



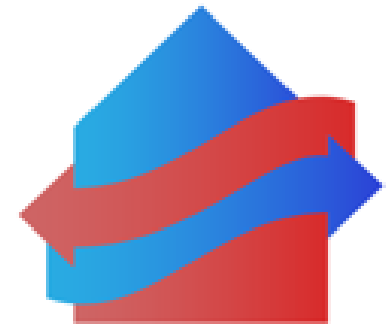
# Impact of energy flexible buildings on the energy system

FlexBuild Annual WS

5<sup>th</sup> Apr 2022

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# Research questions

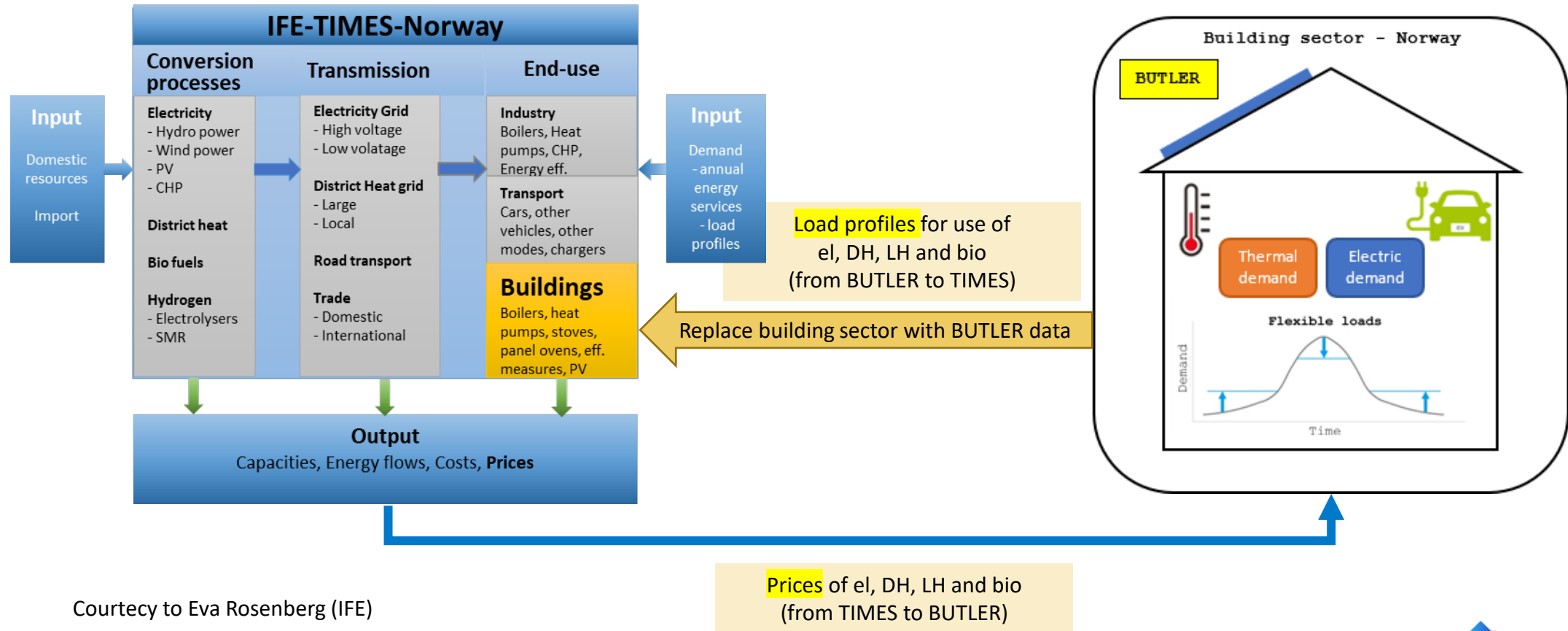
- The future is renewable and local
  - The devil is in the details
1. How can end-user flexibility in buildings aid the energy transition?
  2. How are the optimal energy solutions in buildings affected by enabling energy flexibility?
  3. How does a more detailed building sector modelling affect the quantification of the future role and value in the energy system of end-user flexibility in buildings&EV?





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# Modelling framework

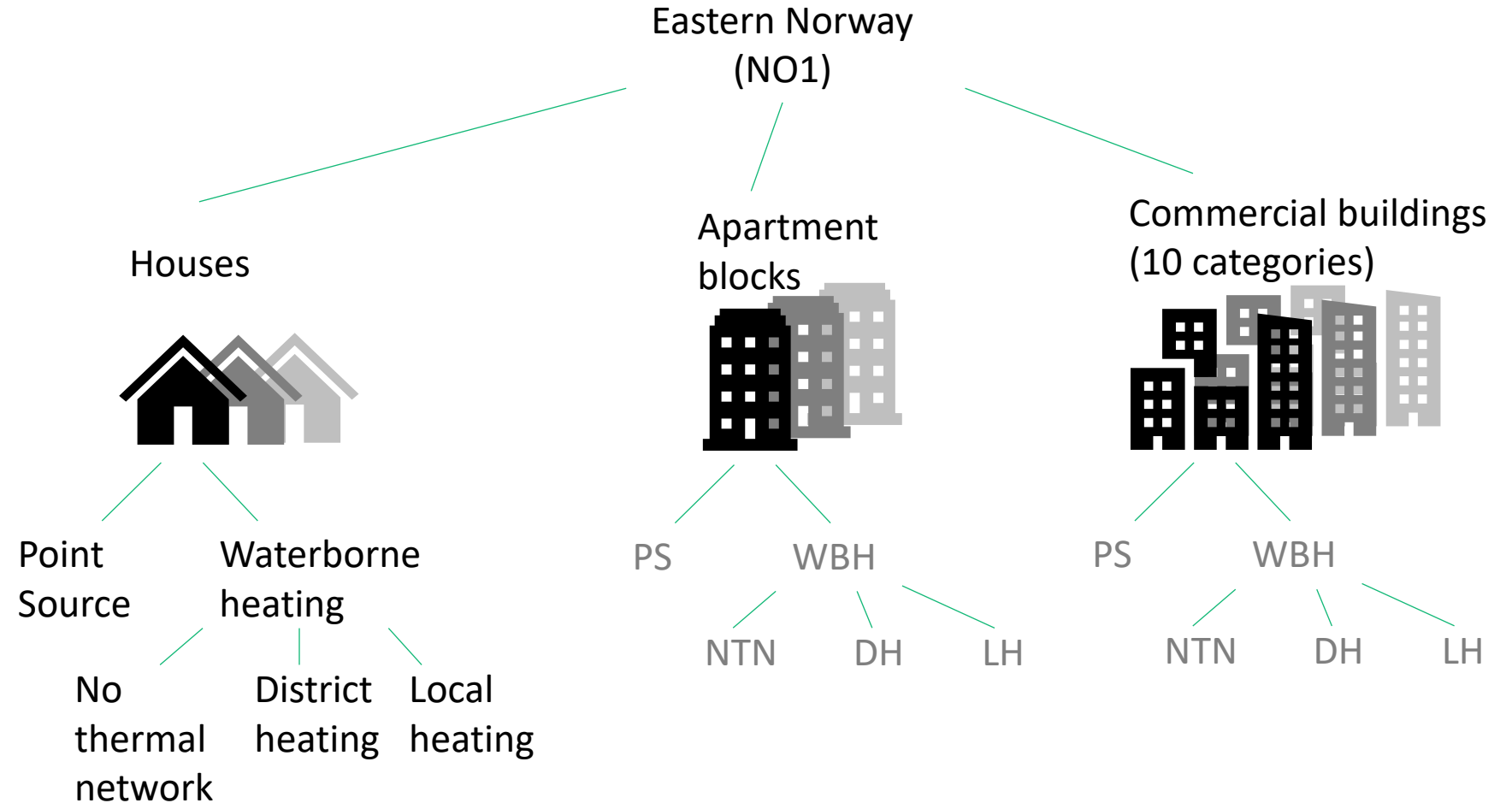




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# Building sector: aggregation methodology

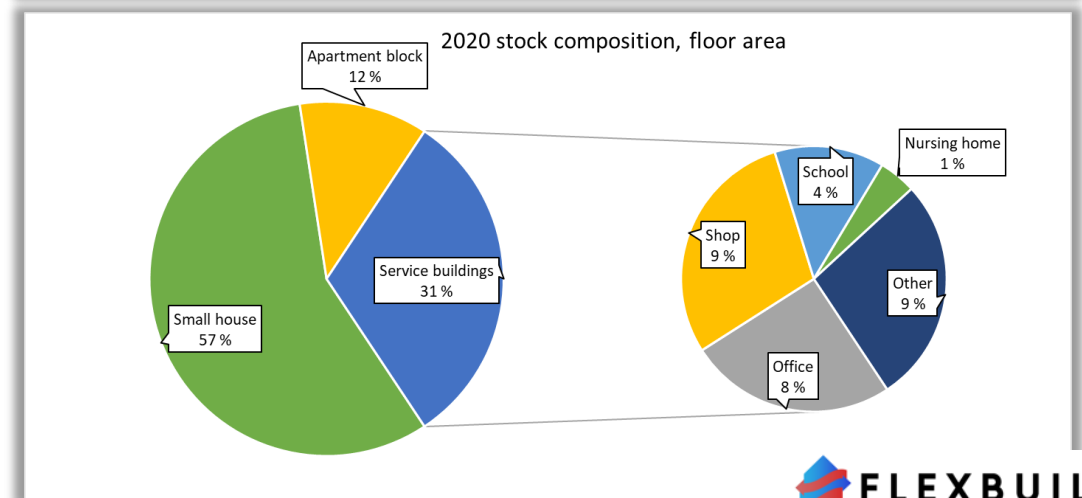
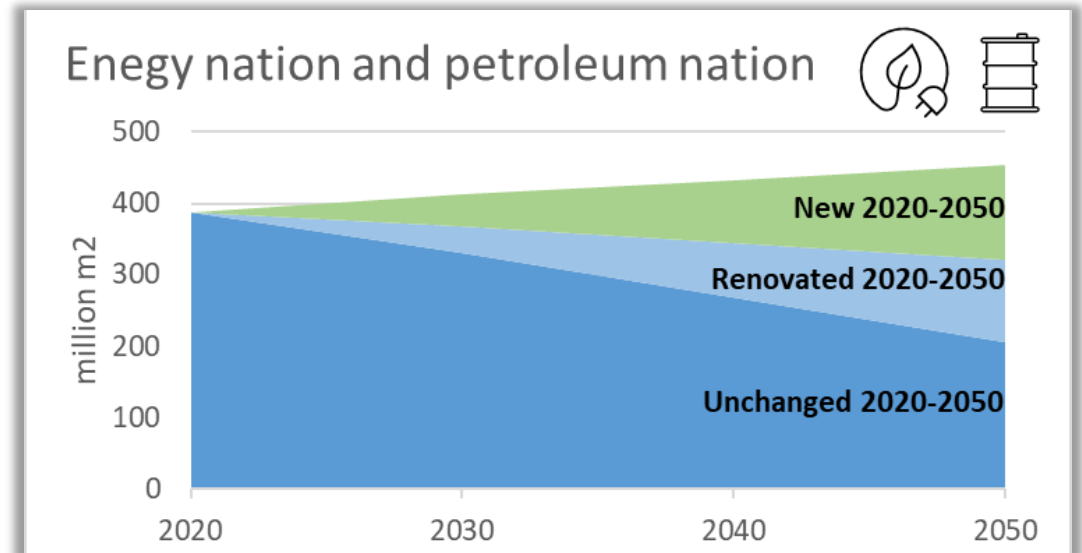
- 12 building categories
- 3 efficiency standards
  - Regular, Efficient, VeryEfficient
- 4 types
  - PS, NTN, DH, LH
- Total 144
  - single building simulations
  - Aggregation by building area (m2)





# Input and assumptions for 2050

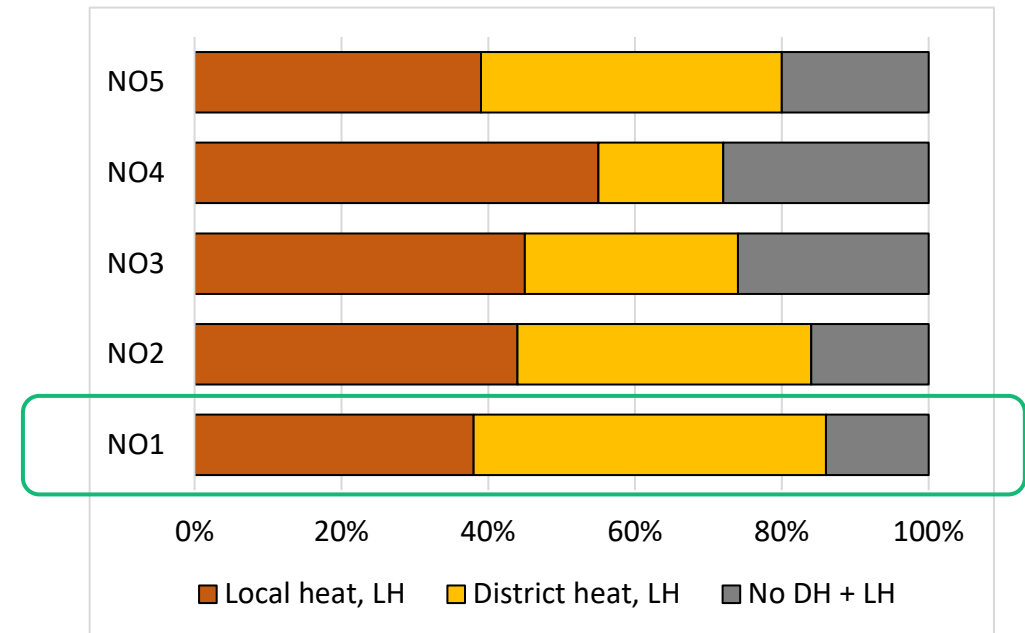
- Technology costs
  - NVE-report (2015) and market of today
  - PV og battery costs 2050 (IEA)
    - PV: 410 €/kW
    - Battery: 188 €/kWh
- Grid tariffs
  - Peak power tariff (el): Elvia
  - District heating: Fortum
- PV investment constraint
  - 20% of floor area & max 0,2 kWp/m<sup>2</sup>
  - Roof area assumed available:
    - House: 40 % (30 m<sup>2</sup>)
    - Apt: 80 % (600 m<sup>2</sup>)
    - Commercial: 100 % (2000 m<sup>2</sup>)
  - These assumptions may be adjusted
    - Feedback appreciated





# Input and assumptions (cont.)

- EV-use not included
- Flexibility in buildings
  - Thermal mass (space heating demand)
  - Max 2 degrees over-/preheating
- 4 different sets of technology availability
  - Local heating (LH), district heating (DH), no-thermal-network (NTN) and point source (PS)
  - Determines the availability of
    - ASHP or GSHP (heat pumps)
    - Bio fuel
    - District heating grid
    - Local heating grid





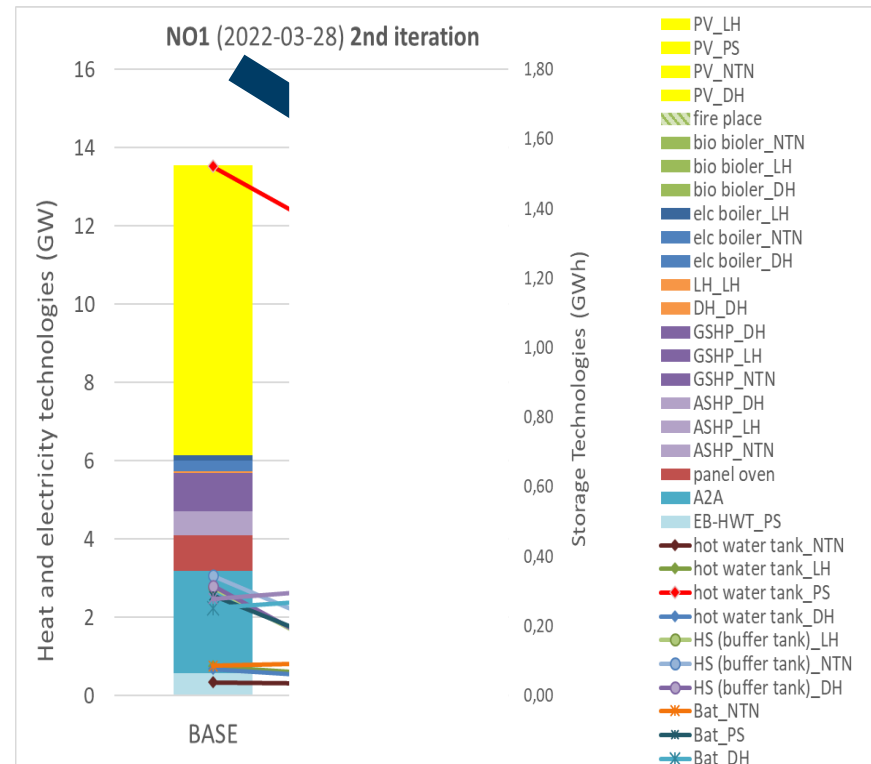
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# Results: Building sector in 2050

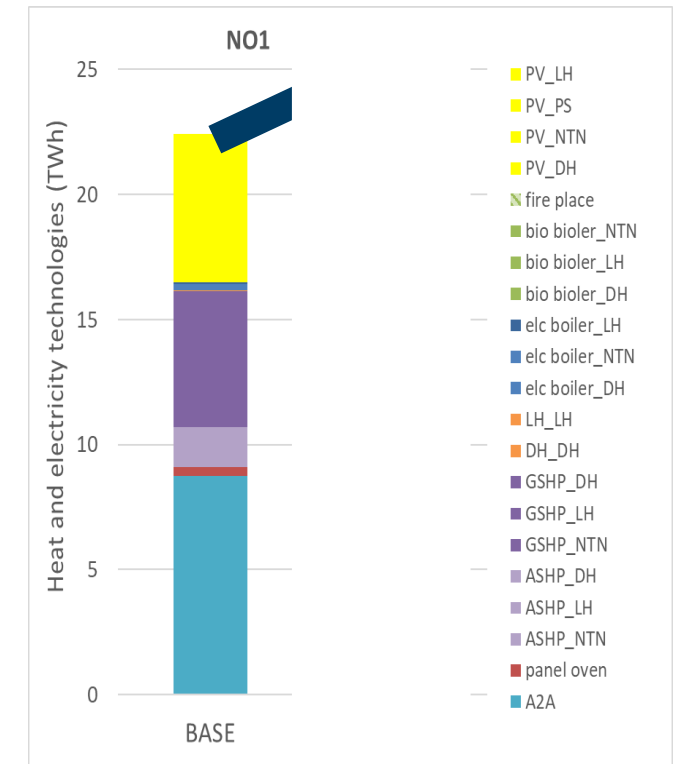
## Eastern Norway (NO1)

- PV and batteries are profitable
  - PV: 7,4 GW (5,9 TWh)
  - Batteries: 0,9 GWh
- Activating thermal flexibility
  - Total costs: -1,6%
  - Reduced capacities
    - storage (battery and heat)
    - peak load technologies
  - Increased energy use

## Installed capacity



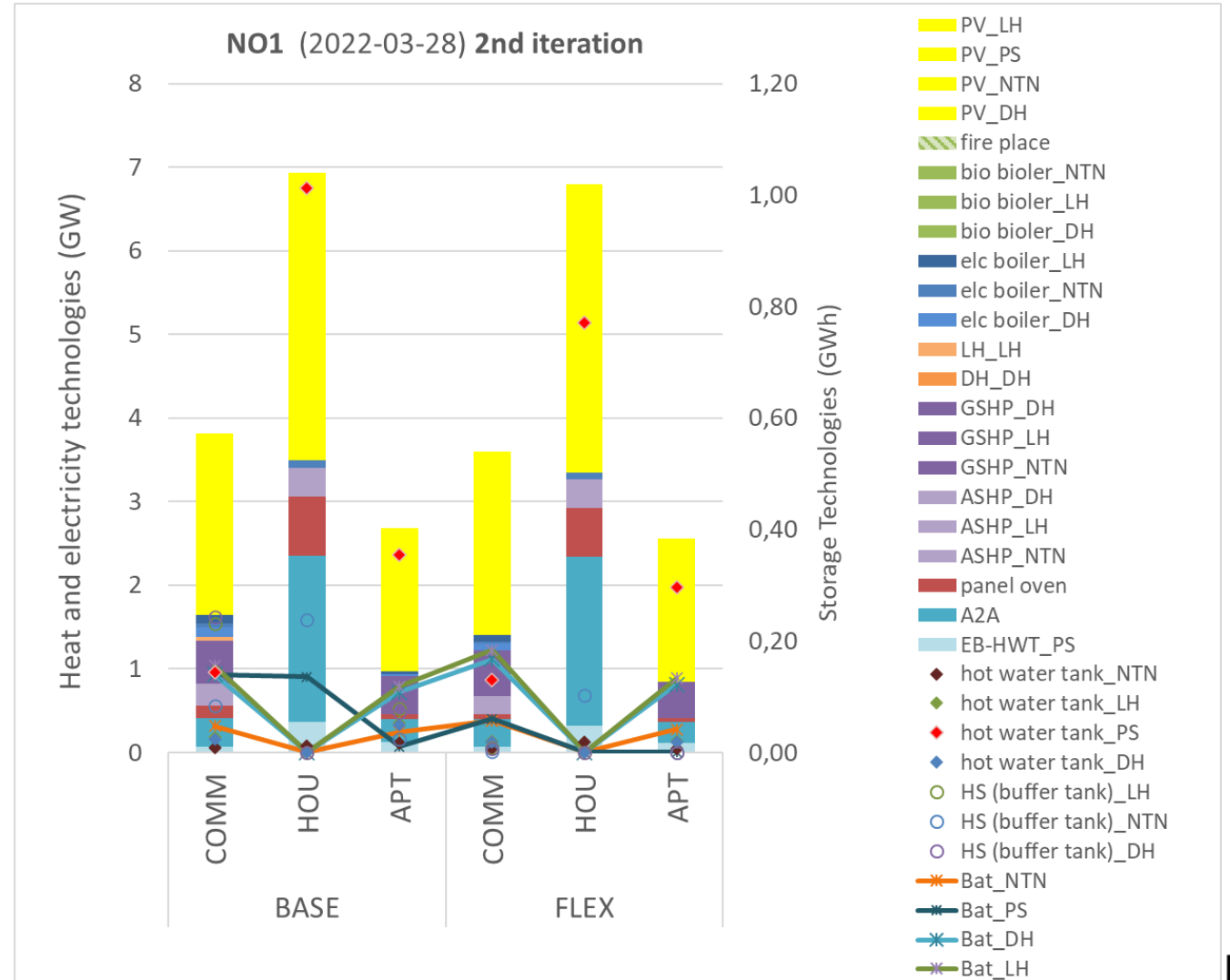
## Heat and EI produced





# Flexibility – impact on optimal energy solutions

- Energy solution
  - Technology choices not changed
- Technology size is smaller
  - Peak load technologies
  - Storage (battery and heat)
- Batteries
  - Mainly to increase PV self-consumption
  - HOU: disappears
- Utilising space heating flexibility
  - Reduces need for battery for PS



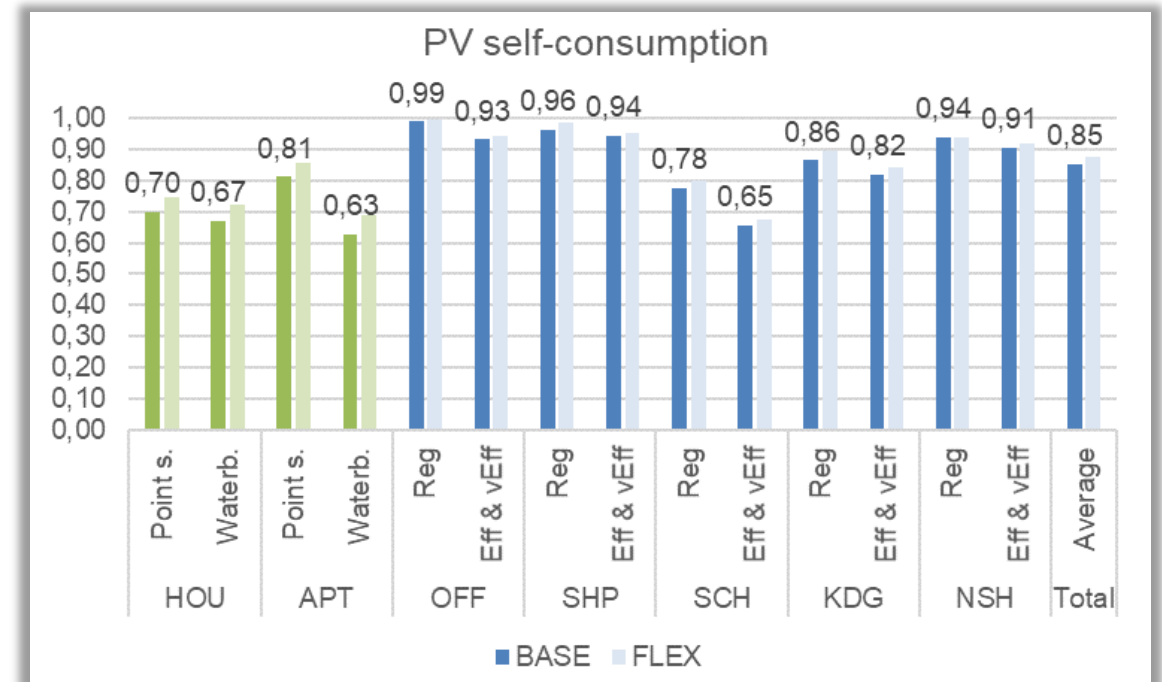




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# PV self-consumption

- Solar power production (PV)
  - Residential NO1: 3,8 TWh
  - Commercial NO1: 2,1 TWh (max limit)
  - Total Norway: ~ 14 TWh
- PV self-consumption
  - Average: 0,85
    - Residential: 0,70
    - Commercial: 0,88
  - Flexibility increases self-consumption
    - by +7 % (residential)
    - by +2 % (commercial)





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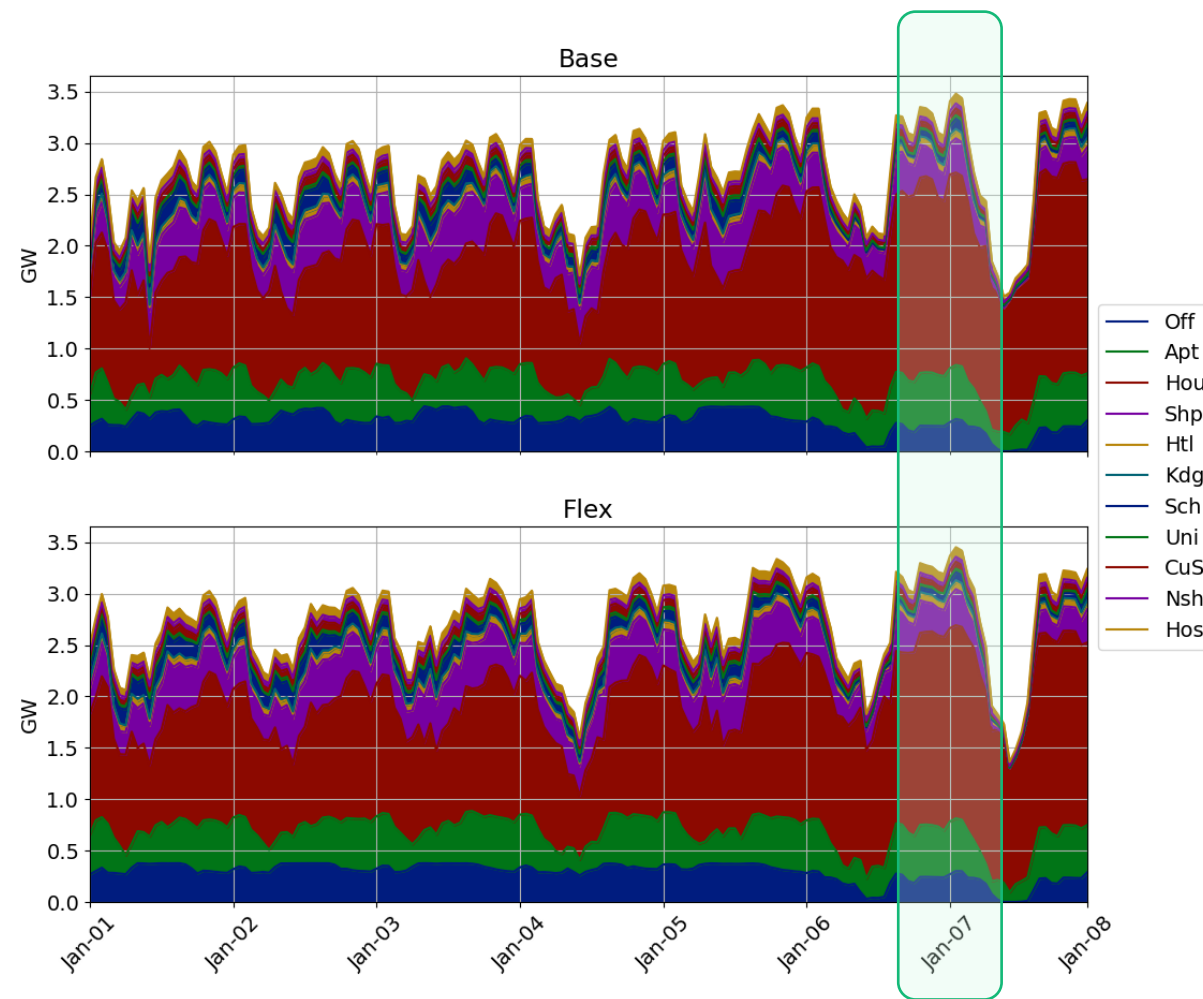
# Peak load of building sector

Individual peaks

		BASE	FLEX	DIFF.
HOU	MW	2047	1891	-8 %
APT	MW	528	514	-3 %
OFF	MW	438	387	-12 %
SHP	MW	485	447	-8 %
SCH	MW	179	158	-12 %
CUS	MW	92	85	-7 %
HOS	MW	95	94	-1 %
HTL	MW	76	74	-3 %
KDG	MW	30	22	-26 %
NSH	MW	61	60	-1 %
UNI	MW	49	44	-11 %
OTH	MW	99	94	-5 %
<b>sum</b>	<b>MW</b>	<b>4179</b>	<b>3869</b>	<b>-7 %</b>
<hr/>				
<b>Electr. import</b>	<b>MW</b>	<b>3 578</b>	<b>3 533</b>	<b>-1,26 %</b>

Aggregate peak

- Coincidence factor
  - reduces the aggregate effect of building's thermal flexibility

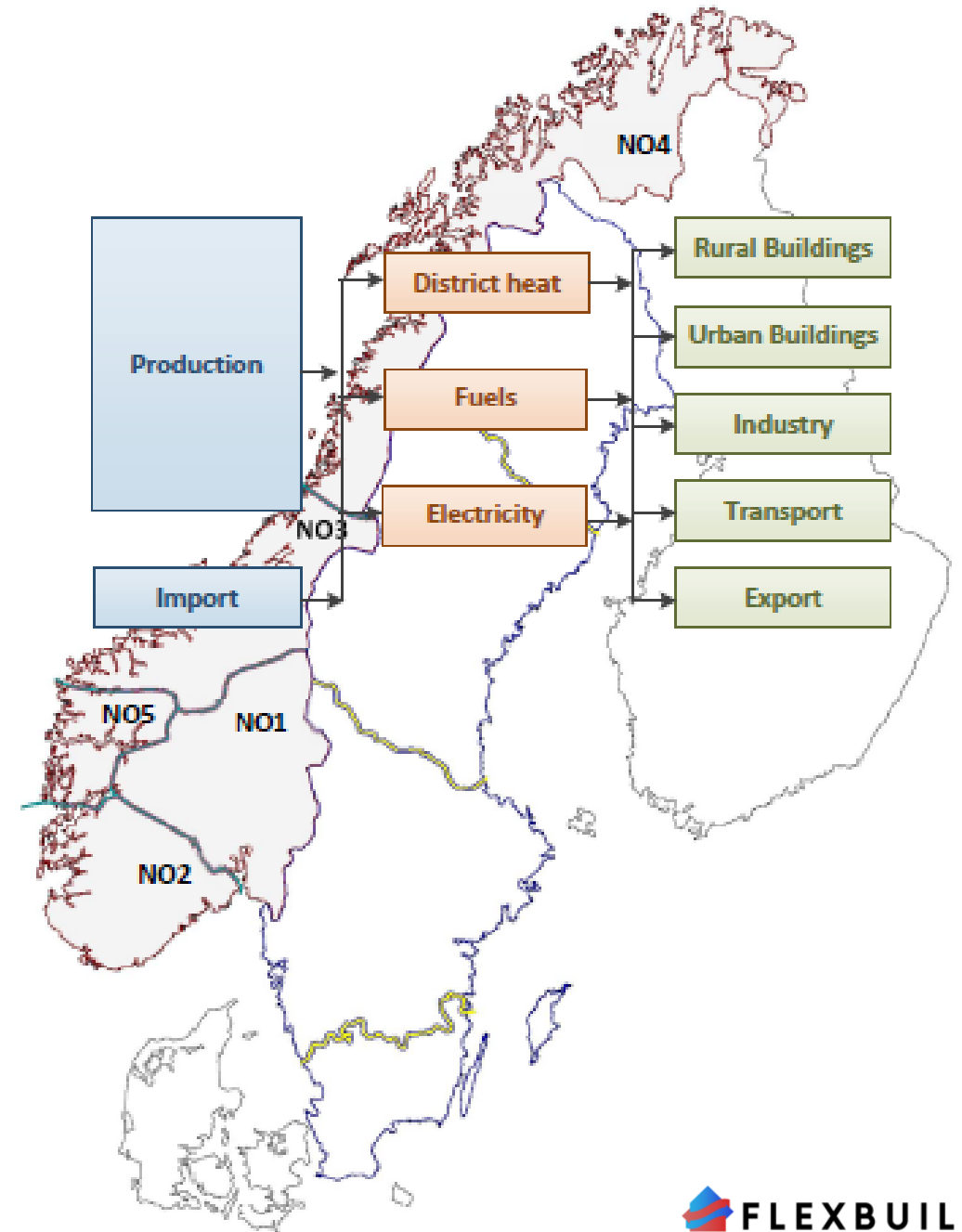




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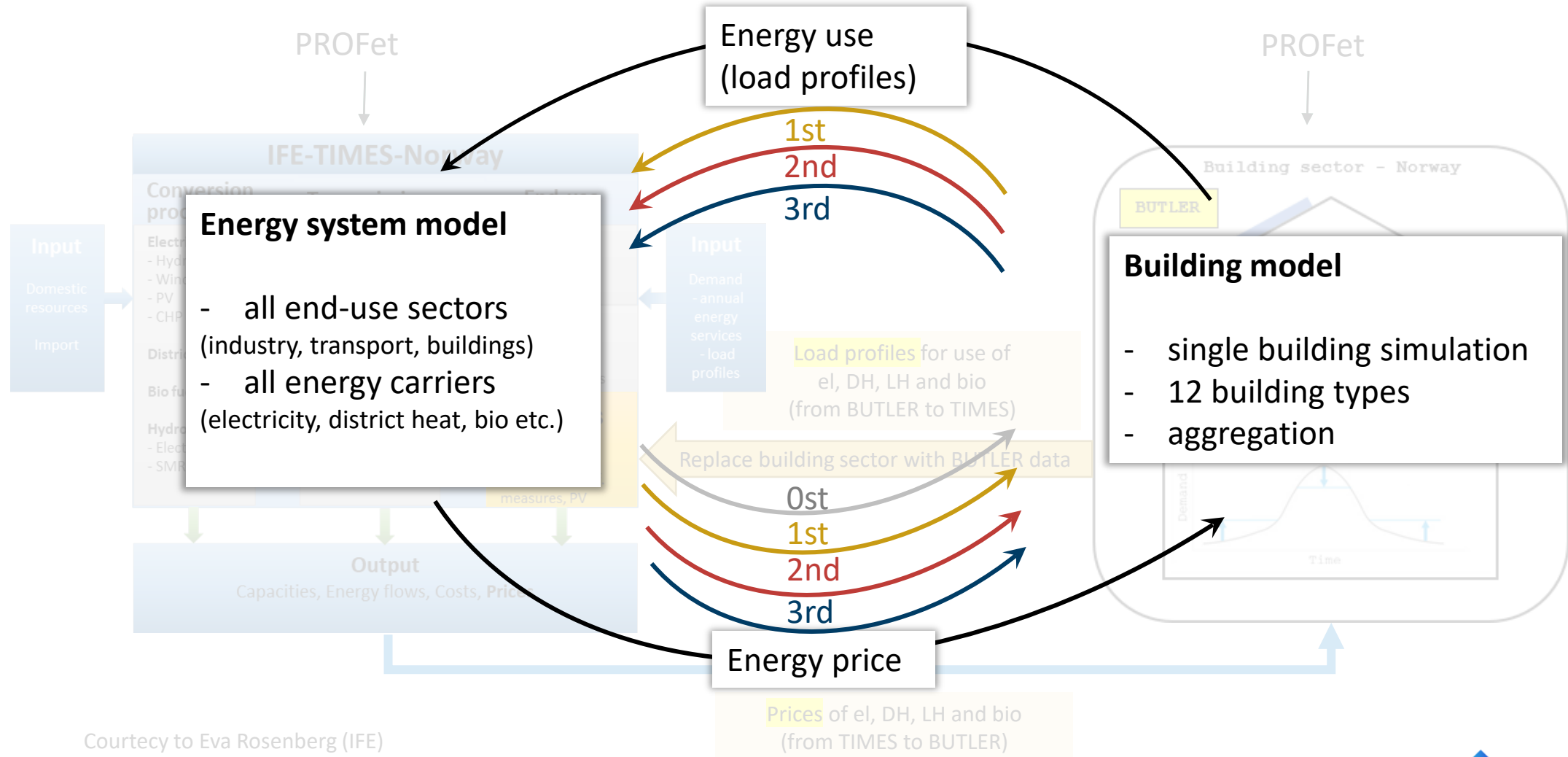
# LINKING RESULTS

- 2050
- Scenario "Energy nation"
- NO1
- Deterministic mode
- No flexibility applied





# Linking of TIMES and BUTLER

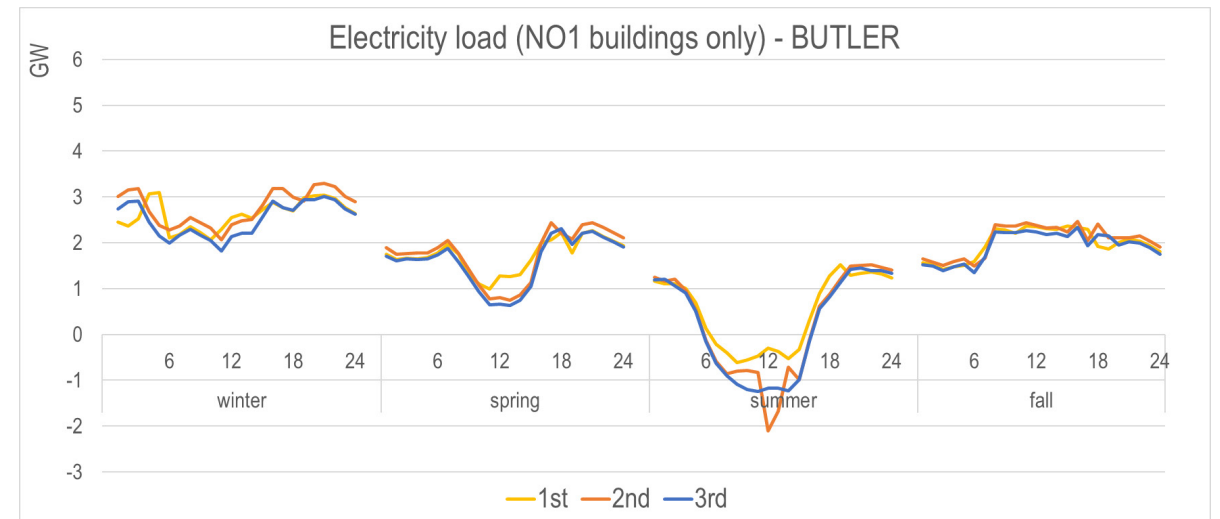
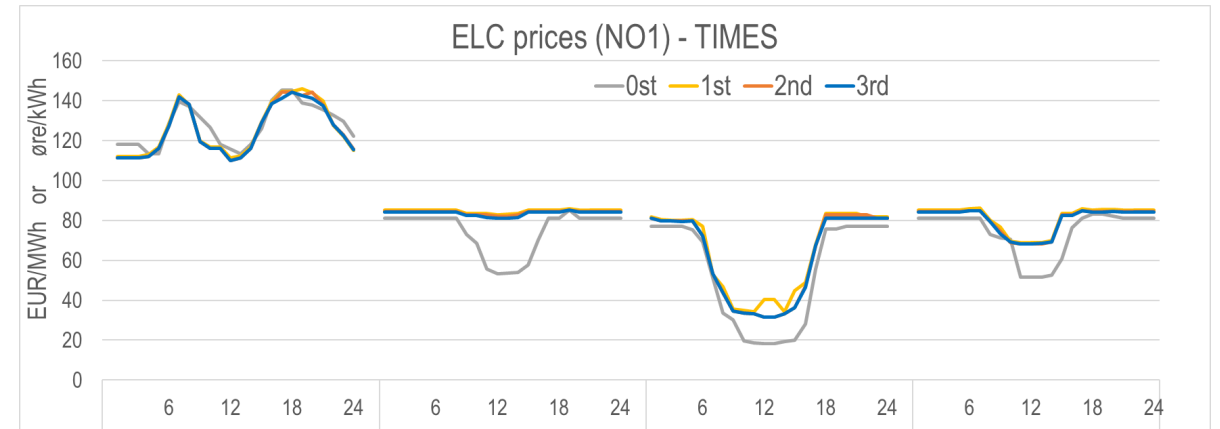




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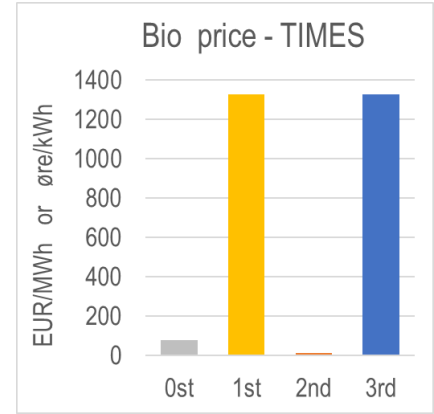
# Linking results

- Electricity prices
  - from TIMES
  - Convergence
  
- Electricity load - buildings only
  - from BUTLER
  - Partly convergence



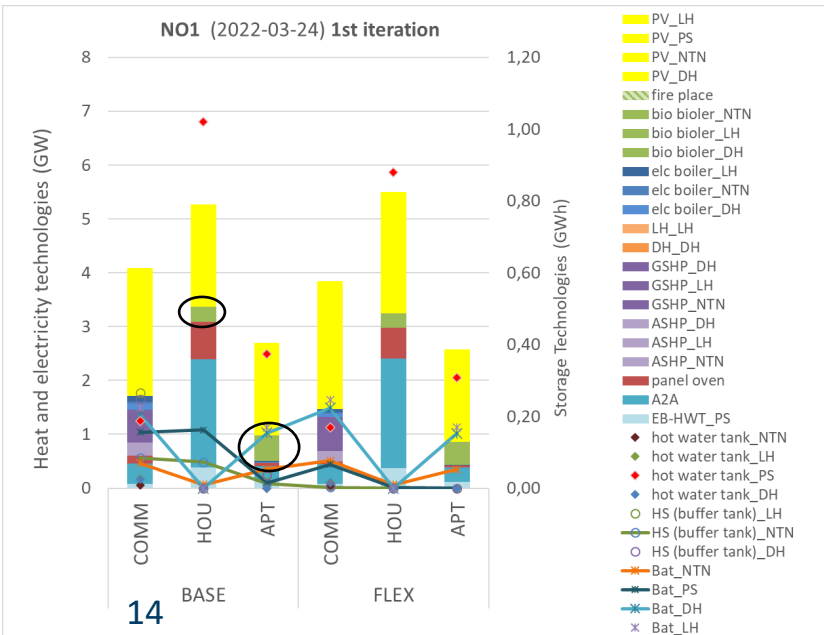
# Building sector

- Use of bio energy affects the bio energy price in TIMES



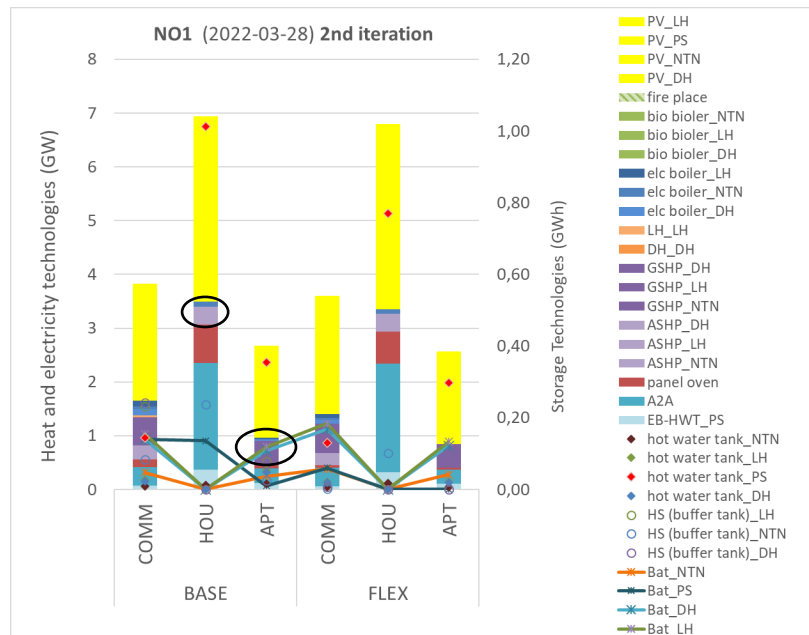
## 1<sup>st</sup> iteration

- bio boiler in residential



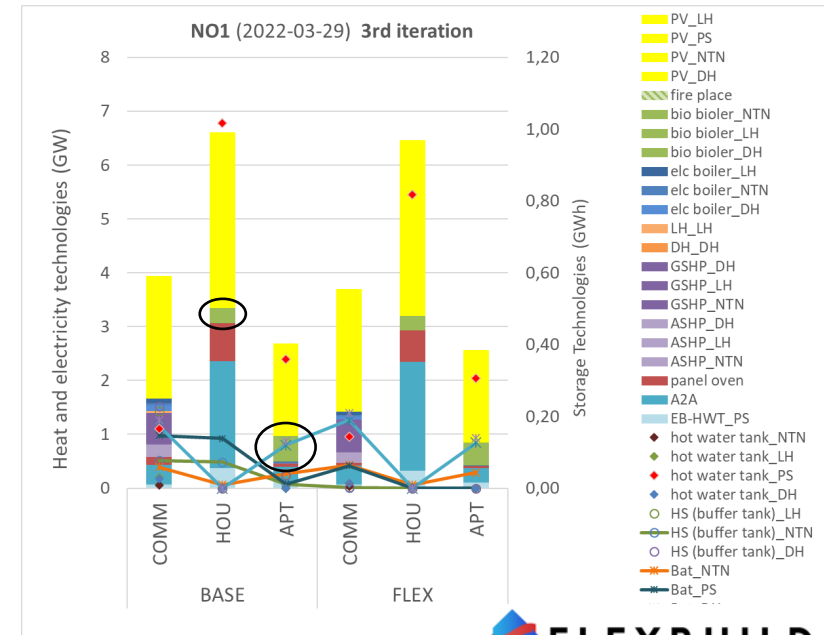
## 2<sup>nd</sup> iteration

- ASHP in Hou., GSHP in Apt.



## 3<sup>rd</sup> iteration

- Bio boiler in residential

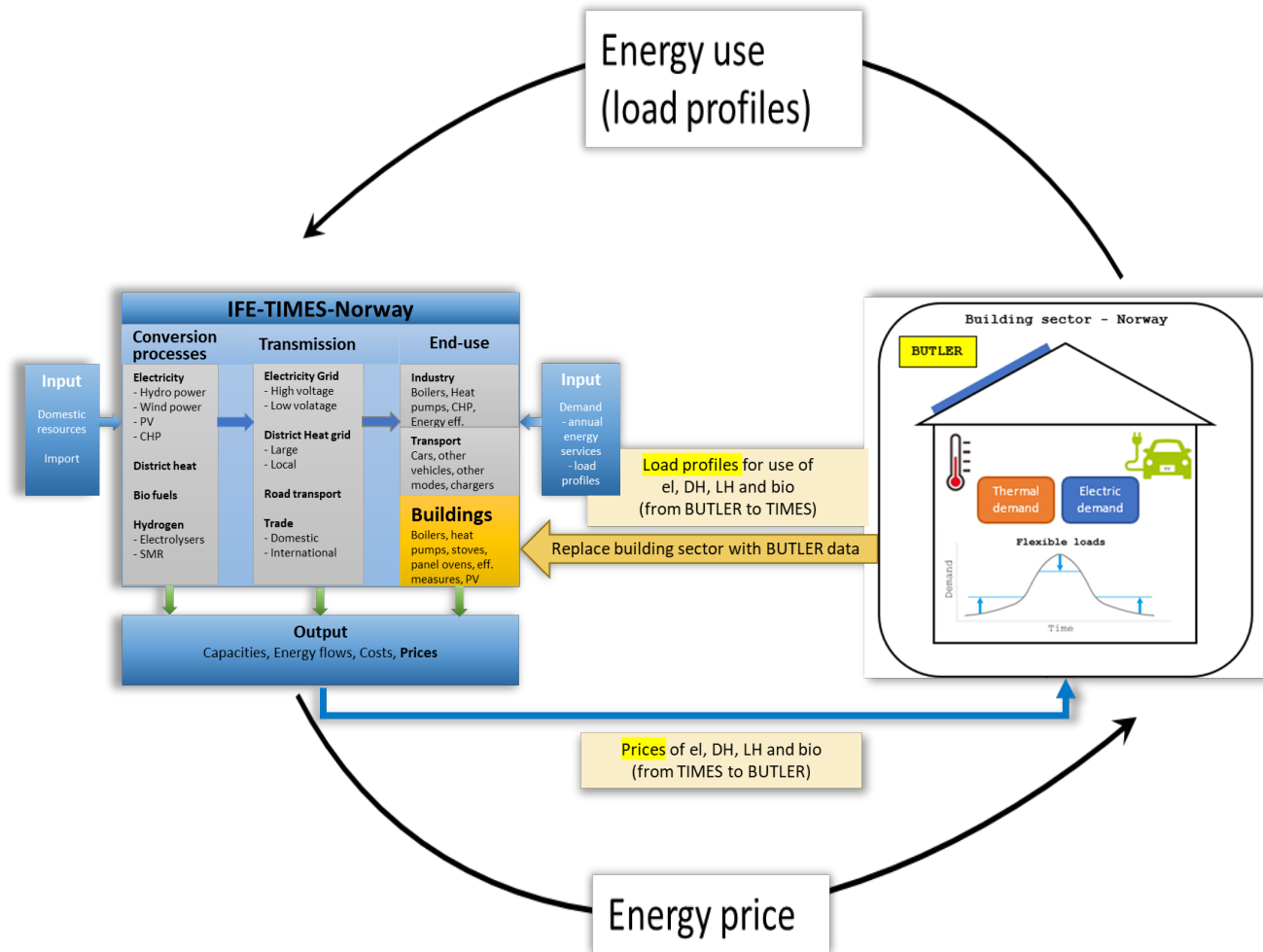




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# Conclusion

- Preliminary results – work in progress
- The linking works
  - Investigate the role of bio energy and local heating (LH)
- Building sector's space heating flexibility
  - Peak load reduction higher for individual buildings than aggregate (as expected)
- Next steps
  - Improve climatic correlations
    - stochastic optimisation (3 weather scenarios)
  - Include more flexibility options
    - EV charging and hot water





— 70 år —  
1950-2020

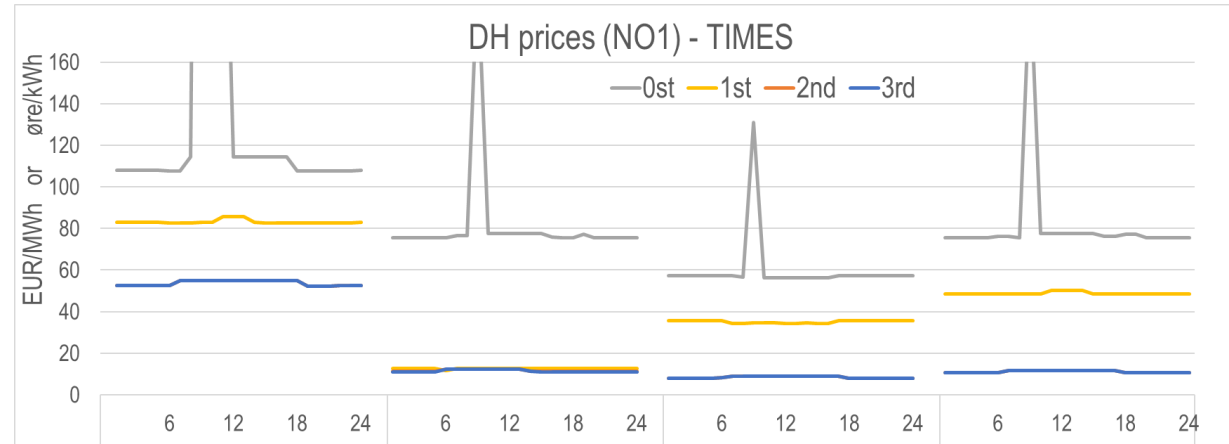
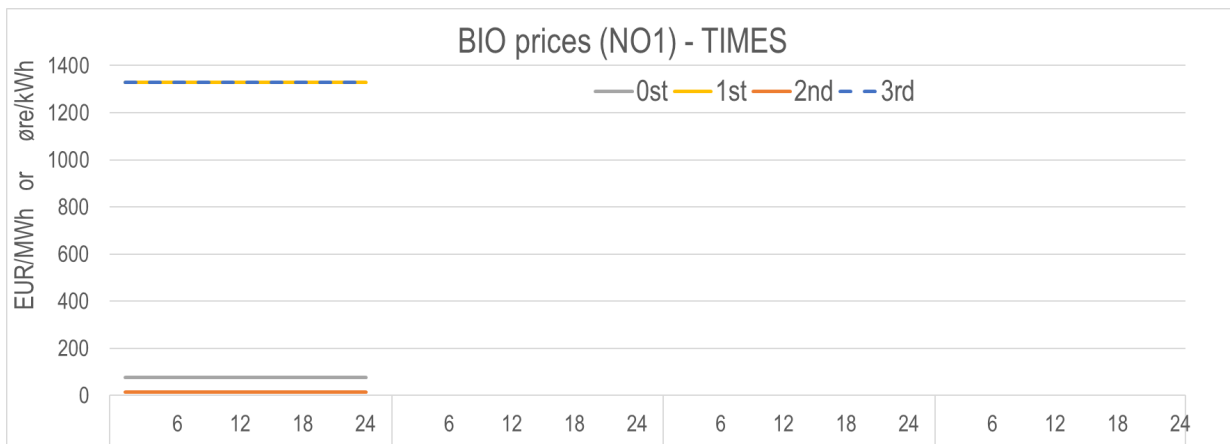
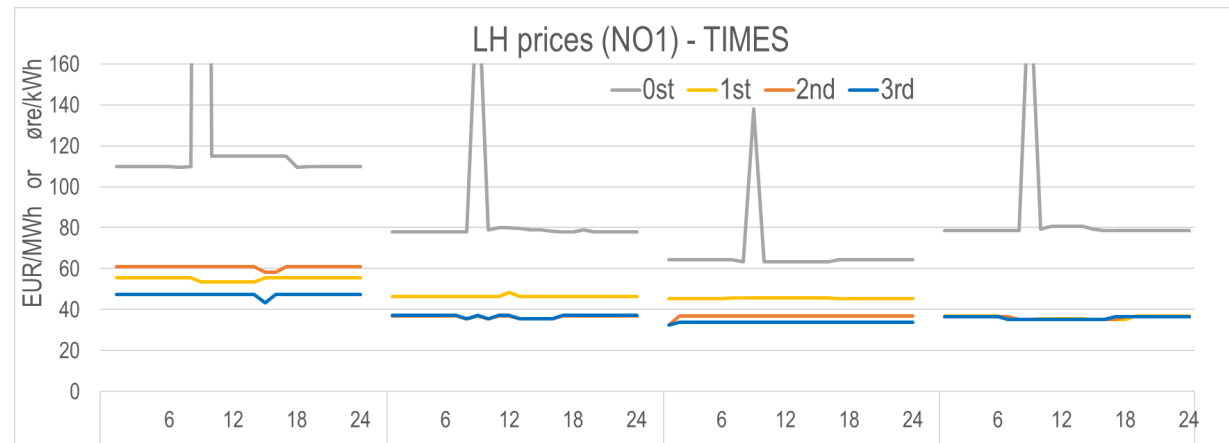
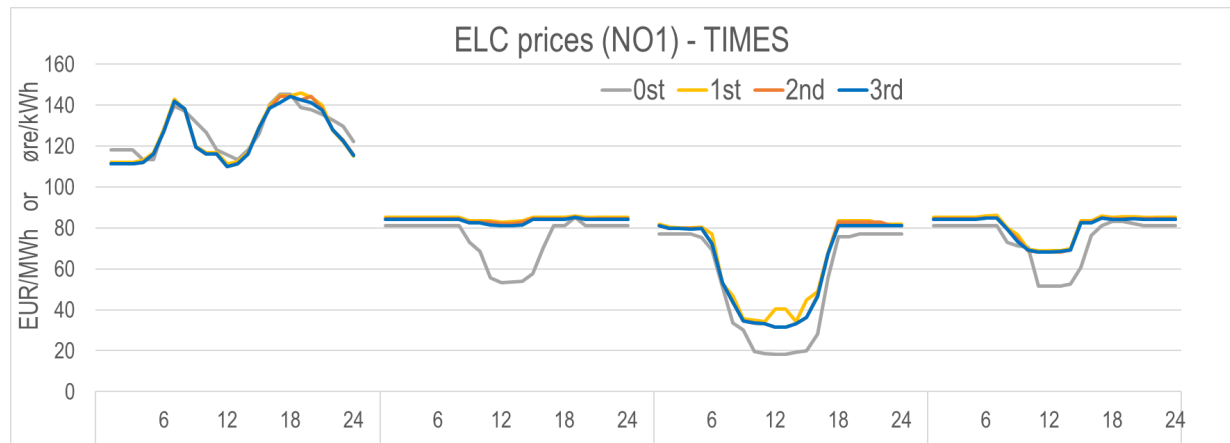
Teknologi for et bedre samfunn





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# Results (1/2): energy prices





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# Results (2/2): energy loads

