AEE INTEC

Federal Ministry
Republic of Austria
Climate Action, Environment,
Energy, Mobility,
Innovation and Technology

FFG
Promoting Innovation.

EBC
Energy in Buildings and
Communities Programme

IEA Research Cooperation
Part of open4innovation

IEA EBC Annex 75 | Cost-effective Building Renovation at District Level Combining Energy Efficiency & Renewables

Renovation? Renewables?

Agenda (I)

08:30	Reception and Registration
09:00	Welcome and opening Ingo Leusbrock, AEE - Institute for Sustainable Technologies
09:05	Current facts and figures on the renovation rate in Austria Wolfgang Amann, Institute for Real Estate Construction and Housing
09:25	Overview IEA EBC Annex 75 | Cost-effective Building Renovation at District Level Combining Energy Efficiency & Renewables Manuela Almeida, University of Minho
09:55	Lessons learnt from international and Austrian case studies Ingo Leusbrock, AEE INTEC
10:15	Policy Instruments & Stakeholder Dialogue Bernhard Gugg, Salzburger Institut für Raumordnung und Wohnen
10:35	Outlook, potential next steps Jan Peters-Anders, AIT Austrian Institute of Technology
10:50	Coffee break and bilateral exchange

Agenda (II)

10:50	Coffee break and bilateral exchange
11:15	Panel discussion Manuela Almeida, University of Minho Bernhard Gugg, Salzburger Institut für Raumordnung und Wohnen Jan Peters-Anders, AIT Austrian Institute of Technology Jorgen Rose, Danish Building Technological Institute Roman Bolliger, INDP Erwin Mlecnik, TU Delft
11:45	Reflection and closing words
12:00	Laboratory tour AIT Computational design methods for sustainable urban development (Theresa Fink) City Intelligence Lab (CIL) Thermal building simulation for the evaluation of renovation measures (Aurelien Bres)
12:45	Snacks and end workshop

More information

- IEA EBC Annex 75 website
  - https://annex75.iea-ebc.org/

Acknowledgements

- This project has been funded in scope of the Austrian IEA Research program, project no. 864141.

AEE INTEC

IDEA TO ACTION

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FFG

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

AEE INTEC

AEE – Institute for Sustainable Technologies

Member of

AUSTRIAN COOPERATIVE RESEARCH
KOOPERATION MIT KOMPETENZ

2020

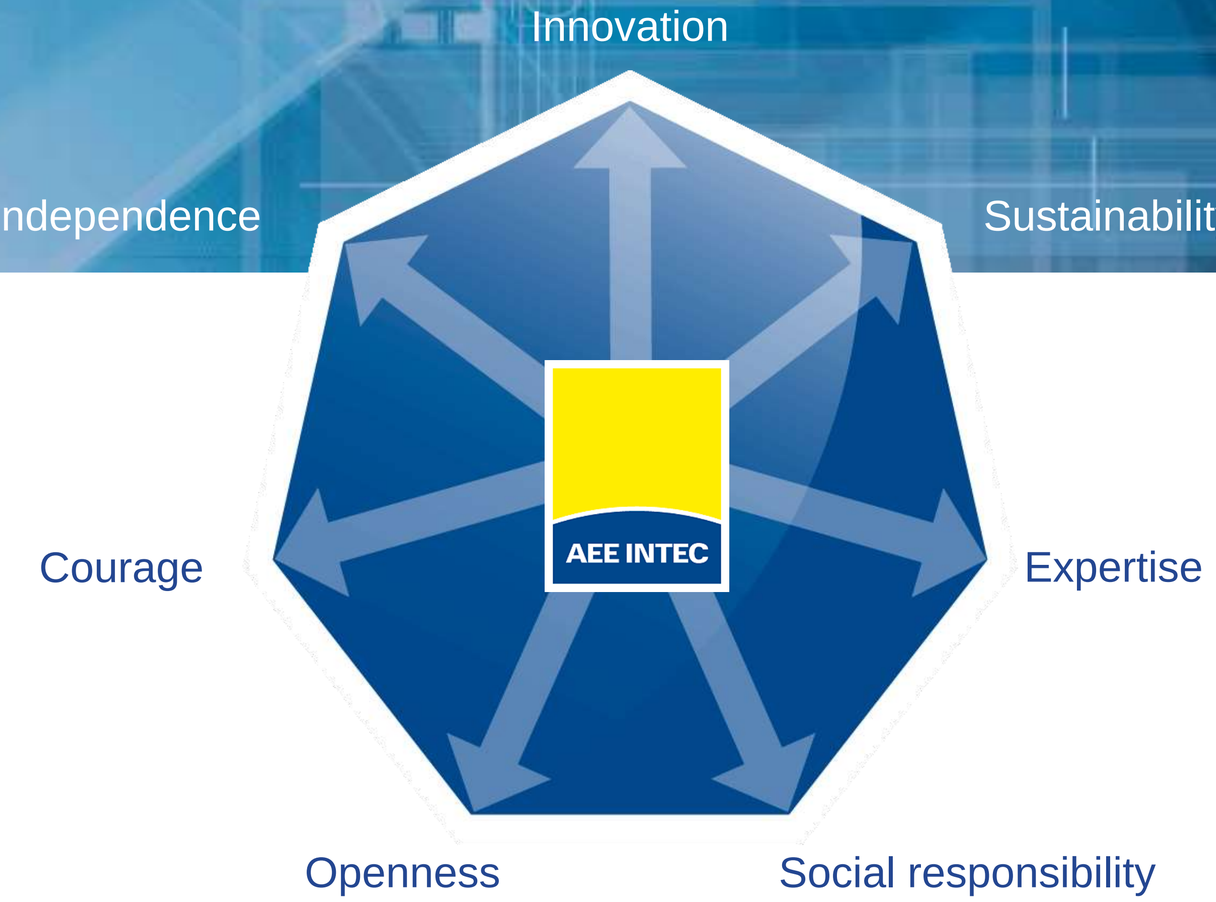
AEE - Institute for Sustainable Technologies was founded in1988 as a non-university research institute. It is today one of the leading institutions in the field of renewable energy and resource efficiency.

1988

In the world of renewable energy and resource efficiency we transform ideas into reality through:

- Research
- Development
- Consulting
- Training

Our Value Septet



Our Employees

90

Staff Members

10-15

Master Students

4

PhD Students

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Current facts and figures on the renovation rate in Austria

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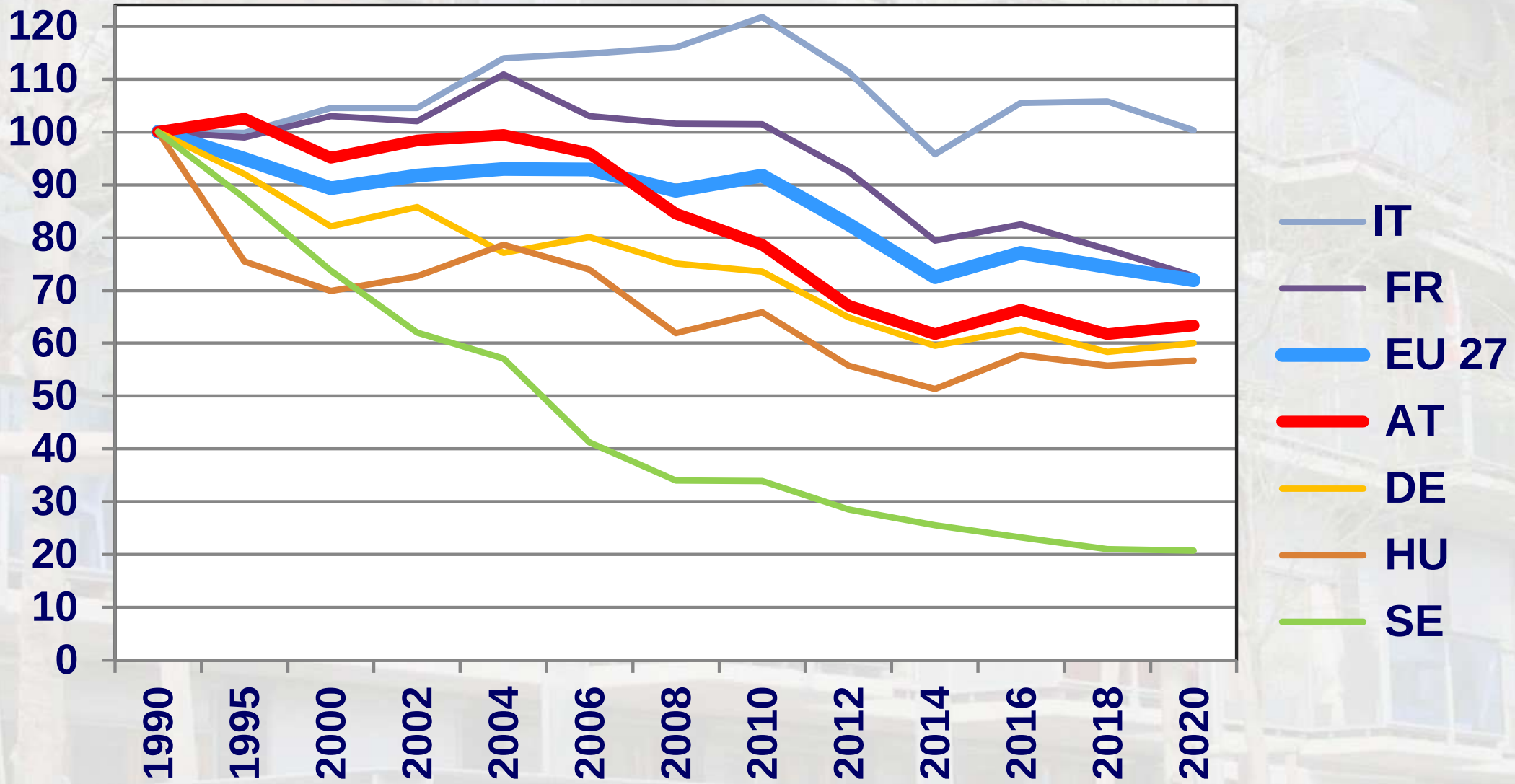
GHG emissions in buildings (Index, 1990=100)



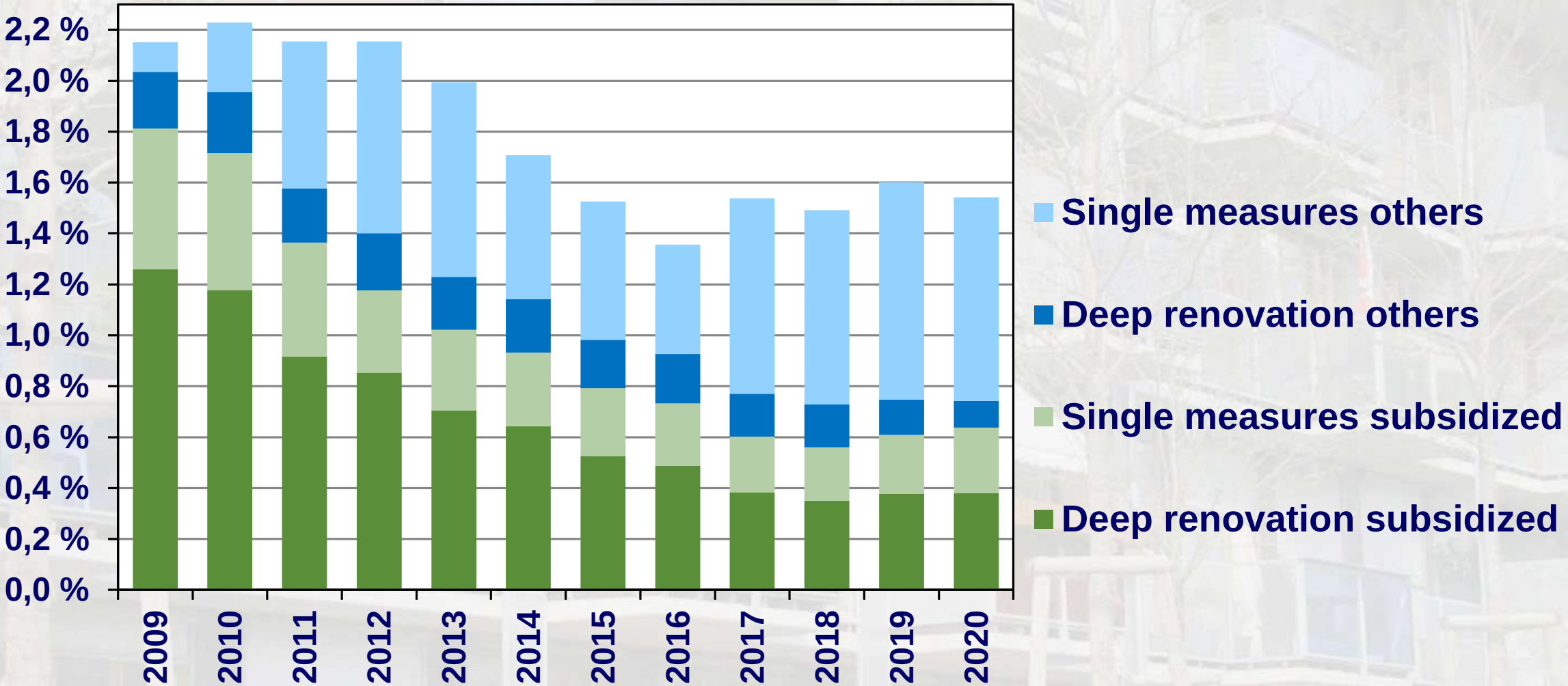
Re.: Buildings = sector CRF 1.A.4
Source: Eurostat, GHG emission inventory, IIBW

New approach to define and measure a renovation rate in Austria

(IIBW, Environment Agency Austria)

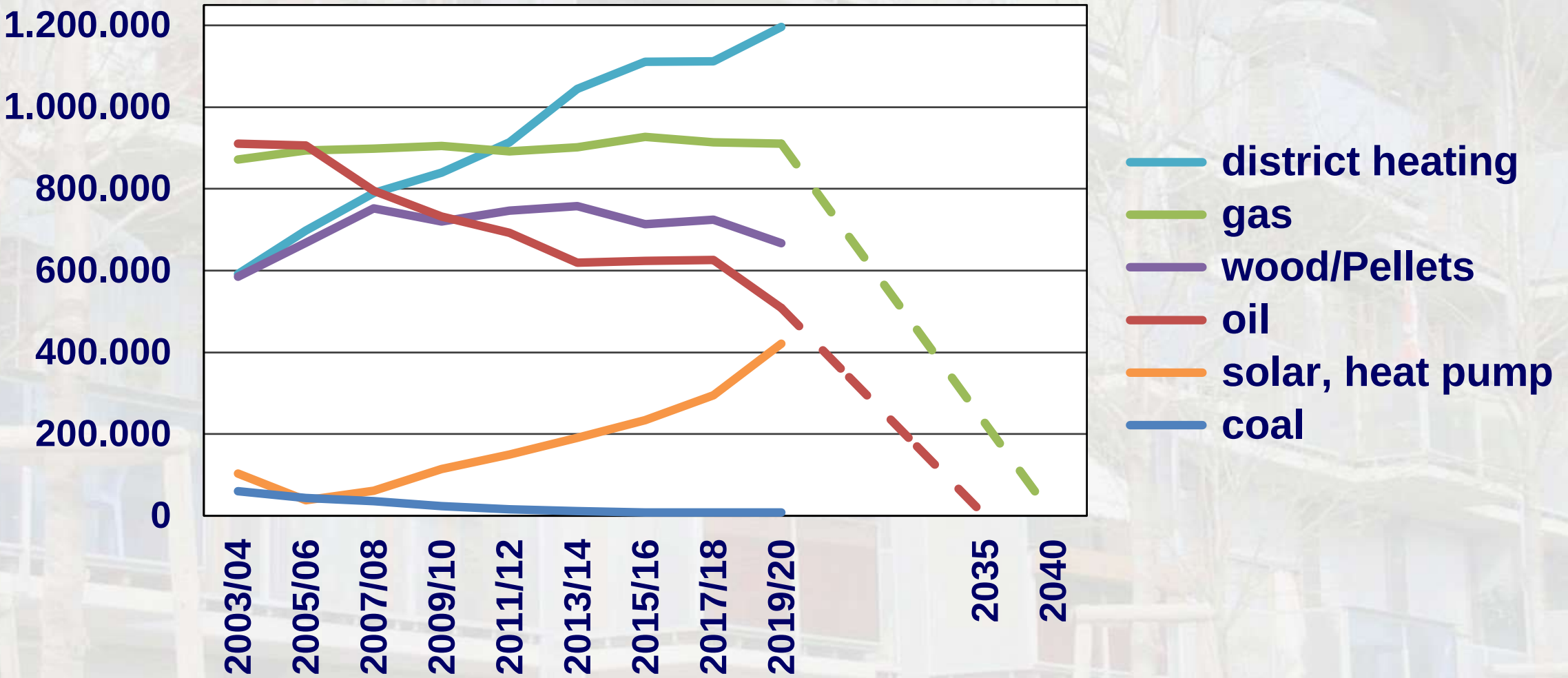
$$= \frac{\Sigma \text{ deep renovations} + \Sigma \text{ equivalent single measures}}{\text{total stock of housing}}$$

Renovation rate in Austria



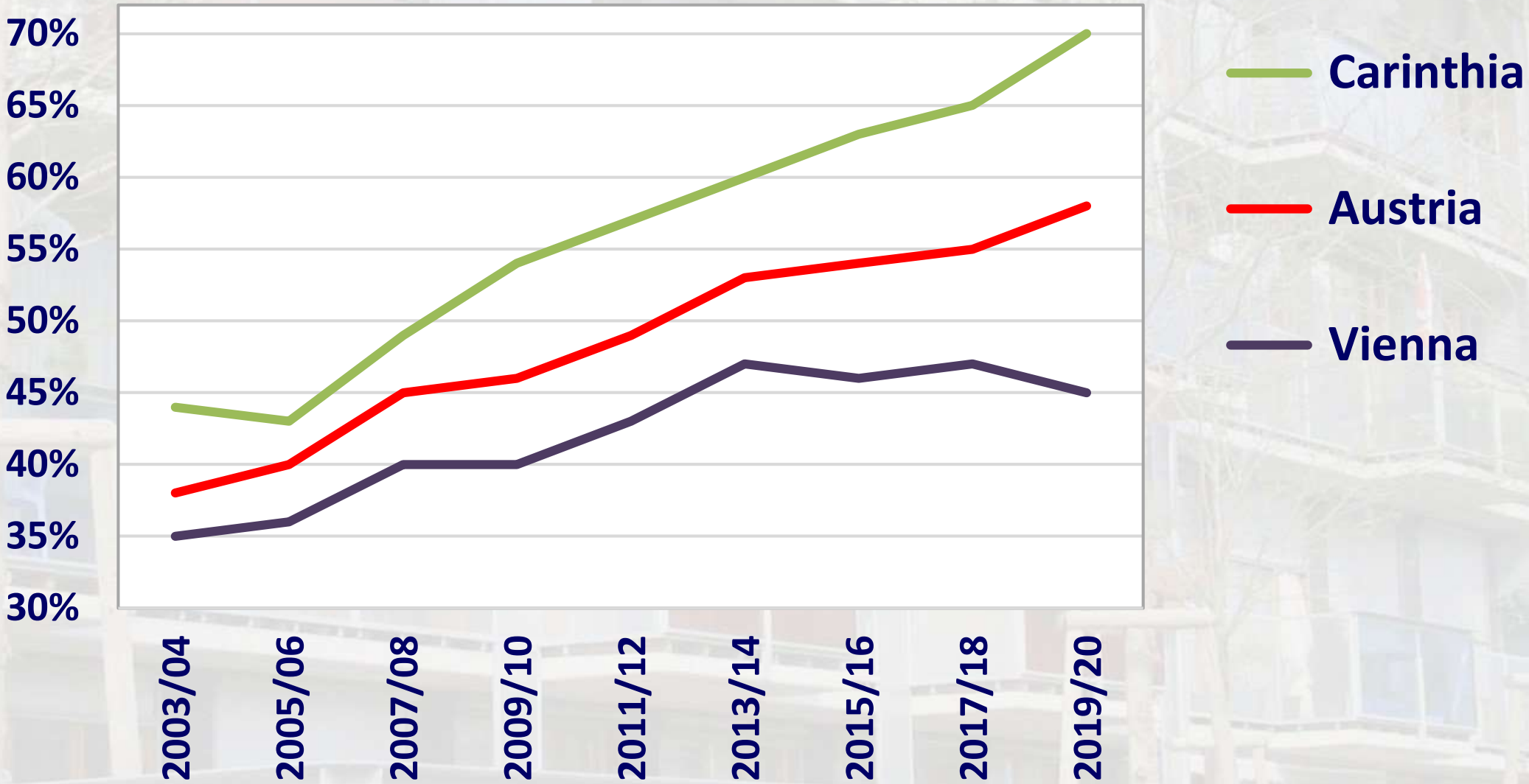
Source: IIBW, Environment Agency Austria (2021)

Development of heating systems in Austria / fuel switch



Re.: Number of households (main residence), primary heating system
Source: Statistik Austria Microcensus bi-annual special surveys on energy input of households

Share of renewables in the Austrian housing stock



Re.: Share of households (main residence), primary heating system
Source: Statistik Austria Microcensus bi-annual special surveys on energy input of households

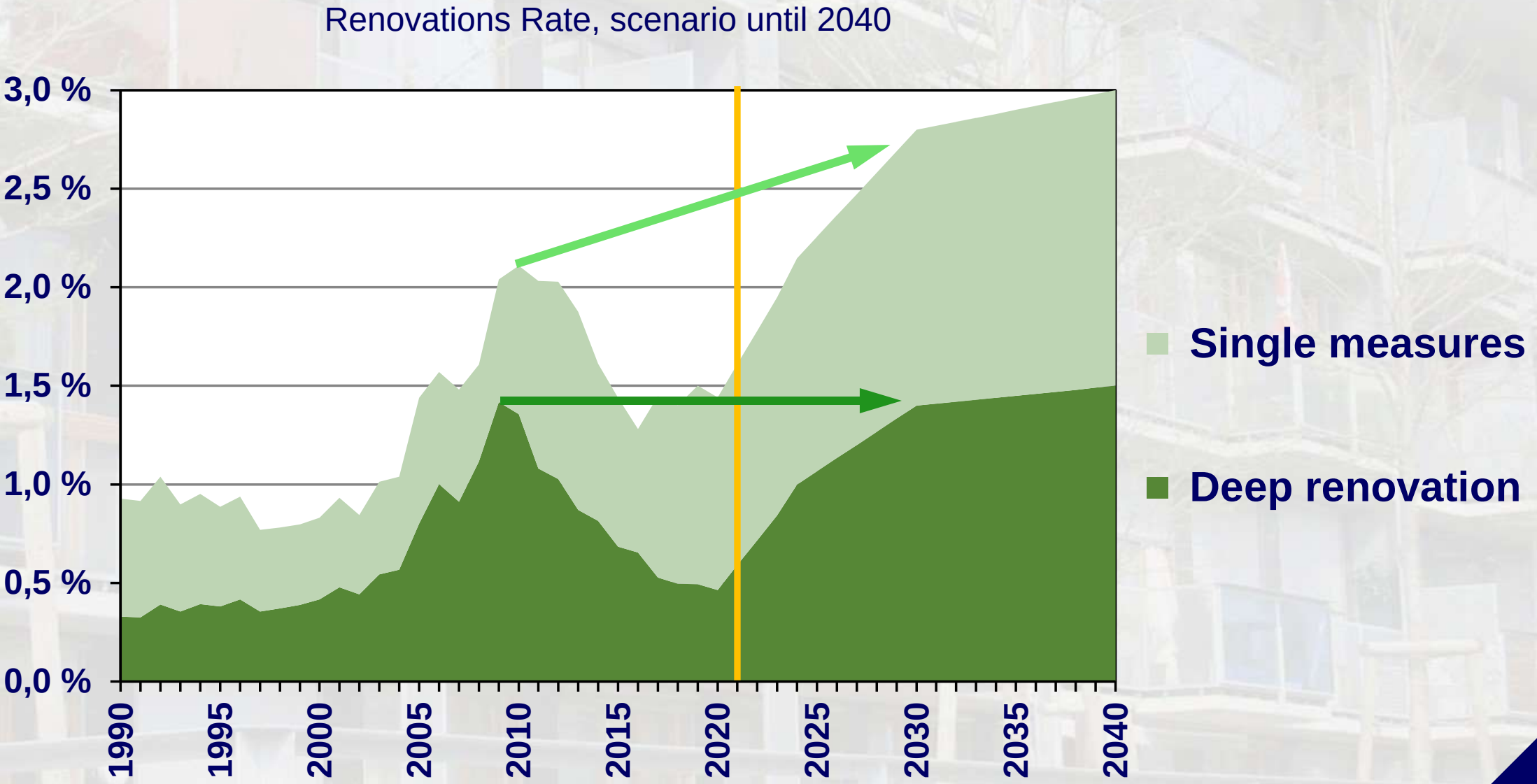
Barriers to increase the renovation rate

- For the construction industry:
  - Lower value than with new construciton
  - Higher economic risks compared to new construction
  - Higher qualification of staff required
  - Scarcity of personnel and professionals
- For policy makers:
  - Scattered authorities (Federal State, „Länder“, different ministries)
  - Necessity of action in quite different fields of policy, necessity of a bundle of measures no „simple story“
  - Hardly scarcity of financing
- For building owners:
  - Insufficient incentives, insufficient economic feasibilty
  - Currently heavy price increases
  - Deep renovation is complex and costly (particularly burdensome for single family homes)

Legal drivers

- Ban of oil heatings in new construction (2020)
- Ban of gas heatings in new construction (probably 2023)
- Obligatory replacement of old oil/coal heatings in case of defect (probably 2023)
- General replacement of oil/coal heatings dependent to age (planned by 2025)
- Similar path with few years delay for gas heatings
- Reforms in housing legislation
- Closedown of all oil and gas heatings by 2035/2040

Is there reason for optimism?



Source: IIBW, Environment Agency Austria (2021)

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IEA EBC Annex 75

Cost-Effective Building Renovation at District Level Combining Energy Efficiency & Renewables

13 countries are involved in the project:
AT, BE, CH, CN, CZ, DK, ES, GE, IT, NL, NO, PT, SE

January 2018 – November 2022

Manuela Almeida (Operating Agent)
University of Minho
Portugal

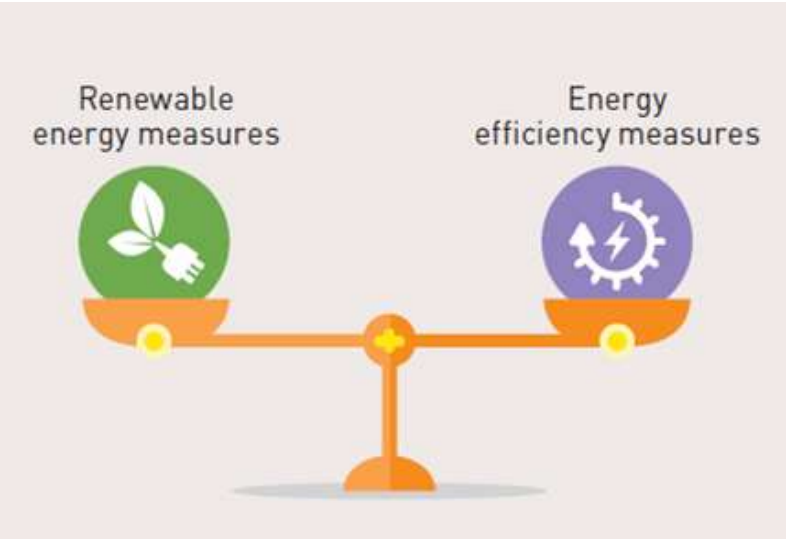
Technical Workshop
Vienna
28th of June, 2022

1. Project Goal

Project Goals:

- To **investigate cost-effective strategies for reducing carbon emissions and energy use in buildings at district level**, combining both energy efficiency measures and measures to promote the use of renewable energy

- To **provide guidance to policy makers, companies** working in the field of the energy transition, as well as **building owners** for cost-effectively transforming the city's energy use in the existing building stock **towards low emission and low energy solutions**



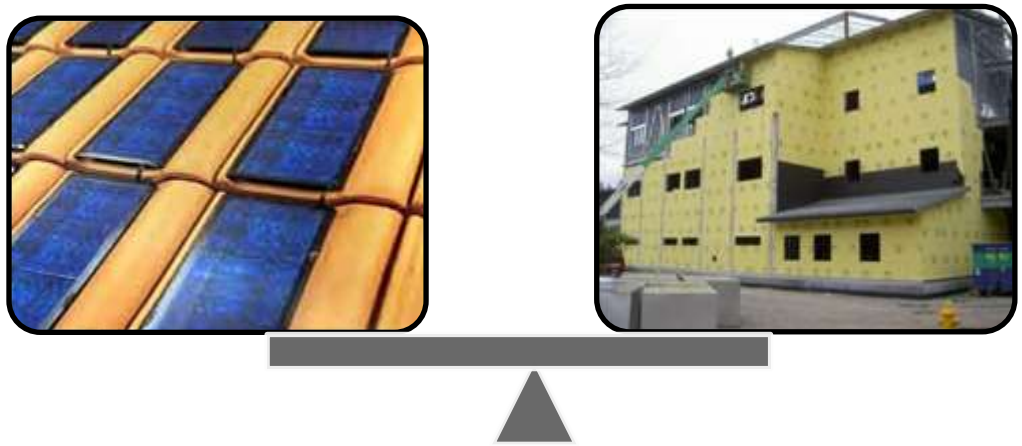
Scope:

- Residential Buildings and non residential buildings without complex HVAC systems

2. Project Idea

- At district level there are specific opportunities as well as specific challenges when compared to the building level

- Finding the balance between renewable energy supplies and energy efficiency measures for the renovation of the existing stock is more complex at district level than for individual buildings, but may also bring larger benefits



2. Project Idea

There are several options available that can be explored:
Exemples:

- **We can benefit from economies of scale for energy efficiency measures due to aggregated demands and synergies in construction procurement, processes and planning**

  The provision of low-temperature district heating systems to groups of buildings may benefit from synergies when combined with energy efficiency measures applied to the buildings envelopes

- **There is also an opportunity to benefit from centralized renewable energy approaches**

  The availability of heat storage facilities that in a single building intervention is limited to the building floor space, at district level the options are wider

2. Project Idea

However, there are also some challenges:

- **At the level of individual buildings, synergies between energy efficiency measures and installation of renewable energy systems can be easily achieved but, at district level such synergies are not necessarily available as they depend on the existing heating systems and on the synchronization of the buildings´ renovation cycles**

- **Districts are complex structures with several actors involved, sometimes with conflicting goals. At district level coordination and communication are crucial**

In this context, it was important to explore the potential of cost-effective renovation interventions at district level to accelerate the necessary transition towards low-emissions and low-energy districts

3. Annex 75 Objectives

Specific objectives of Annex 75:

- Give an overview on existing and emerging technology options for cost-effective strategies
- Define a flexible methodology, supported by efficient tools, to identify cost-effective strategies for renovating urban districts to significantly reduce carbon emissions and energy use
- Identify and document good practice examples showing strategies for transforming existing urban districts into low-energy and low-emissions districts
- Prepare Guidelines for policy makers and energy-related companies on how to encourage the market uptake of cost-effective strategies combining energy efficiency measures and renewable energy measures
- Prepare some guidance for building owners and investors about cost-effective district-level solutions

http://annex75.iea-ebc.org/

5. Annex 75 Outputs

- Technology Overview
- Methodology on cost-efficient building renovation at district level
- Annex 75 online tool
- Parametric assessments of generic districts
- Parametric assessments of case studies
- Strategy development
- Good practice examples (online)
- Barriers and drivers for energy efficient renovation at district level
- Good practice guidance for transforming existing districts into low-energy and low-emission districts
- Policy instruments (including recommendations for subsidy programmes and for encouraging market take-up)
- Business models and models for stakeholder dialogue
- Guidelines for policy makers and energy related companies on how to encourage the market take-up of cost-effective strategies combining energy efficiency measures and renewable energy measures
- Guidelines for building owners/investors about cost-effective renovation strategies, including district-based solutions

6. Outputs

Technology Overview Report

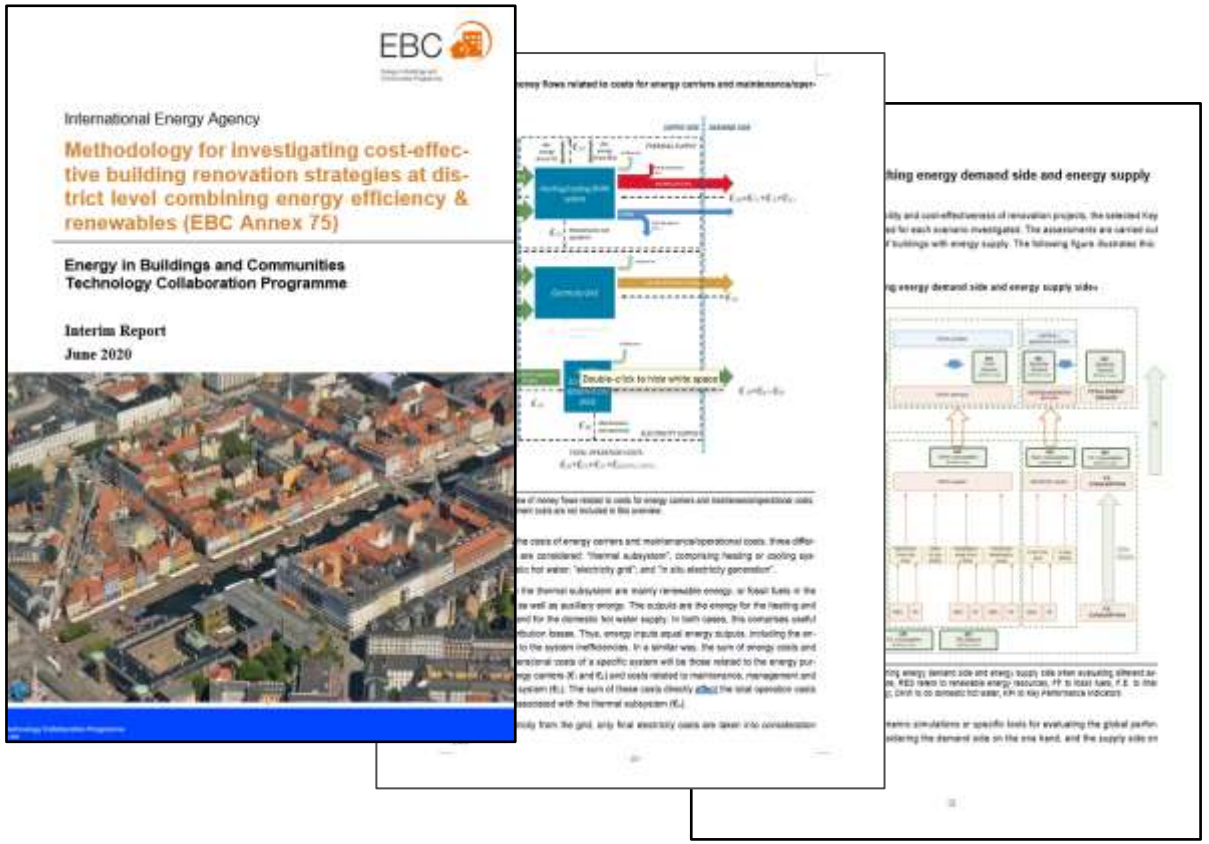
The report presents an overview of the available technologies for energy renovation and renewable energy supply at the district level, showing:

- **Technical and economic characteristics of the technology options, taking into account economies of scale.**
- **Interdependencies, obstacles and success factors for combining the technology options.**
- **Available potentials, and expected future developments.**

https://annex75.iea-ebc.org/publications

6. Outputs

Methodology Report



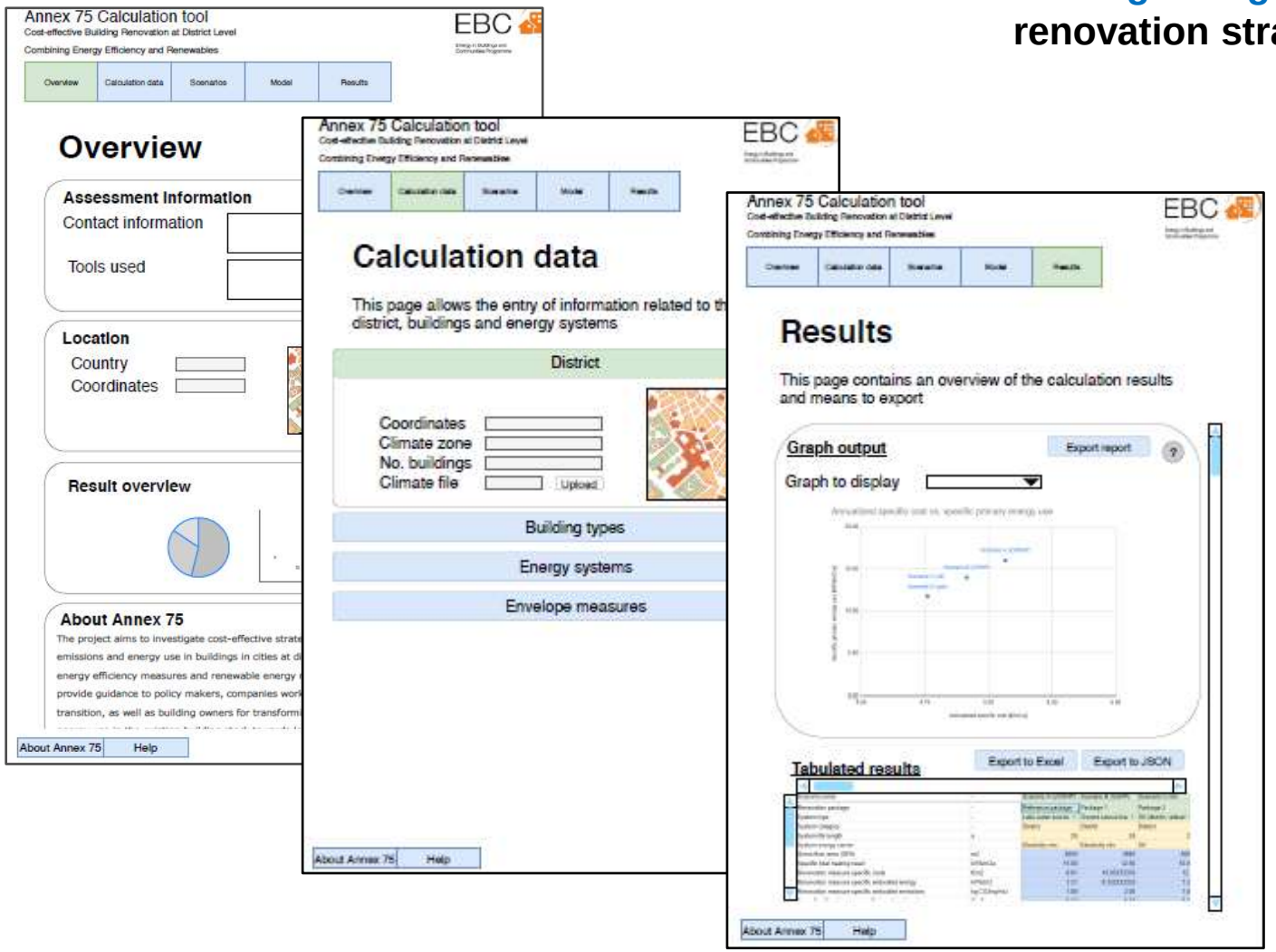
The report describes the **methodology for identification and assessment of cost-effective strategies** for renovating urban districts:

- Defines the **boundary conditions** for the assessments
- Presents the main **research questions** investigated
- Defines the **outputs** generated in the analyses

This document intends to **support decision makers** in the evaluation of the **efficiency, impacts, cost-effectiveness and acceptance** of various strategies for **renovating urban districts**

6. Outputs

Annex 75 District Calculation Tool

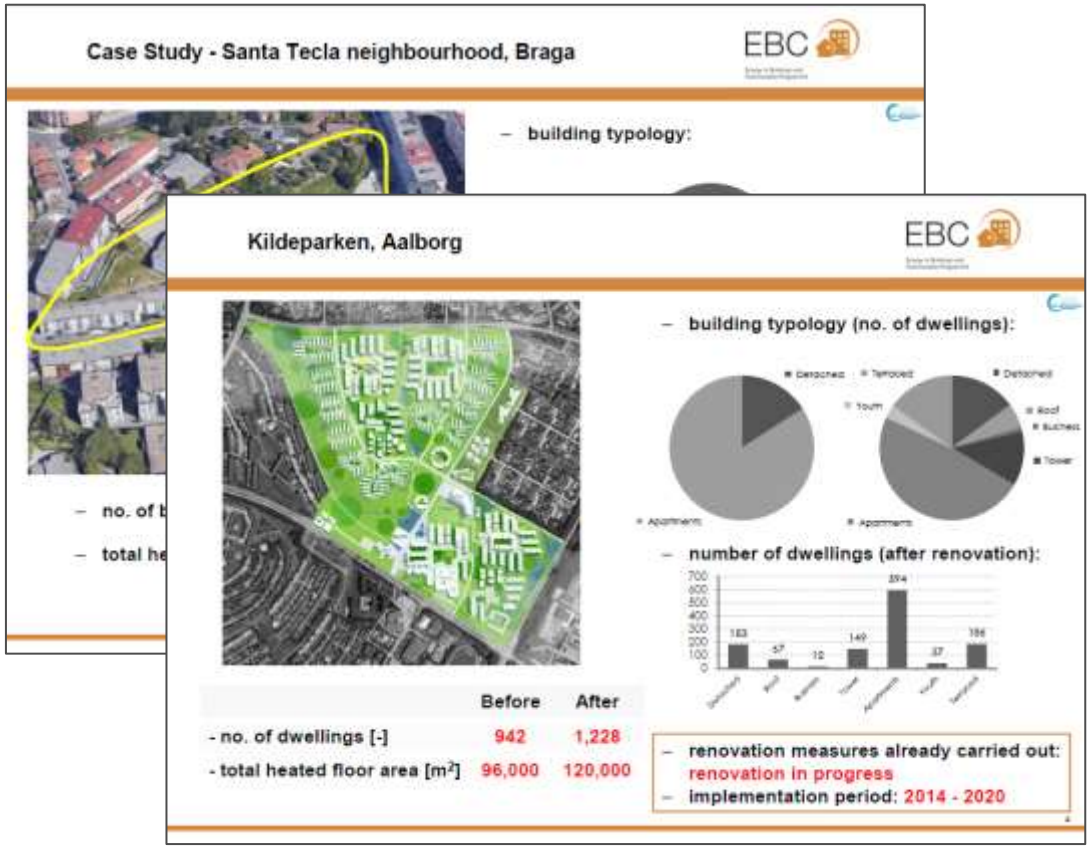


Online calculation tool for district heating sizing and cost-effectiveness of renovation strategies

- characteristics of the district
- characteristics of the buildings
- renovation scenarios
- cost curves
- …

6. Outputs

Identification of Success Stories and Case Studies



Success Stories – already finished district-based renovation **projects**

where **economic**, **technical** and **social factors** that **enable or hinder** successful renovations were identified and analysed

Case Studies – open renovation projects used to **apply and test** the Annex 75 **Methodology**

There is still the possibility to **provide guidance in choosing the most appropriate renovation strategy** especially in finding synergies and trade-offs for combining energy efficiency measures and renewable energy measures

Results obtained and lessons learned were used to **identify the barriers and drivers** for an energy efficient renovation at district level and to prepare a **good practice guidance** for reaching low-energy and low-emission districts

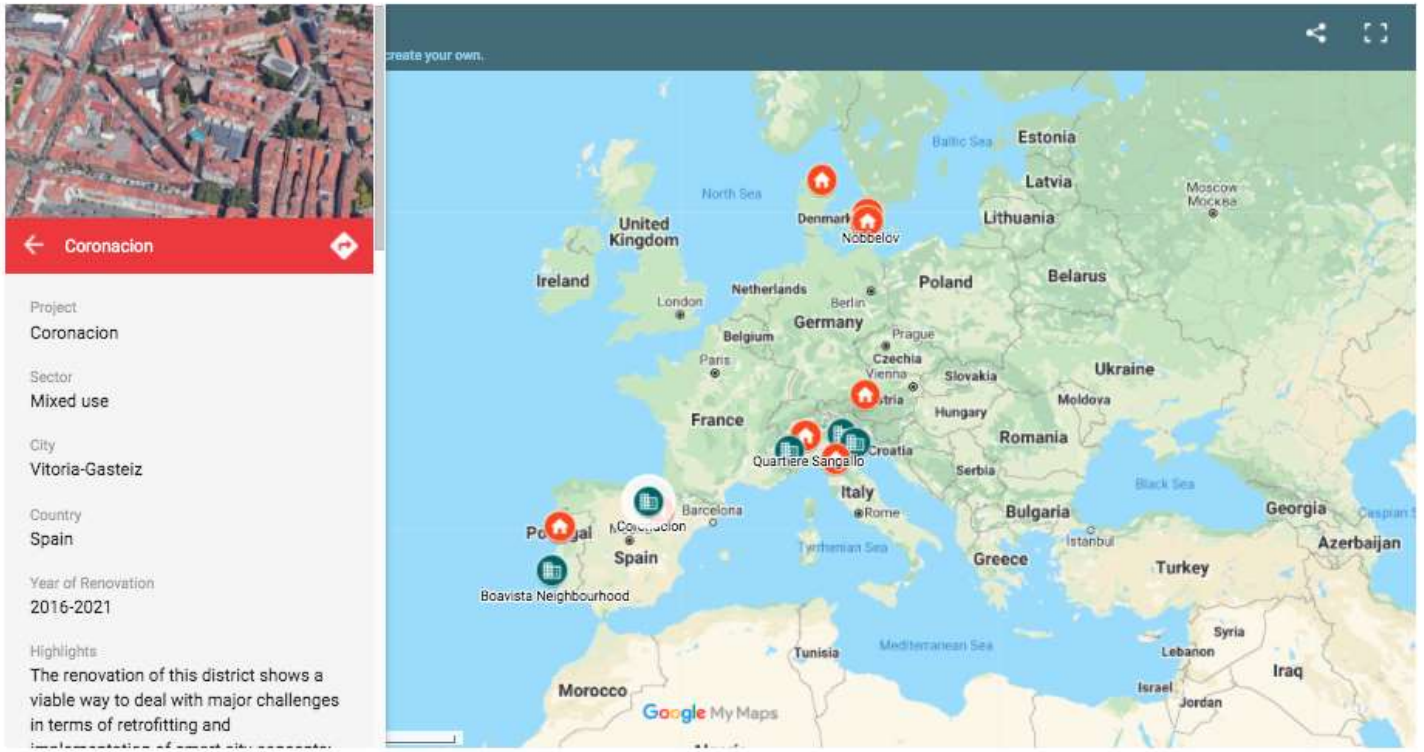
6. Outputs

Success Stories Webpage

HOME ABOUT SUBTASKS SUCCESS STORIES PUBLICATIONS PARTICIPANTS NEWS MEETINGS MEMBER AREA

HOME / SUCCESS STORIES

Success Stories



HOME ABOUT SUBTASKS SUCCESS STORIES PUBLICATIONS PARTICIPANTS NEWS MEETINGS

Interactive map integrated in the Annex 75 website.

https://annex75.iea-ebc.org/success-stories

6. Outputs

Policy Instruments, Stakeholder Dialogue and Business models for upscaling District energy renovation

Workshop at Bilbao – March 2019

Workshop at Delft – October 2019

With insights from several workshops and interviews, reports were prepared:

- To give an overview on various policy instruments and business models at the district level
- To evaluate stakeholder's acceptance of the proposed policy instruments
- To illustrate the development and assessment of innovative local policy instruments in selected cases
- To give recommendations to policymakers and their key partners on how they can influence the uptake of cost-effective low carbon renovation solutions

7. Annex 75 Findings

General Findings

- **There are no ready-made solutions. Each district/neighbourhood has to be analysed individually taking into account its specificities**
- **The best solutions depend on the starting situation of the district/neighbourhood (as the insulation level, installed heating/cooling system, available energy sources and the possibility of integrating renewable energies)**
- **Co-benefits should be considered when deciding on the best solution to be implemented**
- **Not just the technical and economic aspects matter in a district energy renovation**
- **Social, legal and planning issues are equally important, and communication with different stakeholders is crucial**
- **Policy measures are essential to implement district energy renovations because the market by itself is unlikely to deliver district solutions to a large extent**

8. Annex 75 Recommendations (examples)

- Adapt laws and regulations to stimulate building energy renovation at the individual, collective, cluster and district levels
- Create a certification scheme also at the cluster and district levels
- Make the implementation of RES mandatory whenever a heating system or district grid is replaced and there are adequate conditions for renewables integration
- Offer a single point of contact offering integrated solutions and services
- Assure quality in procurement, design and execution by facilitating easy-to-use and reliable tools
- Promote a holistic approach linking buildings renovation to urban planning, energy grid development and carbon reduction goals
- Deploy financial measures and business models to promote zero-carbon-ready renovations
- Create financial incentives and unburden local collectives to make RES and energy storage systems more accessible
- Facilitate specialised technical capacitation and supply chain collaboration on deep energy renovation for the whole chain of the building sector professionals, building owners and local administration staff
- Provide transparent communication

9. Annex 75 information

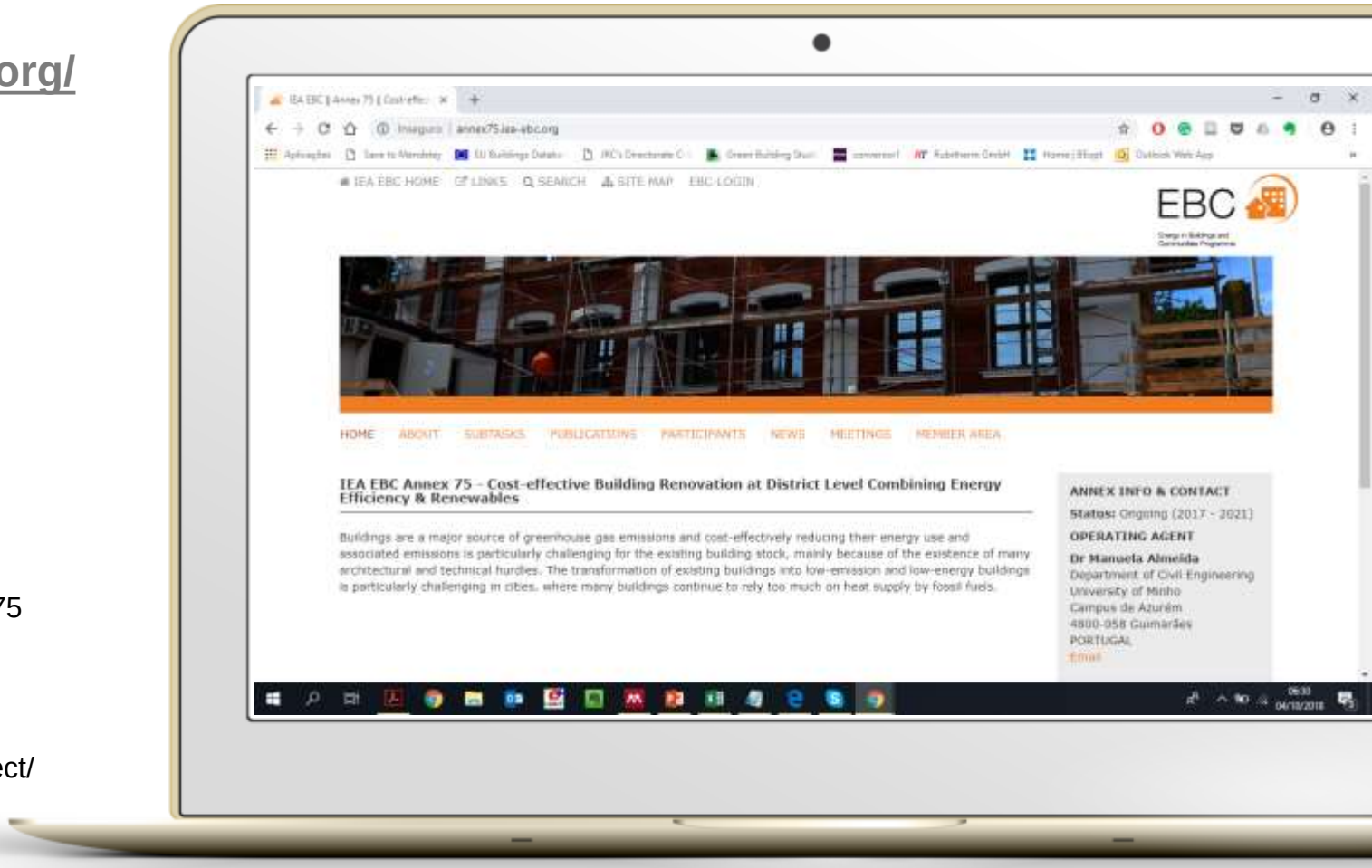
http://annex75.iea-ebc.org/

linkedin.com/company/ebc-annex-75-project/

facebook.com/ebcannex75

twitter.com/iea_ebc_annex75

www.researchgate.net/project/IEA-EBC-Annex-75



Thank you for your attention!

Manuela Almeida

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University of Minho, Civil Engineering Department, Portugal

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Lessons learnt from international and Austrian case studies

IEA EBC Annex 75 – Subtask C

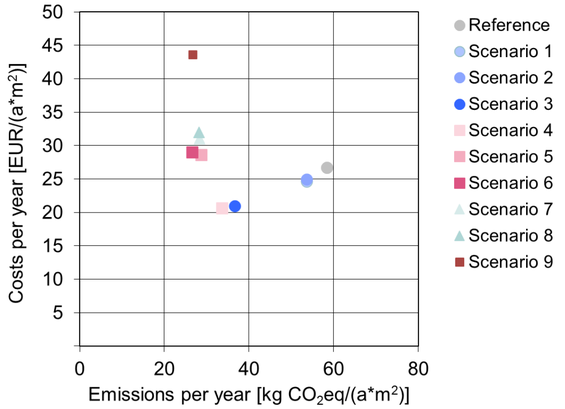
Ingo Leusbrock, David Venus, Franz Mauthner

Objectives of the research

- Development of cost-effective strategies to combine energy efficiency measures and renewable energy use
  - in selected case studies

- Investigate factors influencing the choice of a cost-effective strategy
  - Technical, economical, …

- How?
  - Carrying out parametric assessments
  - Applying and testing the Annex 75 methodology



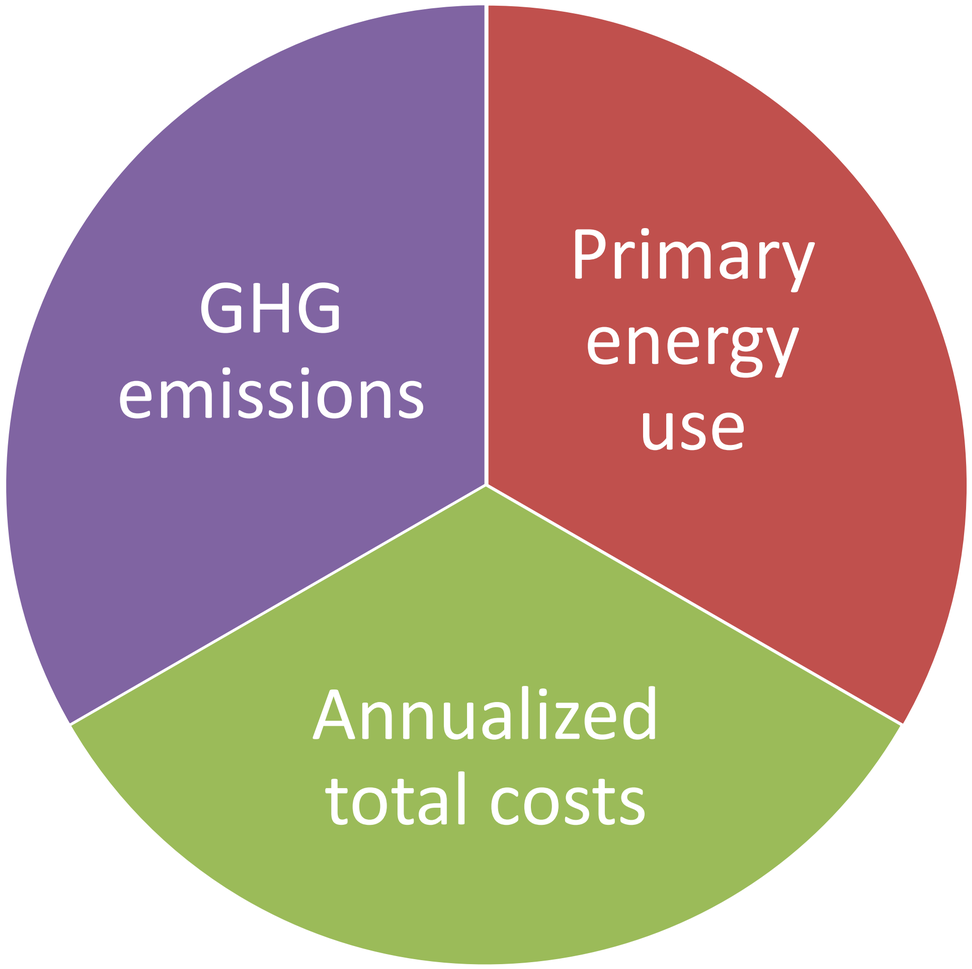
What are case studies in Annex 75?

- Existing districts
  - not yet renovated
  - heating based on fossil fuels

- Representation of the country´s building stock
  - Unique challenge per country

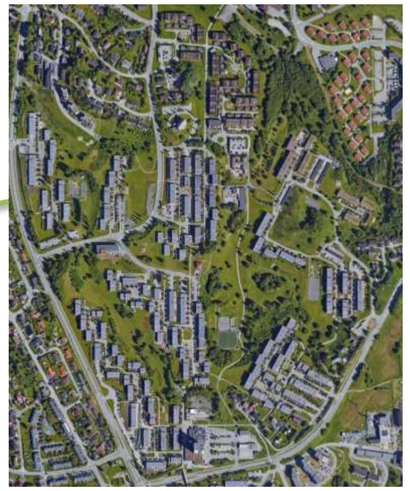
- Building types:
  - Residential buildings (Single-family houses and multi-family buildings)
  - Non-residential buildings without complex HVAC systems

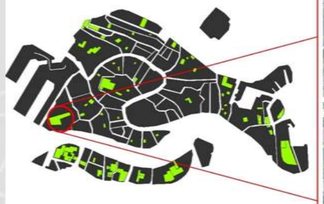
Key Performance Indicators (KPIs)



- Investment costs
- Replacement costs
- Operating costs
- Consumption costs
- PV own use and feed-in
- Residual value

Annex 75 case studies – Austria, Italy, Norway, Portugal, Spain, Sweden and the Netherlands





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Austrian case study

- 26 buildings with different years of construction
- various building components with different thermal properties
- various existing energy supply systems:
  - natural gas boiler
  - heat pump
  - district heating
  - oil boiler
  - direct electric heating
  - wood pellets

source: © GIS-Steiermark, 2020; modified by AEE INTEC

Investigated measures

Roof / Facade / top floor ceiling

Windows

Ventilation

Heat supply

Solar thermal

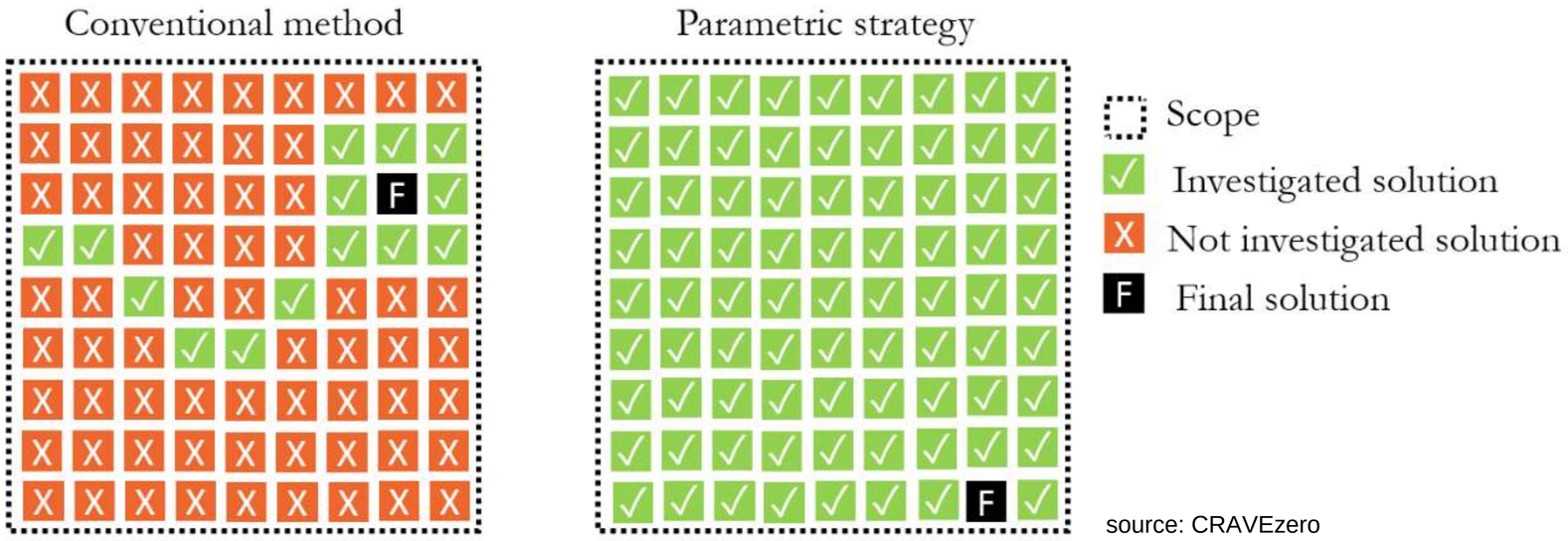
PV

Investigated measures

- Top floor ceiling / roof / facade
  - anyway measures
  - insulation according to national standard
  - insulation according to passive house standard
- Windows
  - anyway measures
  - new windows according to national standard
  - new windows according to passive house standard
- Ventilation
  - window ventilation
  - mechanical ventilation with heat recovery
- Heat supply
  - replacement of existing heating system (biomass boilers and heat pumps)
  - new decentralized natural gas heating
  - new decentralized heat pumps (air/water)
  - connection to district heating (based on 20% natural gas and 80% RES)
- Solar thermal
  - no solar thermal
  - only DHW
- PV
  - no PV
  - with PV
  - with PV and electric battery

Parametric calculations

- “Brute-force method” with a study of all possible solutions (parametric strategy)

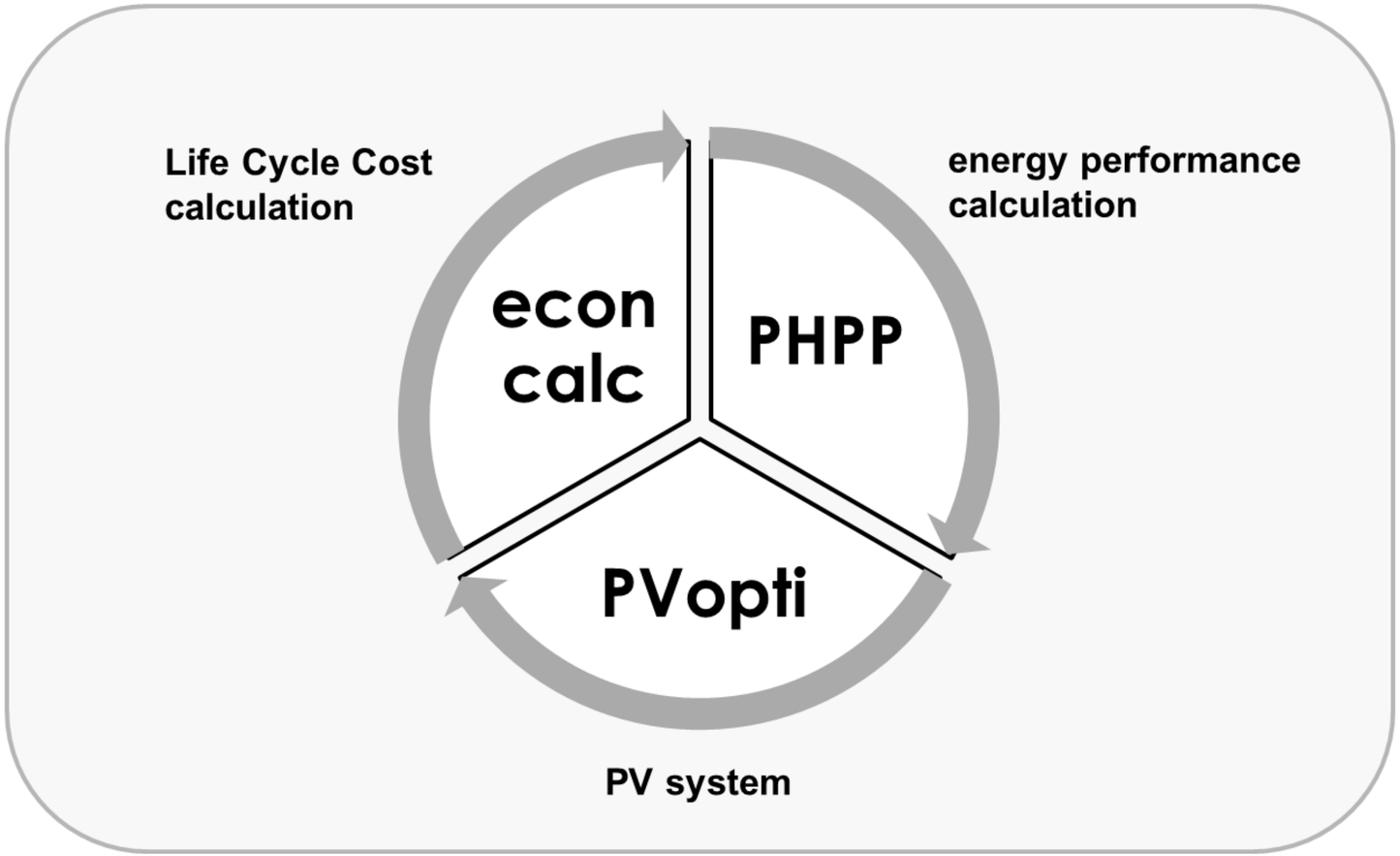


source: CRAVEzero

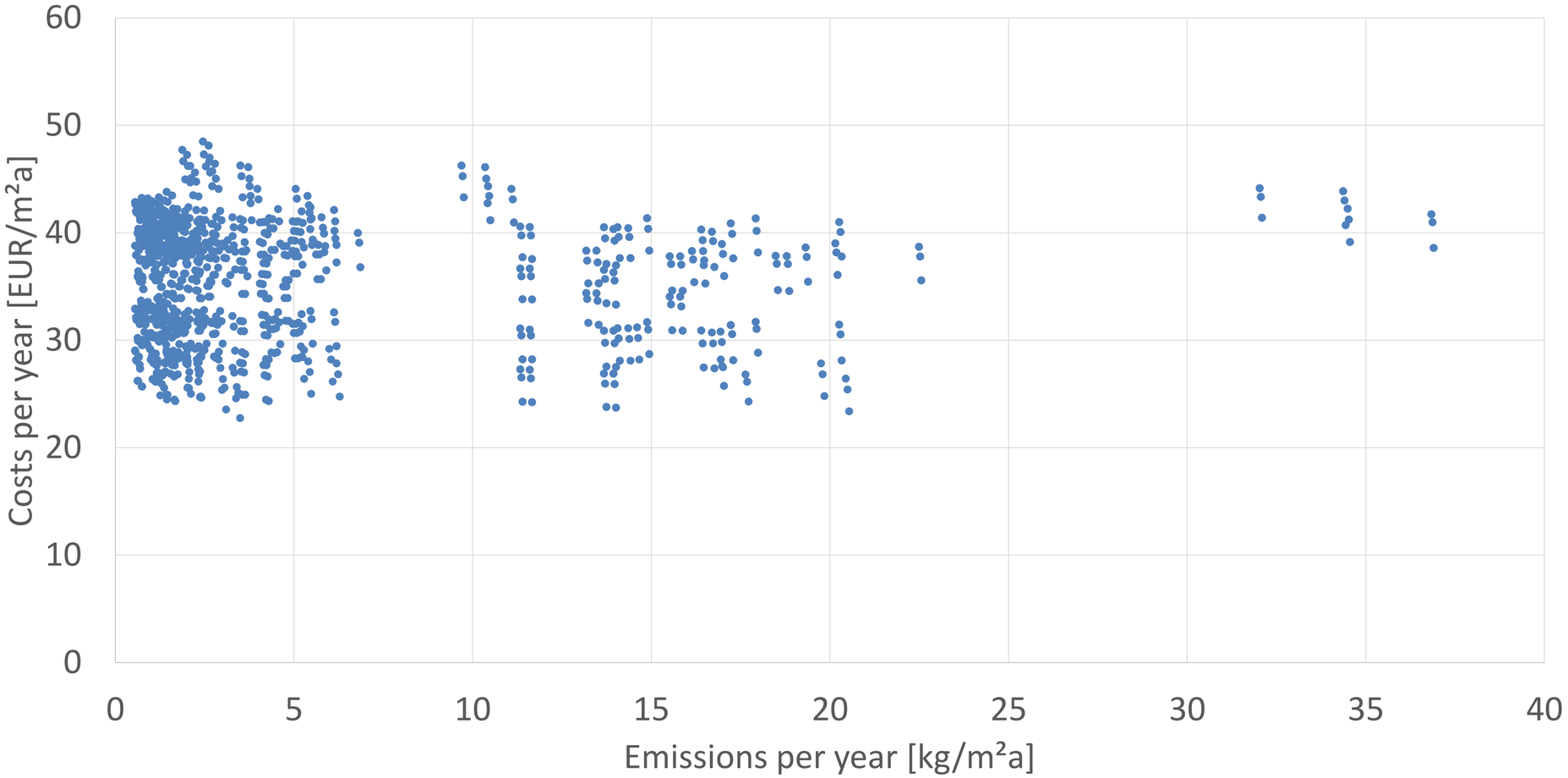
- 36 – 972 scenarios per building
- 19.584 scenarios in total (all buildings)

Calculation tools

automated calculation using VBA macros in MS Excel



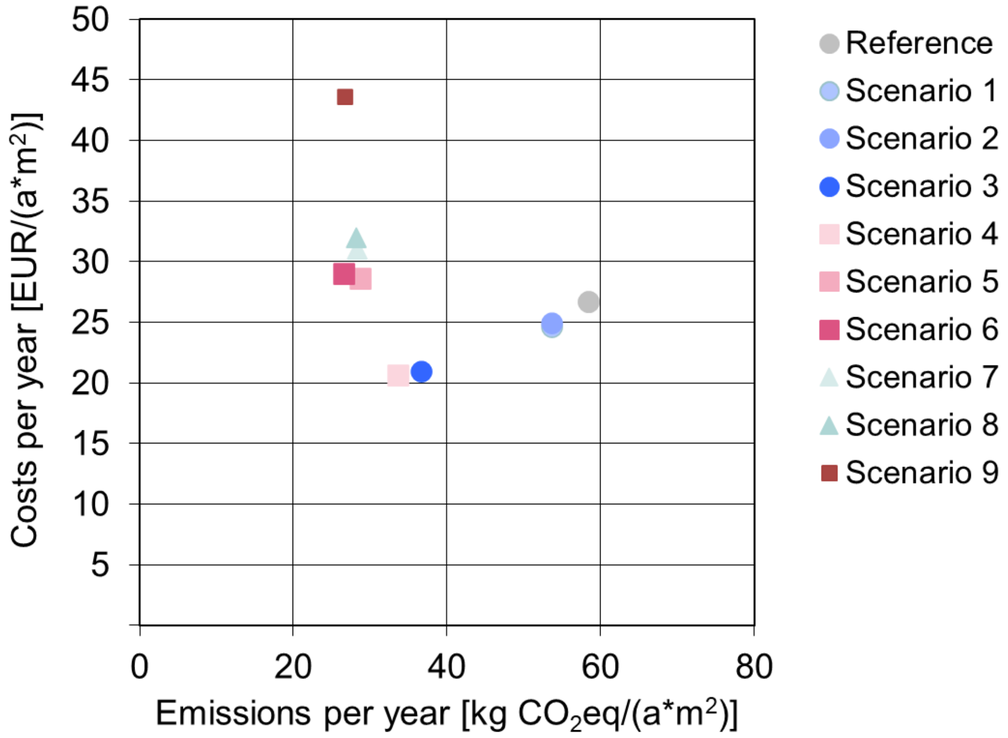
Overall results – LCC and CO2 emissions

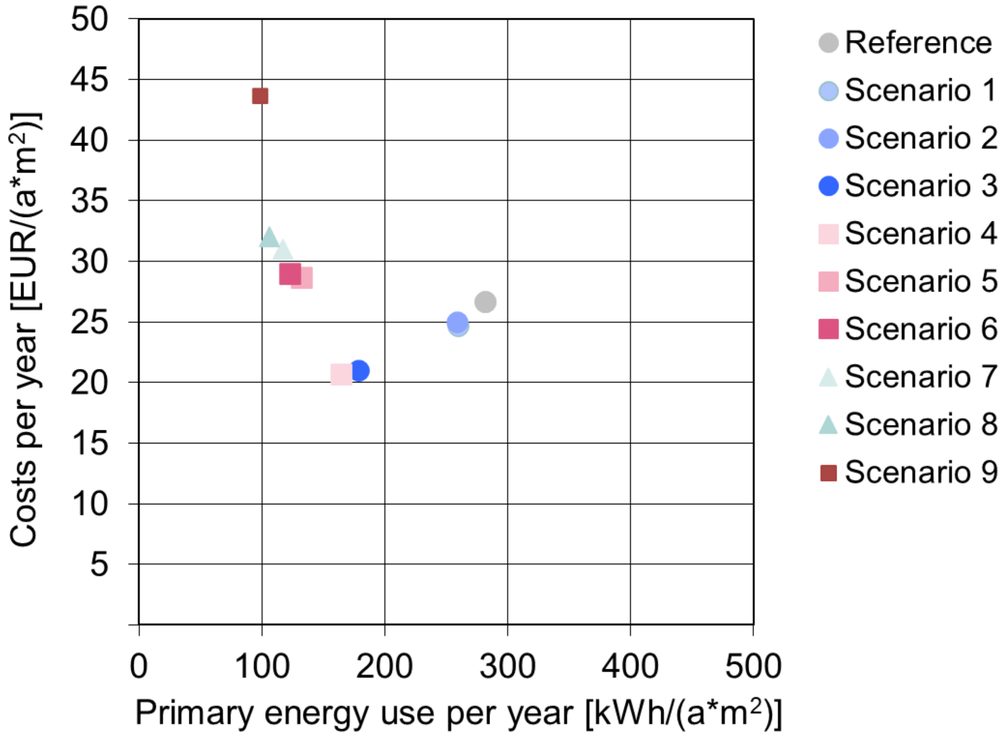


Next step: detailed investigation of 9 renovation scenarios

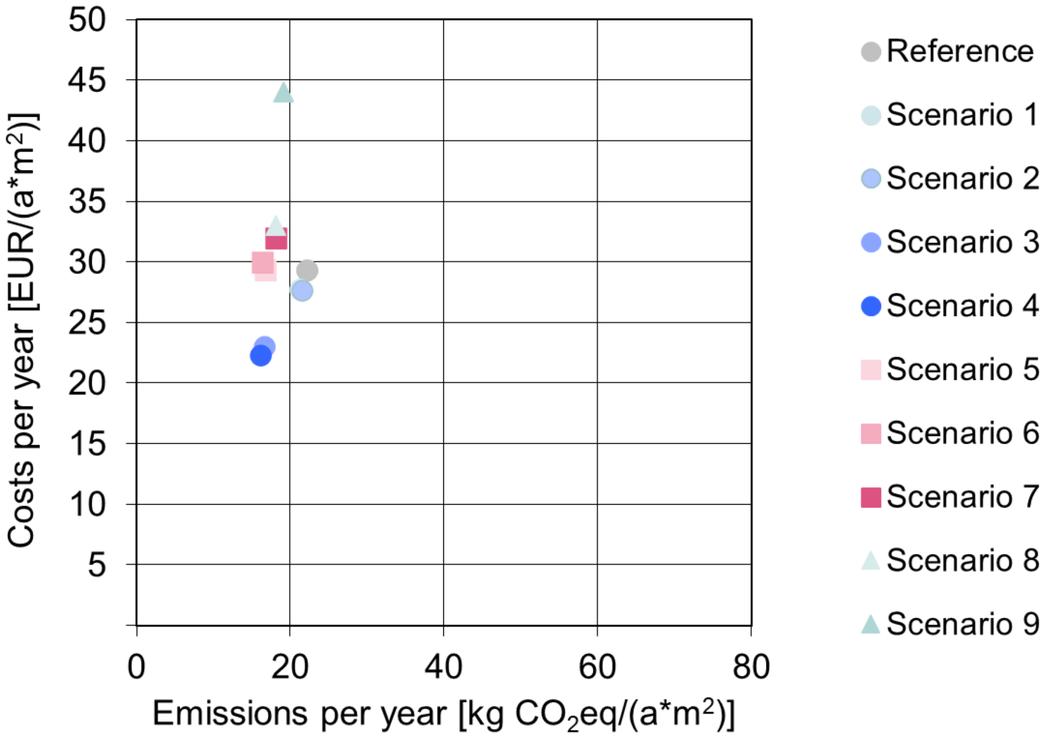
- Scenario 1: roof (national standard)
- Scenario 2: roof (passive house standard)
- Scenario 3: Scenario 2 + façade (national standard)
- Scenario 4: Scenario 2 + façade (passive house standard)
- Scenario 5: Scenario 4 + windows (passive house standard)
- Scenario 6: Scenario 5 + solar thermal system
- Scenario 7: Scenario 6 + PV
- Scenario 8: Scenario 7 + electric battery
- Scenario 9: Scenario 8 + MVHR

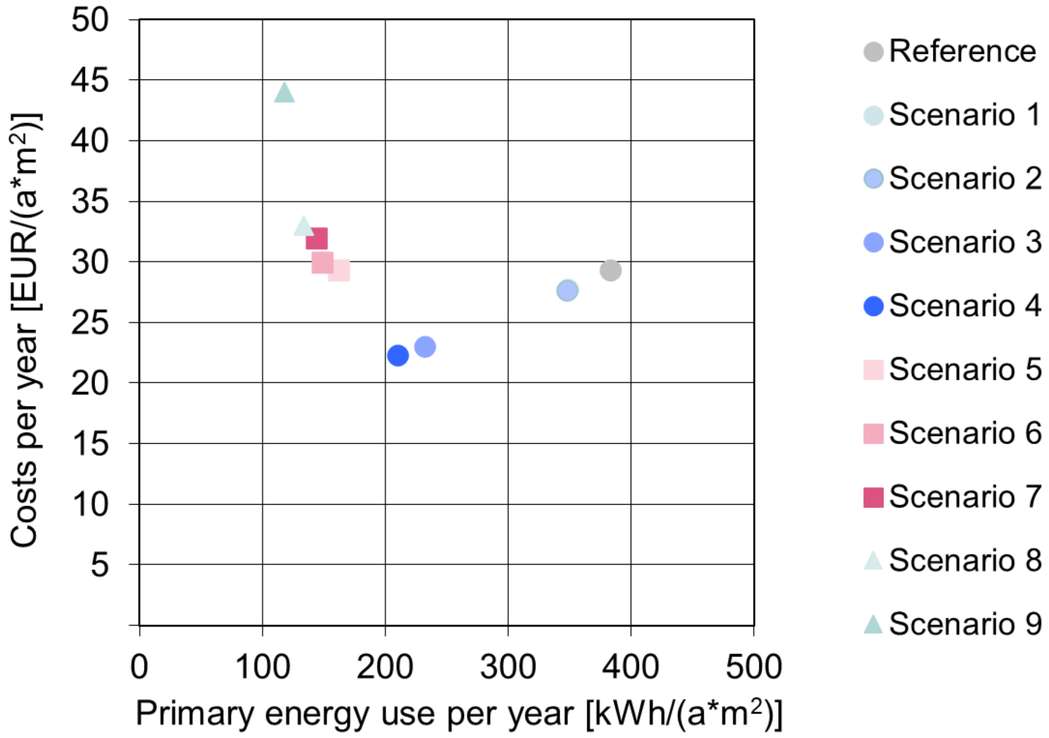
Results – Natural gas heating



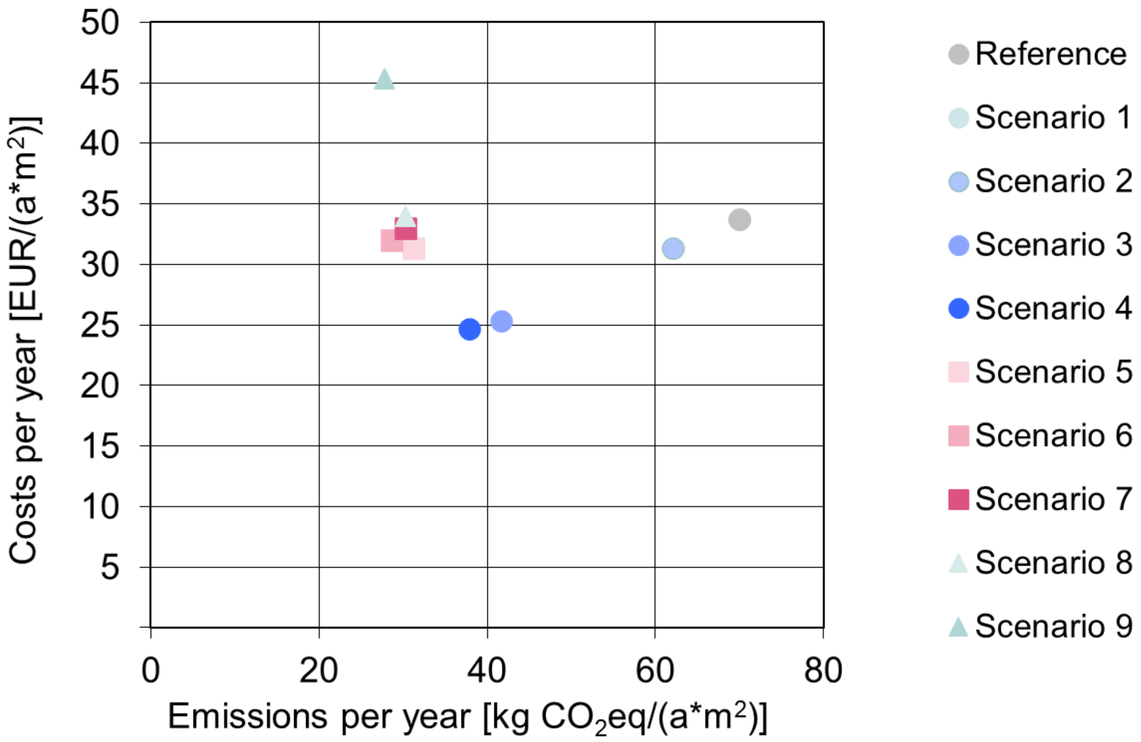


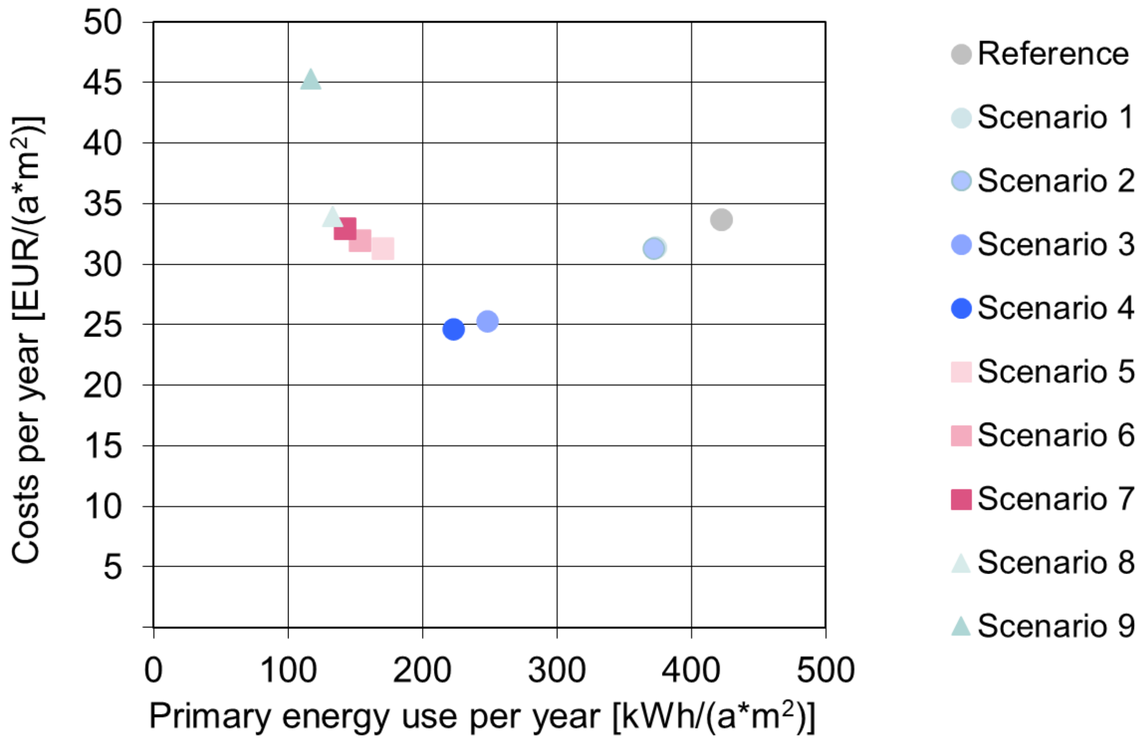
Results – District heating



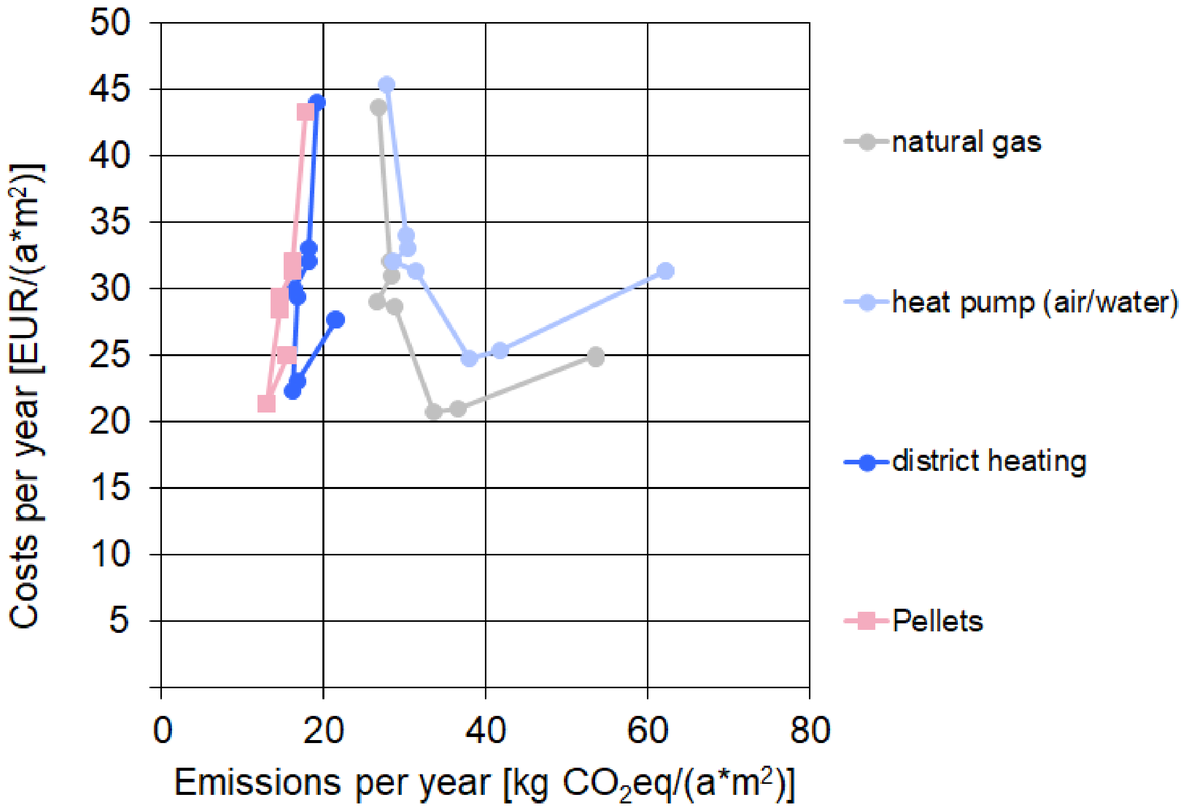


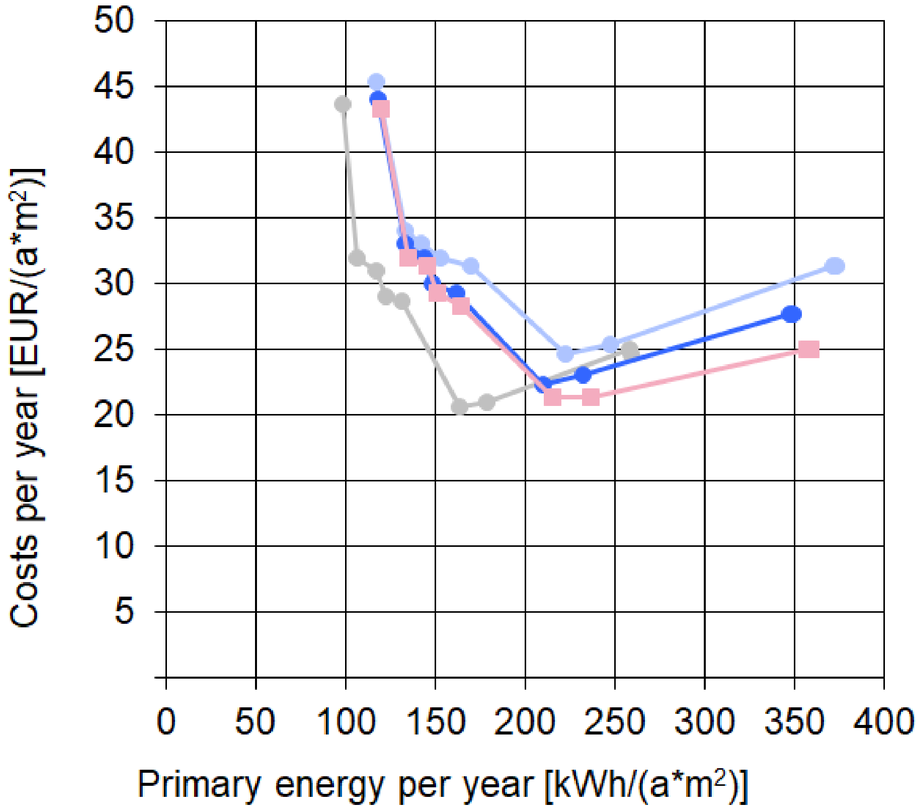
Results – air source heat pump





Results – Comparison





Findings and conclusions from the Austrian Case Study

- No reduction from changing energy source for heating and domestic hot water only
  - Contrary: GHG emissions, primary energy demand, and life cycle costs increase when only the energy supply system is changed and no other measures are considered

- Air-water heat pump shows lowest results
  - Even if renovation measures on the building envelopes are considered, the primary energy demand, the greenhouse gas emissions, and the life cycle costs are the highest.

- Insulation of the roof and the façade are always cost-effective

General findings and conclusions

- Renovation of the thermal envelope generally recommended
  - Which exactly → building dependent

- Boundary conditions important
  - initial situation (building already insulated or not),
  - climatic conditions (how much heating is required)
  - prices (ratio of investment to energy costs).

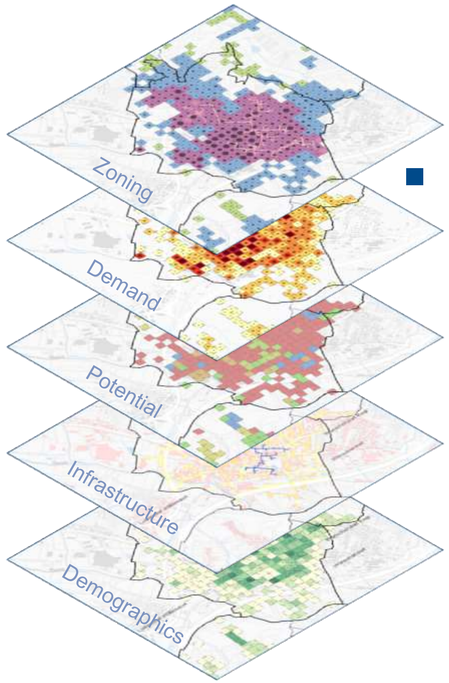
- PV system makes sense from an energy point of view (and thus also CO2 emissions), economic viability not always immediately given

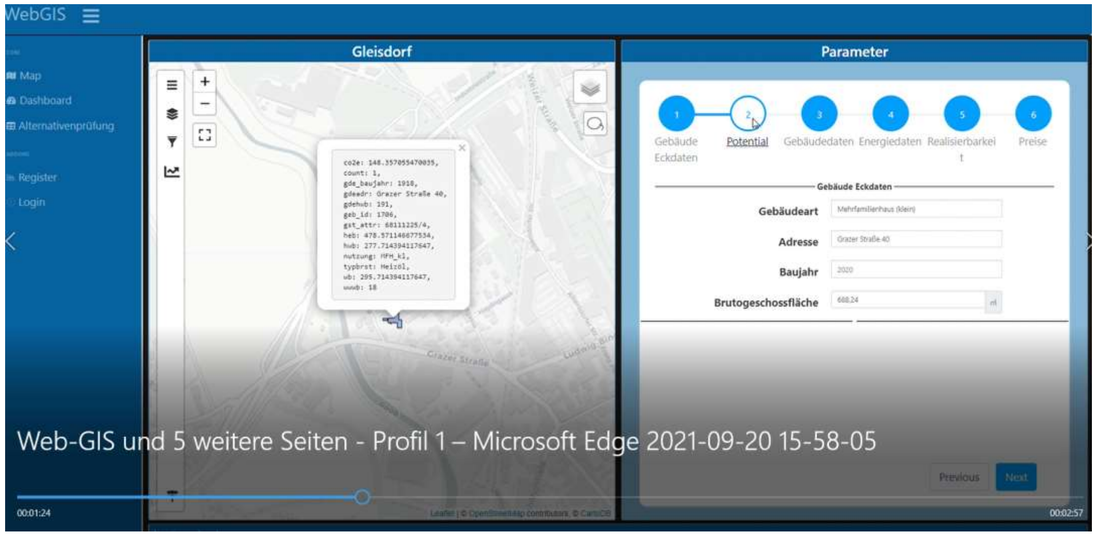
Case Study report

- Introduction
- Evaluation framework
  - Objectives of the analysis
    - Starting situations
    - Research Questions
    - Hypothesis
    - Key performance indicators
  - Assumptions and Boundary conditions
    - Tools and databases
    - Energy prices
    - Conversion factors
- Case Studies
  - Description of the district
  - Calculation parameters and scenarios
  - Case study results
  - Discussion
- Discussion of overall results
- Conclusions

Outlook

- Extension of included technologies and systemic options?
- Interactive calculation tools based on GIS
- Link to spatial (energy) planning





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FFG

Bundesministerium
Klimaschutz, Umwelt,
Energie, Mobilität,
Innovation und Technologie

Acknowledgements

- This research was funded
- This project has been funded in scope of the Austrian „Stadt der Zukunft, 3. Ausschreibung“ Research program, project no. 854666.
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2020

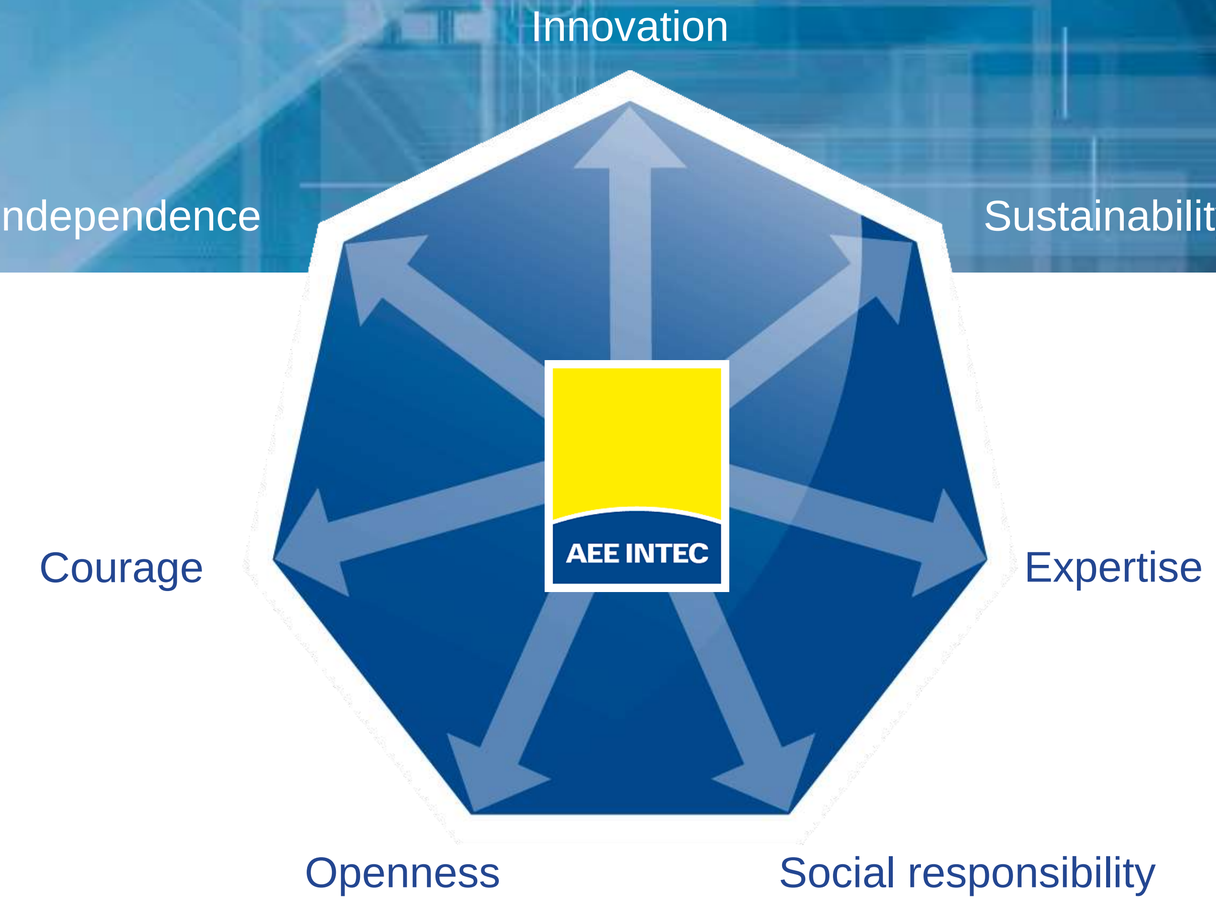
AEE - Institute for Sustainable Technologies was founded in1988 as a non-university research institute. It is today one of the leading institutions in the field of renewable energy and resource efficiency.

1988

In the world of renewable energy and resource efficiency we transform ideas into reality through:

- Research
- Development
- Consulting
- Training

Our Value Septet



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90

Staff Members

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digital resilient cities

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GIS BASED MODELLING OF ENERGY SYSTEMS & IMPLICATIONS FOR IEA ANNEX 75 ANALYSIS STRUCTURE

Jan Peters-Anders

IEA Annex 75 Workshop, Vienna, 28.6.2022

EBC Energy in Buildings and Communities Programme

Based on “GIS Based Modelling of Energy Systems“ by Giorgio Agugiaro, Licence CC BY-NC-SA 4.0

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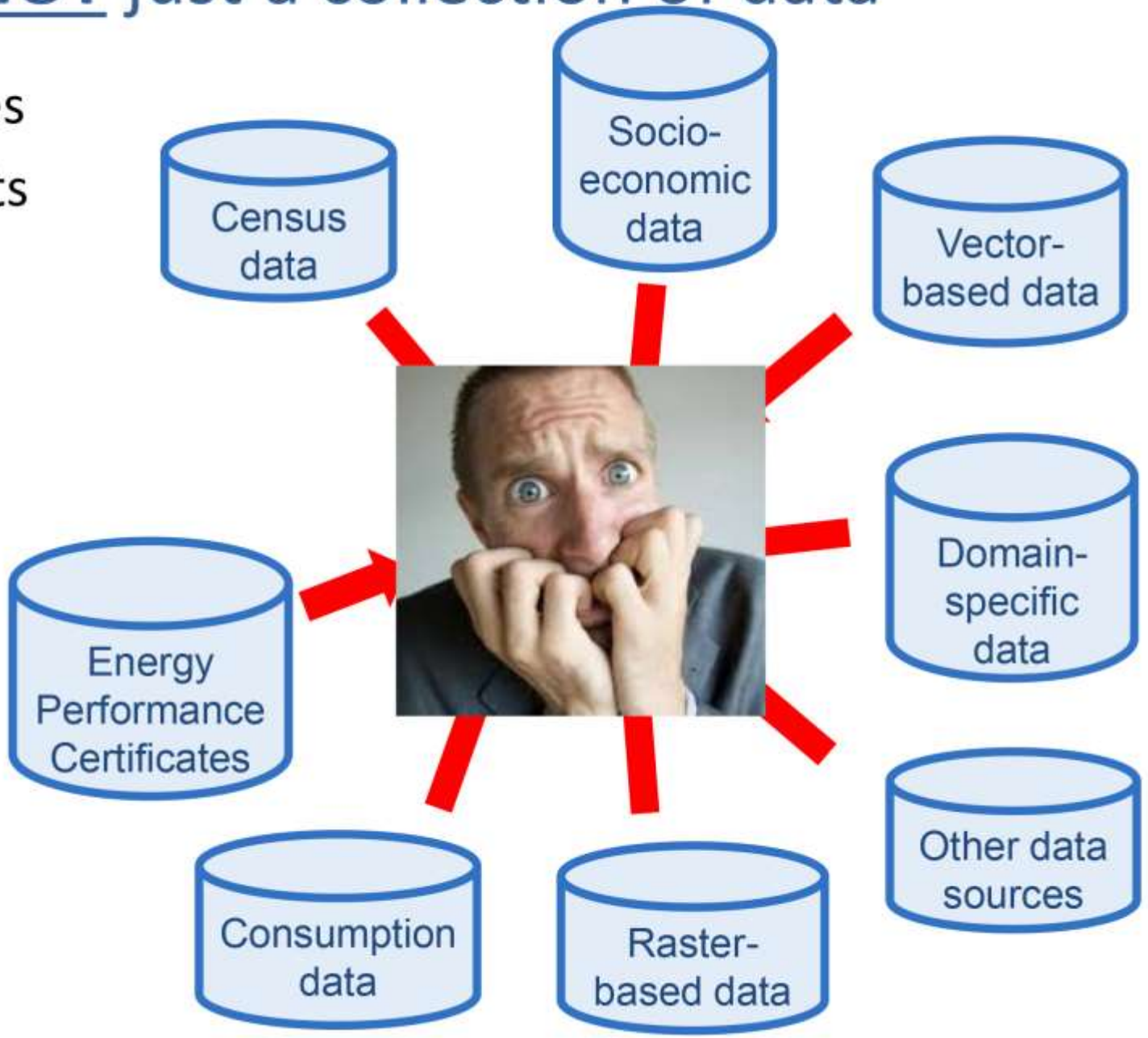
City models as information hub

(Semantic) 3D city models help **reducing complexity** and facilitating cooperation and **exchange of information** among city departments, companies, cities and citizens, etc.

A city model is **NOT** just a collection of data

- Different data sources
- Different data formats
- Different semantics
- Different scales
- Different accuracies
- …



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Energy ADE

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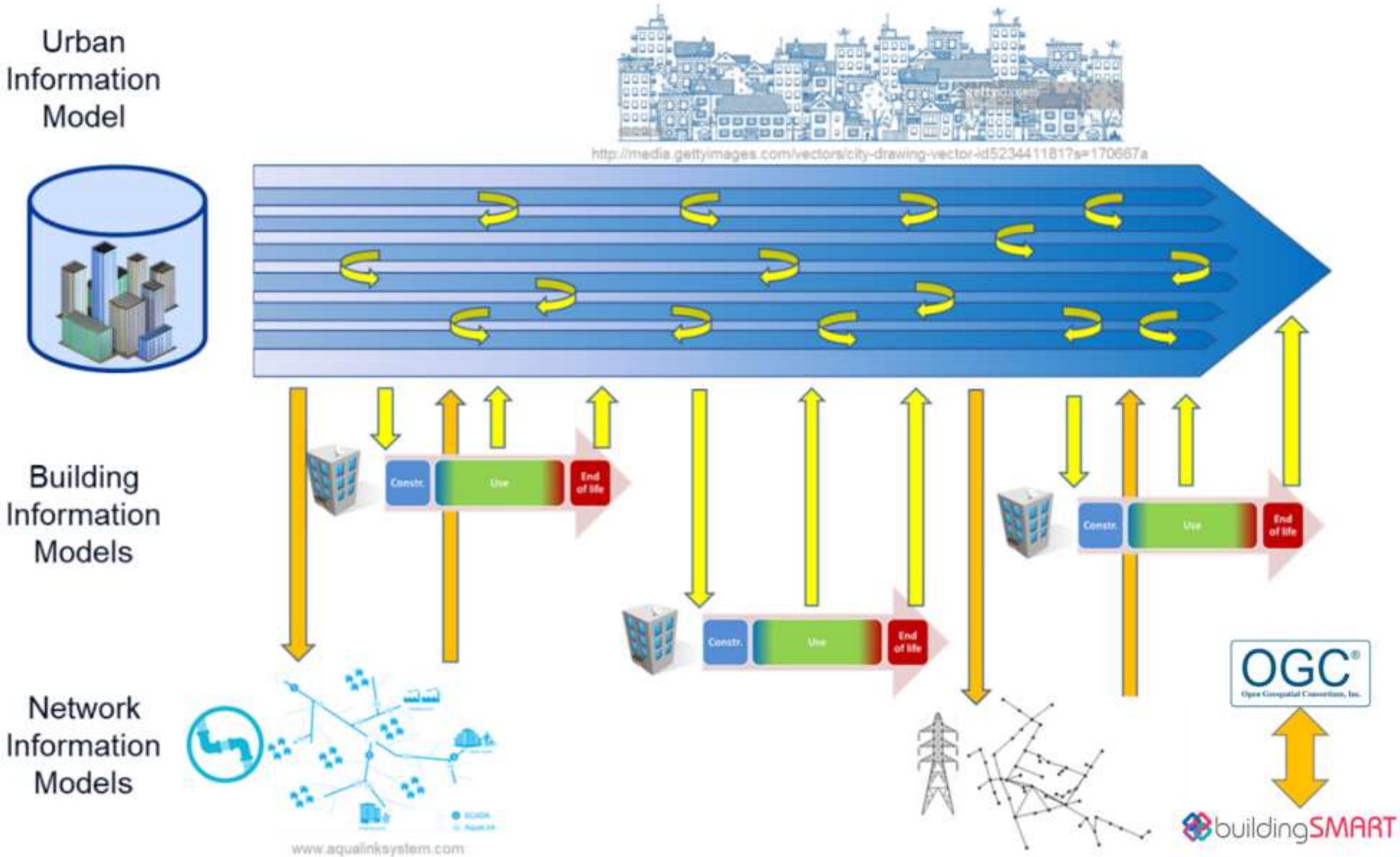
Utility Network ADE

Conclusions

Glimpse of GeoBIM

A city model as «living» information hub



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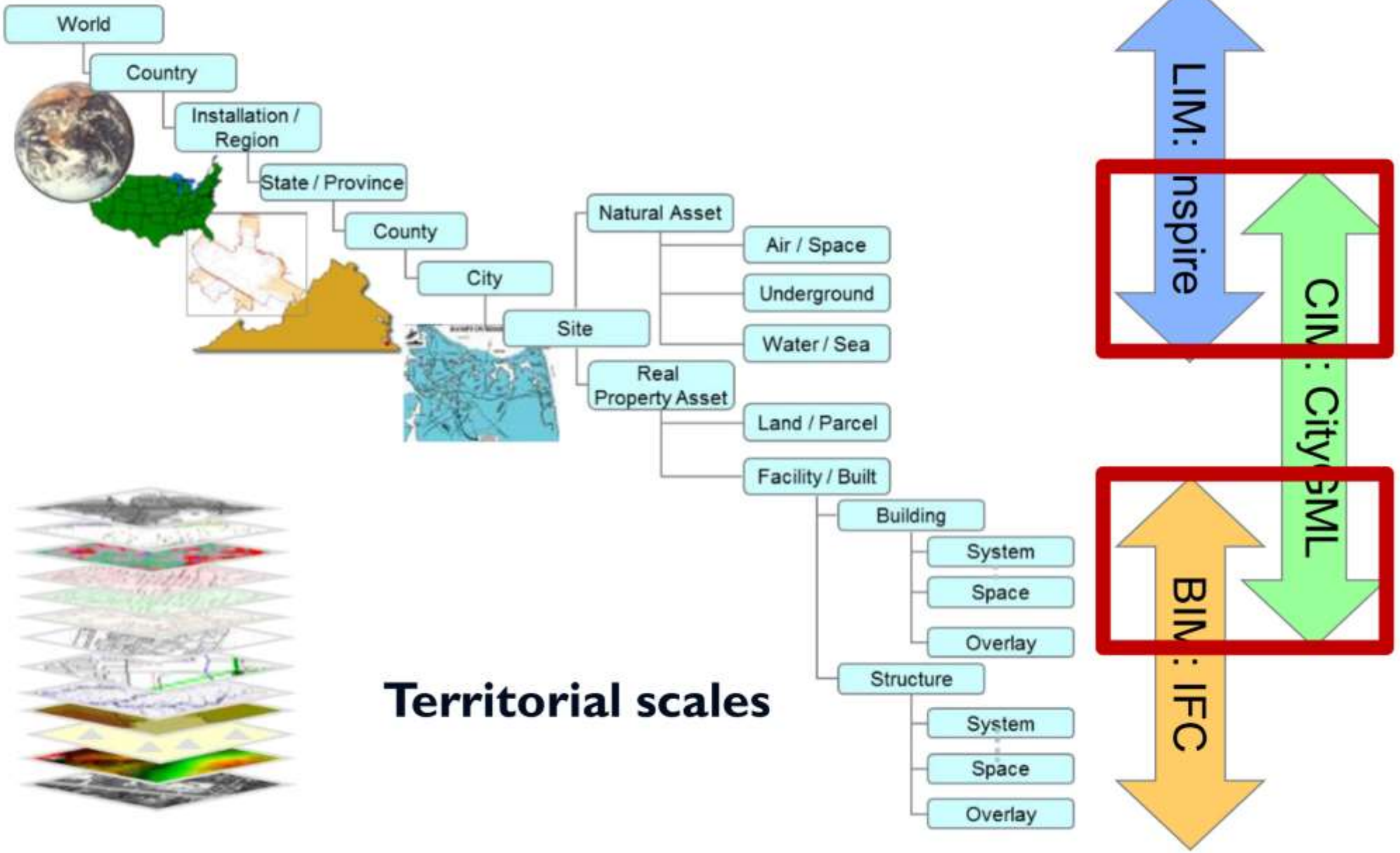
What about *international* (geo-spatial) standards?



What about *international* standards for energy?

- BIM (Building Information Model):
  - Availability of some standards (*gbXML, IFC*)
  - In general, the focus is the *new* building/object

buildingSMART

- LIM (Land Information Model):
  - INSPIRE *Data Specification on Buildings*: Lack of or too few attributes/classes usable for energy simulations

INSPIRE · Infrastructure for Spatial Information in Europe

- CIM (City Information Model):
  - CityGML a bit better than INSPIRE, but still not enough
  - But: **extensibility through *ADEs*** (Application Domain Extensions)

CityGML

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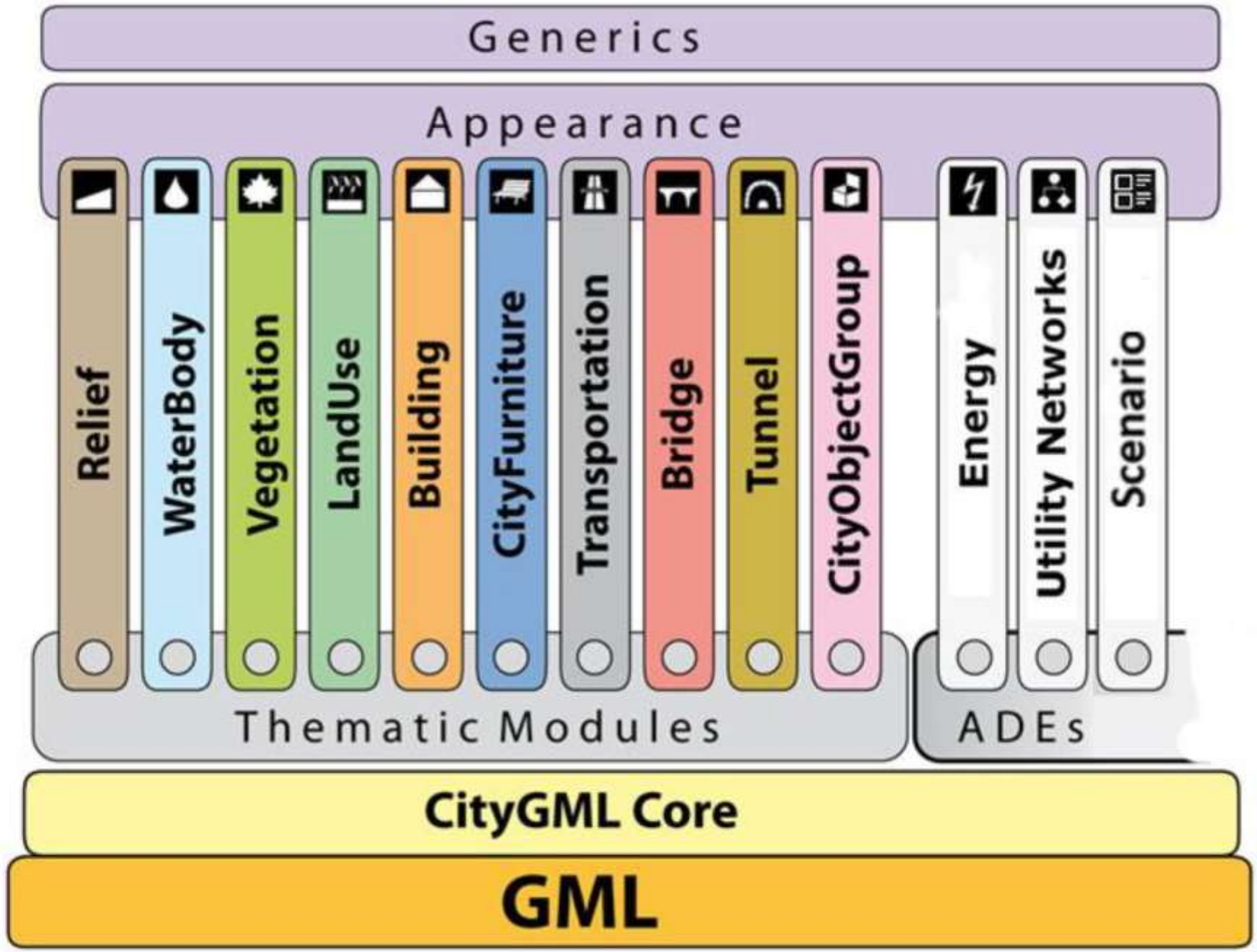

Image source/adapted from: virtualcitySYSTEMS

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What about standards for energy?

CityGML Energy ADE

- Eases data interoperability for Urban Energy Modelling
  - Among heterogeneous software tools
  - Among heterogeneous stakeholders
- Defines energy-related data in a standard, open, urban data model
  - Allow for multi-scale energy modelling and simulation
  - From single building up to whole district/city
  - Both top-down and bottom-up approaches
- Open development by int. consortium since 2014, v. 1.0 released in 2018
  - https://git.rwth-aachen.de/energyade/citygml-energy

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Energy ADE

Modular structure:

- Core module
  - Shared classes, enumerations and codelists
- Building Physics module
  - Thermal zones, thermal boundaries
- Material and Construction module
- Occupant's Behaviour module
  - Building usage, occupants, appliances, …
- Energy Systems module
- Supporting Classes
  - Weather data, time series, etc.

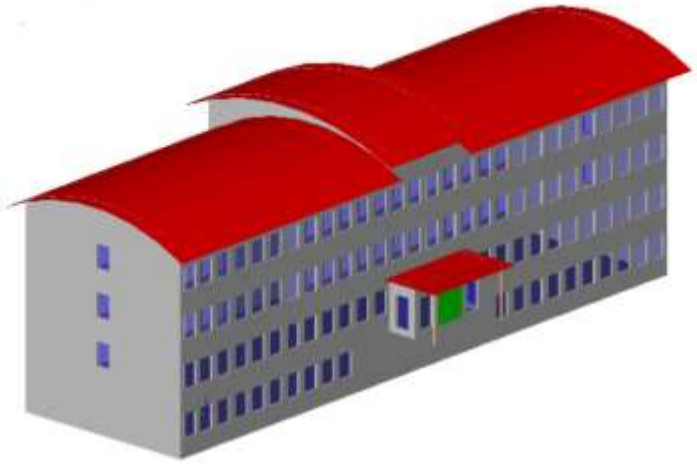
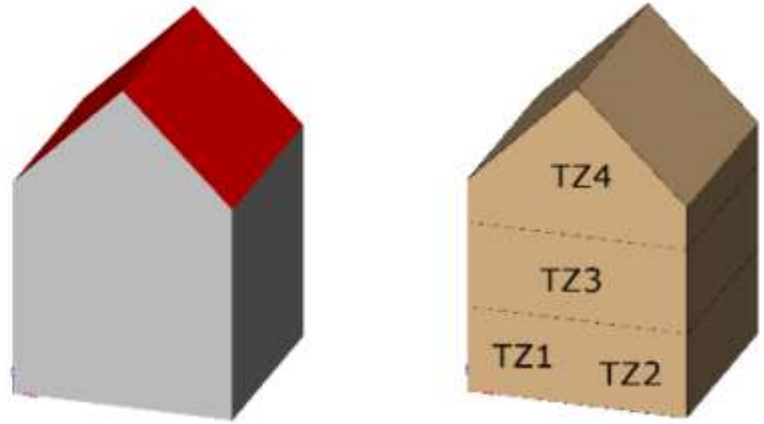


Image source: Courtesy of KIT



Partitioning of a building into thermal zones (example)

Further details:
Agugiaro, G., Benner, J., Cipriano, P., Nouvel, R., 2018
The Energy Application Domain Extension for CityGML: Enhancing interoperability for urban energy simulations.
Open Geospatial Data, Software and Standards 2018 3:2

CityGML modules overview

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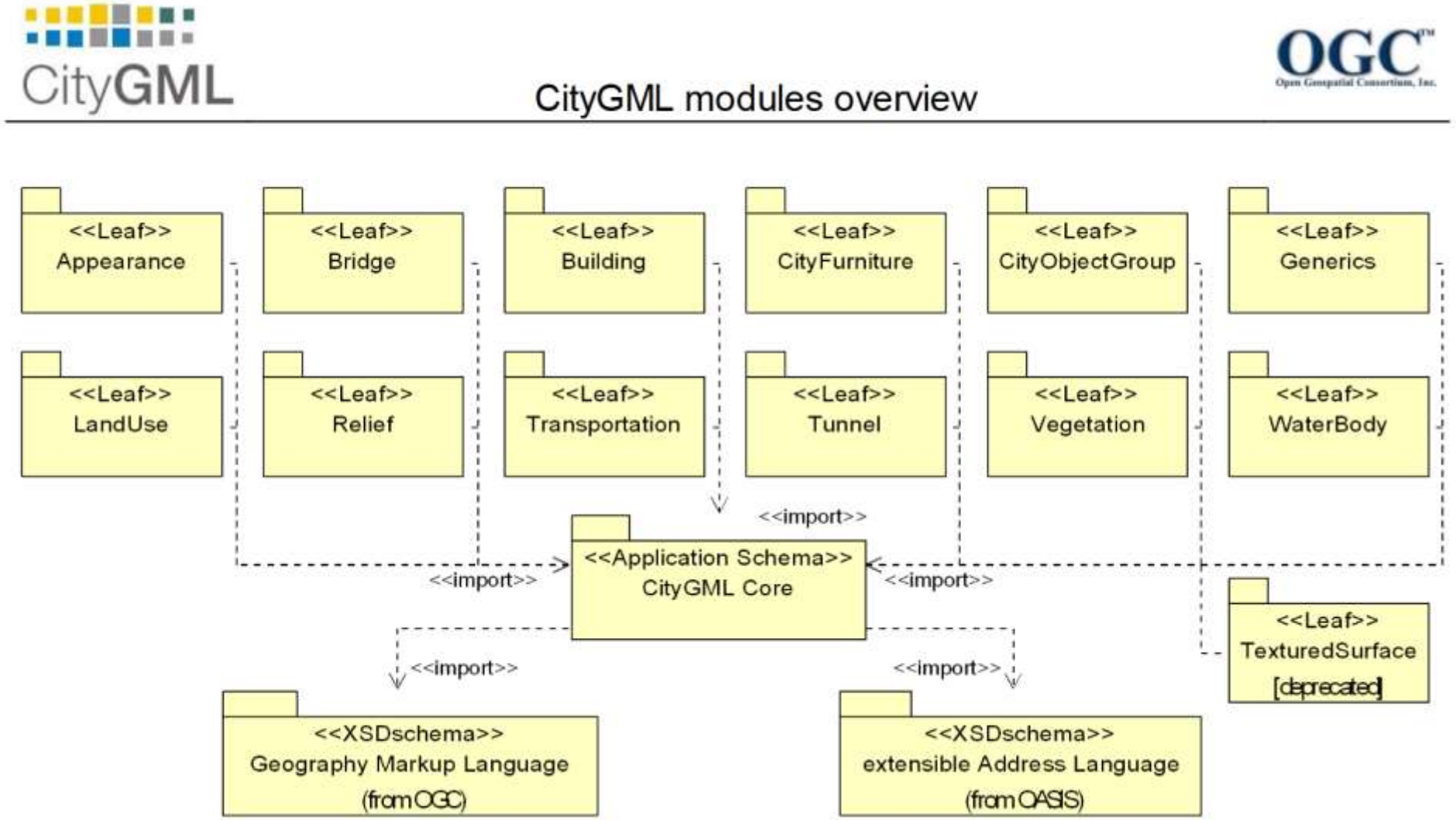

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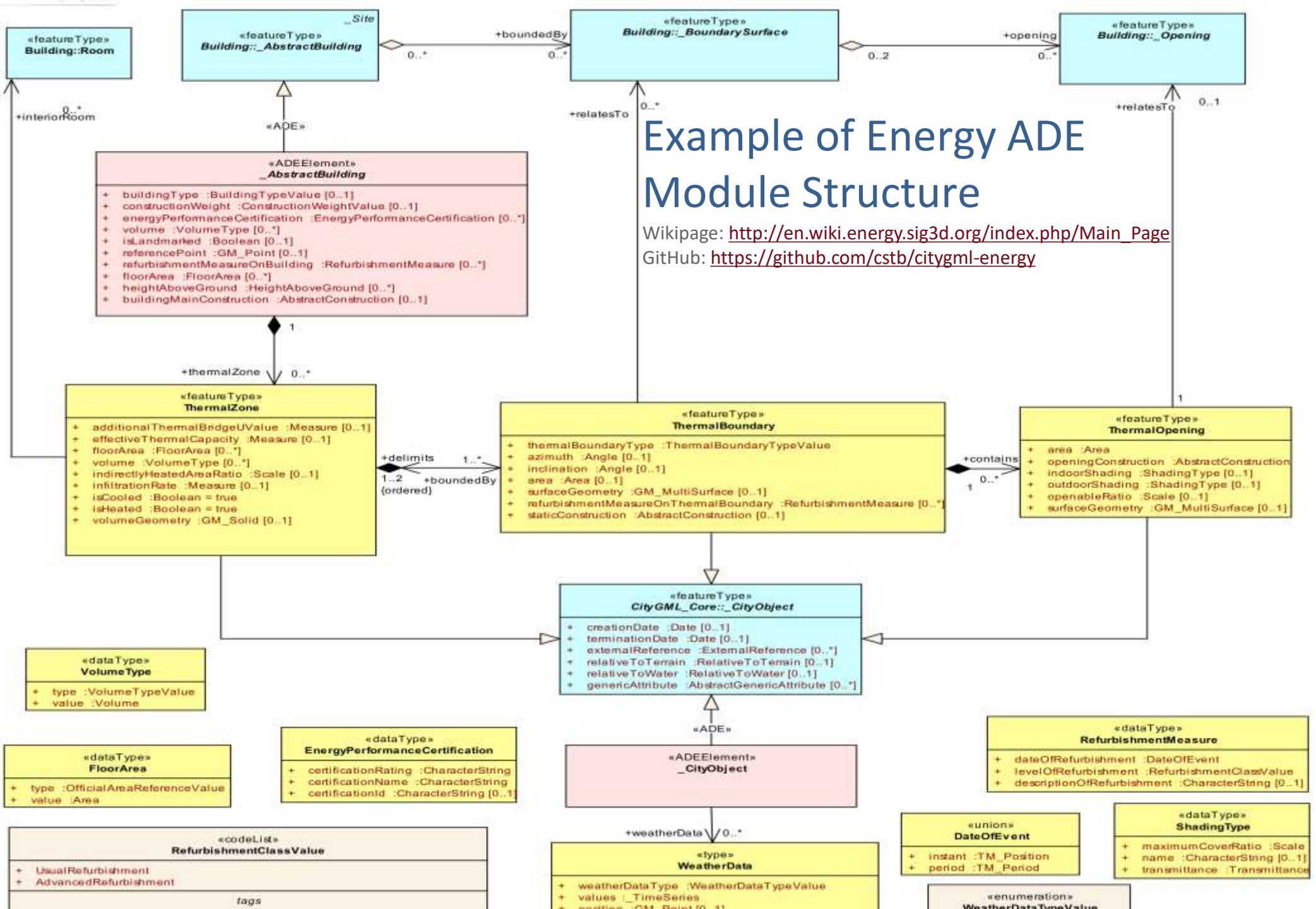
Example of Energy ADE Module Structure

Wikipage: http://en.wiki.energy.sig3d.org/index.php/Main_Page
GitHub: https://github.com/cstb/citygml-energy



Possibilities for Case Study Analysis

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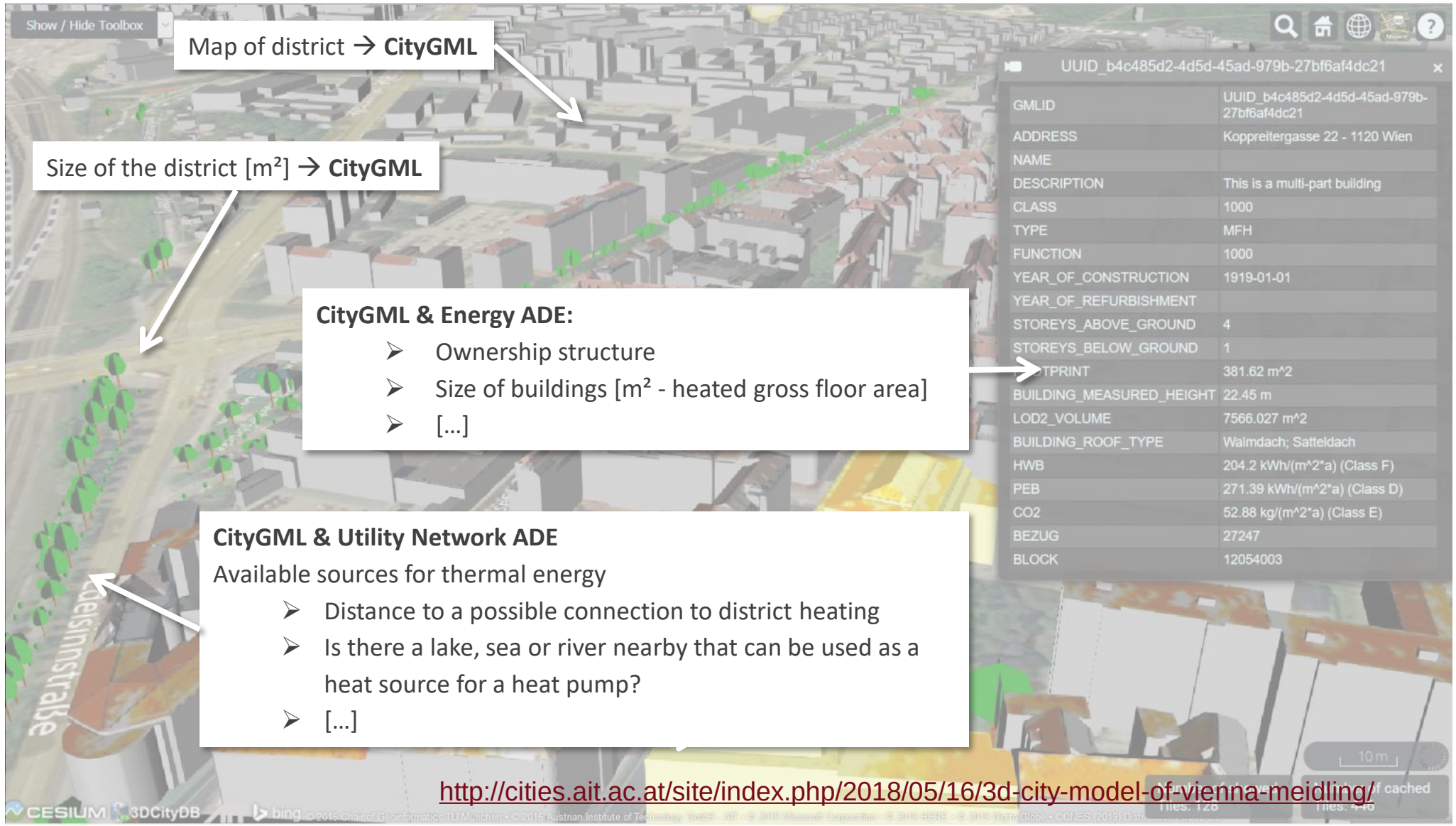
A. Information on the district/buildings



CityGML & Energy ADE:

- Ownership structure
- Size of buildings [m² - heated gross floor area]
- […]

CityGML & Utility Network ADE

Available sources for thermal energy

- Distance to a possible connection to district heating
- Is there a lake, sea or river nearby that can be used as a heat source for a heat pump?
- […]

http://cities.ait.ac.at/site/index.php/2018/05/16/3d-city-model-of-vienna-meidling/

Possibilities for Case Study Analysis

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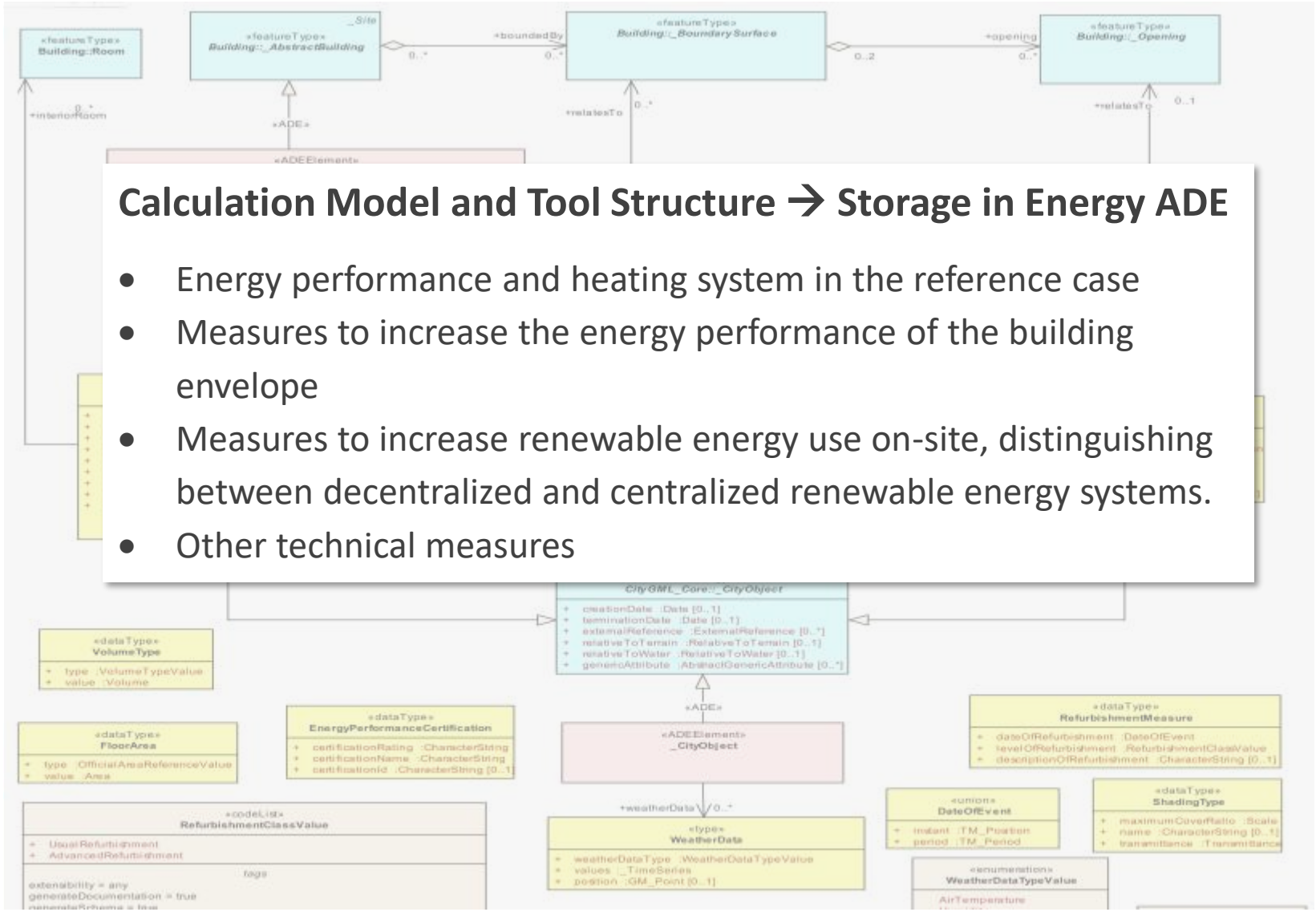
B. Information on the calculation parameters



Calculation Model and Tool Structure → Storage in Energy ADE

- Energy performance and heating system in the reference case
- Measures to increase the energy performance of the building envelope
- Measures to increase renewable energy use on-site, distinguishing between decentralized and centralized renewable energy systems.
- Other technical measures

Possibilities for Case Study Analysis

D. Results

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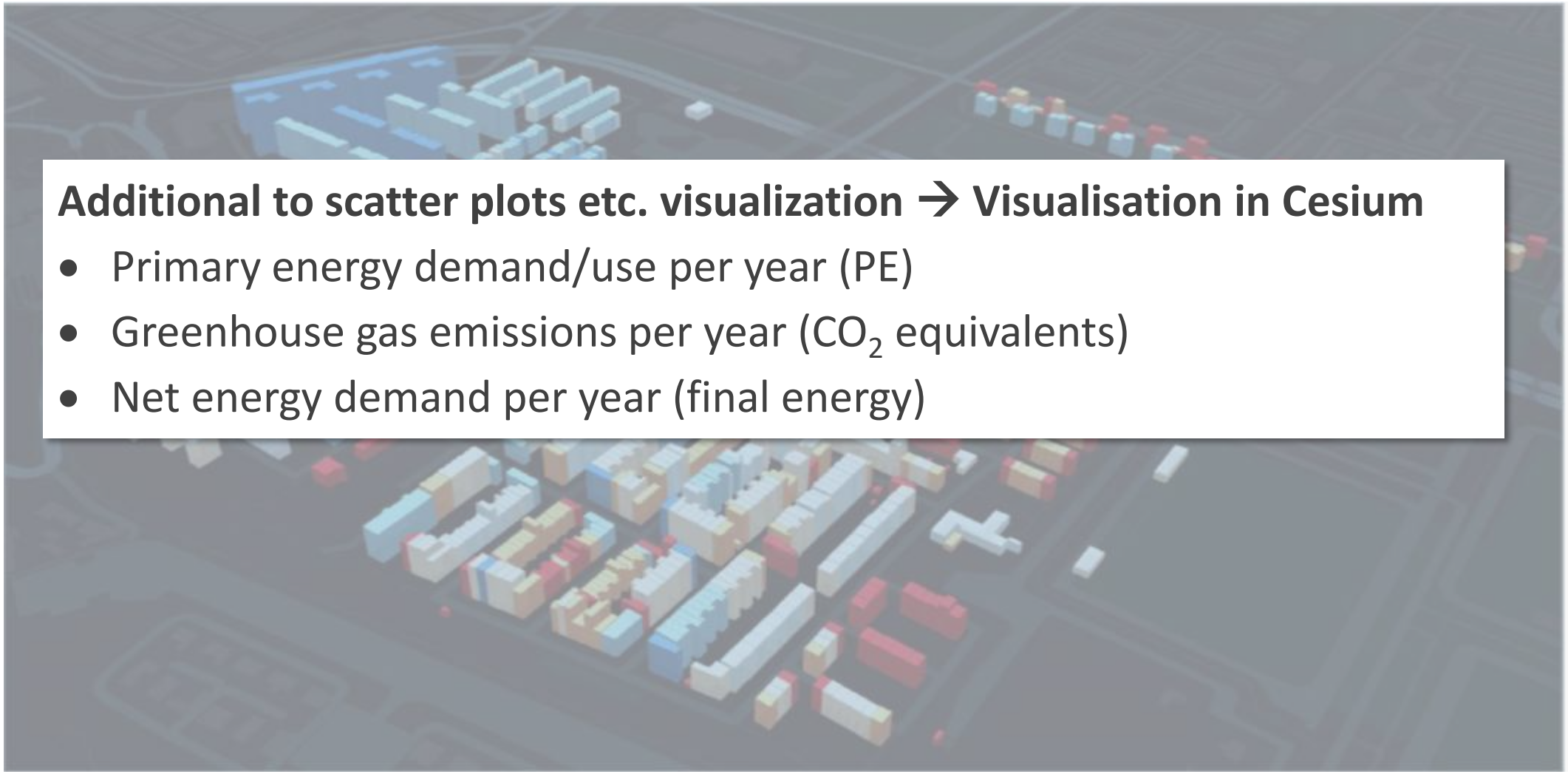

Additional to scatter plots etc. visualization → Visualisation in Cesium

- Primary energy demand/use per year (PE)
- Greenhouse gas emissions per year (CO_2 equivalents)
- Net energy demand per year (final energy)

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Possibilities for Case Study Analysis

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Technical Implementation: 3D City Database (3DCityDB)

Free and open-source database implementation of the CityGML data model

- For PostgreSQL / PostGIS and for Oracle
- Comes with an importer / exporter for ("vanilla") CityGML data from / to the database
- Consists of 60 predefined tables + a number of functions

→ **Central storage for Annex 75 Analysis Data with PostgreSQL DB API**

Integration of Energy ADE v1.0 into 3DCityDB

Future Possibilities for an extended Annex 75 Tool

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Energy ADE

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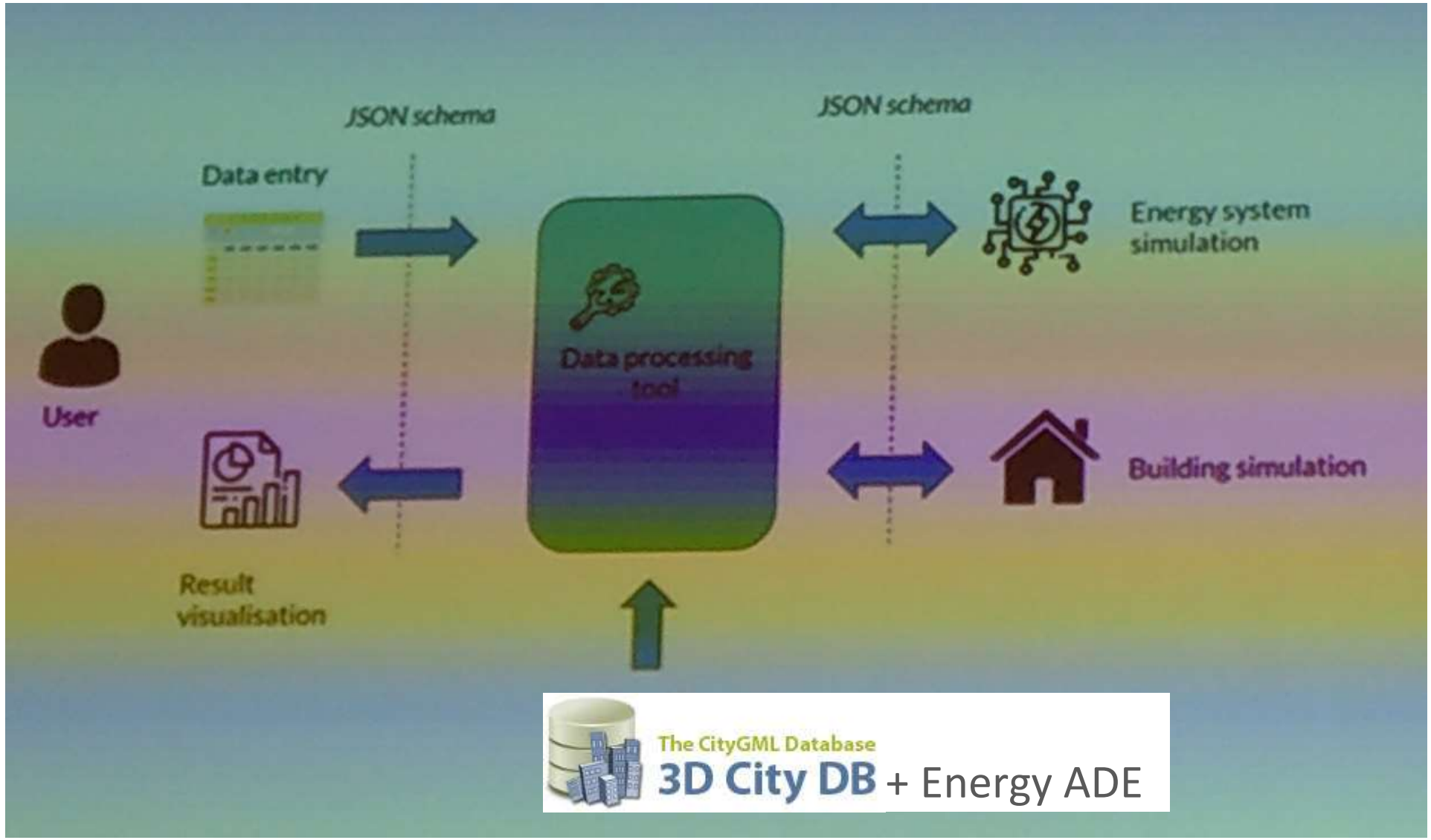
Glimpse of GeoBIM



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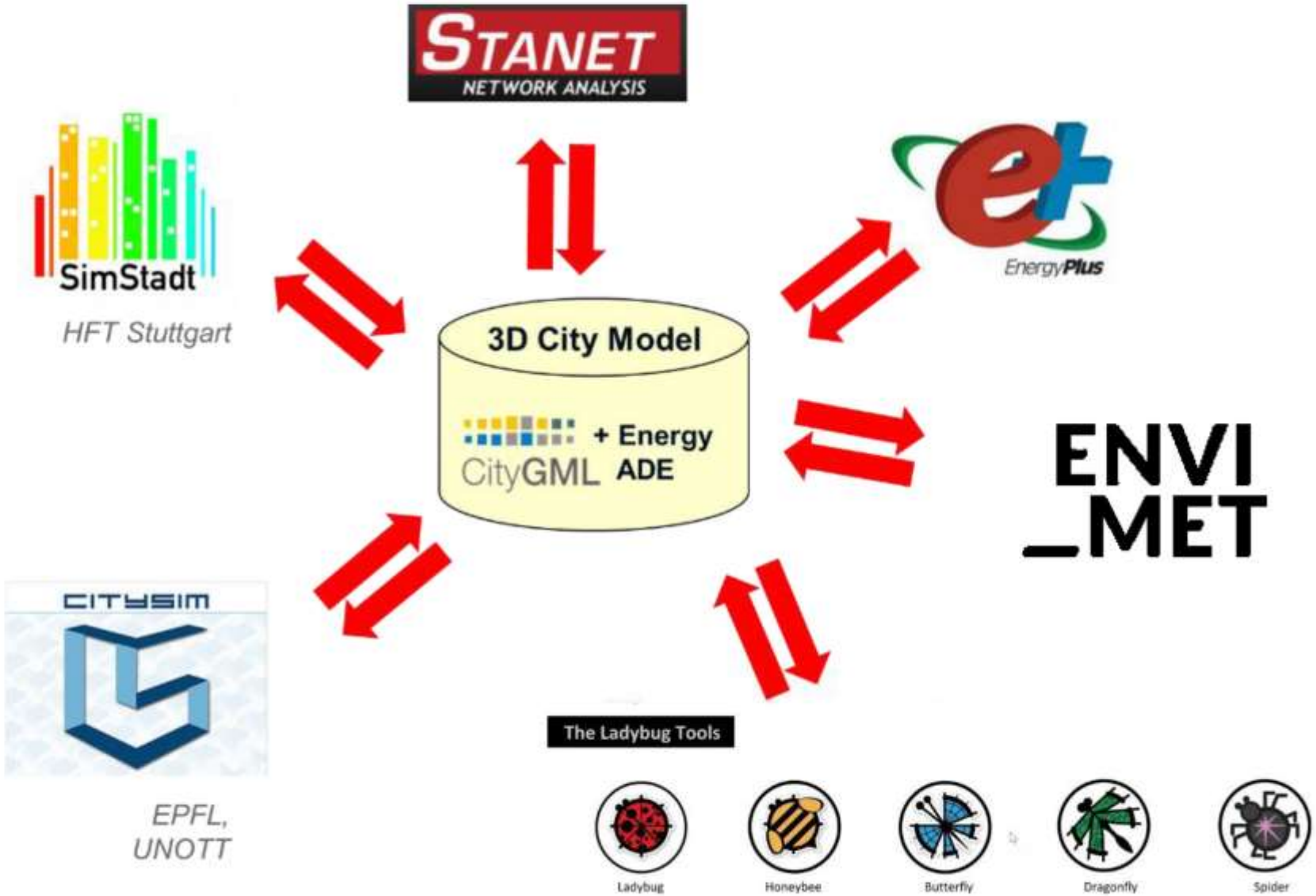
Possibilities for Case Study Analysis

Additional software which can use the 3D City Model to do further analyses



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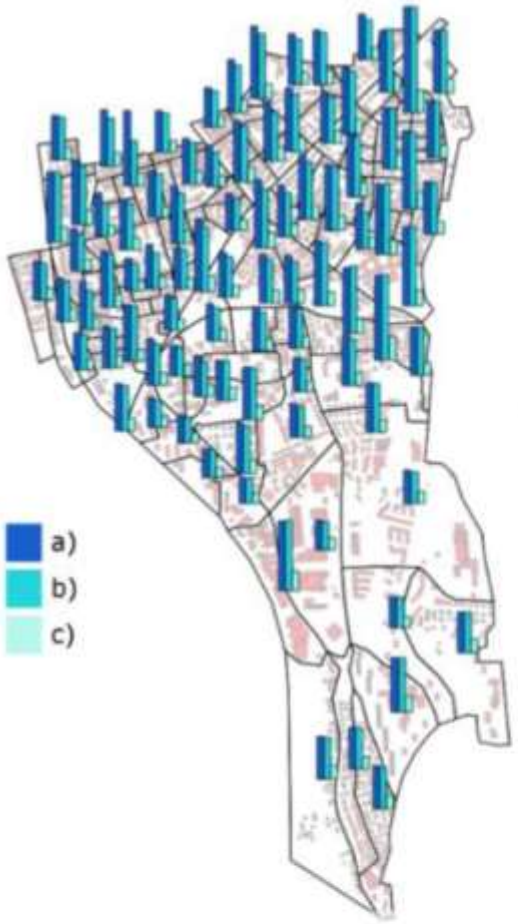
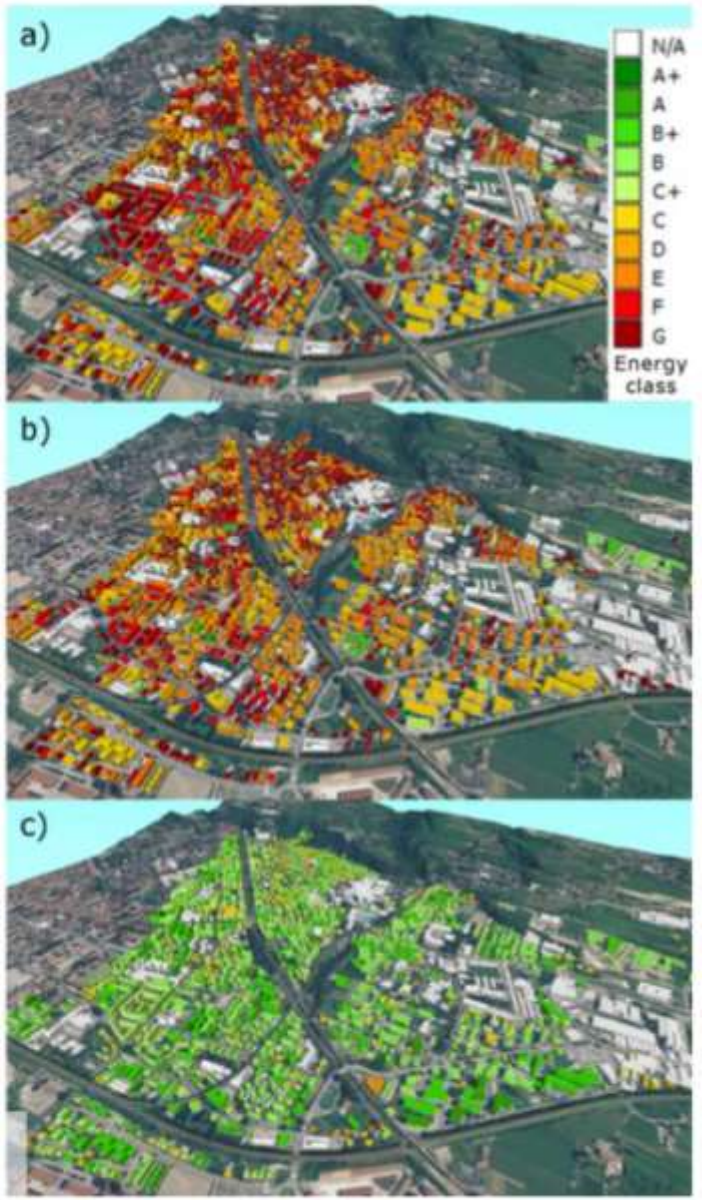
Some experiences: Trento

Primary energy demand computed according to the Italian UNI TS 11300 norms



Energy scenarios:
a) Original state
b) Current state
c) Refurbished state



Mode details:
Agugiaro, G., 2016
Energy planning tools and CityGML-based 3D virtual city models. Experiences from Trento (Italy)
Applied Geomatics, 8(1), pp. 41-56, Springer Berlin Heidelberg, ISSN: 1866-928X

Some experiences: Vienna

Estimate energy demand + scenarios

Mode details:

Skarbal, B., Peters-Anders, J., Faizan Malik, A., Agugiaro, G., 2017,
How to pinpoint energy-inefficient buildings? An approach based on the 3D city model of Vienna.
ISPRS Ann. Photogramm. Remote Sens. Spatial Inf. Sci., IV-4-W3, pp. 71-78

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Some experiences: Amsterdam

- First tests with CityGML + Energy ADE in progress

Image: MSc thesis of C.-K. Wang (TU Delft, 2018)
https://repository.tudelft.nl/islandora/object/uuid:bc0d7164-be60-485a-ad7d-f7a049a3851d?collection=education

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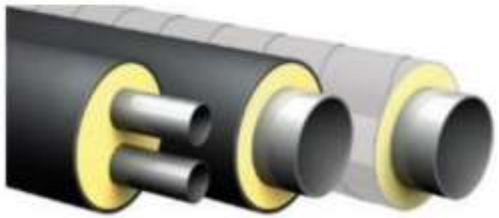
City-wide energy "chain"



Production

- Fossils
- Renewables
- Industrial processes
- Nuclear

Distribution

- Electrical
- Gas
- District Heating & cooling
- Waste water
- Steam
- Oil

Consumption

- Housing
- Industrial
- Tertiary

Slide courtesy of A. Nichersu, EIFER

What about standards for energy?

CityGML Utility Network ADE

- Goal: tackle interoperability issues among heterogeneous network data models
- Defines standardised entities needed for utility networks
  - District heating and cooling, gas, power grid, telecommunications, etc.
  - First mapping between CIM and Utility Network already carried out
- Development by int. consortium since 2016
  - v. 1.0 (alpha) presented tomorrow at OGC meeting in Leuven, Belgium
  - https://github.com/TatjanaKutzner/CityGML-UtilityNetwork-ADE

Image source: Kutzner (2017)

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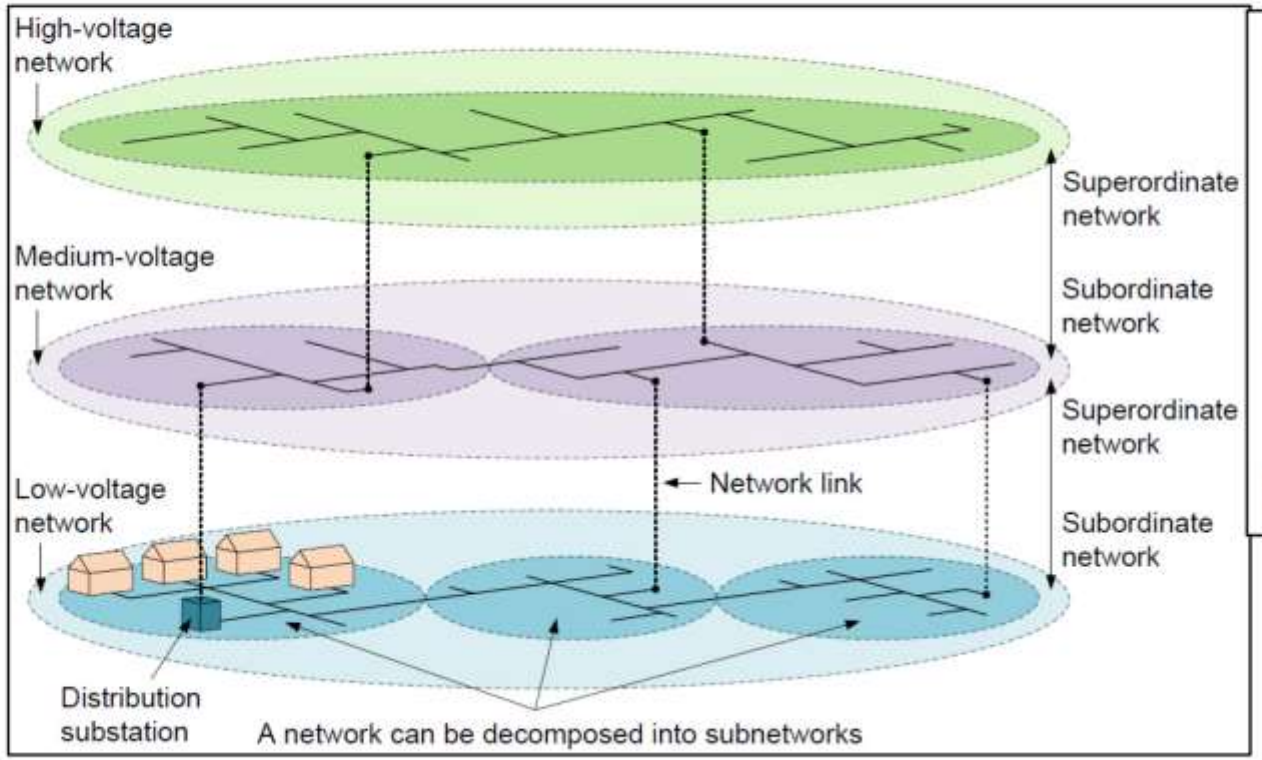
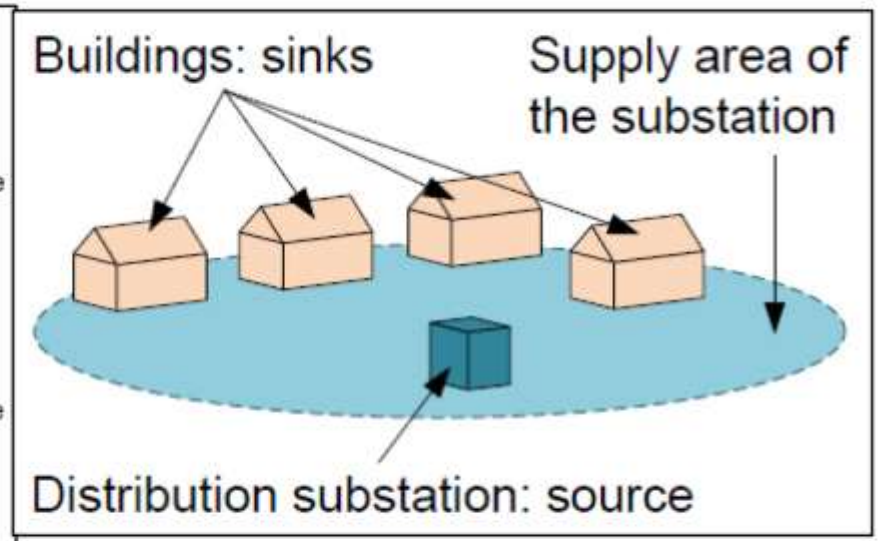
Utility Network ADE

- Allows for integrated representation of networks:
  - Hierarchical structure of networks
  - Definition of different supply areas (also with missing topology)

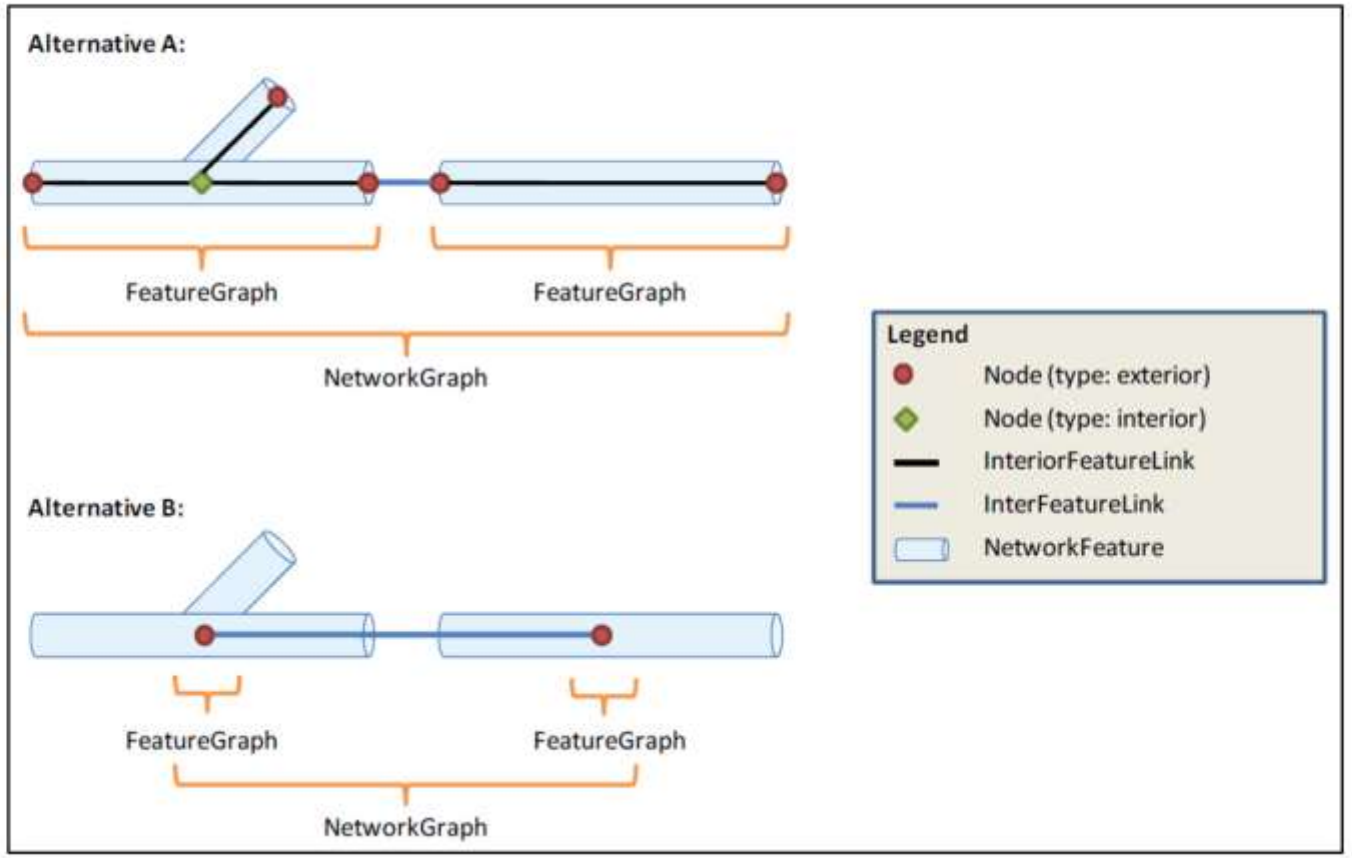




Images source: Kutzner et al., 2016

Utility Network ADE

- Allows for integrated representation of networks:
  - Hierarchical structure of networks
  - Definition of different supply areas (also with missing topology)
  - **Topological** (graph-based) AND **topographical** representation



Images source: Becker et al. 2012

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Some experiences

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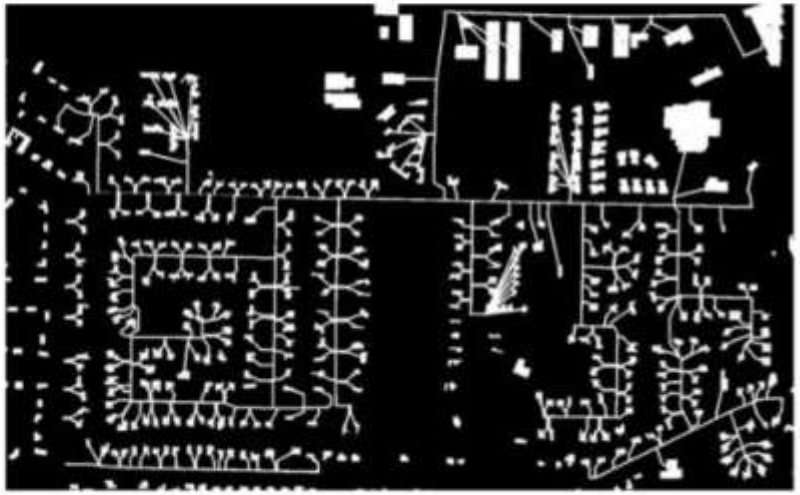
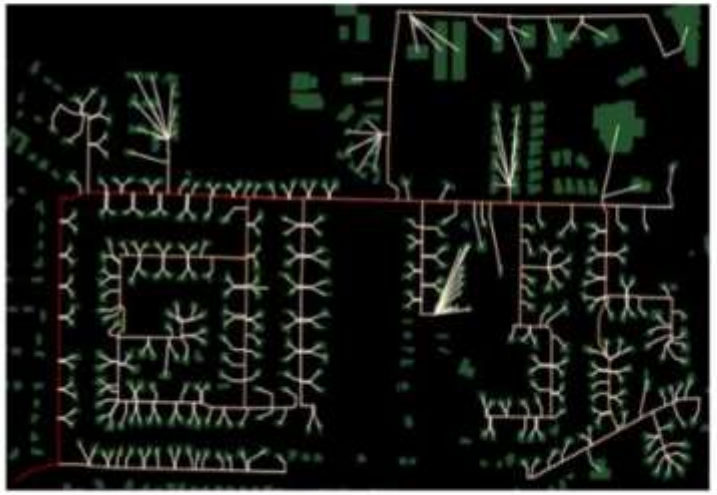
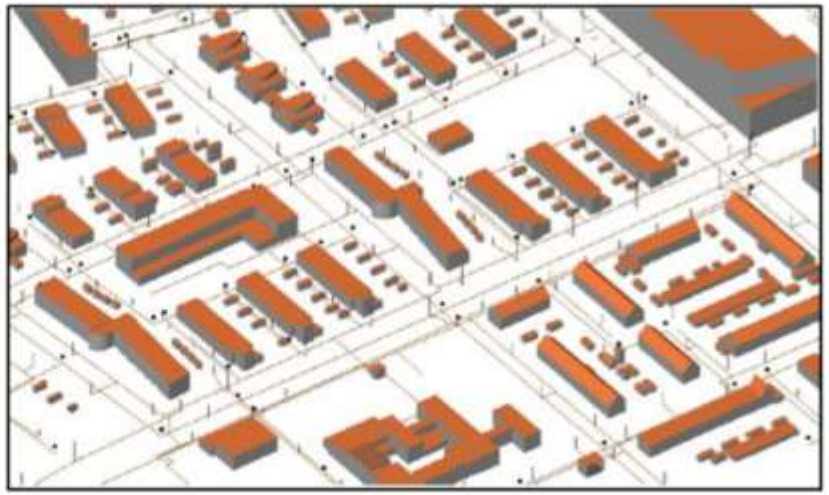


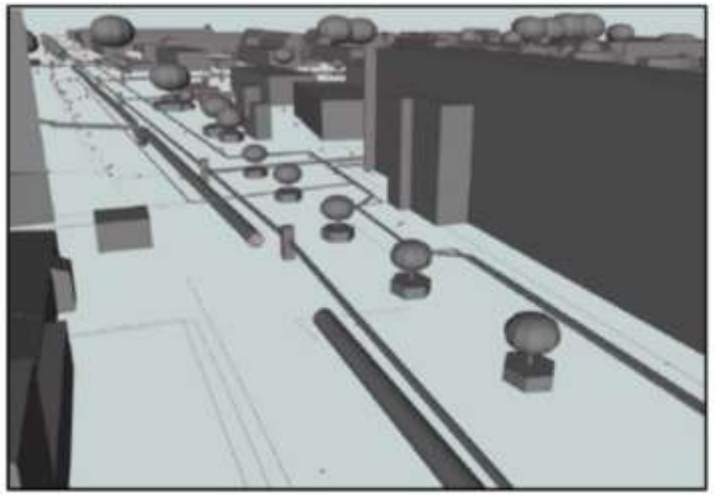


EIFER

Master thesis of Isaac Boates (2018)

Electricity and and freshwater





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Master thesis of Xander den Duijn (2018)

Electrical and sewer network

Conclusions

- **Urban Energy Modelling (UEM)** requires large quantities of harmonised, spatial and non-spatial data

- Standard-based semantic **3D city models** represent a powerful and useful **information hub** for city-wide applications
  - Structuring and semantic enrichment of data plays a fundamental role wrt. to data (re)usability

- As of today, **CityGML** + **Energy ADE** + **Utility Network ADE** are the only existing *integrated* and *open* data models for Urban Energy Modelling between the BIM (IFC) and LIM (INSPIRE) scales

GeoBIM: Goal

Lossless (circular) conversion

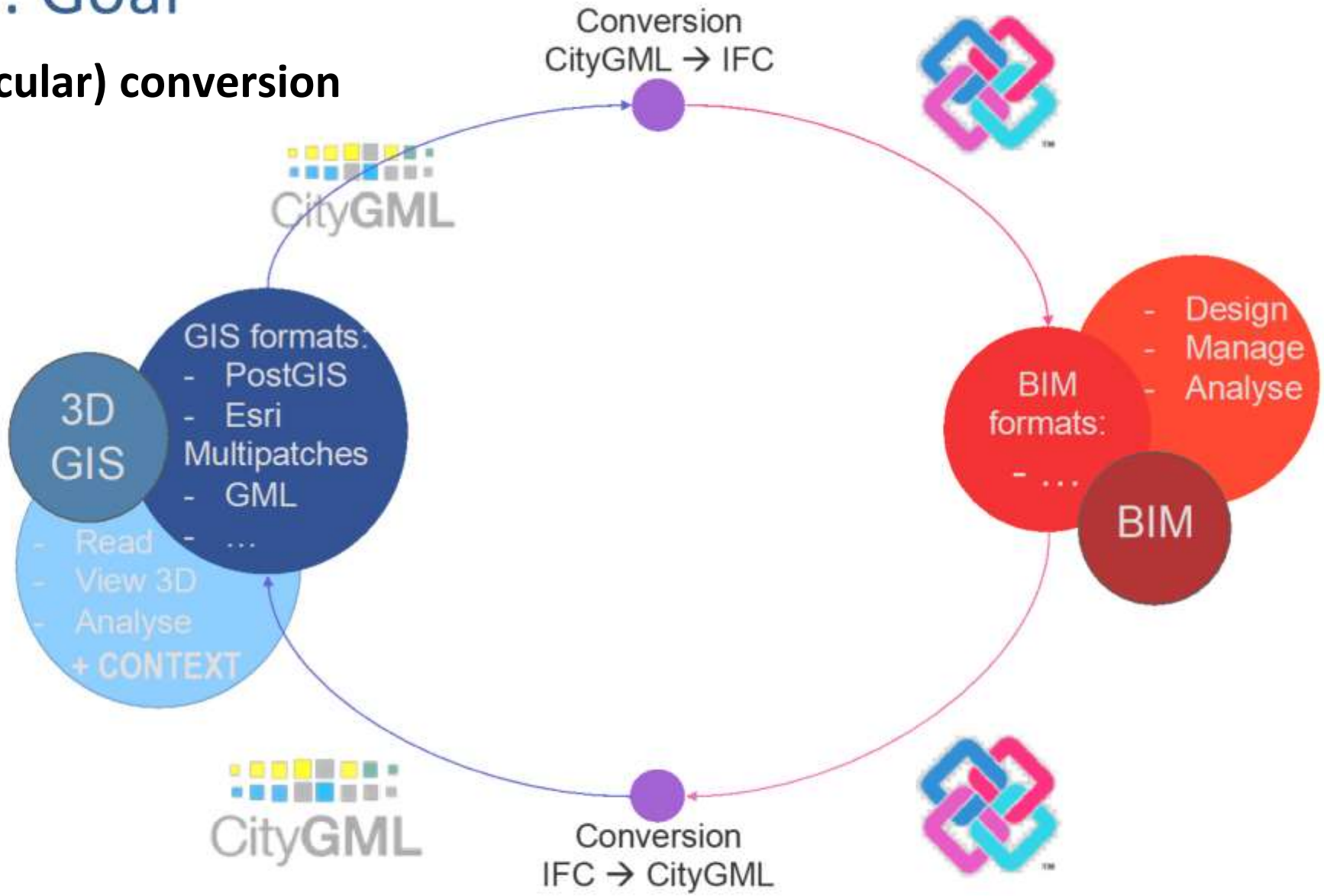

Figure: High-level schema summarising the kinds of data conversion needed in the management of GeoBIM information.

Source: Francesca Noardo, C. Ellul, L. Harrie, I. Overland, M. Shariat, Ken ArroyoOhori & Jantien Stoter (2019): Opportunities and challenges for GeoBIM in Europe: developing abuilding permits use-case to raise awareness and examine technical interoperability challenges,Journal of Spatial Science, DOI: 10.1080/14498596.2019.1627253

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GeoBIM

- Partners:

EuroSDR – research association of European National Mapping and Cadastral Agencies

https://3d.bk.tudelft.nl/projects/eurosdr-geobim/

GeoBIM

EuroSDR

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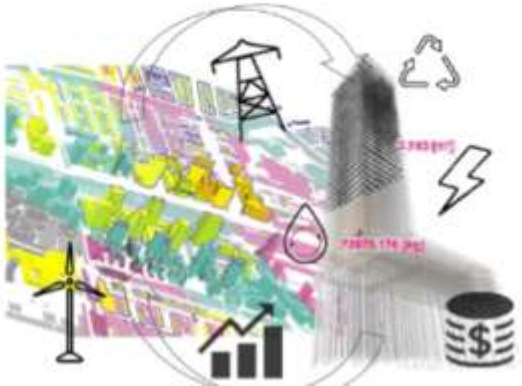
Conclusions

Glimpse of GeoBIM

- Develop and share best practices to guarantee interoperability between IFC and CityGML
- Use cases:

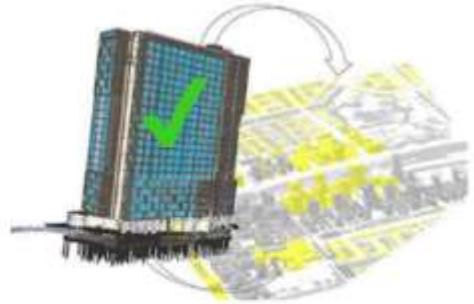
1) **Automatic issuing of building permissions**

2) Life-cycle support in asset management



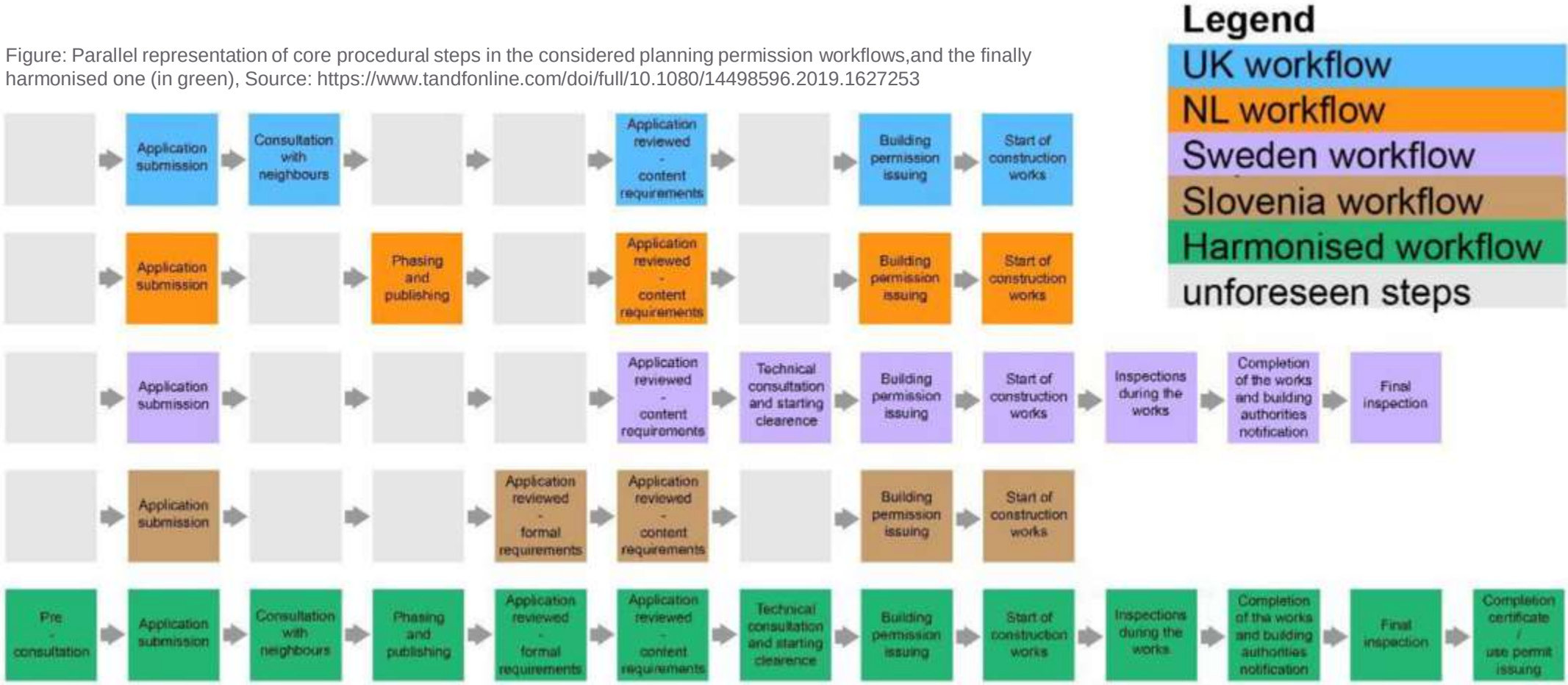
https://3d.bk.tudelft.nl/projects/eurosdr-geobim/

GeoBIM



- Automatic issuing of building permissions
  - Investigate needs with stakeholders
  - Define and harmonize workflows at national level

Figure: Parallel representation of core procedural steps in the considered planning permission workflows,and the finally harmonised one (in green), Source: https://www.tandfonline.com/doi/full/10.1080/14498596.2019.1627253



Source: Francesca Noardo, C. Ellul, L. Harrie, I. Overland, M. Shariat, Ken ArroyoOhori & Jantien Stoter (2019): Opportunities and challenges for GeoBIM in Europe: developing abuilding permits use-case to raise awareness and examine technical interoperability challenges,Journal of Spatial Science, DOI: 10.1080/14498596.2019.1627253

City Modelling & Energy
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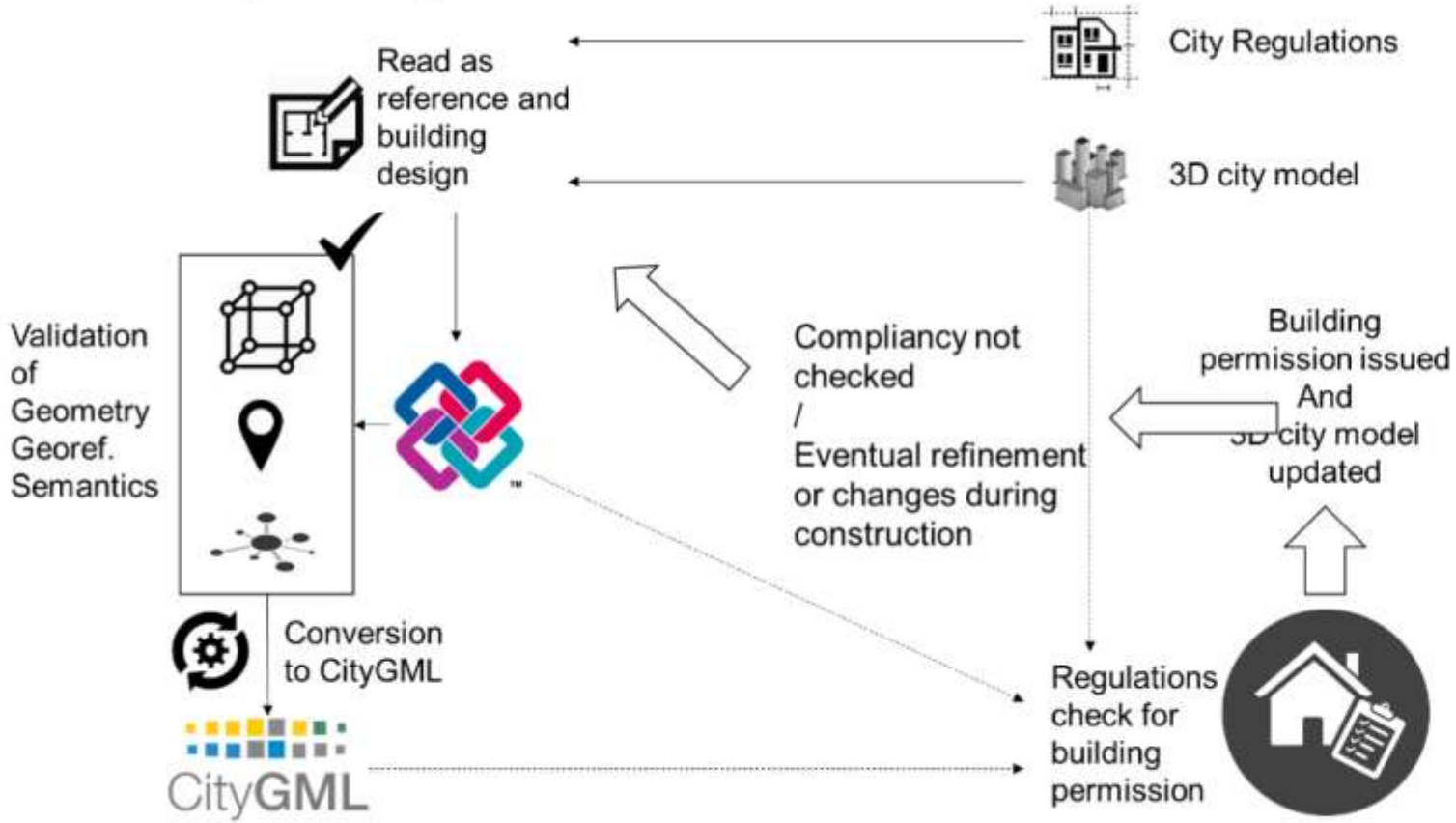
Conclusions
Glimpse of GeoBIM

GeoBIM

- Automatic issuing of building permissions
  - Investigate needs with stakeholders
  - Define and harmonize workflows at national level
  - Formalize unique, integrated workflow



Source: https://speakerdeck.com/francescanoardo/geo-and-bim-does-not-make-a-geobim, 25.9.2019

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