Swedish Energy Agency

Energy Storage in the Swedish Electricity System

Current Status and Developing Trends

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Introduction

- Purpose of the presentation: Share insights into the development of energy storage systems in Sweden

- Swedish Energy Agency
  - National authority for energy policy issues
  - Falls under the Ministry of Climate and Enterprise
  - The Director-General is appointed by the Swedish Government
  - Government funded
  - Research and Innovation – part of toolkit for policy on energy transition, energy security and competitive industry sector

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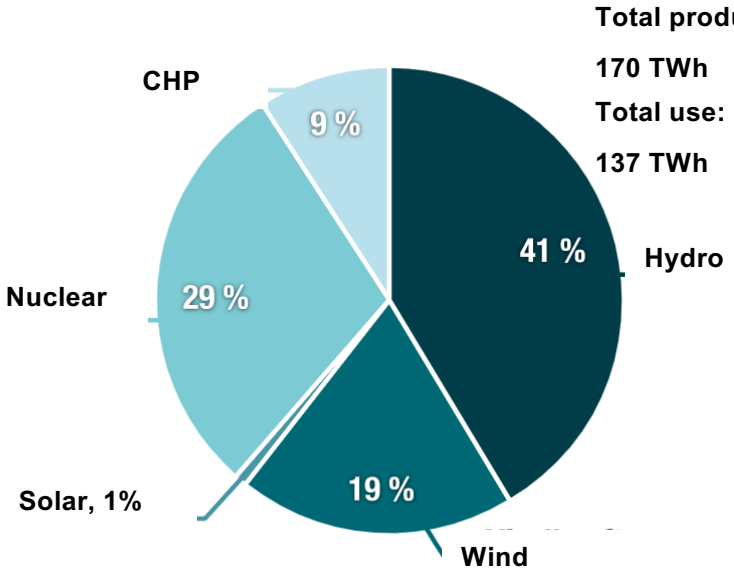
Overview Swedish Electricity System - Electricity Production (2022)

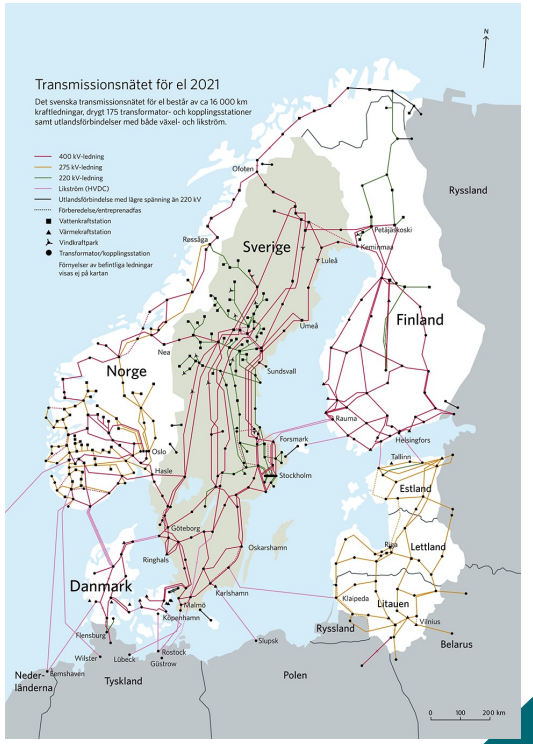


Total production:

170 TWh

Total use:

137 TWh



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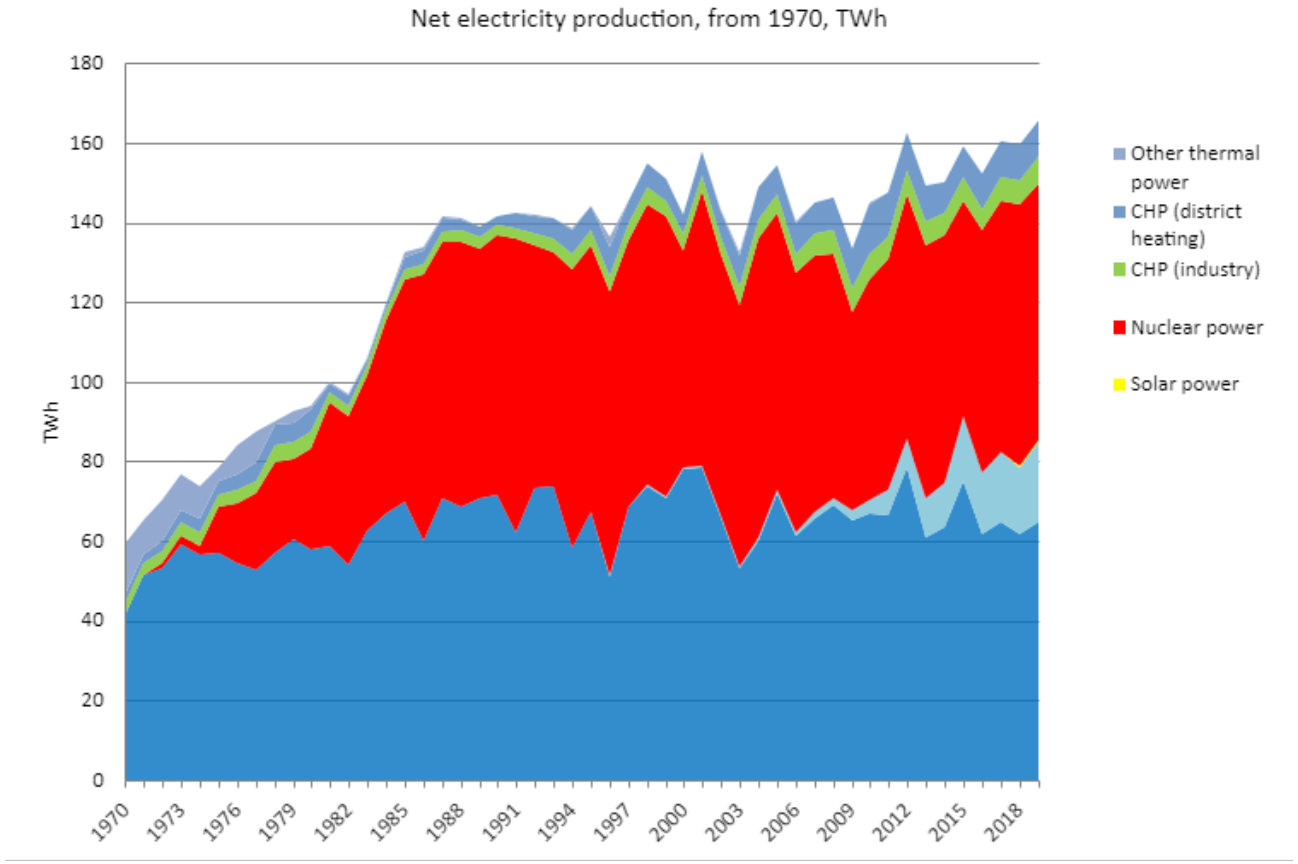
Nuclear and Hydropower are largest supply sources but Wind Power is growing the most (and solar the fastest…)



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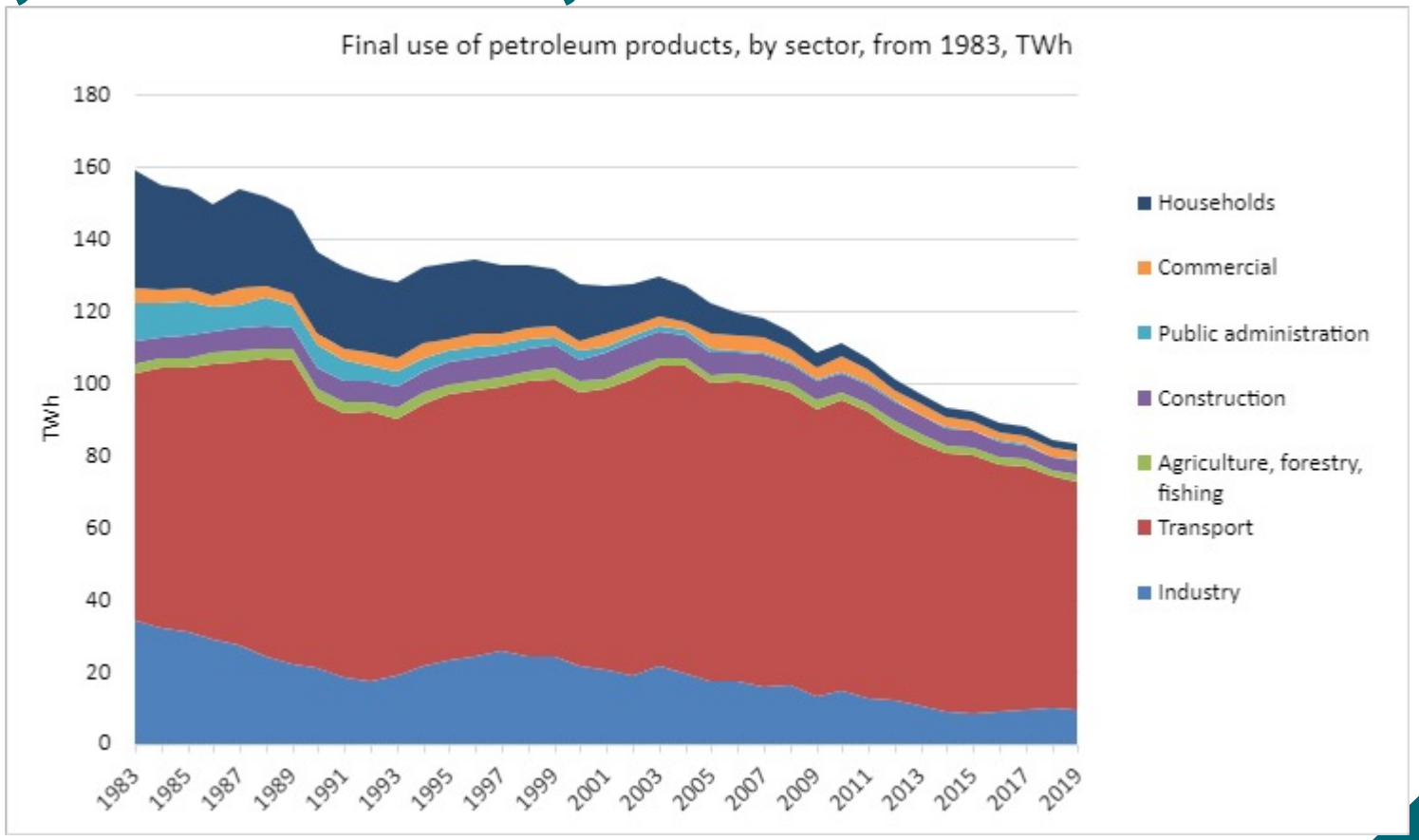
Final use of petroleum products, by sector, from 1983, TWh



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Trends and Challenges ahead

- Electrification (2x Elecectricity demand in ~20 years)
  - Data centers (short and medium term)
  - Transport sector (medium and long term)
  - Industry (medium and long term)

- Expansion of RES and Nuclear
  - Windpower to increase from 27,5 (2021) TWh 47tWh (2025)
  - Pv fastest growing but from low levels (1TWh 2022 5TWH 2025?)
  - Preparation for new Nuclear Capacity (up to 10 new reactors ~starting 2035?)

- Energy Security and Resilience
  - Increased requirements on security of supply (Island mode, robust grids etc)
  - Integrated Electricity Market in Europe
  - Dependency of materials and other resources
  - Competitiveness

Energimyndigheten

Energy Storage in the Electricity System Today

- Mainly Large Hydropower Reservoirs (~35 TWh) and rotating machines

but ….

- Battery deployment is accelerating (PV+ batteries, household batteries, Grid Scale battery systems, electrification of transport)
- New plans for pumped hydro
- Hydrogen storage in connection to decarbonisation of industry

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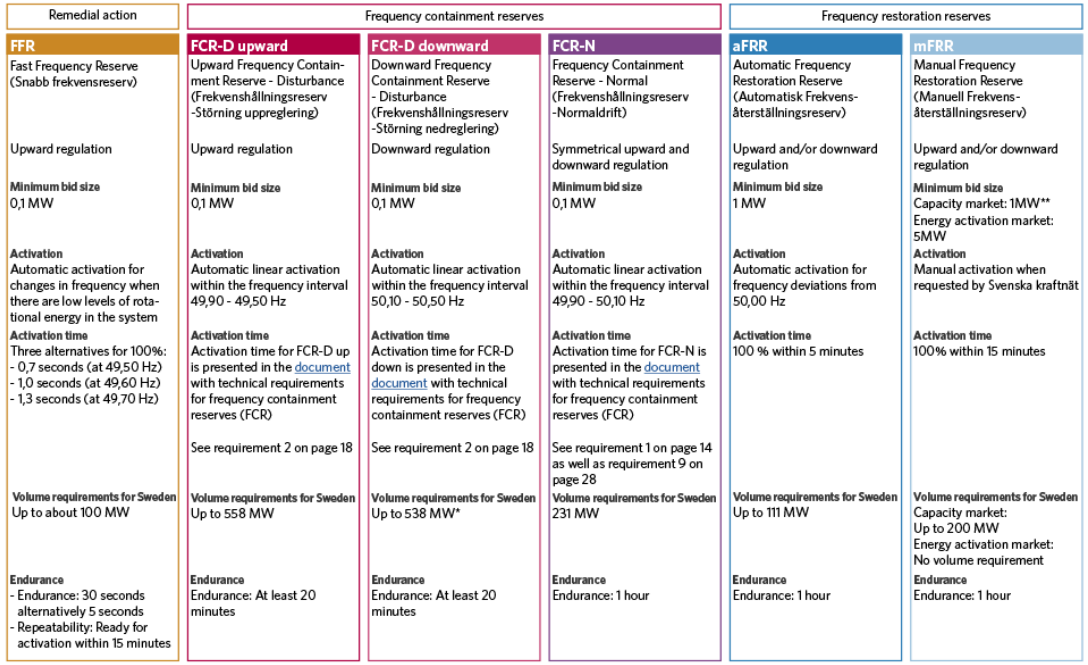
Driving Factors for Investment in New Energy Storage Systems

- **Increasing market for Ancilliary Services** (Euro 100Mio 2021, Euro 600Mio 2023)
- **Arbitrage on electricity spot prices (hourly and weekly)**
- **Tax discount on investment for houshold batteries** (when installed together with PV)
- **Grid Capacity constraints** for charging infrastructure



Remedial action	Frequency containment reserves			Frequency restoration reserves	
FFR	**FCR-D upward**	**FCR-D downward**	**FCR-N**	**aFRR**	**mFRR**
Fast Frequency Reserve (Snabb frekvensreserv)	Upward Frequency Containment Reserve - Disturbance (Frekvenshållningsreserv -Störning uppreglering)	Downward Frequency Containment Reserve - Disturbance (Frekvenshållningsreserv -Störning nedreglering)	Frequency Containment Reserve - Normal (Frekvenshållningsreserv -Normaldrift)	Automatic Frequency Restoration Reserve (Automatisk Frekvens-återställningsreserv)	Manual Frequency Restoration Reserve (Manuell Frekvens-återställningsreserv)
Upward regulation	Upward regulation	Downward regulation	Symmetrical upward and downward regulation	Upward and/or downward regulation	Upward and/or downward regulation
Minimum bid size 0,1 MW	**Minimum bid size** 0,1 MW	**Minimum bid size** 0,1 MW	**Minimum bid size** 0,1 MW	**Minimum bid size** 1 MW	**Minimum bid size** Capacity market: 1MW** Energy activation market: 5MW
Activation Automatic activation for changes in frequency when there are low levels of rotational energy in the system	**Activation** Automatic linear activation within the frequency interval 49,90 - 49,50 Hz	**Activation** Automatic linear activation within the frequency interval 50,10 - 50,50 Hz	**Activation** Automatic linear activation within the frequency interval 49,90 - 50,10 Hz	**Activation** Automatic activation for frequency deviations from 50,00 Hz	**Activation** Manual activation when requested by Svenska kraftnät
Activation time Three alternatives for 100%: - 0,7 seconds (at 49,50 Hz) - 1,0 seconds (at 49,60 Hz) - 1,3 seconds (at 49,70 Hz)	**Activation time** Activation time for FCR-D up is presented in the document with technical requirements for frequency containment reserves (FCR) See requirement 2 on page 18	**Activation time** Activation time for FCR-D down is presented in the document with technical requirements for frequency containment reserves (FCR) See requirement 2 on page 18	**Activation time** Activation time for FCR-N is presented in the document with technical requirements for frequency containment reserves (FCR) See requirement 1 on page 14 as well as requirement 9 on page 28	**Activation time** 100 % within 5 minutes	**Activation time** 100% within 15 minutes
Volume requirements for Sweden Up to about 100 MW	**Volume requirements for Sweden** Up to 558 MW	**Volume requirements for Sweden** Up to 538 MW*	**Volume requirements for Sweden** 231 MW	**Volume requirements for Sweden** Up to 111 MW	**Volume requirements for Sweden** Capacity market: Up to 200 MW Energy activation market: No volume requirement
Endurance - Endurance: 30 seconds alternatively 5 seconds - Repeatability: Ready for activation within 15 minutes	**Endurance** Endurance: At least 20 minutes	**Endurance** Endurance: At least 20 minutes	**Endurance** Endurance: 1 hour	**Endurance** Endurance: 1 hour	**Endurance** Endurance: 1 hour

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Medium Term Outlook – Where are we Heading?

- Electrification of transport sector means strong deployment of distributes batteries and system change
- Market for ancillary services levels out and eventually get saturated
- Energy storage market for price arbitrage will continue growing (specifically for price fluctuations in time scale of weeks and months)
- Security of supply and grid resilience increasingly important – driven by legislation?

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Critical Aspects when Supporting Energy Storage Deployment

- Technology neutral market places (focus on functionality, not technology)
- Grid legislation that enhances procurement of ancillary services
- Legislation and taxation that stimulates ”multi” use cases (e.g. arbitrage, grid service, transport etc)
- Taxation that is friendly for bidrectional energy transactions
- Support distributed storage systems for increased resilience and efficient use of grid capacity


Thank you!
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