Research Centre on ZERO EMISSION NEIGHBOURHOODS IN SMART CITIES

NTNU SINTEF

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

Is it Possible to Supply Norwegian Apartment Blocks with 4th Generation District Heating?

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Research Centre on Zero Emission Neighbourhoods in Smart Cities – FME ZEN

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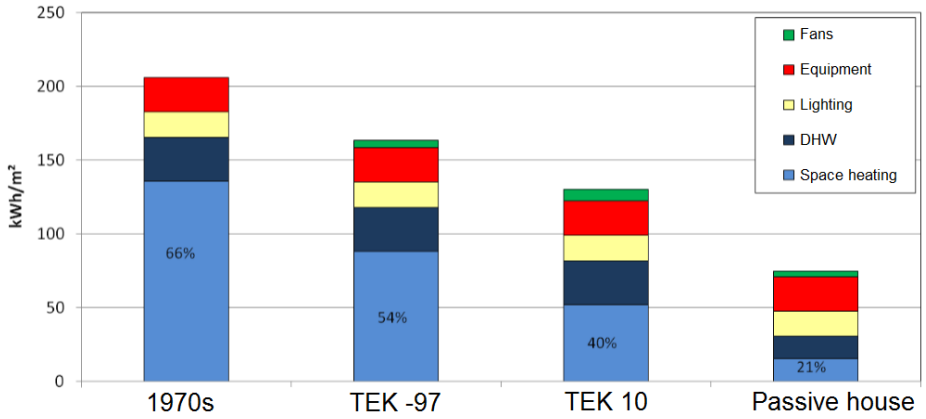
Background



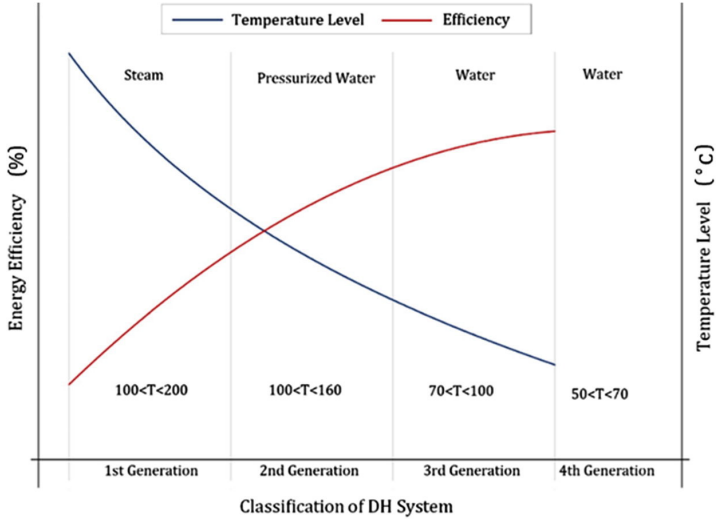
Sources: Jensen, 2015

Energy efficient buildings and DH systems
→ Transition to lower temp. levels

ZEN - both new and existing buildings
→ different temp. requirements

Is it possible to reduce T_{supply} in existing Norwegian apartment blocks?

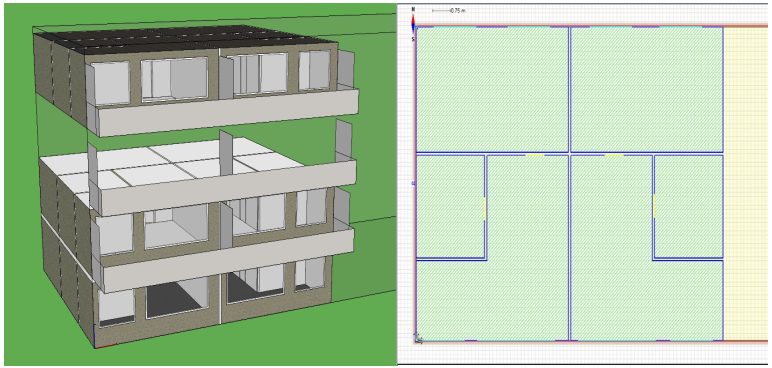
Park et al. 2017



Method

Building models in IDA ICE – 30 variants

Model	Building year	Number of floors / apartments	Floor area [m²]
AB_01	Before 1956	4 / 8	557
AB_02	1956-1970	4 / 16	1115
AB_03	1971-1980	4 / 24	1672
AB_04	1981-1990	4 / 24	1672
AB_05	1991-2000	4 / 24	1672
AB_06	2001-2010	4 / 24	1672
AB_07	2010-2020	4 / 24	1672
AB_08	After 2020	4 / 24	1672



- Input from TABULA/EPISCOPE-projects: U-values, heat recovery, etc.
- Radiators in living room and bedroom, el. floor heating in bathrooms
- Oslo climate, energy calc. according to SN TS 3031:2016
- Limitations: Focus on the building side, DHW not evaluated

Example, AB_03

- Building year 1971-1980
- Similar to AB_04-05, i.e. valid for 1971-2000
- Radiators dim. 80/60 then reduced temp. to 60/40 °C
- 3 building standards → 6 model versions

AB_03
- 80-60 Var 1
  - 80-60 Var 2 win+inf
    - 80-60 Var 2
- 60-40 Var 1
  - 60-40 Var 2 win+inf
    - 60-40 Var 2

Component	Specifications Var 1 As-built	U-value Var 1 (W/m²K)	Specifications Var 2 Standard renovation	U-value Var 2 (W/m²K)
Roof	Concrete slab, 180 mm mineral wool, compact roof	0.21	+70 mm min wool	0.14
External wall	Frame-built timber wall, 100 mm min wool + 50 mm thermal bridge barrier	0.34	+50 mm minwool + brick veneer	0.18
Windows	Double-glazed window, regular glass, air-filled	2.60	Double-glazed window, one LE-coating, air-filled	1.90
Floor	Concrete floor, 100 mm min wool	0.31	+50 mm min wool in cold basement	0.26

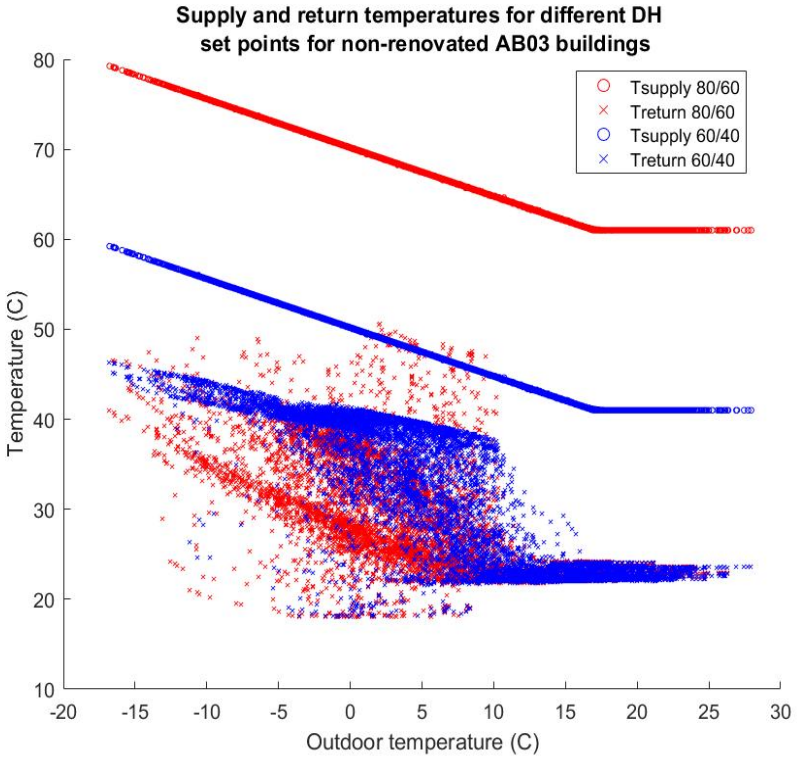
Results

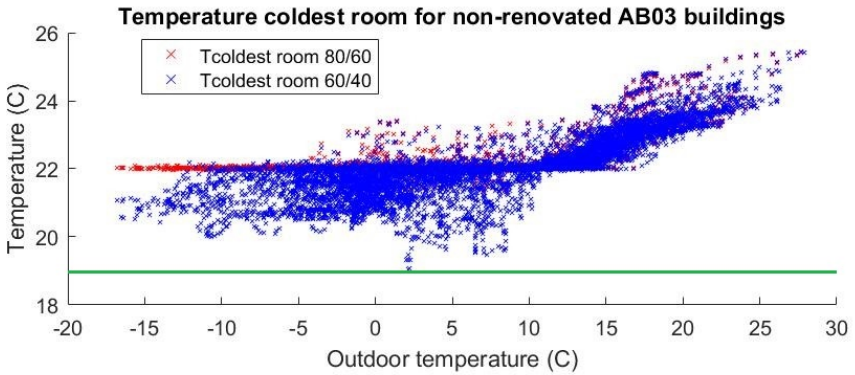
- Evaluated acceptable T_{in} in living room for apartment on ground floor gable wall,

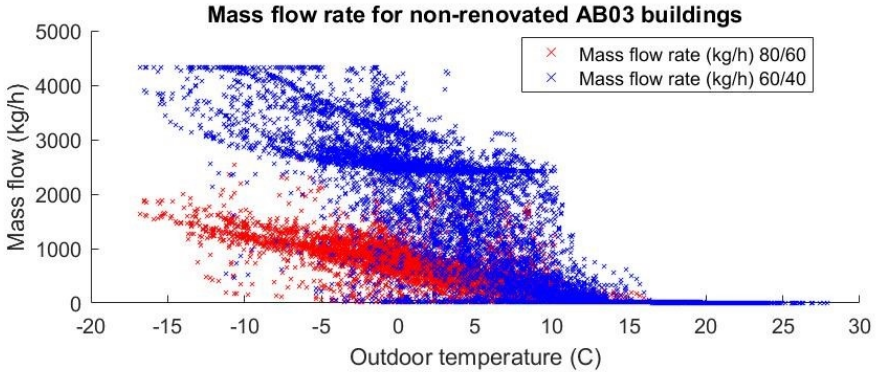
T_{set} = 22 °C and T_{min} = 19.0 °C.

- Reduced $T_{radiator}$ from 80/60 to 60/40 °C
- Three standards for the building envelope:
    - As-built (var 1)
    - Intermediate renovation (var 2 win+inf)
    - Standard renovation (var 2)

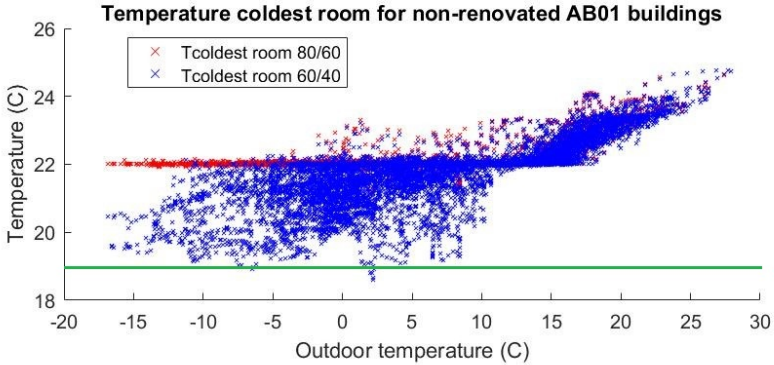
AB_03 as-built (1971-2000)

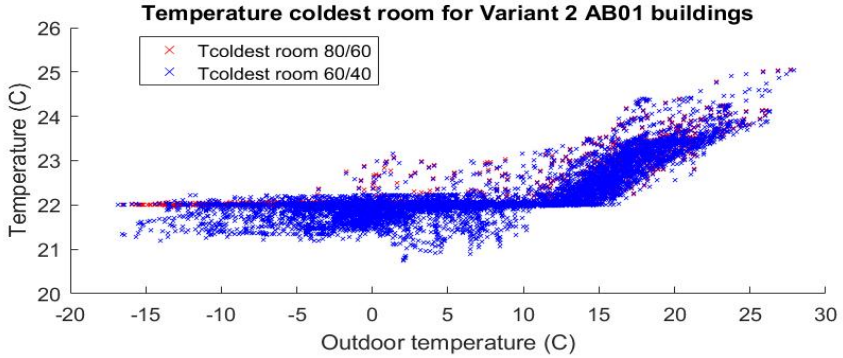


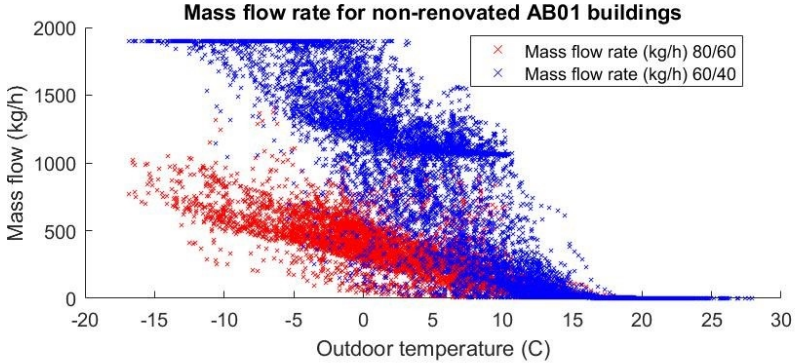


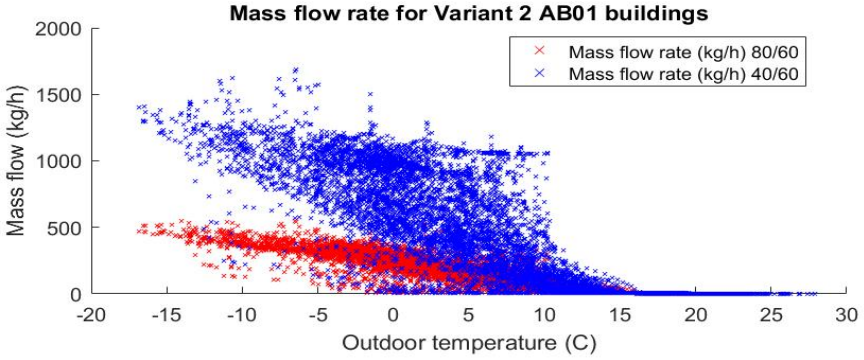


AB_01 (before 1956) as-built and std renovation



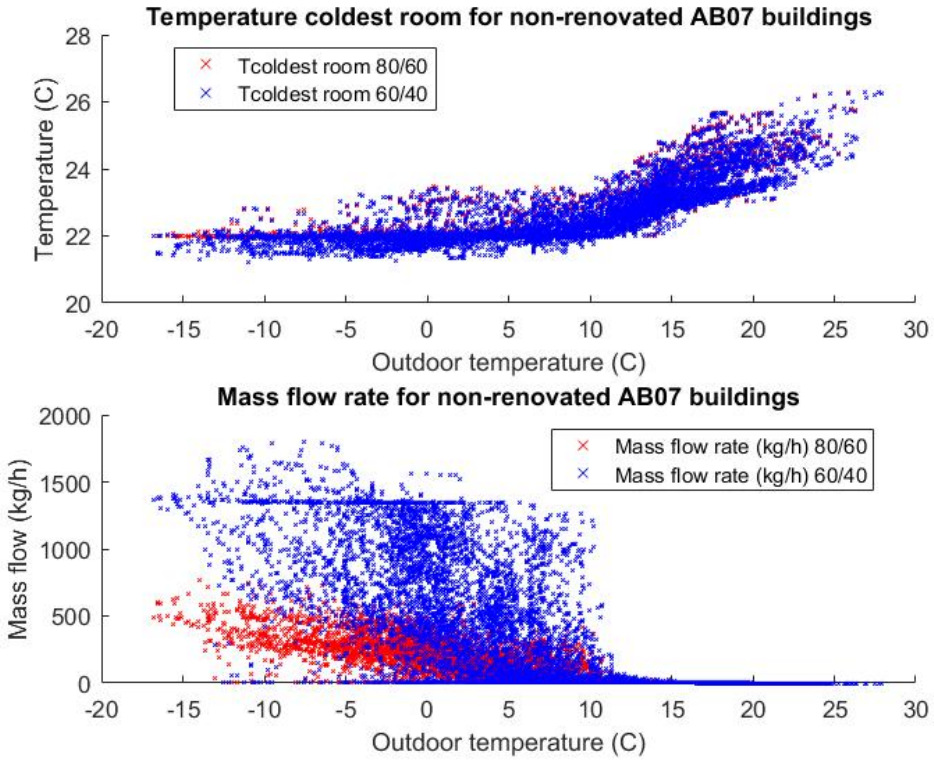






AB_07 (2010-2020) as-built

T_{in} close to 22 °C



Comparison of heating needs to Tabula

Space heating + heating battery, not recovered heat in kWh/(m²·yr)

		As-built (Var 1)			Standard renovation (Var 2)		
	Bldg. year	IDA ICE	TABULA	Deviation	IDA ICE	TABULA	Deviation
AB_01	-1956	196	172	12 %	129	112	13 %
AB_02	1956-1970	175	180	-3 %	112	94	16 %
AB_03	1971-1980	108	101	7 %	89	73	18 %
AB_04	1981-1990	95	90	5 %	89	74	17 %
AB_05	1991-2000	104	93	11 %	88	74	16 %
AB_06	2001-2010	52	56	-9 %	40	43	-7 %
AB_07	2011-2020	36	41	-15 %	-	-	-
AB_08	2020-	19	9	53 %	-	-	-

Conclusion

- Challenge: Supply 4GDH to existing apartment blocks, not new buildings.
- Ok to reduce $T_{radiator}$ from 80/60 to 60/40 °C for apartment blocks built after 1970 + std renovated older buildings.
- Backup option: local peak load systems
- Users want 22 °C -> standard renovation is recommended
- 4GDH ok for thermal comfort, remaining issues on the DH side?

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Thank you!

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