

UNIVERSITY OF OSLO

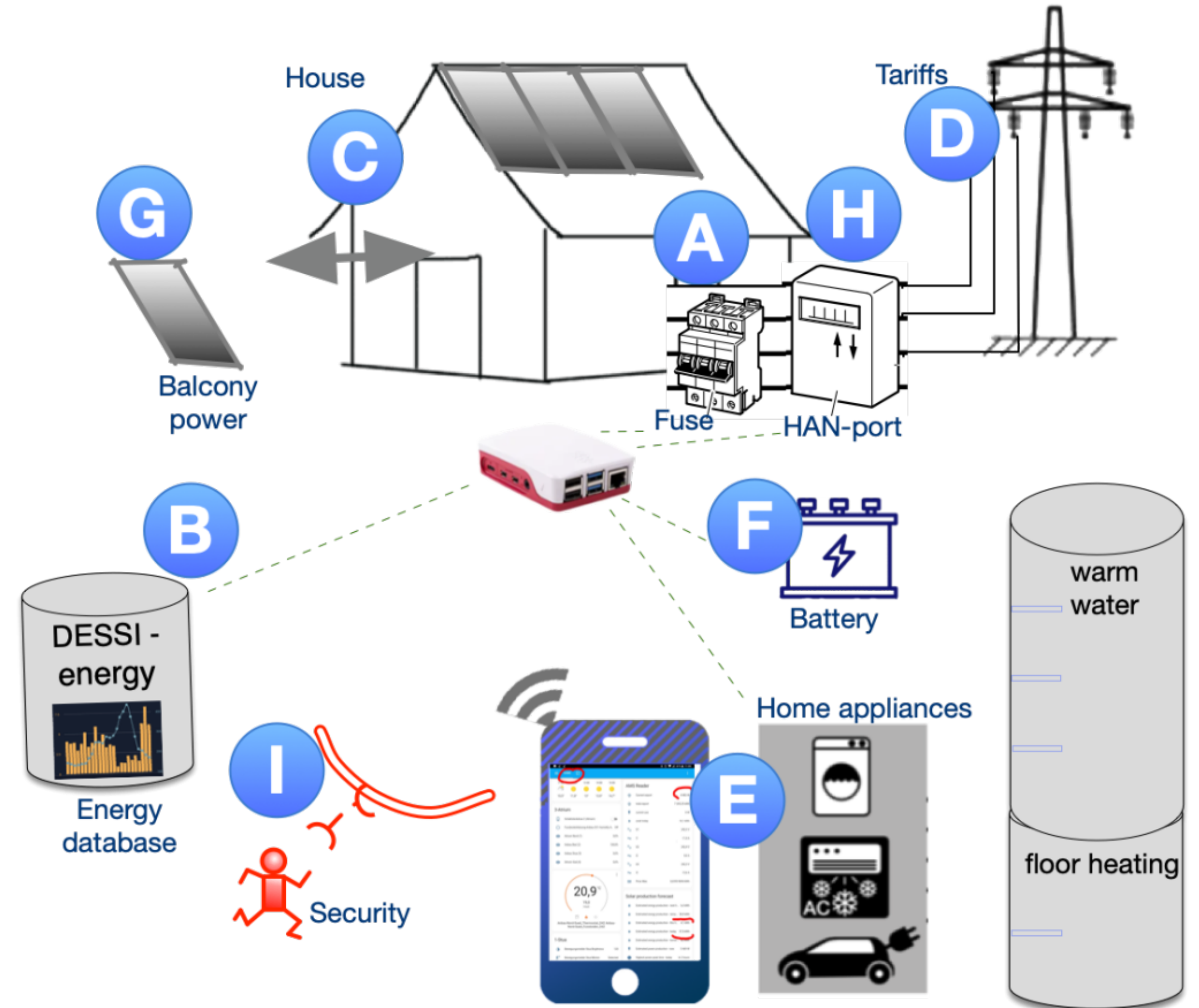
DTU visit UiO, 3Apr2025

Residual Buildings contributing to the Energy Transition

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Challenges in the Transition towards Electrical Energy (Nordic)

- ➔ Municipality goals
 - new businesses
 - transition to electrical energy (“fit for 55”)
- ➔ Grid capacity is limited
 - dominated by winter at -20 deg
 - added 30% reserve
- ➔ Grid extension is costly
 - new lines, new transformers
 - typical building time 7-14 years
- ➔ How can municipalities & residual buildings contribute?

Request from Municipalities

- 1



how much energy is produced?
 - solar, hydro, wind
 - fuels
 - total
- 2



what is the potential of renewables?
- 3



Barriers for adoption?
 - how can the municipality contribute?

National framework

- ➔ Assessment of potential
- ➔ Miljødirektoratet
 - 85 climate actions towards 2023
 - increase with $\sim 30\%$ (38 TWh)
- ➔ Today: Oslo & Akershus
 - 1,2 TWh/year
 - 86% hydro, 4% sun, 10% heat
- ➔ Demand gap
 - 16 TWh (962 GWh higher consumption)

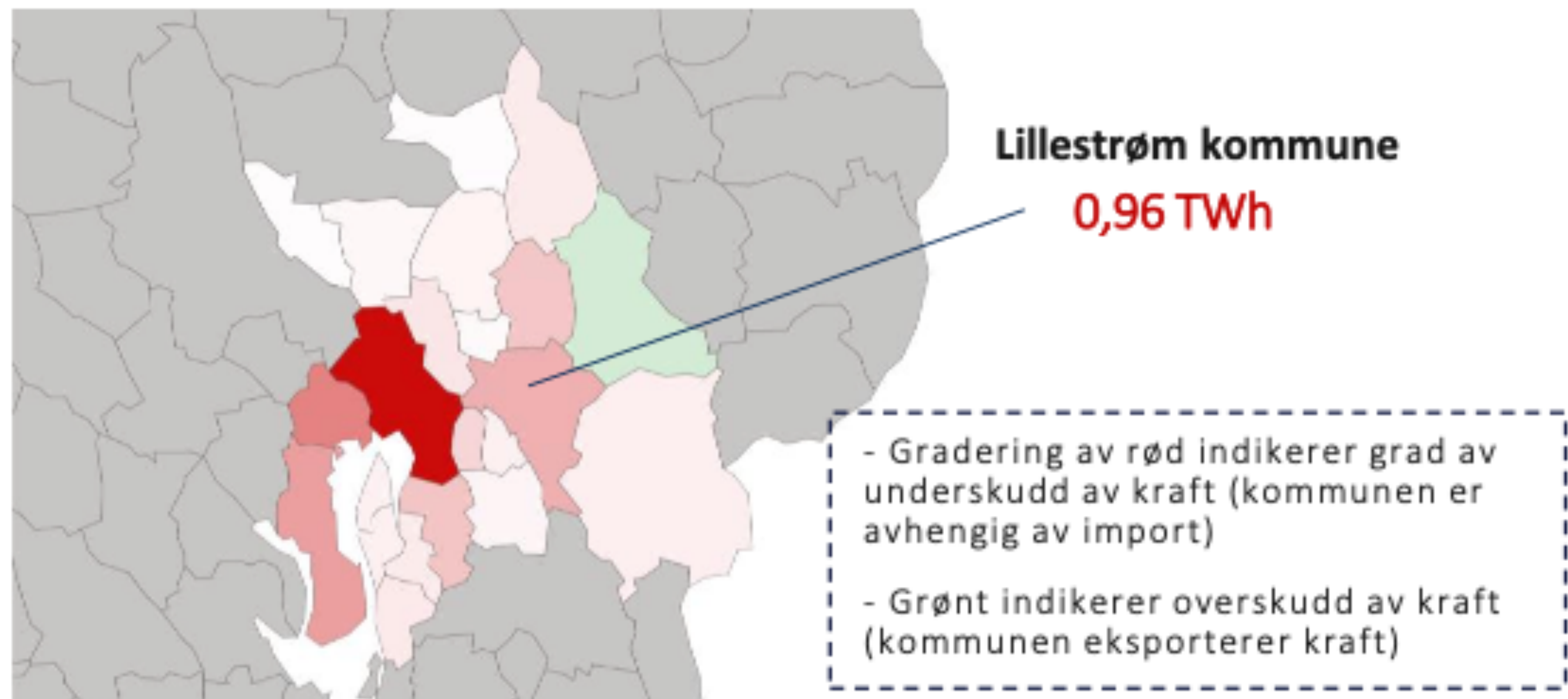


[Akershus Energi, "Muligheter for utslippsfri kraftproduksjon i Lillestrøm kommune", Apr2024]

Potential for new energy

- ➔ More production
- ➔ Efficient use
- ➔ Peak & consumption shaving
 - residential houses
- ➔ Storage
 - battery, thermal storage

Kart over kraftbalansen per kommune 2022

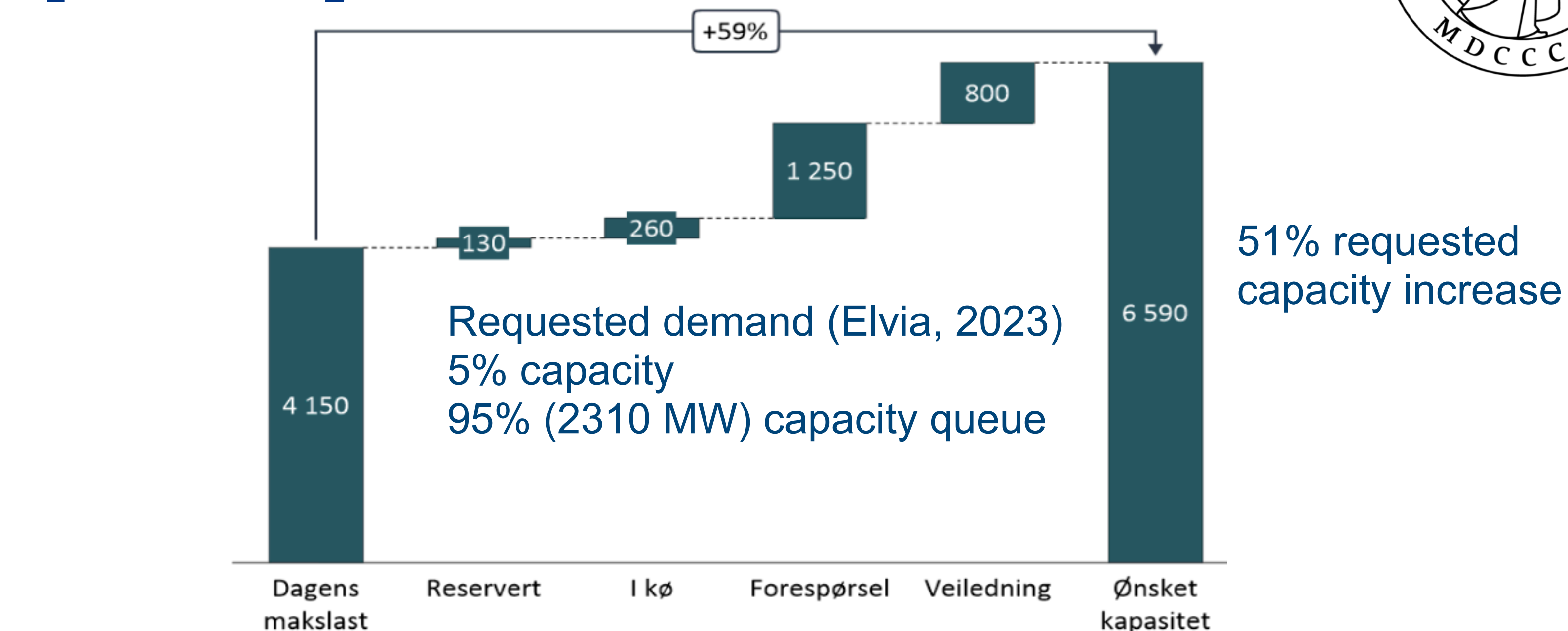


[Kraftløftet Oslo & Akershus (LO & NHO, 2023)]

Limited Grid-capacity

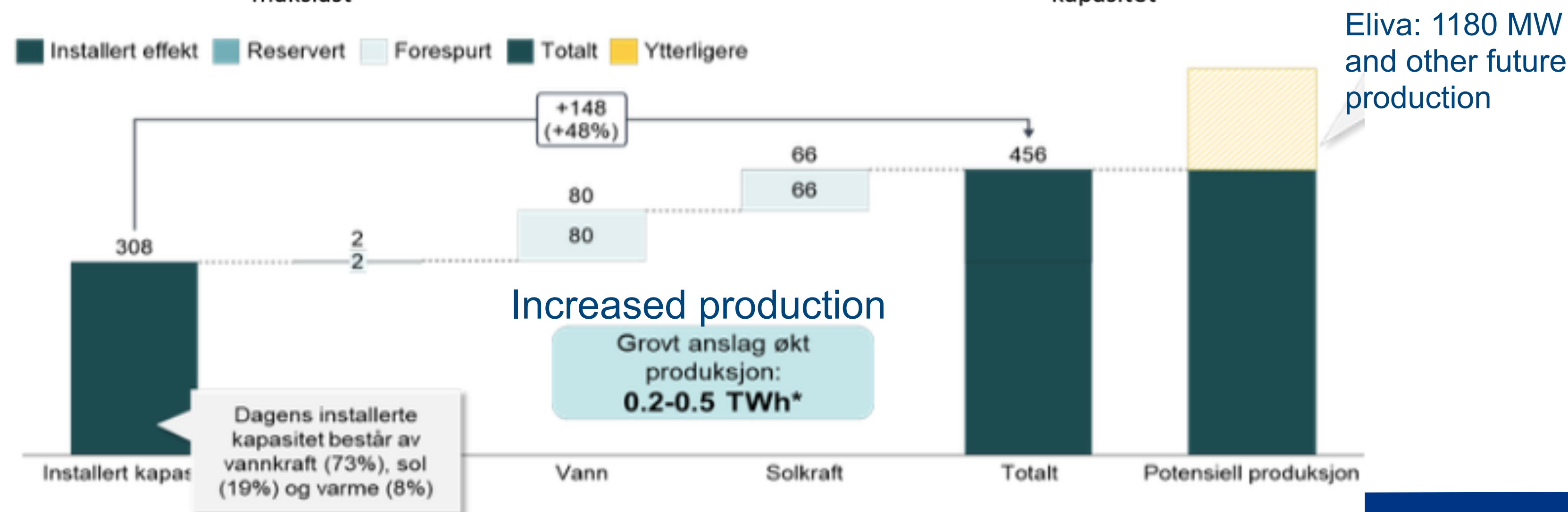
[SSB, <http://ssb.no/stabank/table/10314/>]

→ “No capacity for new usage in Oslo, Østfold and Akershus until 2030-2035”



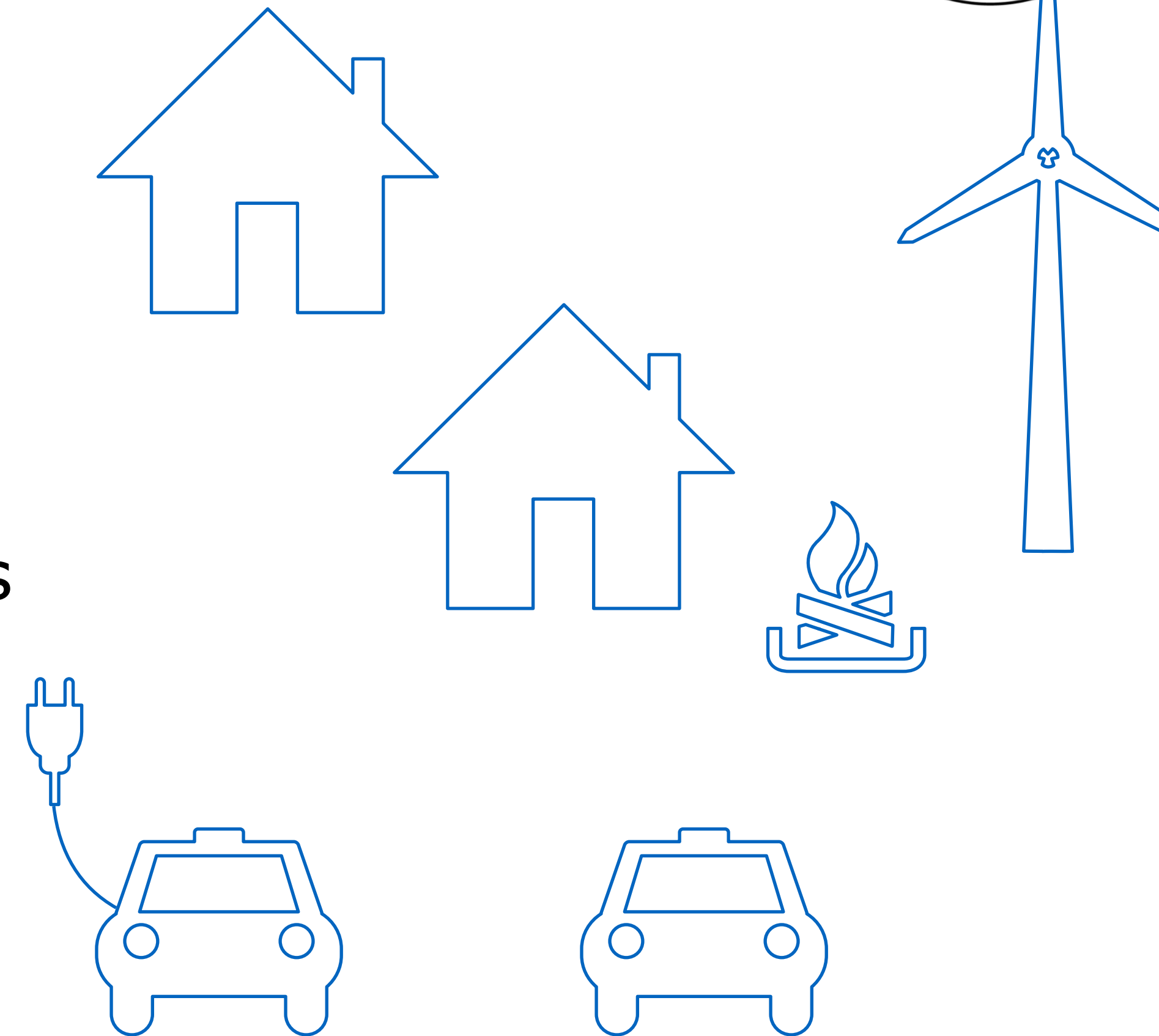
[Kraftløftet Oslo Akershus, LO & NHO, 2023]

→ Green business development?



Steering the load

- Upgrade of lines & transformers
 - too long to wait
- Renewable, example Lillestrøm
 - 241 buildings, 19 swimming pools, 750 car chargers
 - "Municipality as a battery"
- Residential houses
 - car charging, heat pump & hot water
 - storage (V2G, battery, thermal)



Energy Control

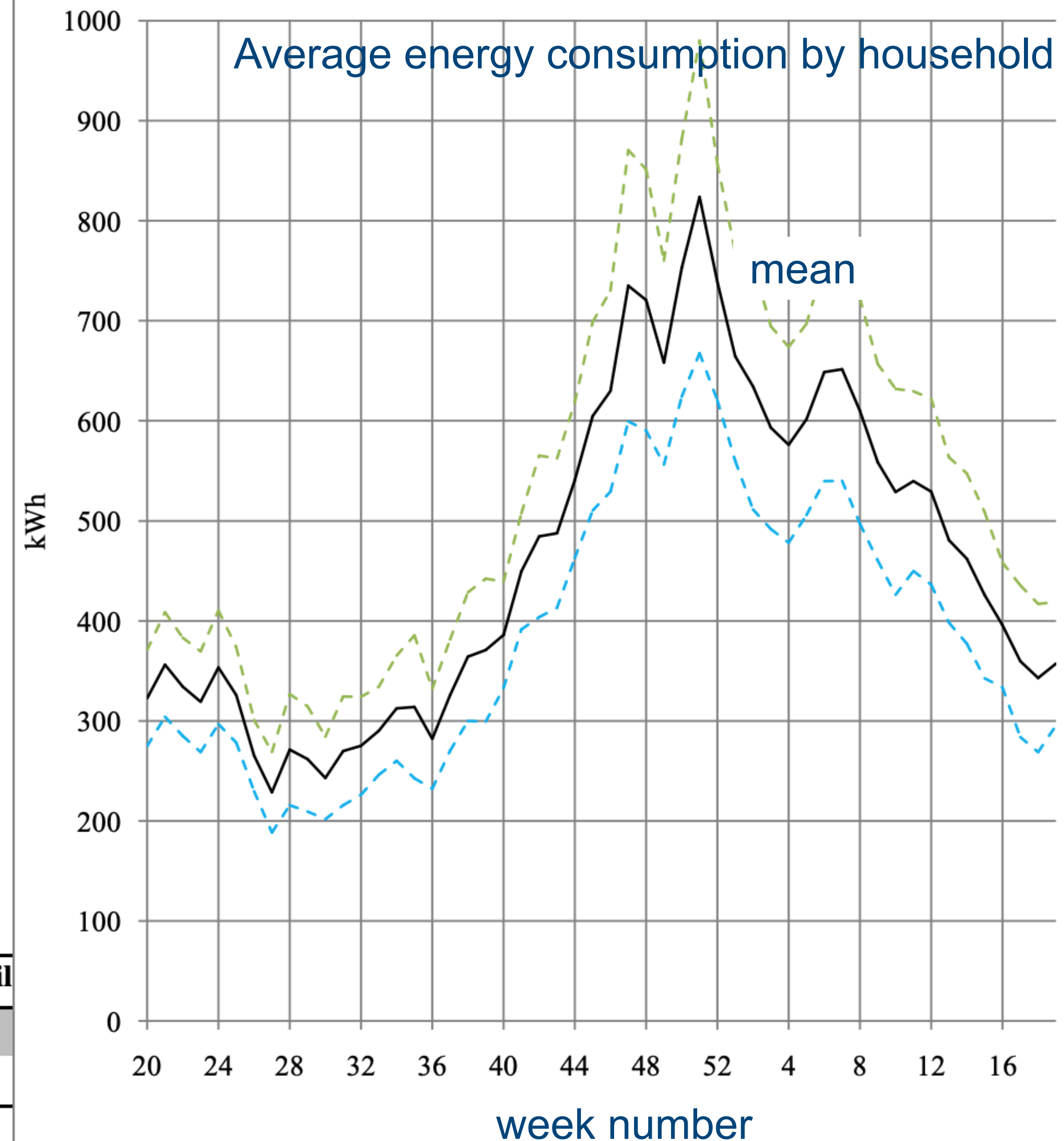
Electricity variability

- Strong variation during the year
 - heating with electricity



Monthly mean temperature Ørlandet

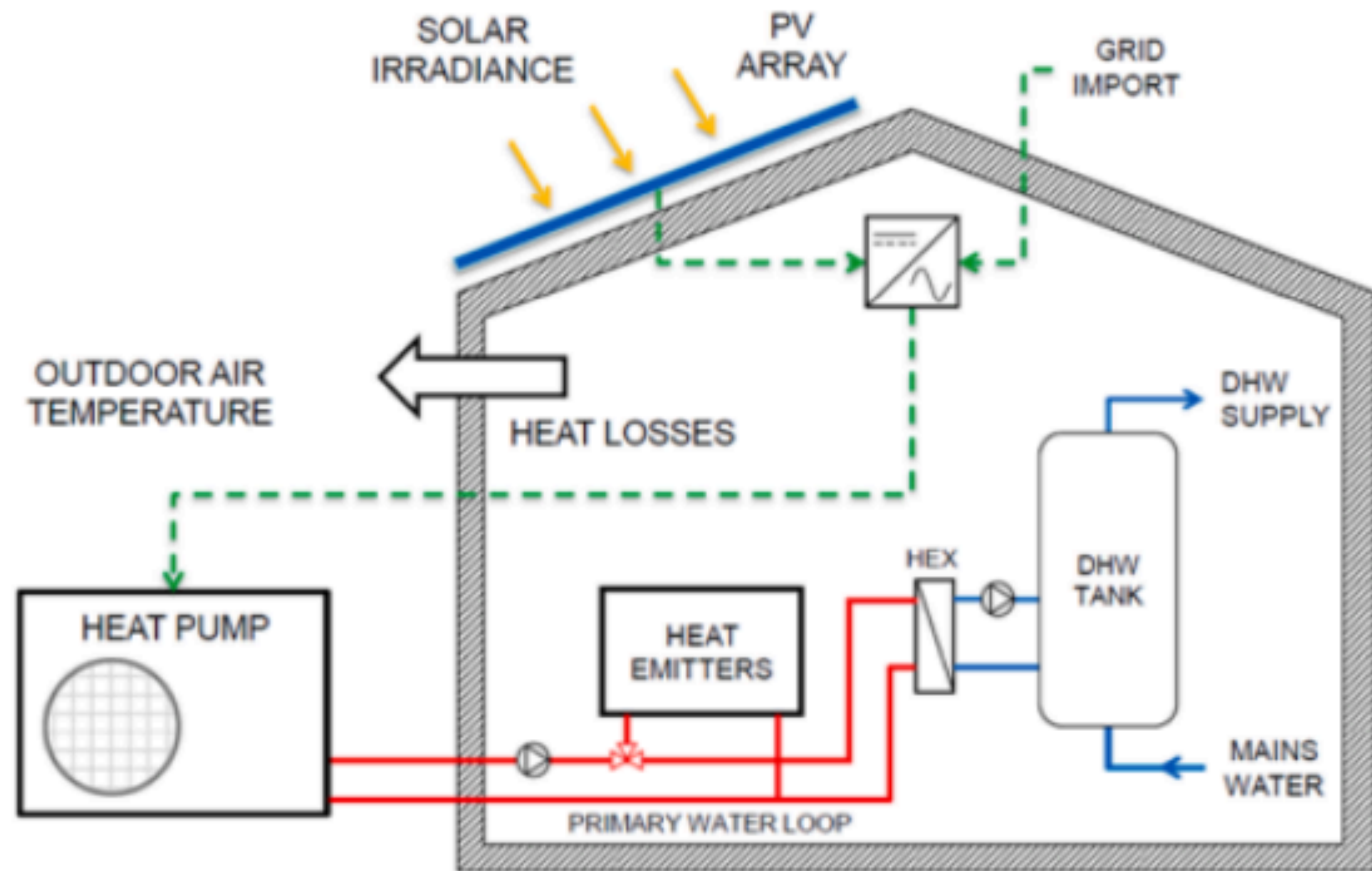
Måned	Mai	Juni	Juli	Aug	Sept	Okt	Nov	Des	Jan	Feb	Mars	April
Middel, °C	7,7	10,1	14,4	14,2	10,6	7,6	-1	-3,7	1,6	-0,5	2,1	7,2
Normalår, °C	8,7	11,4	12,7	12,9	9,9	6,9	2,6	0,5	-0,7	-0,3	1,4	4,1



<https://www.sintef.no/globalassets/project/eldek/publisering/stromforbruk-i-norske-husholdninger.pdf>

energy.jnoll.net > E-ApplianceControl

- ➔ Solar production 16 kW peak
- ➔ Heat pump (hot water & floor heating)
 - optimise after costs vs convenience
 - shifting of energy demand
 - el. car charger
 - all other appliances
- ➔ Raspberry Pi with Home Assistant
- ➔ AMS reader (MQTT)
- ➔ Schneider Electric Fuse monitor



MSc Thesis by Eirik Fagerbakke:

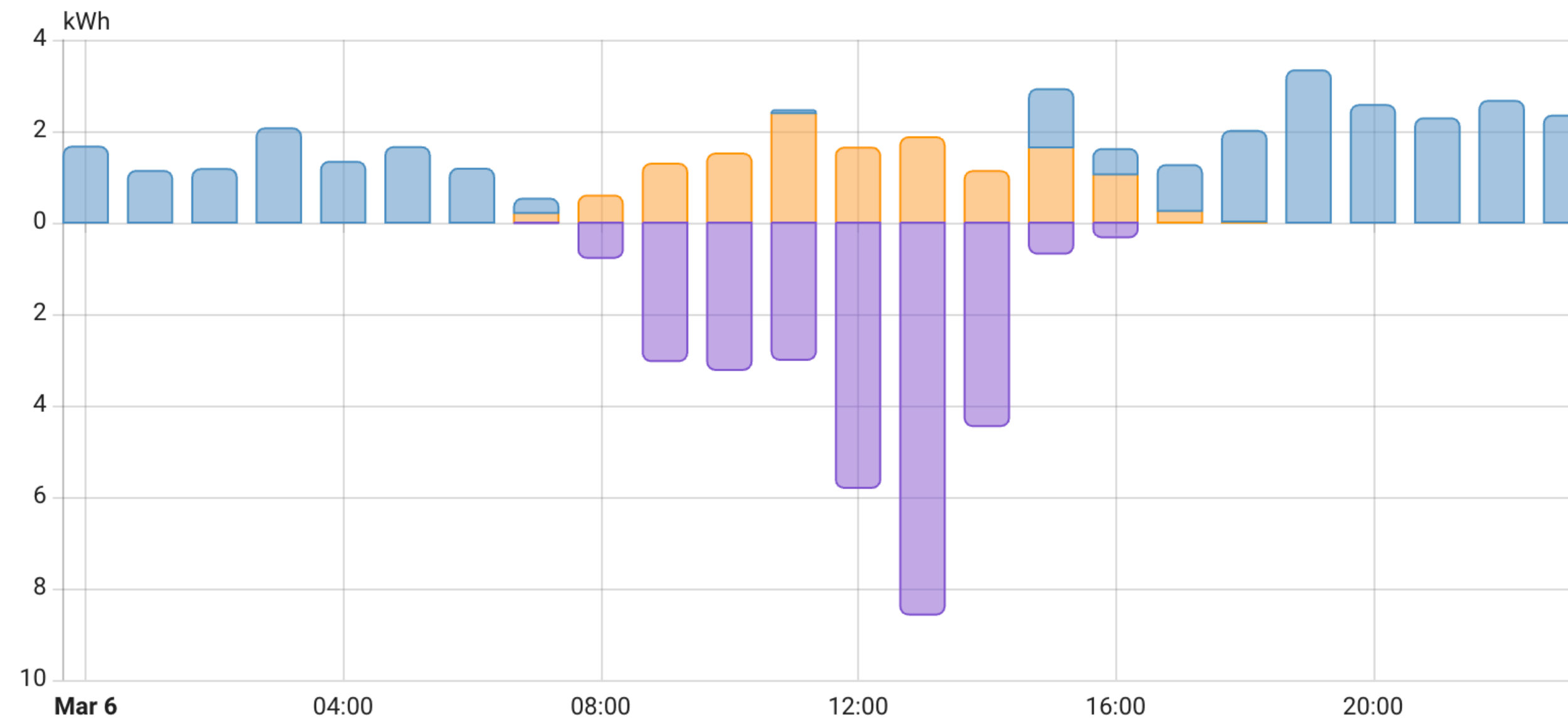
https://its-wiki.no/wiki/Improving_the_grid_through_decentralised_production_and_control

6 Mar 2025

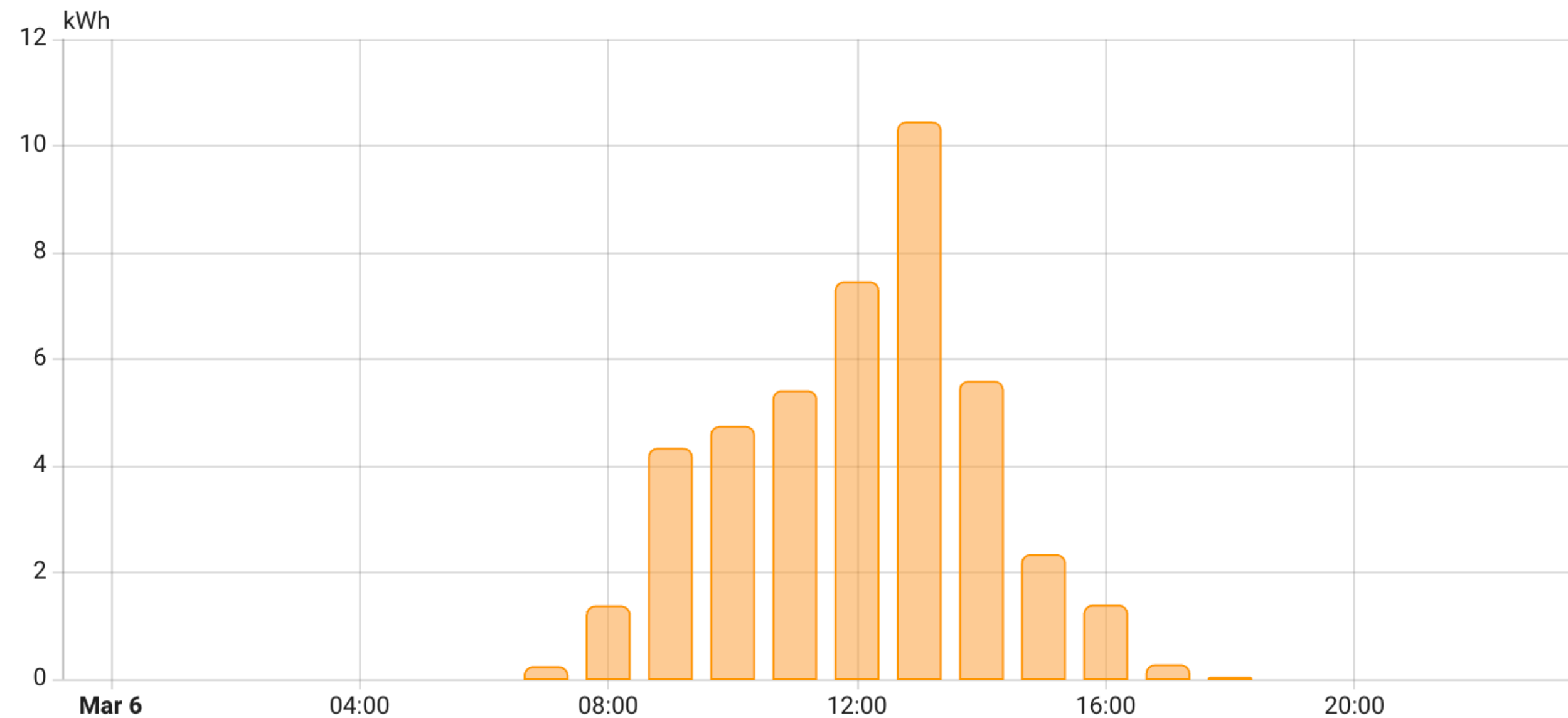
→ typical situation

- 31% self consumed
- 43,5 kWh produced (orange)
- 29,9 kWh to the grid (pink)

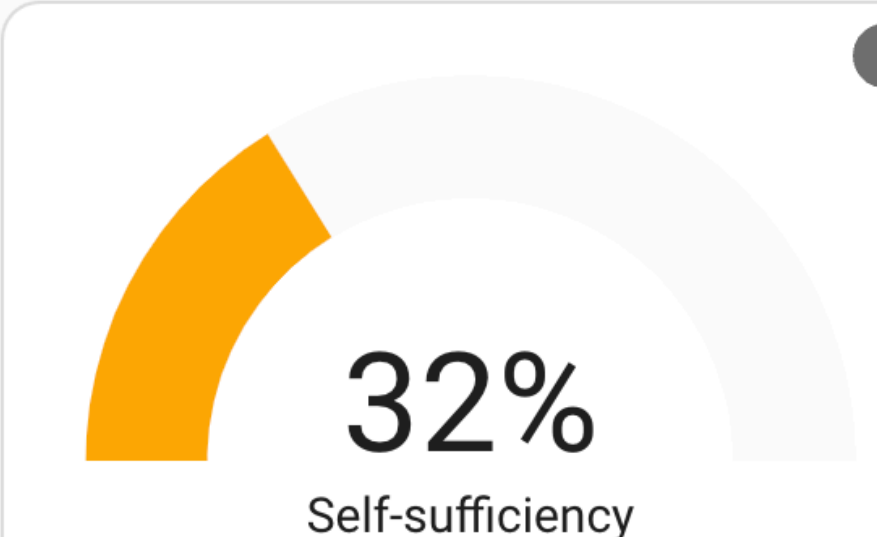
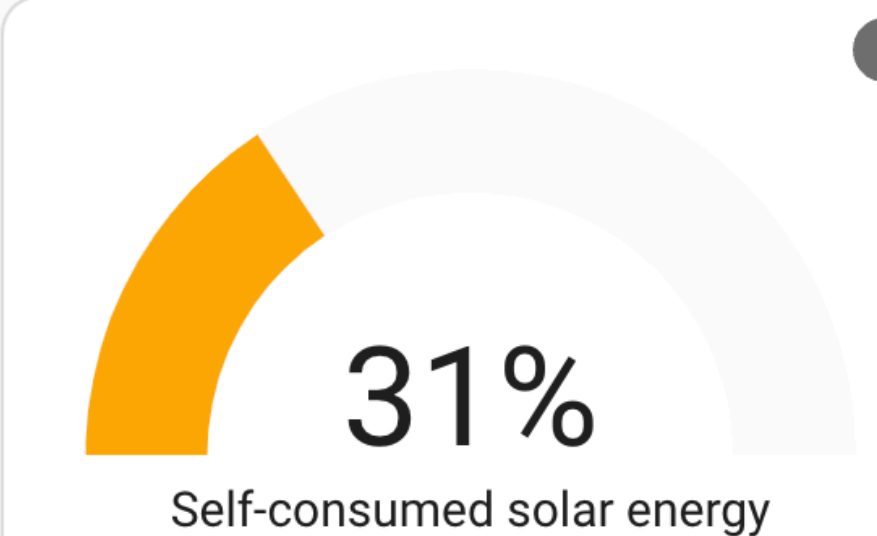
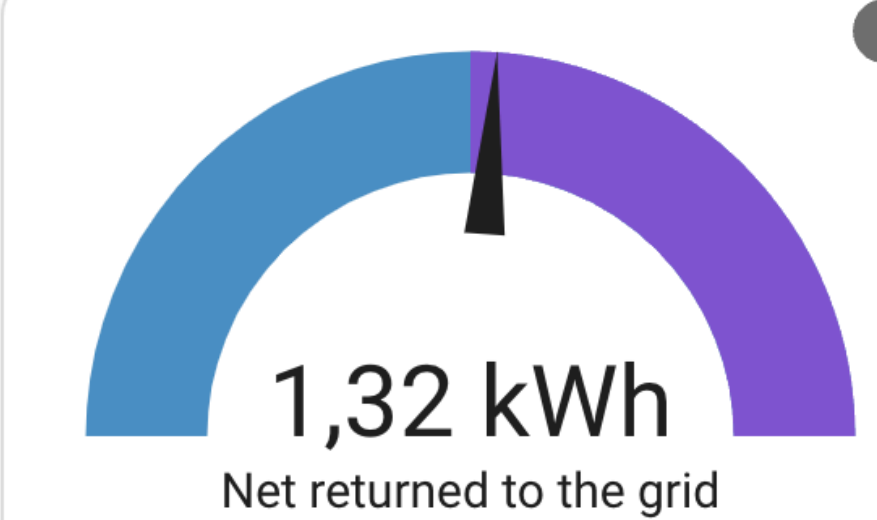
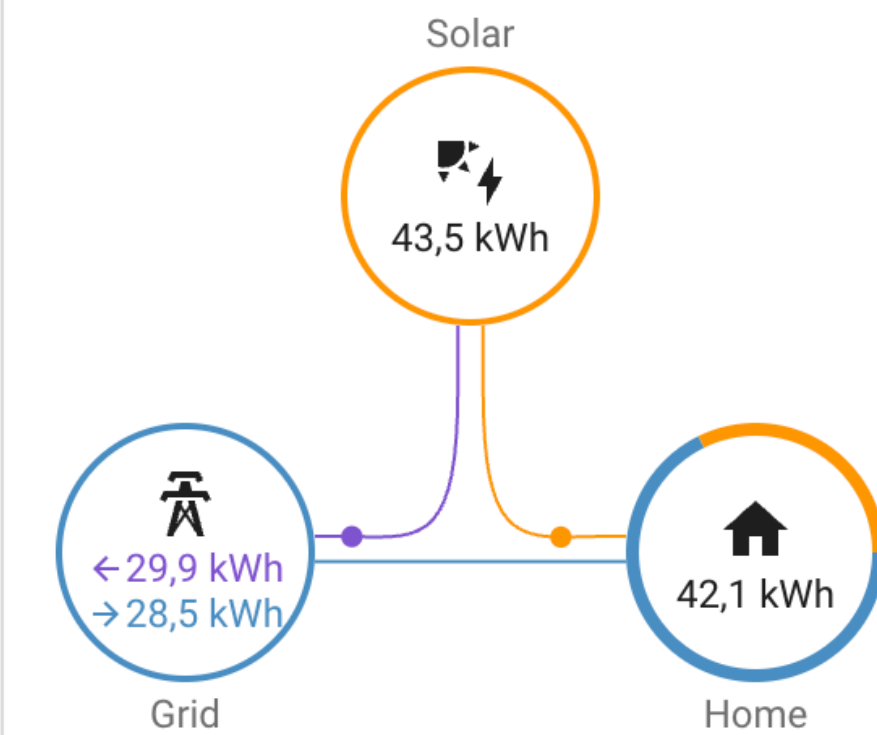
Electricity usage



Solar production



Energy distribution

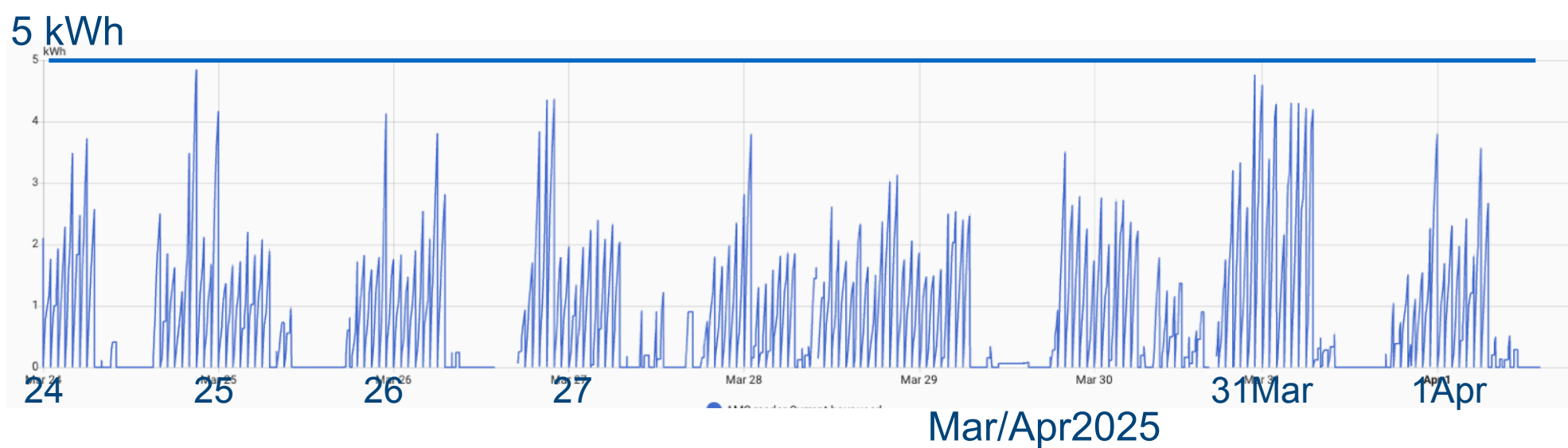




DESSI infrastructure by ITS@Uio

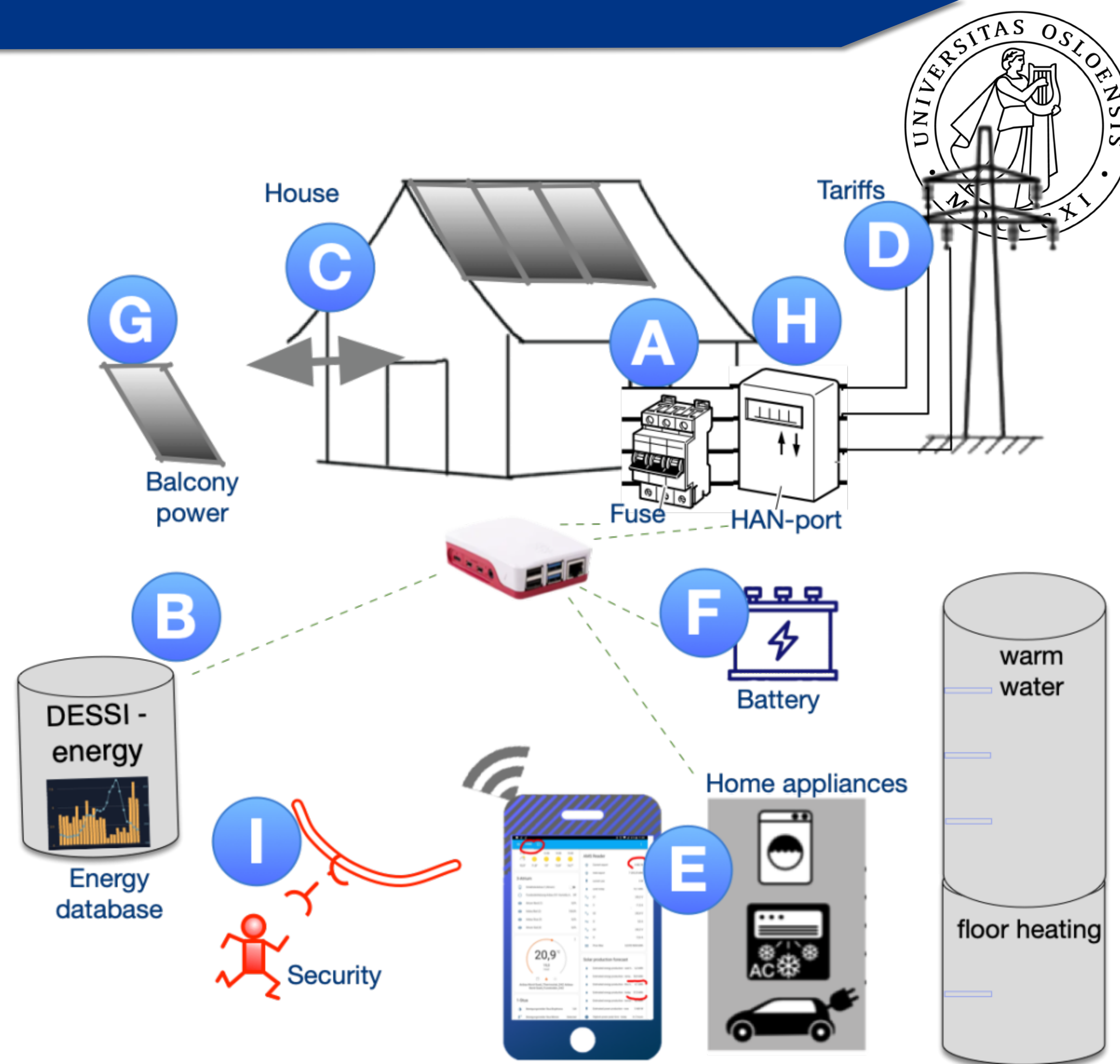
<https://www.mn.uio.no/its/english/research/projects/dessi/index.html>

- busy hour reduction
 - 0700-0900: 84%, 96%
 - 1700-1900: 69%, 25%
- Peak shaving
 - below 5 kWh/h



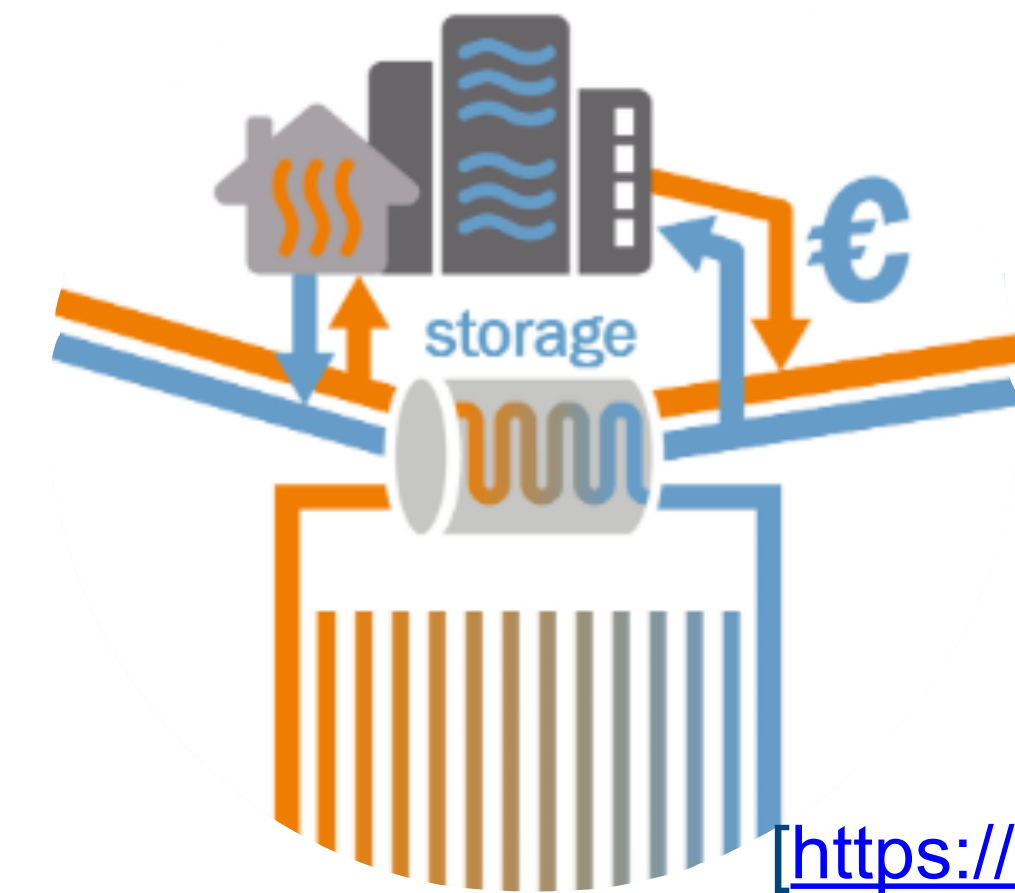
Next steps

- Cost of installation “smart”
 - heat pump
 - car charger
 - V2G charger
- Economic incentives
- Convenience modelling
 - temperature
 - car mobility
- Seasonal storage
 - Thermal storage

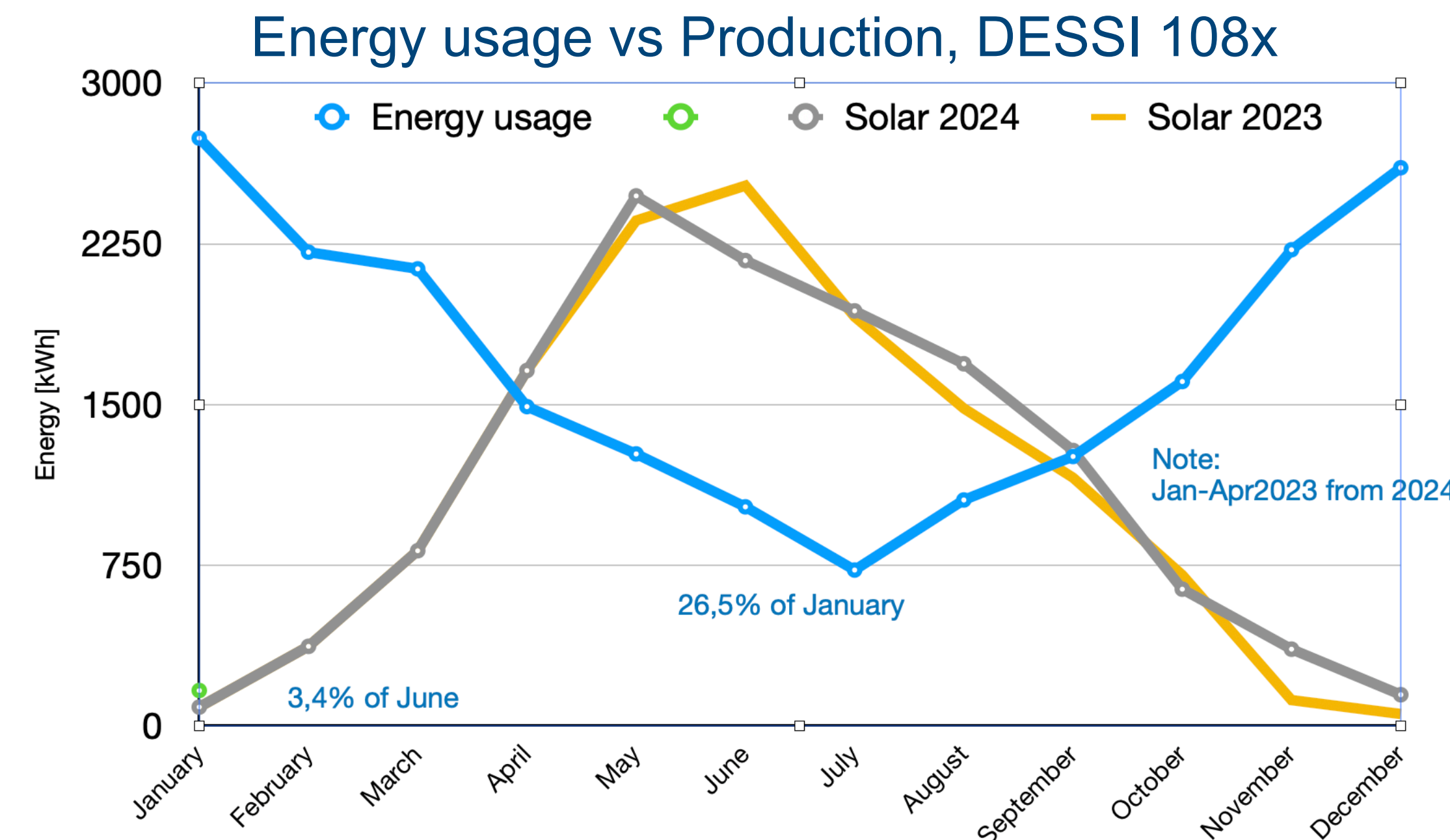


Seasonal (thermal) storage

- Battery, Hydrogen, Compressed air, Water, Concrete, molten salts ... storage
 - cost-benefit for seasonal storage?



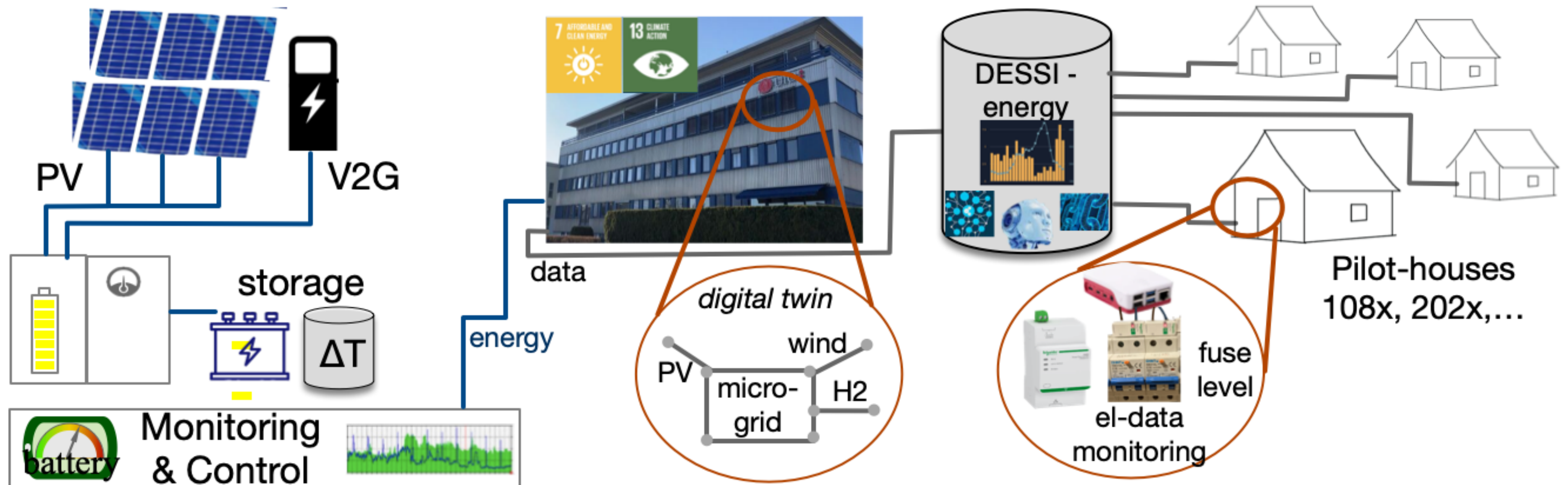
- Thermal storage in boreholes
 - reducing the grid load
 - enabling new consumers



Additional Slides

DESSI Infrastructure

→ physical, digital twin, high-res data

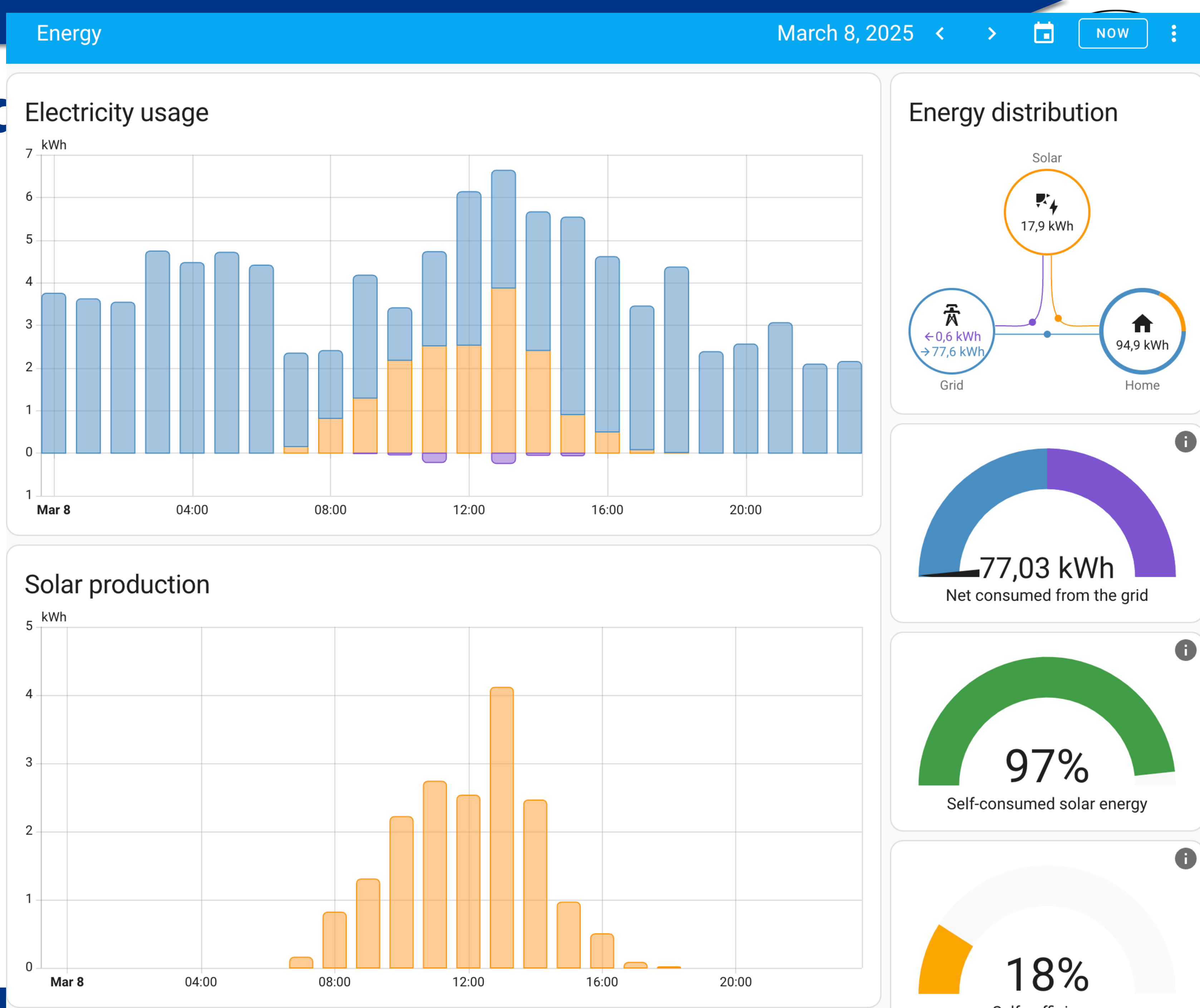


<https://www.mn.uio.no/its/english/research/projects/dessi/index.html>

Energy dashboard

8 Mar 2025

- Energy dashboard
 - blue: from grid
 - orange: from solar
 - ping: to grid
- Solar production
- Energy distribution



Grid challenges here: NO3

- Increased demand
- low production
- grid bottlenecks
- Ready to go industry
 - 27 projects (1400 MW, Dec2023)
 - 40 projects (1700 MW, Jun2024)
- Energy coordinators

Energisituasjonen i Midt-Norge (NO3)

Kø i transmisjonsnettet

- Stor forbruksvekst og lite ny produksjon
- Flaskehalser i Statnett sitt overføringsnett mellom landsdeler gir begrensninger for nye store laster
- Per i dag må alle forespørsler over 5 MW eller 20 GWh søkes om og godkjennes hos Statnett
- Alle nye forespørsler over 5 MW / 20 GWh havner i kø. Dette gjelder også utvidelser.
- Per desember 2023 sto 27 modne industriprosjekter (1400 MW) i kapasitetskø – denne har vokst til 40 prosjekter (1700 MW) per juni 2024.
- Vanlig forbruk under 5 MW er ikke berørt



smartgrids.no conference Sep2024 - Tensio

Austria - new tariffs for energy neighbourhood

→ energy.jnoll.net >
G-Balcony Power
Plants



[Source: TU Oct2024, Willy Kramer]

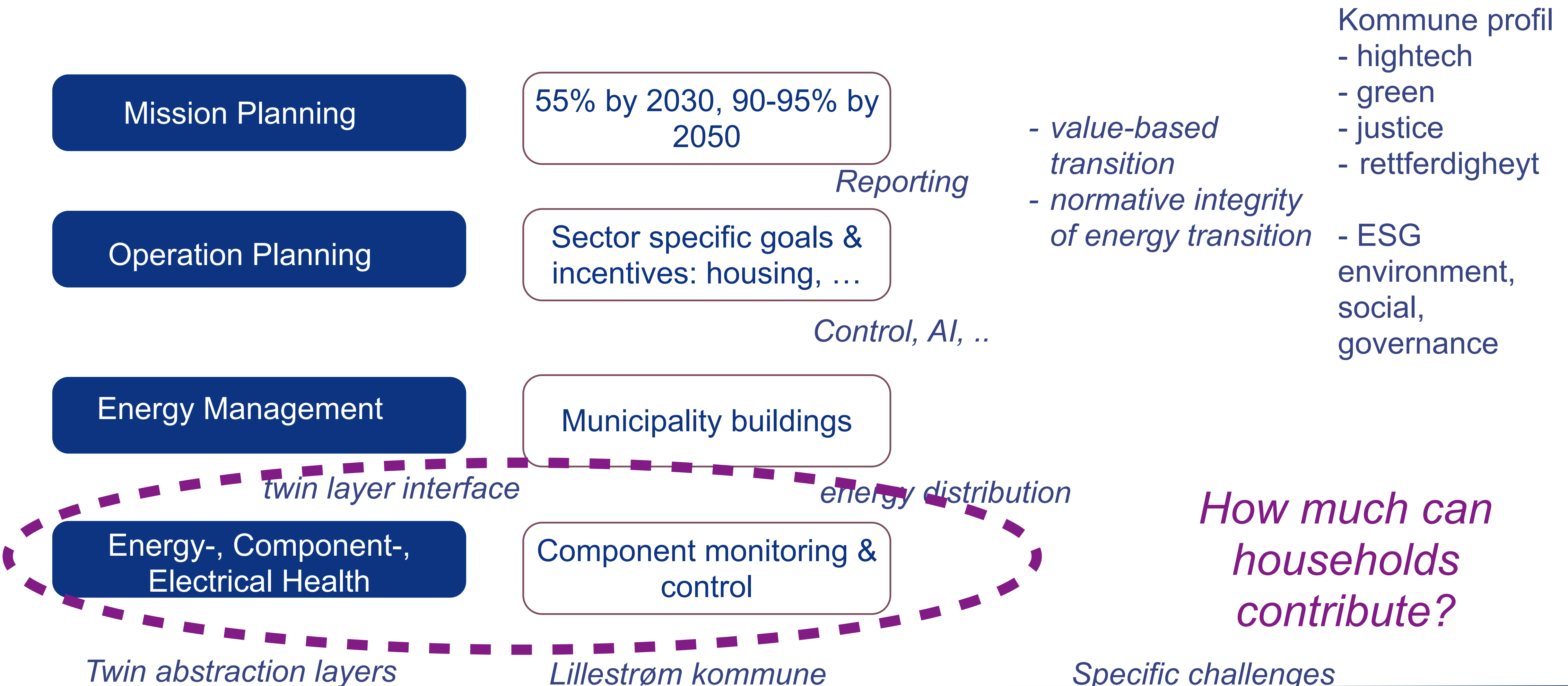
NB-IoT in praxis - Monitoring the Grid (heimdall.no)

- Until now: no control of electricity
- With Heimdall "neurons", measure
 - power, line inclination, line vibration,
 - snow load and wire temperature
- Science: vibration amplitude is linked to energy flow [1]
- Communication through NB-IoT [2]



- [1] https://www.researchgate.net/publication/282956268_Measurement_of_vibration_characteristics_of_power_cable_line_under_typical_laying_conditions
- [2] <https://www.telia.no/magasinet/norsk-oppfinnelse-kan-lose-arhundrets-stromutfordring/>

TwinEnergy Architecture applied for municipalities



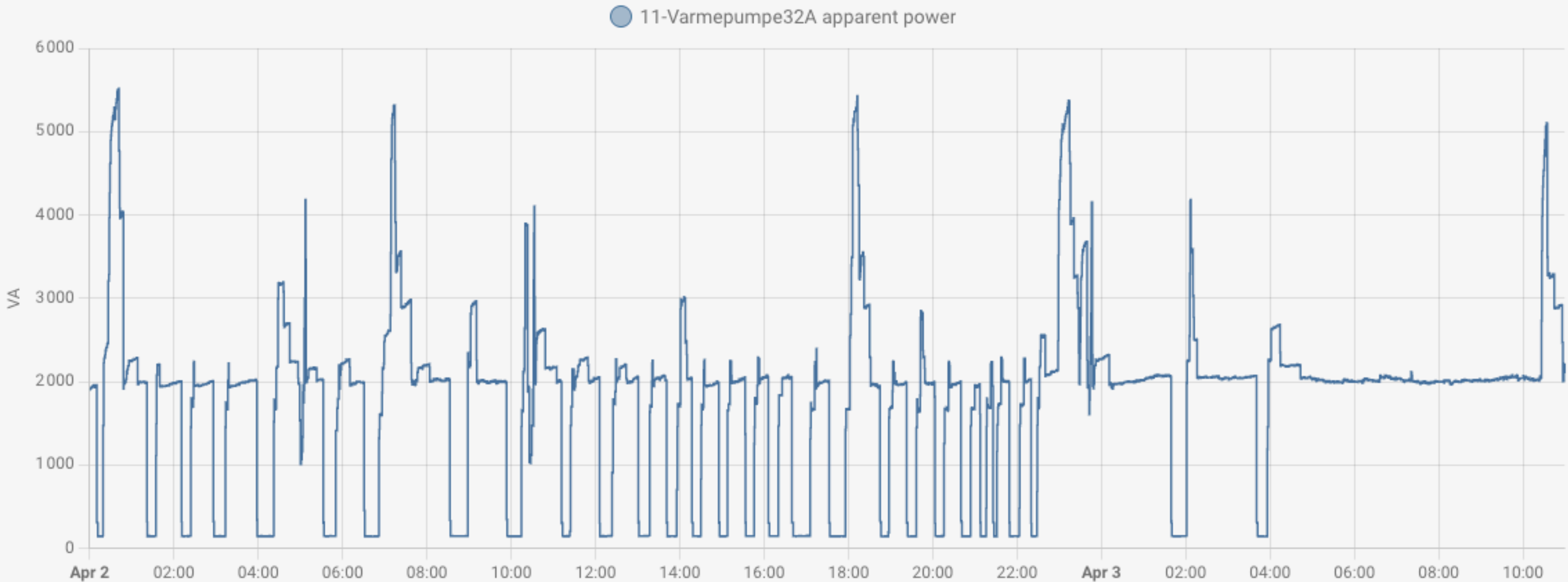
Pilot house 108x Energy Control

- Solar production 16 kW peak
- **Heat pump (hot water & floor heating)**
 - optimise after costs vs convenience
 - shifting of energy demand
- el. car charger
- all other appliances

- Raspberry Pi with Home Assistant
 - AMS reader (MQTT)
 - Schneider Electric Fuse monitor

⚡	Solar input (active power)	-6 908,0 W
⚡	AMS reader export	4 553 W
⚡	AMS reader import	0 W
⚡	Heat pump	2 473,0 VA
⚡	HotWater extra	0,0 W
⚡	Car charger	0,0 W
⚡	ExtraHeat Pump	0,0 W
⚡	Kitchen Stove	0,0 W
⚡	Kitchen Light	-31,0 W
⚡	Cellar lights	-95,0 W
⚡	First Floor energy	-121,0 W
⚡	Second Floor energy	-10,0 W
⚡	Internet fuse 09	Unavailable
⚡	Old Bathrooms	-37,0 W

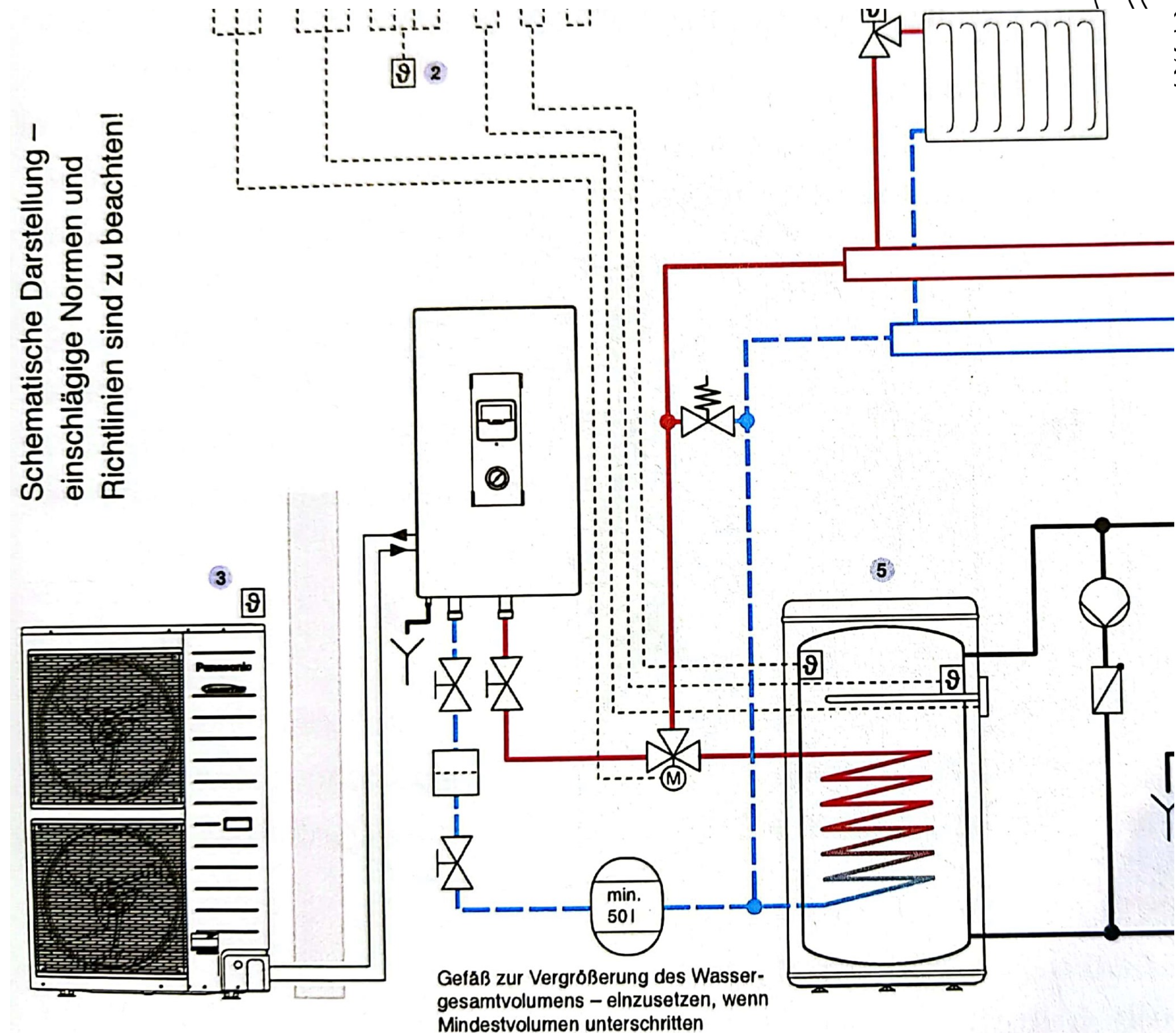
Example: Energy of Heat Pump



Real world assessment

Heat pump control

- ➔ Heat pump drives tank
 - Top: 240 l hot water
 - Bottom: 120 l floor heating
- ➔ Goal:
 - set temperature of water
 - price, convenience,



How to control?

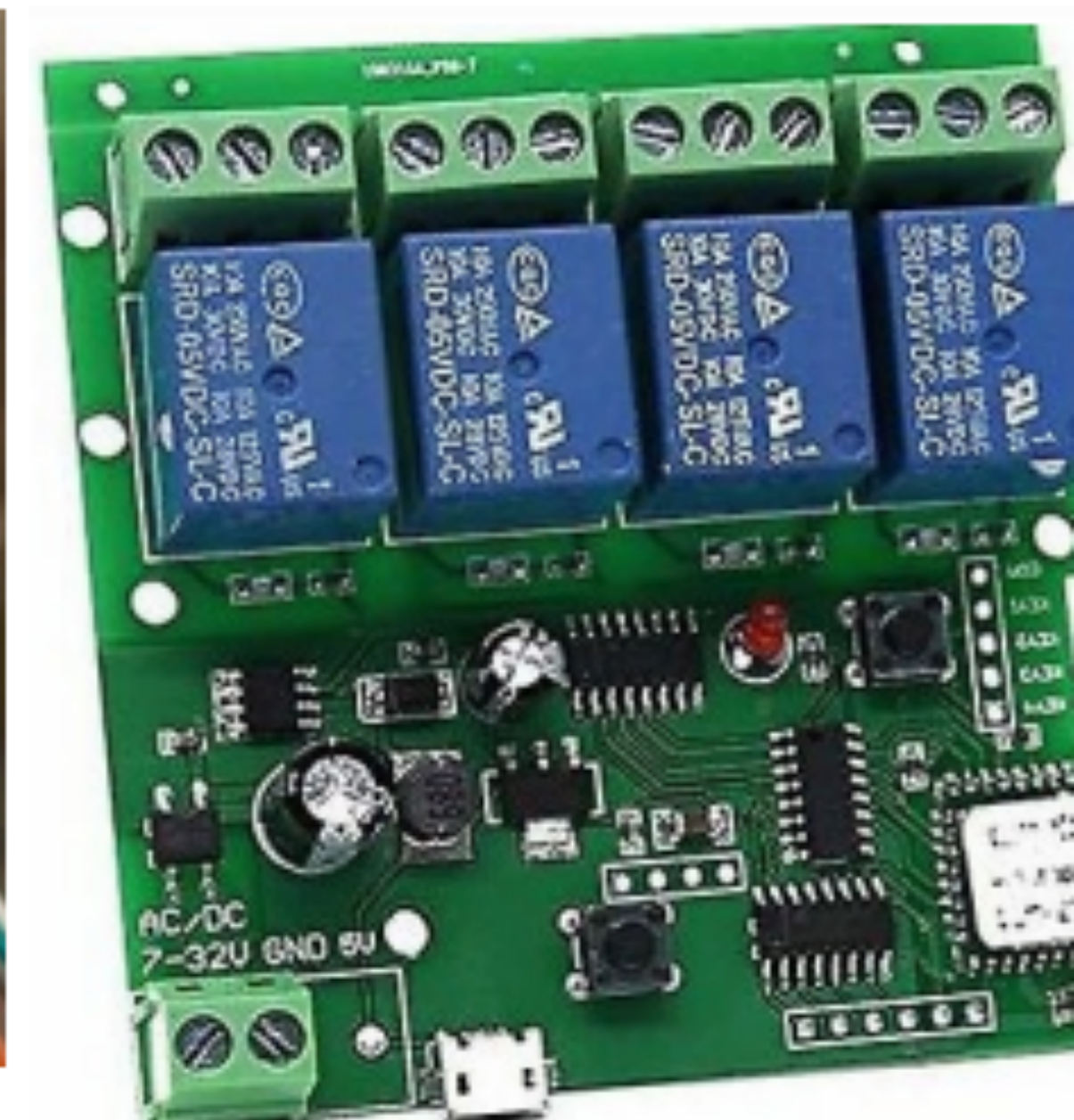
- Measure
- Switch power



(a) DS18B20 Temperature sensor



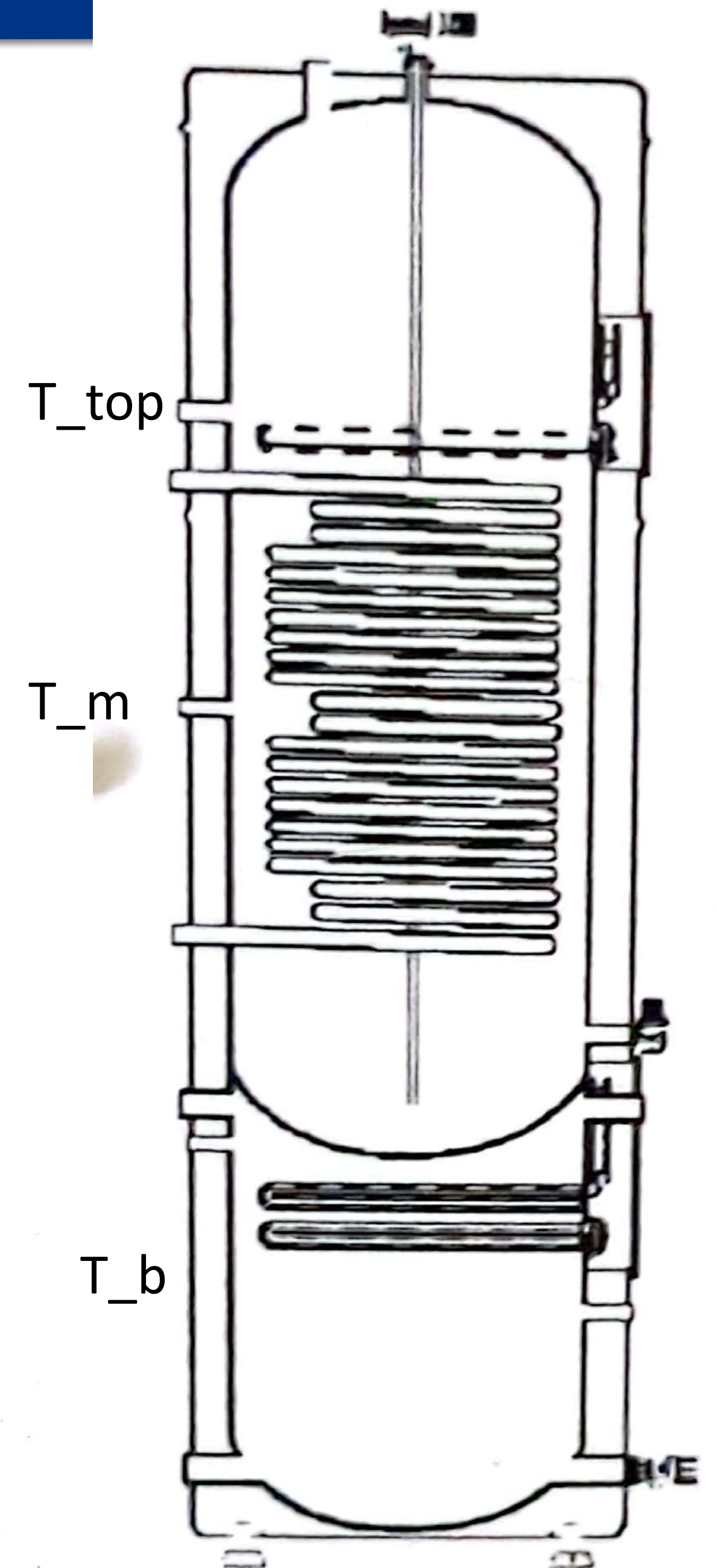
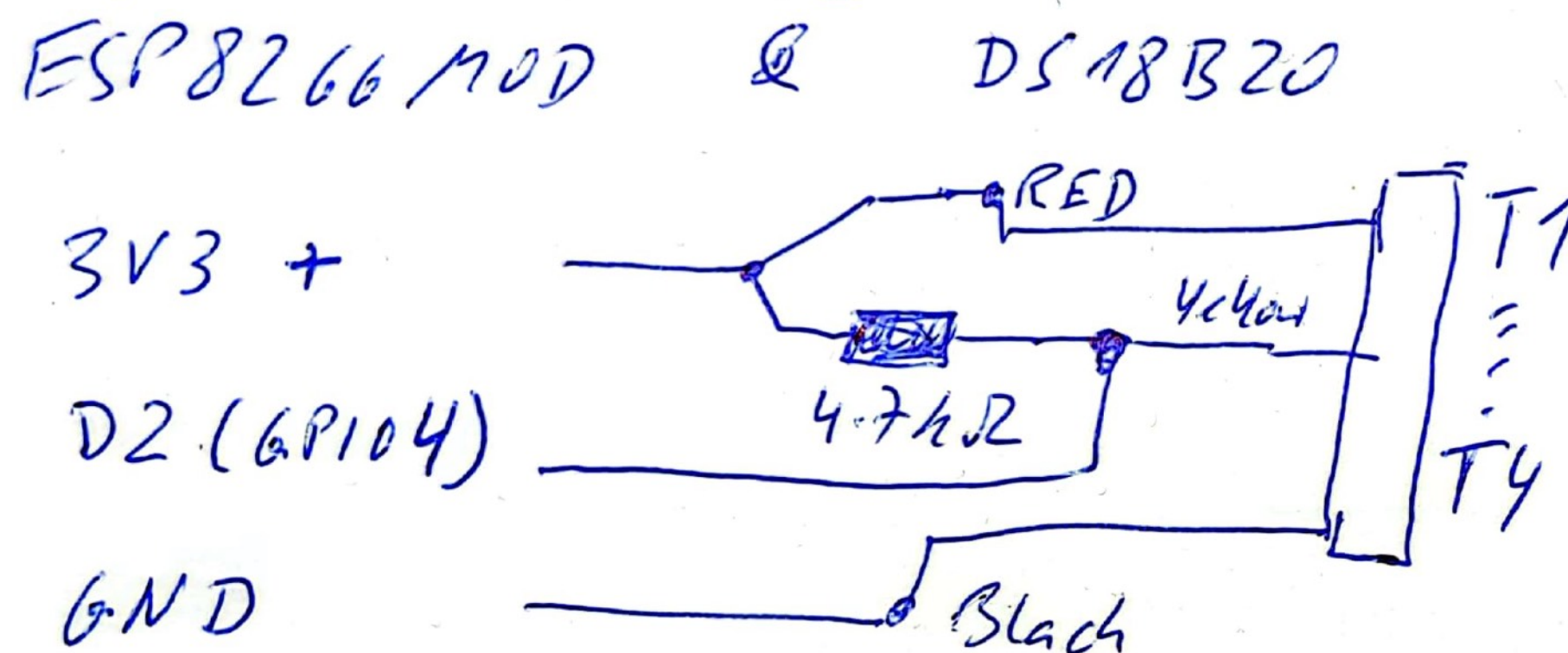
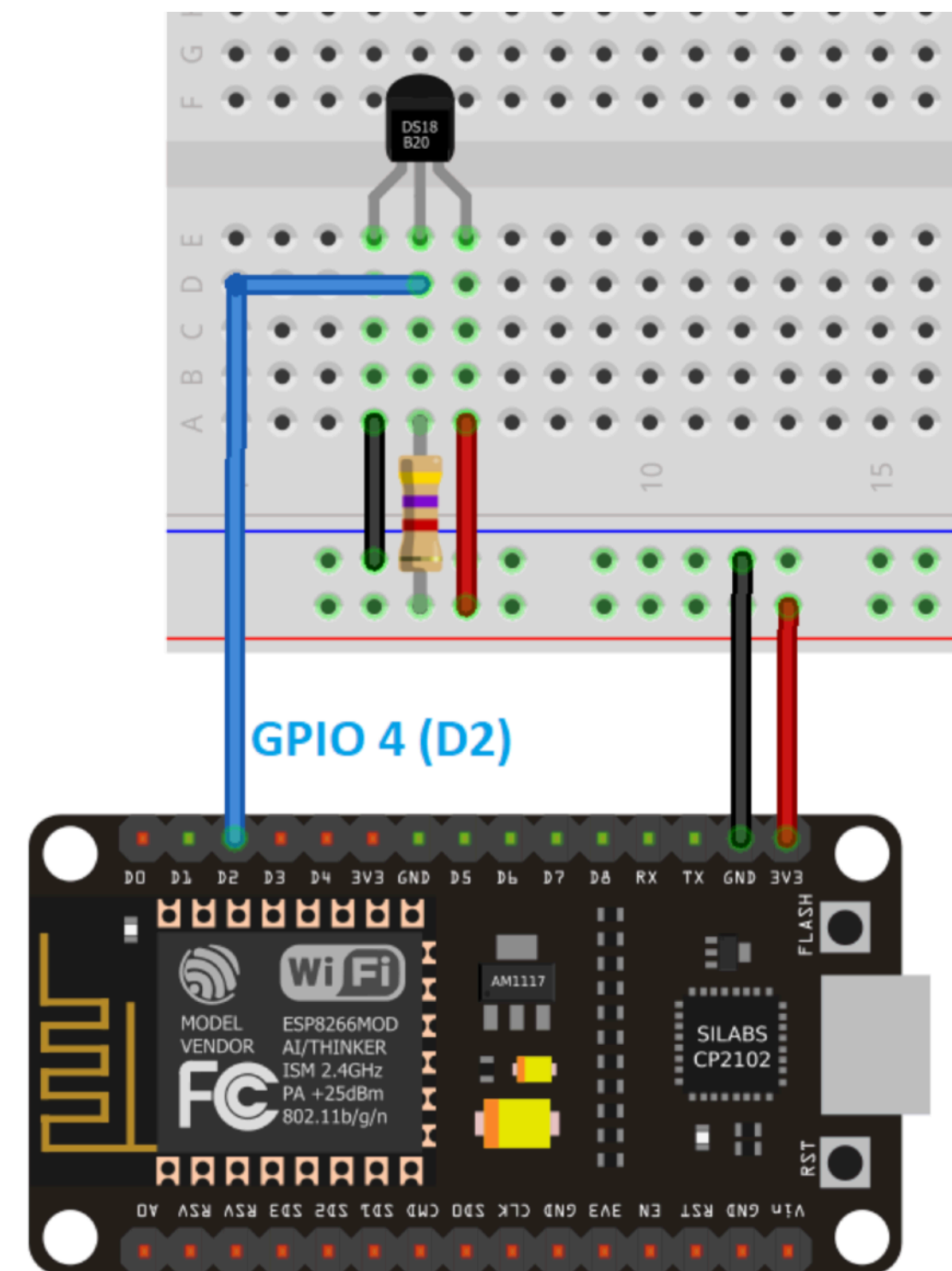
(e) Esp8266 microcontroller



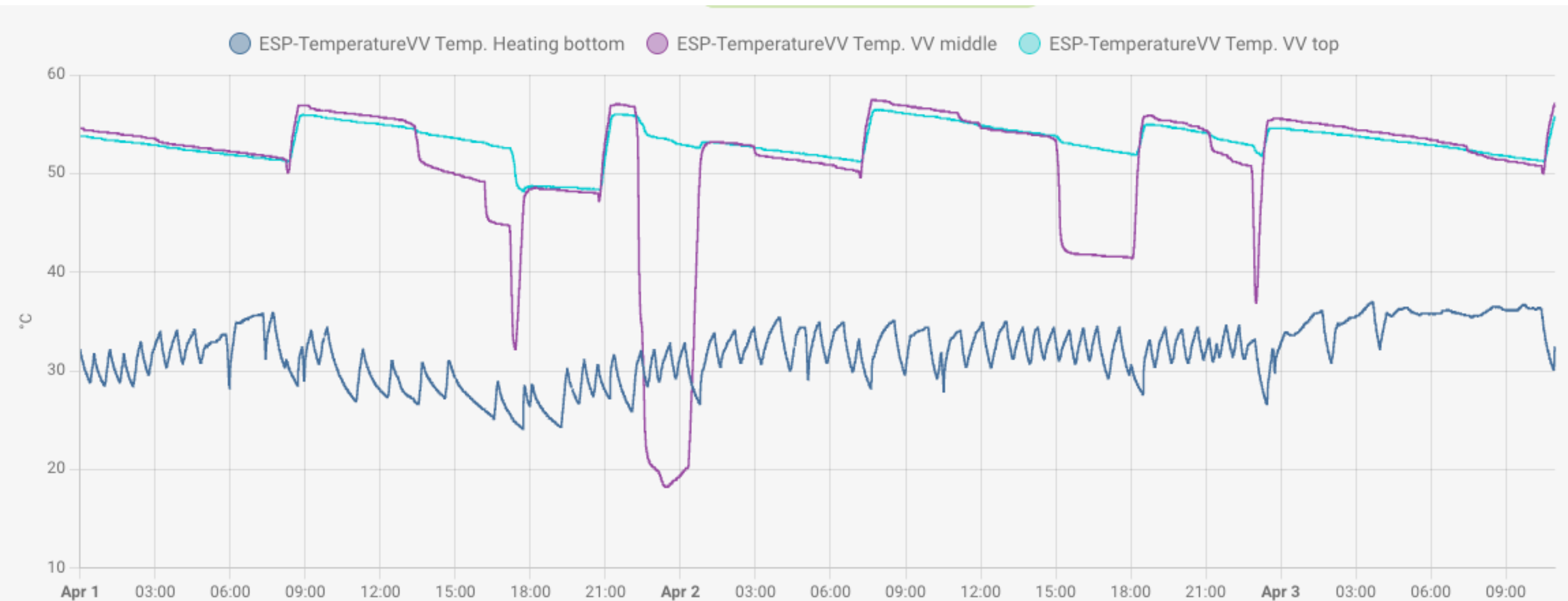
(b) Luxor Relay: 4-gates

Temperature control

- ESP8266Mod
 - Tank top
 - Tank middle
 - Tank bottom
- connected to Raspberry Pi with Home Assistant



Example: Hot-water tank (top, middle) & floor heating (bottom)



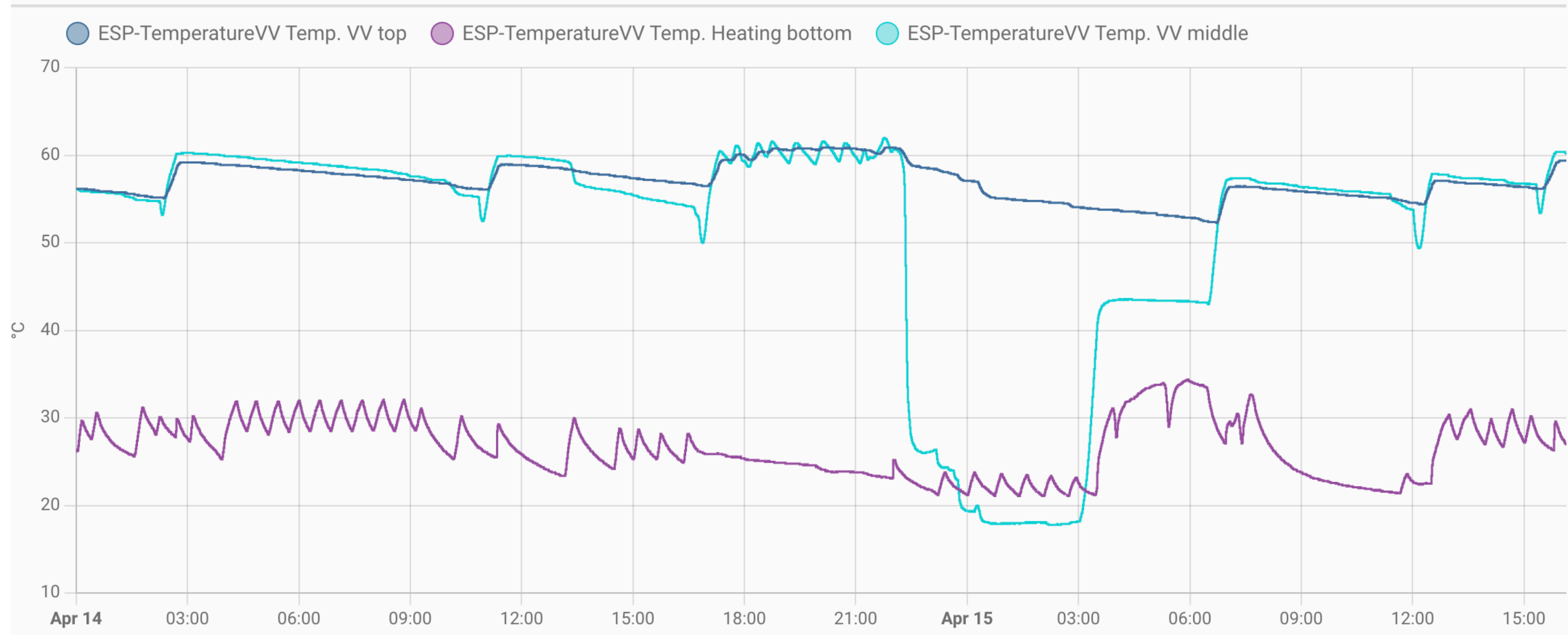
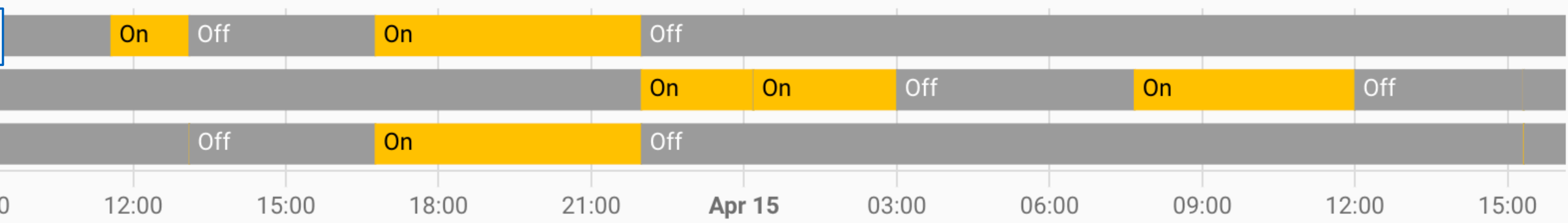
DESSI pilot house 108x - switching capabilities



Room Temperature reached (invers)

Heat pump (invers)

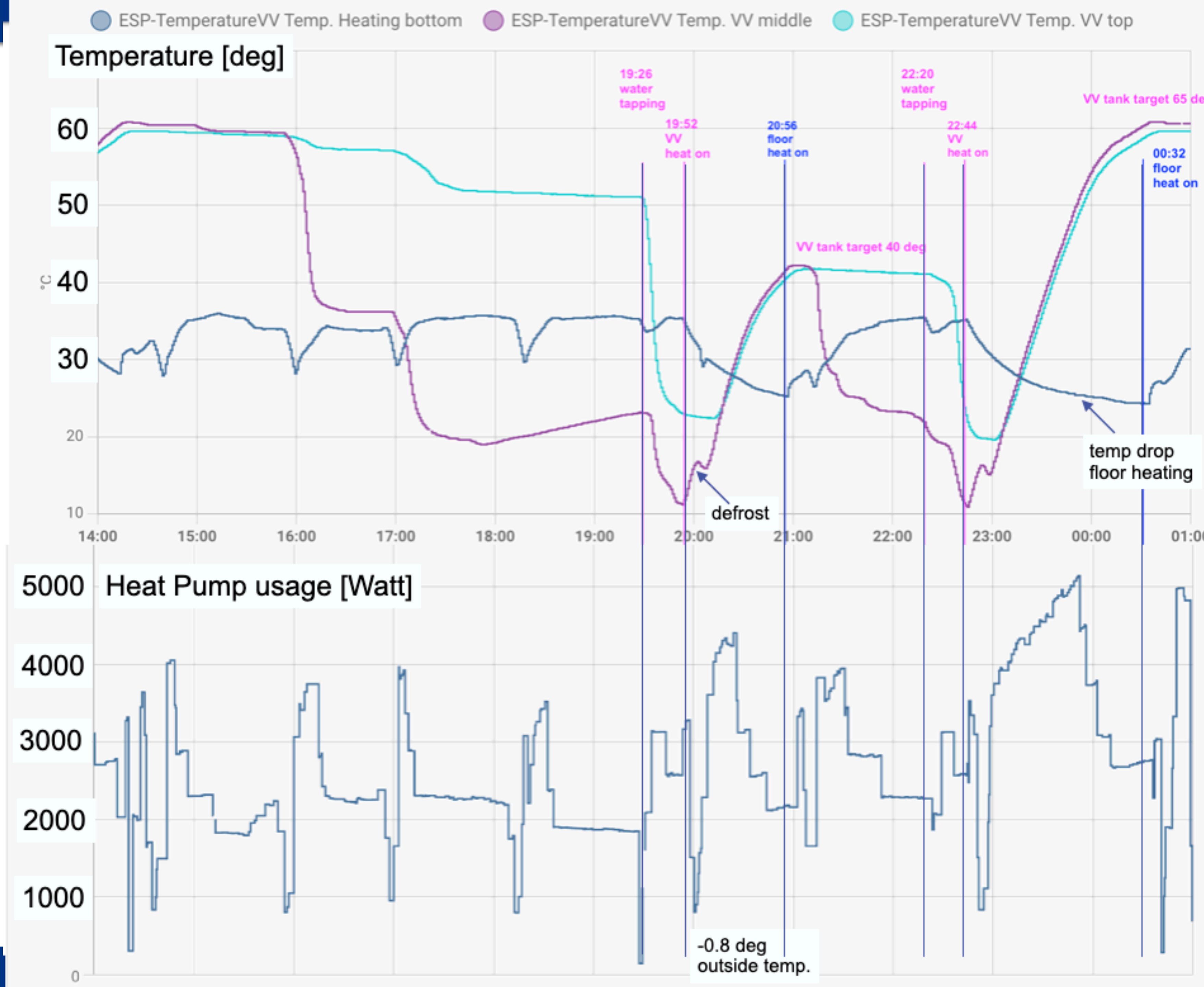
fake tank temperature (invers)



DESSI 108x

→ Energy profile of heat pump

- warm water
- radiator/floor heating



Automation goals

- Always have min 50 deg hot water
- Heat pump
 - pre-heat before busy hours
 - switch off during busy hours
- Car charger
 - minimum charge to 55%
 - full charge to 80% when solar
- Low-price (and solar)
 - pre-charge warm water
- Grid level (3,5,10 kWh/hour)

	02_While_Hot_Water_below_50 HotWater
	04_energy_used_grid_step
	04-Heat pump off-on at selected times
	05_car_charging_55percent
	05_solar_car_charging
	05-car_charging_off_at HP1off
	05-Stop_Charging_Afternoon
	06-lowPrice_forceHotWater

L12: Energy control main takeaways

- Energy exchange
 - influence of renewables
- Energy neighbourhoods
 - impact of tariffs
- Energy control
 - infrastructure
 - capabilities

