"Opportunities and challenges for energy storage using flow batteries."

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The International Flow Battery Forum

Swanbarton Limited

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FLOW BATTERIES EUROPE

IFBF The International Flow Battery Forum™

Good morning

- Fundamentals of energy storage
- Are flow batteries a good idea?
- How will flow batteries fit future applications

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A little introduction to electrical energy storage

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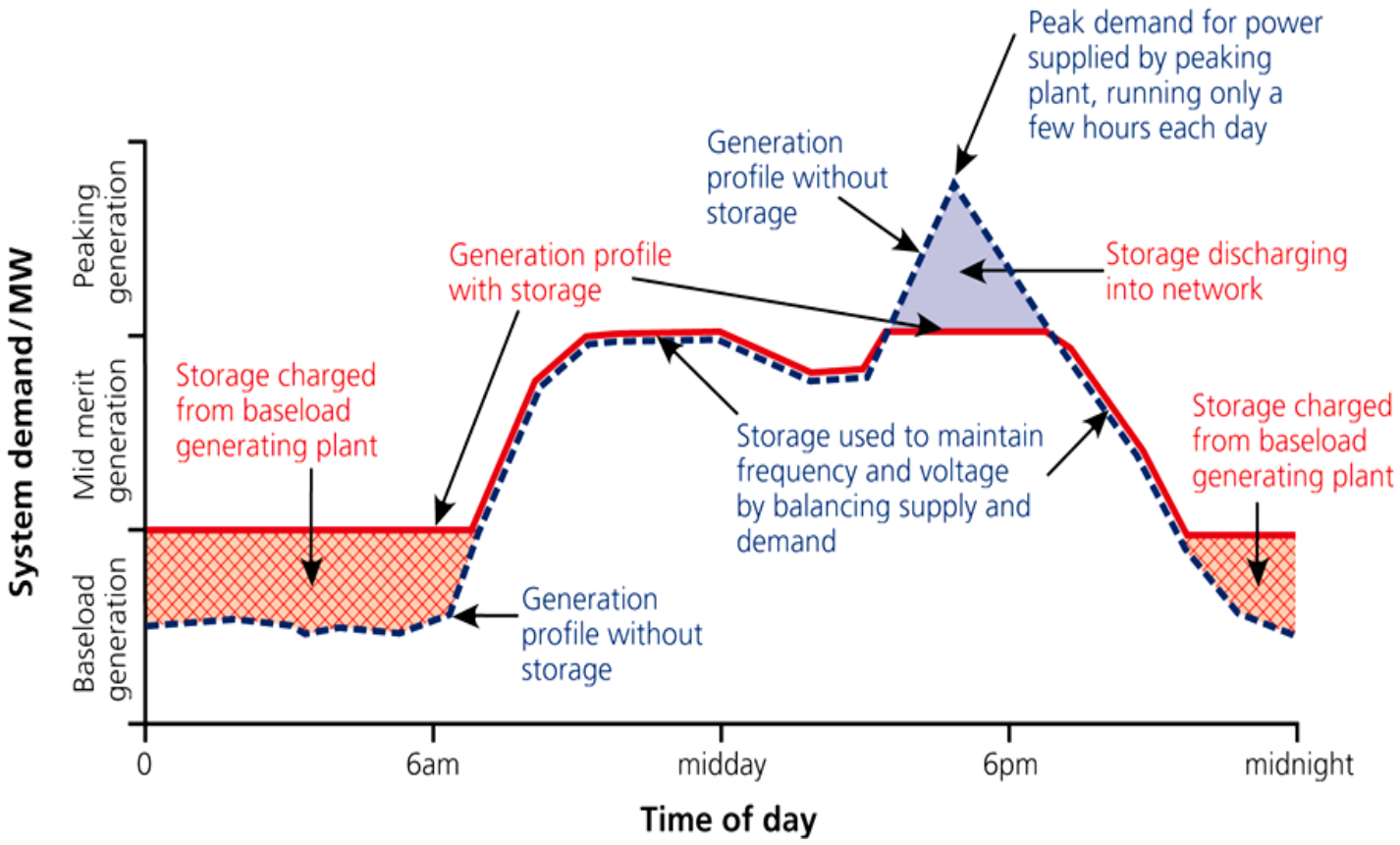
Energy storage

Electricity storage: electricity to thermal, electricity to chemical

Network connected storage

Network connected electricity storage


Peak demand for power supplied by peaking plant, running only a few hours each day
Generation profile without storage
Generation profile with storage
Storage discharging into network
Storage charged from baseload generating plant
Storage used to maintain frequency and voltage by balancing supply and demand
Storage charged from baseload generating plant
Generation profile without storage
Peaking generation
Mid merit generation
Baseload generation
System demand / MW
0
6am
midday
6pm
midnight
Time of day

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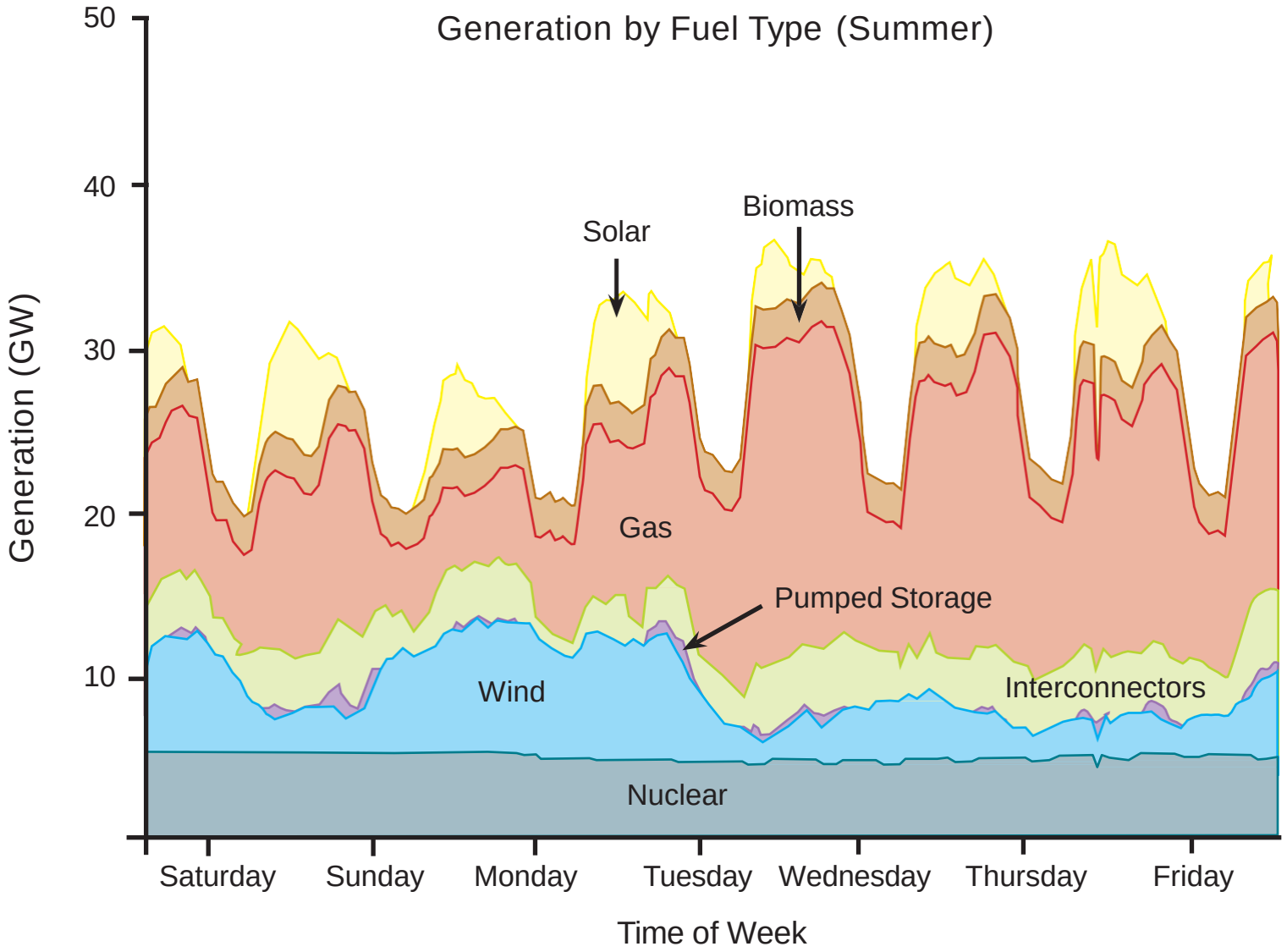

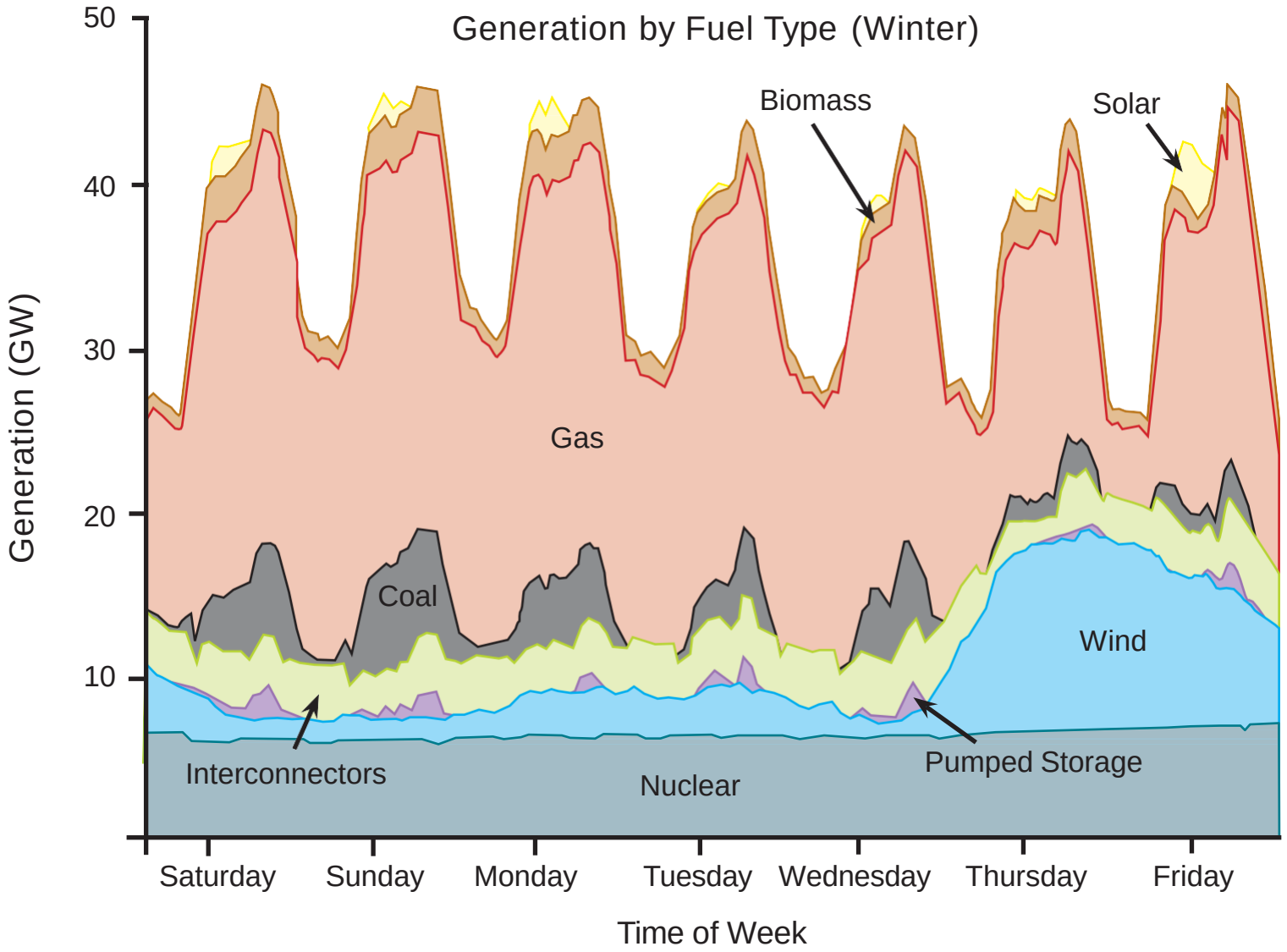
Generation by Fuel Type (Winter)
Generation (GW)
50
40
30
20
10
Biomass
Solar
Gas
Coal
Wind
Interconnectors
Nuclear
Pumped Storage
Saturday
Sunday
Monday
Tuesday
Wednesday
Thursday
Friday
Time of Week

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The value of energy storage

- Very little storage in the supply chain
- Keeps supply and demand continuously in balance, over short and / or long time periods
- Provides system capacity to meet peak demand
- Increases utilisation of power system assets
  - plant choice
  - fuel choice
- Enables the integration of renewable production
- Enhances supply quality and reliability
- So storage is "the missing link" in the electricity supply chain

Energy storage: current state of the art

- Large scale: stationary
  - kW to MW and kWh to MWh
  - Energy and power important
  - Reliability critical
  - Lifetime cost
  - Speed of response / efficiency / weight & volume are less significant
- Mobile – electrically powered transport / hybrid power
  - Weight / volume / reliability critical
- Portable:
  - Performance / weight / volume critical

Flow battery benefits

- Low lifetime cost
  - Long lifetime
  - Recyclability and reusability
  - Low cost of storage / kWh -Simple electrolytes – abundant - fully soluble
  - Low cost of manufacture Modules can be made from low cost materials –eg HDPE
  - recyclability
- Scalable technology
- Variable energy and power
  - Energy storage capacities are independent of their power rating
  - Capable of long duration energy storage
- Common electrolyte in all cells of the module have a common state of charge.
  - State of charge of whole system can be measured at a single point (or can be used to check correct functioning)
- The flowing electrolyte provides a means to chemically manage the electrolyte(s) for the entire battery.
- Overcharging and fully discharging does not usually cause permanent damage to the electrodes or electrolytes.
- The flowing electrolyte aids thermal management – in contrast to conventional battery systems.

Flow battery benefits (2)

- Multi-functional
  - Power applications
  - Energy applications
  - High cycling rate possible
  - High cycle lifetime
  - Long calendar life
- Limited self discharge – standby power
- Residual value in electrolytes
- Recycling
- Upgrading

Size ranges

- Large scale: 50 – 100 MW + = Transmission connected
- Mid size 10 – 50 MW = Distribution 33 kV
- Ditto 1 -10 MW = Distribution 11 or 33 kV
- Smaller 10 kW – 1 MW = local / community, small business, small industrial
- EV 40 kW
- Domestic 0 – 10 kW

Flow battery applications

- Packaged systems: self contained units, packaged, sold and installed, including the power conversion system and all fittings for connection to the local AC electricity network. May also be configured for off grid AC or DC supplies. Probably at the smaller power and energy levels – domestic, telecom towers etc
- Containerised systems: Packaged in shipping containers or similar packaging
- Large scale installations: using a generic or specific design – skid mounted modules or assembled configurations
- Others:
  - Mini and micro systems for specialist applications
  - Transport

Energy storage: technology drift

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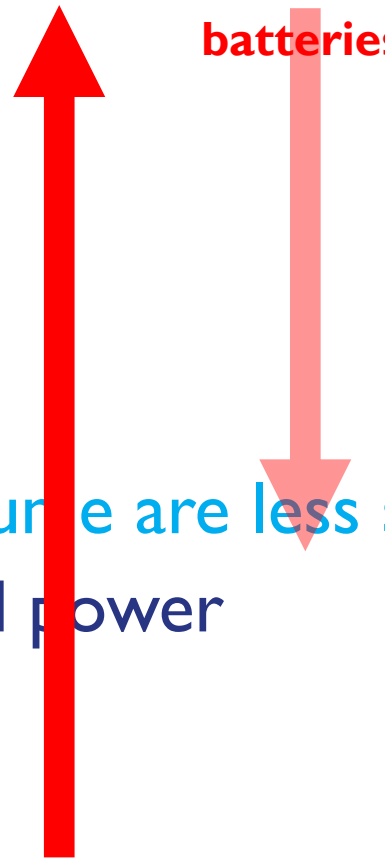

The future

- Energy is one of the world's strategic priorities
  - Energy storage will is critical
  - In recent conference, three out of four investment managers in energy storage said that supply issues for batteries were a critical part of their project assessment
  - Raw material supply is critical
- How do we get to build a flow battery Giga Factory?

The future

- Long duration energy storage report (LDSC / McKinsey)
  - 10% of all electricity will need to go through long duration storage
- User report (Jan 2022) by Aurora Research
  - GB needs 24 GW of long duration storage by 2035
- "The provision of LDES is not a market responsibility, it is a public good"
  - Joao Galamba – Deputy Minister and Secretary of State for Energy, Portugal
- We cannot move to a renewable energy system without energy storage. We cannot become reliant on renewable energy without longer duration, multi role, energy storage.

Join us at the next IFBF in Brussels, Belgium, held jointly by IFBF and FBE

CONTACT US!

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