ETH zürich

The role of wood for the Swiss building stock

Discussion Forum 60

Zurich 4. December 2015

Overview

1. Wood in the building stock
   - How much wood is stored in the Swiss building stock?
   - What material flows (in and out) can be expected?
   - What is the environmental benefit of an increased wood use in the building stock?

2. Sensitivity analysis
   - What are the drivers of environmental impact?
   - Is the difference in thermal inertia an issue?
   - Do wooden buildings have a favorable life cycle impact?

Swiss building stock assessment

Approach:

1. Determine the material quantities in the building stock
2. Determine energy demand
3. Prospective scenario analysis

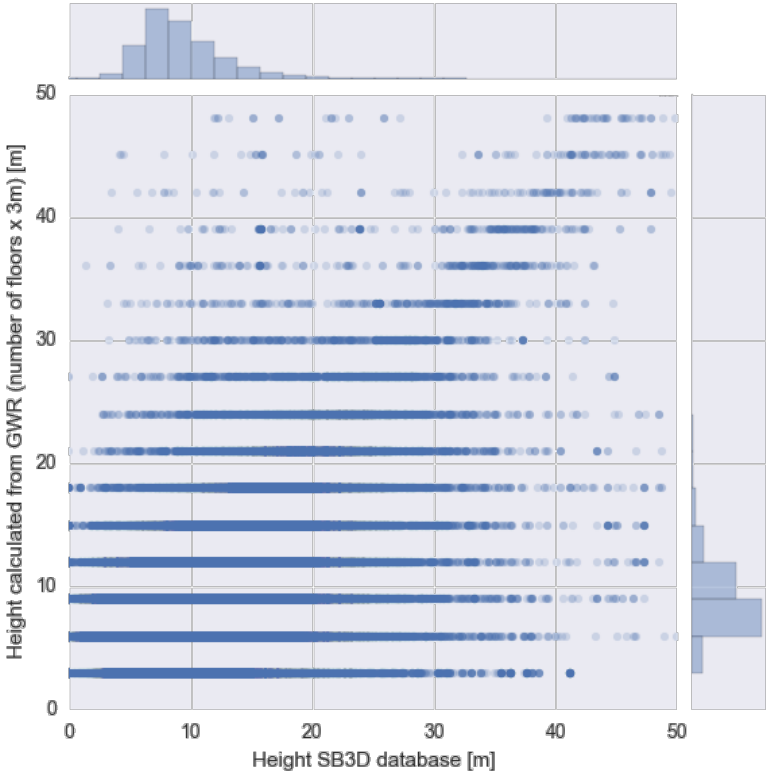
Method:

- Database join using geo-spatial, relational databases
- Bottom-up modelling of residential buildings
- Typology for material inventory

Merging databases

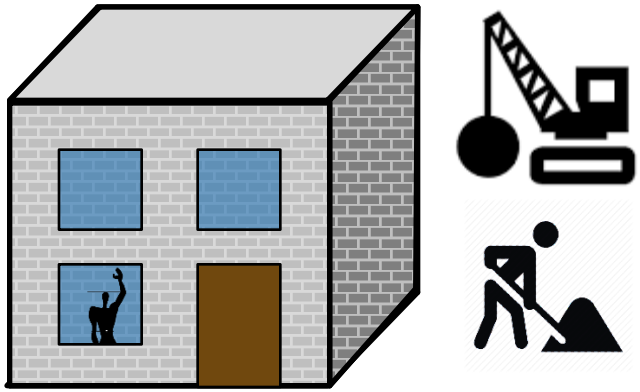
GWR: Swiss Federal Register of Buildings and Dwellings (point data)

SB3D: swissbuildings 3D (polygons)

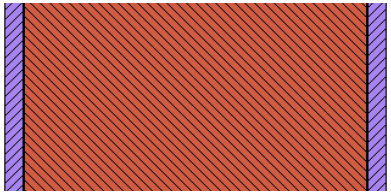


Building inventories

Information	Source
Location	GWR, SB3D
Footprint	SB3D, (GWR)
Age, heating, etc.	GWR

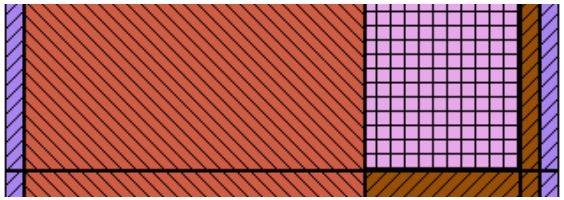


Building inventory
Example: Exterior wall 1920-1946 (brick type)



Initial construction
Plastered brickwork
Thermal property (*U*): 0.82 W/m²K

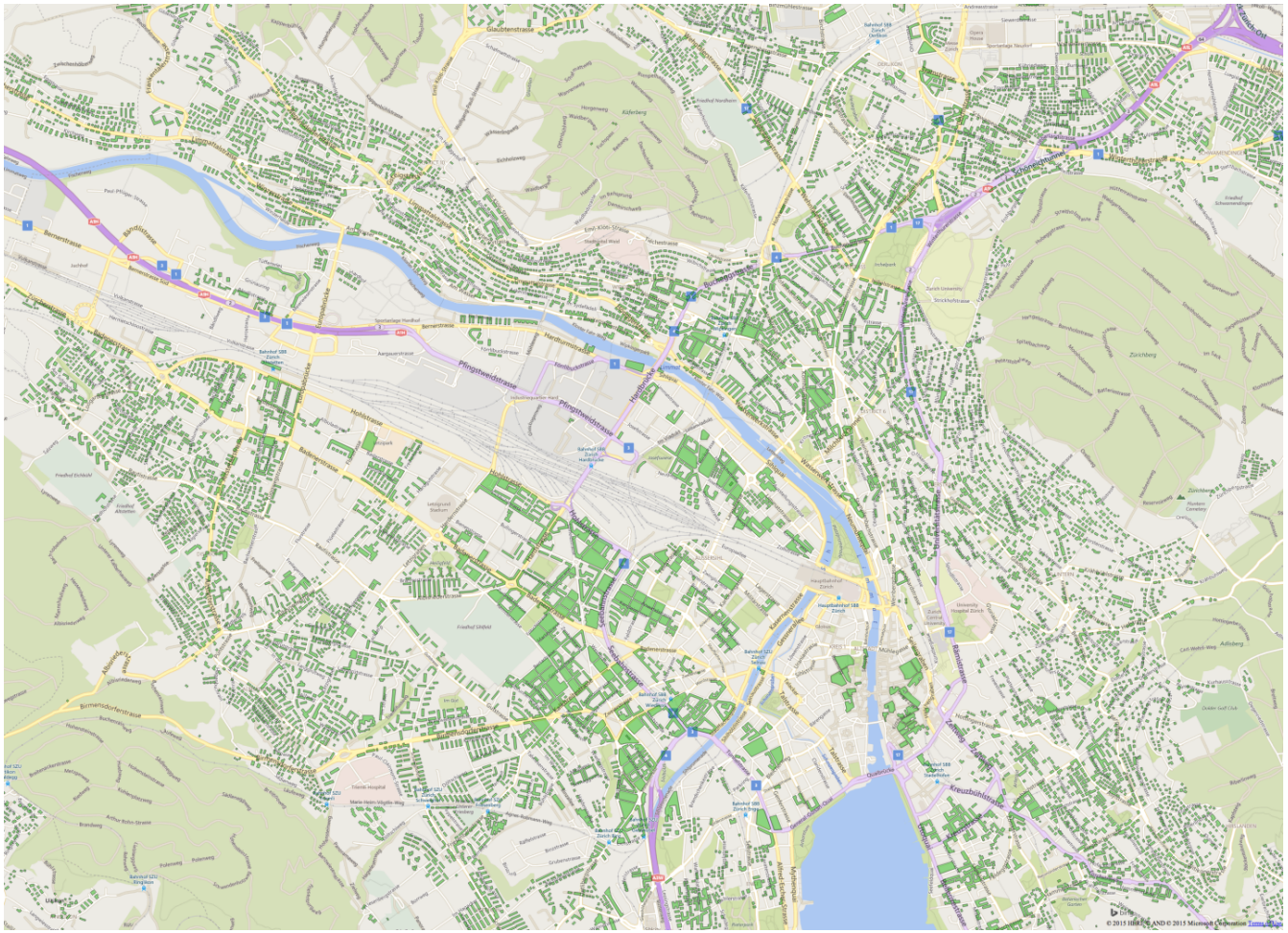
Legal minimum
+10cm insulation, +2cm plaster
-2cm plaster
Thermal property (*U*): 0.24 W/m²K



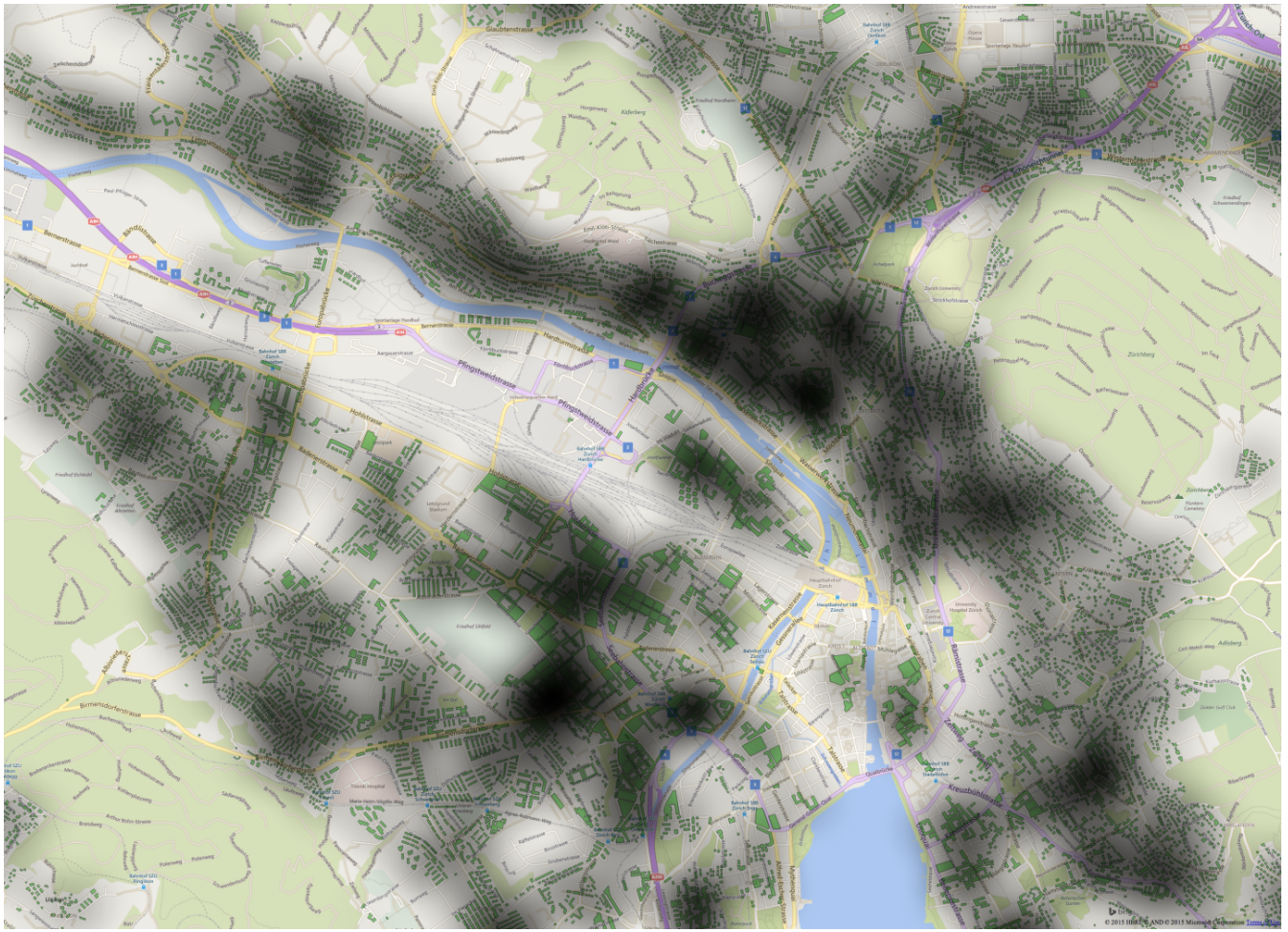
Wooden refurbishment
+16cm wood-based insulation,
+16cm wooden beam,
+2cm wooden fibre board
+2cm plaster, -2cm plaster
Thermal property (*U*): 0.25 W/m²K

Ostermeyer et al. 2015 (accepted)

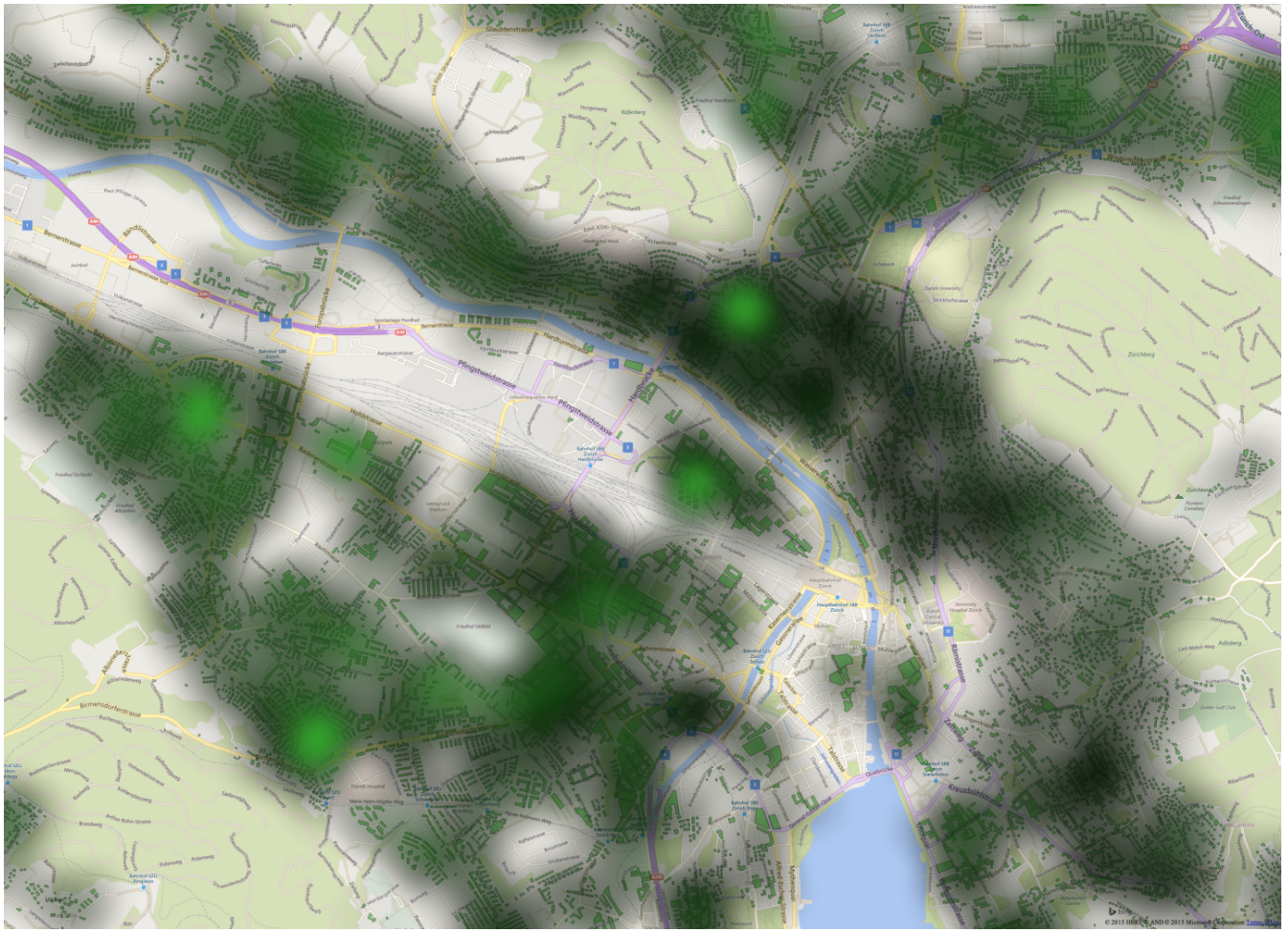
Results



Results
mineral material volume 2015

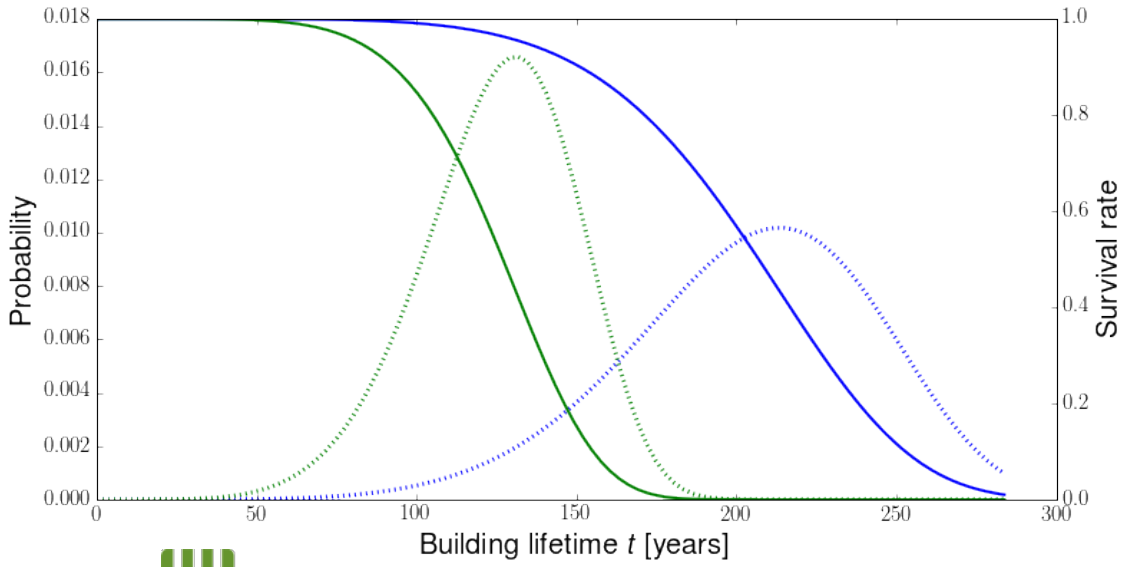


Results
wooden materials 2015



Stock development

- Each building is assigned a lifetime
- Each component is assigned a renewal date
- Lifetimes modelled based on Swiss empirical values



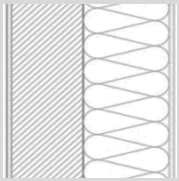
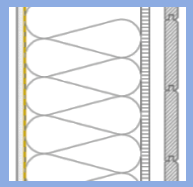
Modelling approach – space heat demand

- Bottom-up modelling of energy and material demand (quasi 3D-models)
- Heat transmission loss (building envelope)
- Solar gain (window orientation, shadowing)
- High-resolution thermal simulation

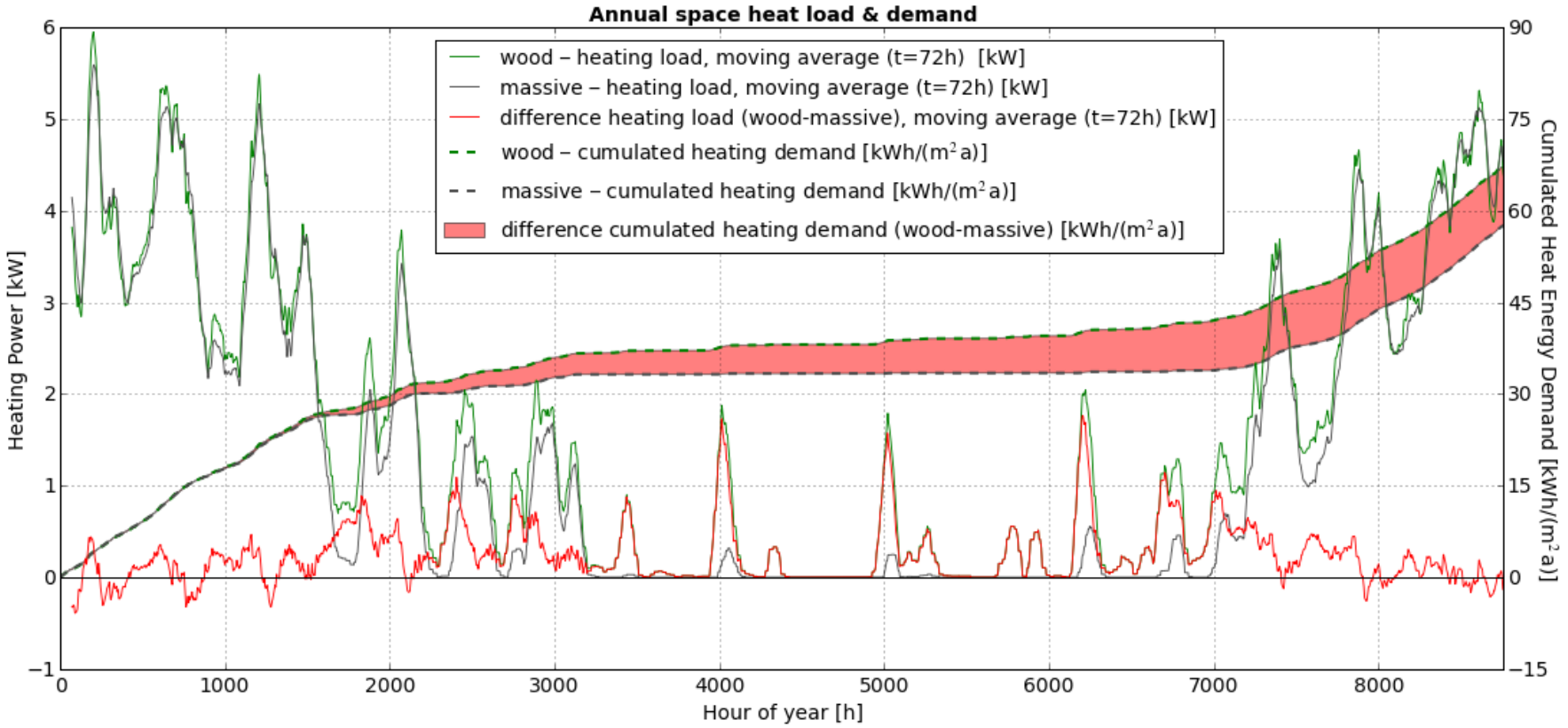
Sensitivity analysis on an individual building

- Monte Carlo simulations (9000 iterations)
- Wooden and massive variant with identical conditions (U-value, occupation, windows, etc.)
- Dynamic thermal simulation (energyplus)
- Material demand: LCIs including production, maintenance and disposal (system expansion EOL)
- ecoinvent 3.1 cut-off
- Different LCIA methods (IPCC 2013, UBP 2013, etc.)

Material

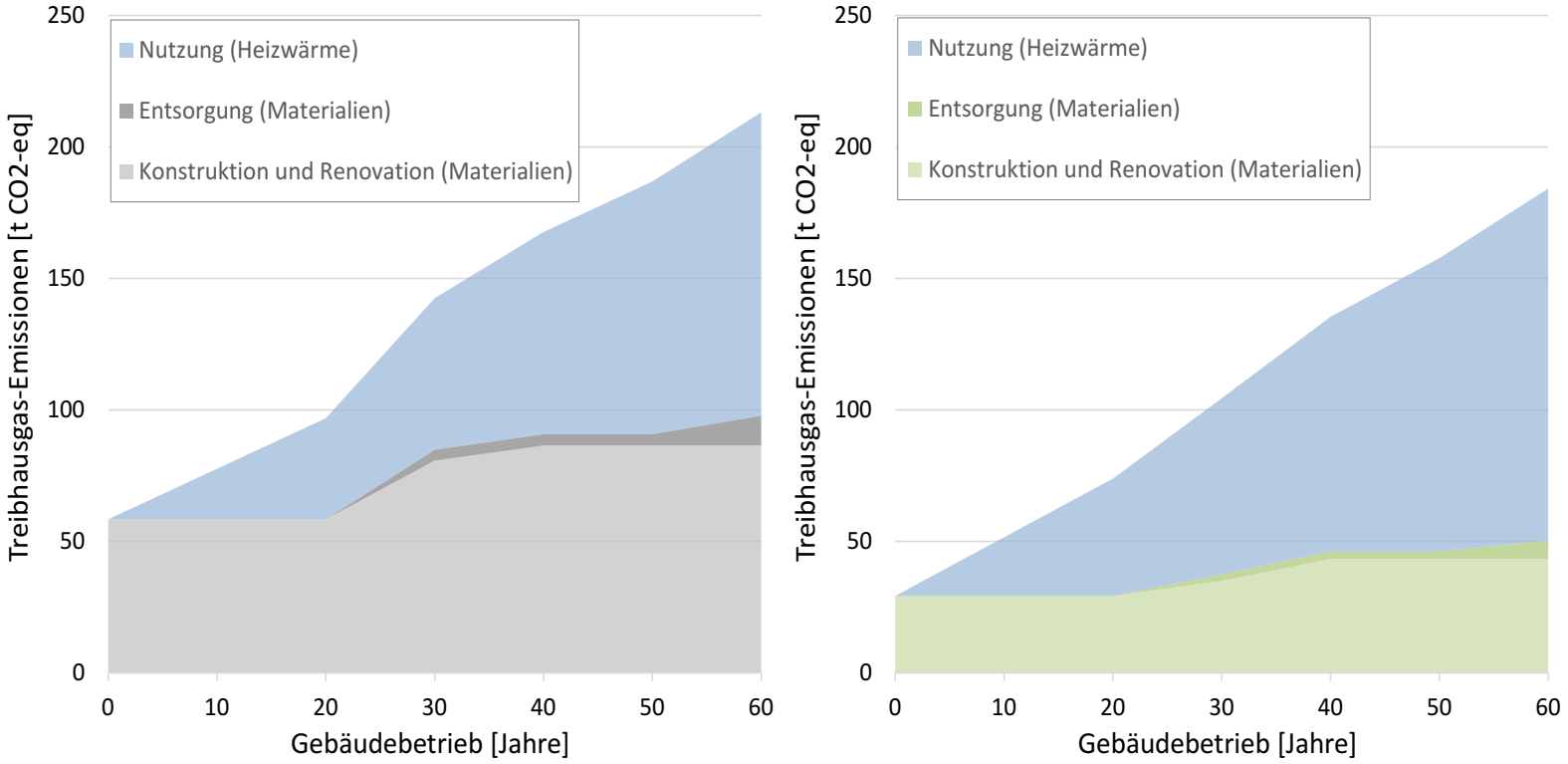
Construction	Massive brick	Timber frame
Schema		
Envelope U-value	0.27 W/m2K	0.27 W/m2K
Total heat capacity	12.3 kWh/K	4.0 kWh/K
Median space heat demand	46.1 kWh/m^{2}a	48.1 kWh/m^{2}a
Average space cooling demand	0.6 kWh/m^{2}a	1.9 kWh/m^{2}a
GHG emissions construction material	3.8 kg CO_2eq/m^{2}a	1.9 kg CO_2eq/m^{2}a

Space heat demand



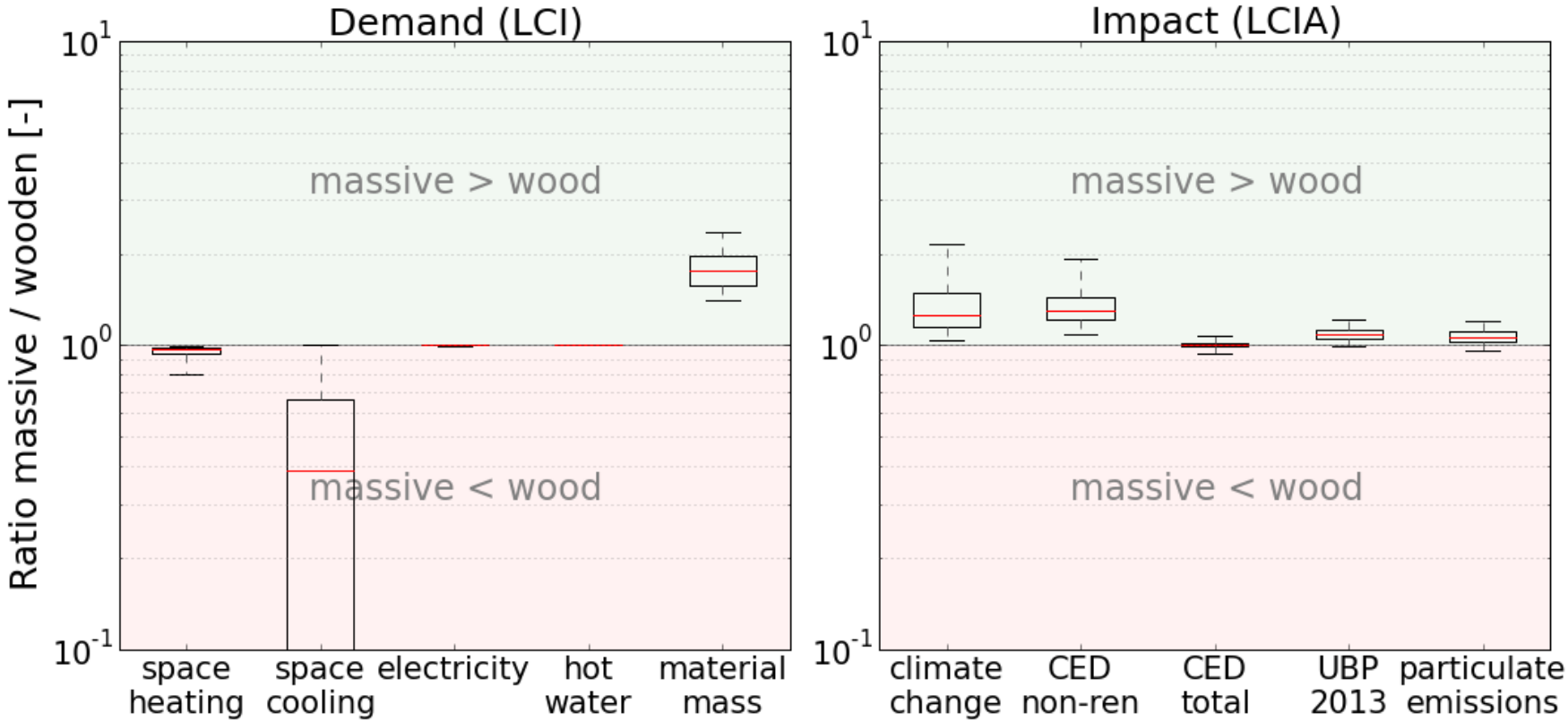
Heeren et al. 2015

Sensitivity analysis



Steubing et al. 2015

Sensitivity analysis results



Heeren et al. 2015

Conclusions

- Wooden buildings have lower environmental impacts
- Bottom-up material analysis of building stock
  - Expected material flows – Input and Output
  - Combined assessment of construction policies (energy & material)
- Any level of temporal and spatial aggregation possible
  "Volume of all brick buildings in Zurich from 1940-1960"

Next steps

- Dynamic spatial MFA / LCA
- Space heat demand
- Future scenarios
  - Wood-based scenarios
  - Renewal / demolition rates
  - Thermal insulation scenarios

Acknowledgements

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Resource Wood
National Research Programme NRP 66

Project partners

CHALMERS

AVENY

GEO PARTNER AG RESOURCE MANAGEMENT

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- Heeren, N; Jakob, M; Martius, G; Gross, N; Wallbaum, H; A component based bottom-up building stock model for comprehensive environmental impact assessment and target control; Renewable and Sustainable Energy Reviews 2013, 20