Research Centre on ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

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CENTRE FOR ENVIRONMENT-FRIENDLY ENERGY RESEARCH
The Research Council of Norway

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Analysing electricity demand in neighbourhoods with electricity generation from solar power systems: A case study of a large housing cooperative in Norway

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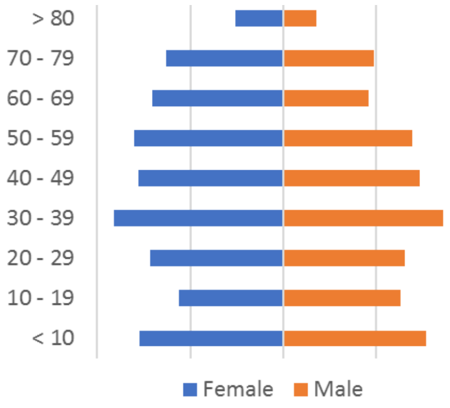
Introduction to the case

How does **electricity generation** from photovoltaic (PV) systems fit with **electricity demand** in a housing cooperative, on an hourly basis?

- Size and location?

Case Risvollan housing cooperative

- Trondheim, Norway, built in the 1970s
- 1000 apartments in 120 building blocks (94 000 m^2 heated floor area)
- Energy infrastructure
  - District heating 139 kWh/m^2
  - Electricity 57 kWh/m^2



Method – Simulation of PV generation

- PVsyst simulation for two orientations
  - Rooftop
    - 15° tilt orientated east – west
    - 754 kWh/kW_p
  - Building façades
    - 90° tilt orientated south
    - 800 kWh/kW_p
- 2018-climate data from eKlima
- Hourly PV generation from PV systems
  - Rooftop: 50, 100, 500, 1 000, 2 000 kW_p
  - Façade: 50, 100, 500 kW_p

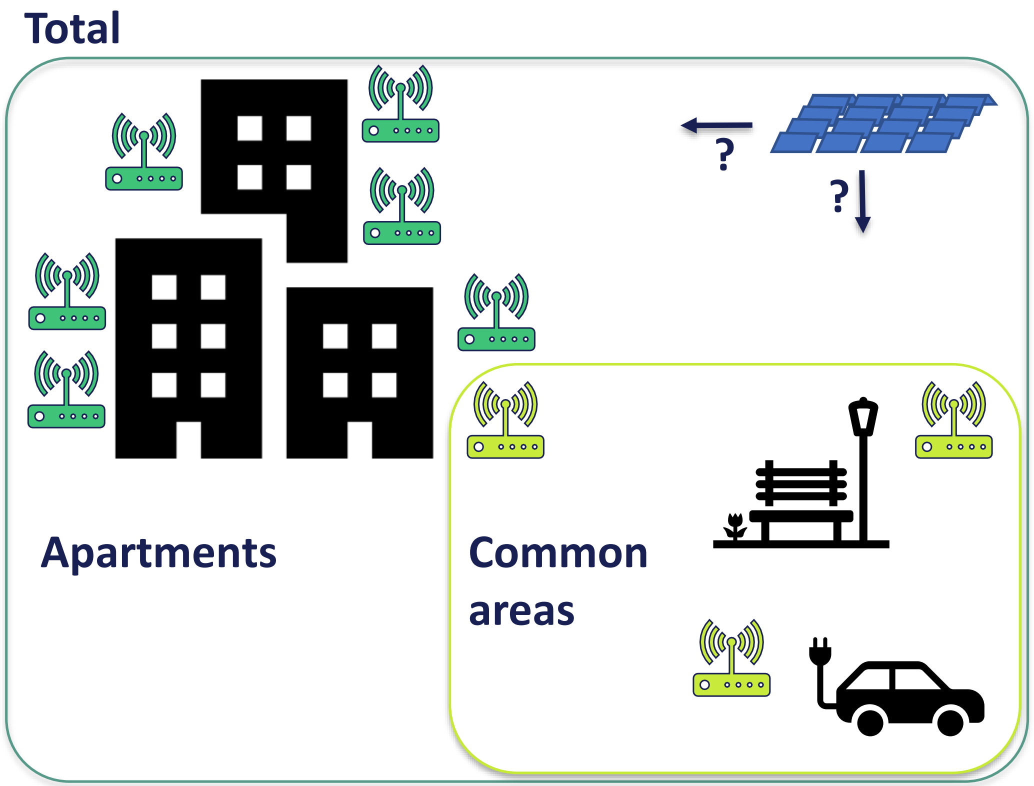
Self-consumption of PV-generated electricity

In Norway:

- Prosumer agreement - Normally financially beneficial to maximise self-consumption
  - Electricity generated behind an AMS-meter can be used directly
- Self-consumption factor is therefore important when evaluating results

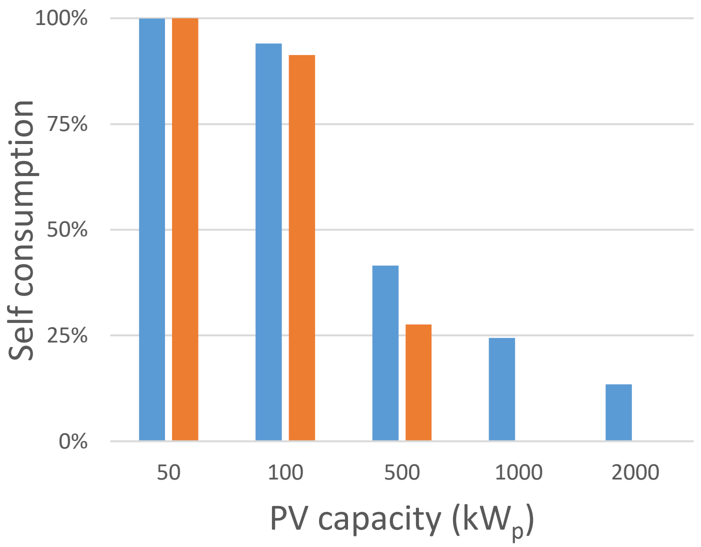
- Several AMS-meters in a housing cooperative
  - Every apartment has an AMS-meter
  - Housing cooperatives normally have several AMS-meters
- Location of AMS-meters affects self-consumption factor

Electricity demand in common areas versus total

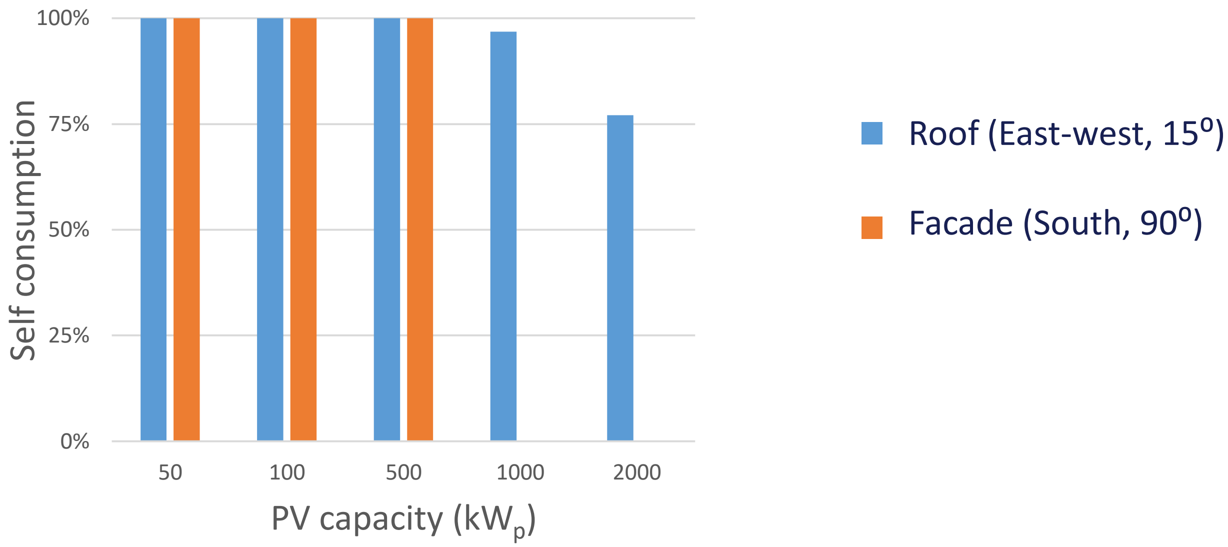


- Common areas
  - Street lighting
  - Lighting in hallway of apartment blocks
  - Lighting in garage
  - Automatic gates in garage
  - EV charging
- Total
  - Individual aparatments
  - Common areas

Results: Self-consumption



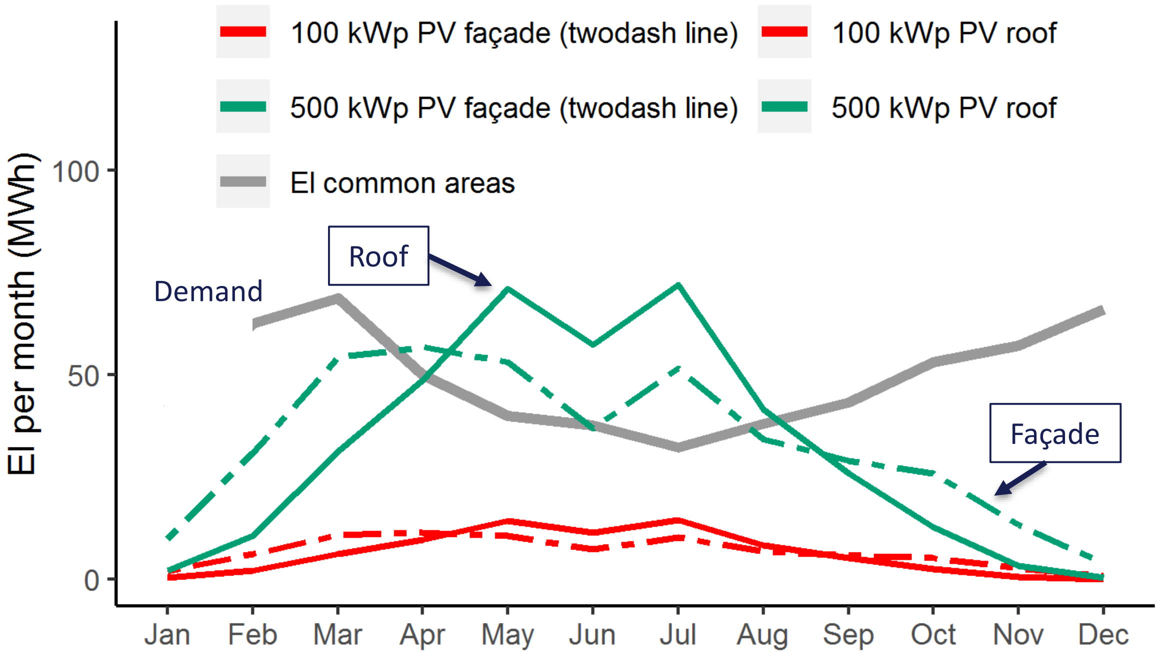
Common areas
electricity demand
(576 MWh/yr)



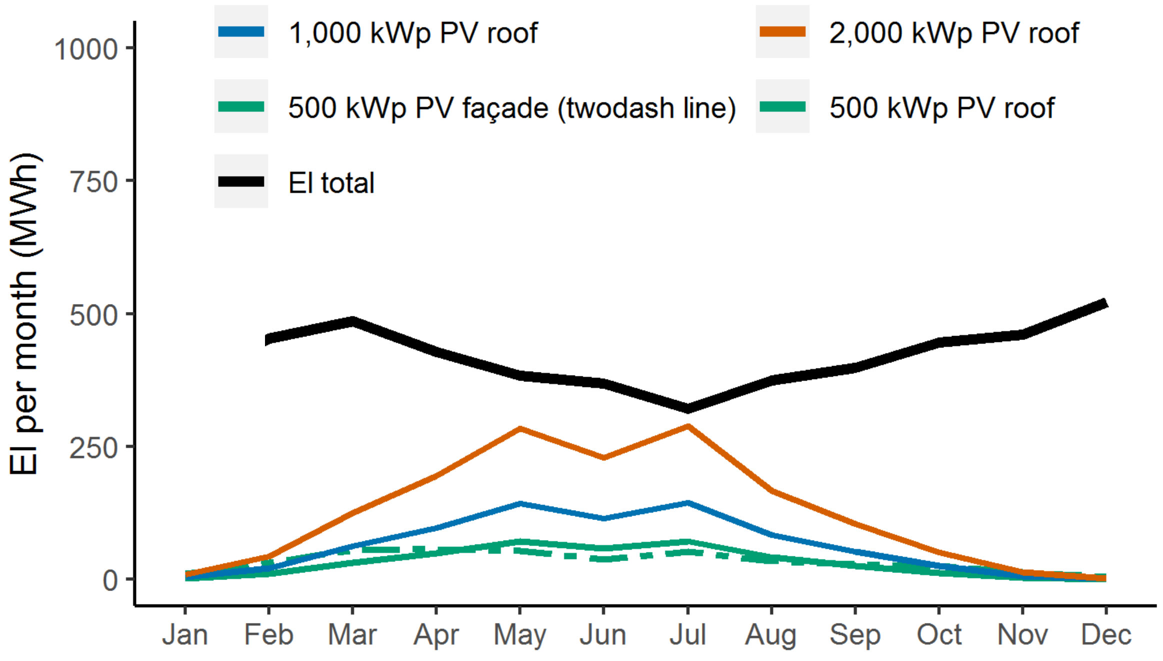
Total
electricity demand
(4,977 MWh/yr)

Monthly electricity load and PV generation

Common areas



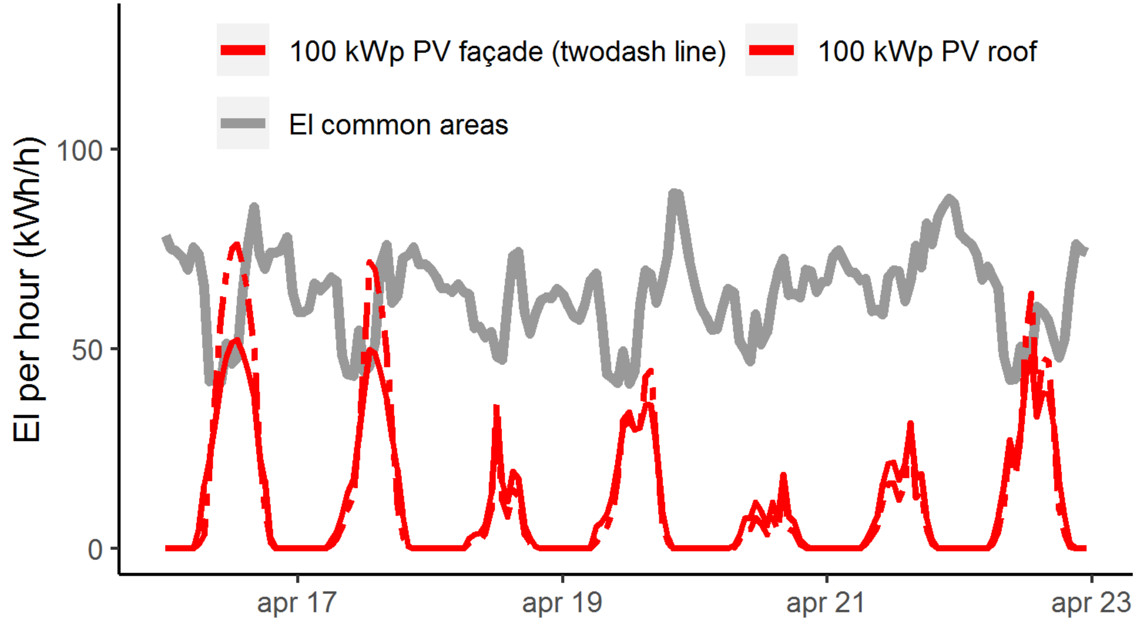
Total



- South oriented façade-placed systems generate more electricity during swing seasons, compared to east-west oriented rooftop systems, but have a lower electricity generation during the summer

Example week April, hourly load and generation

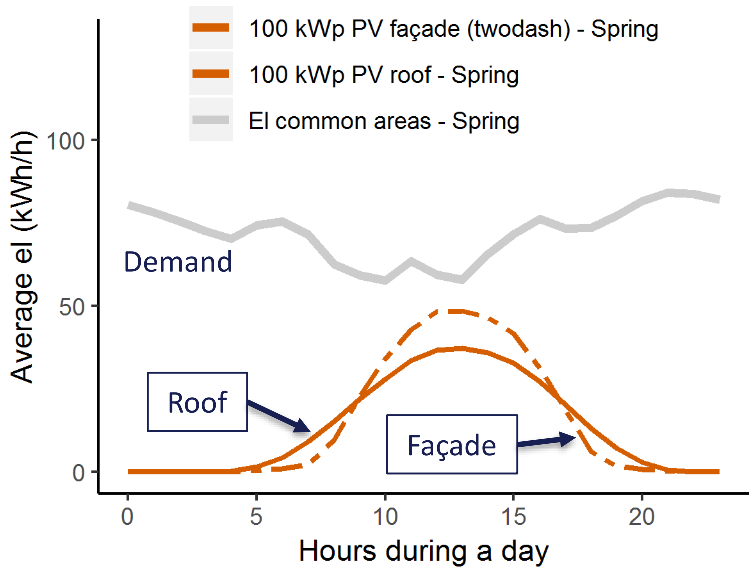
Common areas



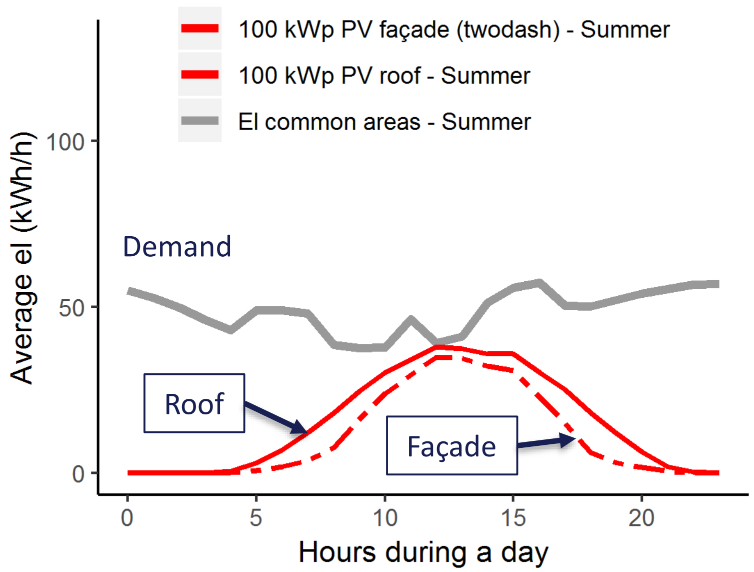
Daily average electricity profiles

Common areas

Spring



Summer



- East-west oriented rooftop systems generate more electricity early and late during the day, but less mid-day during the swing season, compared to south oriented façade-placed systems

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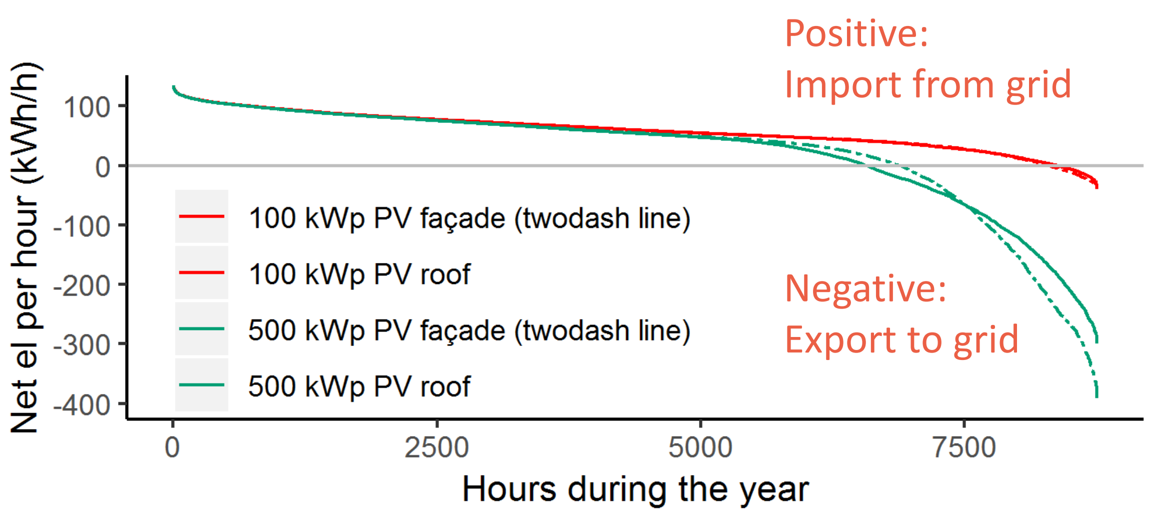
Hourly net electric load duration curves

Common areas



- The export increases, if the PV system is large compared to the electricity demand

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PV system configuration

PV system tilt	Spring	Summer	Autumn	Winter	Annual
Façades (90º)	+		+	+	Generates about 5-6% more
Rooftop (15º)		+			

PV system orientation	Morning	Mid-day	Afternoon
Façades (south)		+	
Rooftop (east-west)	+		+

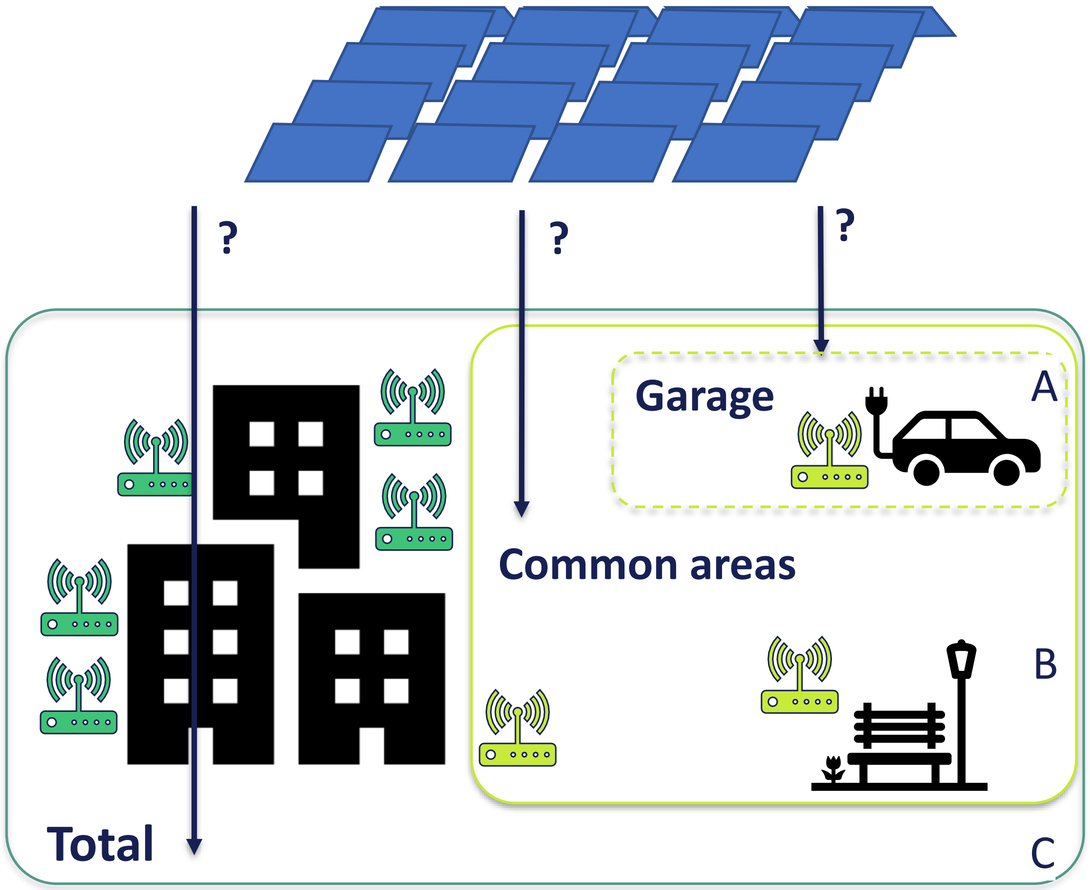
Practical considerations:

- Limited suitable areas available on façades. Roofs are more available

Conclusion

- A combination of PV systems on the roofs and façades seem advisable

Economic analysis



PV plant

1 100 kW_p PV

(equal to 50 kW_p on each of the 22 garages)

Cases

A: 22 PV plants to 22 garages

B: 1 PV plant to common areas

C: 1 PV plant to total Risvollan (apartments and common areas)

Assumptions

price buy: 1.0 NOK/kWh

price sell: 0.5 NOK/kWh

Results of economic analysis

		Self-consumption	Total annual value	Comment
A:	22 PV plants, electricity used in **22 garages**	14.3%	475 kNOK	Possible today
B:	1 PV plant, electricity used in **common areas**	22.6%	508 kNOK	7% higher
C:	1 PV plant, electricity used in **total Risvollan** (apartments and common areas)	95%	808 kNOK	70% higher

Conclusion

- Case study
  - Analysing how PV production matches electricity use for a housing cooperative of 1,058 apartments

- Economic results
  - Financial beneficial to use PV electricity locally for total Risvollan (both common areas and apartments)
  - For this to be possible, also housing cooperatives must be facilitated for in the prosumer agreement

- Size and type of PV plant
  - For the total housing cooperative, a PV capacity of about 1000 kW_p seem suitable, roof-mounted, east-west oriented
  - Gives a self-consumption factor of 97% based on 2018 data

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