# **Options for flexibility**

Energy system integration requires changes to market design

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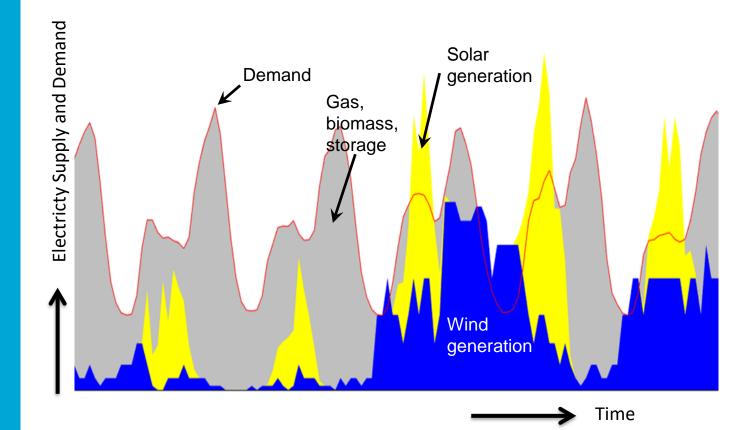
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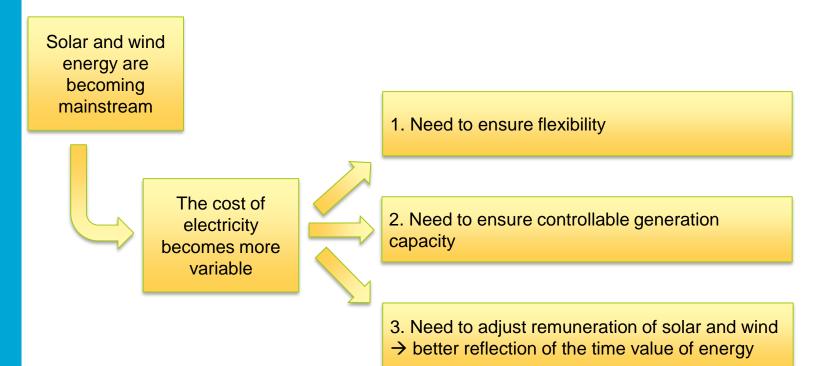


#### The impact of variable renewable energy



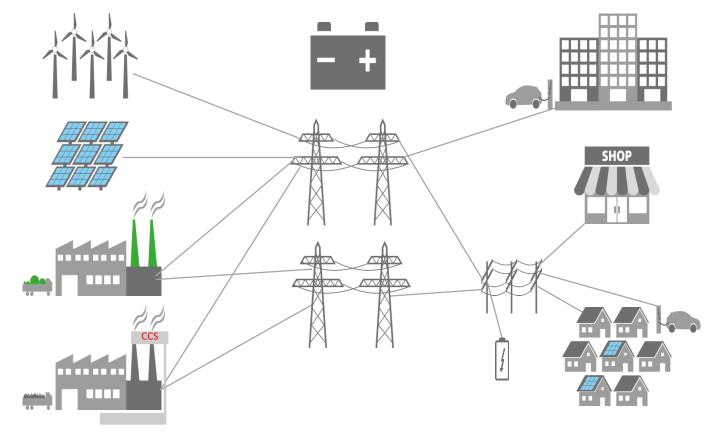


# Changing requirements for the design of the electricity market





# 1. Flexibility options





### Flexibility challenges

- Level playing field for:
  - All renewable energy sources
  - Wholesale / retail
  - Between energy carriers
- For example, consumer market design:
  - Need to manage flexible demand, such as EV charging, batteries, electric heating and cooling
  - They should respond to wholesale prices, but not overload the grid.
  - Investment incentives should be aligned across electricity, gas, district heating and transport infrastructures



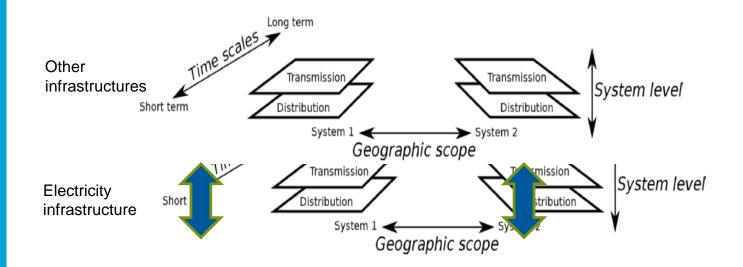
# Flexibility challenges (2)

Example: investment in home batteries:

- Consumer market design should stimulate their flexibility services to the grid, but:
  - The same incentives should be given to flexible EV charging and other demand response.
- Large-scale storage and controllable generation should receive the same incentives.
- If batteries create network congestion, they should change their operational mode: lower cost than network investment.
- Network investment can be cheaper than other flexibility options.



#### Challenges to system integration





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## Operations industry Investment choices Network development $\rightarrow$ TSOs and DSOs Policy making and market design → government $\rightarrow$ knowledge institutes Research and analysis

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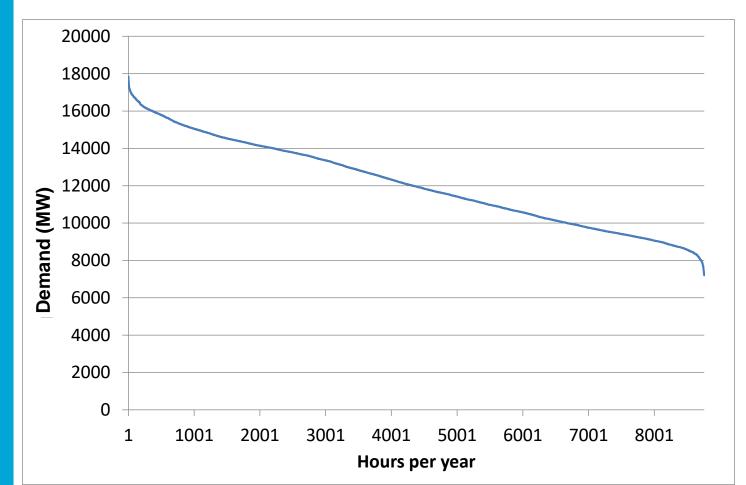
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System integration... (conclusion)

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#### 2. Controllable generation: the load-duration curve...

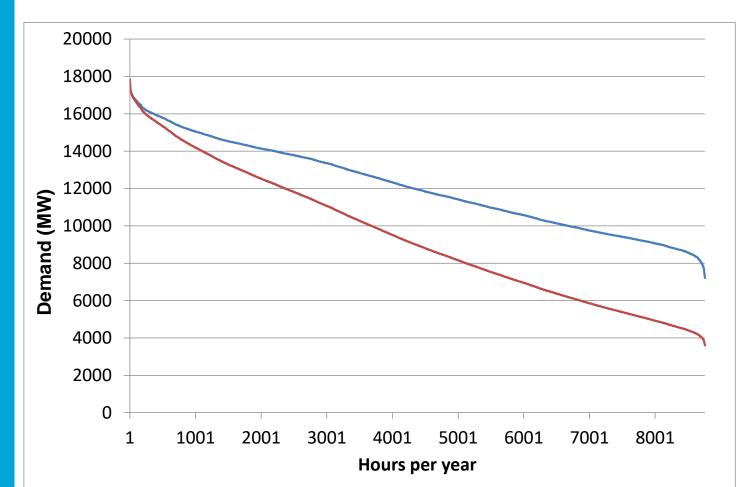


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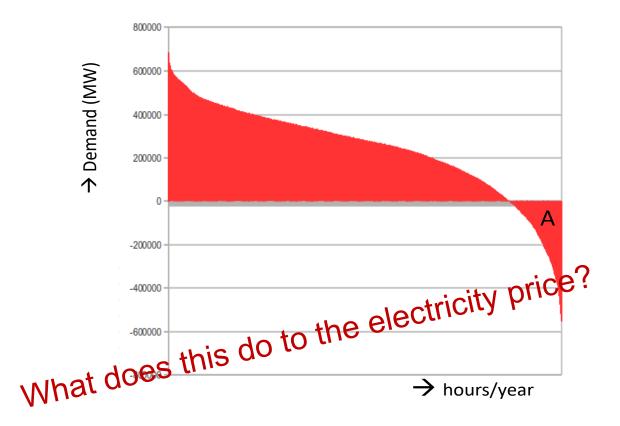
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#### The load-duration curve...

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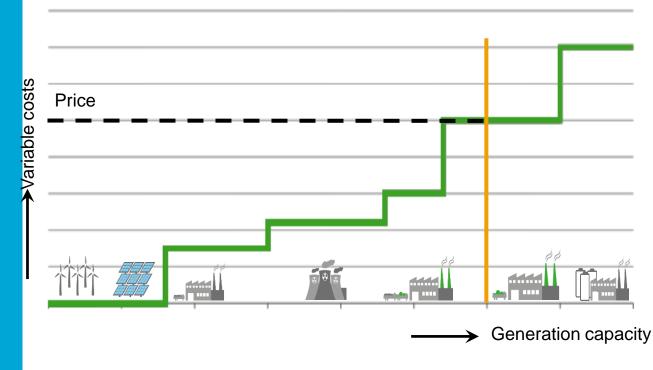


#### The impact of solar and wind...





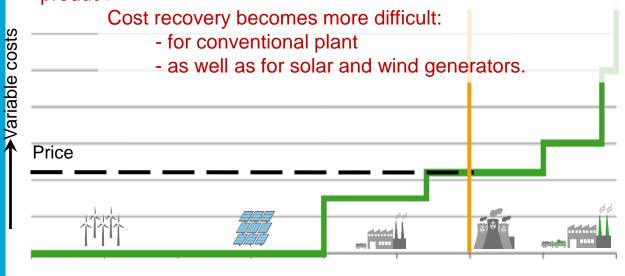
#### The impact of solar and wind on prices...





#### The impact of solar and wind on prices...

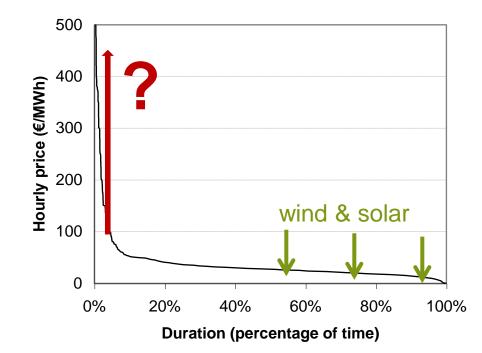
Solar and wind generators push the market price down when they produce.



→ Generation capacity



# Changing price profile





#### Problems with short-term markets

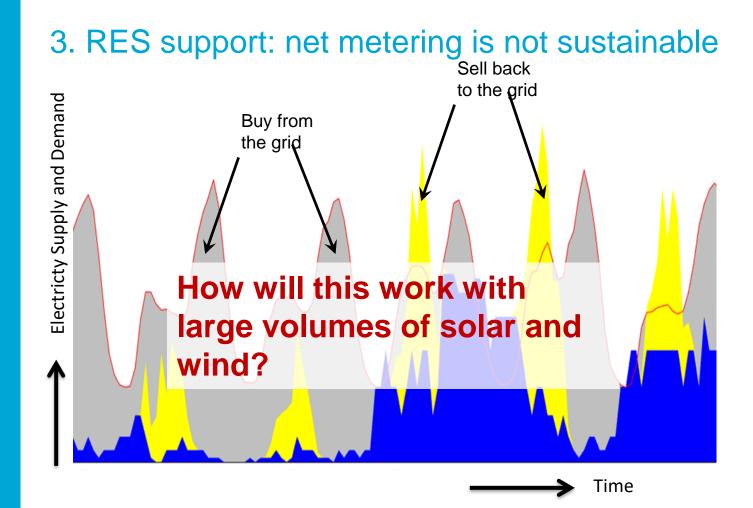
- Prices are volatile, will become more so with solar and wind.
  - → Unpredictable
    - Increasing year-on-year changes to price profile!
  - High investment risk for solar and wind as well as for controllable generation
- Prices are dropping when solar and wind produce
  - Cost recovery remains a challenge, despite falling costs of generation



## Need additional incentives for investment security

- Additional challenges:
  - Policy uncertainty
    - Renewable energy policy
    - CO<sub>2</sub> policy and price
    - Network development
  - Fuel price risk, demand development (electrification?)
- Solution (?):
  - Capacity market
  - Or: capacity subscription
    - More advanced, consumer-oriented, but not proven







#### Wholesale investment in renewables

- Dutch/Danish tenders for renewable energy: seem to work well.
  - Government provides location, site studies and permits.
  - TSO provides grid connection.
  - Investors bid for needed subsidy.
  - Tenders will phase themselves out if the technology begins to recover its cost in the wholesale market..
- Problem: still no reflection of the time value of electricity
  - Option: pay for generation *capacity*, not *energy* output.
  - Or stop paying subsidy when the electricity price <=0.</li>



#### Small-scale consumers: beyond net metering

- Let self-generation be netted with consumption *in real time only.*
- And small consumers should pay and receive *real-time prices*.
- How to ensure enough household investment in renewable energy?



# Coordinating renewable energy generation – wholesale and retail

- Add the costs of the renewable energy tenders to the consumer price of electricity...
- ... Then there is a level playing field for self-generation
  → no need for subsidies.
- This should also provide an efficient incentive for storage behind the meter!
- Drawback: consumer price not exactly the same as marginal cost
  - Because of RES levy.
  - And due to VAT.
- Option 2: If renewable generation *capacity* is subsidized
  - The tender amount is also paid to small-scale generators.



#### Conclusions

- More RES  $\rightarrow$  more flexibility
  - More flexibility  $\rightarrow$  energy systems integration
    - Energy systems integration  $\rightarrow$  improvement of market design
- Controllable generation (including biomass, large-scale storage) probably requires a capacity market or capacity subscription
  - Need to optimize demand response!
- Renewable energy markets need to be redesigned
  - Coordination of local and wholesale
  - Balance between short-term incentives and investment security.

