

# Scope: Climate change and potential impacts on NPPs

- NP in the Nordic countries, i.e. Sweden and Finland
- Certain focus on conditions in Sweden
- The system in focus: the power plant and the power-plant site (and external grid)
- Available data from specific climate-model runs and a selection of complementary assessments
  - Both qualitative and quantitative estimates
  - Large remaining uncertainties for certain relevant weather events and phenomena, while relatively large certanties for other observations
- Impacts on NP in terms of relevance and severity largely assessed through working-group discussions with experts

# Main findings

- In general, NP is a climate-robust source of energy
- Due to extremely high safety standards and high margins against operational disturbances ...
  - Design and planning with respect to extreme events is "normal business"
  - Continuous improvements in safety and operational performance
- ... but also since some climate-change impact of more significance to NP still lies relatively far in the future
- Climate-change impact on NP is primarily a matter of increased risk of operational disturbances (unplanned outages) ...
- ... and not a concern for safety



# Main findings (contd.)

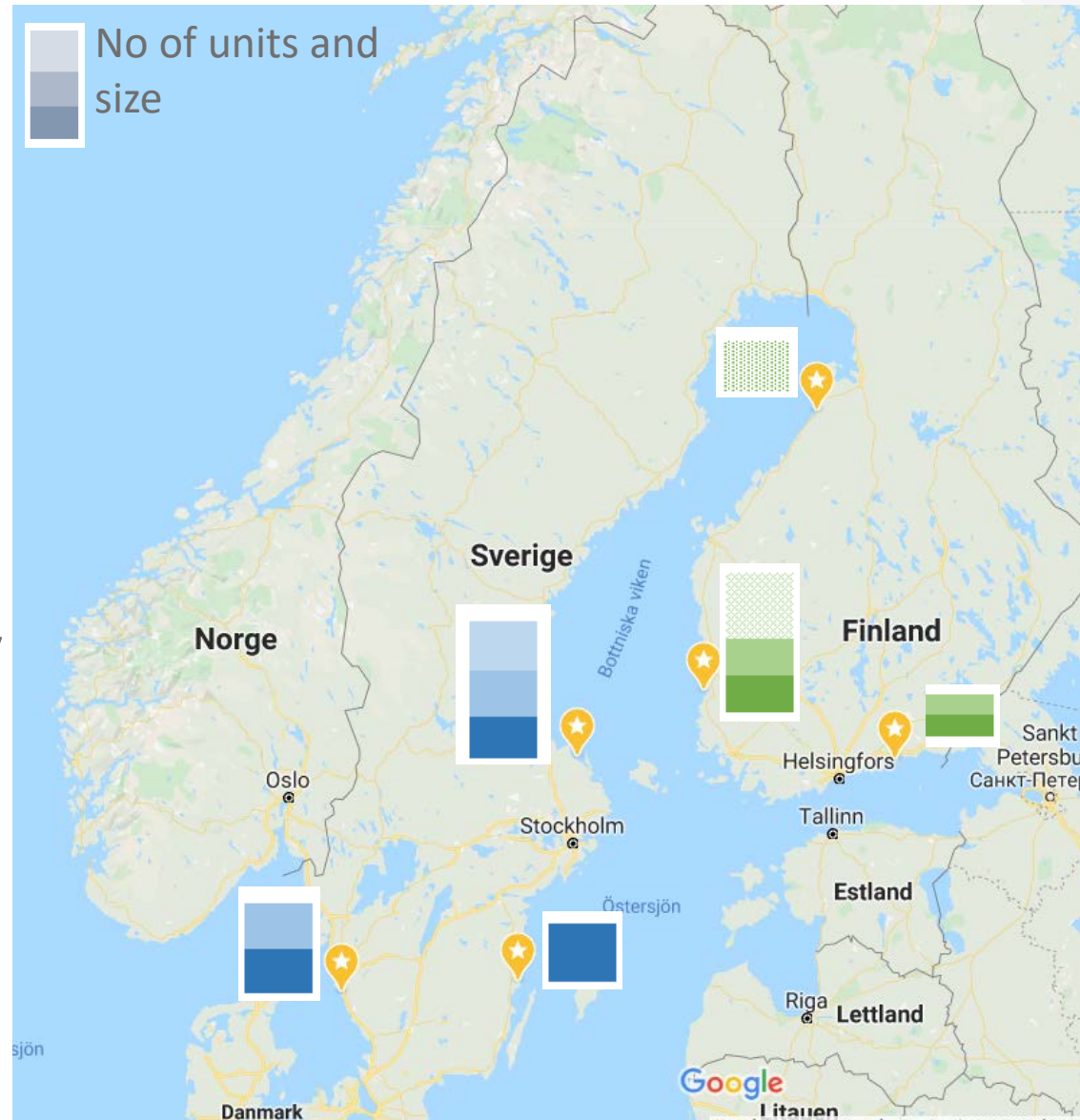
- Measures are at hand and additionally available if considered necessary
- Ultimately a question of finding the balance between additional costs and benefits
- There are, however, remaining (large) uncertainties as regards e.g. frequency and amplitude of certain relevant weather events ...
  - e.g. extreme events (e.g. thunderstorms) and compound events,
- ...why the NP sector needs to continue to monitor climate-change research
  - PSRs typically every 10 years
  - Event classification of extreme weather events

# Nuclear power sites in the Nordic countries

- Ringhals
- Oskarshamn
- Forsmark
- Loviisa
- Olkiluoto
- Hanhikivi (under construction but not yet fully licensed)

Around 11 GW with OL3

Approx 110 GW in total generation in the Nordic countries



# Weather-related events have occasionally lead to unplanned outages ...

- High seawater temperatures in heat wave of 2018 impacted production at Ringhals and Loviisa
- Jellyfish intrusion at Oskarshamn in 2013 and 2005
- Frazil ice leading to outages at Olkiluoto in 2008
- Salt coating (due to salt storm) of switchyard at Ringhals in 2005
- No concern for safety but obvious disturbance to the operation, yet with limited duration
- Lessons have been learned and measures increasing the resilience have been implemented
- Historically, weather-related events have occurred very rarely in the Nordic countries, typically during single hours or less as an annual average ... (IAEA, Operating Experience with Nuclear Power Stations in Member States) ...
- ... but we have reasons to believe that climate change may potentially increase the frequency of such disturbances in the future
- Weather-related *indirect* impacts include above all impact on the external grid.



# Key climate and weather phenomena and their potential impact

- **Disturbances on internal and external electricity grid infrastructure**
  - Lightning strikes
  - Protective measures implemented and more available if considered necessary
  - In case of loss of external grid → house load operation for internal electricity supply and for enabling a swift re-connection
- **Increasing seawater temperatures**
  - Negative (but limited) impact on electric efficiency
    - Marine heat waves during summer
    - Reduction in power output → temporal outage (summer 2018)
    - Economical question: new heat exchangers and/or relocation of CW intakes
    - Refined technical design criteria
  - Increased presence of marine organisms (e.g. jellyfish and alga)
    - May impact/(partly) clog CW intakes
    - May be relatively fast-progressing events difficult to predict
    - Filtering and screening equipment, and improved monitoring/detection to increase preparedness
- **Sealevel rise and the risk of flooding**
  - Relatively slow progress → time to prepare and, if necessary/profitable, to adapt
  - Sea-level rise reduces margins against extreme weather conditions
  - Possibly relevant for Oskarshamn and Ringhals in a long time perspective
  - Land uplift counteracts (Forsmark and Finnish NPPs)
  - In Sweden, all reactor units completely safe up to +3 m above currently normal sealevel. In Finland even more
  - Sufficient margins in a "2070-2080"-perspective, or "approaching 2100".





A photograph of a power plant with a tall smokestack and large cooling towers, partially obscured by autumn foliage in the foreground.A large, light gray spiral graphic that starts from the center and expands outwards, framing the central text.

**Thank you for listening!**