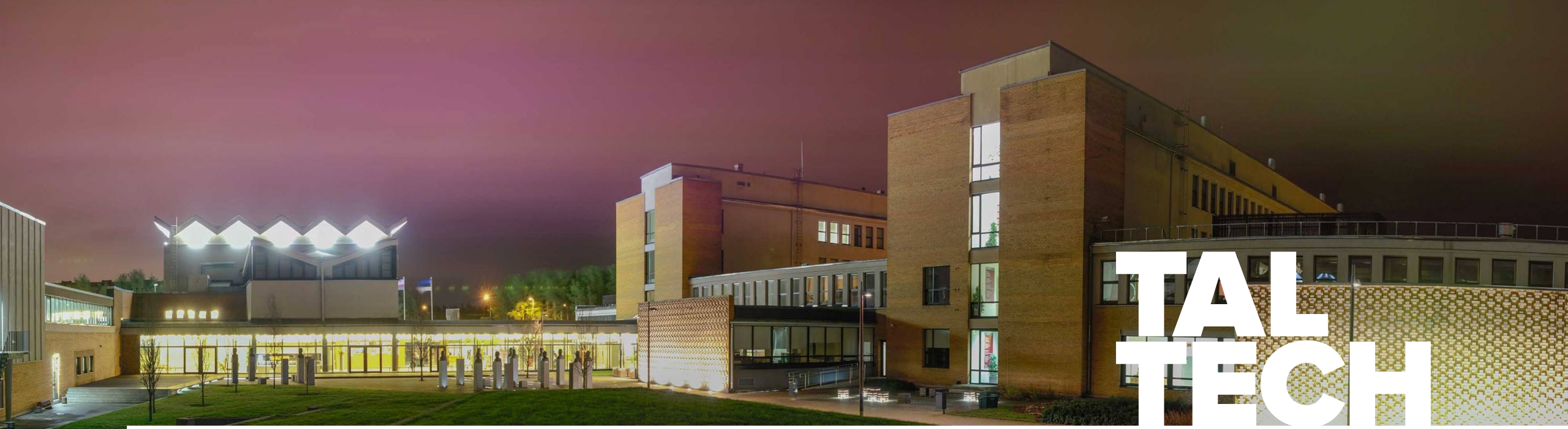


DIGITAL TWIN IN RENOVATION PROCESSES

Ergo Pikas

Assistant Professor
Civil Engineering and Architecture Department
Tallinn University of Technology

25.05.2022

INTRO TO PROBLEM BACKGROUND

GREEN DEAL 2050 TARGETS

The EU will:



Become climate-neutral by 2050



Protect human life, animals and plants, by cutting pollution

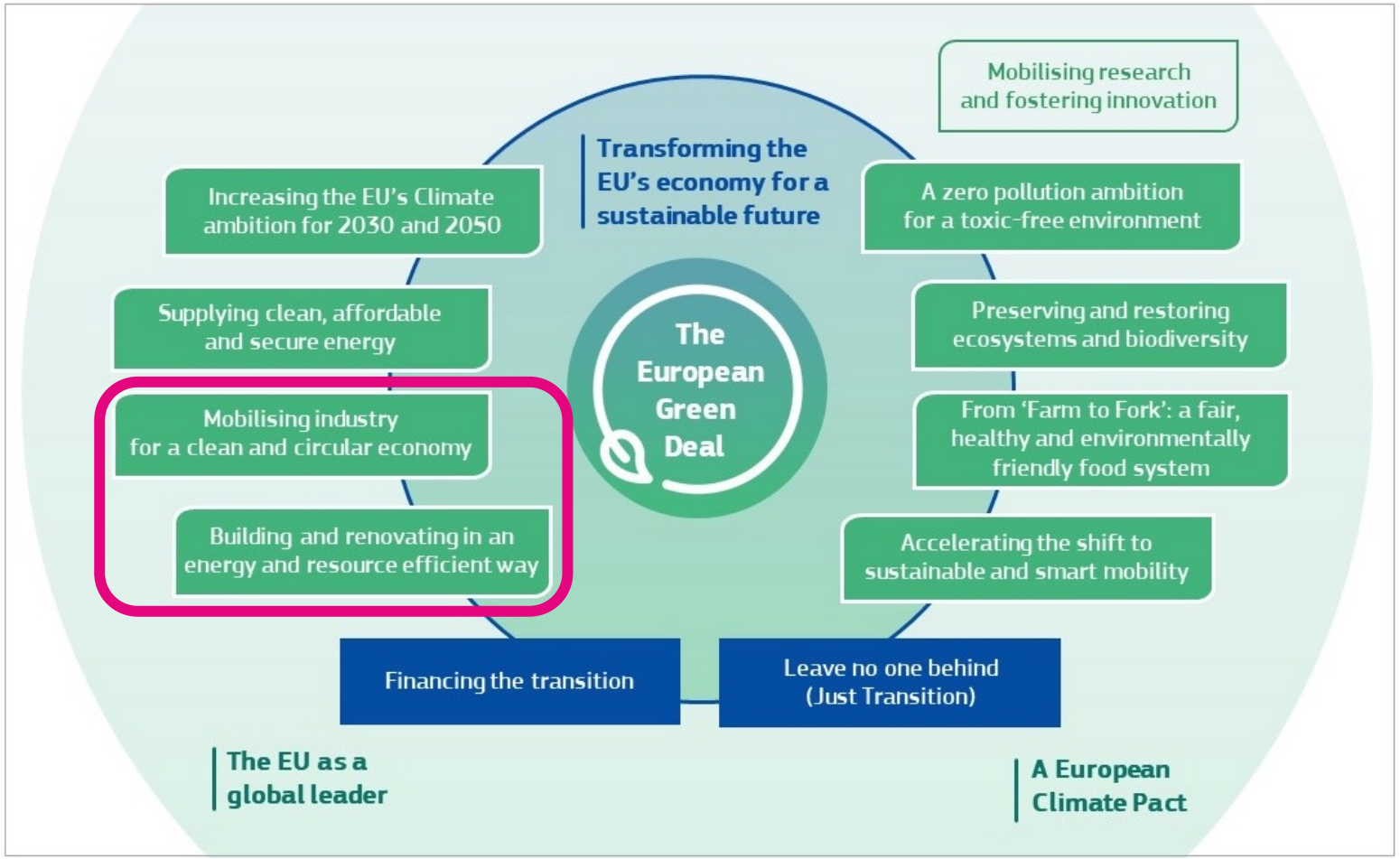


Help companies become world leaders in clean products and technologies



Help ensure a just and inclusive transition

GREEN DEAL 2050 TARGETS

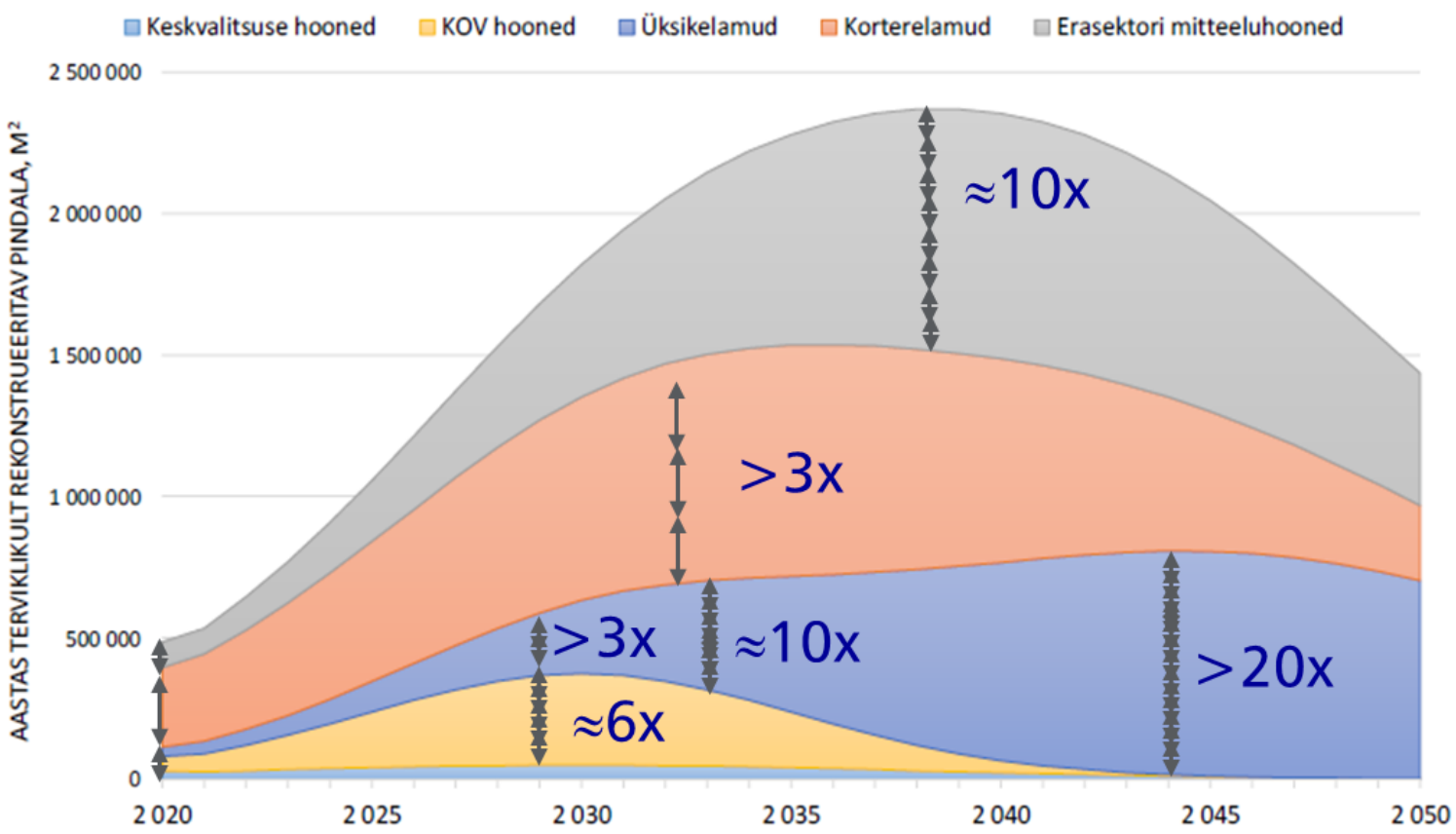


RENOVATION WAVE



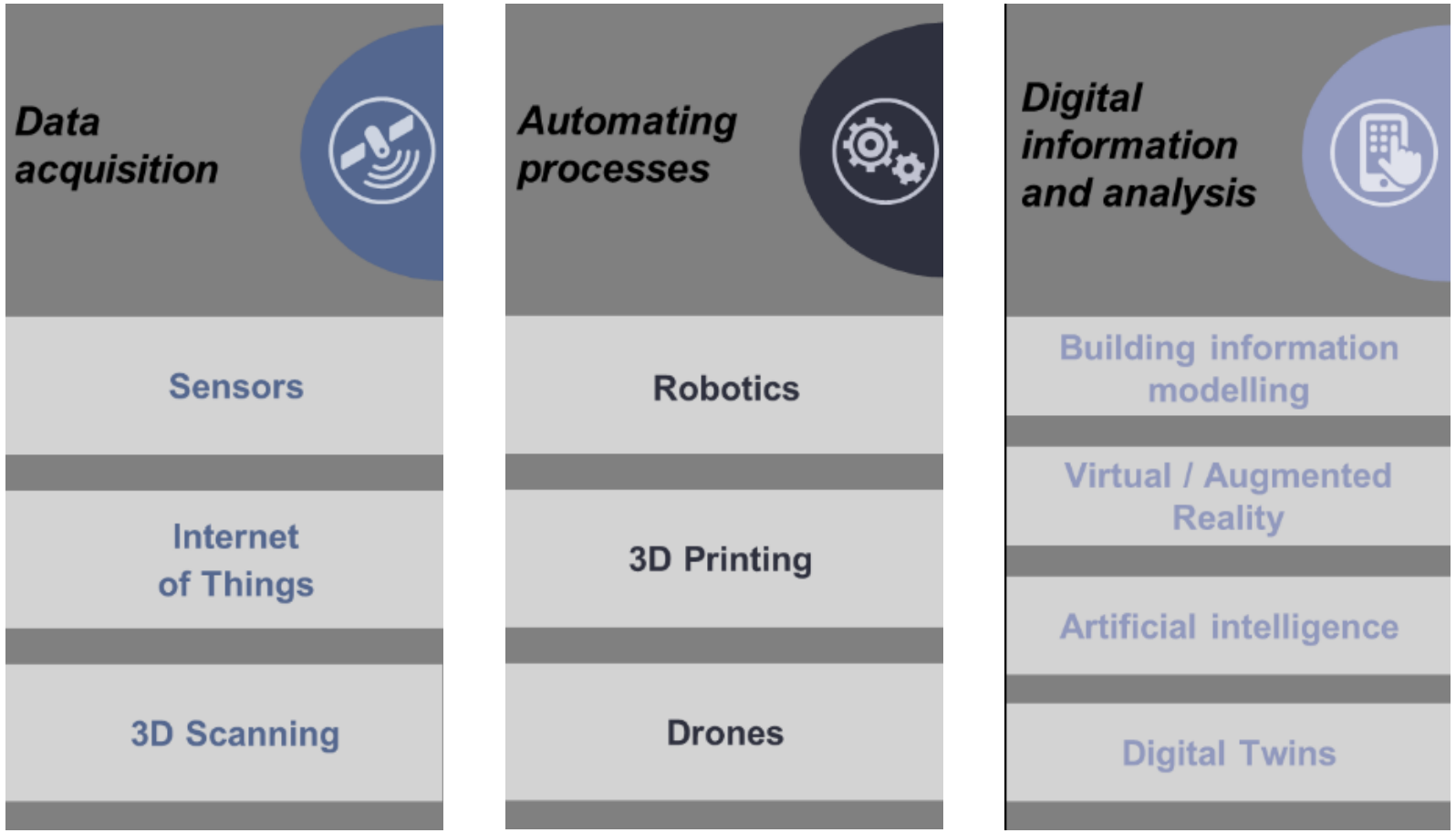
Renovation of buildings can support saving 70-80% from heating energy and 20-30% from electricity

CHALLENGES IN RENOVATION



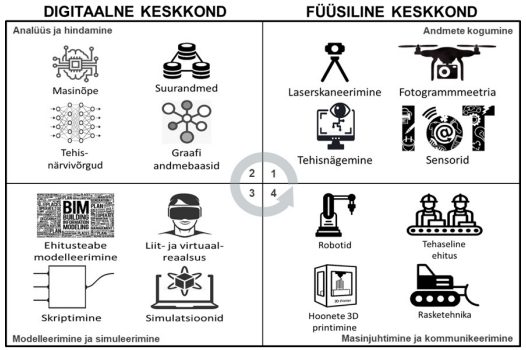
- Increase renovation annual rate 3 to 10 times depending on the building type
- Financial challenges in apartment buildings and single family houses
- Main design, production and construction companies not interested in small scale renovation projects
- Current processes and technologies not fit for purpose

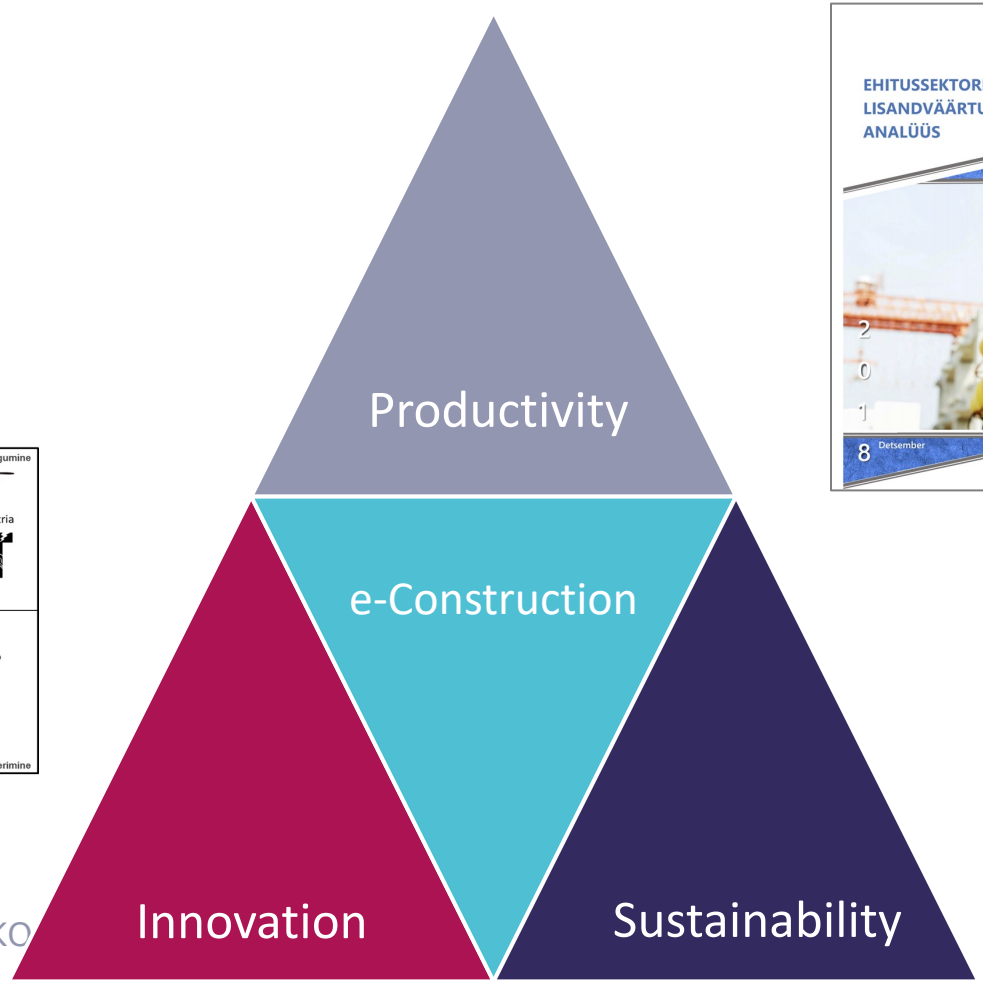
DIGITAL CONTRUCTION TRENDS IN EU



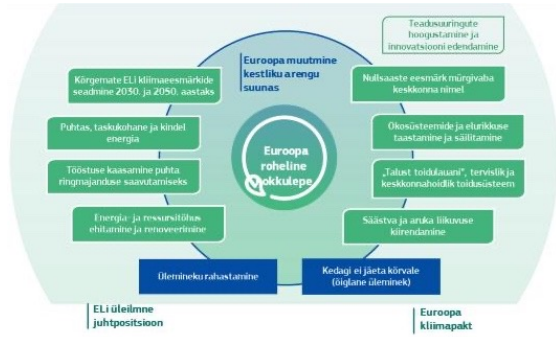


AN EVOLVING PARADIGM: E-CONSTRUCTION



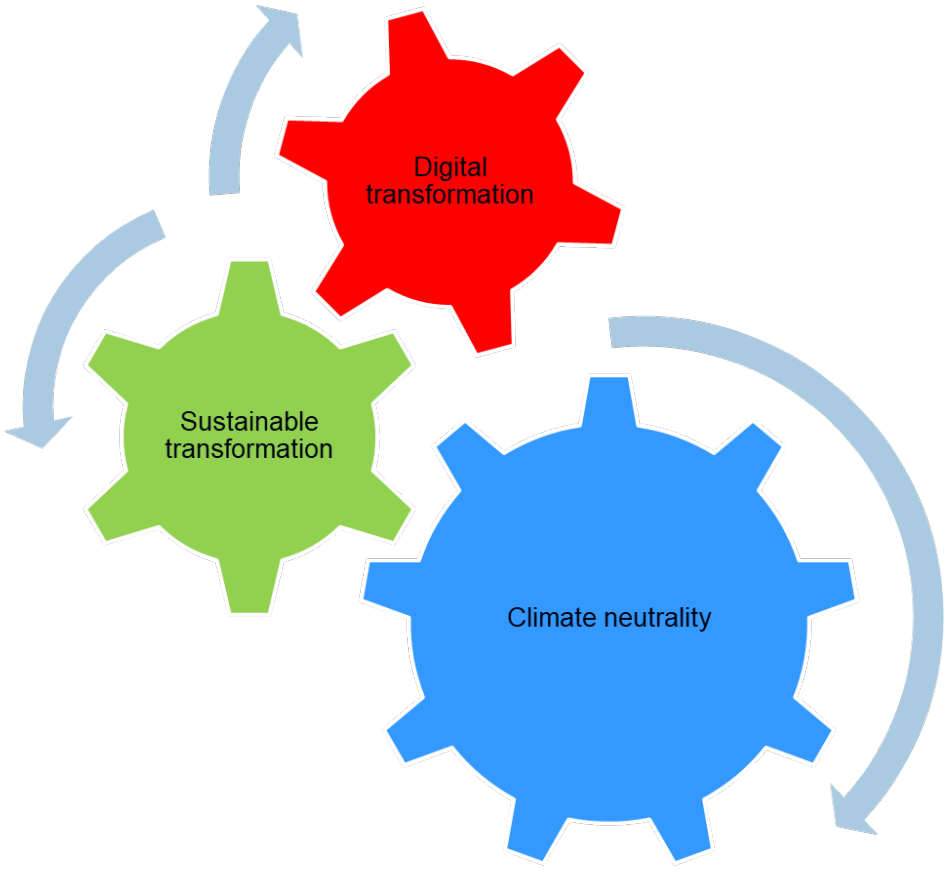


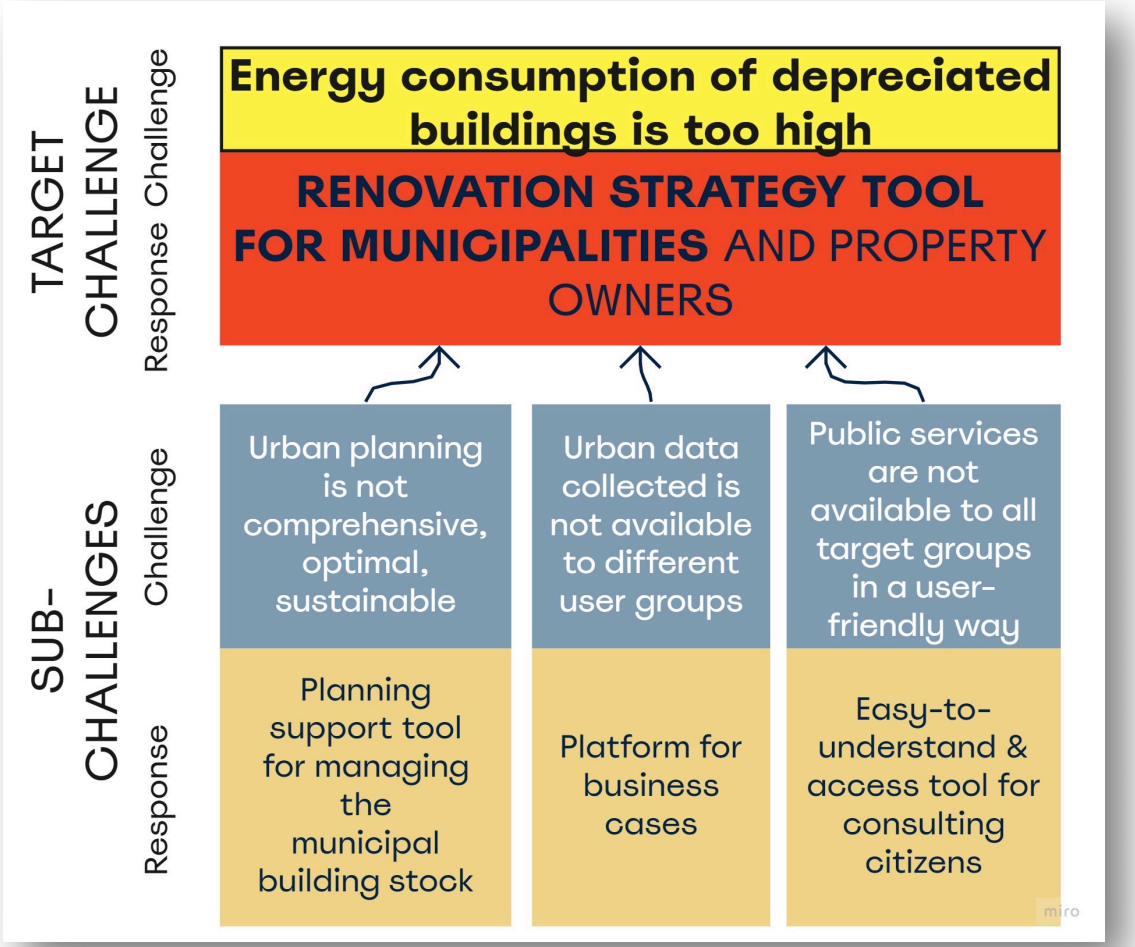




SCALING RENOVATION THROUGH INDUSTRIALIZATION AND DIGITALIZATION

SCALING RENOVATION THROUGH INDUSTRIALIZATION AND DIGITALIZATION





TECHNOCRATIC IMPROVEMENTS BLIND TO WHAT IS IMPORTANT

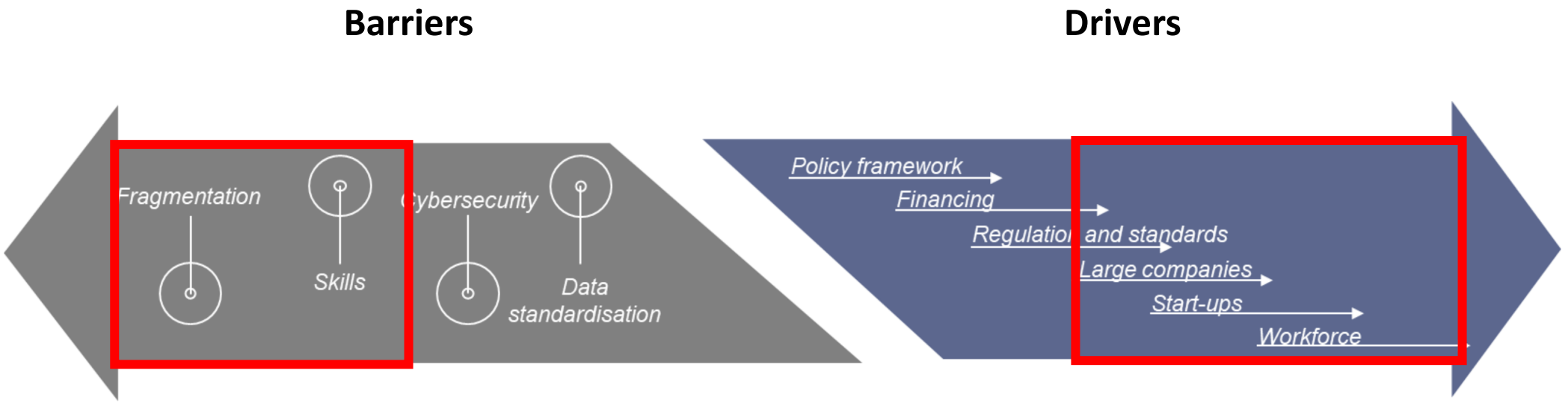
“The first rule of any technology used in a business is that automation applied to an efficient operation will magnify the efficiency.”

“The second is that automation applied to an inefficient operation will magnify the inefficiency.”

Bill Gates



NEED FOR ARCHITECTS AND ENGINEERS WITH DIGITAL COMPETENCIES

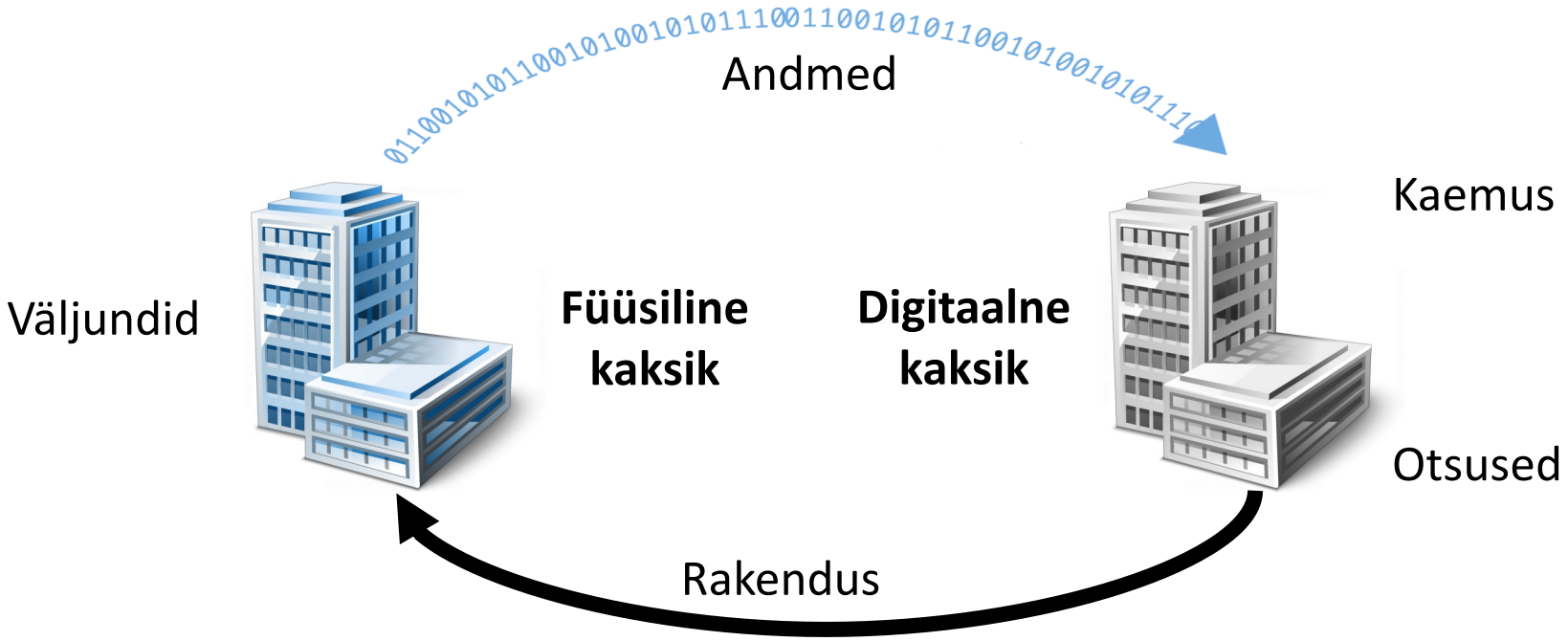


THREE DIGITALIZATION PRINCIPLES

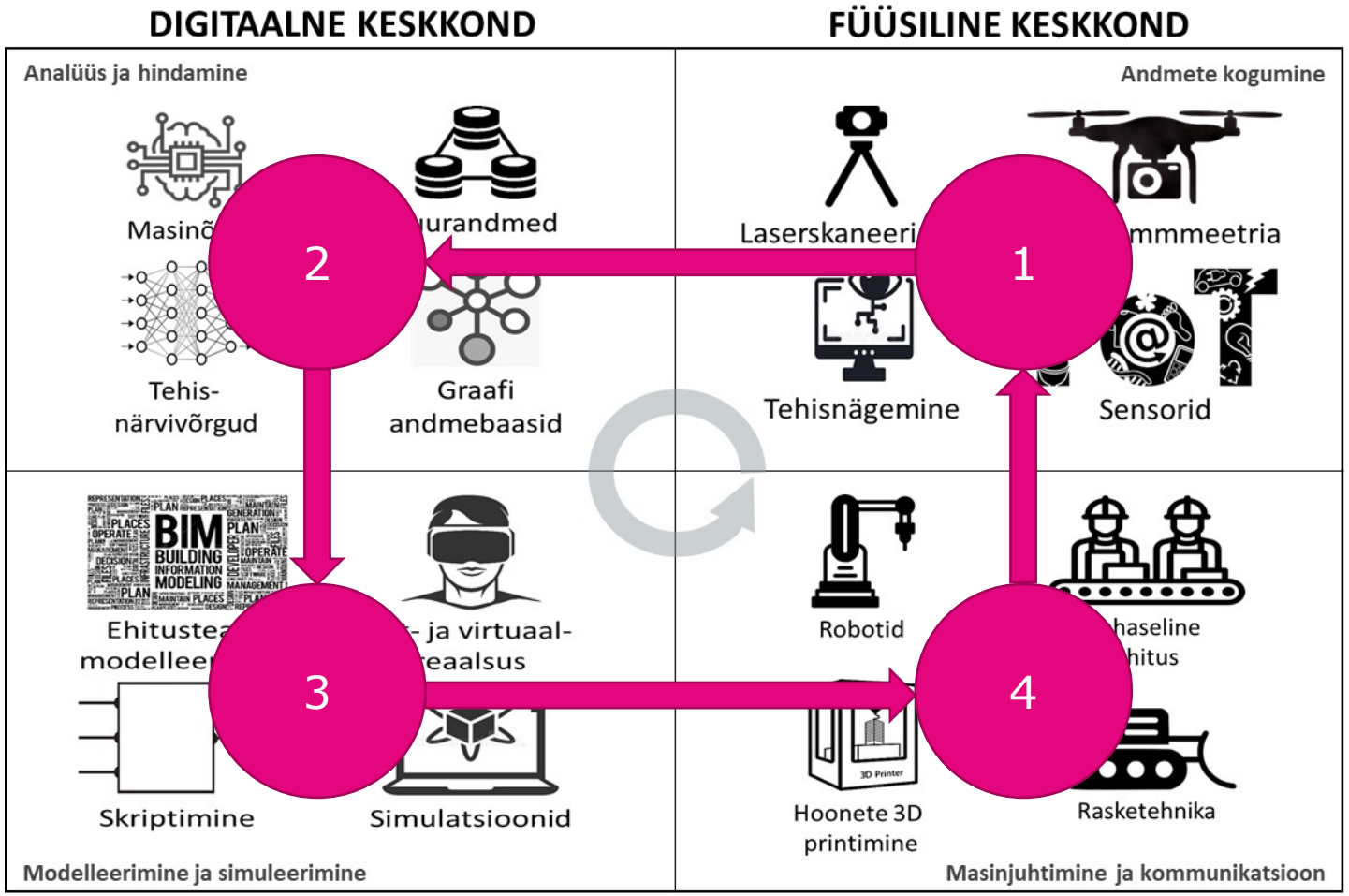
- Proper culture (e.g., Integrated Project Delivery)
- Fundamentally proven and standardized processes (Lean Management)
- Digitalization and automation as accelerators (e.g., BIM and Digital Twins)

DIGITAL TWIN FOR SCALING RENOVATION

DIGITAL TWIN CONCEPT



DIGITAL TWIN CONCEPT



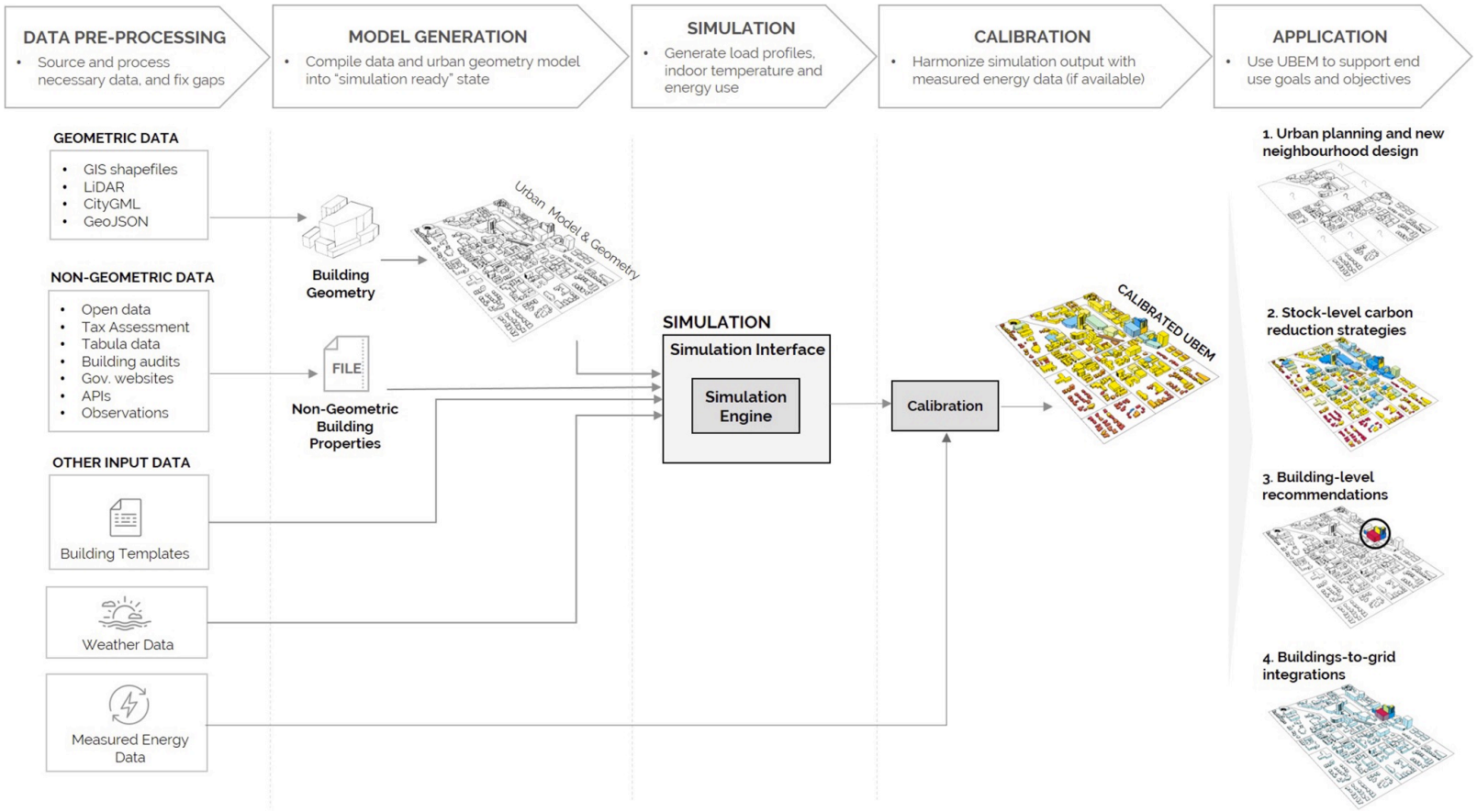
(Pikas, 2020)

DIGITAL TWIN CONCEPT FOR RENOVATION

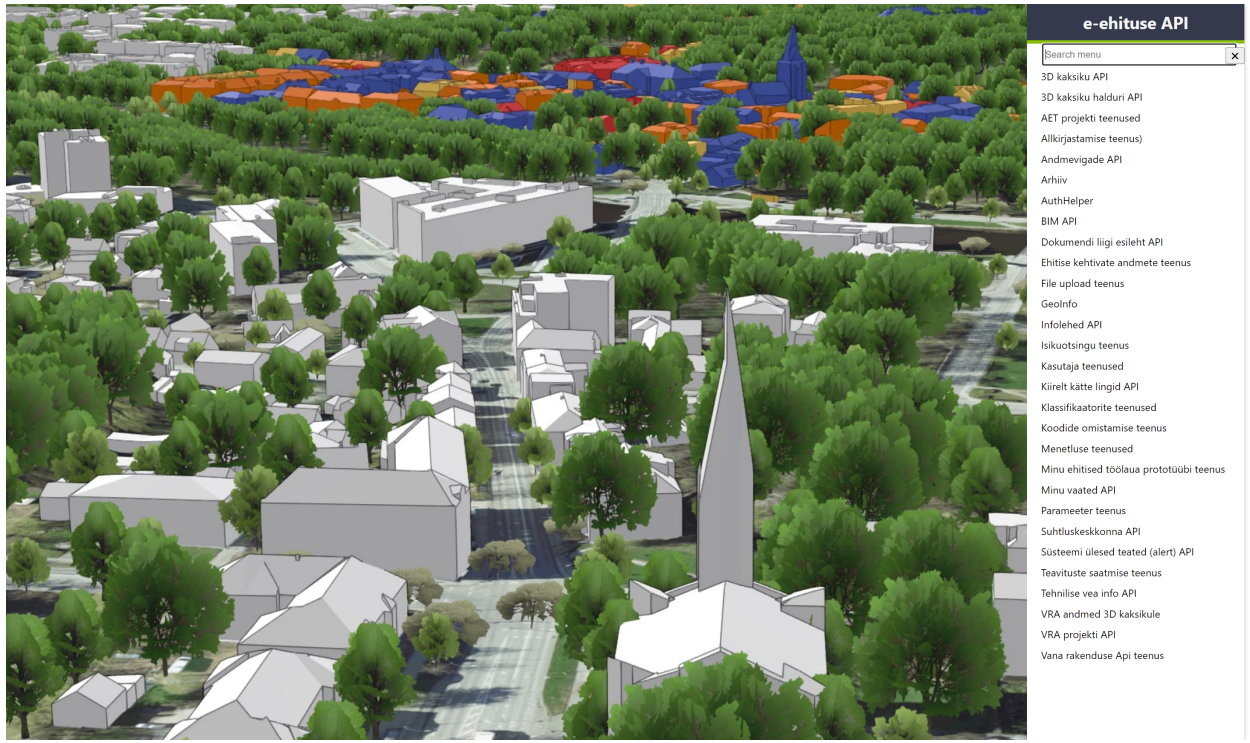
RESTO OBJECTIVES AND KEY CONCEPTS

- **Objective:** Support local authorities and large real estate owners to evaluate the energy performance of buildings and plan and develop energy efficient renovation strategy and estimate the impact on the city/neighborhood level.
  - Data-based strategic decision-making
  - City or real estate portfolio climate neutrality by 2050
  - Reduction of energy consumption
  - Extending the lifetime of buildings
  - Renovation in phases
  - Investment needs and impact
  - Co-operative procurement

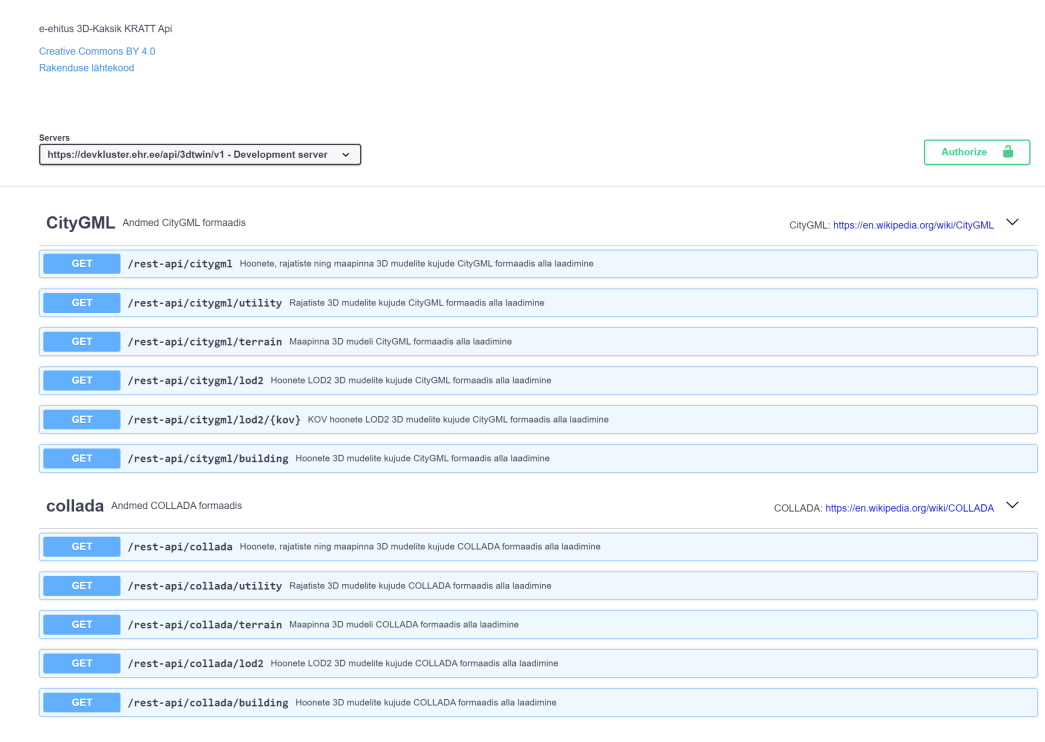
- **Key concepts:** Existing databases, reference models, calculation calibration against measured energy consumption, renovation measures, renewable energy production and donation, design requirements, co-operative procurement



DATA SOURCES



Link



Link

COMMON BUILDING TAXONOMY FOR INDUSTRIALIZED RENOVATION

BUILDING STRUCTURES: first use year, material and location

BUILDING GEOMTRY: Number of floors, ground surface area, and number of apartments







COMMON PROCESS FRAMEWORK FOR INDUSTRIALIZED RENOVATION

0 PLAN AND PROCURE
Needs and opportunities

1 DESIGNING
Preparation and concept

2 ENGINEERING AND MANUFACTURING
Design for Manufacturing

3 CONSTRCUCTION WORKS
Preparation, general works, transport/installation and commissioning

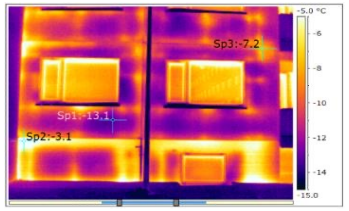
Gap

Contract

Permit

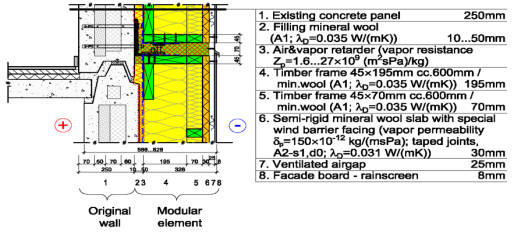
Detailed design and manufactured elements

Renovated building

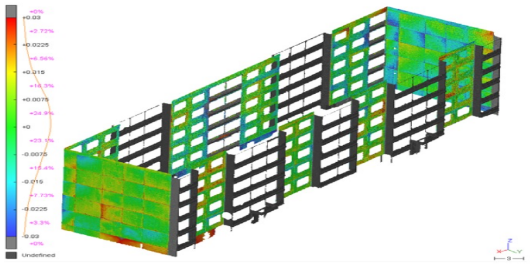




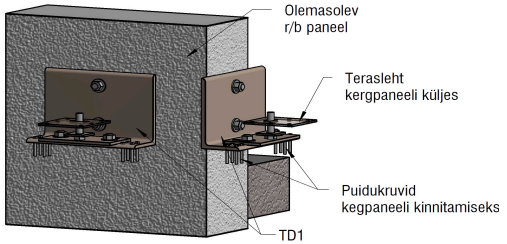














RESTO WORKFLOW EXAMPLE

SELECT AREA ON MAP

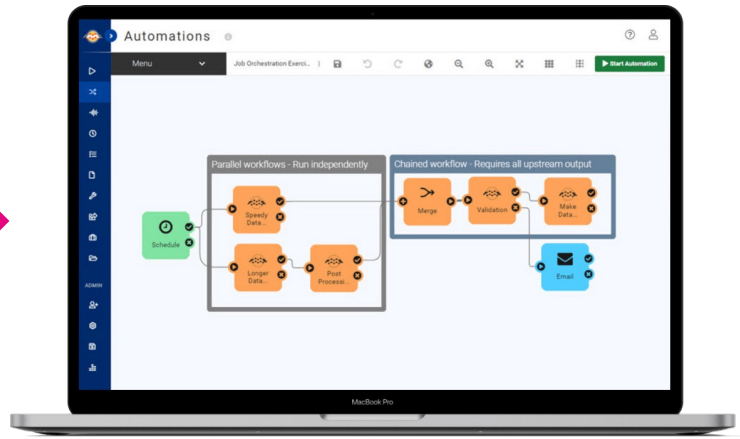
Select region or buildings:

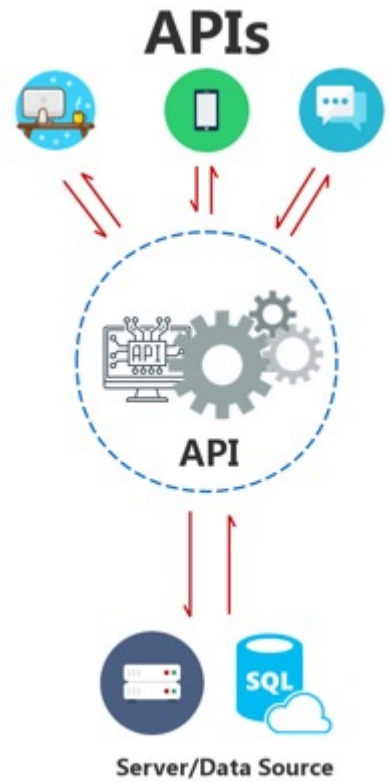
- Select region on a map
- Entre building IDs from the Estonian e-Permitting system
- Entre cadaster numbers



EXTRACT DATA

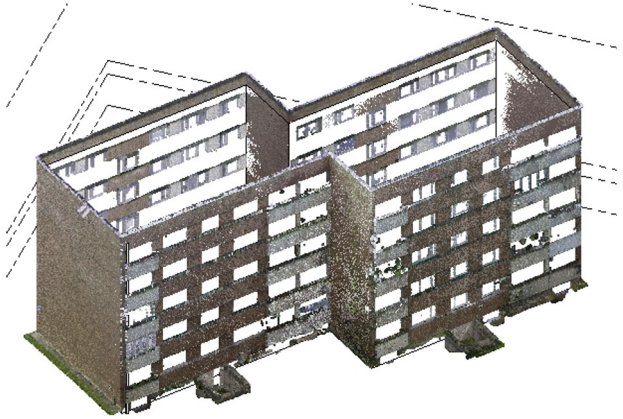






CAPTURE REALITY

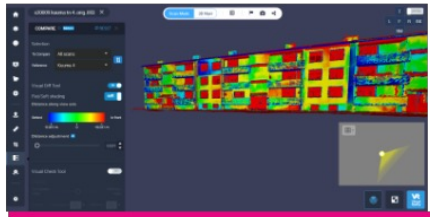






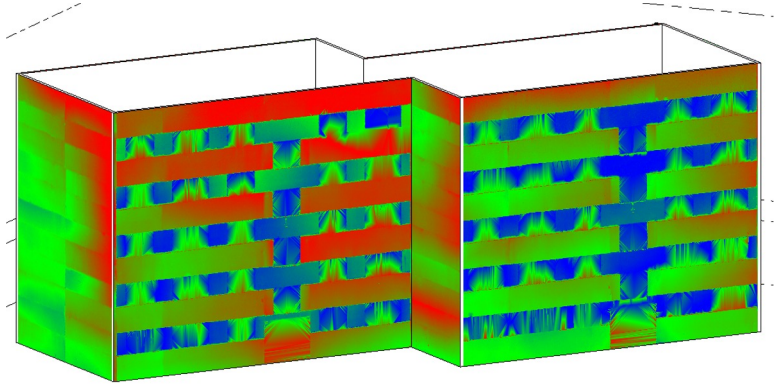
CloudCompare

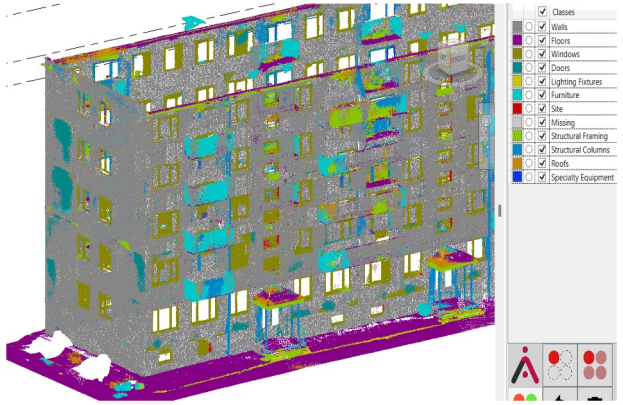
PILV vs PILV

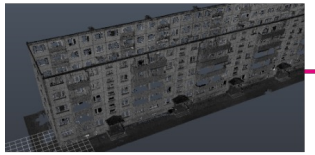


Cintoo Cloud

PILV vs MUDEL







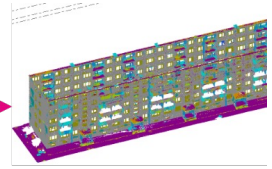
Punktipilv

E57

AURIVUS

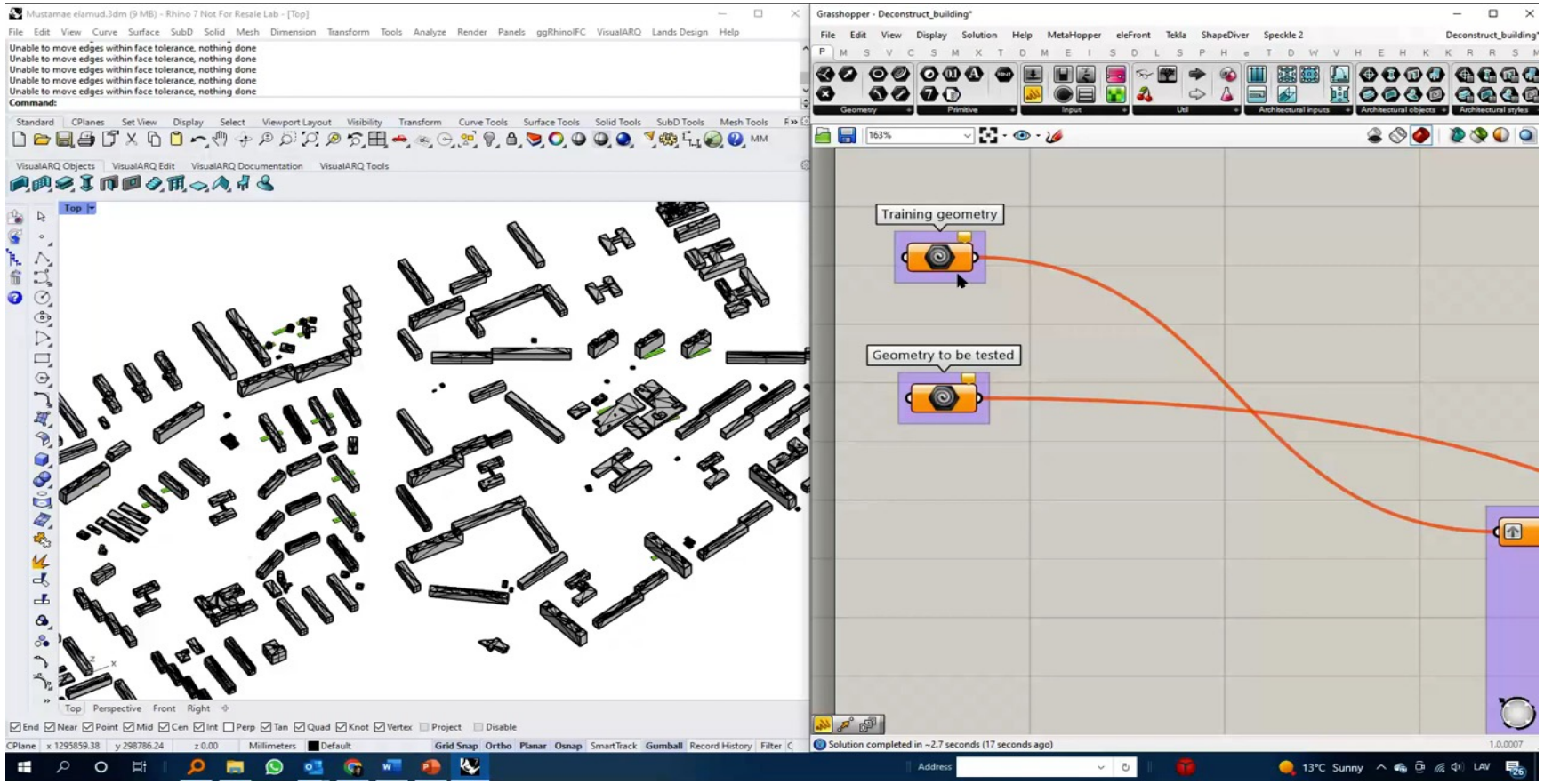
Veebiplatvorm

segmenteerimine

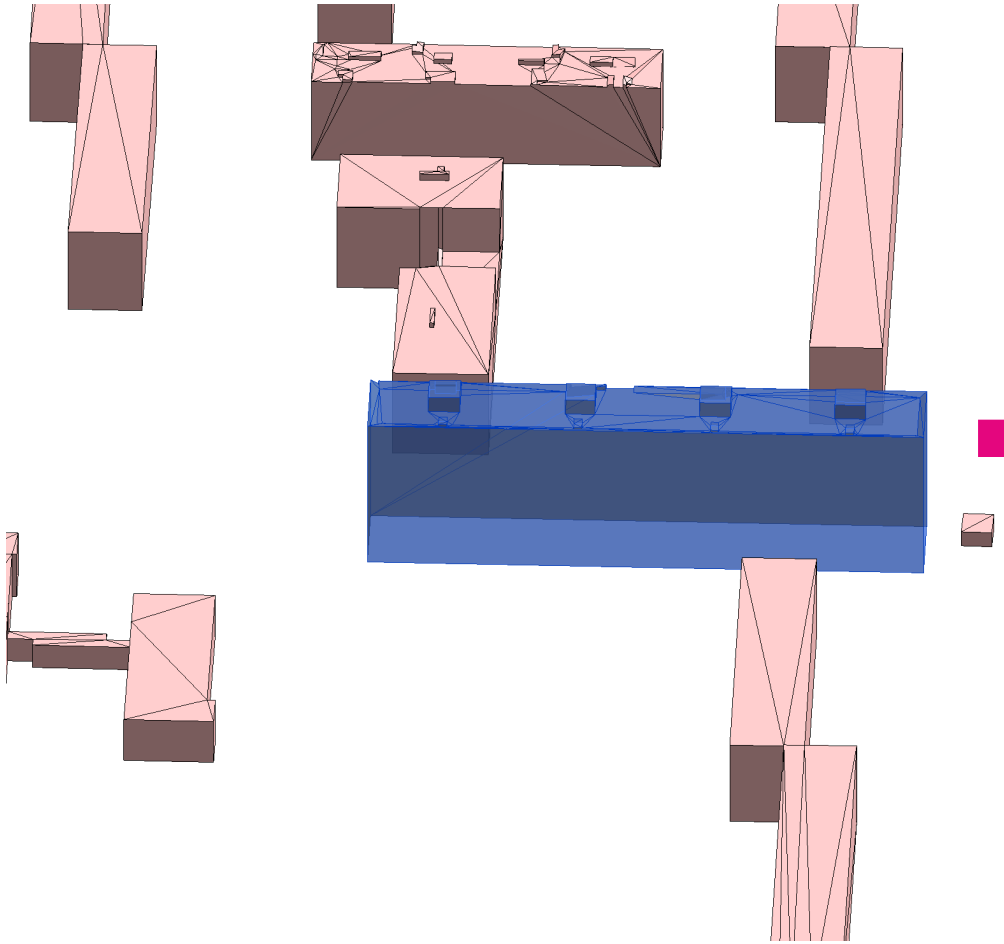


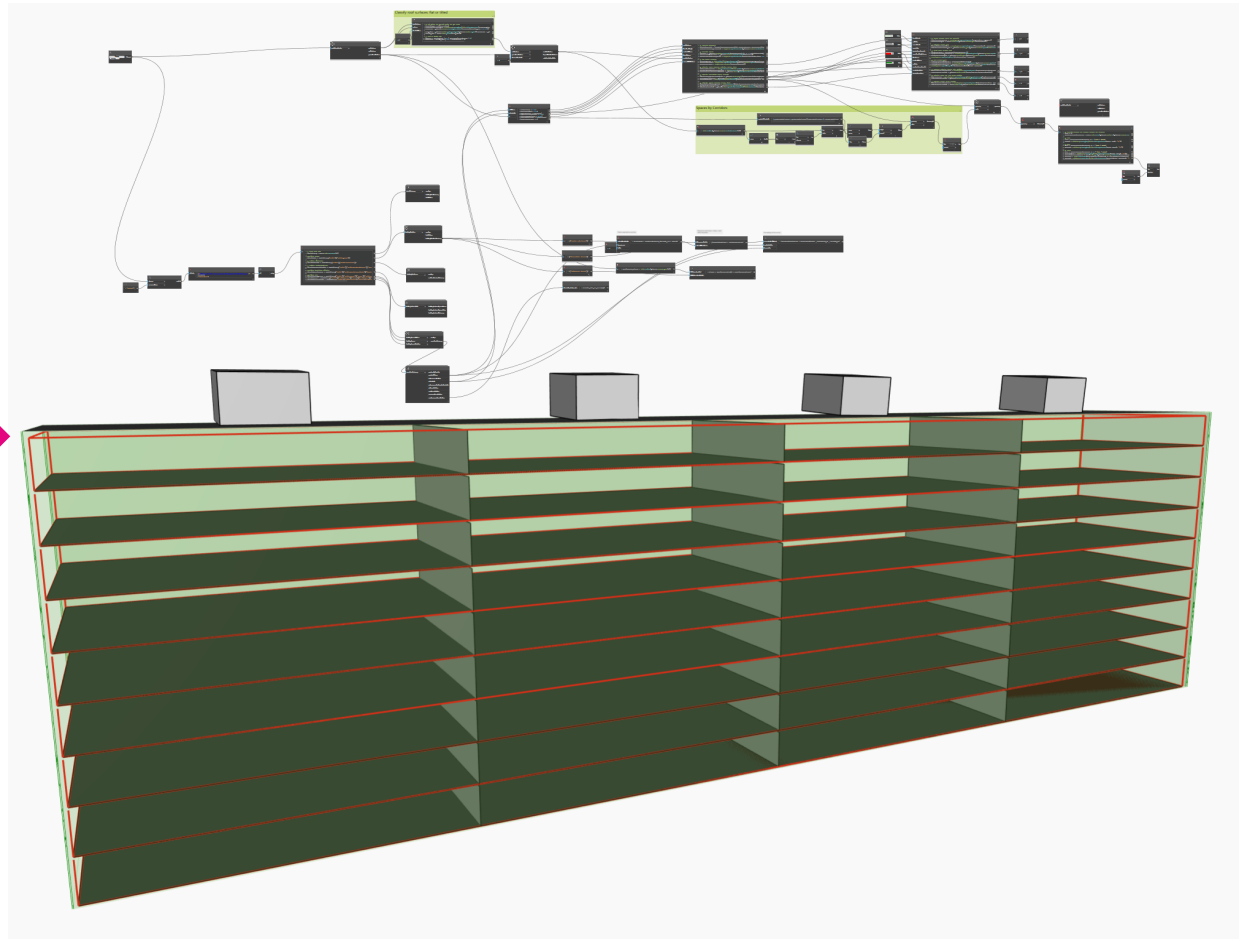
PLY (Revit + plugin)
E57 segmendid

MATCH TO TYPOLOGY



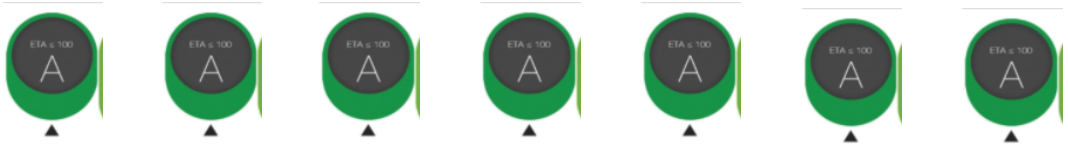
GENERATE DATA FOR SIMULATIONS AND CALCULATIONS





ESTABLISH OBJECTIVES AND CRITERIA FOR IDENTIFYING RENOVATION MEASURES

- **Option 1** = Climate neutrality for all buildings



- **Option 2** = Climate neutrality for selected buildings
  - Apartment buildings A+++



  - Buildings under heritage protection

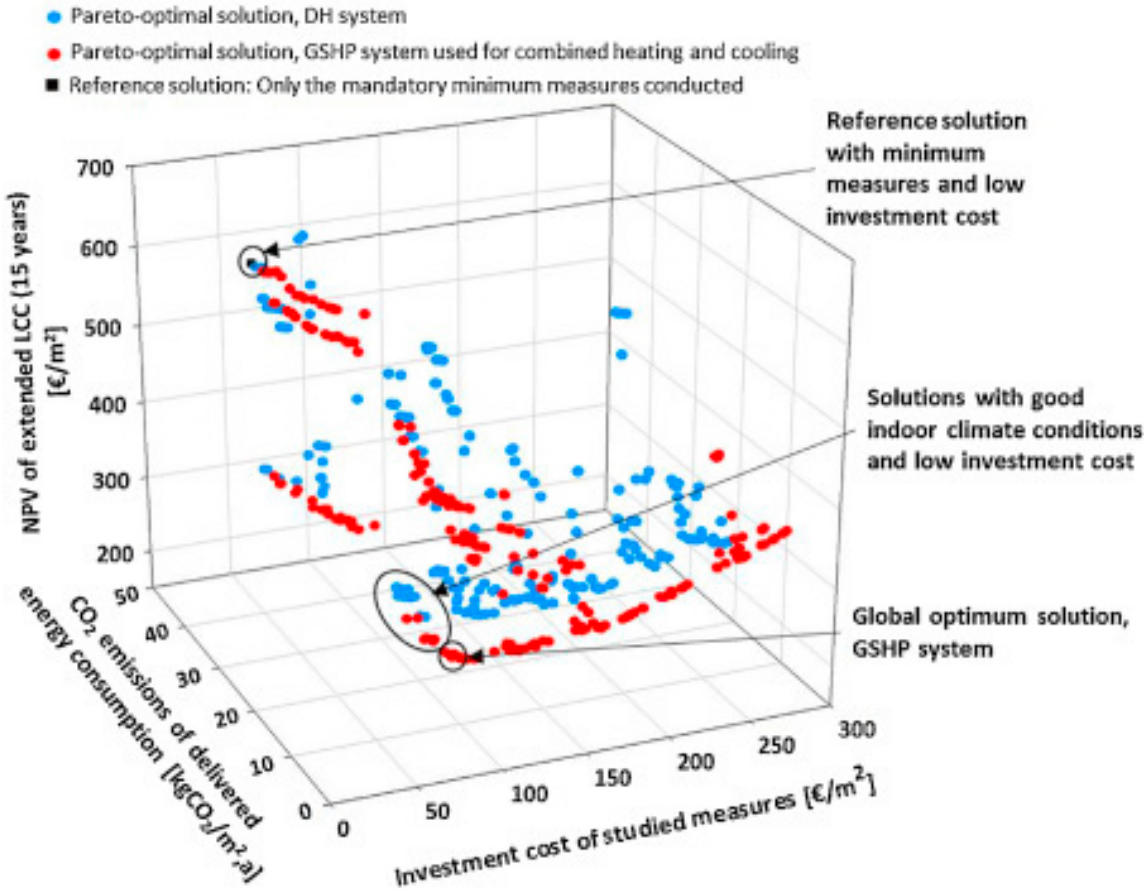




TAL TECH | TALLINNA TEHNIKAÜLIK

ASSESS INVESTMENT NEED AND COST-BENEFIT ANALYSIS

- Evaluate the measures
- Define a priorities for measures
- Create alternative packages for buildings
- Create alternative scenarios for area





ERGO PIKAS

ergo.pikas@taltech.ee