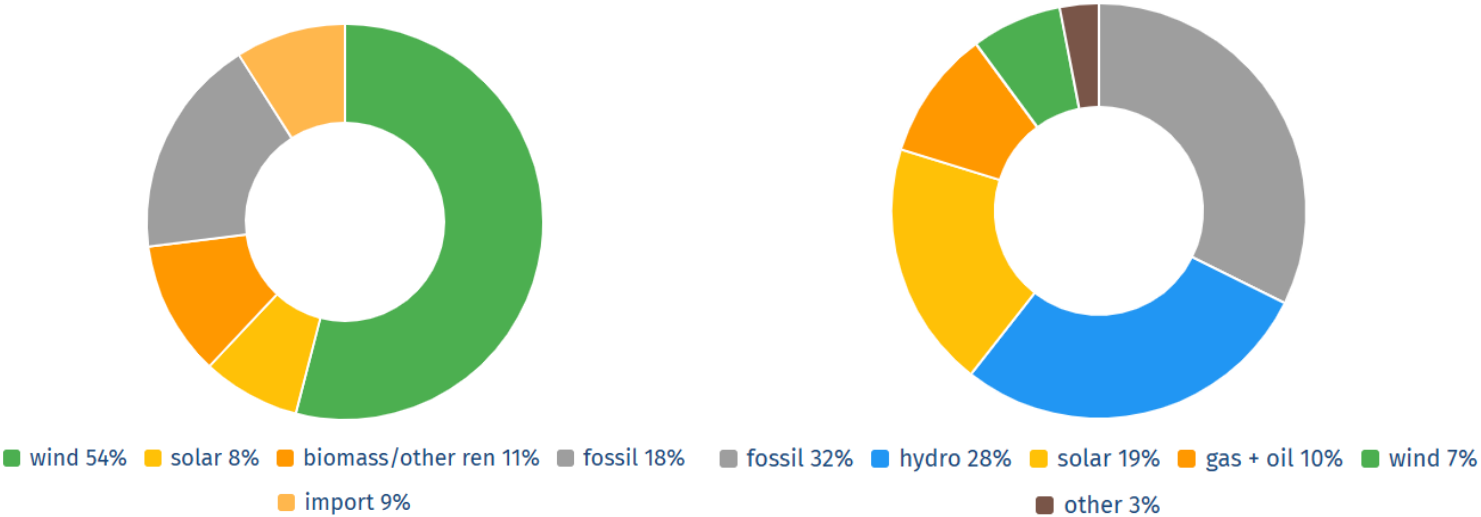
OVERVIEW COMPARISON

Features	 Denmark	 Vietnam
 Installed capacity	18 GW	86 GW
 Peak load	6.5 GW	48 GW
 Population	5.9 million	98.9 million

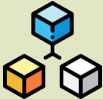
 Annual power consumption

44 billion kWh

310.65 billion kWh



OVERVIEW COMPARISON

Feature	 Denmark	 Vietnam
 Interconnection	Highly interconnected and interdependent within Nordic and Europe	Stand-alone system with limited asynchronous interconnections
 Configuration	DK1 (synchronous with Continental Europe) & DK2 (Nordic synchronous area)	Three regionals (Northern, Central, Southern) connected by 500 kV backbone
 Bidding zone	2 bidding zones in DK and a total of 12 in Nordic region	1 bidding zone
 RES penetration	62% installed capacity	28% installed capacity



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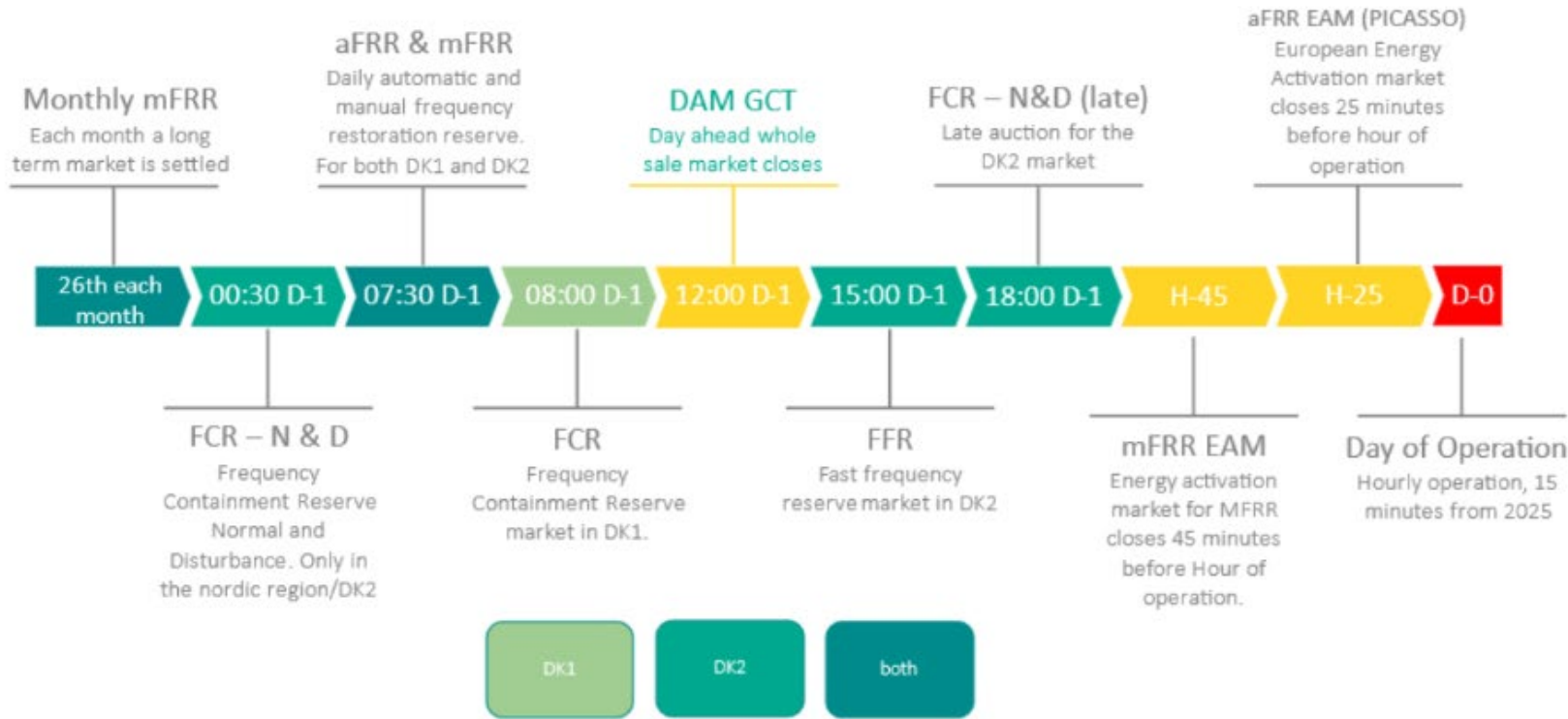
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SECONDARY RESERVE

Vietnam - Denmark

SEQUENTIAL SETUP IN DENMARK (NORDIC)

CAPACITY RESERVE MARKETS GATE CLOSURES (AFTER 2ND SEP 2024)



Market structure and Gate closure times in Denmark

DENMARK, NORDIC ANCILLARY SERVICES MARKET



Secondary Reserve (aFRR - Automatic Frequency Restoration Reserve)



Deliver within **5 mins**

Characteristic: Medium-fast reserve; all power delivered within 5 minutes of activation.

Main Purposes: Releases FCR, corrects minor imbalances, restores interconnector balance and handles remaining imbalance after mFRR.

Activation: TSO (Energinet) signal to Balance Responsible Parties (BRPs).

Procurement: Capacity via hourly auctions (Nordic aFRR CM); energy via PICASSO.



Tertiary Reserve (mFRR - Manual Frequency Restoration Reserve)



Deliver within **12 mins**

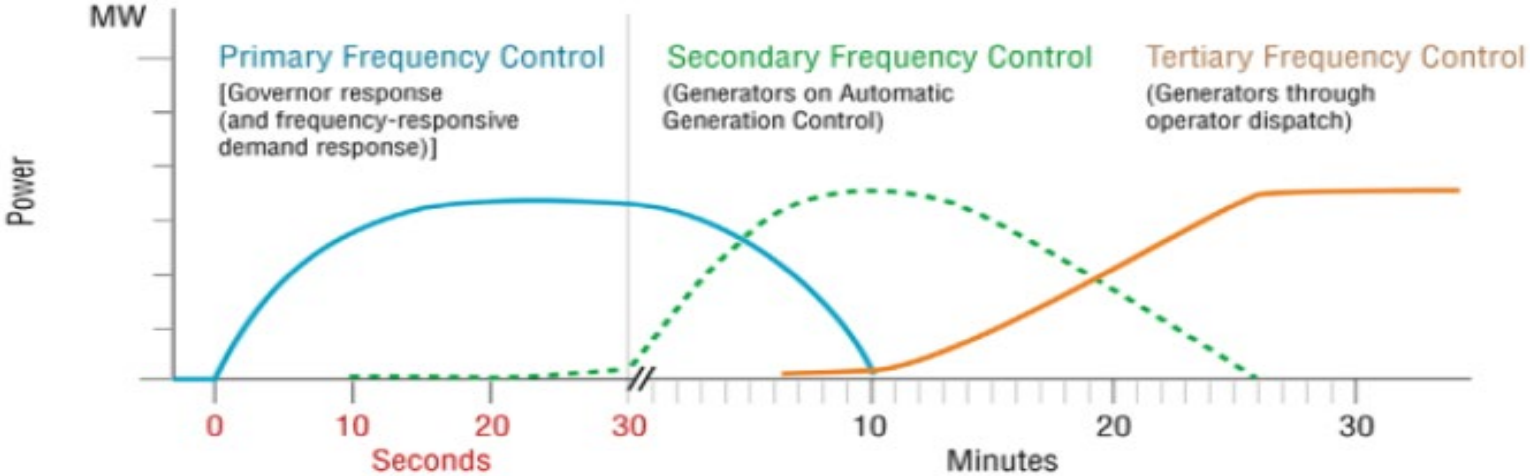
Characteristic: Manually committed capacity; full response within 12.5 minutes of activation.

Purpose: Addresses significant imbalances from unplanned production/consumption changes.

Activation: Direct signals from Energinet.

Procurement: Capacity via trilateral mFRR market with Sweden and Finland and energy via joint Nordic mFRR energy activation market.

VIETNAM FREQUENCY REGULATION



Primary Frequency Control

Immediate & Automatic

Automatic, by generator governors; mandatory for all connected units.

150 ~ 180 MW



Secondary Frequency Control

AGC System

Via Automatic Generation Control (AGC) to restore frequency to nominal range.

~716 MW



Tertiary Frequency Control

Manual Dispatch

Dispatching order to stabilize frequency economically.

SECONDARY RESERVES COMPARISION

 Feature	 Denmark - aFRR	 Vietnam Secondary Reserve
Concept Name	aFRR (Automatic Frequency Restoration Reserve)	Secondary Reserve
Balancing Philosophy	Balancing in advance: Forecasts inform mFRR scheduling; remaining imbalances handled by faster products (mainly aFRR)	Balancing in Real-time (no market): AGC calculates setpoints based on frequency deviation
Characteristics	Automatic activation after 30s ; Full Activation: 5 min	Start delivery within 20s of AGC signal; Full activation in 10 min ; Sustain for ≥15 min
Capacity Procurement	Common total Nordic: 325 MW up, 375 MW down.	716 MW (both directions) (Assigned by NSMO)
Energy Activation	PICASSO (Common European EAM – 15 minutes) (TSO signal to BRPs – 4 seconds) Denmark max. possible aFRR activation DK1: 200 MW, DK2: 100 MW	TSO AGC signal to plant units – 8 seconds

VIETNAM'S KEY CHALLENGES AND DEVELOPMENT NEEDS

Secondary frequency regulation reserve capacity: **716 MW**



Practices

- ⚡ **Ancillary Services Market:** No ancillary services market currently exists.
- ⚡ **Primary Frequency Control:** Primary Frequency Control is mandatory for all units.
- ⚡ **Secondary Frequency Control :** Using large Hydro Power Plant via AGC signal.



Requirement

- ⚡ **High RES Integration:** Essential given high RES penetration goals.
- ⚡ **Carbon Neutrality:** Required for 2050 targets.
- ⚡ **Urgency:** Need to accelerate AS market as RES with high uncertainty accounted for 28% of total installed national capacity. Revised PDP8 RES will account for 40-48%.

DANISH EXPERIENCE CAN HELP VIETNAM



Danish Experience

- ➔ **Common Nordic aFRR market:** Has already evolved significantly since its beginning in 2022 where it transitioned from combined capacity and balancing energy market –to today with separate capacity and balancing energy activation.
- ➔ **Start is always hard:** High prices and low volumes characterized the initial stages. Competition and liquidity have increased over time.



Lessons learnt can be useful for Vietnam

- ➔ **Danish experience:** Market development is a step-by-step process and continuous problem-solving is necessary. Lots of design choices to be made!
- ➔ **Co-optimisation:** Energinet takes part in the European R&D on the potential application of co-optimisation of aFRR and mFRR balancing capacity with the European Day-ahead market.



Partnership Goals: Denmark can provide valuable input to Vietnamese market development efforts



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ONGOING STUDY

Sequential and Co-optimization setup

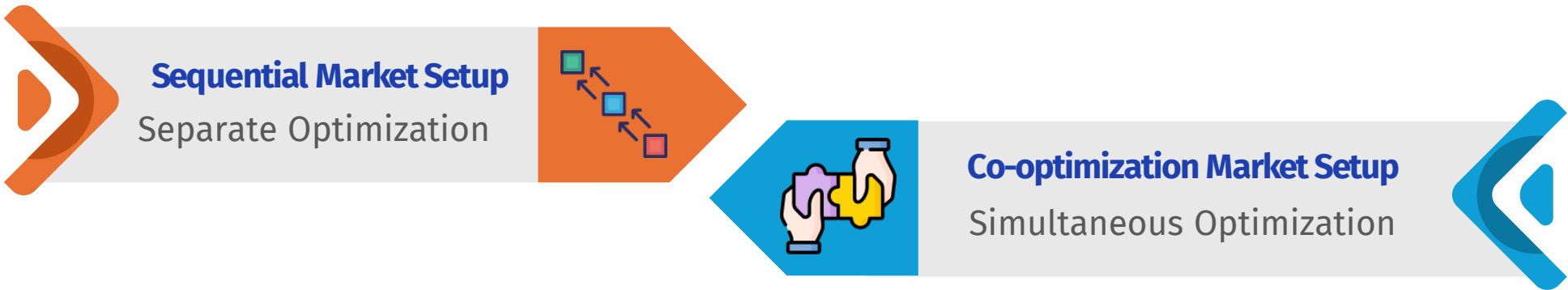
COMPARISON OF TWO MARKET ARCHITECTURES

(NSMO & Energinet ongoing study)



Objective

Evaluate advantages and disadvantages of two market architectures and provide recommendations for Vietnam's ancillary services market deployment



Study focus: Market Structure Analysis • Economic Efficiency Evaluation • Implementation Recommendation for Vietnam



SEQUENTIAL MARKET SETUP



Key function

Mechanism: Separately clears the day-ahead energy market and balancing capacity market.

Allocation: Forecasts decide cross-zonal transmission capacity reservation for reserves before the energy market.

Constraints: Respects physical grid constraints.

Integration: Energy dispatch and reserve capacity are determined sequentially.



Theoretical pros and cons



Transparency: Simpler market steps make roles and revenues easy to understand and estimate.



Broader Participation: The simplicity lowers entry barriers, encouraging wider participation which can increase competition and ease implementation.



Cost Inefficiency Risk: Separate clearing can misallocate resources and capacity which may increase system costs.



Definition

Separate optimisation of wholesale electricity markets (day-ahead) and reserve capacity procurement



CO-OPTIMIZATION CONCEPTS



Key function

Mechanism: Jointly clearing the day-ahead **energy** market and balancing **capacity** market.

Allocation: Efficiently allocates cross-zonal transmission capacity between energy dispatch and secondary reserve procurement.

Constraints: Respects physical grid constraints.

Integration: Energy dispatch and reserve capacity determined simultaneously.



Theoretical pros and cons



Cost Optimization: Minimizes total system costs by jointly considering energy and reserve needs.



Efficiency: Unlike sequential approaches, avoids suboptimal allocation, allow better utilization of resources and capacity.



Market complexity: increase demand on operational and computational market structure.



Definition

Simultaneous optimization of wholesale electricity markets (day-ahead) and reserve allocation



EVALUATING MARKET DESIGNS: PROS AND CONS

Criteria	Sequential Market Setup	Co-optimization Market Setup
Operational Efficiency	Lower – Separate procurement leads to inefficient resource allocation	Higher – Simultaneous clearing optimizes total system costs
Complexity & Market Expansion	Simple – Clear , encourages broader participation	Complex , potential barriers to entry if not managed
Infrastructure Requirements	Lower infrastructure/computational demands; easier initially	Complex - robust infrastructure, regulatory frameworks, clear understanding for participants



VIETNAMS FUTURE ANCILLARY SERVICES MARKET?



Why Co-optimization ?

- ➔ **Resource Efficiency:** Theoretically more efficient resource allocation, reduced total system costs.
- ➔ **Grid Management:** Effective management of cross-zonal transmission allocation.
- ➔ **System Isolation:** Vietnam's largely isolated system simplifies cross-border complexities (no need for international agreements).



Key benefits

- ➔ **Joint Procurement:** Efficient joint procurement of energy and reserves.
- ➔ **System Responsiveness:** Enhanced system responsiveness to changing conditions.
- ➔ **Reserve Optimization:** Better resources allocation such as updated input parameters.
- ➔ **VRE Flexibility:** Improved VRE flexibility and integration.



Analysis result: *Further study of* Co-optimization market in Vietnamese context, *simulation* needed with the new Vietnam market model design



IMPLEMENTATION CHALLENGES

Increased market complexity

Combining energy and ancillary services into one market clearing process makes rules and bidding structures more complicated.

Stronger Regulatory Oversight Needed

This setup will demand clear regulation, continuous monitoring, and fair access rules for all participants.



Higher computational and infrastructure demands

Requires complex algorithms, real-time data processing, and powerful computational capacity, necessitating major system upgrades.

Challenges in expanding market participation

Difficulty in attracting a sufficient number of participants can lead to a shallow market and undermine overall efficiency.



CONCLUSION

Key Conclusions

- ⚡ With 28% share of VRE, Vietnam is going to design and build the ancillary service market.
- ⚡ The main goal of study is to learn reserve model and how to apply to Vietnam context.
- ⚡ Co-optimization theoretically may be a compelling path for Vietnam and should be the working assumption for the upcoming phases



Recommendations for NSMO

-  **Technical Validation:** Continue detailed simulations and technical validation of co-optimization models tailored to Vietnam.
-  **Implementation Roadmap:** Develop a phased implementation roadmap, addressing infrastructure, regulatory, and market participant readiness.
-  **Partnership Strengthening:** Leverage the NSMO-Energinet partnership for ongoing knowledge exchange and support.

Questions & Discussion

Thank You

Partnership Program

Vietnam-Denmark TSO Partnership