

# Country report: Sweden

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2024 High latitude PV Workshop Piteå

An aerial photograph of a solar farm in a snowy, mountainous landscape. The solar panels are arranged in long, parallel rows, partially covered in snow. The background shows a dense forest of evergreen trees under a cloudy sky. The overall color palette is dominated by blues, greys, and whites, with a slight yellowish tint in the bottom right corner.

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# Introducing Swedish conditions

- Sweden is a long country, 55 - 69°N
- 66% of land area is north of 60°N
- 10.5 million inhabitants of which 1.5 lives in the North..
- The north-atlantic circulation and the gulf stream affect climate and temperatures.

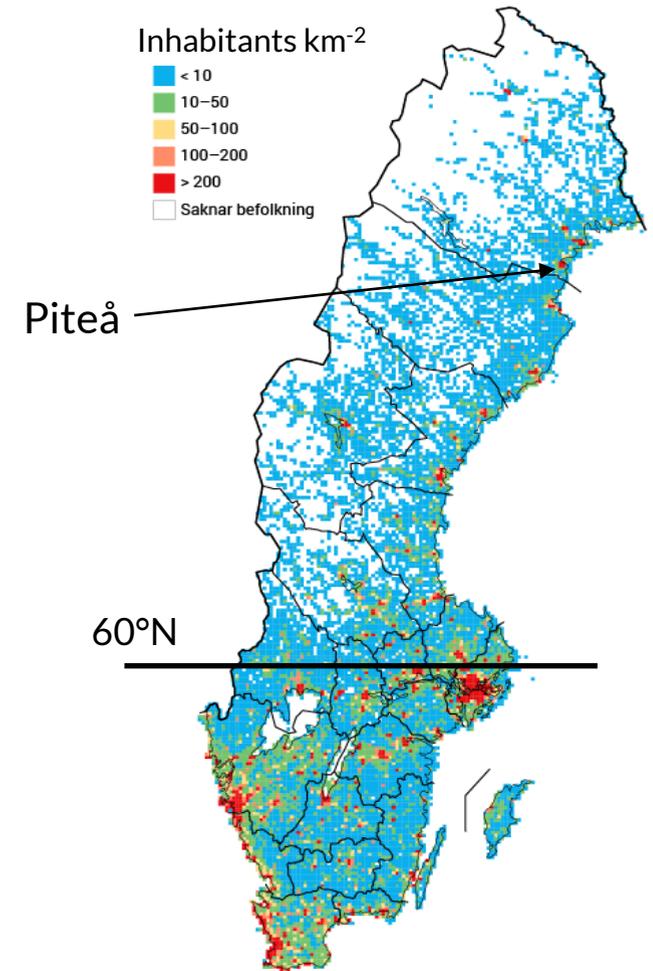


Figure: <https://www.scb.se/hitta-statistik/sverige-i-siffror/manniskorna-i-sverige/befolkningstathet-i-sverige/>

# Irradiation conditions for PV

- North-south gradient and coastal sunshine
- Variations between seasons and within days – low sun path overall
- Coast has higher irradiation

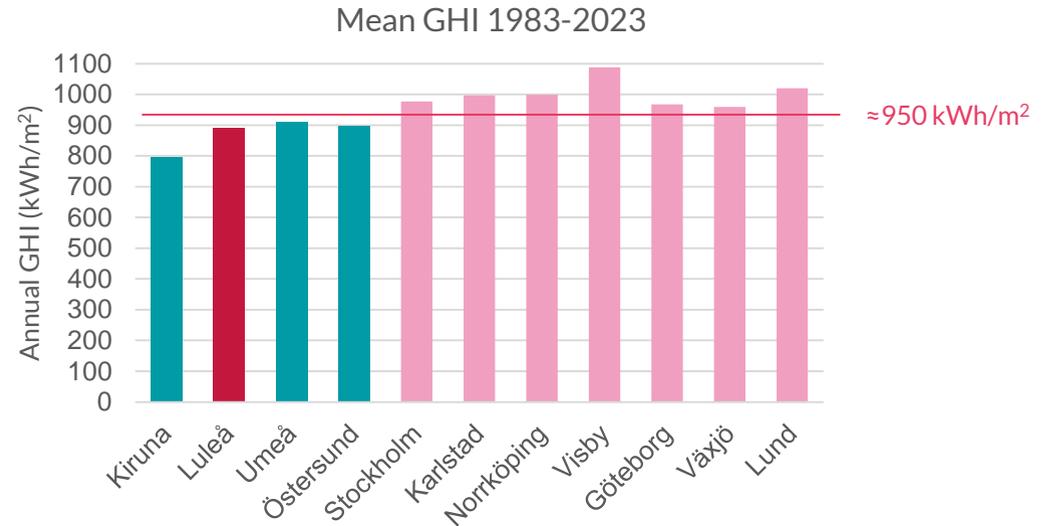
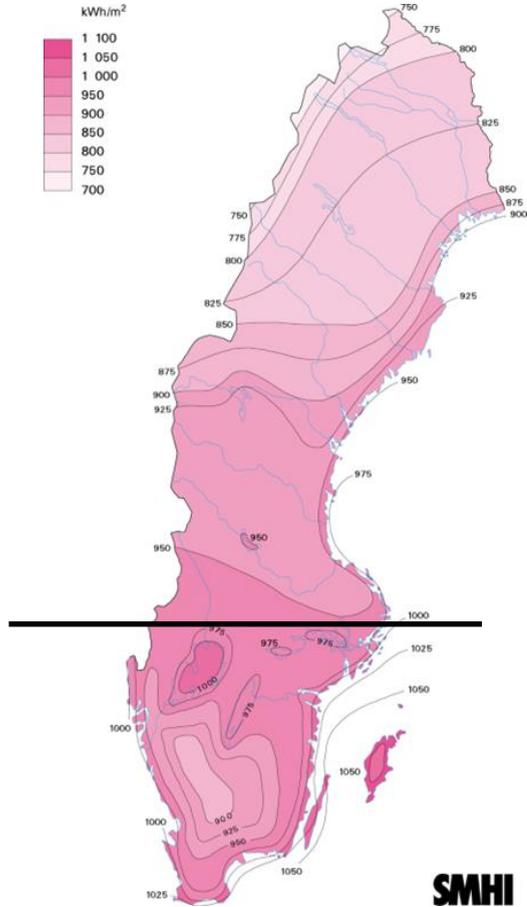
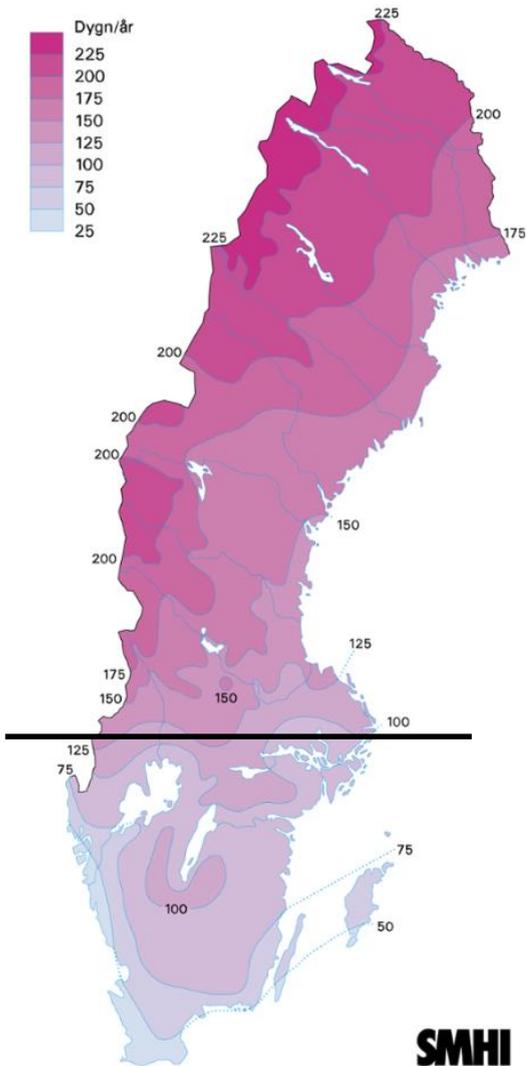


Figure: Swedish Meteorological and Hydrological Institute, accessed 2024



# Snow conditions for PV

- Above 60 deg: 3-6 months per year
- Max yearly snow depth for Piteå shown below.
- Mean ~0.7 m

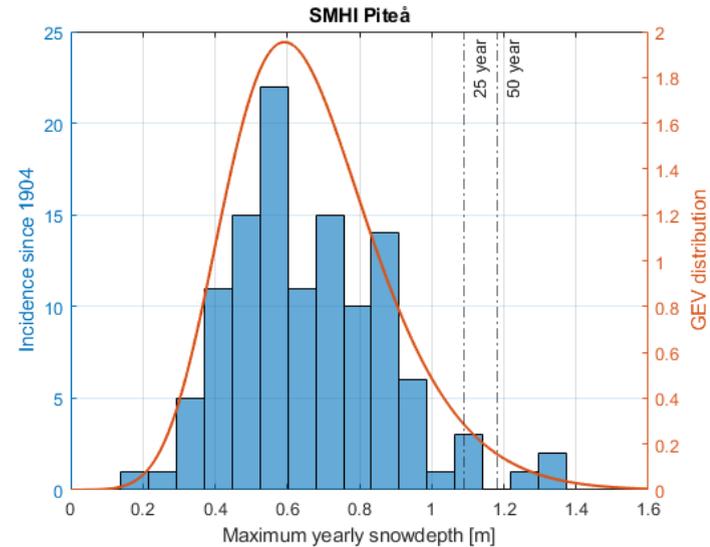


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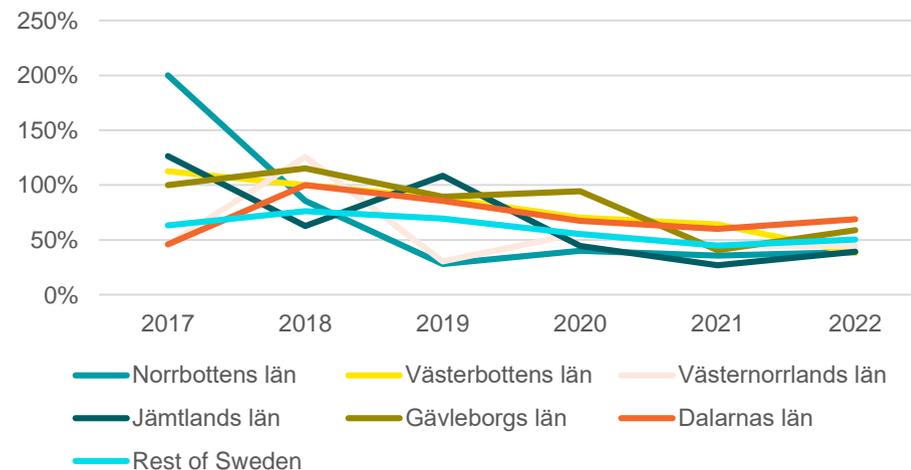
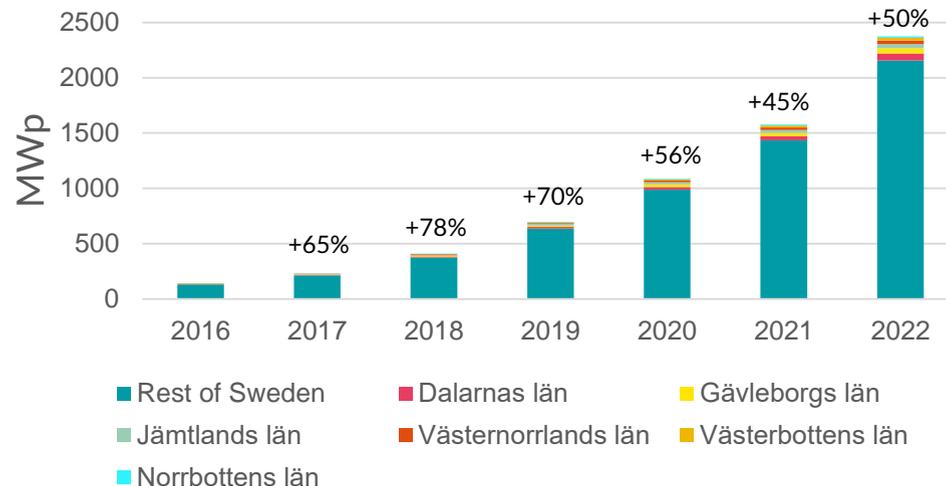
# Installed capacity and growth per year

## Nation wide:

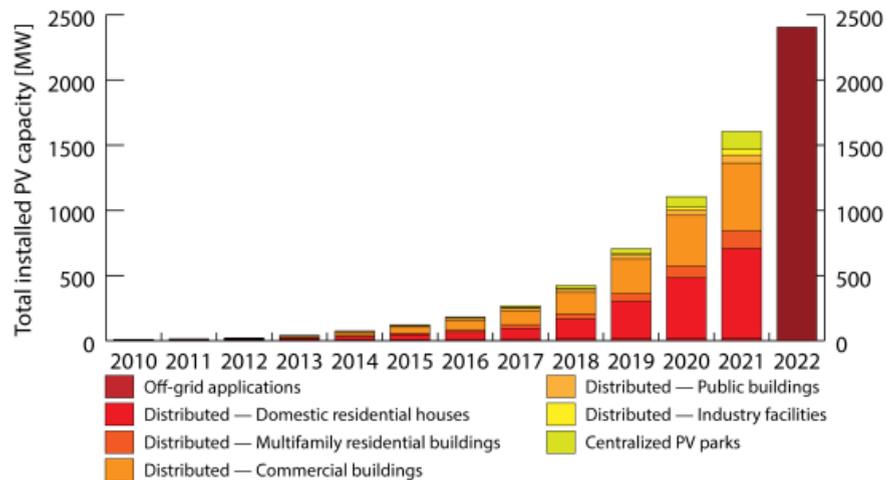
- 2,4 GWp (225 W/pers)
- Growth trend mean since 2016: 61 %/y
  - Fairly stable
- Mean yield 2019-2022 is 853 kWh/kWp

## Six northern counties

- 220 MWp (150 W/pers)
- Growth trend mean since 2016: 72%/y
  - Decreasing
- Decent yield but lower electricity prices



# Distribution and planned projects



Utility PV and Industry facilities appear to grow the fastest.

- The number of utility PV sites that were waiting for its permit end of 2023 in Sweden corresponded to ~14 GWp...
- The six northern 6 counties only ~1,6 GWp



Photomontage 550 MWp in the county of Västernorrland

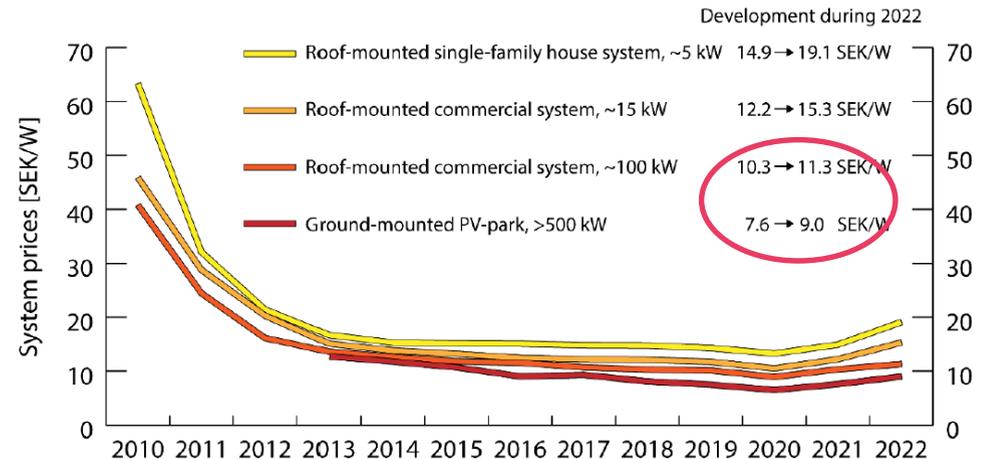
# Policies, legislation and cost of PV systems

## National

- No official capacity goal – trade association and industry aims for 15 %, in 2022 it was 1.2%
- Changing subsidies: now 20 % on investment and tax reduction for private residential sector

## EU

- Energy communities - let's hope for positive development!
- EPBD may increase building applied PV and may affect the market penetration of BIPV
- Debate similar to UFLPA in the US but different outcome – impact on the industry?
- Ecodesign - circularity and energy efficiency in mind



# Issues specific to northern Sweden

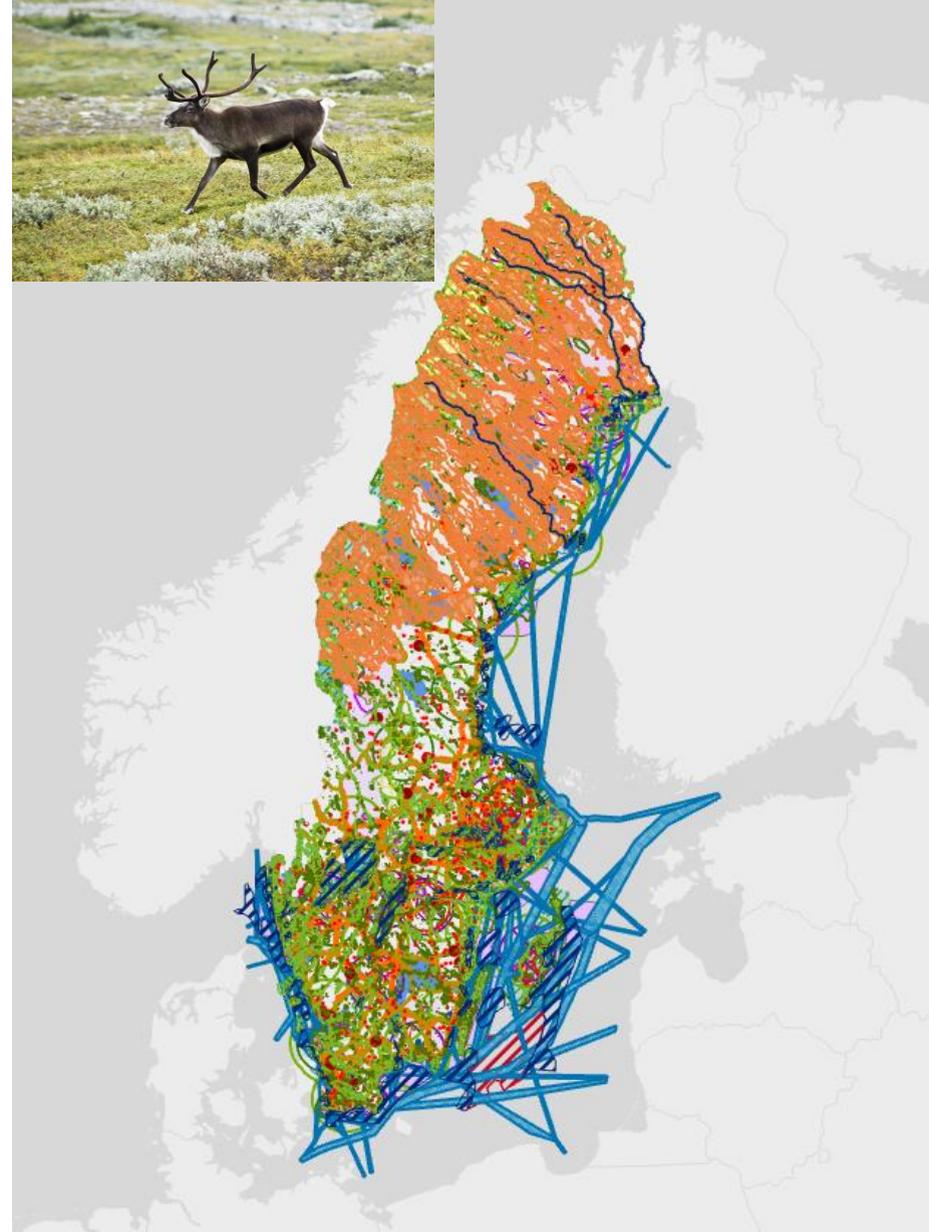
- General high latitude conditions
- Things that differ could be: people, industry and conflicting land use
  - Low population density, but still significant
  - Contribute in the existing and coming infrastructure (grid, industry, H<sub>2</sub>)
  - Conflicting interests...



# Land access and conflicts

- Land area of Sweden is 407 000 km<sup>2</sup>
  - 68% forest
  - 7 % agricultural land
  - ...but?
- National interests of different kinds (*Swedish Environmental Code* Ch. 3 & 4)
- There is no free lunch
- PV must coexist and adapt to what's already there:

Forestry, hunting, fishing, recreational interests, mining, defense, industry infrastructure, roads, and so on...





## Summary

- Long country – most of the land north of 60°N
- North-south gradients
- Exponential growth both as a whole and in the north - cost appears to decrease
- PV on commercial and residential buildings is dominating – utility is growing fast
- Very large PV plants are in the plan
- Conflicts between different land uses are emerging
  
- Obvious high-lat issues are the same
- Implementation and interaction with neighboring fields gives is a chance to be one step ahead.

*Thank you!*

# Lacking info and need for research

## *Lacking information*

- Proper statistics
- Degradation och health of systems
- Accurate irradiance and PV performance modelling in the North

## *Research is needed on*

- Degradation and failure modes in our climate and region
- Design for longlasting efficient and resilient PV plants on ground and C&I
- Snow shading modelling and forecasting
- Agrivoltaics and co-existence with other interests i.e. natives, forestry, agriculture, and industry

