SINTEF

70 years
1950-2020

FLEXBUILD

Optimal utilisation of flexibility in buildings

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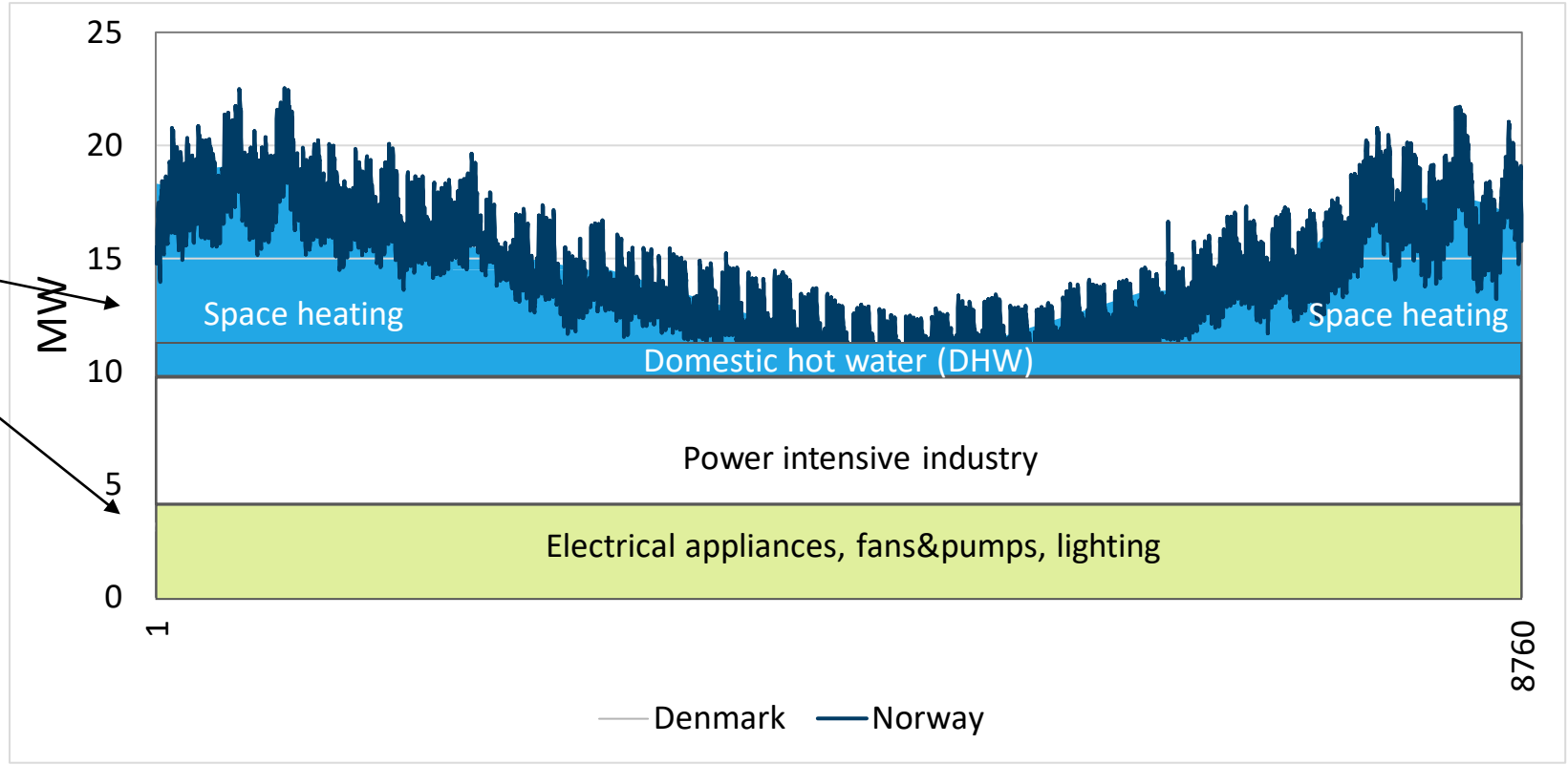
SINTEF Community

CITIES workshop, 12 Aug 2020, Copenhagen (virtual)

National load profile

- Industry
- Buildings
  - Thermal electric load
  - Electric specific load
- Transport
  - EVs



FLEXBUILD

The value of end-use flexibility in the future Norwegian energy system

Evaluate the role of *local flexibility* interacting with the power system and district heating system

- Project owner: SINTEF
- Duration: 4 years
- Budget: 16.6 mill kr

Industrial branch / Partners
Building owners Statsbygg, Omsorgsbygg, TOBB
District heating companies Norges Fjernvarmeforening
Grid companies Statnett, Elvia
Public actors NVE, Enova
Research institutes SINTEF, IFE, NTNU, SINTEF Energi

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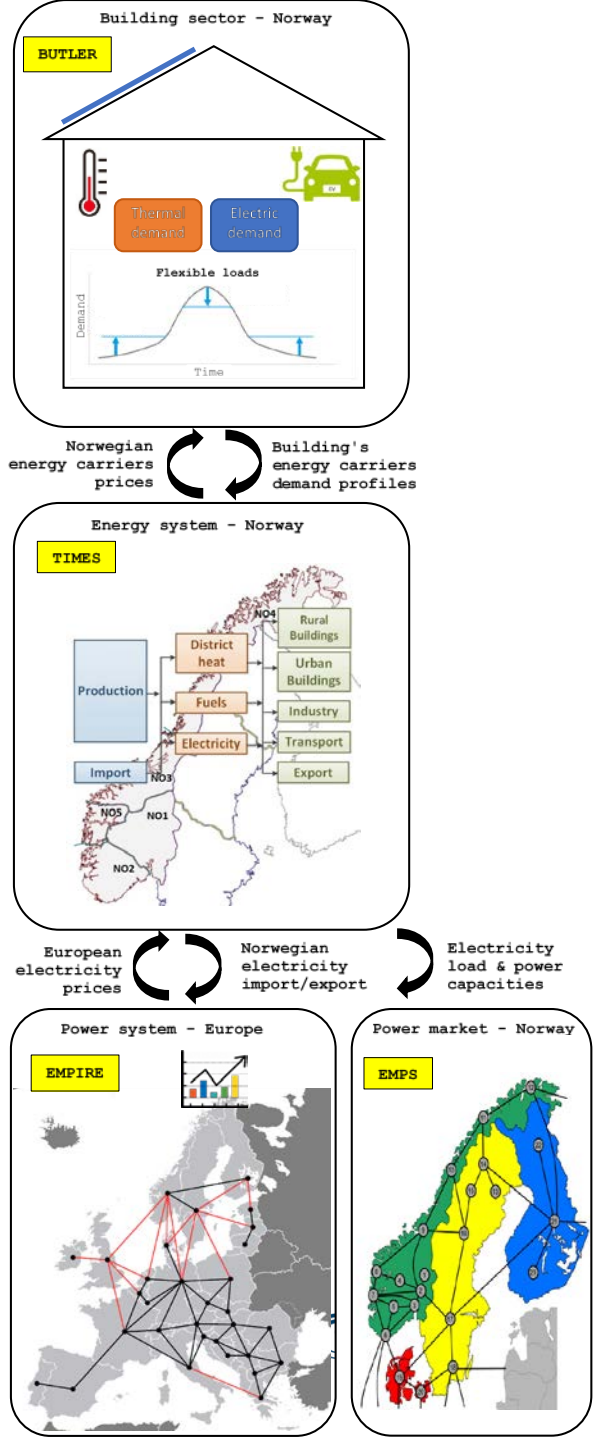
The models and their integration

- BUTLER: Building sector
- TIMES-Norway: Energy system
- EMPIRE: European power system
- EMPS/FanSi: Norwegian hydropower system

Utilise the strength of each model for better decision support

1st year: prepare modelling tools for integration



BUTLER

- BUTLER – flexibility at building level
  - MILP model with hourly time resolution
  - Minimising total cost over 40 years

$$\min \left\{ \text{investment costs} + \sum_{yr} \text{discounted operational costs} \right\}$$

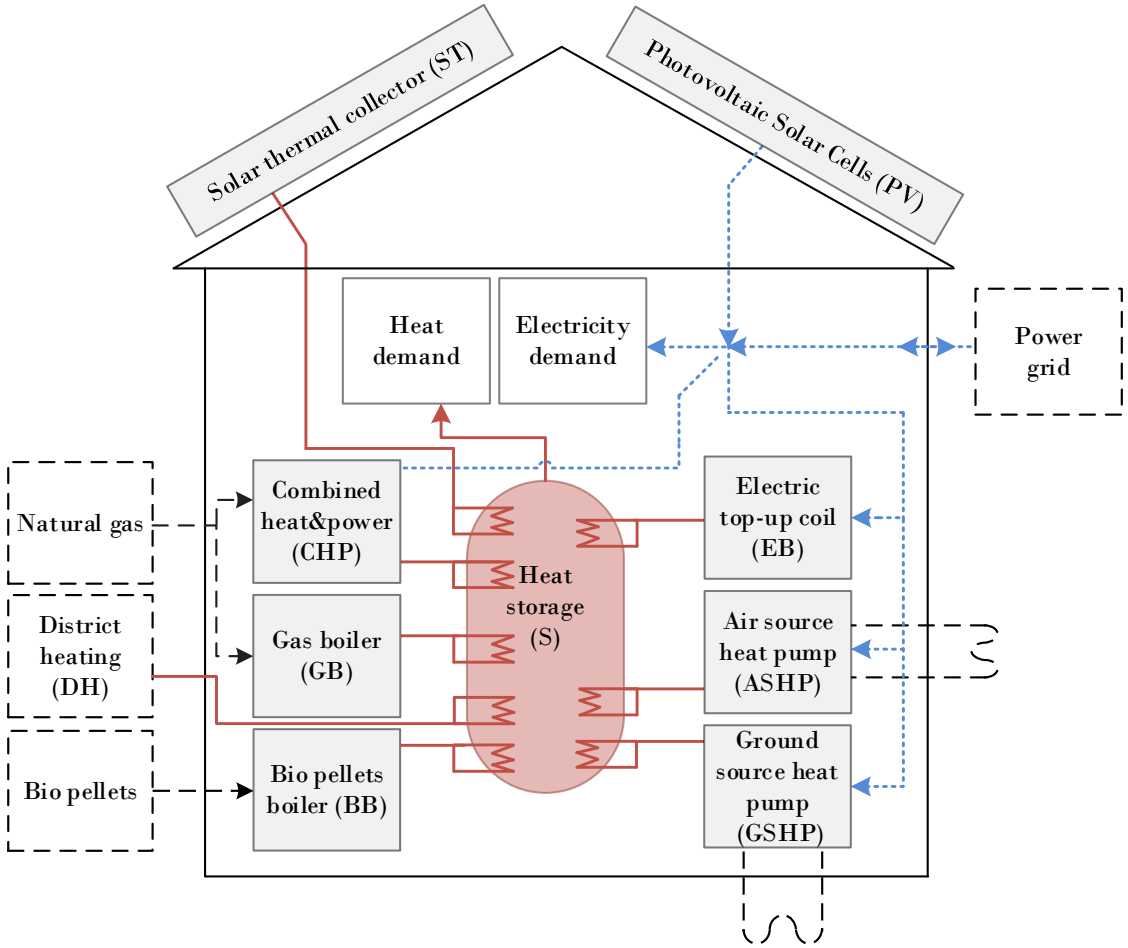
subject to :

zero balance (CO_2 or primary energy)

electricity balance

heat balance

technology constraints



Source: Lindberg et al., 2016. *Methodology for optimal energy system design for Zero Energy Buildings using mixed-integer linear programming*. Energy and Buildings, Vol. 127, pp. 194-205

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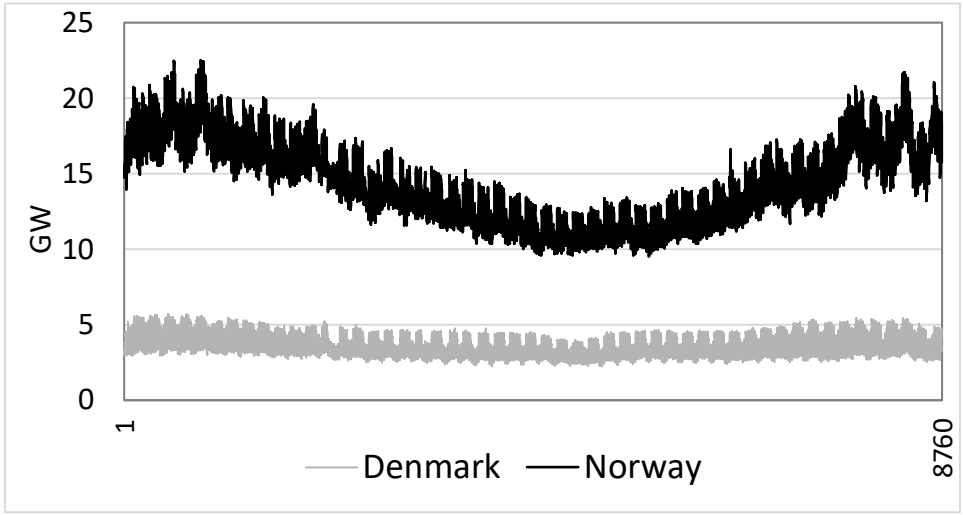
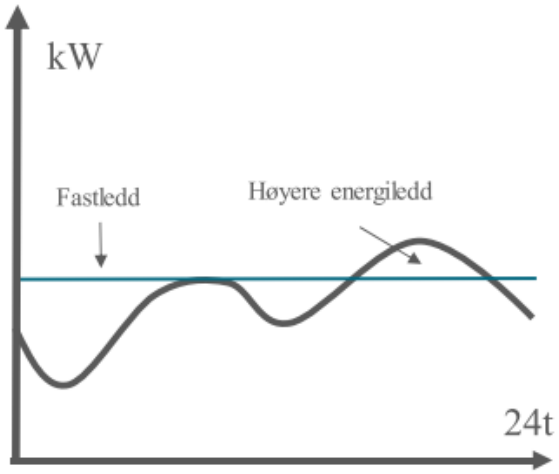
Reduce peak load

- Norwegian energy authorities
  - New incentives for reducing peak load
    - Energy labelling of buildings
    - Grid tariffs
- FlexBuild, 1st year
  - Investigating the impact of new grid tariffs on the peak load
  - Assuming all data-driven technologies are in place
  - All buildings are operated in a least-cost way

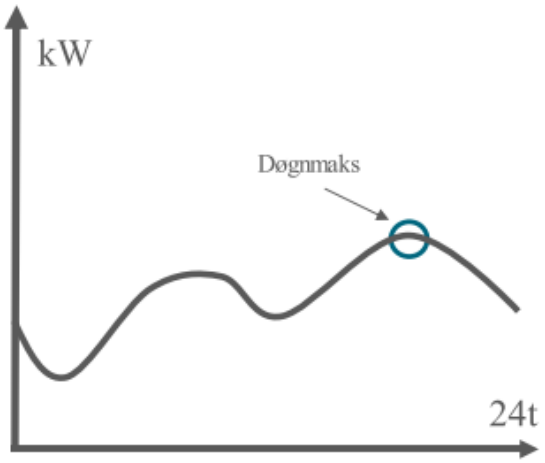


New grid tariffs analysed

- Subscription tariff



- Daily peak load tariff



		Fixed costs	Energy price	Peak price
		EUR/year	cent/kWh	cent/kWh/hr
current	Energy tariff	118 EUR	4.6	
new	Subscription tariff	135 EUR + 67.5 EUR/kW	0.5	8
new	Daily peak tariff	185 EUR	0.5	18 (w) 12 (s)
current	Monthly peak tariff	404 EUR	0.69 (w) 0.39(s)	1490 (w) 790 (i) 230(s)

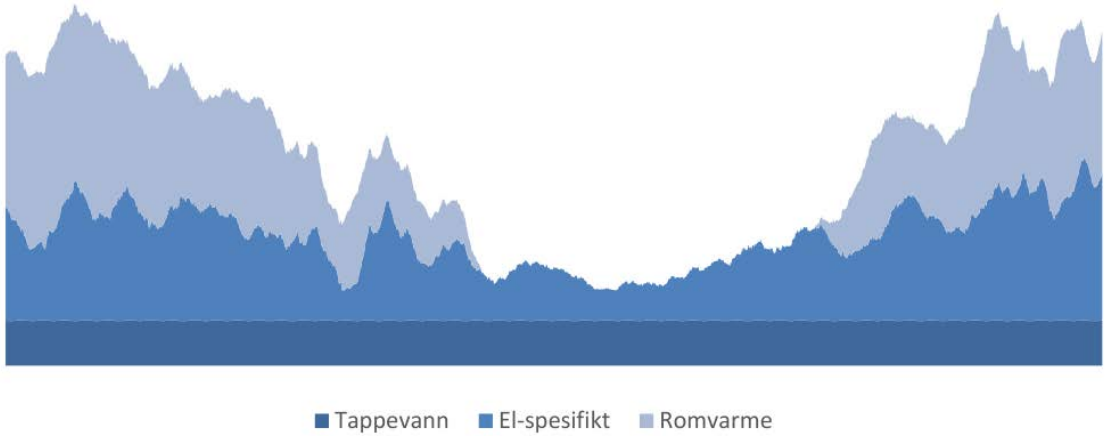
Payment for hours above subscription limit

One payment per day

One payment per month

Single Family Home 250 m^2

- SFH from the 70-80-ies
- Energy demand: 41 800 kWh/år
  - Heat: 31 200 kWh/yr
  - Electric spec.: 10 600 kWh/yr



- 3 use cases

regular
ELECTR. RADIATOR

regular
HEAT PUMP

efficient
HEAT PUMP

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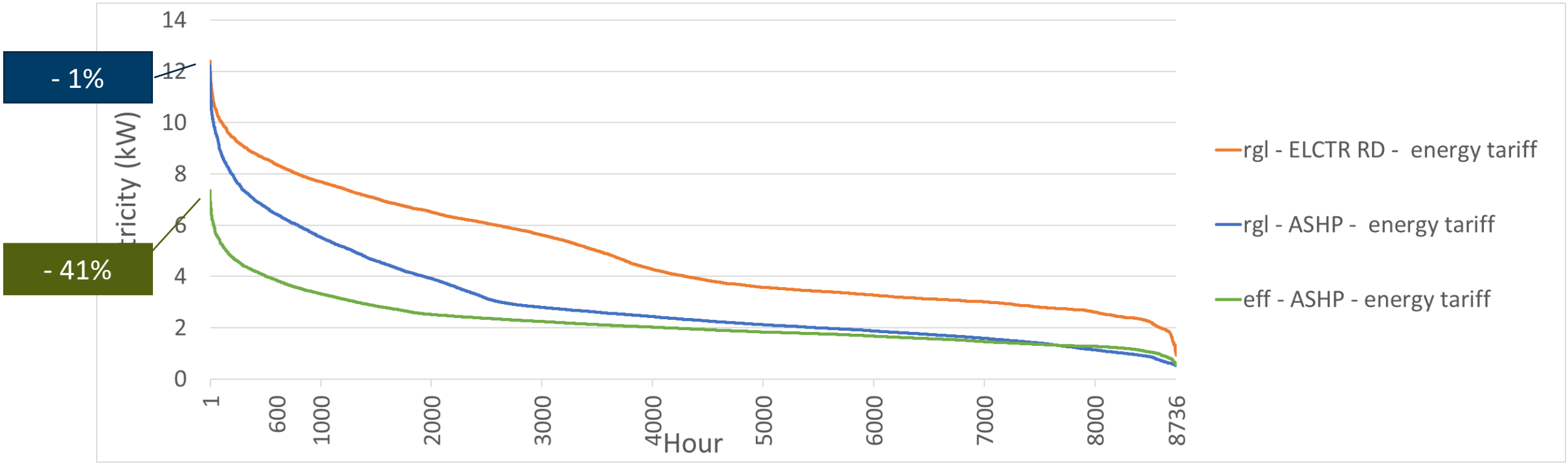
Electricity load with energy tariff



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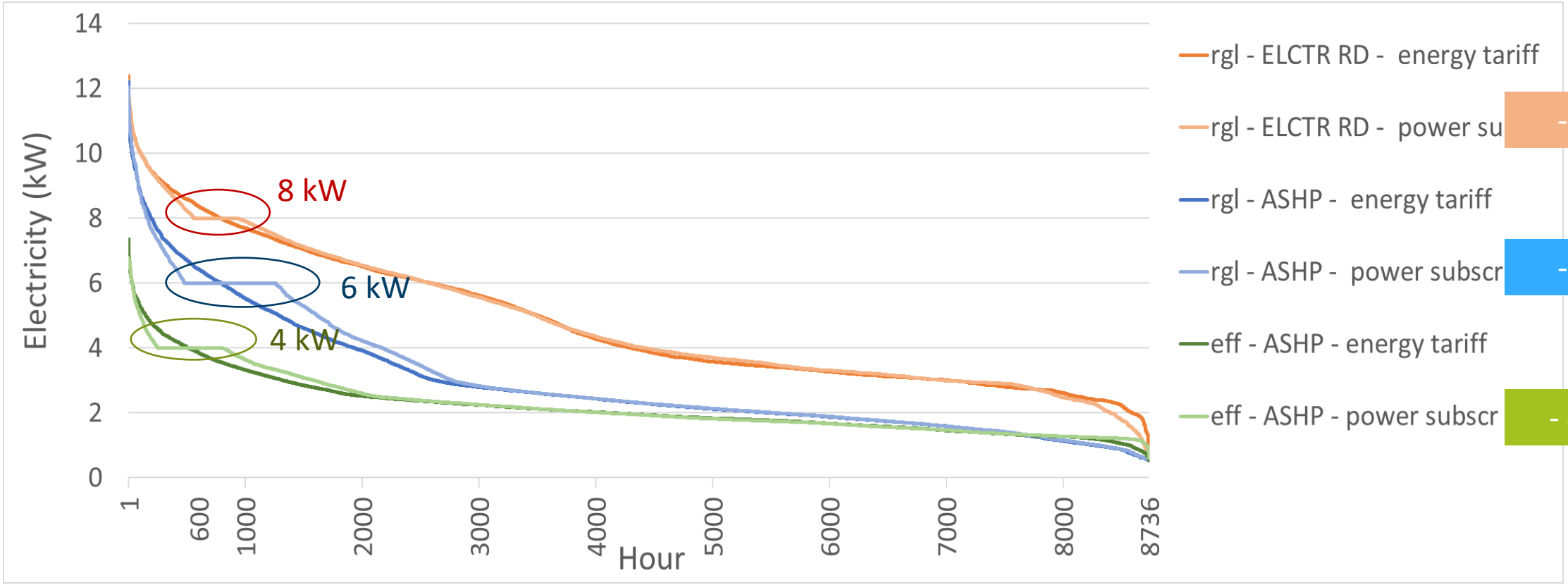
Subscription tariff



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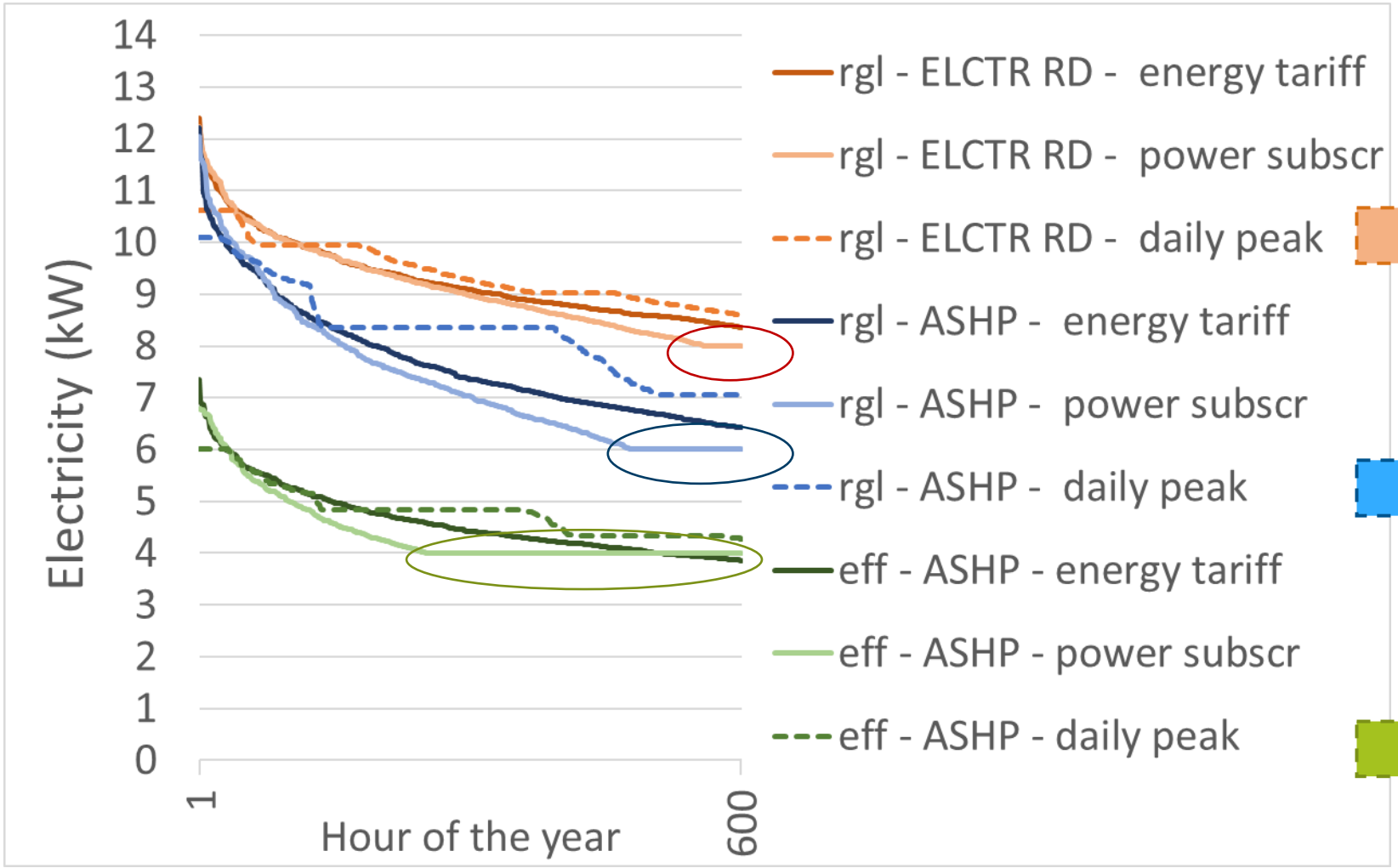
Daily peak power



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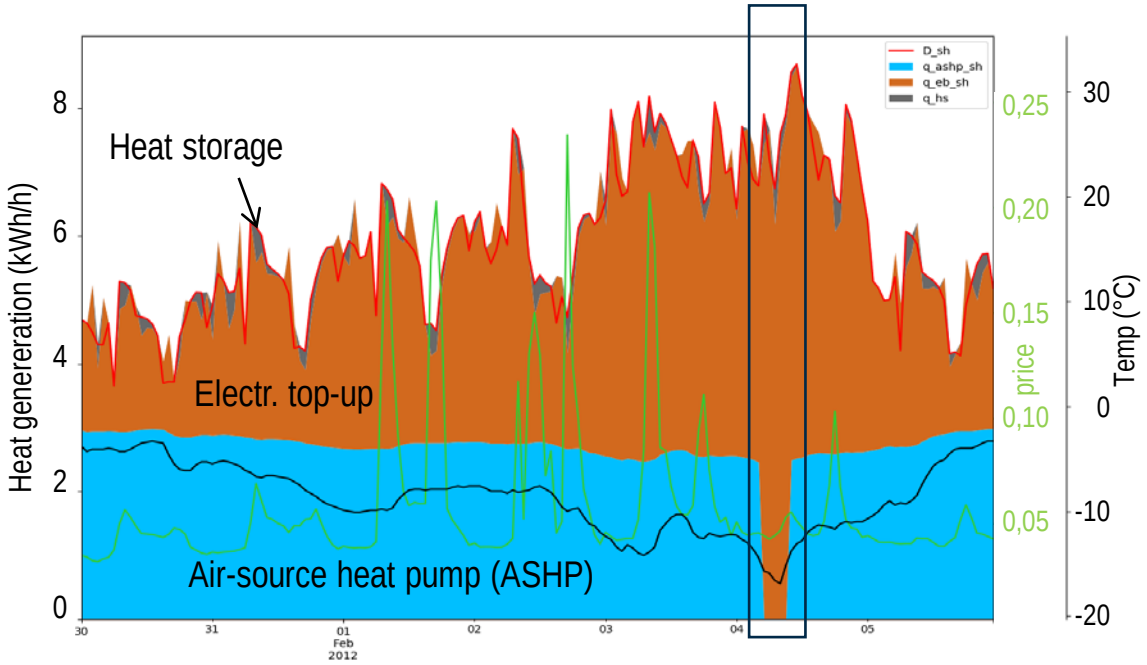
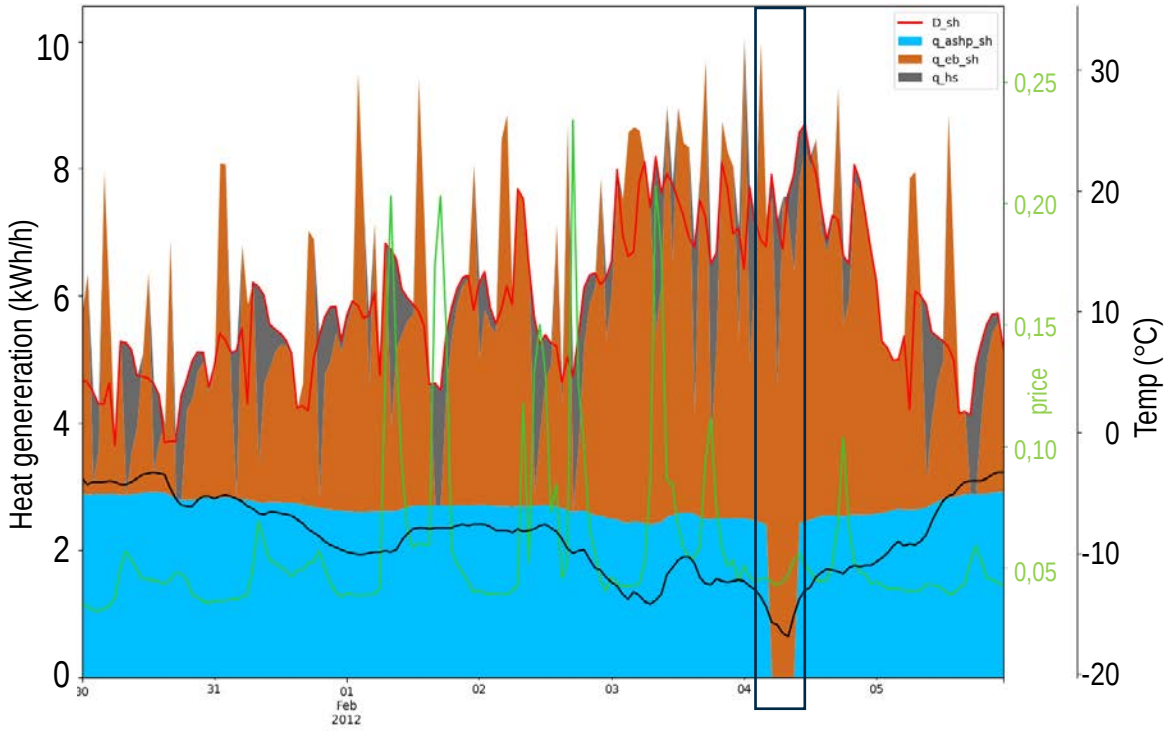
What happens on the coldest day?

Case 2: Regular - ASHP

- Subscription tariff



- Daily peak tariff



BUTLER: Results for region NO1

Categories:

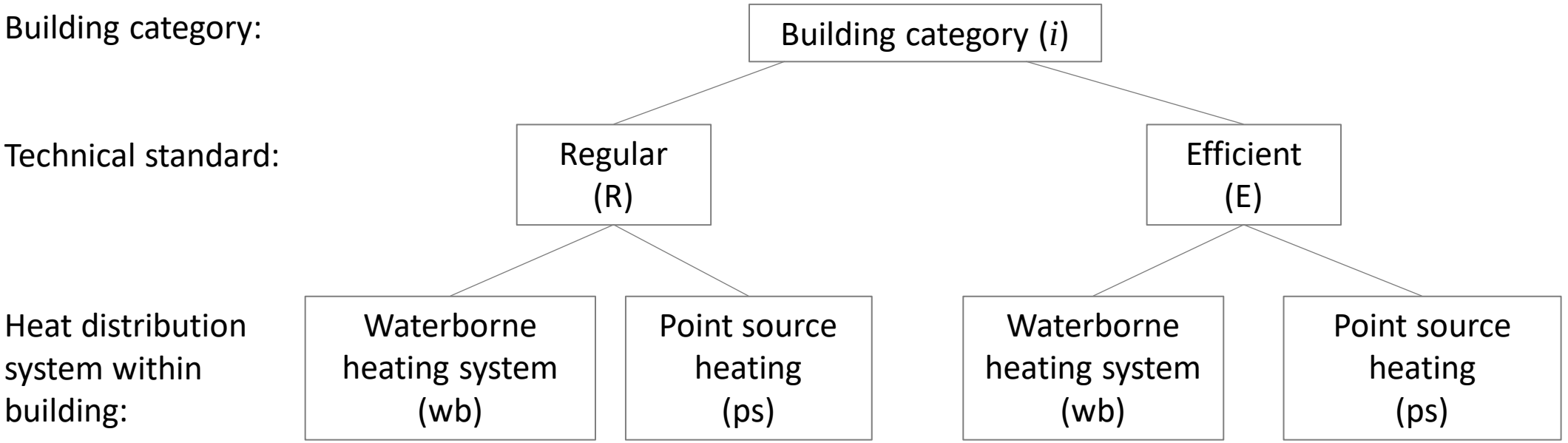
- Single Family Home (SFH) + Apartment = Residential (RES)
- Commercial buildings (COMM)

Technical standard: We only consider regular buildings

Heat distribution system: waterborne and point source

Floor area [mill. m^2]

Single Family Home	99.6
Apartment	22.9
RESIDENTIAL	**122.6**
COMMERCIAL	**42.6**

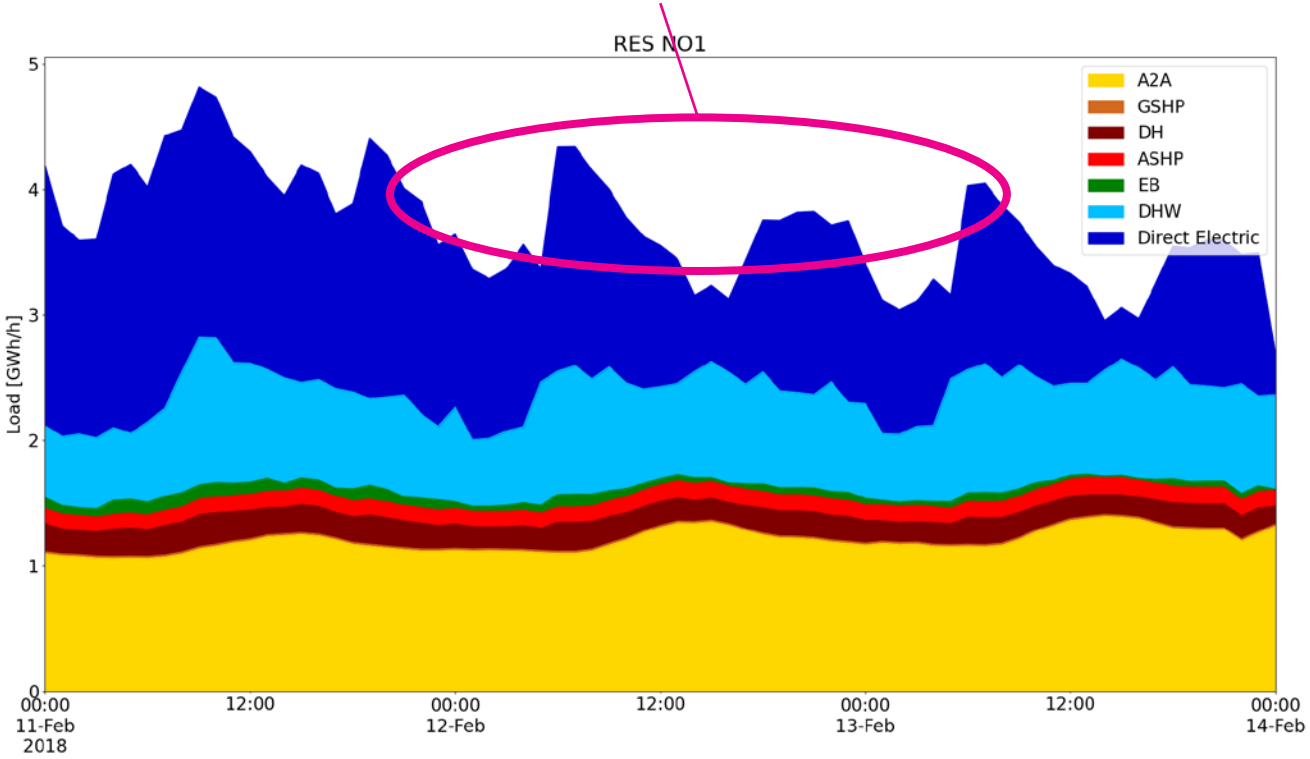


Aggregated heat demand in 2020

- Choice of technologies in BUTLER, when using spot prices from TIMES and "energy pricing" grid tariff
- 3 representative days in winter

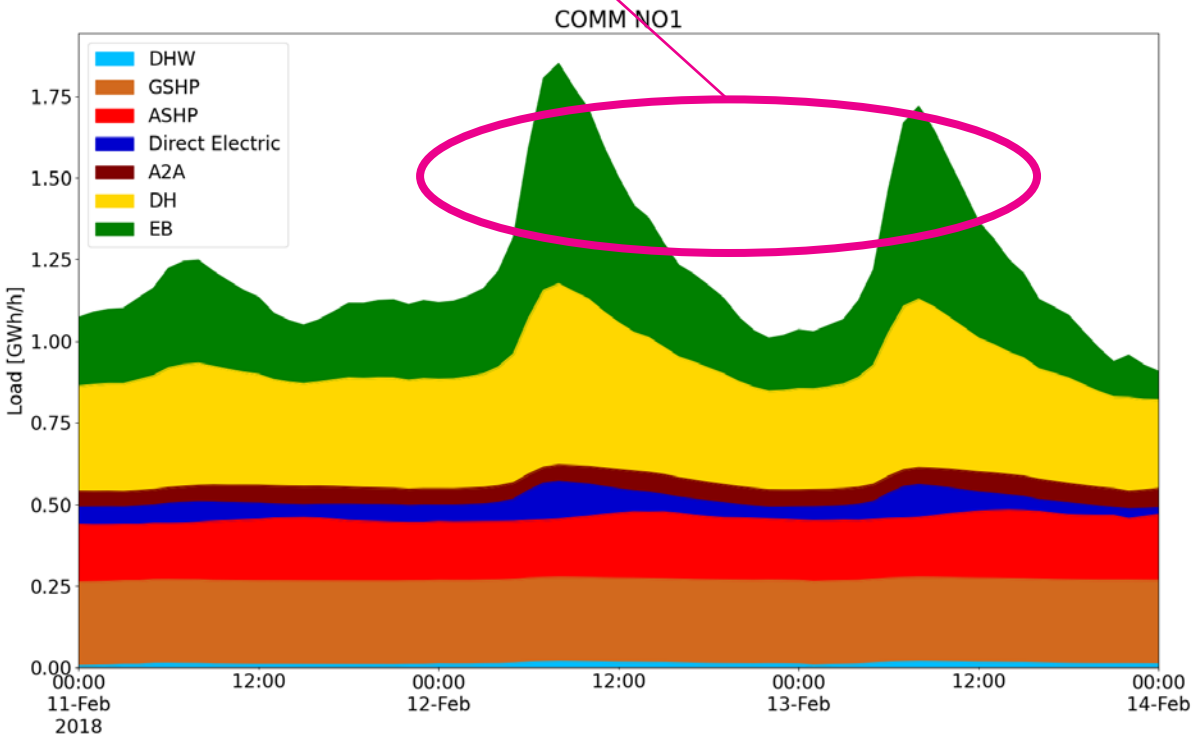
Residential sector

Direct electric (panelovner) as peak technology



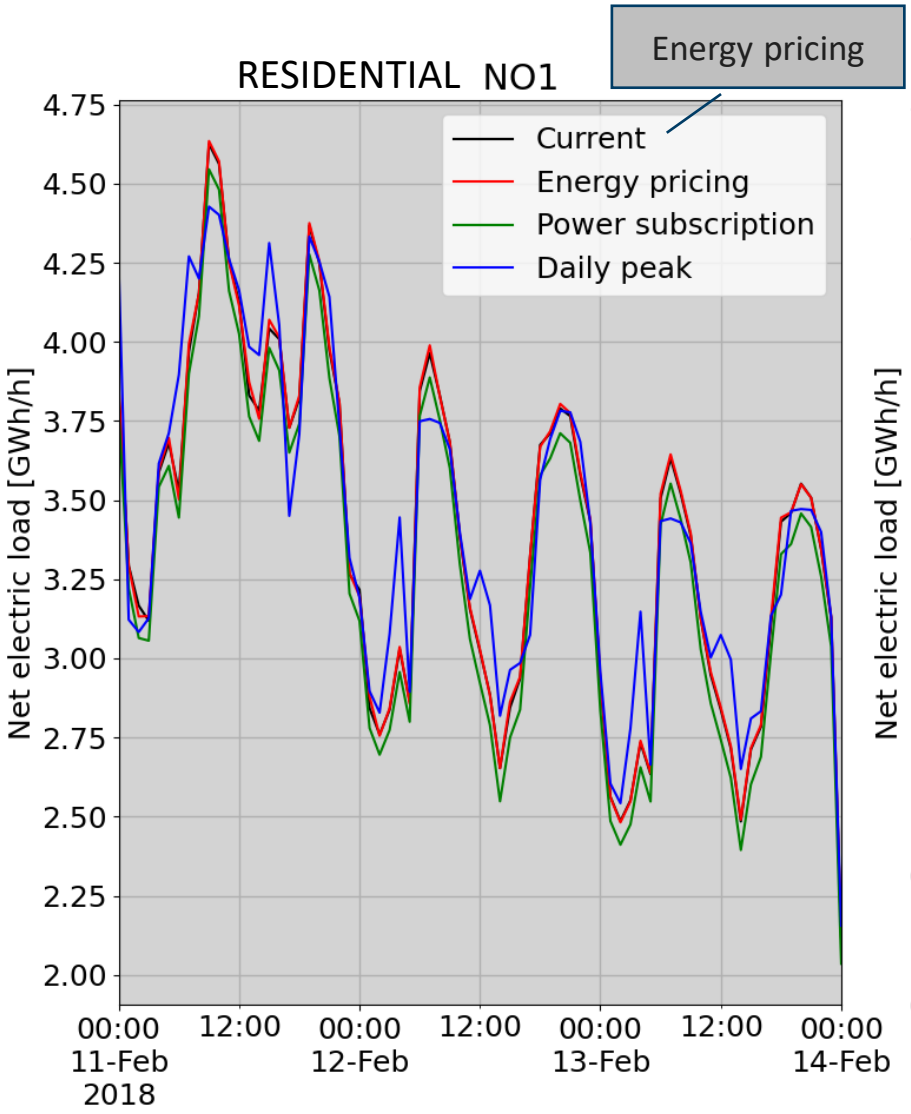
Commercial sector

Electric Boiler as peak technology

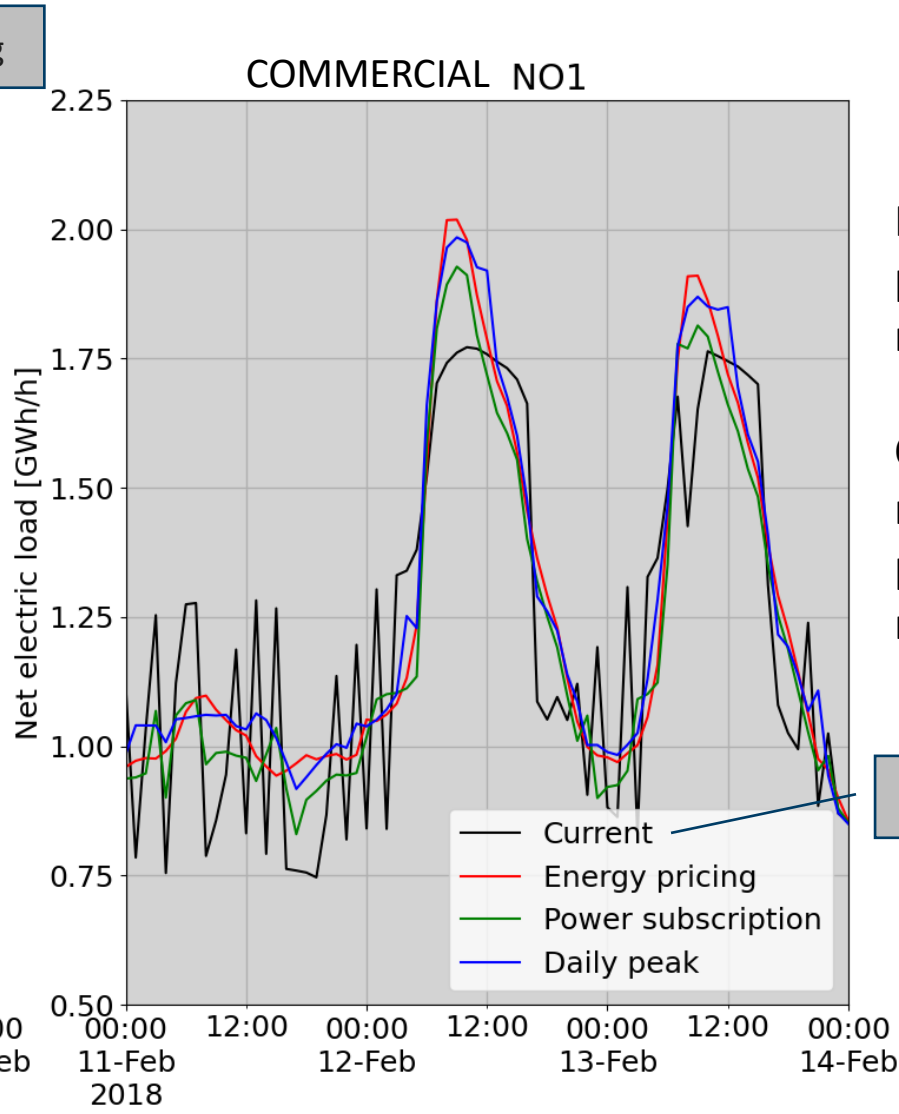


Aggregated electricity load with different grid tariffs

Flexibility potential from *Current* to *Daily peak:* 250 MWh/hr



Energy pricing



Flexibility potential is negative.

Current monthly peak power tariff is most effective.

Monthly peak power tariff

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FlexBuild – value of local flexibility for the system

Energy flexibility in buildings

- Large potential in Norway
- Heating system is essential: *thermal electric flexibility*
- Assess how the heat pump and heat storage influences the electric peak load

Peak load

- Occurs on the coldest day
- Power tariffs contributes
- RESIDENTIAL: daily peak tariff COMMERCIAL: current monthly peak tariff

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70 år

1950-2020

Teknologi for et bedre samfunn