

Nordic Hydropower - The European Battery

EERA JP Hydropower Kickoff - Brussels – Sept 9 - 2019

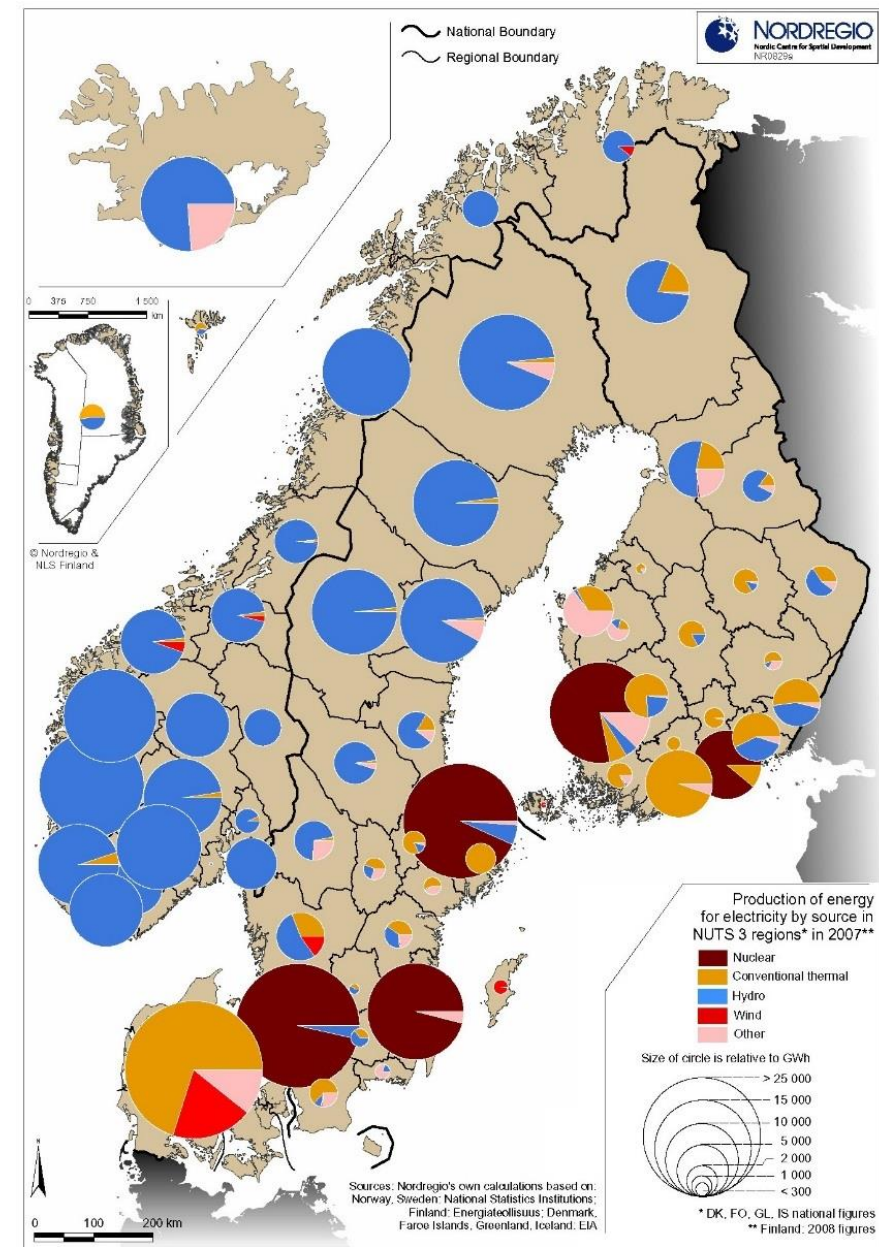
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Basic facts (Sweden)

- Large scale development started in 1910
- Most plants built 1950-1970
- Total installed power today is 16.2 GW
- 700 plants larger than 1.5MW
- 1800 plants smaller than 1.5 MW
- Very few pumped-storage powerplants.
- Annual production 65TWh (~45 %)
- Most capacity is located far up North
- No new builds to expect – major remaining rivers are protected by environmental laws.

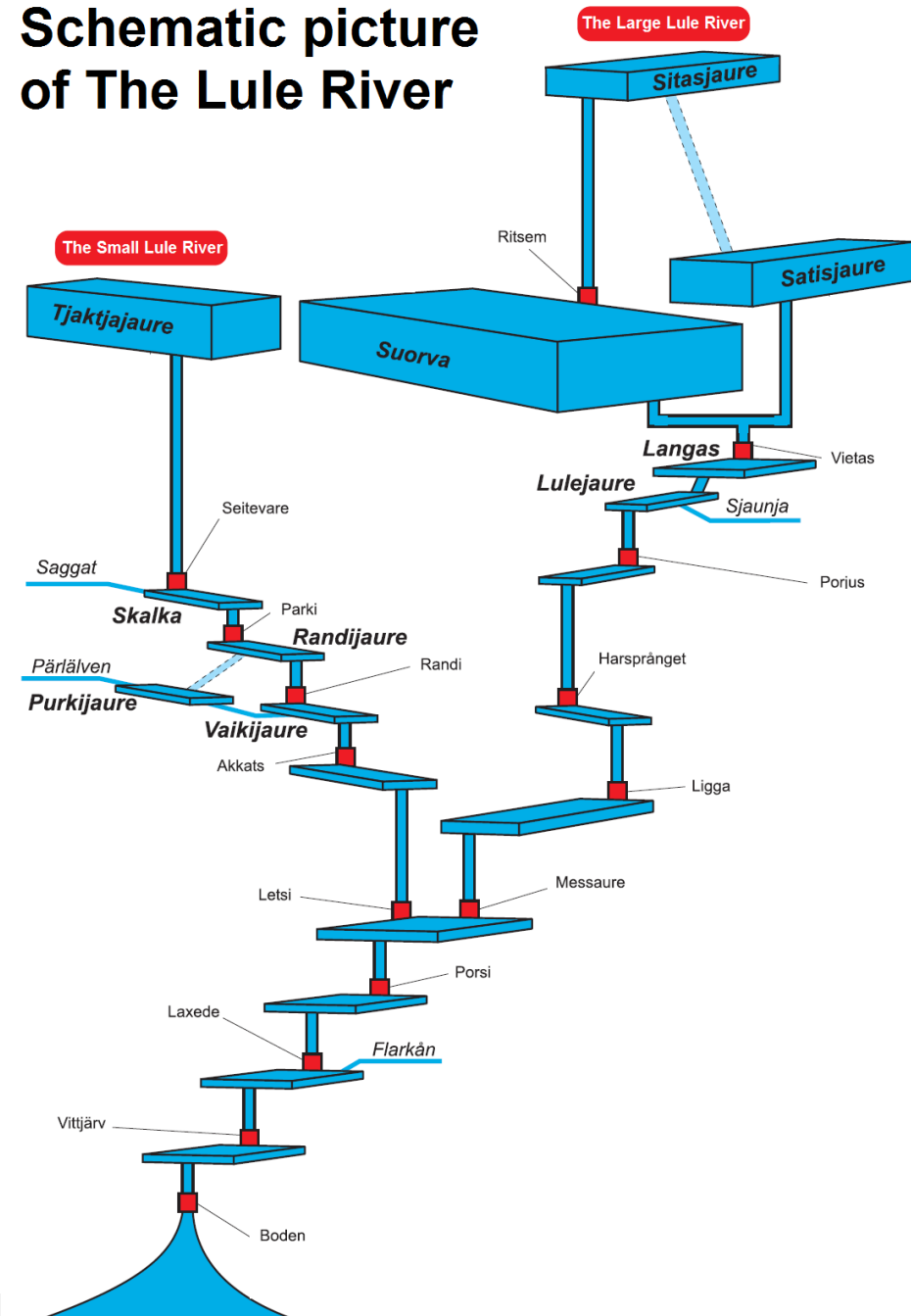


Map shows production of energy for electricity by source in Nordic NUTS 3 regions in 2007.

Flexibility

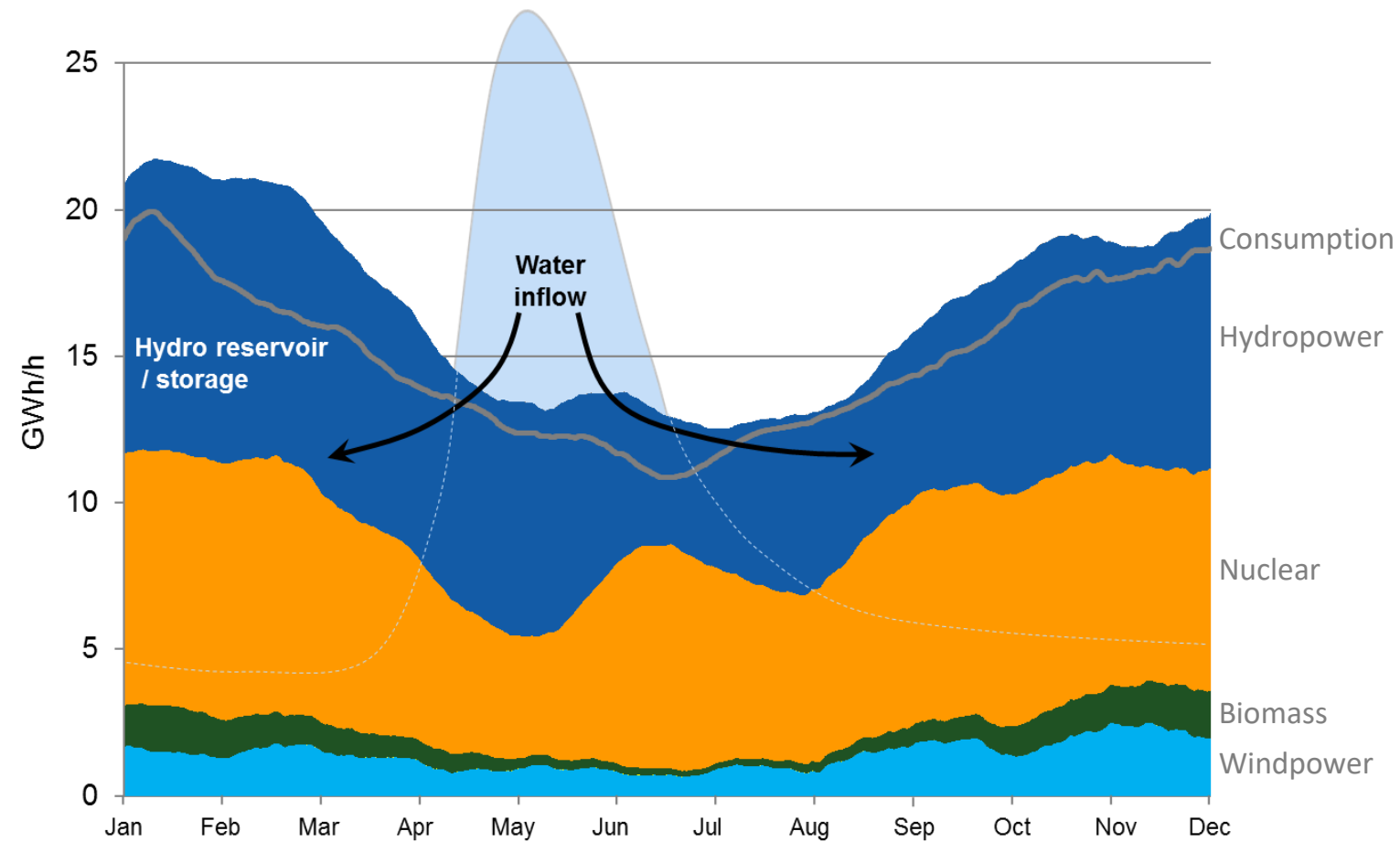
- Nordic hydropower systems are mixed reservoir-type and cascading schemes.
- Flexibility through large power-to-energy ratio (low utilization) and intermediate reservoirs.
- Large ability to balance net load variations on all time scales from seconds to seasons and years.
- N.B. no pumping involved!

Schematic picture of The Lule River

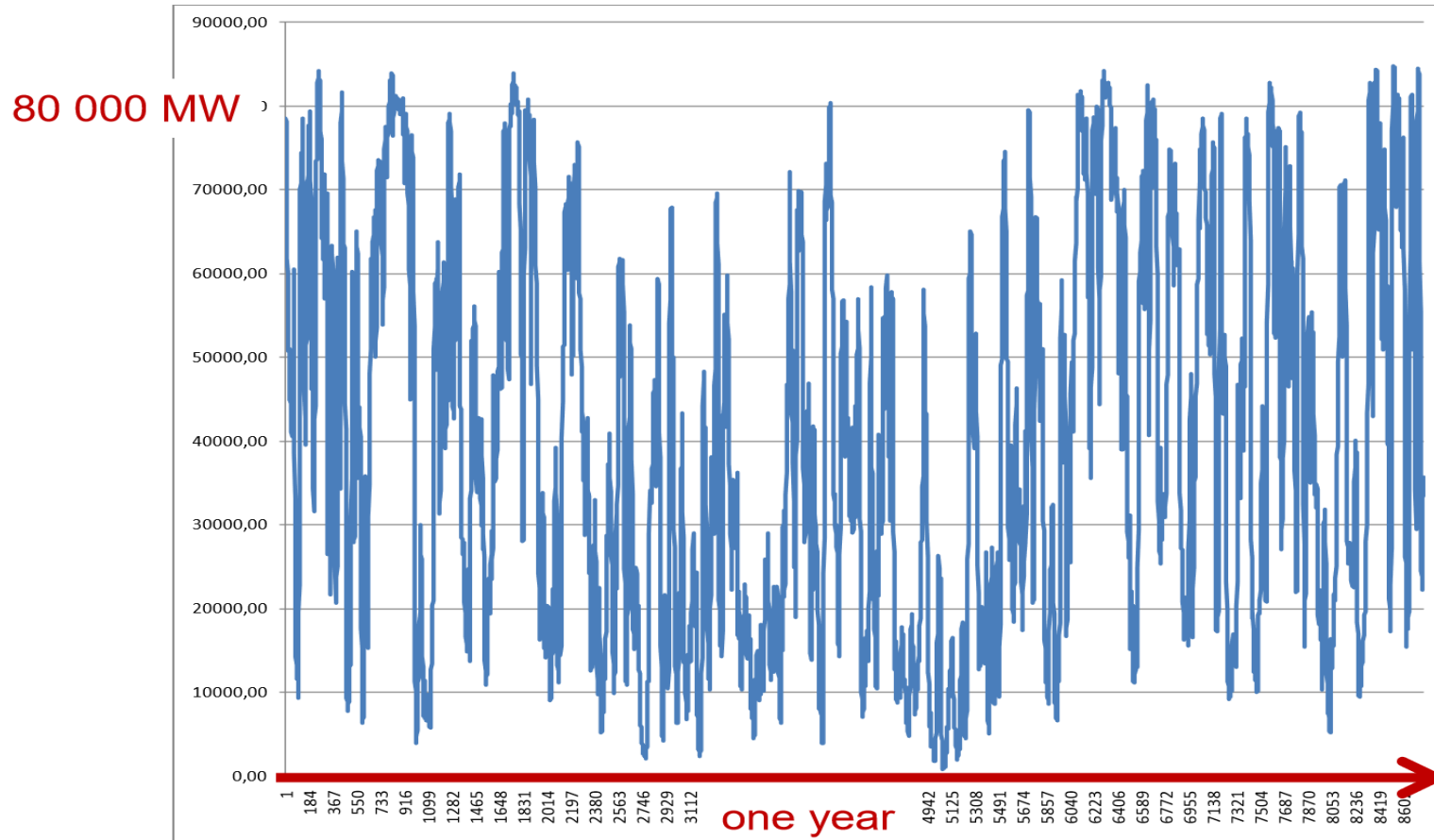


Capturing the fuel

- The spring flood (snow melting) is stored in very large reservoirs (lakes) at high altitude.
- Large storage volumes needed.
- Total storage capacity in Sweden, Norway and Finland is 120 TWh.



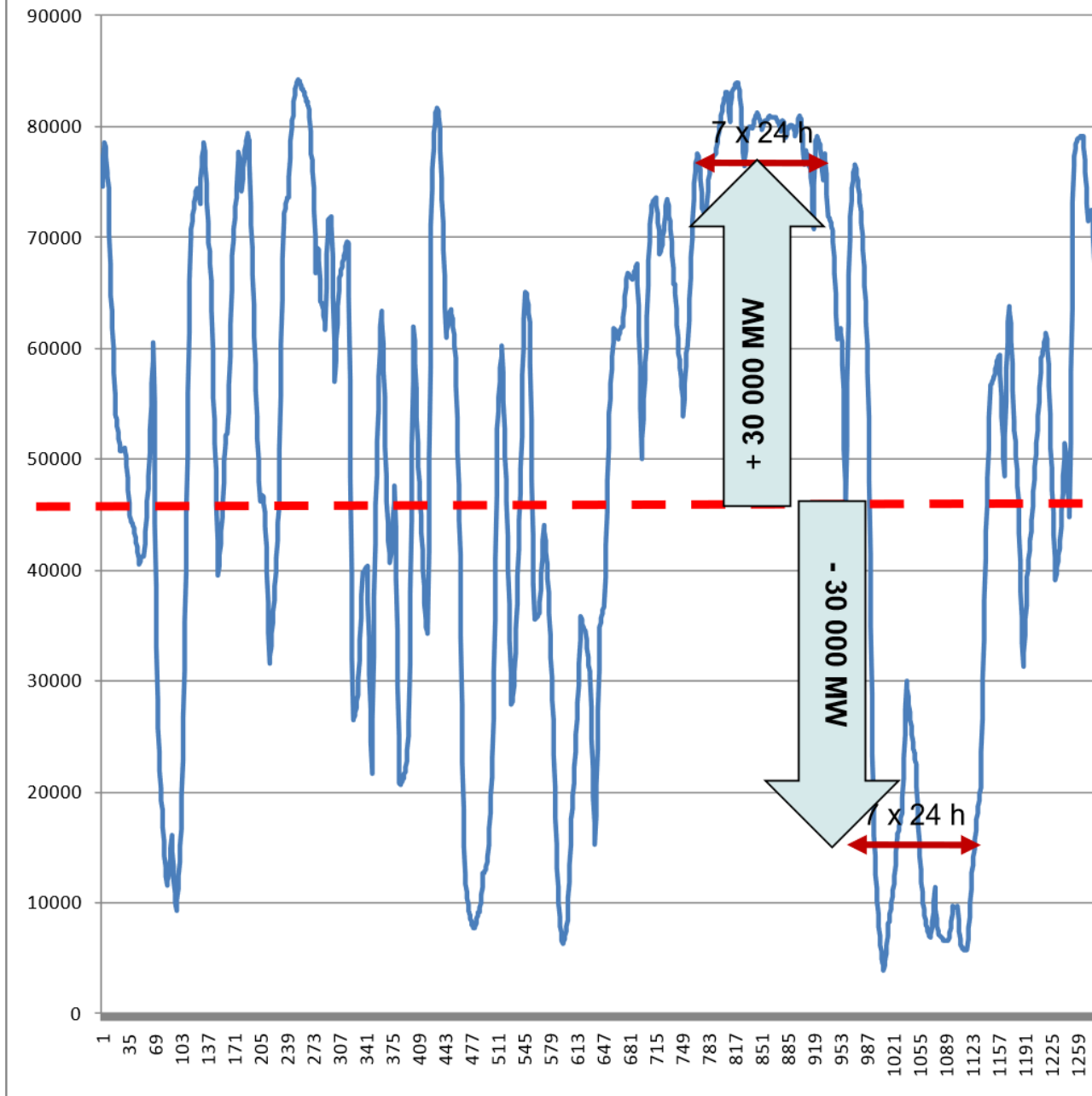
Simulated 95 GW wind power in the North sea area



How much energy storage capacity do we need to balance this?

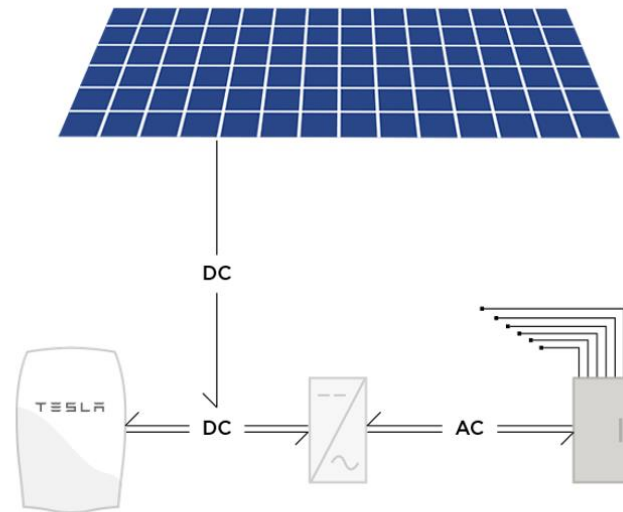
Two quite normal weeks require approximately 5 TWh of storage (30 GW x 7 days x 24 h)

Comparable to 1000 pump-storage plants



Tesla PowerWall

Roof-top solar panel or similar



PowerWall[®]

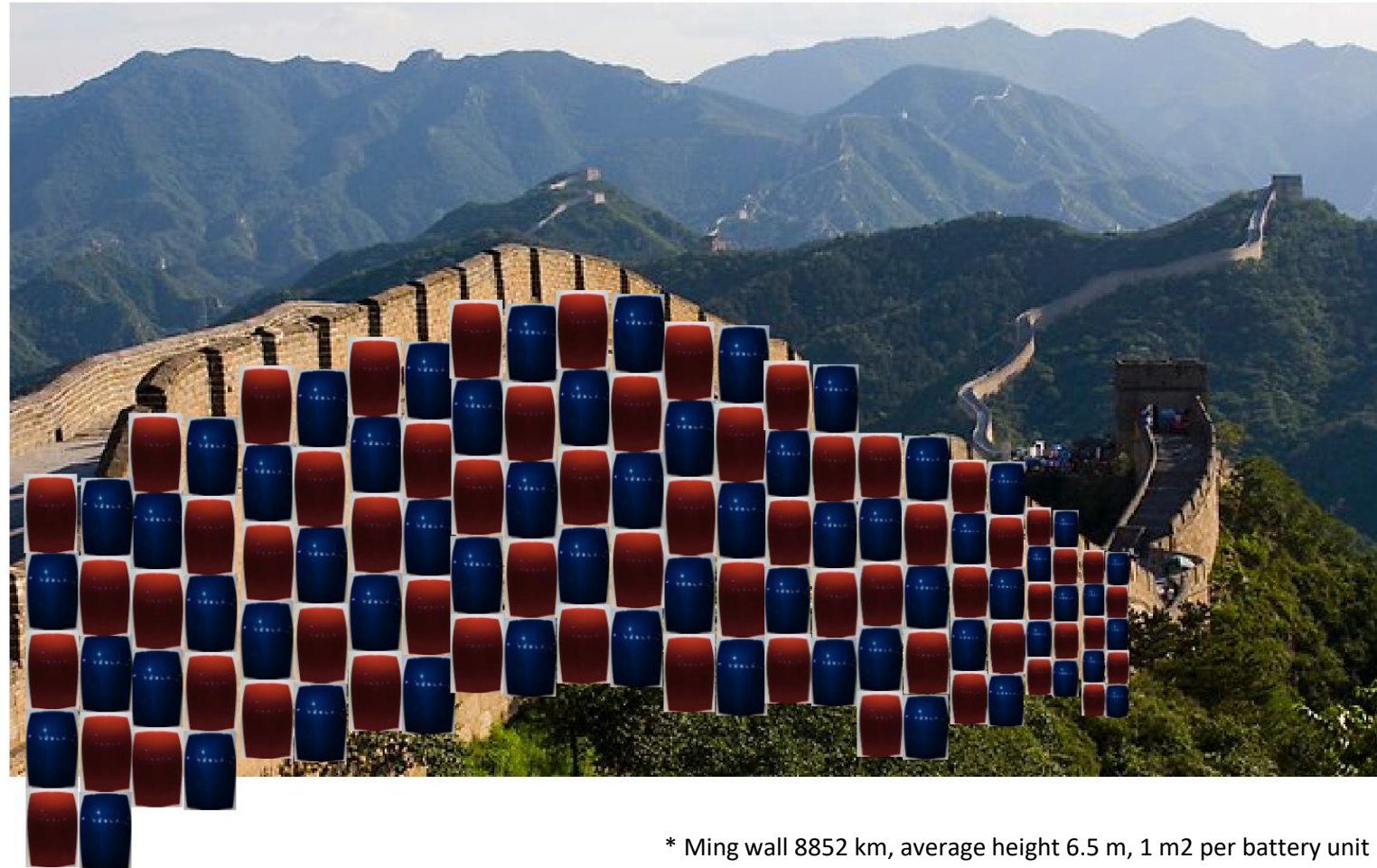


- Balancing solar energy
- Energy security
- Off-grid solutions

Chinese PowerWall

Covering both sides of the Great wall of China* with Tesla batteries would give ~1.2 TWh of energy storage

Only 1 % of the Nordic storage capacity



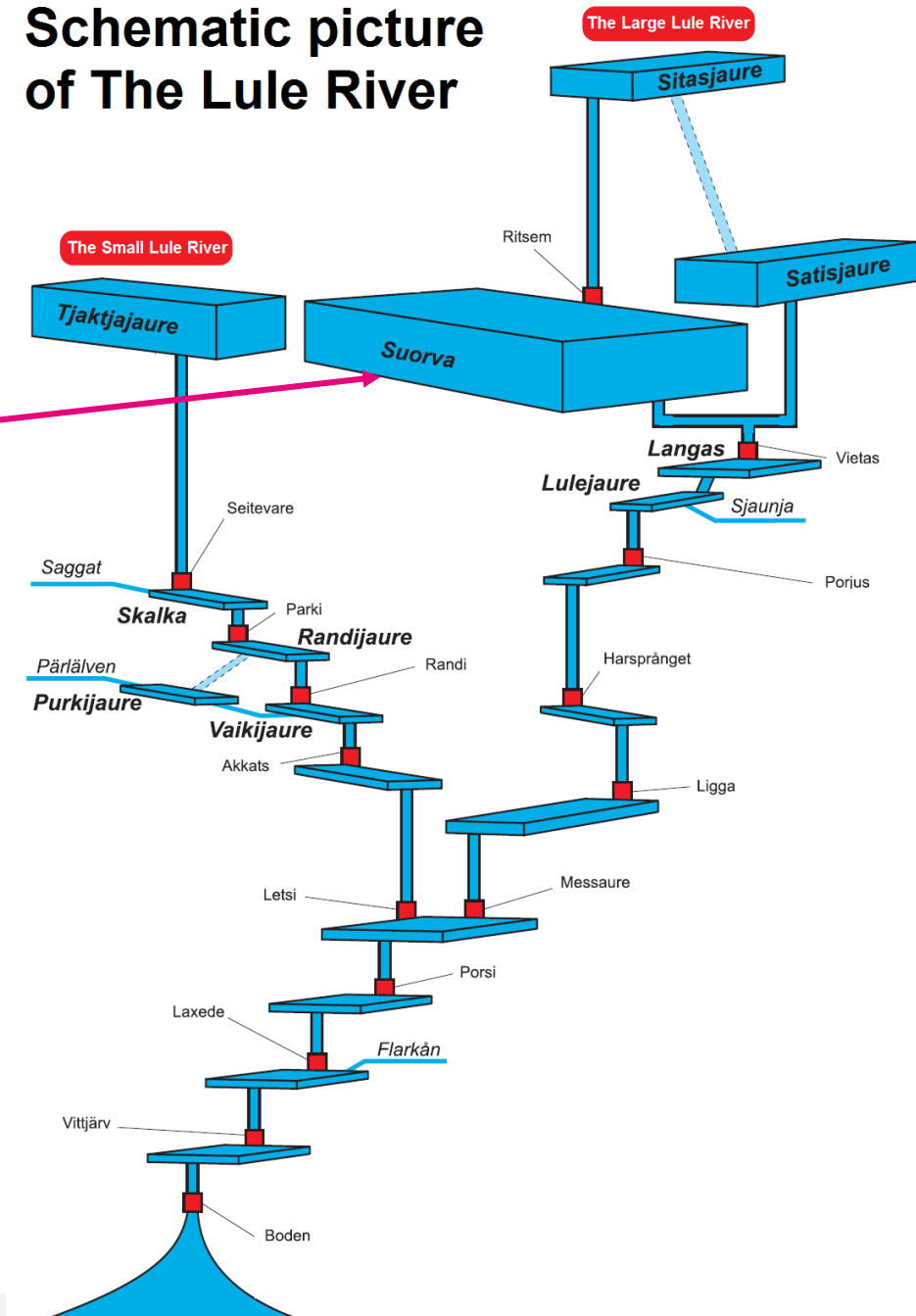
* Ming wall 8852 km, average height 6.5 m, 1 m² per battery unit


The Suorva reservoir

7 TWh



Schematic picture of The Lule River



An aerial photograph showing a large concrete dam structure extending across a wide river. The river flows into a large reservoir on the right side of the image. The surrounding landscape is densely forested with trees in shades of green and yellow, suggesting an autumn setting. In the foreground, near the dam, there are several industrial buildings and a parking lot. A small island is visible in the reservoir.

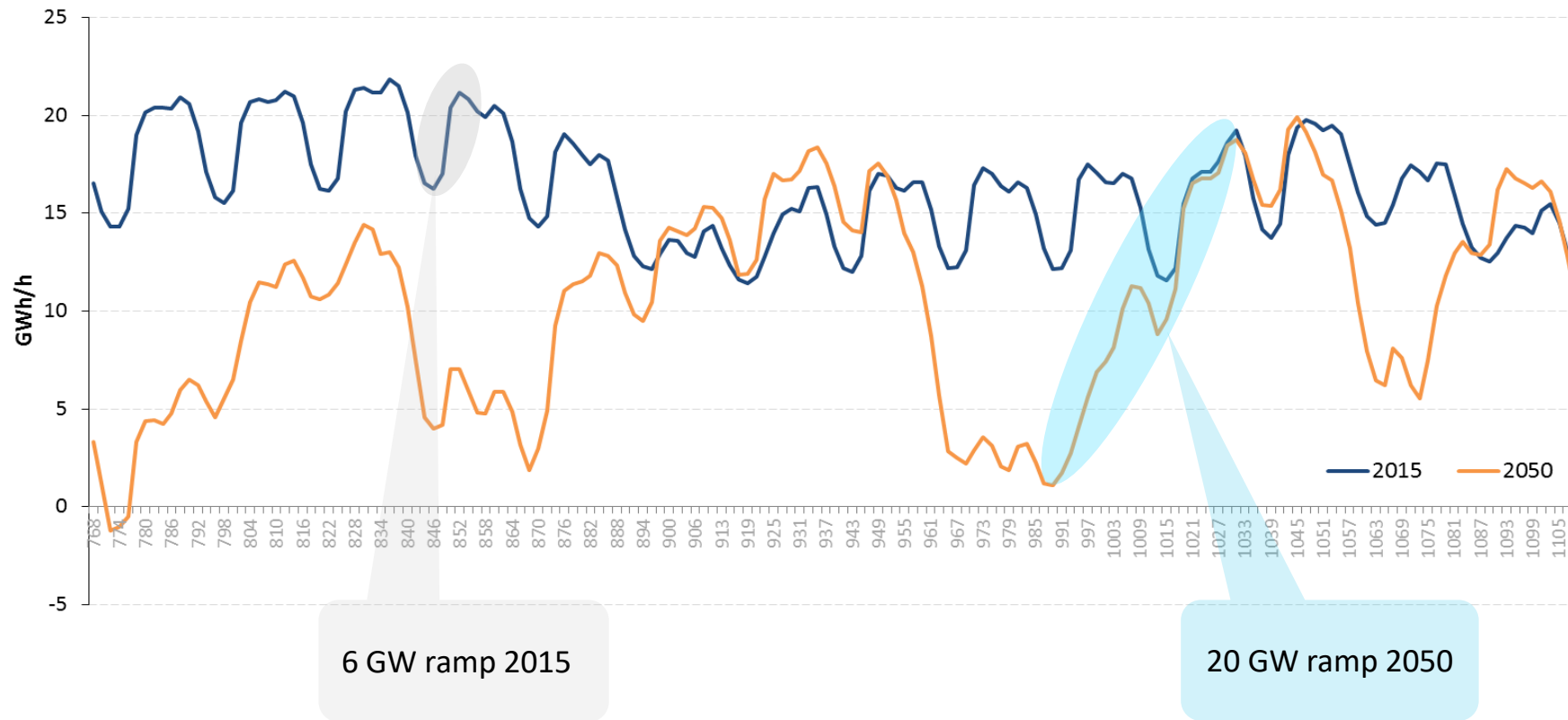
Nordic hydropower is
perfect for balancing large
amounts of windpower

But there are challenges

New operation pattern

Load variations are relatively small and predictable

Windpower variations är larger (in GW), longer (multiple days) and do not follow any predictable pattern.



Environmental adaptation necessary

- Sweden just started a 20-year effort to modernize environmental conditions in permits and corresponding mitigation measures in powerplants and dams.
- Fully funded by the industry through the Vattenkraftens Miljöfond AB, owned by the eight largest hydropower producers.



Fish ladder at the Stornorrfors powerplant in the Ume river.



R&D is key to find a
suitable balance
between conflicting
objectives

R&D areas of interest

Environmental adaptation

Fish passage solutions

Ecological flows

Habitat restoration

Dam safety implications

Hydrology

Increasing flexibility

Understanding future
operations patterns

Extending the operation
range

Understanding wear and
tear mechanisms

Integrating new technology and new methods, e.g.,

Digitalization

Power electronics

New materials

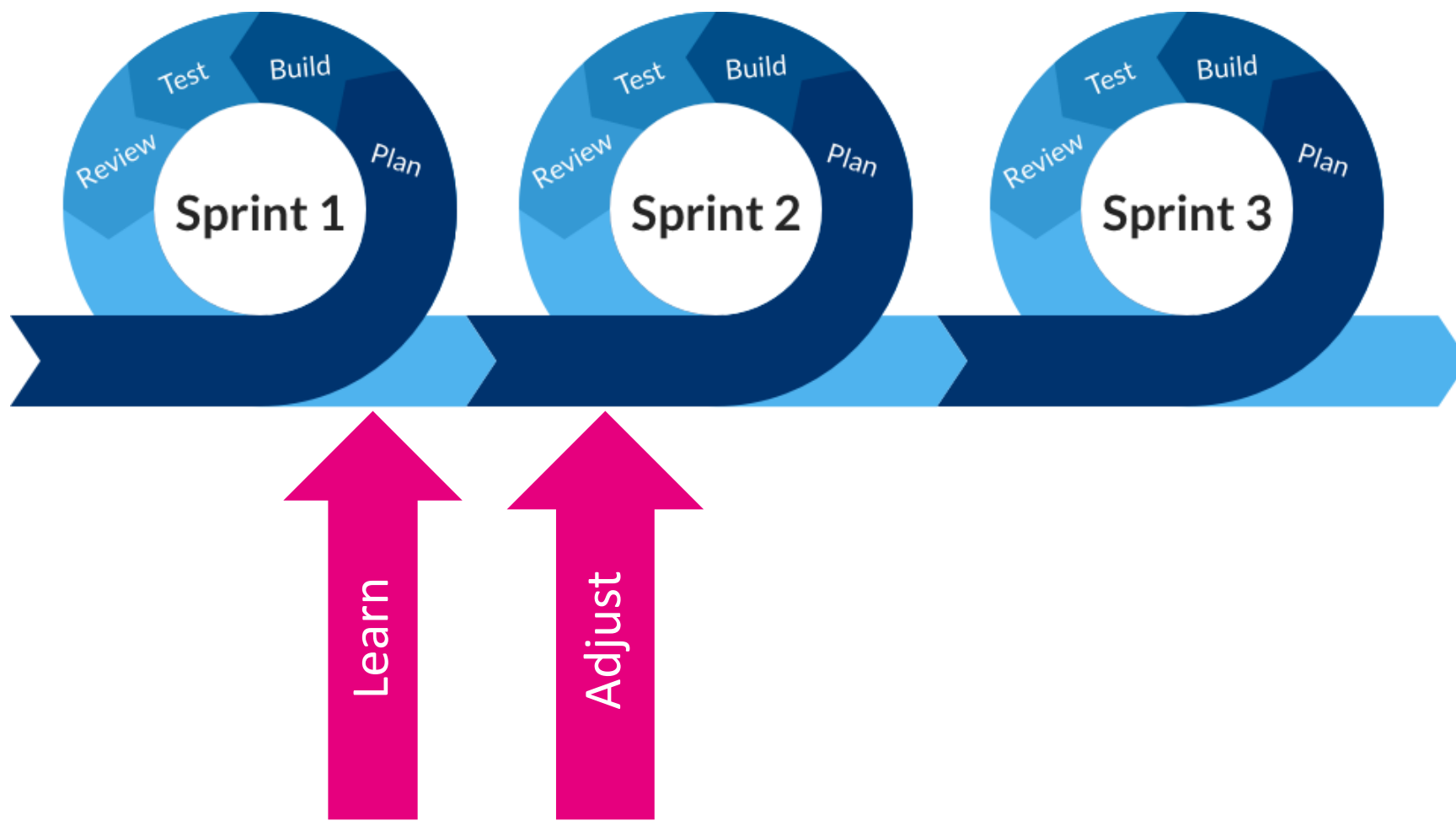
And much more...



Cross-disciplinary projects
have a large potential!

A photograph of a dam in winter. The dam is a long concrete structure with several spillways. The ground in the foreground is covered in a thick layer of snow. There are snow-covered trees on the left side of the image. In the background, there is a dense forest of evergreen trees. The sky is overcast. A pink rounded rectangle is overlaid on the image, containing the text "We need to learn as we go!".

We need to learn as we go!



Additional challenges

- Capital intensive investments
- Long investment cycles (20-100 years)
- Rapid technical development
- Political uncertainties
- Very conservative industry

We need a plan to get the good stuff out there!

A photograph of a dam in winter. The dam is a concrete structure with a spillway. The ground is covered in snow, and there are snow-covered trees in the foreground and background. The sky is overcast. A pink rounded rectangle is overlaid on the image, containing the text "Demonstration is very important!".


Demonstration is very important!

The image shows a large industrial-scale flume laboratory. Two long, parallel channels of water are visible, with turbulent, white-water rapids in the center of each channel. The facility is housed in a large, well-lit building with a high ceiling and structural beams. Blue vertical supports are visible on the left side. A walkway with railings runs alongside the channels. In the background, there are various pieces of equipment and a control area.

The Laxelerator flume lab in Älvkarleby

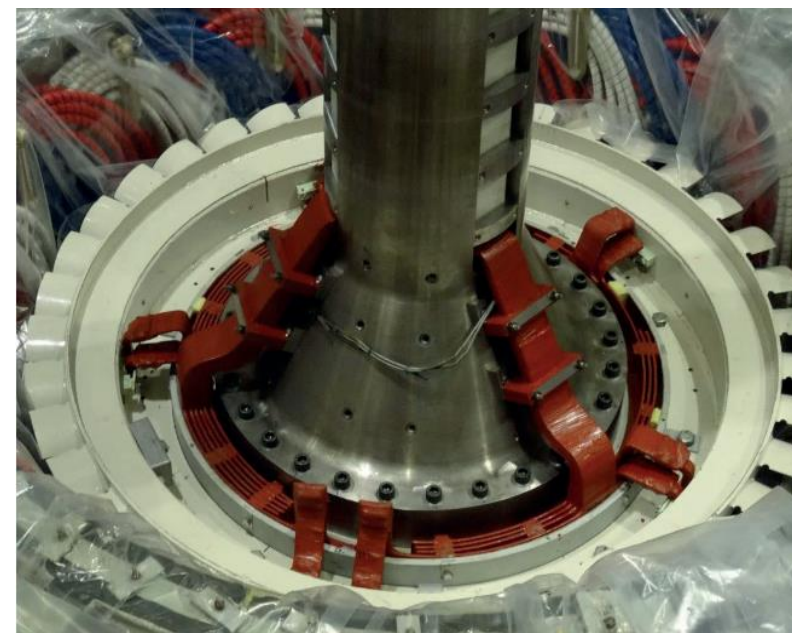
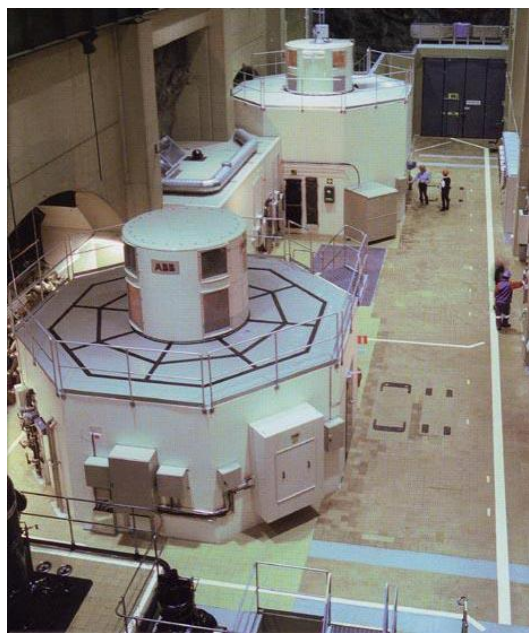
Specifications

- Recirculatory with jet-pumps
- Two 30 m long test arenas
 - Cross-section: 2 x 4 m
- Max velocity = 2 m/s (16 m³/s)
- Controlled light and temperature
- River water: filtered/unfiltered



Porjus hydro- power center

2 × 10 MW units for R&D purposes and education





Thank you!