



CITIES

Centre for IT Intelligent Energy Systems

Long term ideal electricity markets setup

CITIES Workshop

Loui Algren

Anders Bavnhøj Hansen

Energinet, Dept. of Research & Development



Purpose

Variable renewable energy production and increased flexible and distributed demand calls for new electricity market designs. There are many suggestions for new designs including advanced bid/clearing markets, indirect control through price signals and p2p microtrade such as the blockchain based Brooklyn Microgrid. But there is not a common understanding of the long term ideal combination of electricity markets to give the right incentives for the producers, consumers and storage units while maintaining stability. **The purpose of this workshop is to come closer to a long term ideal combination of markets.** Energinet will present a suggestion for such a concept of markets and experts will share their knowledge and experience with different market designs. The day will end with a plenary discussion on Energinet's suggestion with the purpose of evolving and strengthening the concept.

A vision for future electricity markets!

Agenda

09.30 – 10.00: Loui Algren (Energinet)

10.00 – 10.30: Henrik Madsen (DTU Compute)

10.30 – 11.00: Koen Kok (DTU CEE)

11.00 – 12.00: Plenary discussion: Market designs

12.00 – 13.00: Lunch

13.00 – 13.30: Pierre Pinson (DTU CEE)

13.30 – 14.00: Michael Dahl Knudsen (AU)

14.00 – 14.30: Per Dahlggaard Pedersen (Neogrid)

14.30 – 15.30: Plenary discussion: Strengthening the concept

Market Concepts

Searching for the optimal long term energy market concept

Loui Algren

Anders Bavnhøj Hansen

Energinet, Dept. of Research & Development

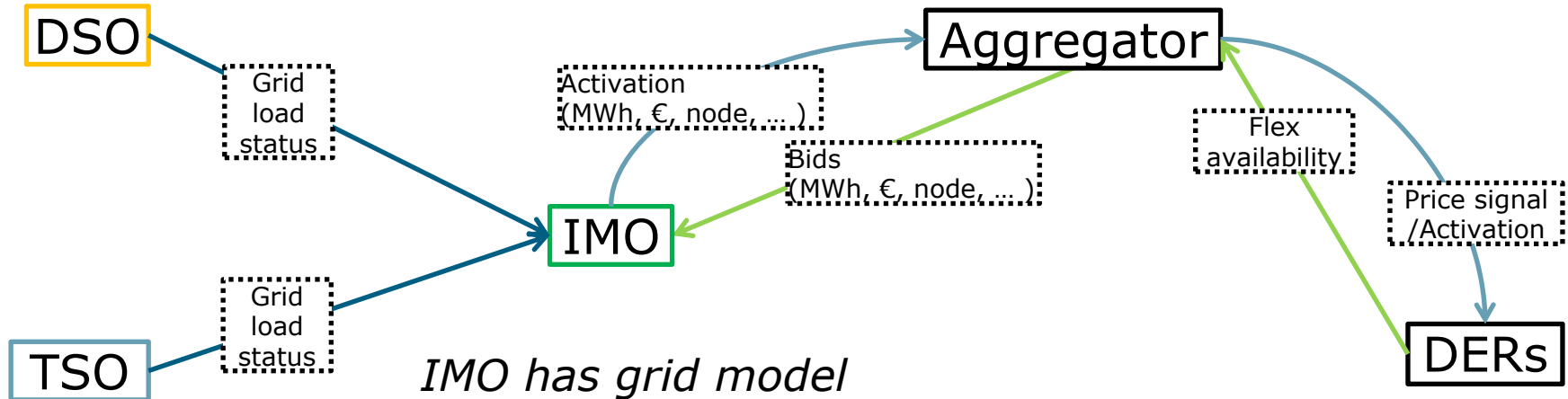


What is the optimal long term market concept?

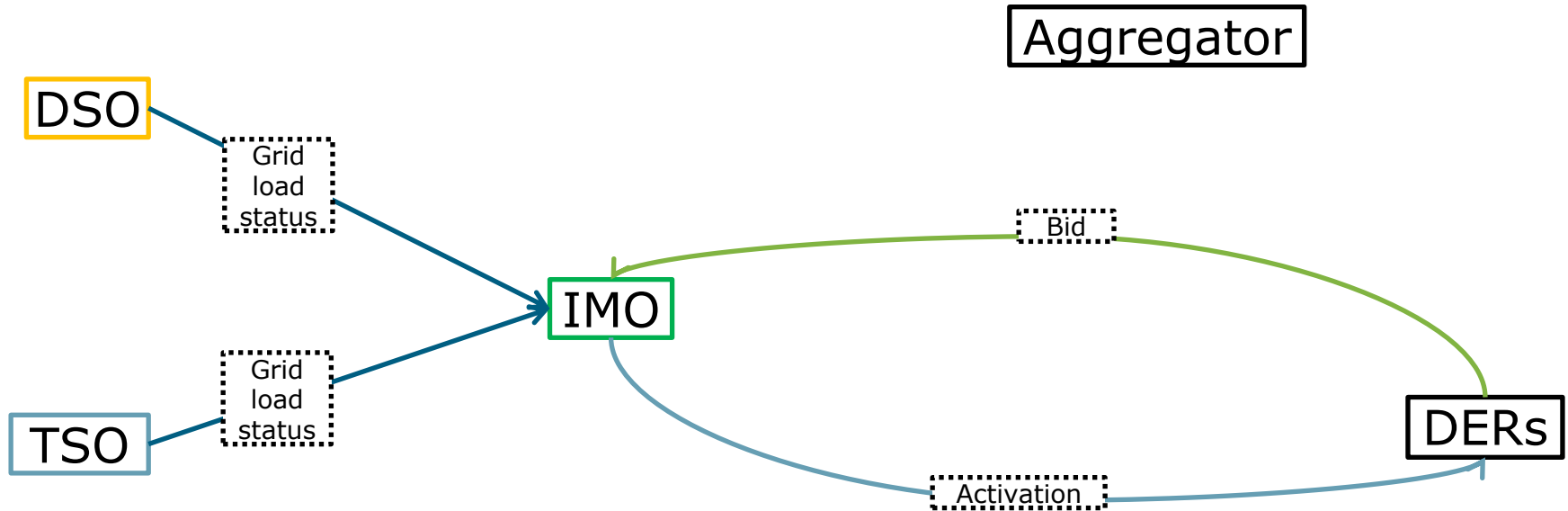
Criteria:

- Economic efficiency
 - Price formation
 - Optimal dispatch
- Allows access of all market players
 - Large/small
 - Flexible/inflexible
 - Consumers/producers
- Cost of operation
- Security of supply
- Other
 - Privacy and data security

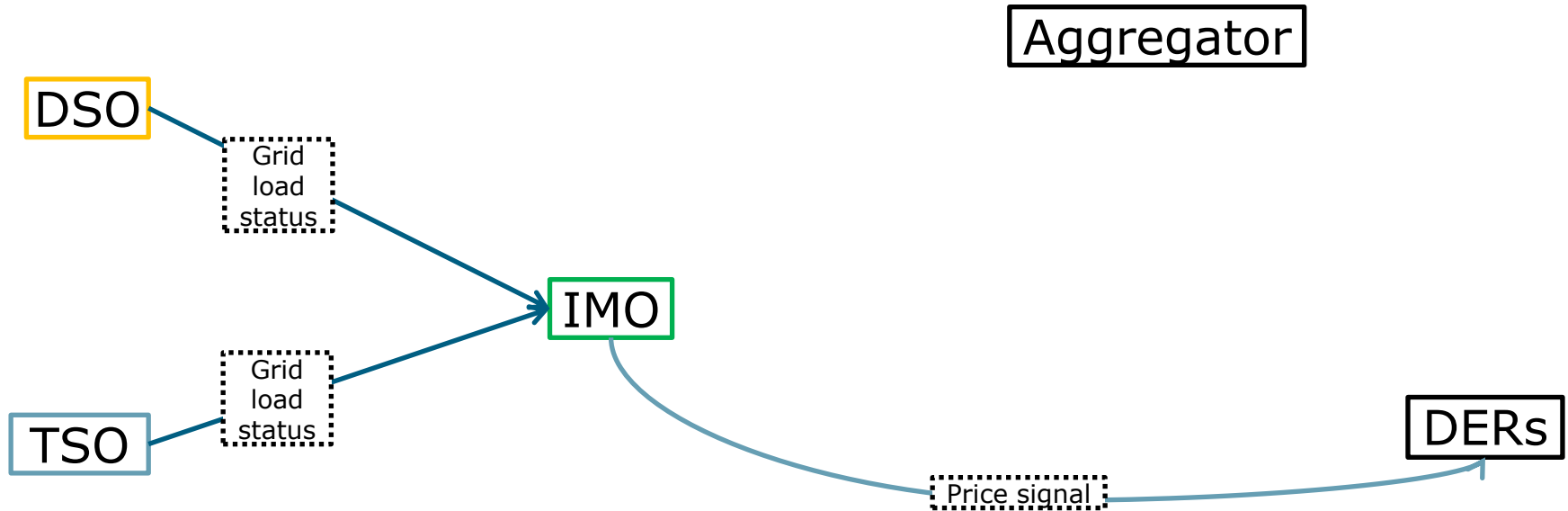
Roles and responsibilities



Roles and responsibilities

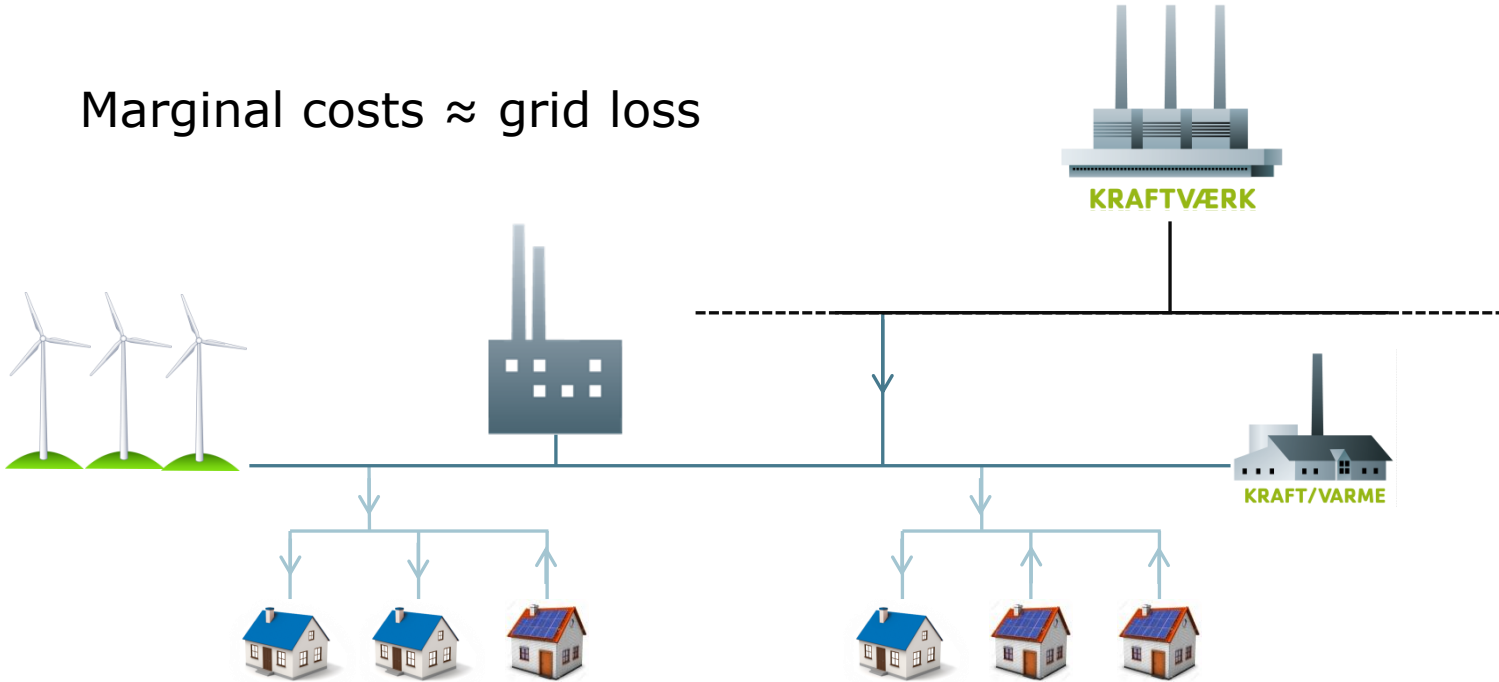


Roles and responsibilities



Grid tariffs based on marginal costs

Marginal costs \approx grid loss

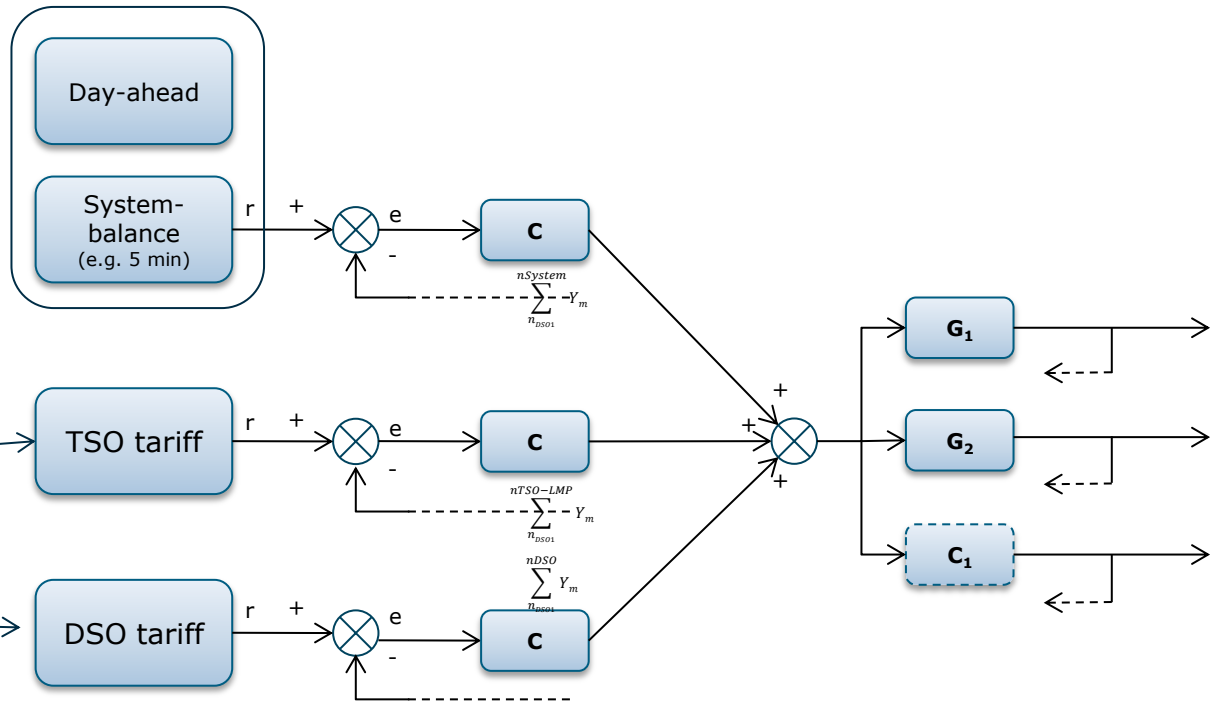
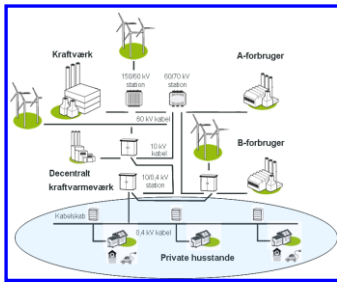
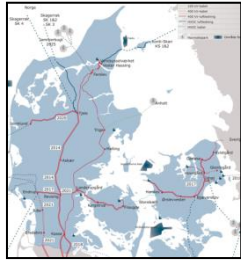
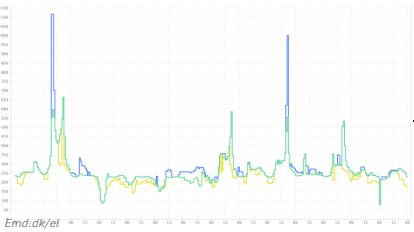


Principles to handle grid capacity dispatch

Electricity trades can be **implicit** or **explicit** which means if grid capacity is included in the trade or not.

1. Nodal pricing (LMP)
 - Individual price is formed in each node based on production, consumption in the node and connections to other nodes.
 - Economically efficient, but can be demanding to operate in high spatial resolution.
2. Variable tariffs
 - The grid tariff for a line is raised above the marginal cost of use when the load of the line is approaching full capacity.
 - Could work well with price signal-based market since the tariff and the electricity price would add up to the final consumer price.
3. Countertrade / redispatch
 - What we do today in case of congestions within a price area at transmission level.
 - Not economically efficient since consumers/producers are not experiencing the real price.

End price = electricity + tariffs



Four electricity market designs

1. Bid/clearing (Fx. current Nordpool Spot)
2. Continuous market (Fx current Elbas and stock exchanges)
3. Price signal market (fx EcoGrid.eu)
4. Reserve market (fx mFRR)

Bid/clearing

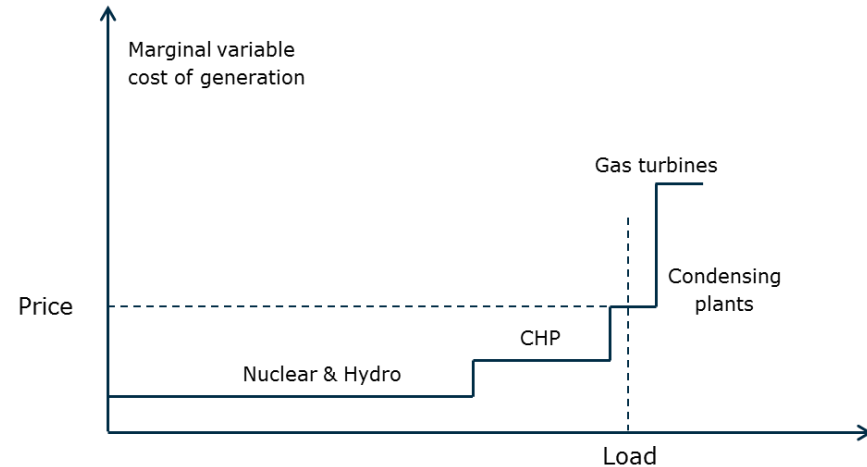
1. Bids are given to the market operator before gate closure
2. The market is cleared for a period, a single price is formed (marginal price)
3. Market participants are informed about their activated positions and pay/receive the single price
4. In case of zonal/nodal pricing there is a single price for each zone/node

Advantages:

- Incentive to bid marginal price leads to optimal price formation

Disadvantages:

- Bidding on beforehand is a barrier for "uncertain" units (wind, solar, consumption)
- The procedure takes time and hence decisions must be taken long time before time of operation



Continuous market

1. Electricity trading happens continuously and bilaterally like in the stock markets.
2. Pay-as-bid
3. Individual price for each zone/node
4. Can be implicit or explicit

Advantages:

- Market actor can continuously change position according to new information. Fx new wind/consumption prognosis
- Market actors can know who they are trading with

Disadvantages:

- Implicit market can be computationally demanding to update continuously
- Price formation less efficient than bid/clear markets





Price signal market

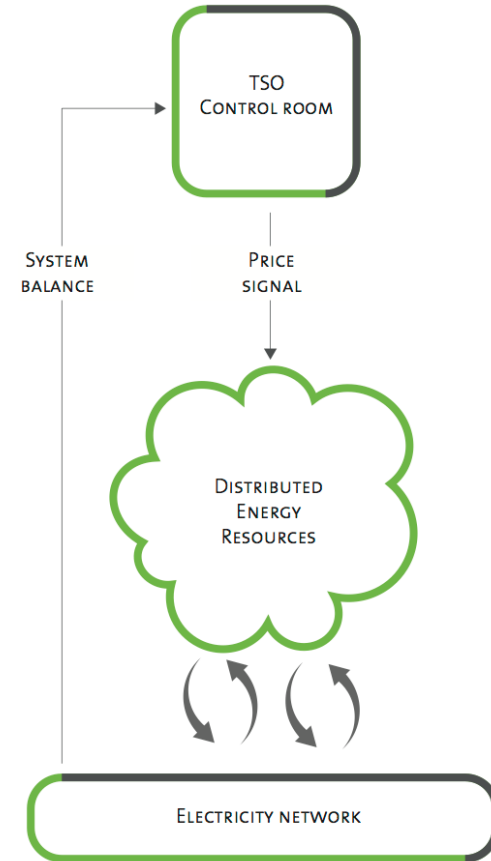
1. Market operator receives "real time" measurements of imbalance
2. Market operator sets and publishes price very frequently and close to operation time
3. Consumers give no information to market operator about consumption until after consumption.
4. Individual price for each price zone/node
5. Can be ex-ante or ex-post (price signal is before/after the actual time step)

Advantage:

- Allows fast reaction on imbalances
- Low entry barriers for DERs because of one-way communication and no obligations
- Very low transaction costs caused by fewer transaction fx 1 per month
- Prices can reflect real time true costs well

Disadvantage:

- Risk of instability in price formation
- Meters must update very frequently
- Difficult to act in this market for inflexible units fx with ramp rates or high start/stop costs



Reserve market

1. The commodity is access to capacity rather than energy.
2. Fx aFRR, auction

Advantages

- Simple way of balancing

Disadvantages

- Capacity is not allways utilized
- Cheaper capacity might be available at time of operation

Discussion of complete market concept

1. Bulk energy market
 - Bid/clear
 - Implicit, high resolution, DLMP
 - No minimum bid size
 - Fx 1 hour time steps
 - Efficient trade of large amounts of energy at marginal price
 - Advantage for slow/inflexible units (thermal power plants)
2. Balancing market
 - Continuous, bilateral, pay-as-bid or bid/clear?
 - Implicit, high resolution, DLMP
 - No minimum bid size
 - 5 or 15 mins time steps
 - Gate closure 5-15mins before time of operation
 - Possibly block chain based
3. "Real time" market
 - Price signal based
 - 30s time steps, ex-ante
 - Market operator sets price for market actors to react on
 - To qualify the actor must have high resolution meter
4. Possibly need for very fast markets such as frequency reserve and inertia
 - Grid tariffs set according to marginal costs for each voltage level

NB. This is an input for discussion only and does not express Energinets opinions nor expectations of development of electricity markets

Questions?

A wide-angle photograph of a modern, multi-story black building with large glass windows, situated in a vast, green field. The sky is bright blue with scattered white clouds. The building is the central focus, surrounded by young trees and a clear horizon line.