Actual Power Demand on Zero-Emission Construction Sites

Based on Key Findings and Case Studies

By Eirik Hordnes / 2024.09.19

2ND OFF-ROAD DECARBONIZATION SYMPOSIUM 2024

Introduction

Objective of the Presentation:

- Provide insights into the real power demand and challenges for zero or partly zero-emission construction sites.

Project Background

- Oslo aims to reduce emissions by 95% by 2030, with construction sites accounting for roughly 10% of todays emissions.
- The municipality aims for all their own construction projects to be zero-emission during **2025**, and all projects fully during **2030**.
- More **real-life data** is needed to understand and plan for the upcoming electrification

Problems to be addressed

- What is the **actual power** and energy demand from the construction site?
- To what extent is power demand a limiting factor for the operation of zero-emission construction sites?
- Assess the relationship between power and energy consumption and site operations.
- What are the **causes of power peaks** at construction sites? How and to what extent can these be avoided (in terms of planning, adjusted routines, technical equipment, etc.)?
- What prior knowledge is required by contractors and builders to optimize planning for energy and power needs in zero-emission construction projects? What should be standard knowledge for contractors and builders regarding power and energy planning?

Method

- Map available data
- AMS meter
- Any circuit meters
- District heating
- Power rig
- Grid capacity / transformers
- Local electricity production
- Dialogue with construction site
- Machinery fleet and logged consumption

- Data cleaning
- Different time resolution, timestamping
- Synchronize data to the same time
- Ensure data quality

- Consumption for different items
- Power / energy
- Simultaneous consumption
- Cause of power usage
- Address issues

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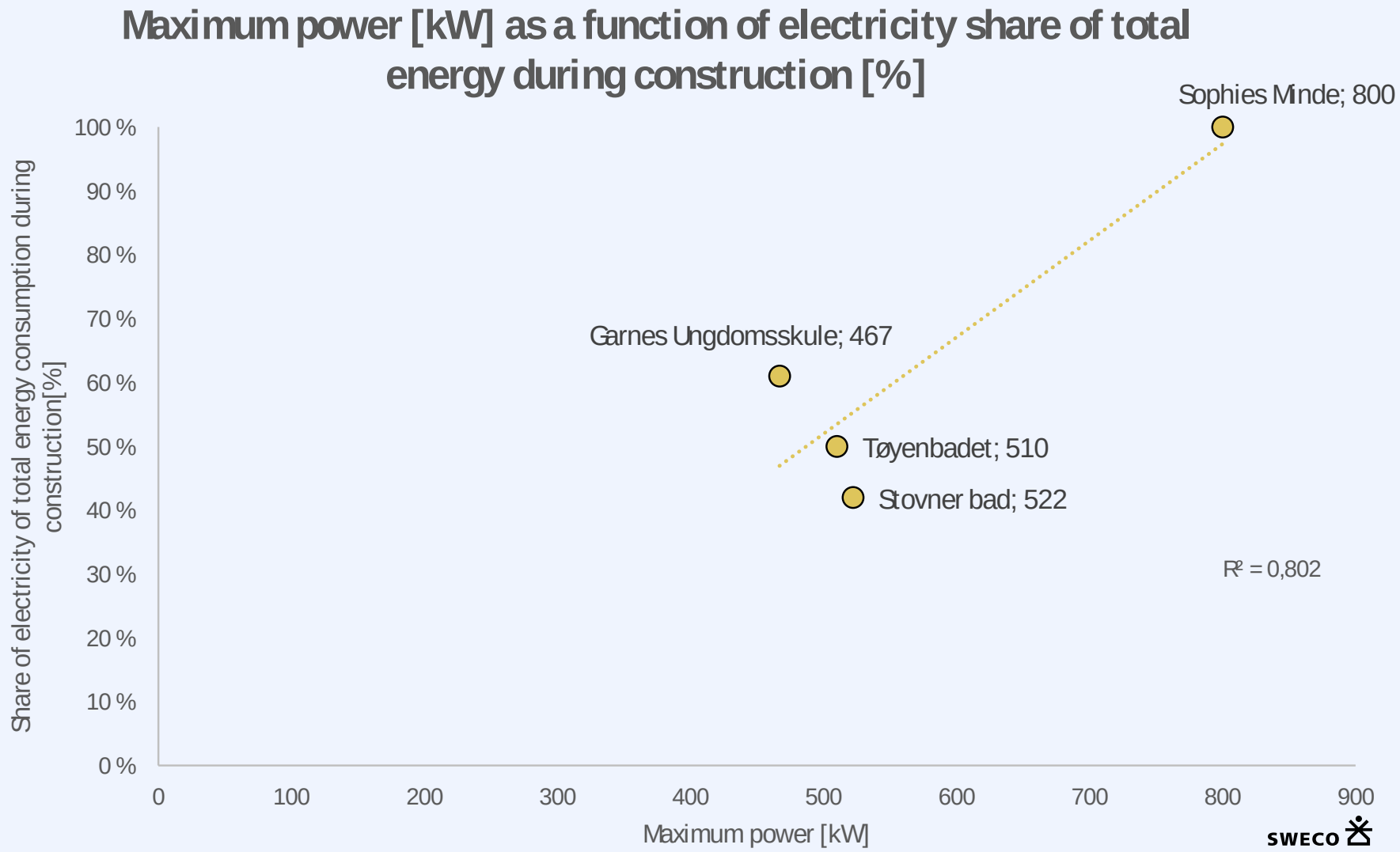
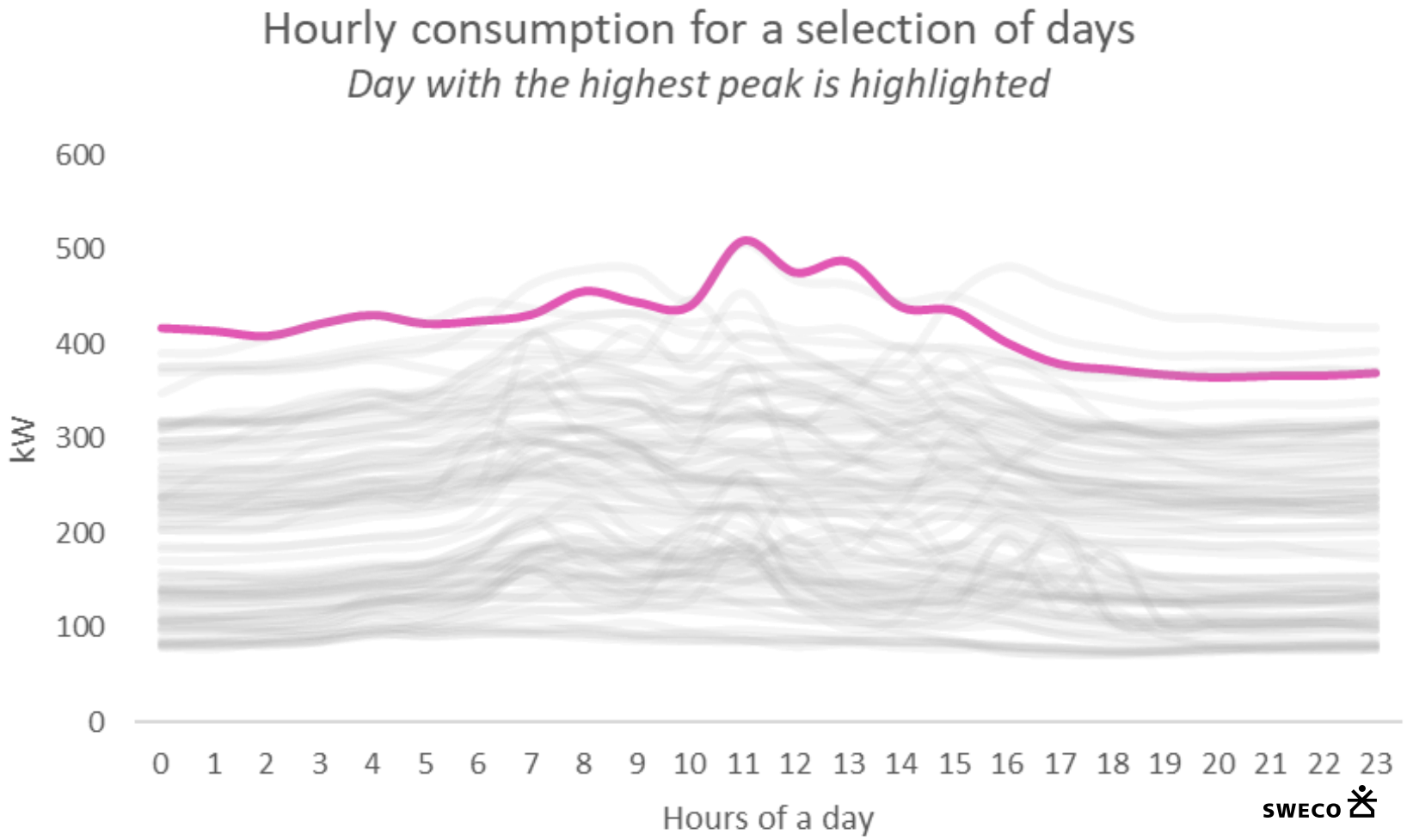
Current Power Demand on Construction Sites - summary

- Peak power demand for 4 construction projects in the diagram.
- Power demand can vary depending on phases, retrofit or newbuild, equipment used, and overall site management.
- Most peaks occurs around lunch time (11-12) or at the end of the work day, **mostly due to simultaneous high power charging** of excavators.



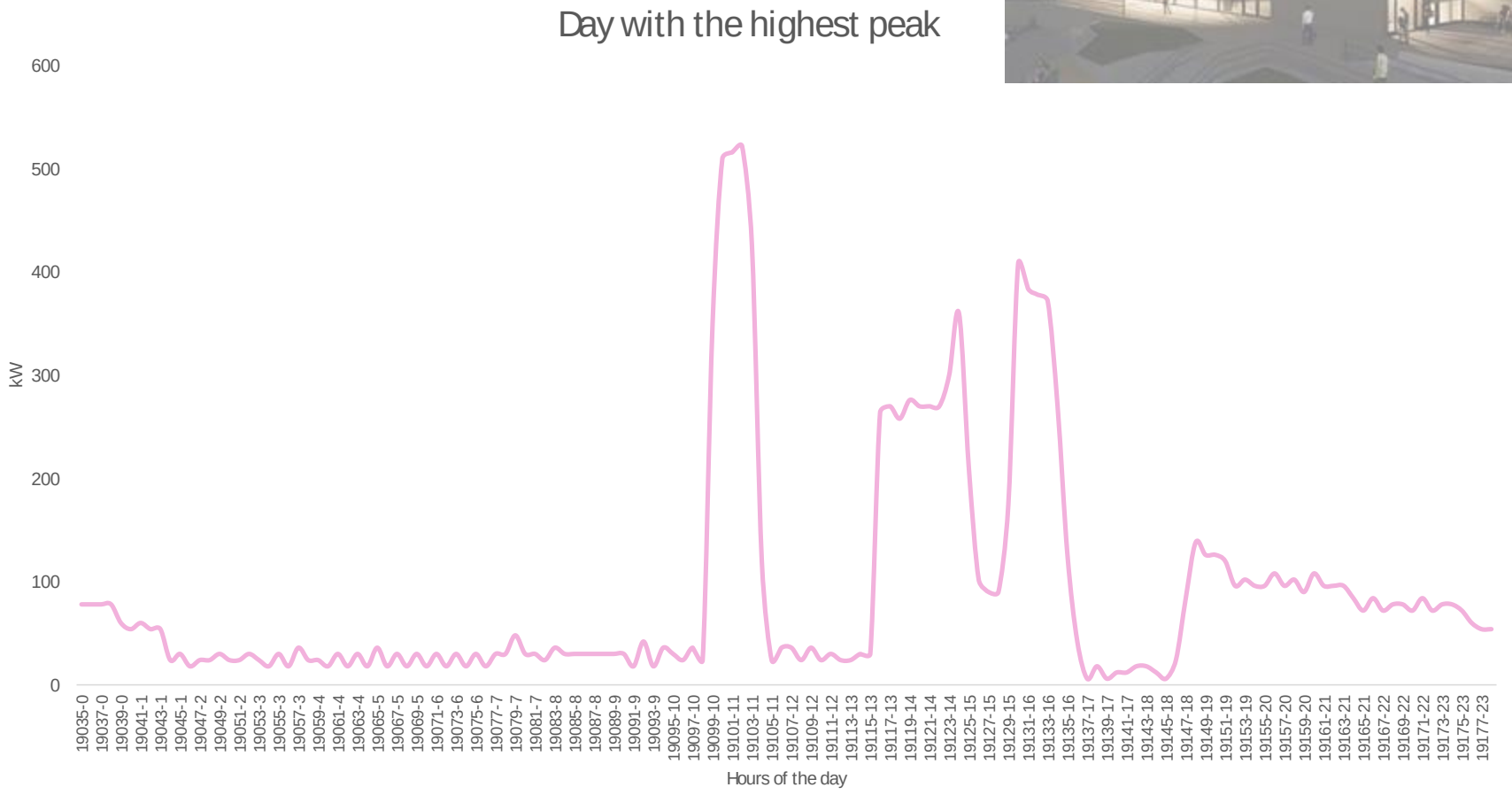
Key Case Study: Tøyenbadet

- Total Area of new building: 15 800 m²
- Max Power Demand: 510 kW (January at 11 AM)
- Grid capacity: 640 kW
- Average Daily Consumption: 2,386 kWh
- Main Equipment in Use: 4 electric excavators, 61 worker huts, lifts, 2 construction cranes
- 87% zero emission, 50% of energy from electricity
- 44% of machine usage zero emission (electric)
- *Data from 2021-09 until 2024-03*



Stovner Bad Case Study

- Total Area of new building: 8 600 m²
- Max Power Demand: 522 kW (October, 11 AM)
- Grid capacity: 640 kW
- Average Daily Consumption: 1,326 kWh
- Main Equipment in Use: 4 electric excavators, 11 worker huts, mobile crane, lifts and construction crane
- 42% zero emission, 42% of energy from electricity
- 38% of machine usage zero emission (electric)
- *Data from 2023-06 until 2024-03*



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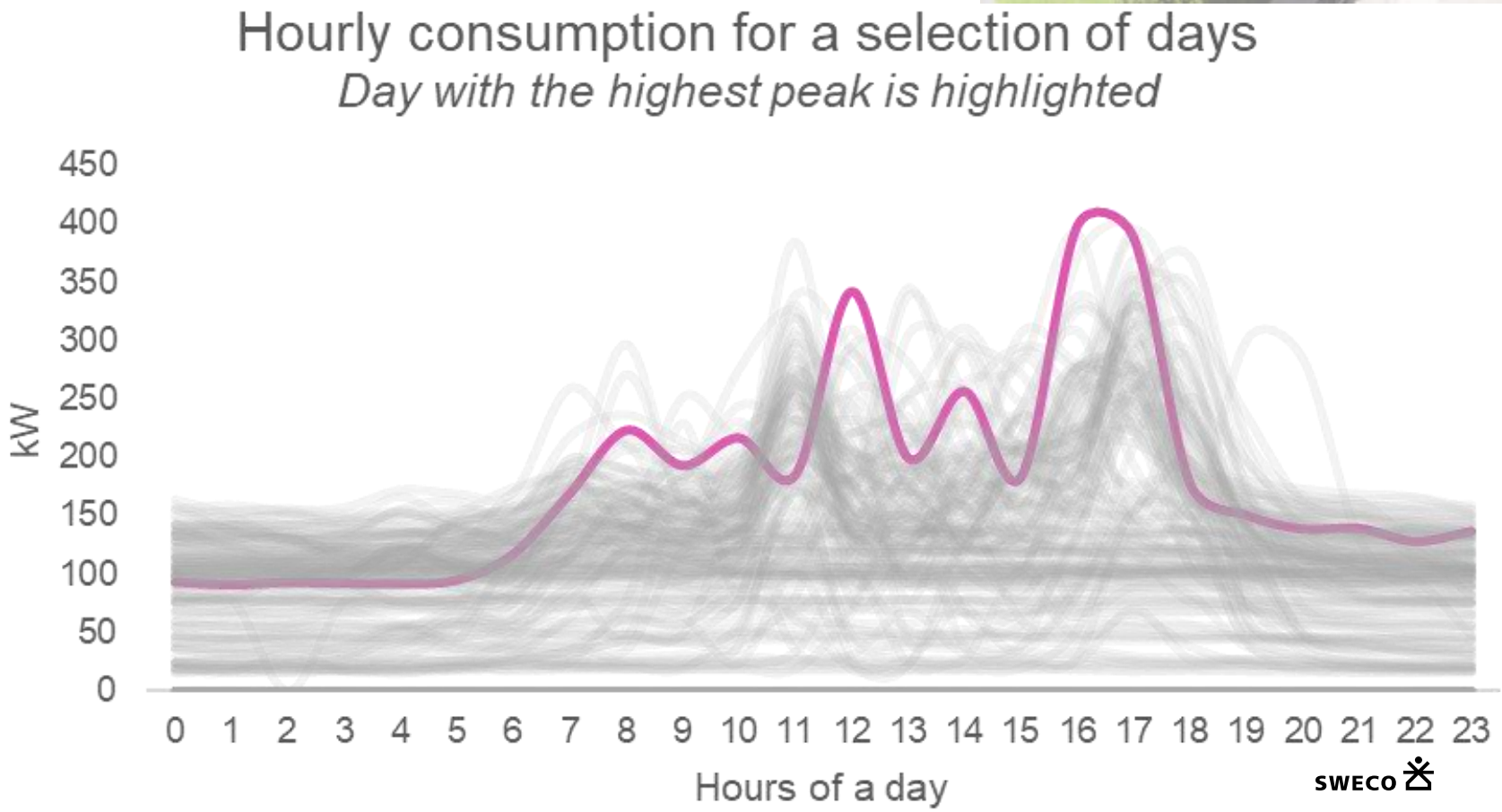
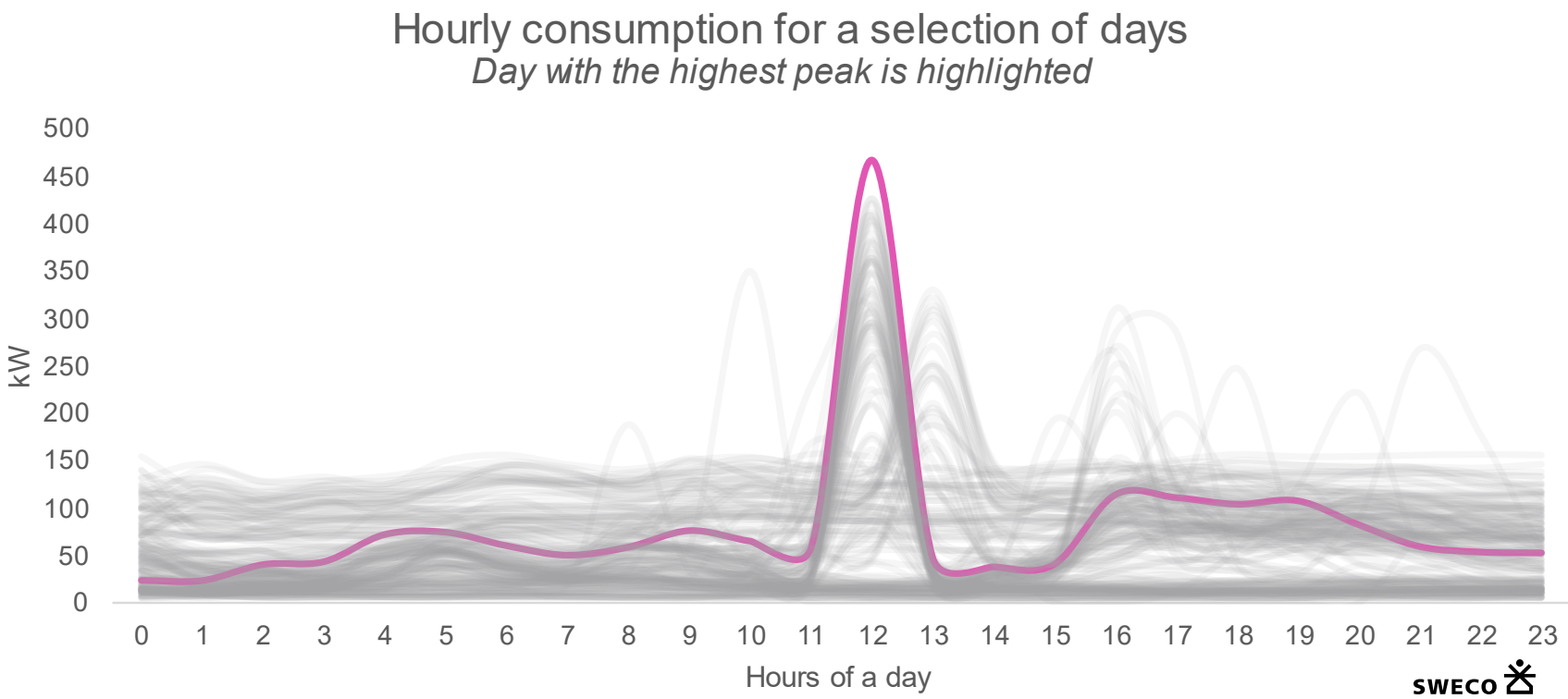
Sophies Minde Case Study

- Total Area of retrofit building: 13 000 m² and 7 100 m² landscaping
- Max Power Demand: 397 kW (January 4 PM)
- Grid capacity: 2 000 kW
- Average Daily Consumption: 2,375 kWh
- Main Equipment in Use: 5 electric excavators, 20 worker huts, and construction cranes
- 100% zero-emission site, 100% of energy from electricity.
- *Data from 2023-08 until 2024-03*



Garnes Ungdomsskule Case Study

- Total Area of new building: 9 300 m² and 1600 m² retrofit
- Max Power Demand: 467 kW (October 12 AM)
- Grid capacity: 640 kW
- Average Daily Consumption: 1,782 kWh
- Main Equipment in Use: 4 electric excavators, 30 worker huts, and 2 construction cranes
- 61% of energy from electricity – *87% if drilling rig was electric*
- 40% of machine usage zero emission (electric) – *79% if drilling rig was electric*
- *Data from 2023-06 until 2024-06*



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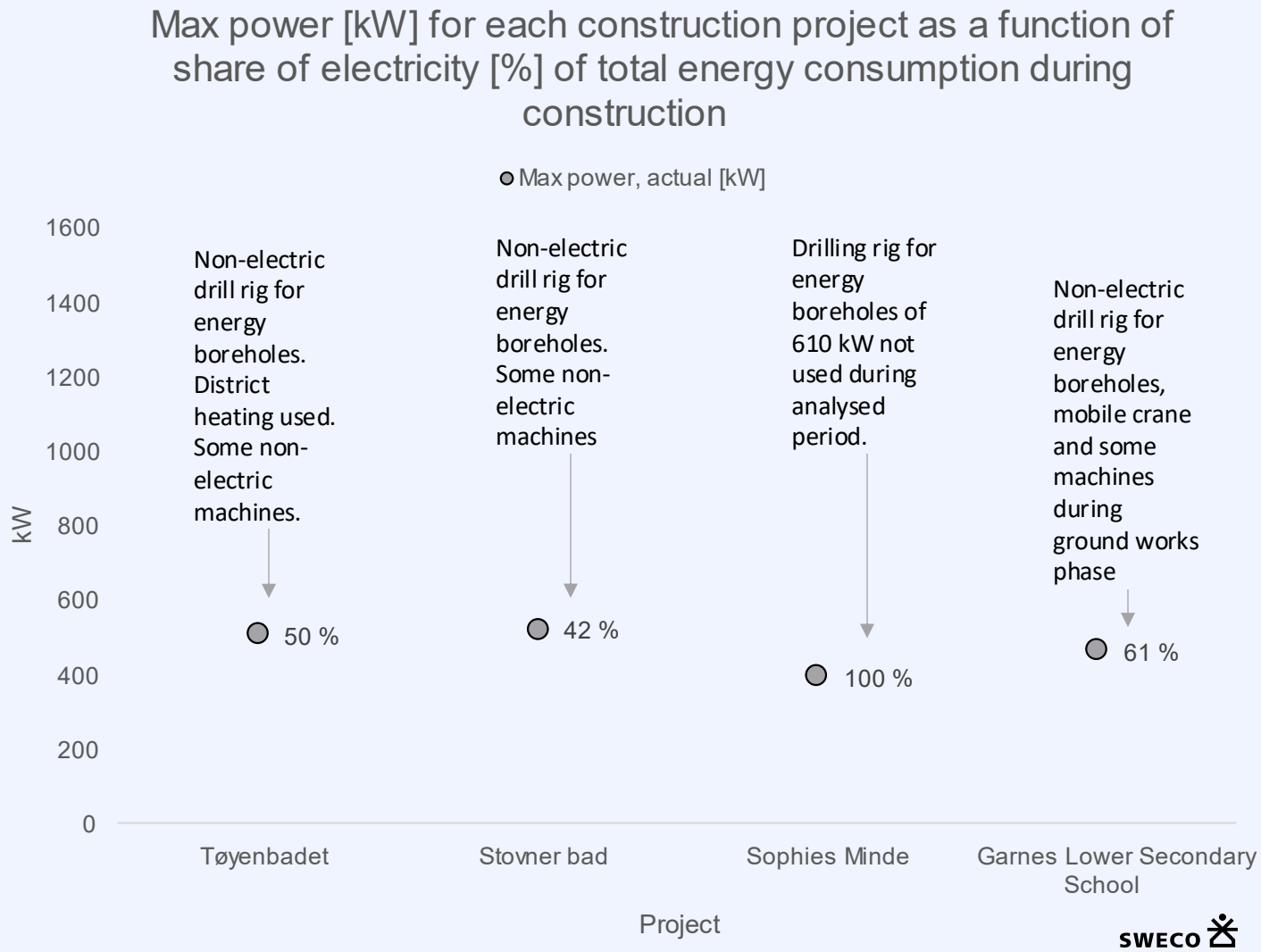
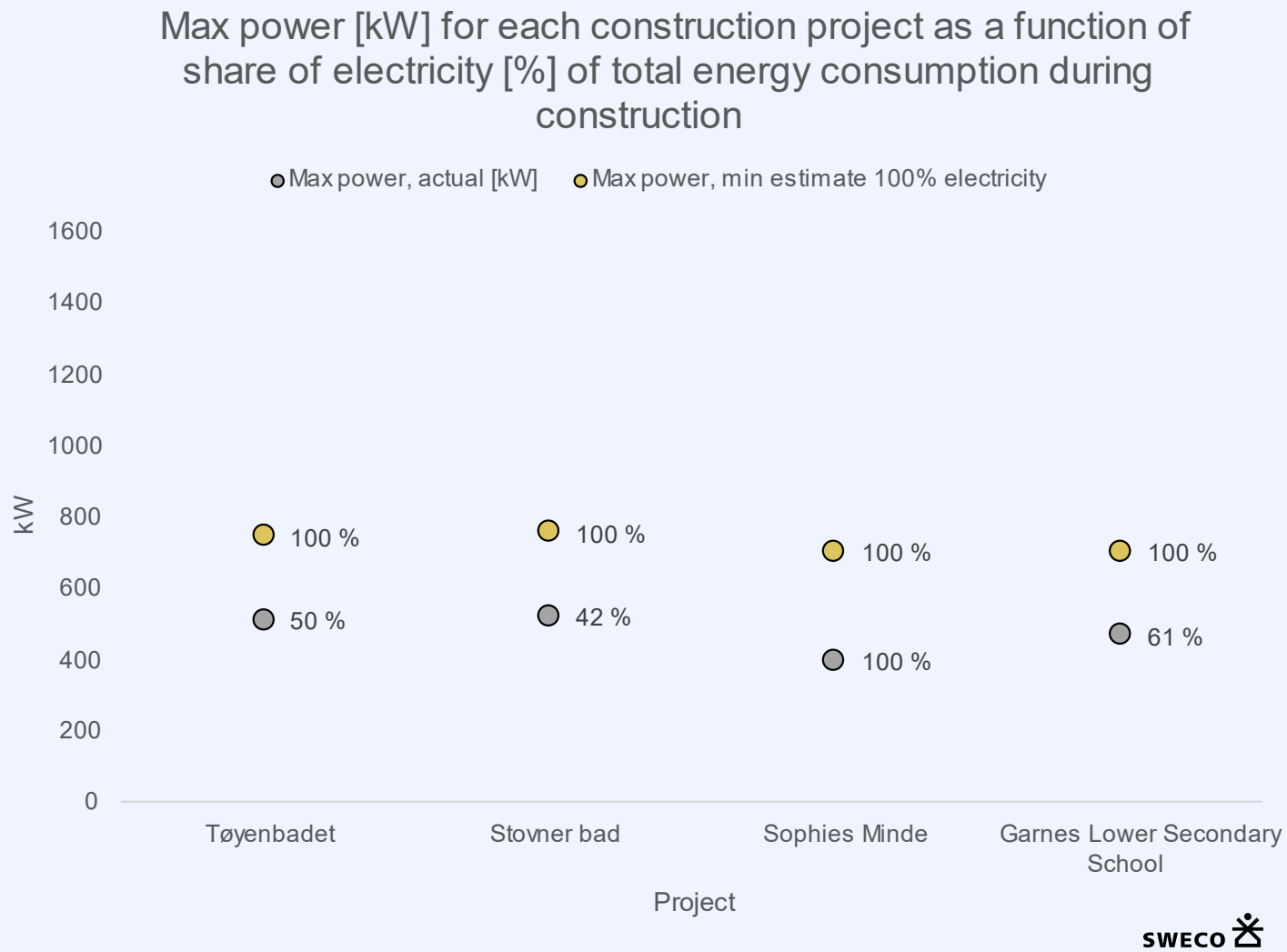
What if zero emission using 100% electricity?

- Sophie Minde only 100 % electric project. But limitied period of the project was analyzed.
- The other projects had a high share of electric energy usage, but started earlier with less available electric machines for some machine categories, mainly some larger excavators, drill rig, mobile crane. Tøyenbadet also had district heating.
- **But what if…?**



What if zero emission using 100% electricity?

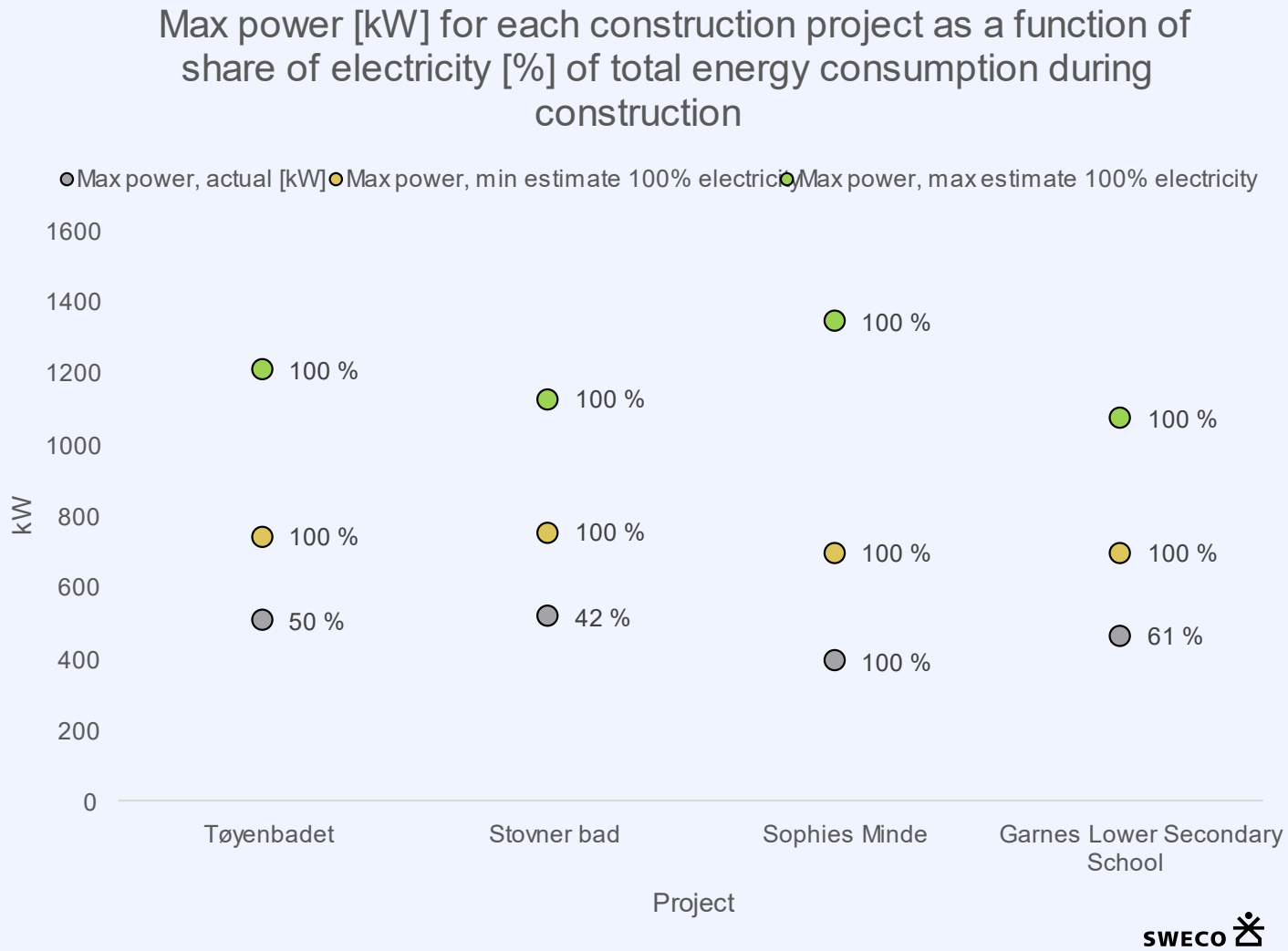
- **Low estimate** using 100% electricity



What if zero emission using 100% electricity?

- **High estimate** using 100% electricity
- For construction projects of these sizes (8600 – 15 800 m^2) **peaks will range between 700-1350 kW**.

- What the maximum peak power will be is complex and will depend on several factors, such as simultaneous usage, load balancing, smart energy control, load utilization factor of machines and equipment, outdoor temperature and more.



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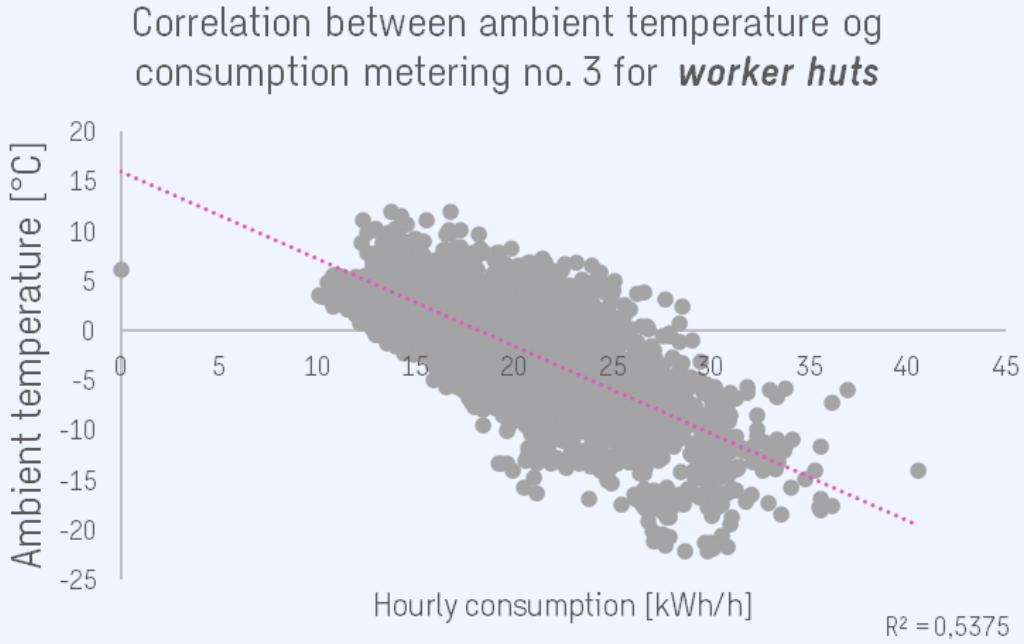
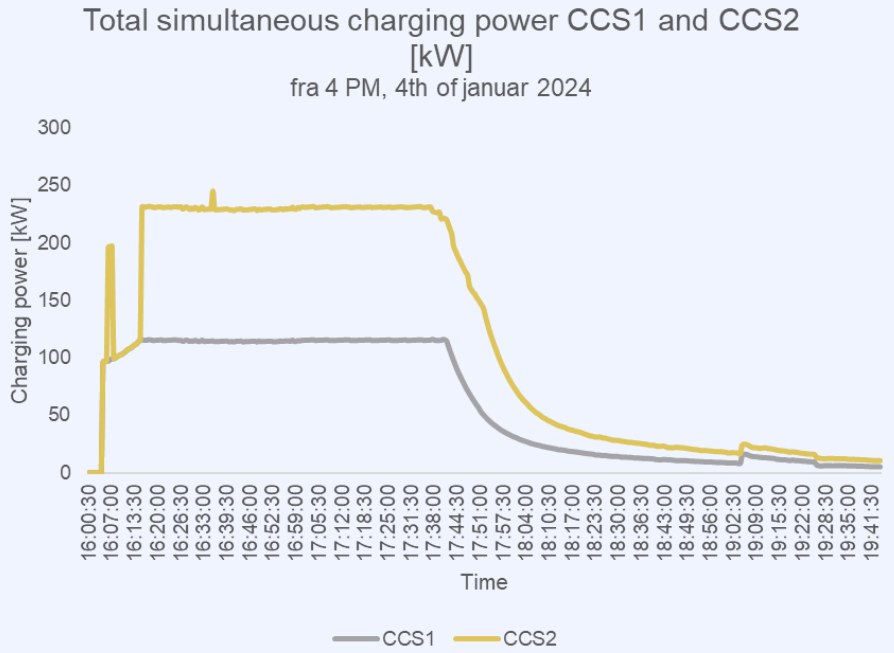
General findings on power demand

- **Time of the day**: Peaks observed during midday due to lunch-time charging and at the end of the workday. Spreading the lunch time out can help reduce the midday peaks and better smart charging will reduce the end-of-the-day peaks.
- **Time of the year**: There is a correlation between ambient temperature and peaks, resulting in extra strain for the grid when it already is under pressure. This is especially true for projects with many worker huts and certainly with lesser energy efficient huts, resulting in a higher base load and increased likelihood of peaks happening during winter.
- Plan for using heat pumps (or district heating if available) for building heating or drying. Make a plan for when to use drilling rig or other very power thirsty machines to avoid high simultaneous usage. This can reduce peak power significantly.





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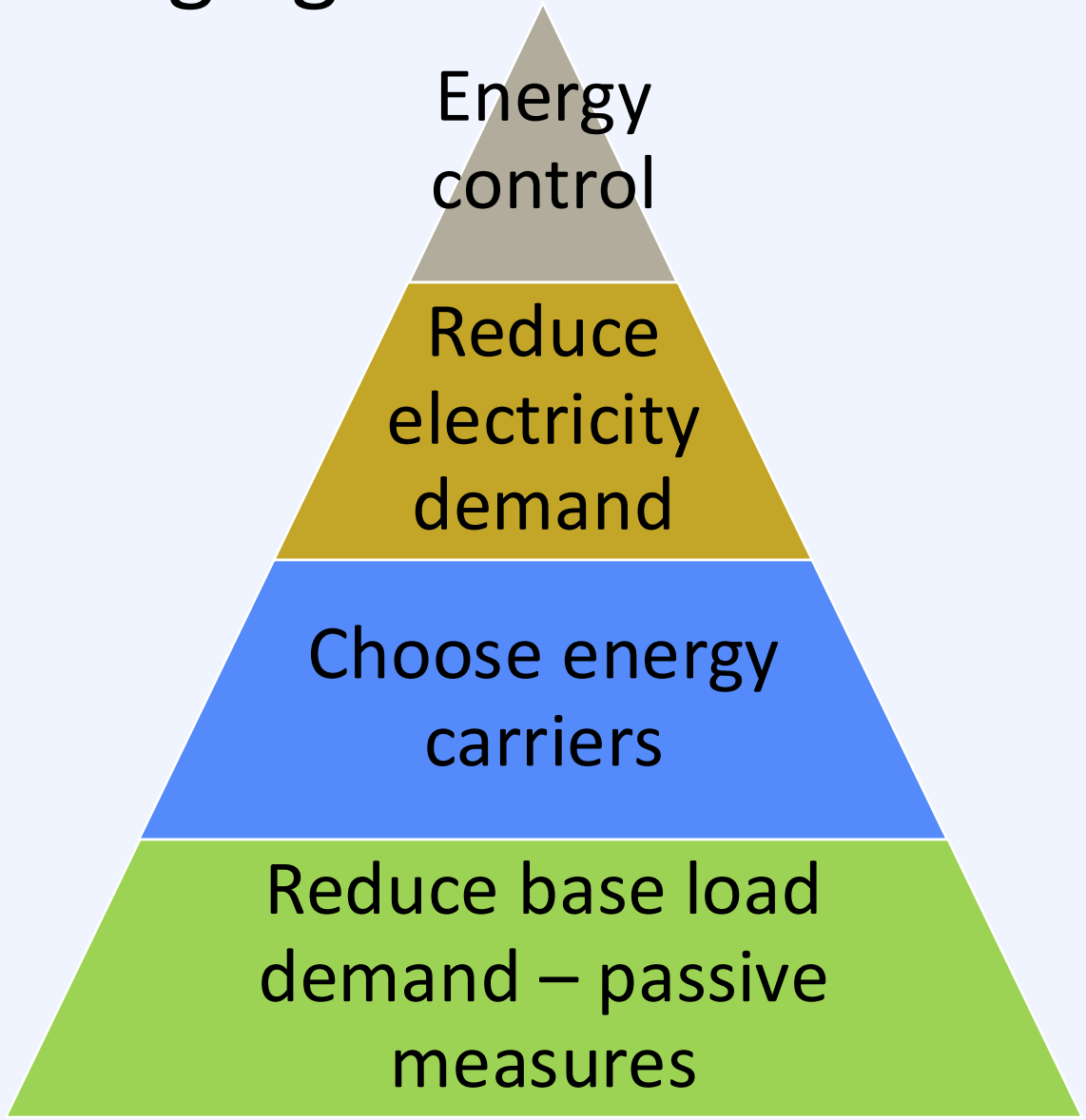
Recommendations for Managing Power Demand

- **Reduce base load** demand using passive measures:
  - Energy efficient worker huts
  - Energy efficient equipment
  - Good planning (reuse of masses), minimize need for digging, logistics
- **Choose energy carriers**
  - Use district heating if available
- **Reduce electricity demand**
  - Use heat pumps for heating / drying
- **Energy control** – reduce peak demand
  - Smart charging / energy control system for the total system
  - Batteries for peak shaving or more machines



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Full report can be found here: https://www.klimaoslo.no/rapport/dagens-effektbehov-pa-bygge-og-anleggsplasser/#:~:text=Sweco%20har%20gjort%20en%20kartlegging,utslippsfrie%20og%20delvis%20utslippsfrie%20prosjekter.