Electricity Storage: Drivers, Applications & Alternatives

A Webinar Presented for:

green power ACADEMY

by

John Massey, *Director*

Grey Cells Energy

Key Storage Drivers include

- Growth in solar & wind ("VRE")
- Costs of peak power (and price volatility)
- Costs of new or upgraded grid
- Growth of distributed generation
- Growth of "smart" systems

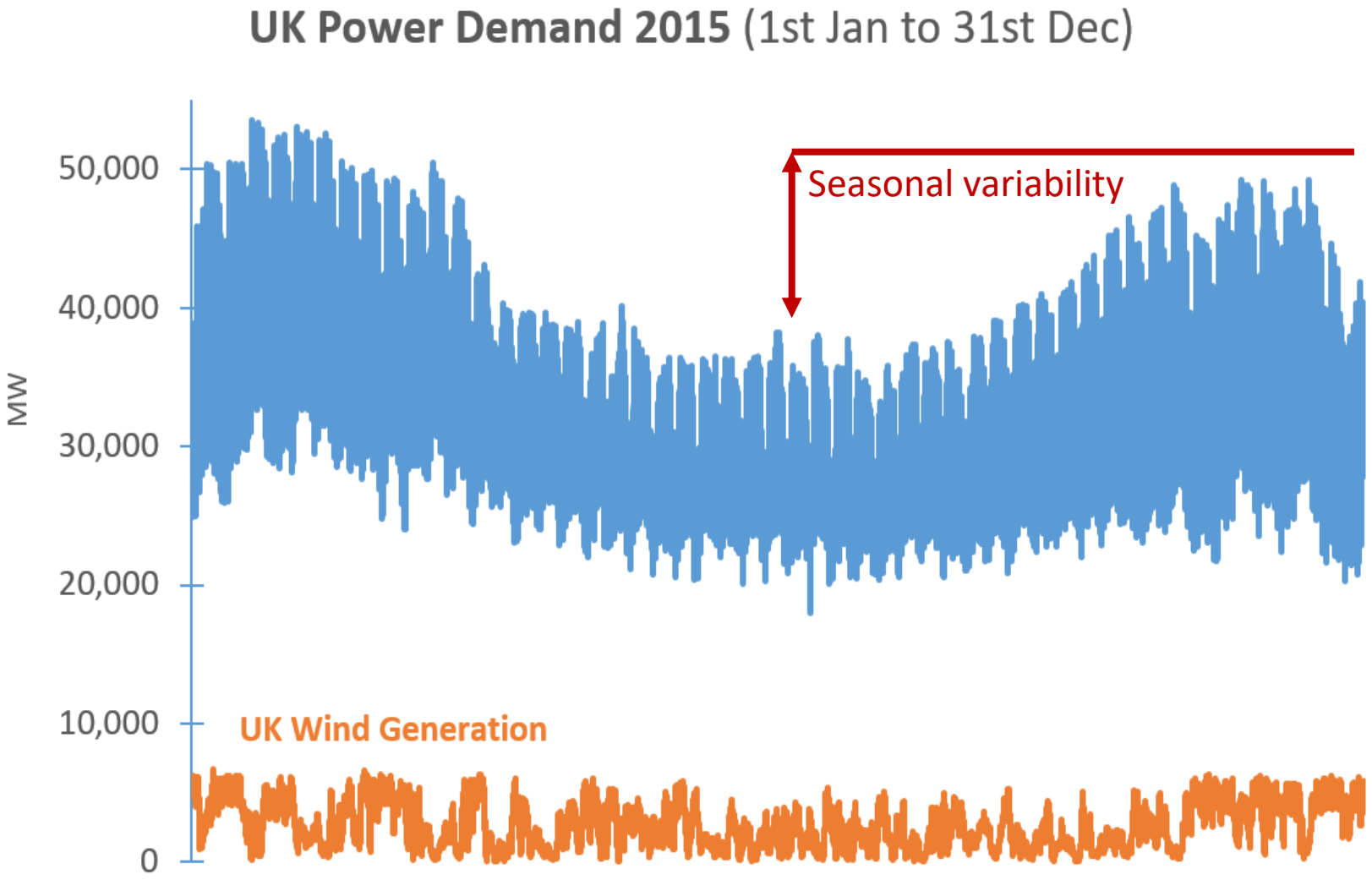
Flexible Power Systems

&

- Reducing battery costs (driven by CE & cars)
- Investor interest

Demand vs. Supply Variability

The Power system exists to supply and deliver the right amount of power at exactly the time it is demanded.



UK data source: www.gridwatch.templar.co.uk

“Load Following” & “Regulation”

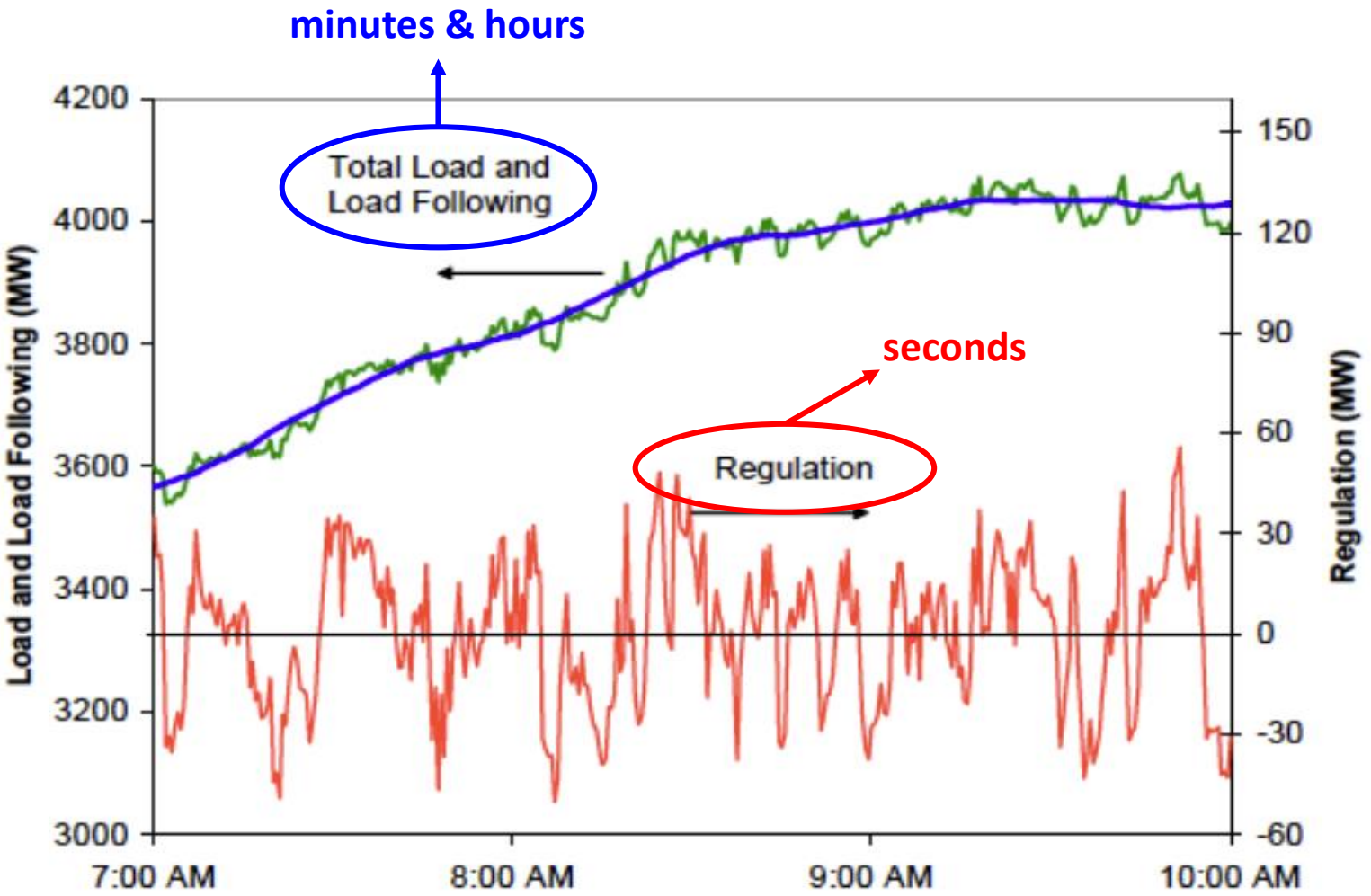
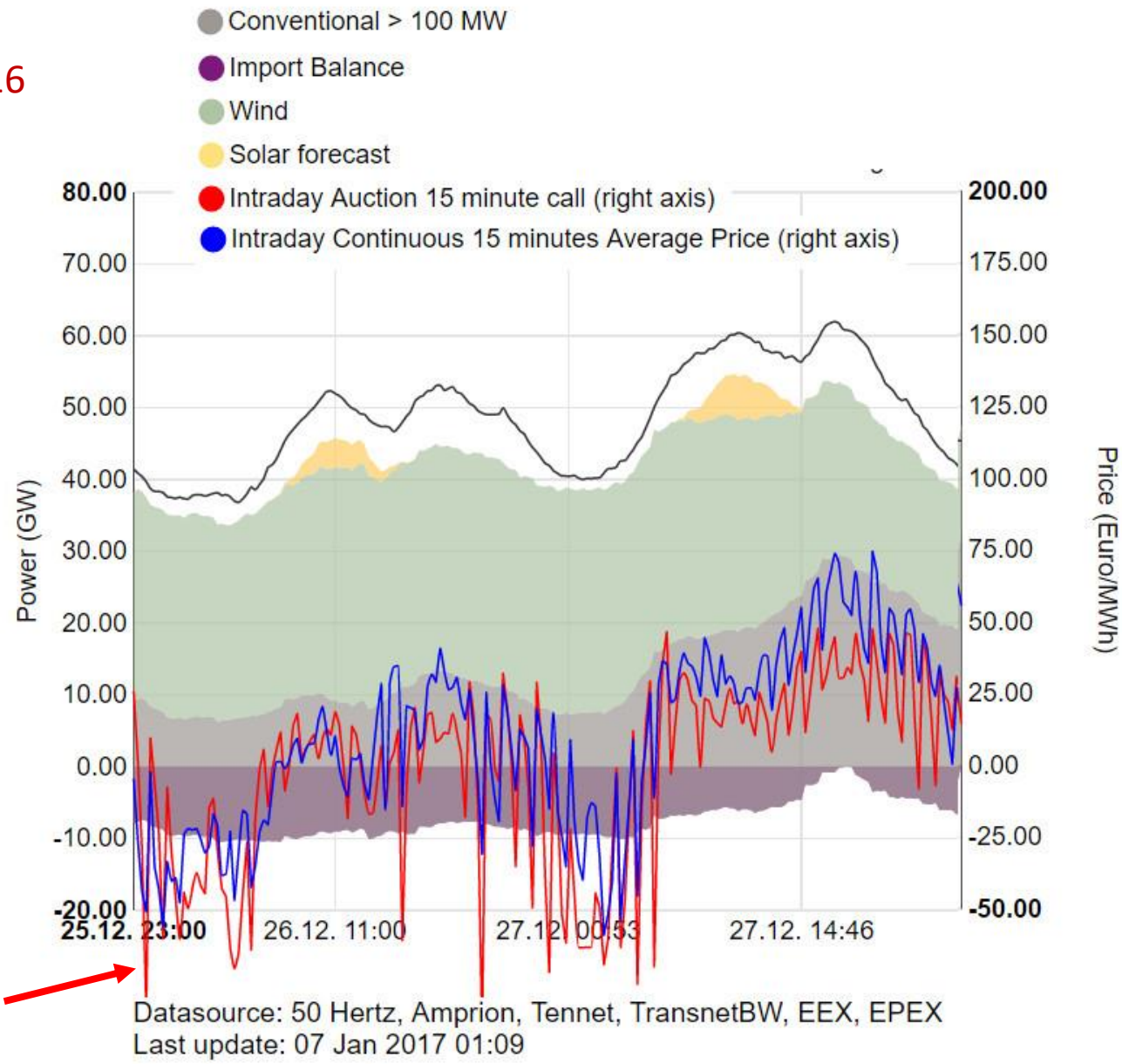


Image source: Oak Ridge National Labs

Inflexible Supply: too much …

Germany,
Dec 25th – 27th 2016



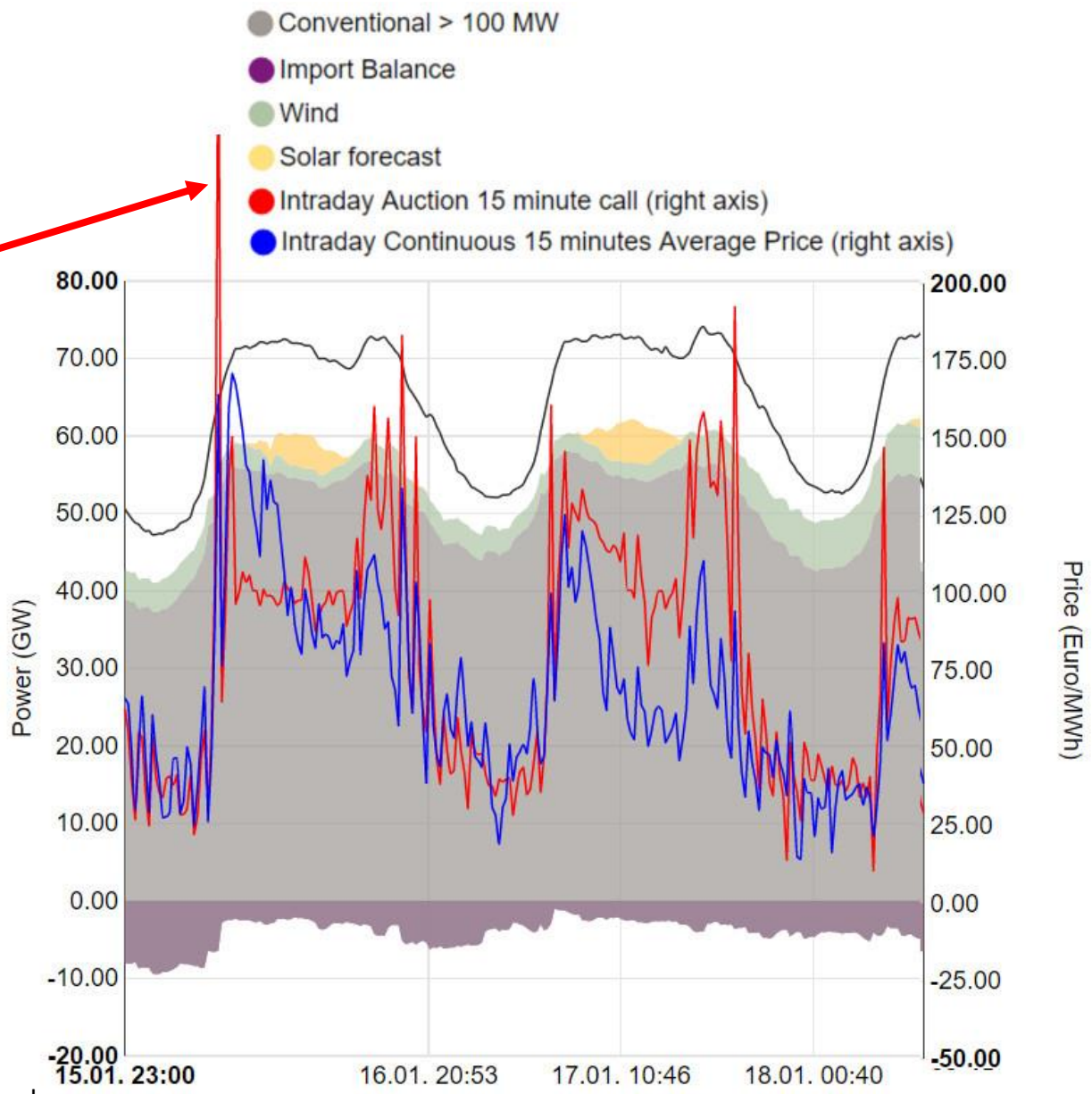
Good for filling storage!

Charting source: www.energy-charts.de

Too little …

Germany,
Jan 15th – 18th 2017

Good for emptying storage!



Charting source: www.energy-charts.de

Embedded/Distributed Generation

The national grids / transmission networks view of distribution-connected generators (DG)...

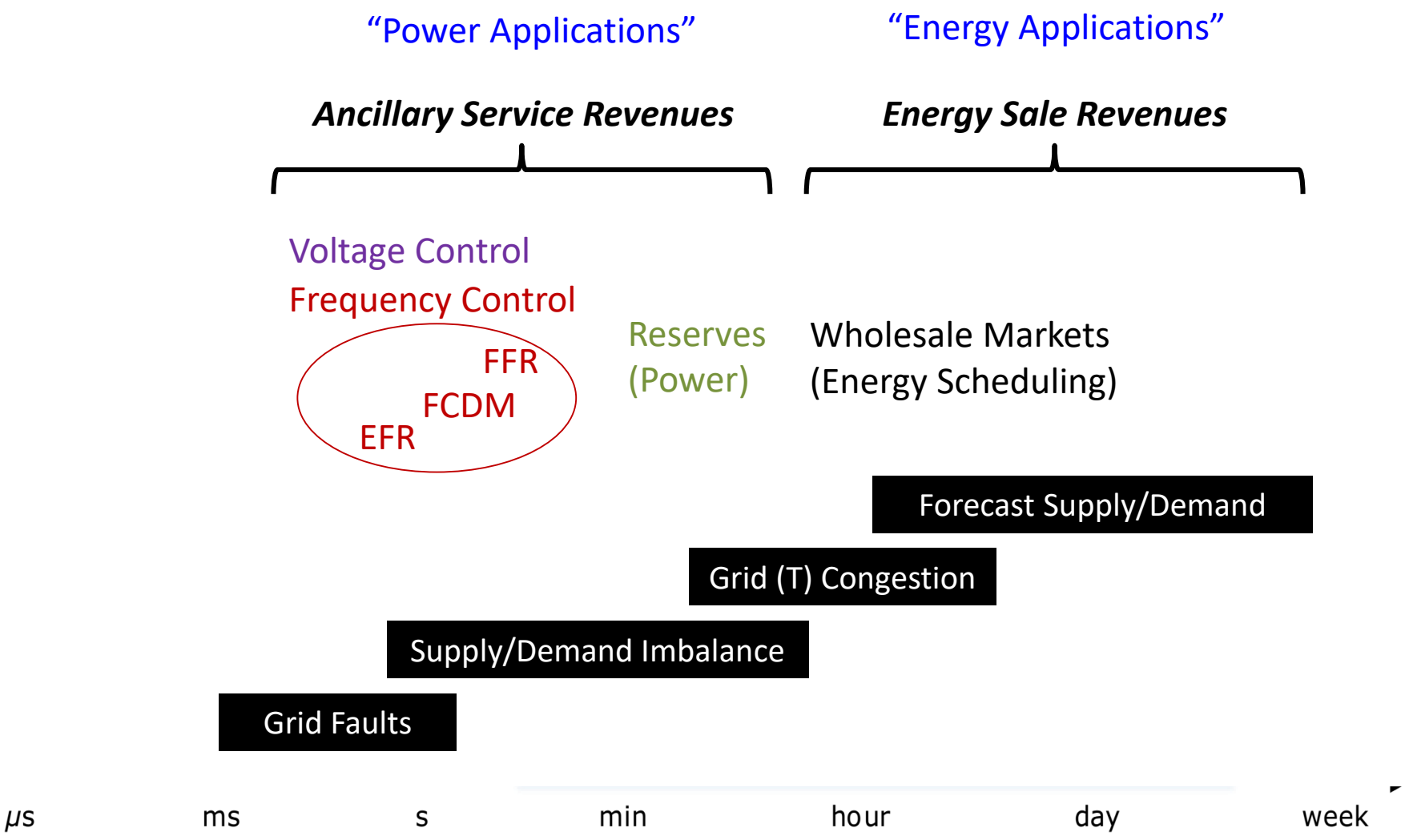
- DG shows as **reduced demand** for electricity on the transmission network.

  (Transmission demand is becoming more variable, with lower "lows")
- **They offset the need for generation** (and associated charges) within the transmission network.

BUT:

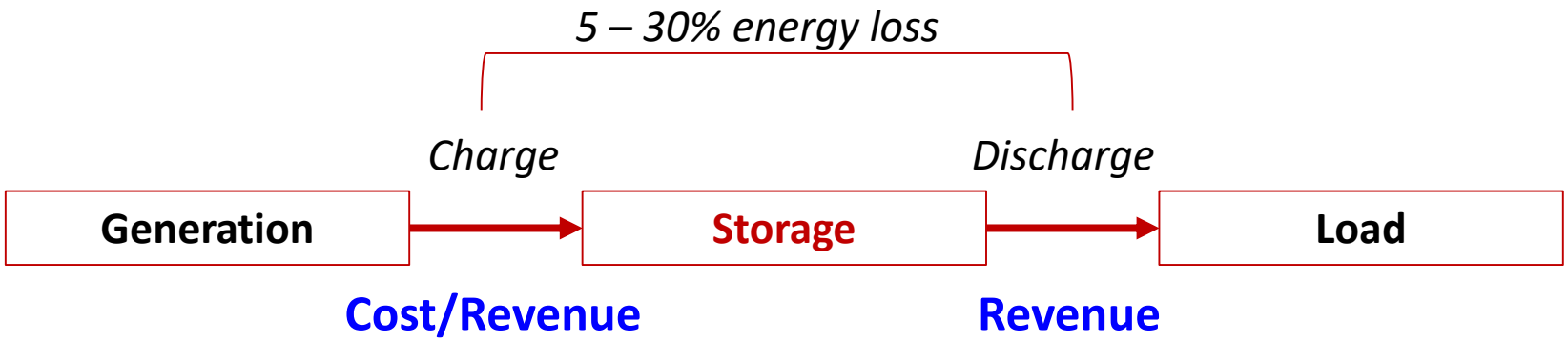
- ***Distribution*** **networks can see local voltage problems, where <u>oversupply</u> at the network edge causes reverse power flows (i.e. *into* the grid)**

Time, Grid Operations & Applications



Storage is not (just) Generation!

- It is an *extra step* between the generation and end-usage of power
- It can be large & centralised or small & distributed
- **It is both generation (when discharging) *and* load (when charging)**



- *It isn't a source of **additional** energy!*
- It doesn't reduce the need for energy generation (it *increases* it)
- It doesn't reduce the need for generating capacity (where that is *inflexible*)
- It may reduce the need for flexible generating capacity (e.g. "peaking")
- It may reduce the need for grid capacity

Example Policy & Licensing Issues?

- Must storage developers hold a generation licence (at what size)?
  - Or obtain a specific exemption from the requirement to hold a generation licence?
  - *Holding a generation licence places obligations on the licensee, such as Grid Code compliance.*
- Is it prohibited for a distribution licence holder to hold a generation licence?
  - Or is there a size limit on generating assets they can own?
  - *Contracting with 3rd parties means licence compliance, but adds project cost and complexity.*
- Are there limits to how much revenue a distribution network owner can make from “non-distribution” activities?
  - *Does this reduce the attractiveness because it limits economies of scale?*
- Is charging treated as end-consumption?
  - *With associated grid/network, demand & environmental charges.*
  - *Are these charges applied again when storage is discharging?!*
- Is storage part of the wholesale market or the retail one?
  - *Charging an EV from the grid: retail. Discharging into the grid: wholesale?*

Current Business Models?

System flexibility & balancing: response, reserve & capacity services

- Frequency response services to the grid
- Fast Reserve, STOR and/or Capacity Markets
- T&D network cost avoidance during peak cost periods, and upgrade deferrals
- Peaking plant cost avoidance

Big energy users: peak cost avoidance

- “Behind the meter” to avoid peak energy retail, transmission and distribution costs

Domestic and community

- With rooftop PV to maximise “own use” and avoid higher retail prices.
- Potentially aggregated and linked to Time of Use tariffs (ToU)

Energy shifting

- Arbitrage between low and high price periods
- Shifting production to times of peak pricing

“Revenue Stacking”: e.g. EFR + Capacity

Four battery projects **already successful within the UK EFR tender** in July 2016 also **gained 15-year contracts in the Capacity Market** auction in December:

- 10MW Cleator project (Low Carbon)
- 40MW Glassenbury project (Low Carbon)
- 49MW West Burton site (EDF Energy Renewables)
- 10MW Blackburn Meadows project in Sheffield (E.ON)

Revenue stacking is widely regarded as key to the economics of storage projects

but

Beware: **penalties**, **contracts** and **warranties**

Example: Utility-scale PV + Storage

- 330MW tracked PV
- **Co-located** 100MW / 400 MWh battery
- 100% equity financed
- Construction starts June 2017
- Target COD end of 2017
- Market context:
  - Demand for electricity on hot days can be >2x average demand on a typical day, and price spikes are growing
  - A reducing supply of dispatchable generation in the system
  - Recent problems with blackout and load shedding events
  - Rationale of the project: “delivering reliable, flexible power to meet South Australia’s summer peak.” (those high peak prices)
  - Prices tend to peak in the late afternoon/early evening, rather than at the time of “peak sun”

= Alternative to conventional “Peaking” supply

Example: Utility-scale Grid Storage

- Located next to a **substation** close to Germany's border with Denmark.
- Capacities: 48 MW / 50 MWh
- Designed to compete against coal and gas in Germany's "primary reserve" market

Market context:

- Schleswig-Holstein lies at a strategic location, where large amounts of electricity generated by wind farms are collected and transmitted to the rest of Germany.
- Construction from June 2017 to COD at December 2017.
- Pilot project to connect nearby wind farms to the battery system and supply when there is surplus production or an overload on the grid

= Grid support and curtailment/grid-cost avoidance

Example: Distributed Utility-scale Storage

- 50MW, 200 MWh total
- A distributed fleet of battery projects *at customer sites* (behind-the-meter)
- Can be operated as a single resource
- Utility (SCE) can shift the whole fleet to stored energy, rather than drawing it from the grid (peak demand reduction)

- For end-users, benefits include demand management, back up generation and enhanced power quality
- There is no up-front cost to users for the storage installations.
- SCE will purchase capacity under 10-year contracts, helping enable traditional project finance
- **Aggregating** sites together allowed the developer (AMS) to offer a large enough supply to interest the utility

= Peaking generation & grid-cost avoidance, plus end-user energy cost reduction

Example: Conventional Utility-scale PH

Glyn Rhonwy in North Wales

- March 2017: project given consent.
- Stats: 99.9 MW, 700 MWh (i.e. ~7 hours).
- Will turn two abandoned slate quarries into reservoirs, connected by underground tunnel.
- Developed by Snowdonia Pumped Hydro.
- "£160m facility", expected payback "~15 yrs".
- Construction expected to start "within 12 months" and will take "3 to 4 years".
- Operational lifetime of 125 years.

Quotes from: www.snowdoniapumpedhydro.com

= Peaking Generation (and ancillary services?)

NB. There *are* Alternatives to Storage

System Flexibility can also be achieved through…

- Increased **Interconnection**
- **Demand** Management / DSR
  (various solutions/incentives)
- Supply **Curtailment**
- Supply **Flexibility**
- **Sub-capacity operation** + smart inverter
  (for regulation/response)
- Energy **substitution**
  (e.g. excess power-to-heat and power-to-fuel)

Storage will
compete *&* ***co-exist***
with all of these