Institute of Thermal Engineering

Graz University of Technology

SCIENCE ▪ PASSION ▪ TECHNOLOGY

Urban Building Thermal Energy Analysis at City District Scale

Hermann Edtmayer, Lisa-Marie Fochler, Peter Nageler, Thomas Mach

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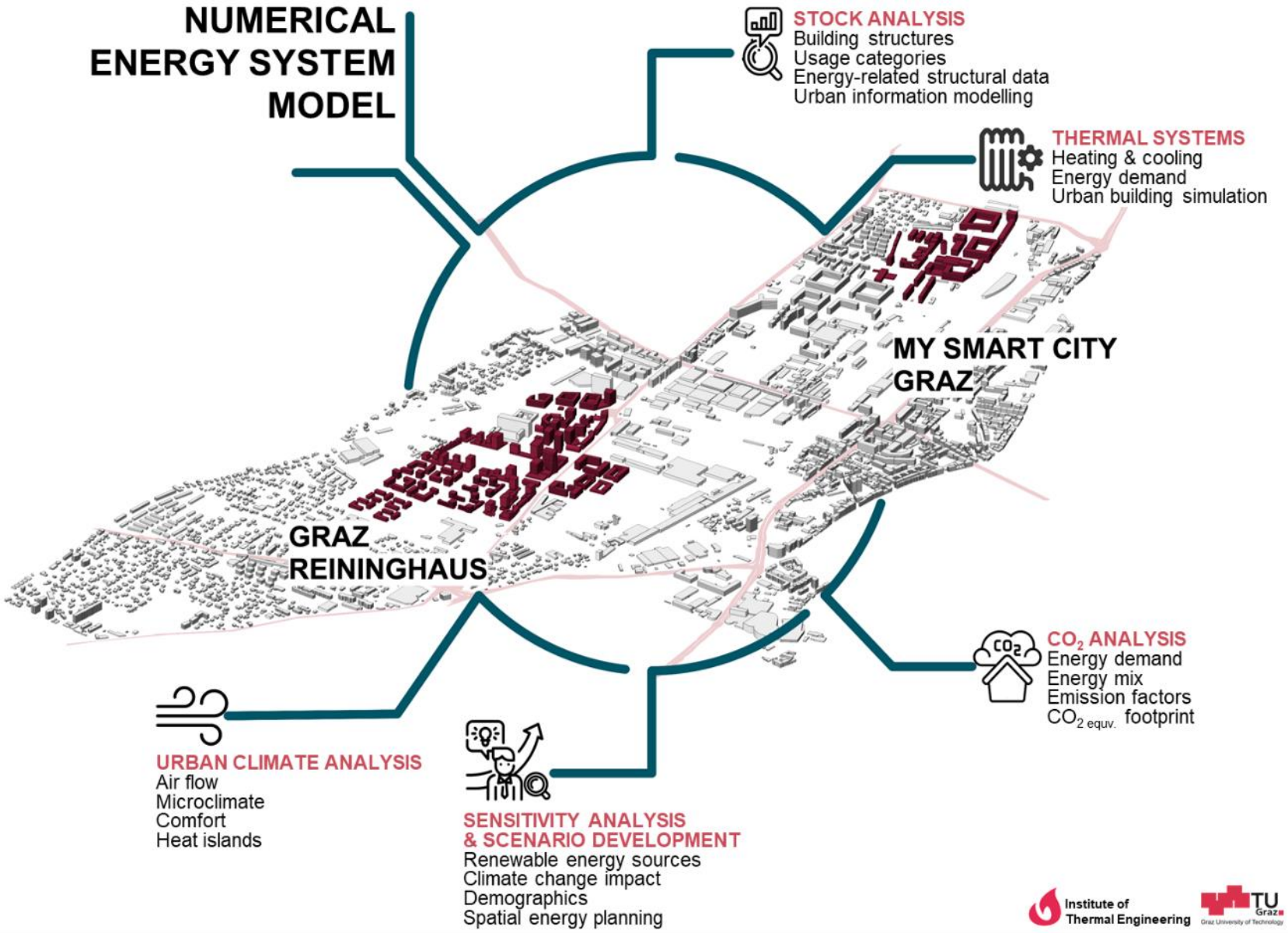
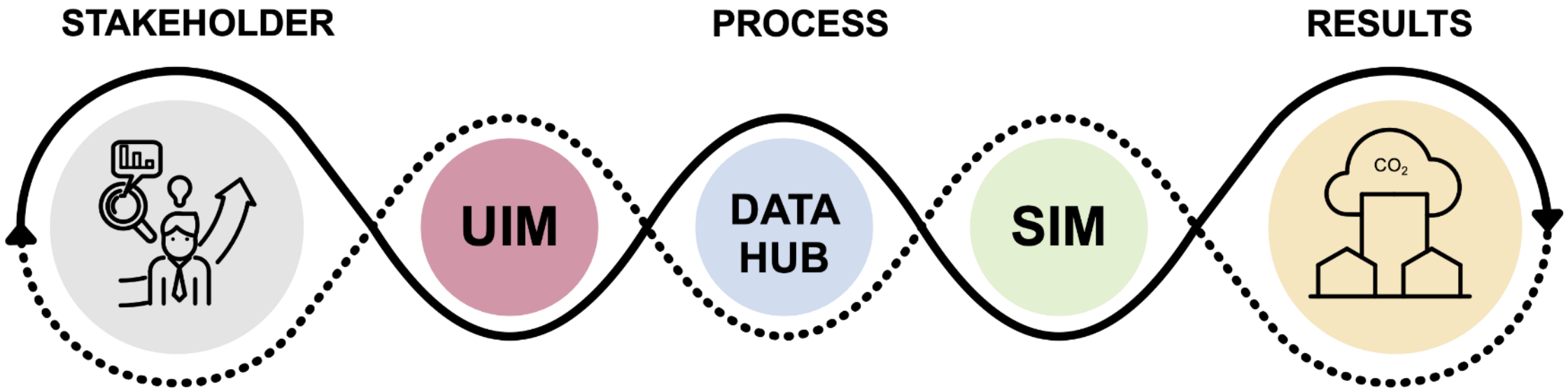
Smart City Research

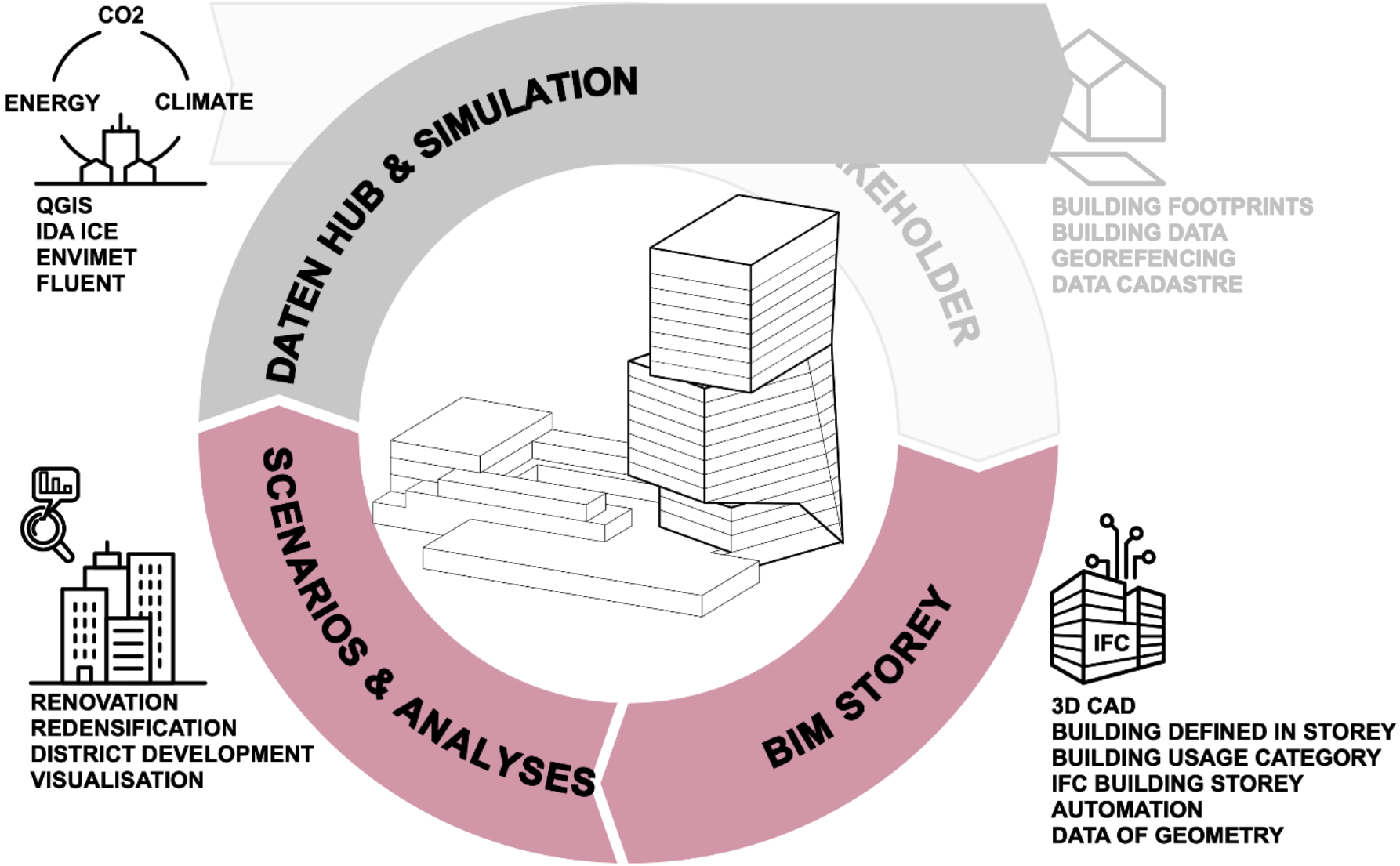
- Multi tool model
- High resolution bottom-up approach
- Heating and cooling energy demand
- $CO_{2equv.}$ Impact
- Sensitivity and Scenarios
- Urban micro climate
- City district scale



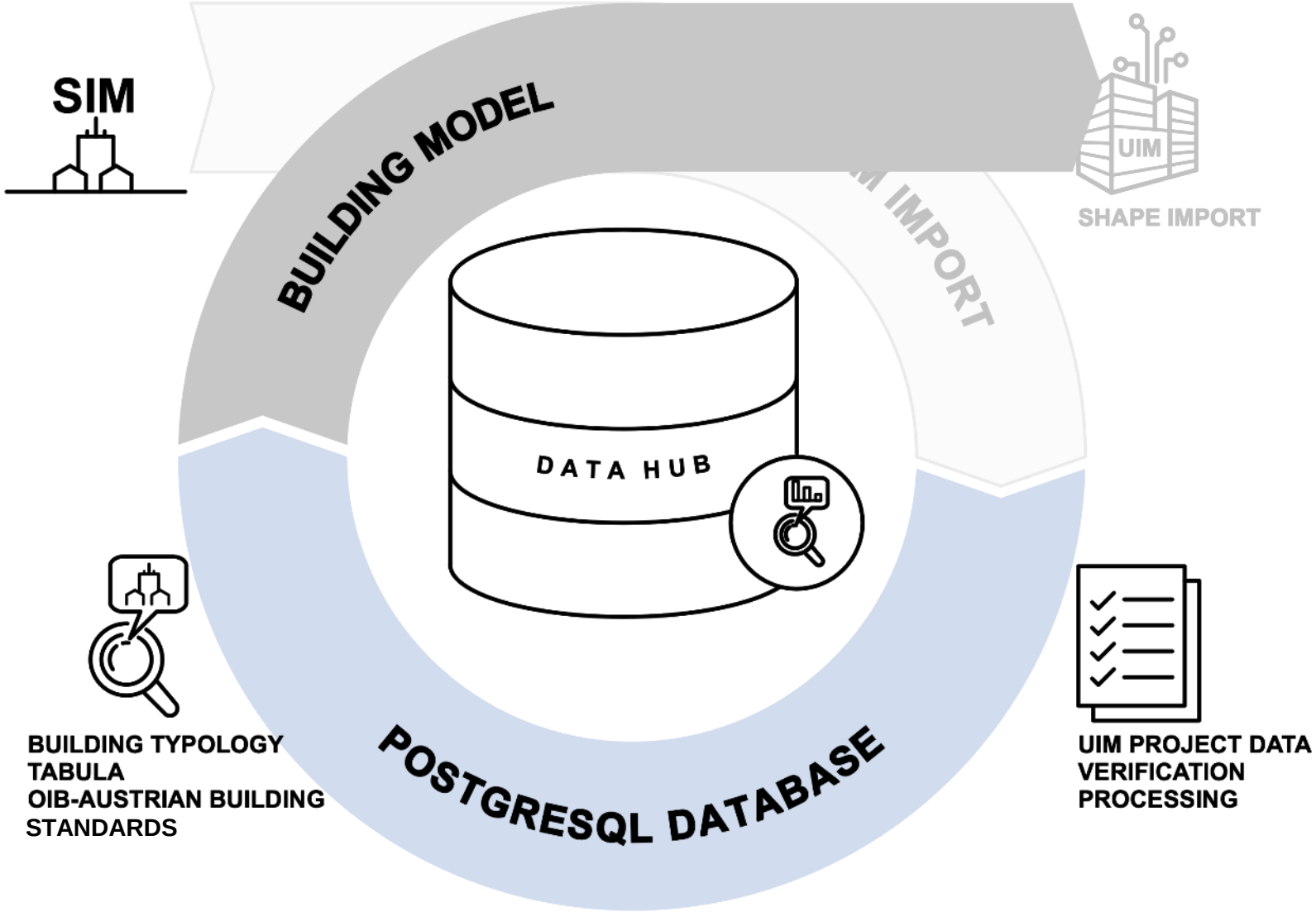
Workflow



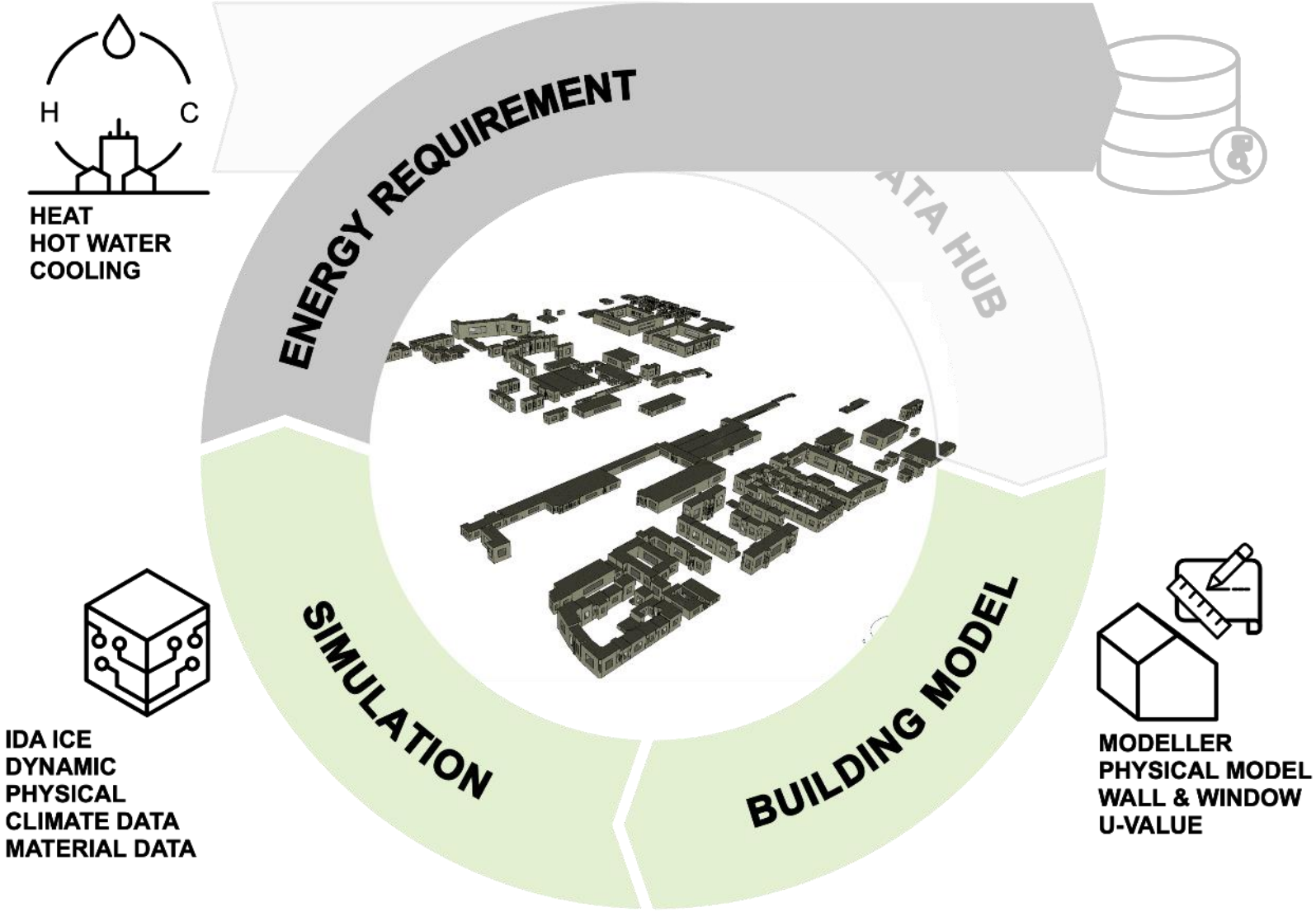
UIM - Urban Information Model

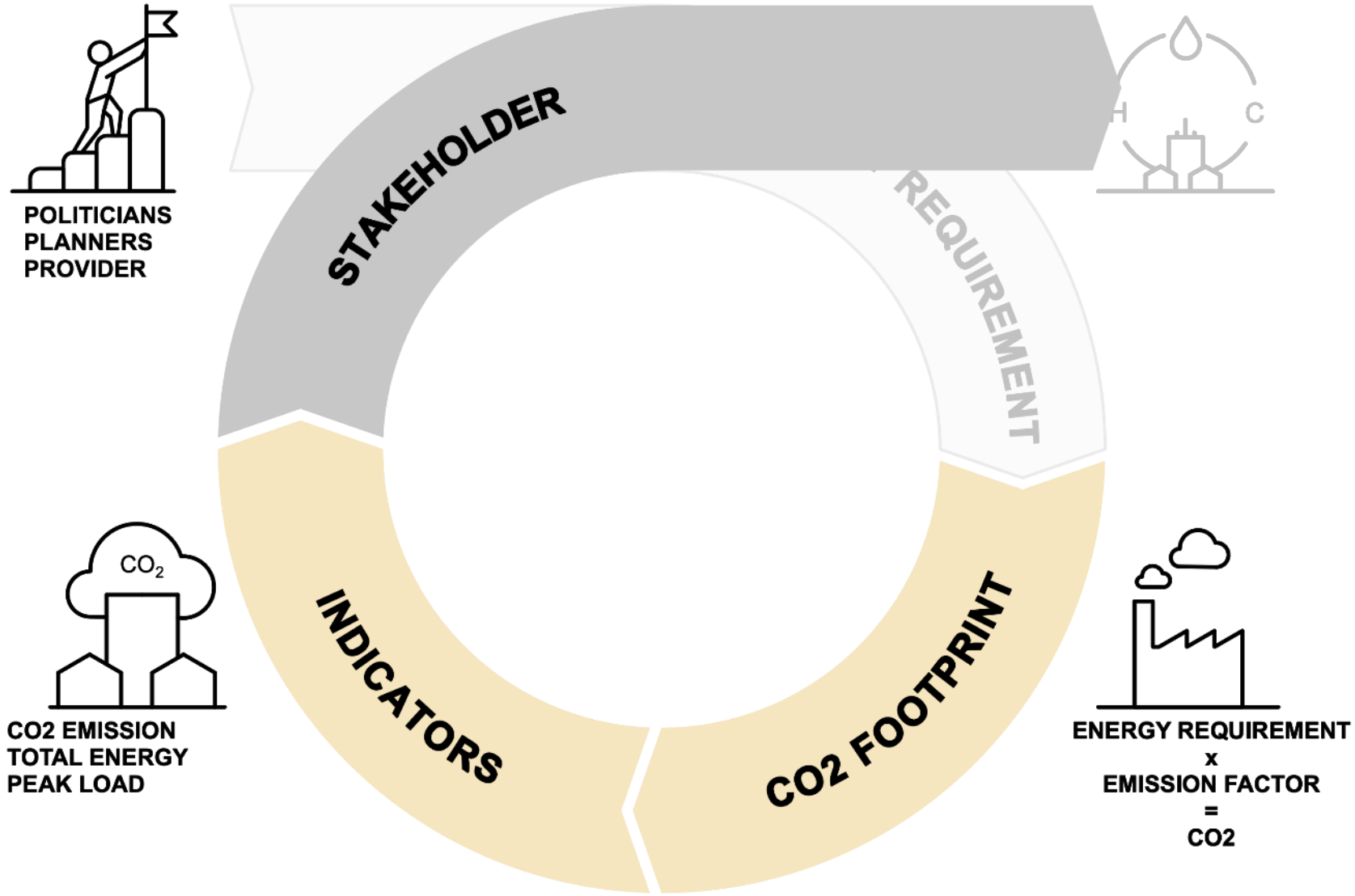


Data Hub


SIM
BUILDING MODEL
UIM
SHAPE IMPORT
IMPORT
DATA HUB
BUILDING TYPOLOGY
TABULA
OIB-AUSTRIAN BUILDING
STANDARDS
POSTGRESQL DATABASE
UIM PROJECT DATA
VERIFICATION
PROCESSING

SIM – Modelling & Simulation




POLITICIANS
PLANNERS
PROVIDER
STAKEHOLDER
REQUIREMENT
H
C
CO2 EMISSION
TOTAL ENERGY
PEAK LOAD
INDICATORS
CO2 FOOTPRINT
ENERGY REQUIREMENT
x
EMISSION FACTOR
=
CO2

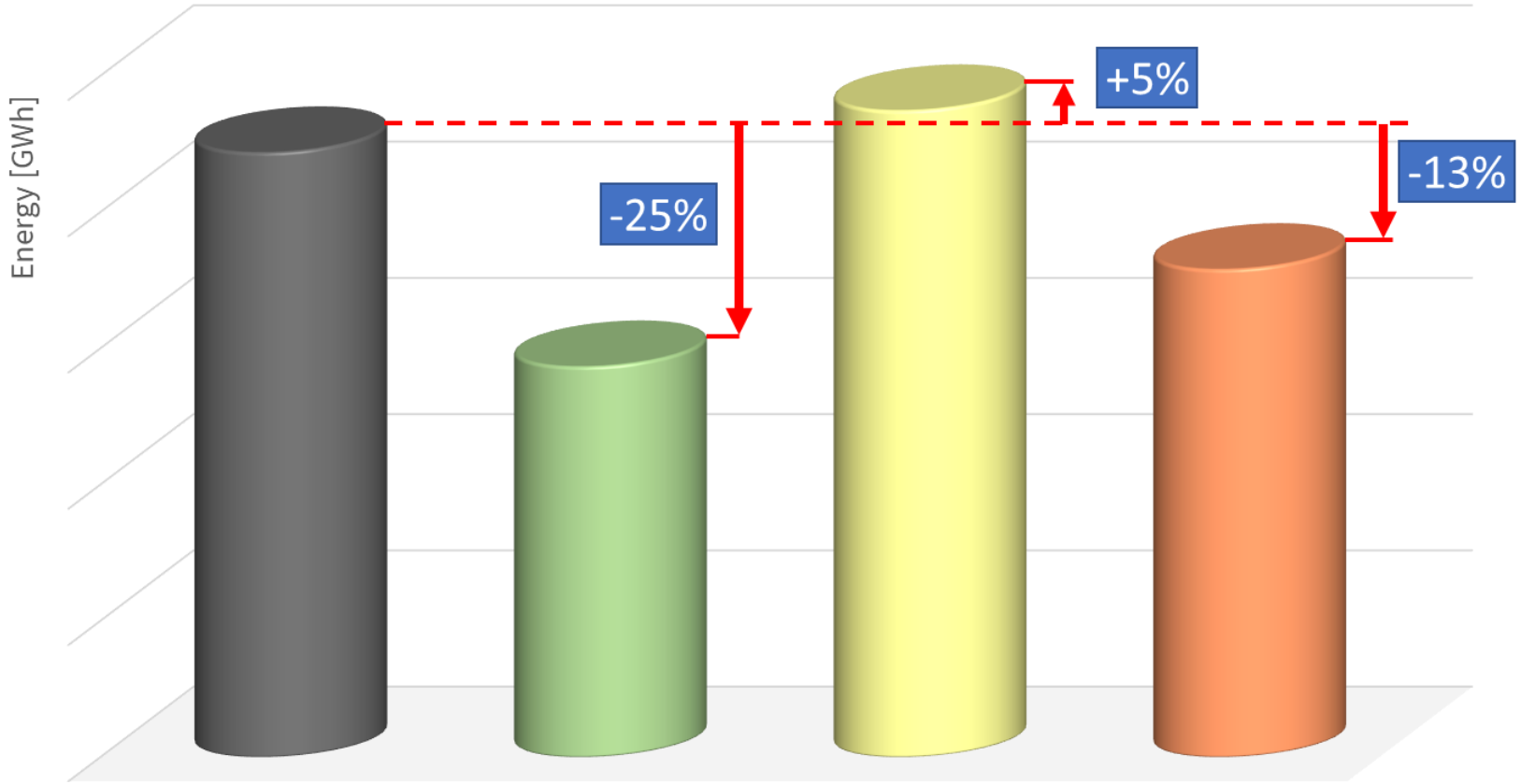
Simulation results: Total energy demand – Sensitivity analysis

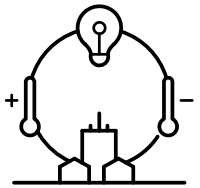
Sensitivity analysis

Variation of different key parameters and calculation of the effect on the total energy demand

Comparison of scenarios

Annual total energy demand for heating + hot water





Parameters varied

Refurbishment

All buildings (except industry) in the 2018 stock are assumed to be refurbished and modelled accordingly for the simulation.
U-values of the building envelope are assumed according to TABULA standard refurbishment in Austria.
→ Significantly improved thermal insulation

Densification 2050:

The residential floorspace in the area under consideration is densified in comparison to the existing floorspace in 2018 in accordance with the requirements of the urban development concept of Graz. Target year 2050
→ Significant increase of the residential gross floor area

Climate 2050:

The climate prediction from the climate forecast model for Graz in 2050 is applied as a climate boundary condition for the simulation of the building stock in 2018
→ Significant temperature rise

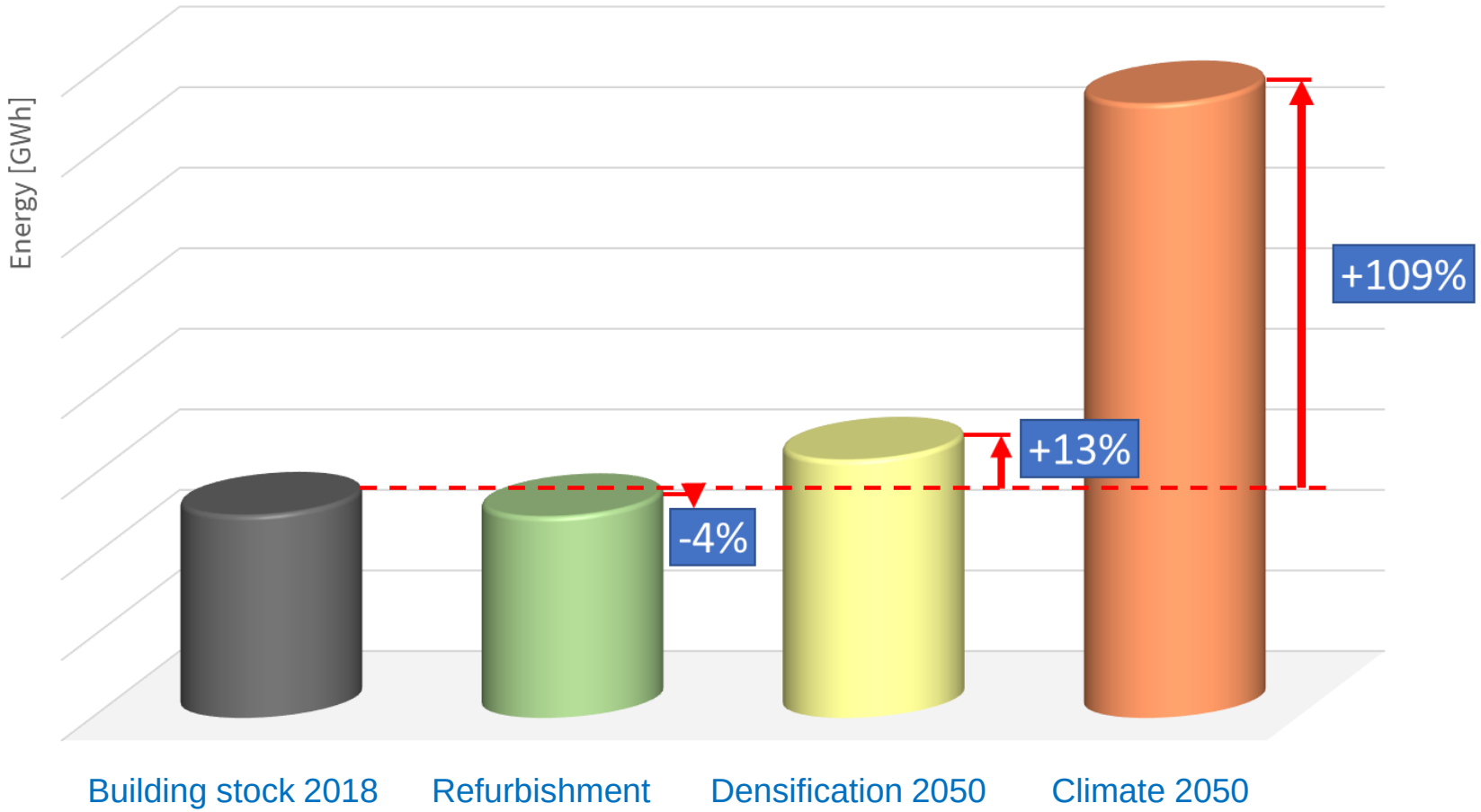
Simulation results: Total energy demand – Sensitivity analysis

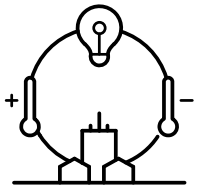
Sensitivity analysis

Variation of different key parameters and calculation of the effect on the total energy demand

Comparison of scenarios

Annual total energy demand for cooling





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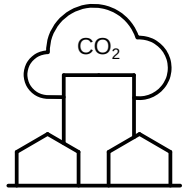
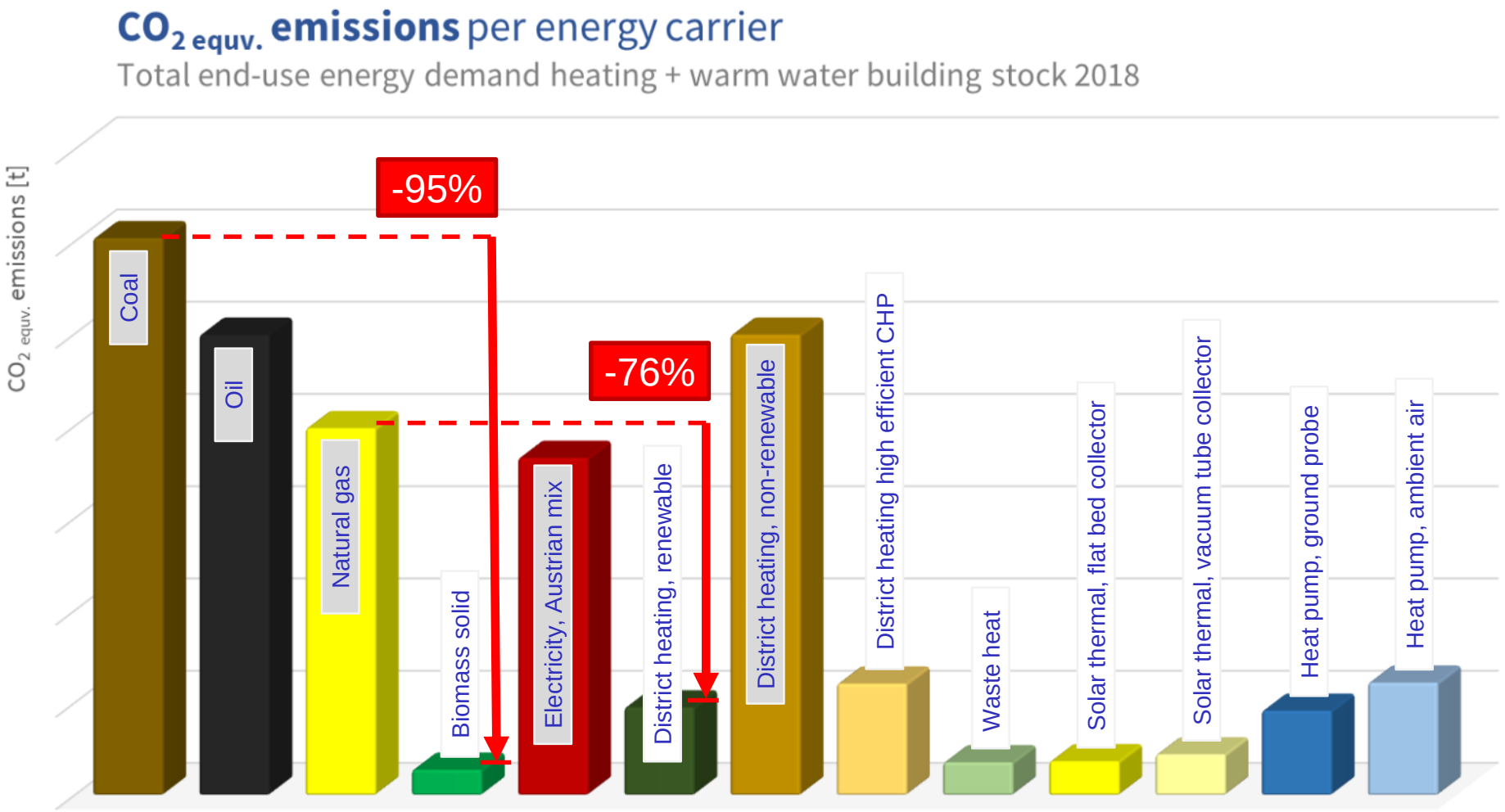
Simulation results: Total $CO_{2equv.}$ emissions – Sensitivity analysis



Sensitivity analysis

Total energy demand is covered by a single energy carrier – Variation of the energy carrier



Calculation

Input values

- Simulation result 'Total energy demand' of existing building stock 2018
- $CO_{2\ equv.}$ emission factors from various literature sources (OIB RL6, UBA-Austria, UBA-Germany, project report ECC, project report Fraunhofer ISE)

Method:

Total end-use energy demand x $CO_{2\ equv.}$ emission factor of energy carrier = $CO_{2\ equv.}$ emission of energy carrier

→ one number/pillar per energy source

Thank you for your attention!

Contact

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Institute of Thermal Engineering

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Links

The research project *'ECR-Smart City 2020'*

- TU Graz
- Researchgate

Project partners

- Institute of Urbanism, TU Graz
  https://www.tugraz.at/stdb
- City of Graz
  https://www.graz.at/SmartCityGraz
  http://www.smartcitygraz.at/
  https://www.graz.at/