Grid Ancillary Services Considering SMR Projects in Estonia

Report Presentation

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Content

"Identify the potential value of a SMR project in Estonia when it comes to grid ancillary services"

Background research

Disconnection from Integrated Power system of Russia

- Estimate of consequences and grid services needs

Establishment of a Load Frequency Control process and associated markets

- Analysis of the TSOs concept document and comparison with the Nordics

Opportunities of SMRs

Participation to Frequency Containment and Restoration Reserves

- Estimate of revenue stream from to-be established markets

Indirect support to grid stability in the Baltic Synchronous Area

- Qualitative assessment of other positive effects

Hybrid Systems

Combination of SMRs with battery storage systems

- Description of advantages and potential sizing

Participation of the hybrid system grid ancillary service markets

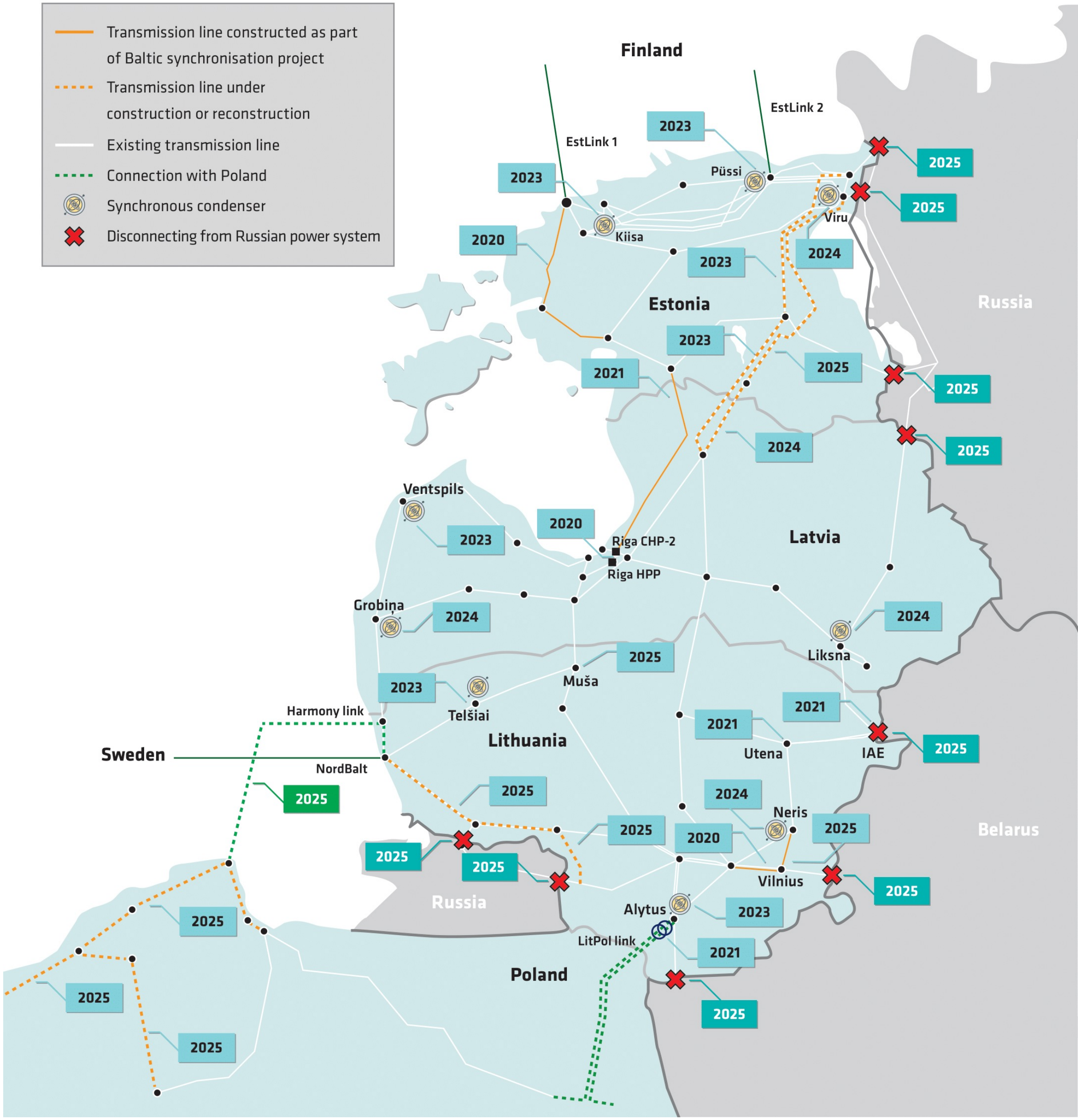
- Estimate of additional revenue streams

Background: disconnection from the Integrated Power System of Russia

To synchronize with the Continental Europe Synchronous Area (CESA), the Baltic States need to establish their own Load Frequency Control (LFC) processes

Baltic TSOs have published a concept document to define their proposal of implementation of the European System Operation Guidelines (SOGL)

Baltic TSOs also performed an assessment of feasibility and economic impact of provision of Frequency Containment and Restoration Reserves.



Source: *https://elering.ee/en/synchronization-continental-europe*

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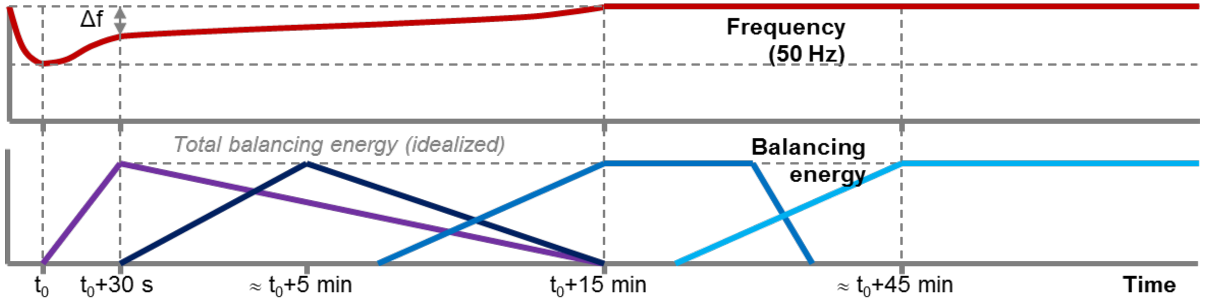
TSOs follow the structure and dimensioning requirements from European SOGL for the Load Frequency Control (LFC)

The LFC is critical to ensure operational security with high level of reliability and quality and requires cooperation between the Baltic TSOs to balance the demand and consumption in real time and achieve a stable system frequency of 50 Hz

Frequency Containment Reserve	Automatic Frequency Restoration Reserve	Manual Frequency Restoration Reserve	Replacement Reserve (not included)
FCR • Automatic activation • Max 30s	**aFRR (+IN)** • Automatic activation • 30 s to 15 min	**mFRR** • Semi-automatic or manual activation • Max 15 min	**RR** • Semi-automatic or manual activation • Min. 15 min



Source: https://elering.ee/sites/default/files/2020-09/Baltic%20Load-Frequency%20Control%20concept%20document_0.pdf

	FCR	aFRR		mFRR	
	MW	Up, MW	Down, MW	Up, MW	Down, MW
Estonia	8	40	40	209	257
Latvia	8	30	30	145	37
Lithuania	9	60	60	226	276
Total	**25**	**130**	**130**	**580**	**570**

Installation of Synchronous Condensers
17 GWs Inertia

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Target inertia level is comparable to the Nordic systems, while sizing of reserves is significantly lower

Target inertia for the Baltics is 17 GWs, proportional to the Nordic's 120 GWs.

FCR is targeted to 25 MW in the Baltics, while Nordics procure almost 2 GW in total

- Calculation from Baltic TSOs has been mainly based on proportion between the areas consumption and the total Continental Europe load.
- This does not take into account grid stability and available production unit's properties.

Depending on the wind power development scenarios FCR need to increase, if the inertia in the system is assumed constant

- 2 GW wind integration would require roughly 400 MW of FCR and 4 GW would require 800 MW.
- With planned FCR sizes, Baltics need to rely on the AC connections to Poland for grid stability and might not be able to guarantee security of supply in case of disconnection from CESA.
- More system inertia from rotating synchronous machines would improve system resilience in case of outages.

SMRs can deliver most of the designed grid services but are more suitable for Frequency Restoration Reserves

Achievable reserve contribution and revenues for a single 300 MWe SMR with a ramp rate of 1,5 MW/min

	FAT (seconds)	Achievable for SMR (MW)	TSO Need (MW)	% of Total
FCR	30	0,75	25	3 %
aFRR (up or down)	300	7,5	130	6 %
mFRR (up or down)	720	18	580	3 %

FAT: Full activation time

Total Yearly Revenue	FCR	aFRR		mFRR	
		Up	down	up	down
Low Scen.	34 000 €	674 000 €	440 000 €	353 000 €	667 000 €
High Scen.	114 000 €	1 220 000 €	1 340 000 €	1 800 000 €	667 000 €

Ancillary service prices are based on other similar established markets and include a high level of uncertainty

aFRR appears to be the most remunerative service for a SMR

Delivery of different services is possible but needs to be coordinated

The ramp limitation is the bottleneck to deliver Frequency Containment Reserves (design dependent)

Additional services (e.g. inertia, voltage control) can be provided by SMRs but no market is planned to be established

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Hybridization: By combining SMR with a battery system it is possible to increase the delivery of FCR

Hybrid system requires smaller battery size compared to stand-alone solutions

- Fortum has succeeded in investing in similar application for hydropower units
- Olkiluoto NPP in Finland will also be equipped with battery systems to support the power grid

A 300 MWe SMR unit equipped with 4,5 MW and 0,3 MWh battery capacity could satisfy the **whole TSO expected FCR need** in Estonia (5 MW)

The value on the FCR market could be limited but the system benefit would be significant

- Baltic TSOs have pointed out that procurement of all services in single areas is not achievable without must-run operation
- The value of a Hybrid SMR is then derived by savings due to avoided must-run cost

Total Yearly Value	FCR market value	Avoided Must-Run Costs
Low Scenario	34 000 €	1 000 000 €
High Scenario	114 000 €	6 000 000 €

Expected CAPEX for the proposed system (battery addition) is between 3-4 M€

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Conclusions

Baltic TSOs have proposed a model for grid services based on European System Operation Guidelines (SOGL) after disconnection from the Integrated Power System of Russia.

- May not be ambitious enough to guarantee the stability of the power system of the Baltic Synchronous Area with the available production sources in 2030
- Comparing with the Nordic Power System, the size of the FCRs in the Baltics would need to be increased
- Must-run operation of conventional units would otherwise be necessary, some of which are planned to be phased-out

Evaluation of the value for grid ancillary services is uncertain since markets have not started yet

- Income from markets is anyway significantly lower than value of avoiding must-run costs
- Additional flexible capacity has a value to guarantee correct power system operation
- SMRs are also able to contribute to system stability providing services which are not commonly remunerated in Europe, but very necessary to guarantee local grid stability.

SMRs can deliver most of grid ancillary services but some of them in limited capacity

- SMRs are suitable of operation in FRR markets due to their ramping capabilities
- Hybridization with batteries could enable provision of all FCR needs for Estonia with one 300 MWe SMR