

3 Region Report

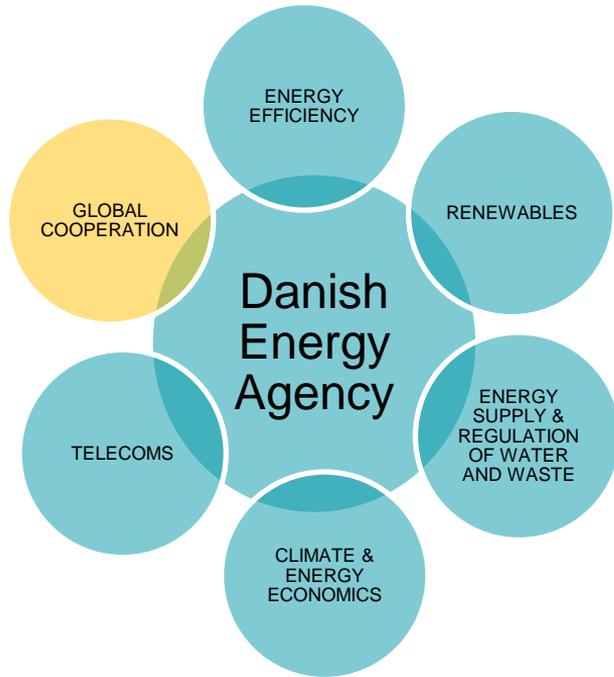
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Flexibility Measures for Integration of Variable Renewable Energy

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Motivation

- Increasing global growth of VRE:
 - New challenges on maximising integration of VRE
- China has the largest installed capacity of VRE in the world
- Look into:
 - Markets
 - Technological innovation
 - Policy and regulation
- Learn from 3 Regions...



https://ens.dk/sites/ens.dk/files/Globalcooperation/Publications_reports_papers/3_region_report_final_en.pdf

3 Focus Regions

China – Western USA - Europe



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Motivation

What: forms of flexibility

When: day-ahead / real-time dispatch

How: economic and policy dimension

Analysis + Cases

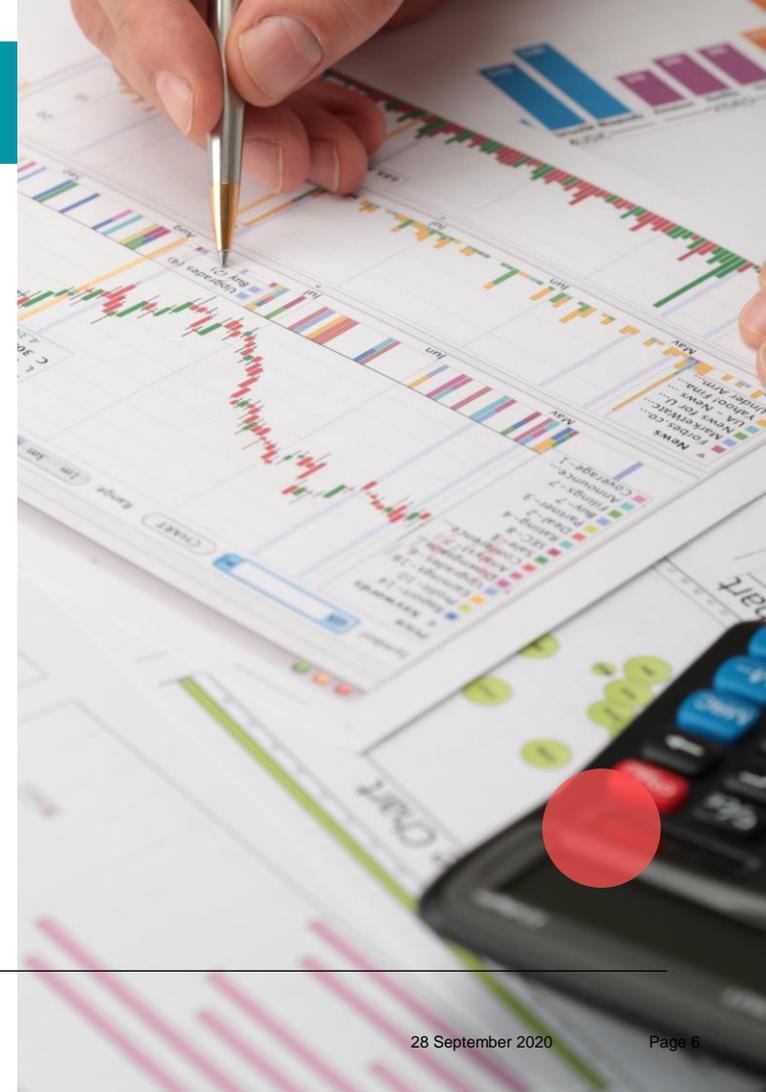
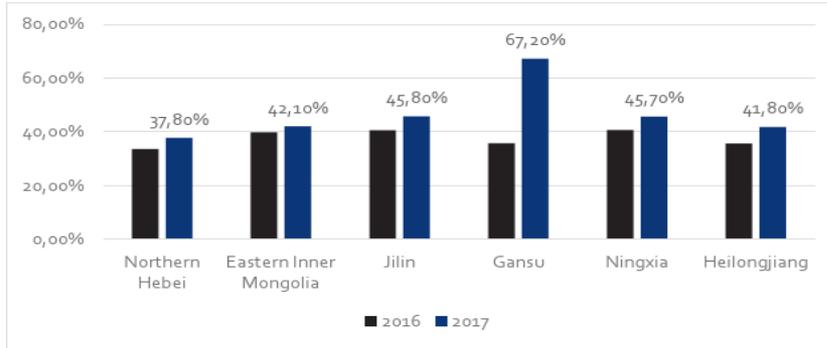
Flexibility Measure	Physical or Institutional?	Ramp Rate	Ramp Mileage	Reaction Time	Dispatch Granularity	Discussed in this Report
Larger balancing areas: Increasing the size of geographic area where operators conduct resource planning and load-interchange-generation balancing	Both	X	X	X		X
Access to neighbouring markets: Physical interconnection via transmission networks and the institutional mechanisms to coordinate transactions with neighbouring power systems	Both	X	X			X
Faster energy markets: Shorten the time scale of scheduling, dispatch and settlement in power market	Institutional	X		X	X	X
Regional transmission planning for economics and reliability: VRE integration is considered in current transmission planning to minimize costs to interconnect and firm resources	Both			X		
Robust electrical grid: Transmission lines with adequate capacity to avoid binding constraints and redundancy to facilitate shifting patterns of power injection	Physical			X		
Improved energy market design: Create resource-neutral and performance-based energy market to select the best resources to provide what services, and avoid barring new resources because they cannot provide all services	Institutional	X	X		X	X
Demand response: Structuring markets to properly incentivize and utilize responsive load	Both	X	X			X
Geographically dispersed VRE: Build VRE resources across large geographic areas to smooth out the volatility of the aggregated supply	Physical	X	X	X		
Strategic VRE Curtailment: Create mechanisms to make economic choices to curtail VRE, evaluating the trade-off between the instantaneous value of	Both	X	X	X	X	

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Focus: China



- Northern regions: very high levels of VRE penetration
- SGCC: 4 provinces with > 20% integration in 2017
- Gansu: VRE production at a peak moment = 67% of the provincial production.

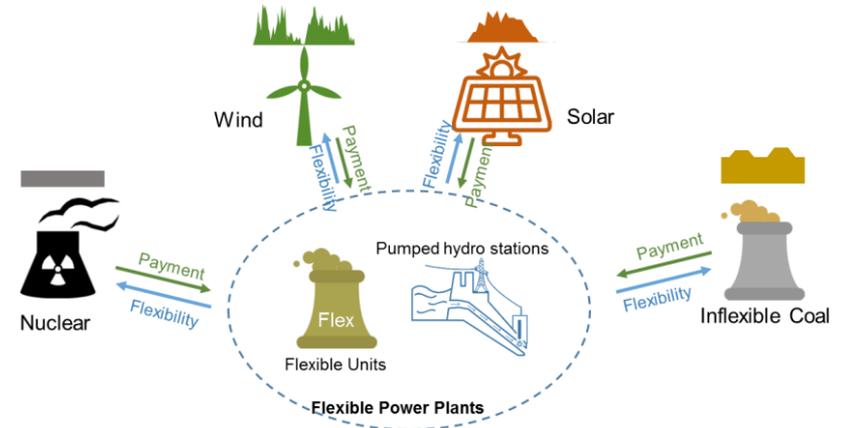
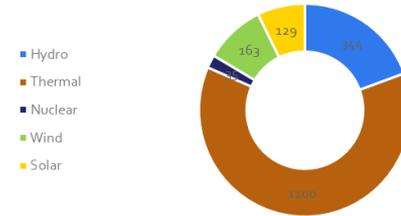


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Focus: China

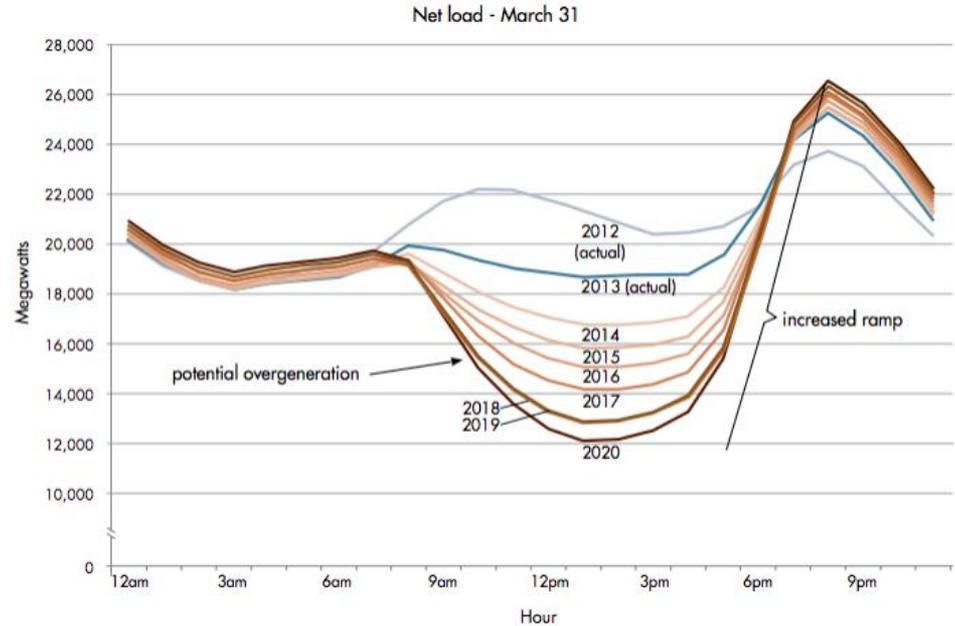


- Transitional period of electricity market reform.
- Very high shares of thermal power
- Mainly long-term bilateral contracts
- Down-regulation market in Northern China:
 - Extra economic incentives
 - New business models have surfaced in traditional thermal power





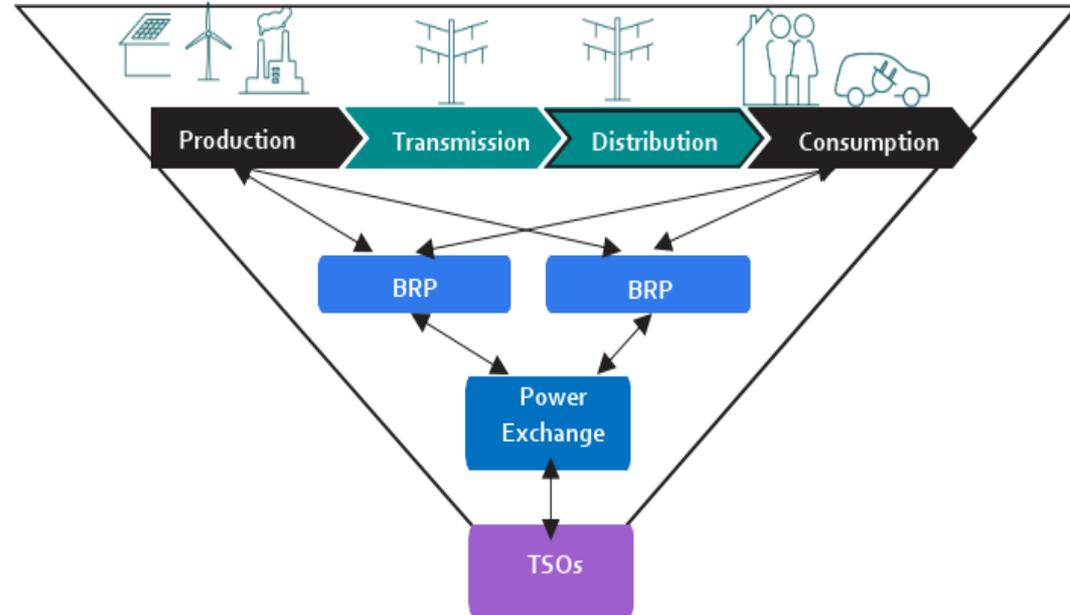
- Different levels of deregulation and competition
- Declining solar and wind prices
- Shale gas boom
- Distributed energy resources:
 - Case: Integrating EVs





Nordic region as an example

- Regional markets and price signals have allowed for:
 - High renewable energy shares
 - Highly flexible and interconnected power system.
- Flexibility incentives for:
 - Hydro power
 - Flexible CHP plants
 - Power-to-Heat
 - Industrial demand response
- BRPs in the market



Conclusions

Relevant experiences

Several relevant flexibility solutions:

- (Short term) power markets are essential for providing price signals for flexibility
- BRPs in Europe facilitate entry to the market, and reduces SO burden
- Design of products for ancillary service markets
- Integrating markets into larger areas has significant economic benefits
- Demand side response can reduce need for expensive peak capacity.
- Dynamic pricing is required for efficient EV integration
- Flexibility of existing power plants is a very effective tool

Flexibility is not a goal in itself.

1. Which technologies are successful depends on many aspects than differ between regions and will change over time.
2. Market price signals are the best way to ensure that the most effective technologies for providing flexibility are activated.

Thank you very much

