RSA FG

Research Studio **iSPACE**

Bottom-Up Heat Demand Model

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Smart Energy Balances
ISEC 2022

SPATIAL ENERGY PLANNING

SAT
DSc
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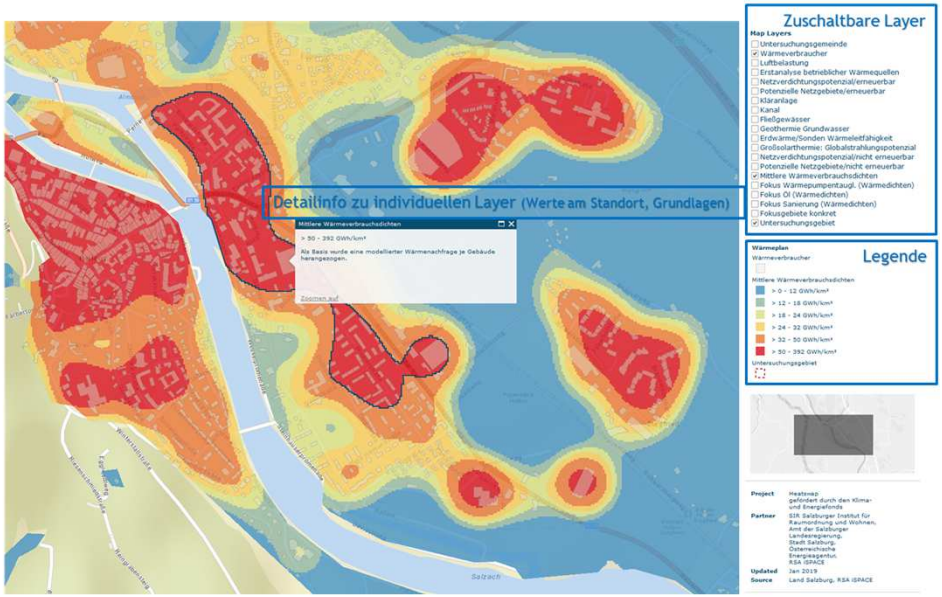
Managing Innovations *from* Universities *into* Markets in Digital Intelligence

Spatial Energy Planning (SEP)

- Definition: Use of energy planning as an instrument for urban planning and the decarbonization of the energy system
- SEP as an instrument of public management can make a significant contribution to the necessary support, coordination and cost efficiency in the decarbonization of the residential sector
- SEP receives increased importance on the energy policy agenda:
  - Baden-Württemberg obliges local authorities to carry out spatial energy planning
  - Vienna creates climate protection areas by mid 2021. The authorities provide a spatial energy plan for each climate protection area

Wärmeatlas – Webkarte



Data

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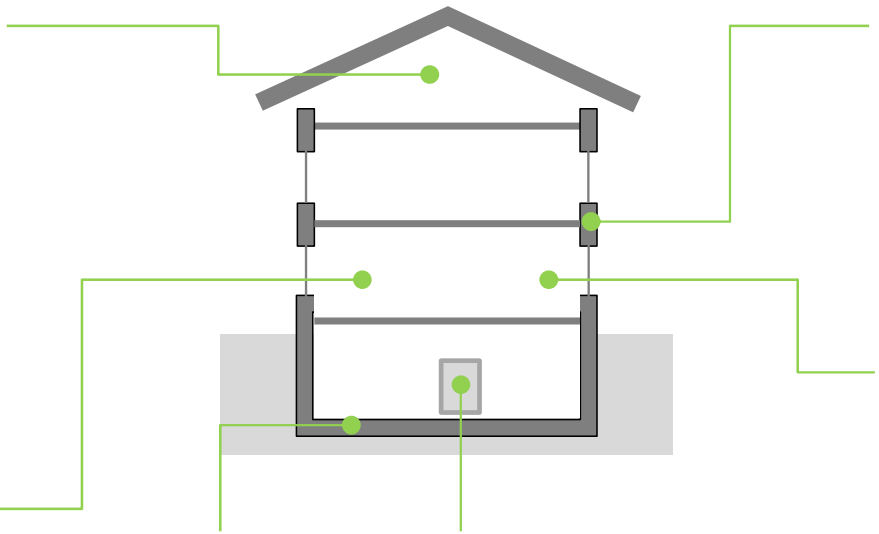
Modules / Data Basis	Identification	Usage	Quality of Envelope	Measures	Conditioning	Energy Consumption Indicators
Register of addresses	x					
Digital cadastre data	x			x		
Buildings of orthophotos	x					
AGWR community data		x	x	x	x	
Open government data (OGD)		x				
ZEUS energy certificates			x		x	x
Protected buildings			x			
Townscape & historic city protection zones			x	x		
Digital elevation model (DEM)				x		
Digital surface model (DSM)				x		
Zoning plan Land Salzburg				x		
District heating & gas network					x	
Subsidised solar collectors, biomass heatings, district heating, heat pumps and photovoltaics					x	
Heating data base					x	
Temperature data						x

Methods

- **Building Indicators**

Identification:
Address



Envelope:
Construction period, protection

Energy Consumption Indicators (ECI):
Warm water, space heating

Usage:
Category, Units, Main Use

Dimensions:
Gross floor area (GFA)

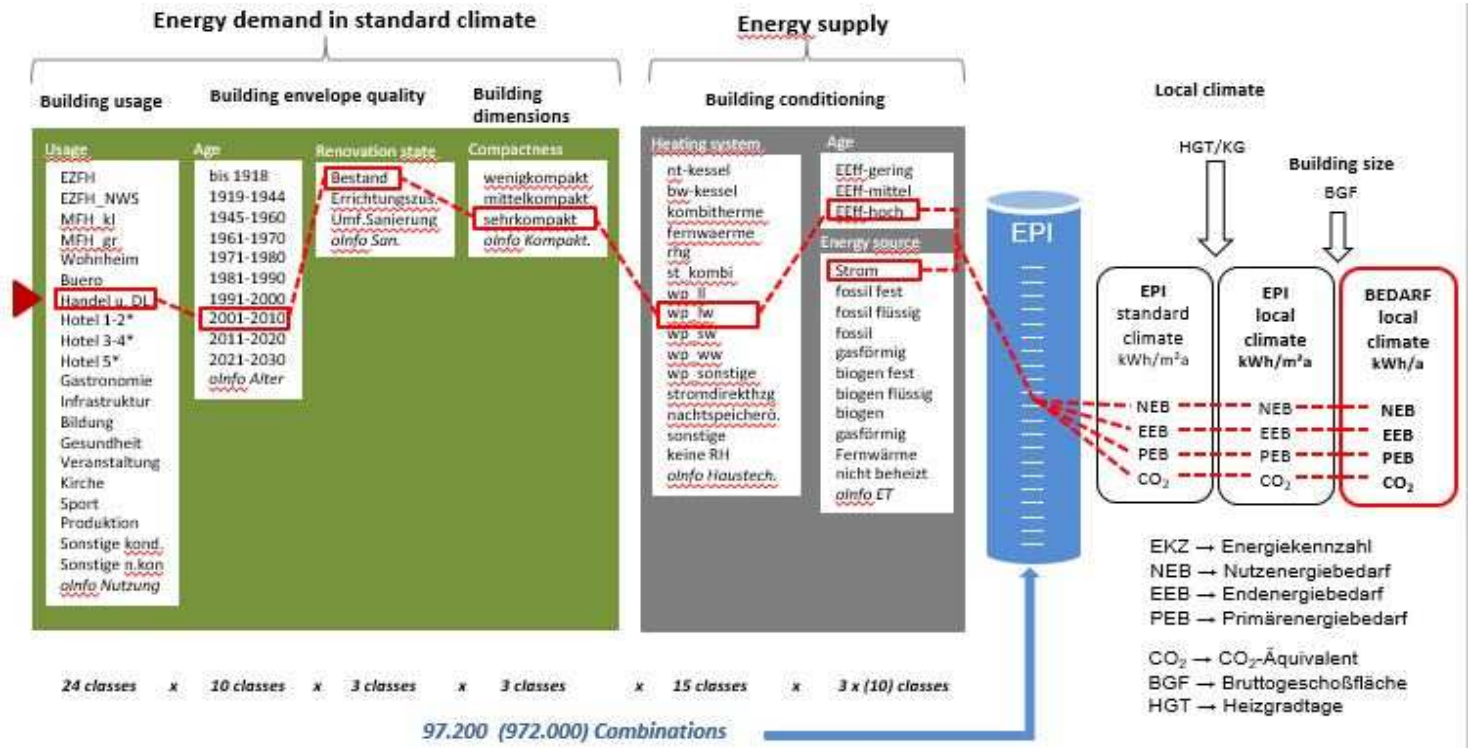
Conditioning:
Energy carrier, heating system

Methods

- Detection and Calibration of Energy Consumption Indicators
  - Based on measured values and defined building archetypes from the QM-Heizwerke programme
  - Definition of the area related heat consumption per building
  - $$q_{del}\left[\frac{kWh}{m^2_{GFA}.a}\right] = \frac{Q_{del}\left[\frac{kWh}{a}\right]}{GFA_{kond}\left[m^2_{GFA}\right]}$$
  - Heating Degree Days (HDD) correction
  - Finally 150 building archetypes accross 22 usage categories

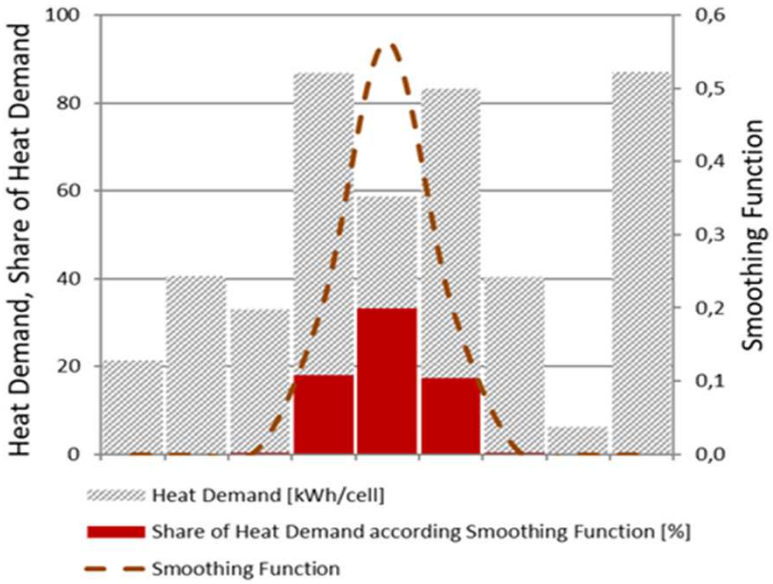
Methods

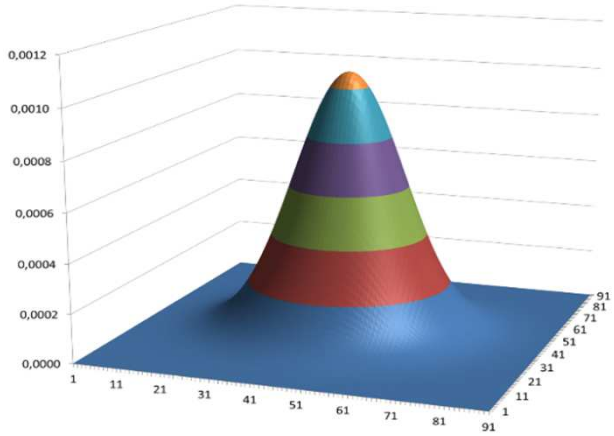
- Assignment of ECI



Methods

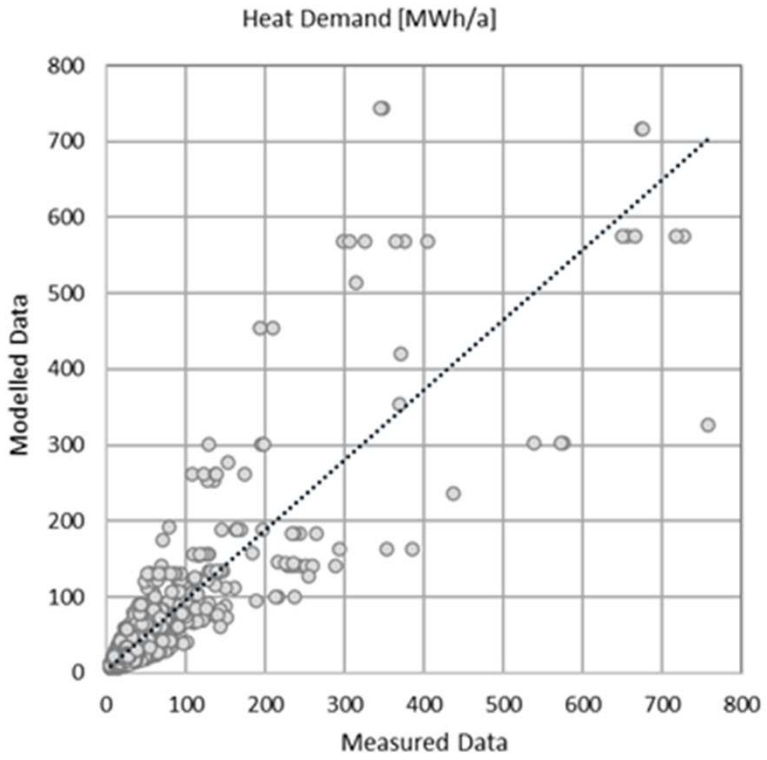
- Generation of Heatmaps





- Enables density calculations from point data
- Kernel used for weighting the values
- Gaussian function as smoothing function

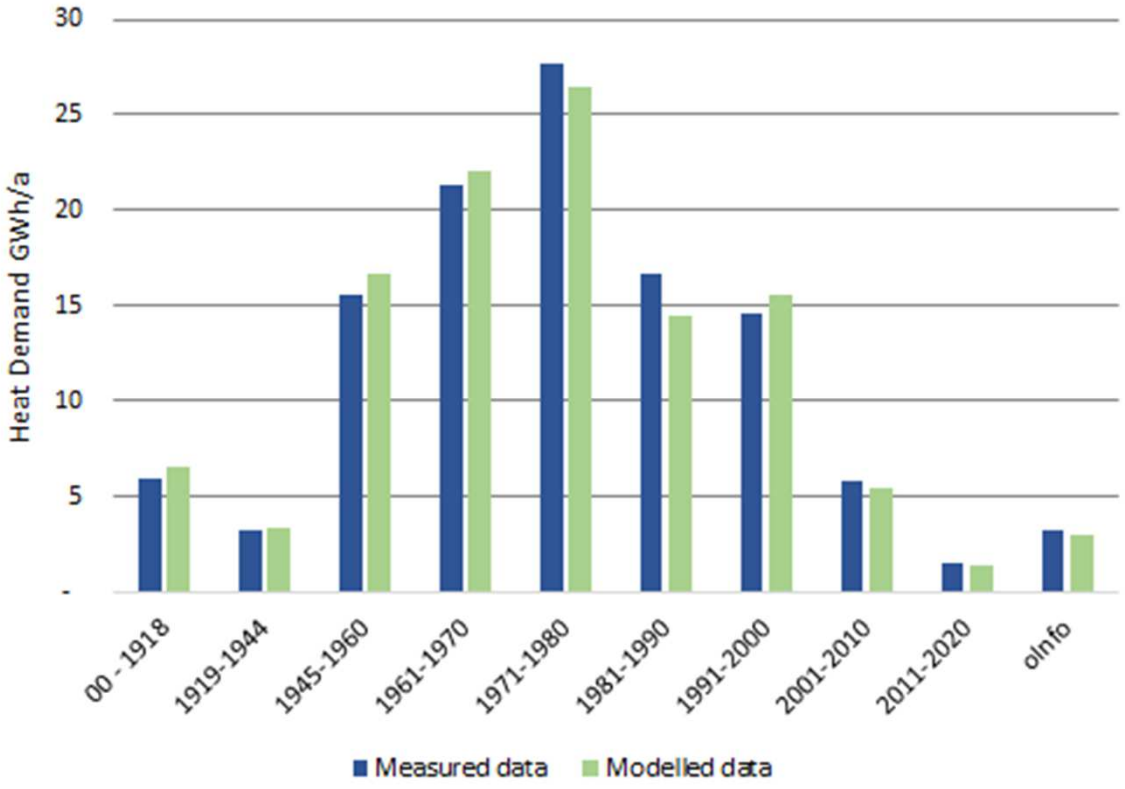
Validation



Sample size [n]	11124
Measured heat consumption sum [GWh/a]	516
Modelled heat demand sum [GWh/a]	538
Deviation of modelled heat demand [%]	+ 4
Correlation coefficient [r]	0.85

- Incorrect and incomplete data were eliminated
- Strong linear relationship
- In sum modelled values are 4% higher than the measured values

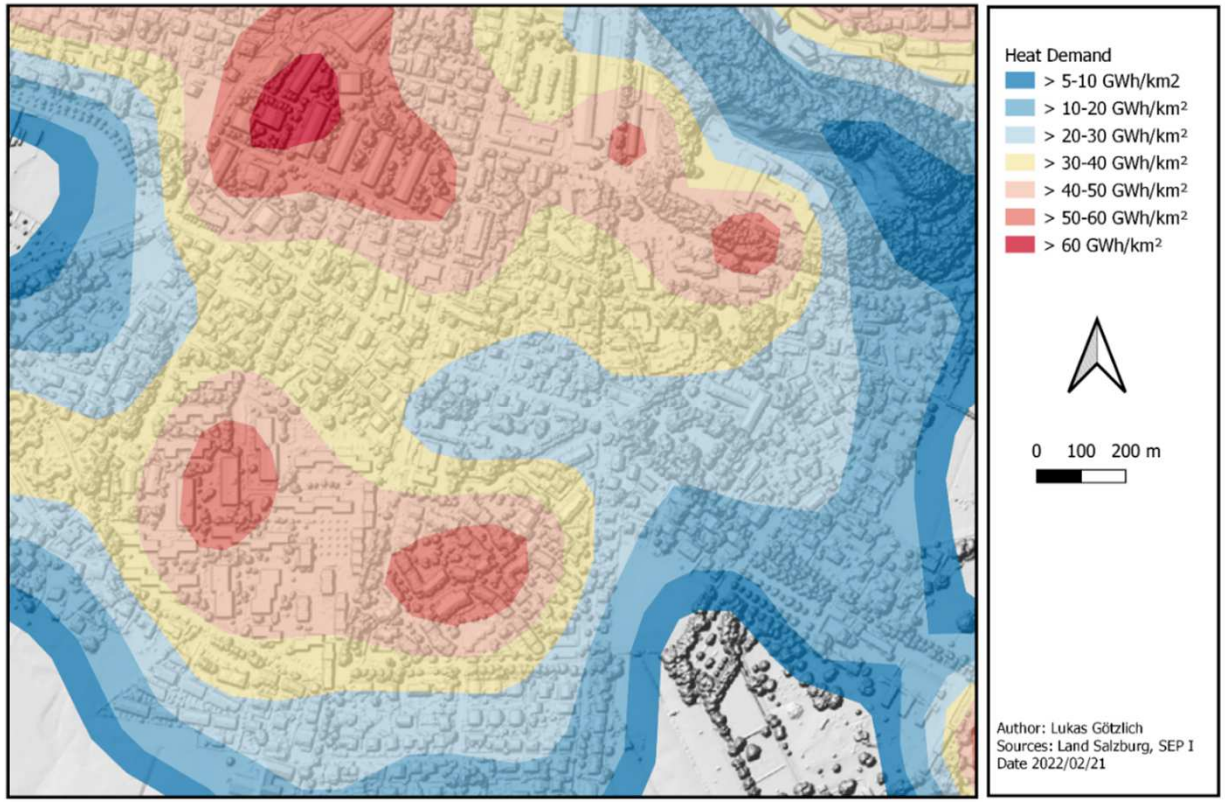
Validation



- Heat demand per building period of one- and two-family houses
- Modelled value in average exceeds the the measured value by 0.4%
- Slight overestimation of older buildings

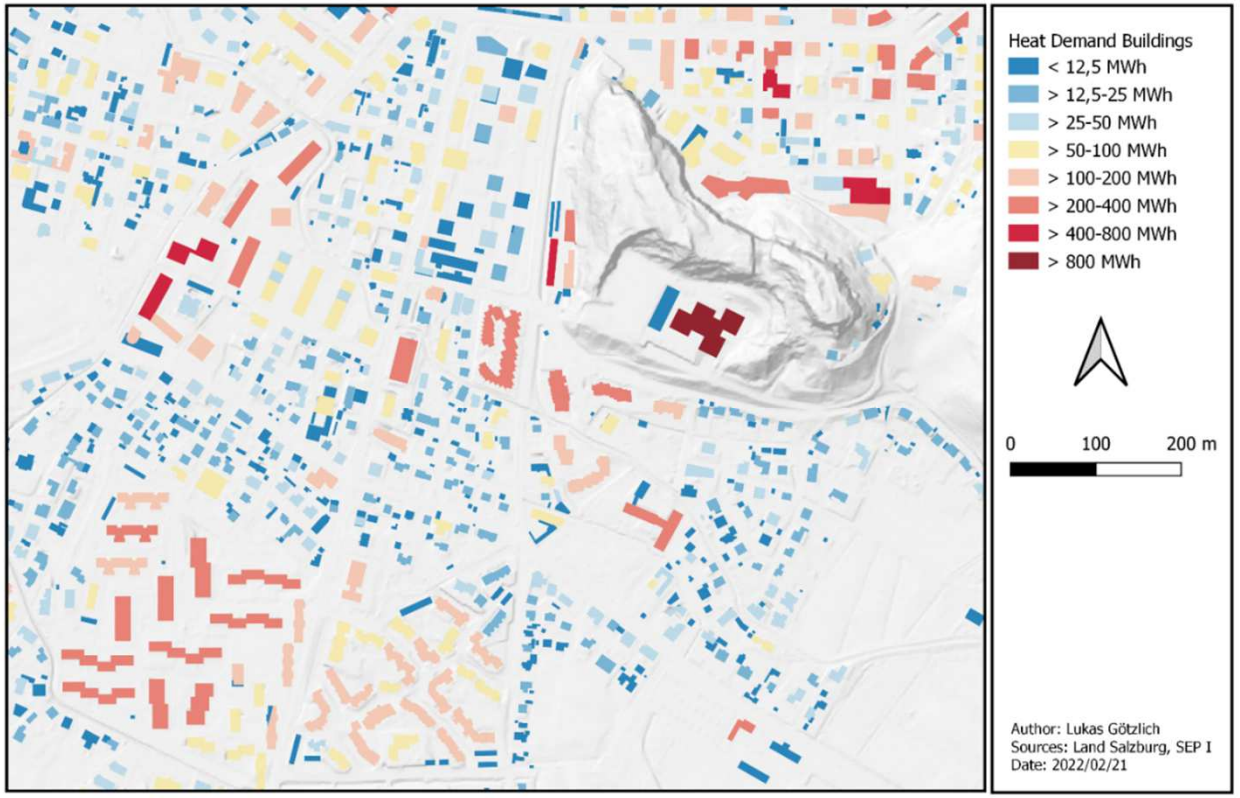
Results

Heat Map of the Study Area



Results

Heat Demand of the Buildings of the Study Area



Results

Usage Category	Heat Demand [GWh/a]
One- and two-family house	1676
Second residence house	259
Small multifamily house	916
Big multifamily house	466
Residential home	84
Non-residential sector	2543
Sum	5944

- Most heat consumed by non-residential sector (2.543 GWh/a)
- 1.676 GWh/a are utilised by one and two family houses

Construction Period	Heat Demand [GWh/a]
until 1918	890
1919-1944	337
1945-1960	672
1961-1970	817
1971-1980	1052
1981-1990	818
1991-2000	504
2001-2010	472
2011-2020	240
No information	142
Sum	5944

- Peak of consumption in the period of 1971-1980

Conclusion

- Realistic model to estimate the heat demand of especially residential buildings
- Determination of district heating potentials
- Area wide information, therefore useful for many applications like a heat atlas, analysis by the federal state of Salzburg
- Implementation in Salzburg, Styria and Vienna
- Still further research required
- Further information: Paper: Götzlich et al (2021): Bottom-Up Heat Demand Model

Thank You!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