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# *The Building as the Cornerstone of our Future Energy Infrastructure*

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International Network for Information on Ventilation and Energy Performance

# OVERVIEW

From Buildings to Urban Areas and Cities

- Directives and Standards
- Renovation and Financing
- Monitoring and Measurements
- Research and Testing
- Modelling and Calculation
- Integration of Renewable Energies
- Two IEA EBC projects

# Energy Policy and Energy Union

2020 RE targets; In EU 20%

2030 Decarbonisation and clean energy

- 32% of RE share in EU
- 40% reduction of GHG emissions - Climate Action
- 32.5% improvement in Energy Efficiency

2030 Security of Supply

- Infrastructure for electricity and gas

2050 Climate neutral and some Member States carbon free

- 80 – 95% reduction of GHG emissions

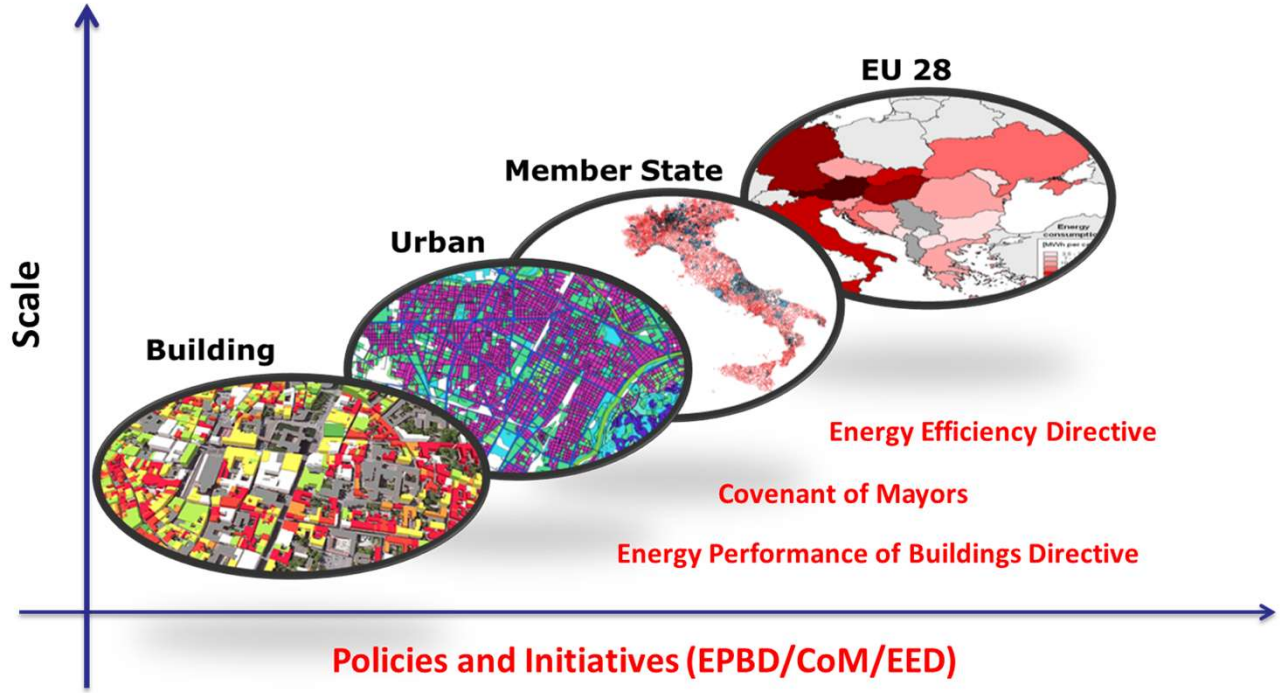
Three pillars: energy efficiency first, RE leadership and fair to consumers (that is us!!!!)

# Renewable Energy Targets


energy statistical country datasheets (last update 17/09/2019)

# Scale-up methodologies

- **Aim**: use location data to support stakeholders engaged in energy policies' lifecycle




To leverage location-based data at building level as enabling factor to scale-up the methodologies to assess energy consumption and performance from local to urban to district to regional to MS level as required by the European Directives in the field of energy efficiency

# Energy Performance of Buildings

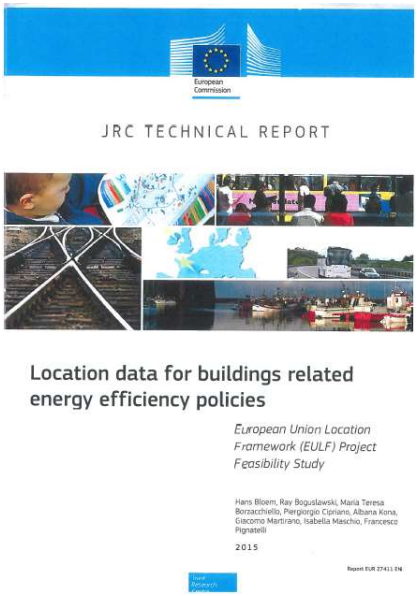
EPB Directive 2010/31/EU article 2:

*revised* Energy Performance of Buildings Directive (EU) 2018/844

The ‘energy performance of a building’ means the **calculated** or **measured** amount of energy needed to meet the energy demand associated with a typical use of the building, which includes, inter alia, energy used for heating, cooling, ventilation, hot water and lighting;

A third, **holistic** approach using administrative databases could be supported by INSPIRE.

# EPBD SUPPLEMENT – EU 244/2012




Reference buildings and criteria

- Age (renovation)
- Type and size
- Climate (zones or regions)
- Orientation (and shading)
- Heritage and protected buildings
- Construction products, elements and structures

In relation to energy:

- Building energy needs (fabric in its climate)
- Building energy systems
- Energy source and carrier

# Energy Performance of Buildings

*revised* Energy Performance of Buildings Directive (EU) 2018/844

**maintains** the key features of the existing EPBD, nevertheless, it:

- modernises and streamlines some requirements and
- introduces binding obligations on **electro-mobility** requirements in buildings,

- introduces a '**smartness indicator**' that assesses the technological capability of buildings in energy self-production and consumption, and

- sets clearer requirements for **national databases** on energy performance certificates.

The revised framework included the obligation that all **new buildings** must be nearly zero-energy buildings by 2021 ('nZEB').

An obligation is introduced to provide documentation on the overall energy performance after any technical building systems are installed, replaced or upgraded.

RENOVATION; Recommendation (EU) 2019/786 on building renovation

# STANDARDS CEN-ISO

EN 52000 series are updated in 2018

More dynamic and options for national choices

## Example of national choices
*from EN ISO 52016-1*

- Main choice is between hourly and/or monthly method (choice may differ per category of buildings)

### A.3 Selection of main method

Table A.2 — Choice between hourly or monthly calculation method (see 5.2)

| Type of object and/or application | ..... [b] | .... [b] |
|---|---|---|
| Description | Choice [a] | Choice [a] |
| Only hourly method allowed | Yes/No | Yes/No |
| Only monthly method allowed | Yes/No | Yes/No |
| Both methods are allowed | Yes/No | Yes/No |

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between type of object, type of building or space, type of application or type of assessment. Use the list of identifiers from ISO 52000-1:2017, Tables A.2 to A.7 (normative template, with informative default choices in Tables B.2 to B.7).

Source: EPB Center – Example of national choices

# Energy in Building sector

Interaction between:

Government

Industry

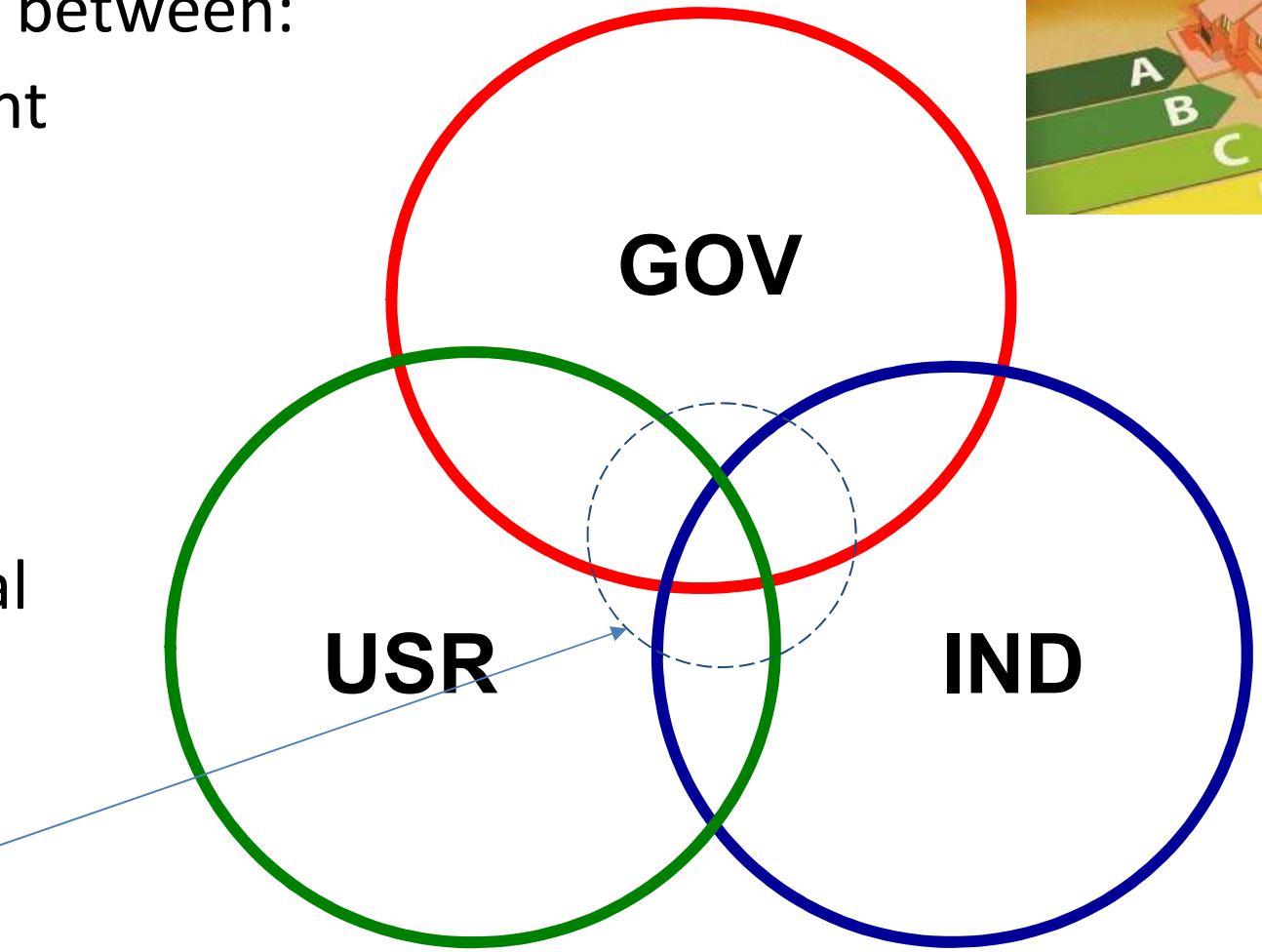
End-user

Politics

Commercial

Private

Financing

# CHARACTERISTICS

**Governments**

Short duration; in place up to 8 years

Define the law, programmes, subsidies for stimulations

May change targets and political goals

**Industry**

Shareholders like to see profit, innovation and flexibility

Through competition the industry sector is more energy efficient

Apply regulations, norms and standards

**Citizen**

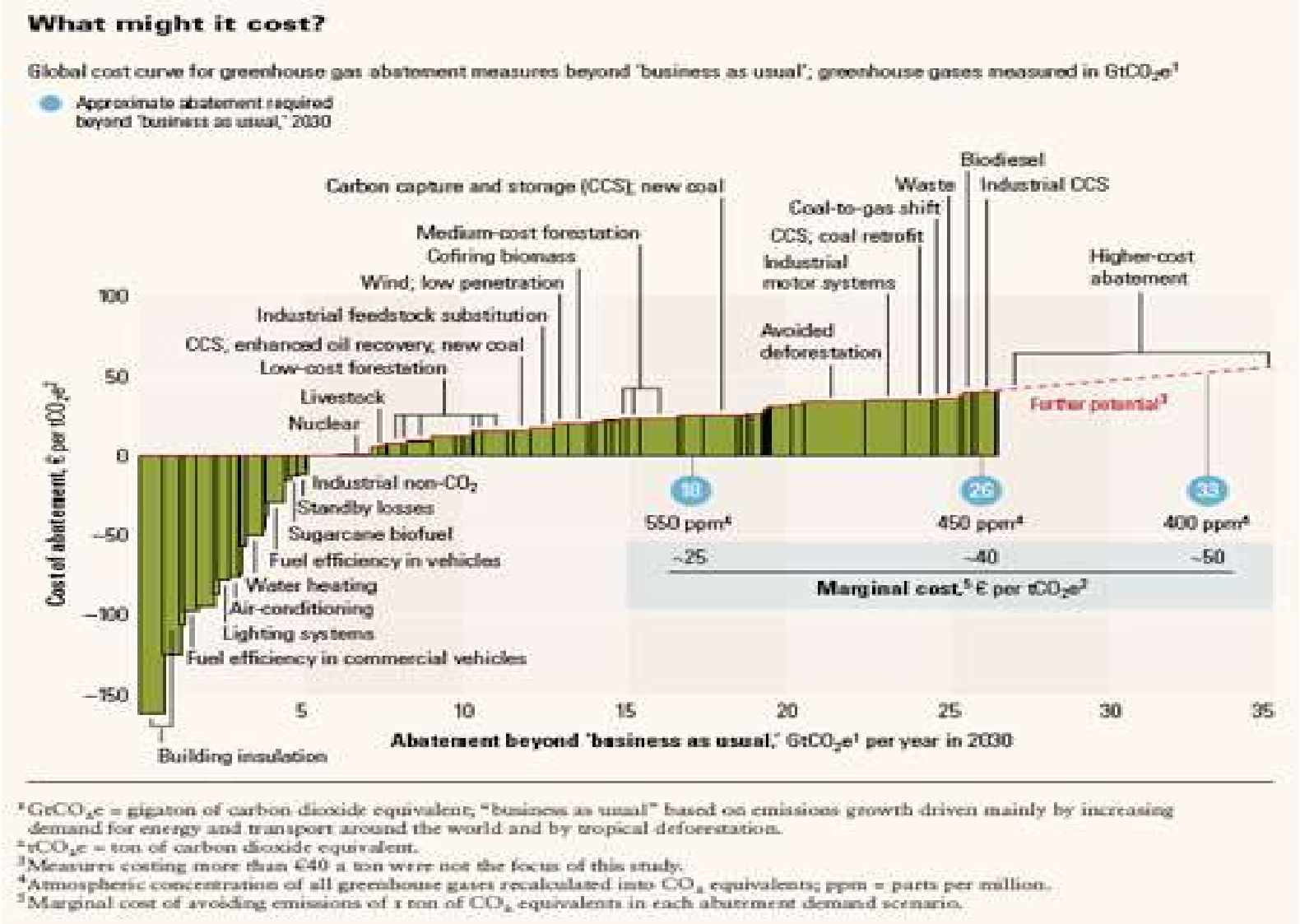
Chooses government; will have to pay for products, services

Live and work in buildings. Often lack of awareness.

**Banks**

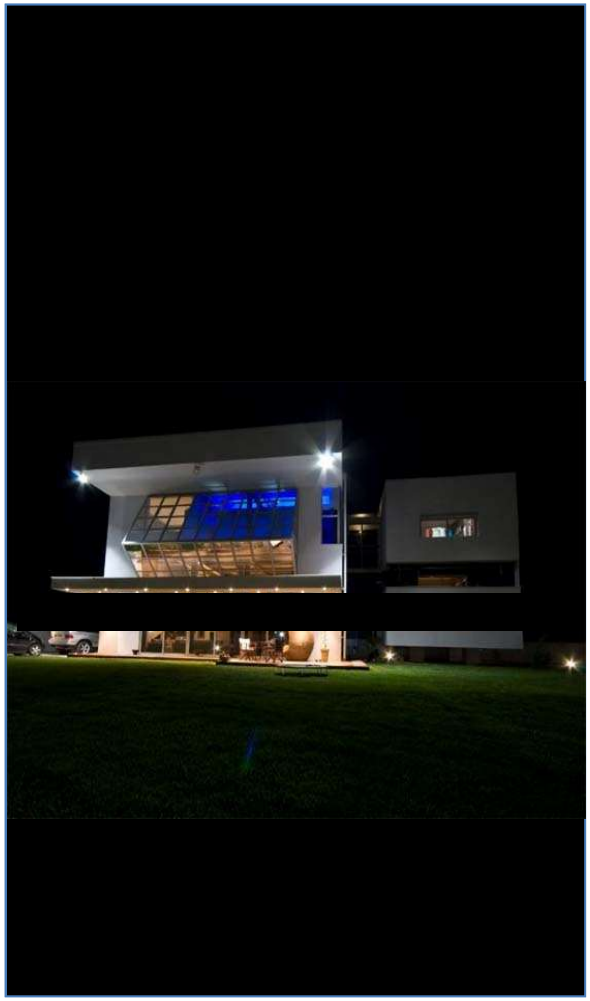
Investment, financing of renovation. Financial market

# Economic perspectives - McKinsey report




[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.
[2] $tCO_2e$ = ton of carbon dioxide equivalent.
[3] Measures costing more than €40 a ton were not the focus of this study.
[4] Atmospheric concentration of all greenhouse gases recalculated into $CO_2$ equivalents; ppm = parts per million.
[5] Marginal cost of avoiding emissions of 1 ton of $CO_2$ equivalents in each abatement demand scenario.

# PHILOSOPHY



The philosophy, TRIAS ENERGETICA that supports the reduction of energy consumption in the building sector is presented in three priority steps:

1. Energy **saving** (improve insulation),
2. Increase energy **efficiency** (building installations),
3. Use **renewable energy** resources (solar energy, bio-energy, etc.).

# RENOVATION

European building stock is in need of renovation about 50% of 210 million buildings

Follows TRIAS ENERGETICA

However should involve the citizens:

- Awareness
- Decision-making
- Financing

RE integration and ICT

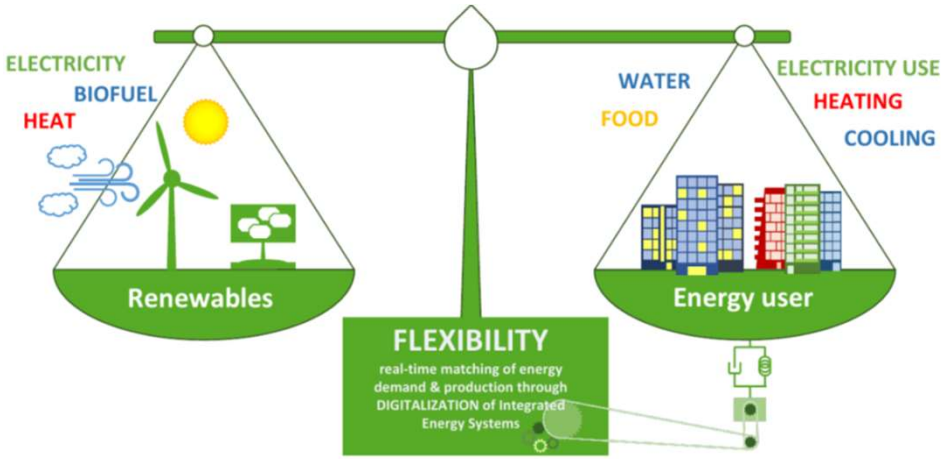
www.cityfied.eu

Source: CARTIF – CityFied project

# Strategies for Energy Savings

- A Building needs an Energy Infrastructure
- The Energy Providers require Buildings

opportunity: Flexibility




Source: DTU – Flexibility issue

**Reasoning:**

Optimise the Balance for …..

Energy ? Emissions ? Economical ? …..

**Energy Providers** are a part of industry and hence have a commercial attitude; the energy market prices electricity, gas, heat etc.

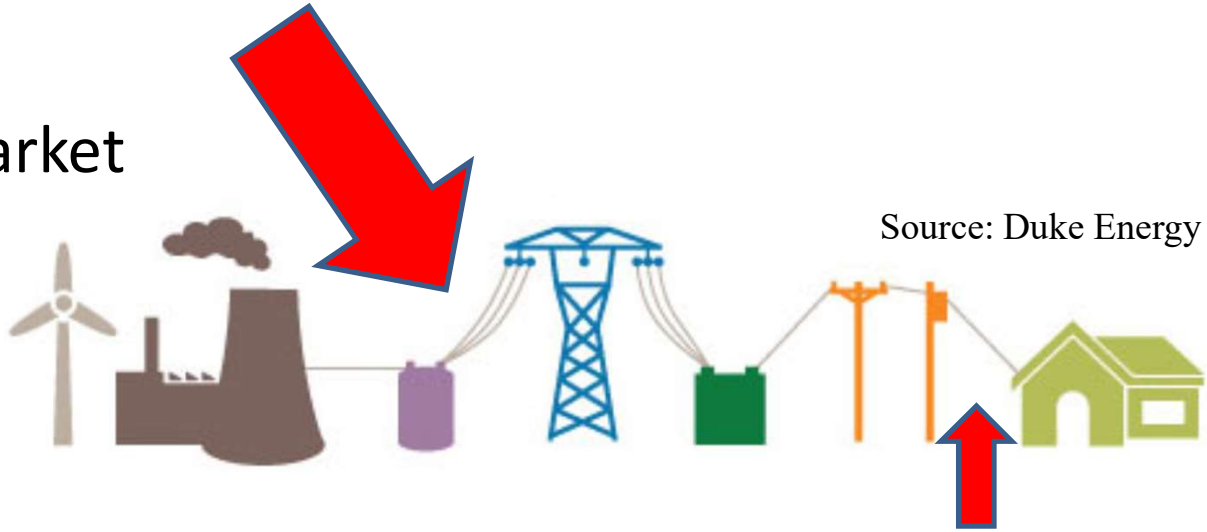
**Building Energy Systems**

*Conversion of energy carriers into required energy needs (defined by EPBD)*

# ENERGY BALANCE

Energy balance at production level, e.g. network

- TSO and DSO
- Electricity market



Source: Duke Energy

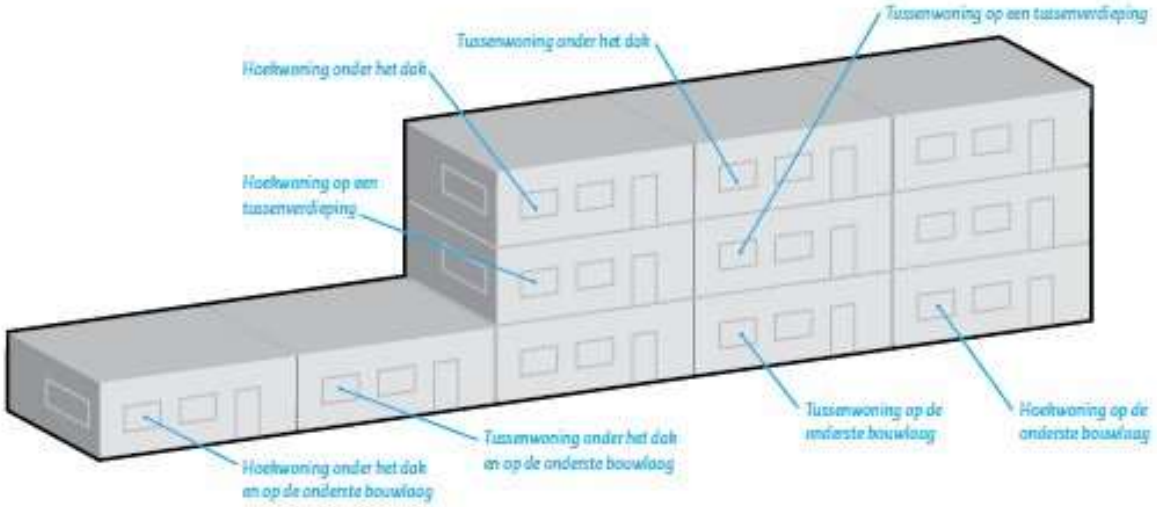
Energy balance at node level, e.g. buildings

- Energy flows in two directions, to and from buildings to network
- Requires communication and intelligent systems
- End-user not (yet) involved

# REFERENCE BUILDINGS

| Woningtype | Bouwperiode | | |
|---|---|---|---|
| | Aantal bouwperioden | Aantal subtypen | Aantal type totaal |
| Vrijstaande woning | 4 | 1 | 4 |
| 2 onder 1 kap woning | 4 | 1 | 4 |
| Rijwoning | 5 | 2 | 10 |
| Maisonnettewoning | 4 | 8 | 32 |
| Galerijwoning | 4 | 8 | 32 |
| Portiekwoning | 5 | 8 | 40 |
| (Overig) flatwoning | 4 | 8 | 32 |
| Totaal | 30 | | 154 |

In de onderstaande figuur ziet u de namen van de subtypen bij de meergezinswoningen.
Enkele subtypen komen in de praktijk erg weinig voor. Dit geldt voor de 'Tussenwoning onder het dak en op de onderste bouwlaag' en de 'Hoekwoning onder het dak en op de onderste bouwlaag'.




Reference buildings and dwellings are required for validation of methodologies

Reference climate should offer the context for comparison of energy efficient measures

Picture source; Agentschap, NL

# ADMINISTRATIVE DATA

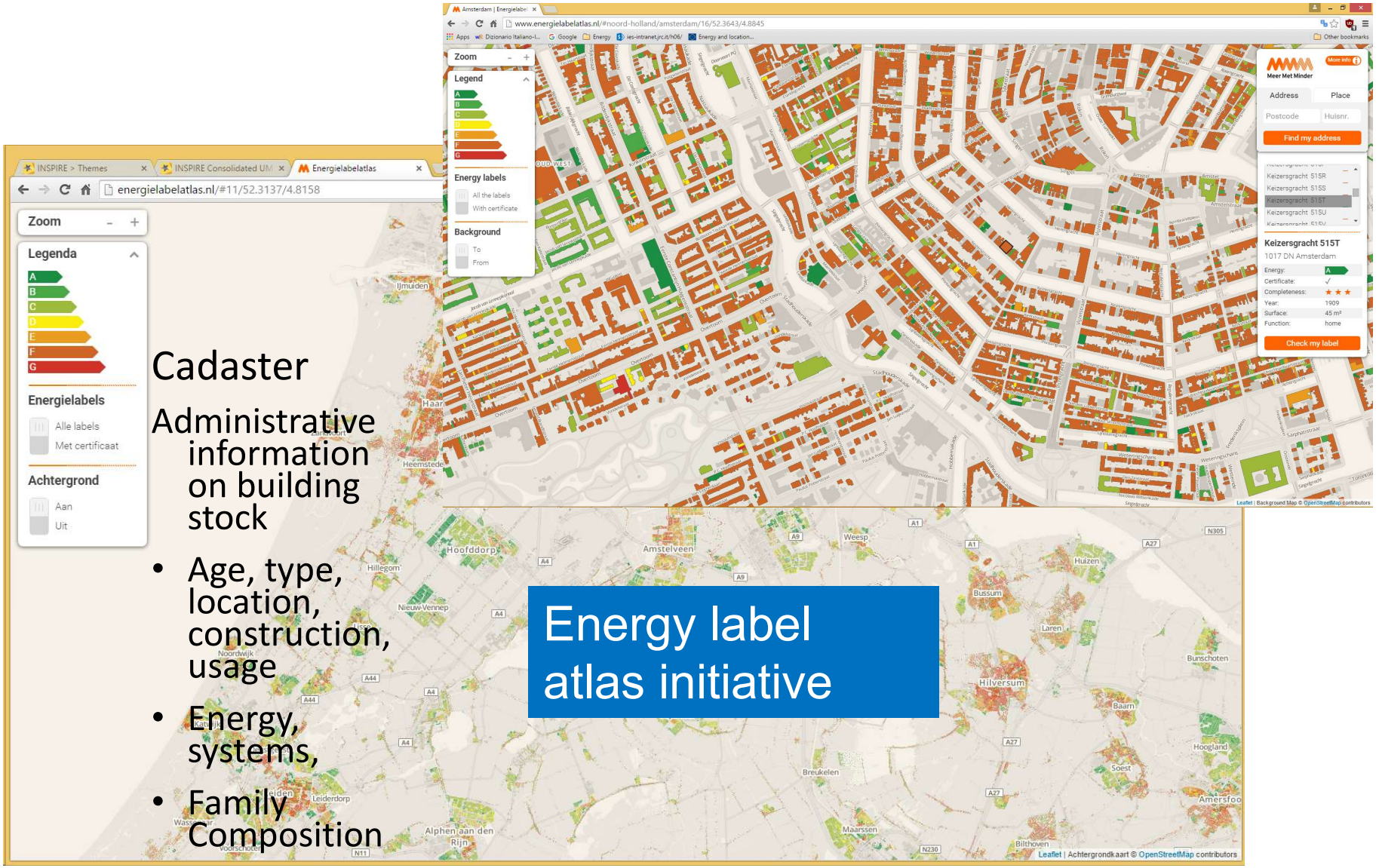
Several of the previous mentioned points relate directly to cadaster information.

Other items request further information as is presently scope of studies based in CityGML definitions :

LOD0 : Actual footprint of structure
LOD1 : Actual footprint, height at half height of the roof (volume)
LOD2 : Actual footprint, roof and orientation
LOD3 : Walls as projections from roof edges

An improved LOD specification for 3D building models
Filip Biljecki, Hugo Ledoux, and Jantien Stoter; TUDelft 3DGeoInfo
Computers, Environment and Urban Systems, vol. 59: 25-37, 2016.

# INSPIRE - Energy & Buildings



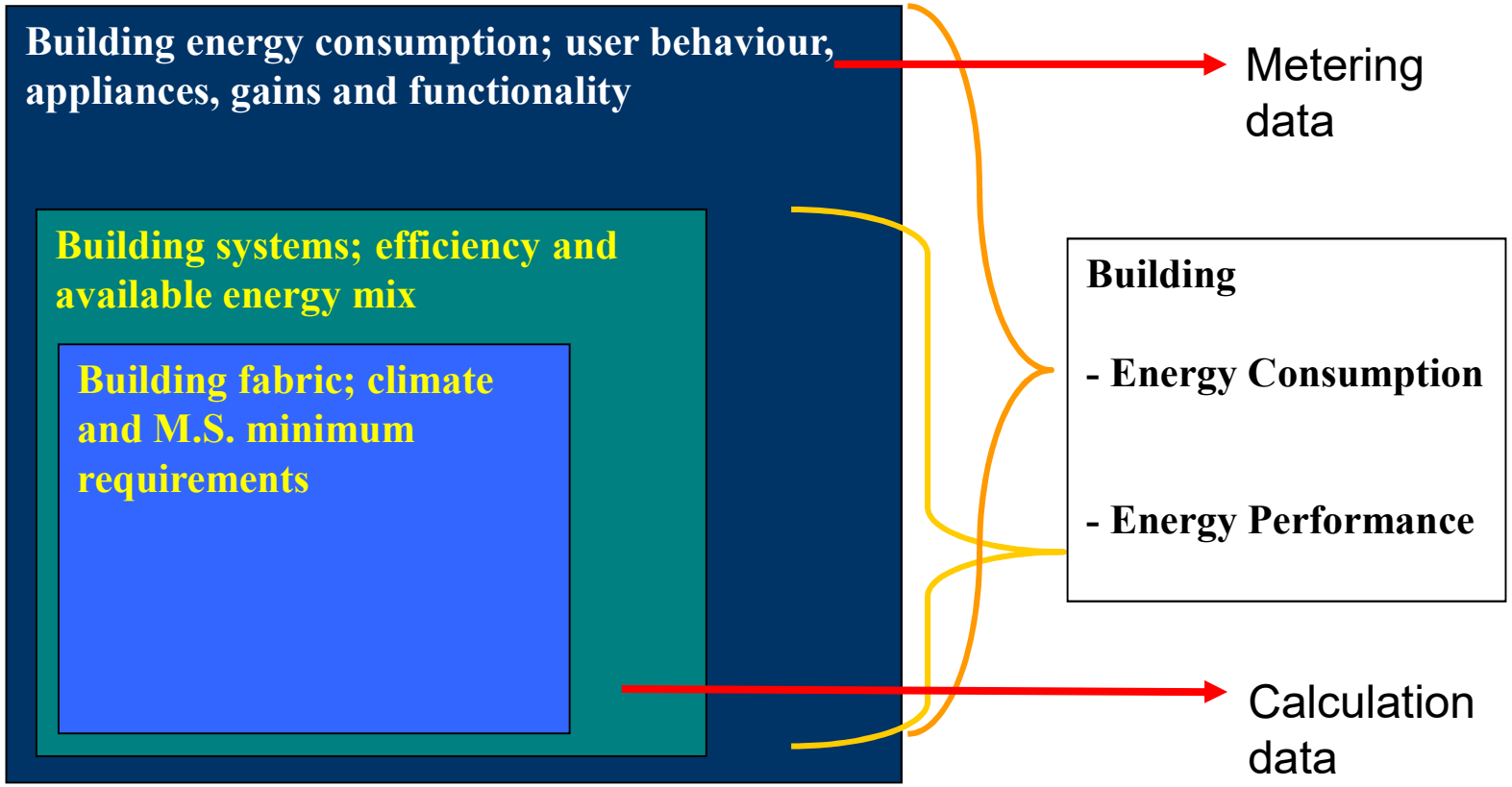

## Cadaster

Administrative information on building stock

- Age, type, location, construction, usage
- Energy, systems,
- Family Composition

# ENERGY AND BUILDINGS

Relation of energy consumption and energy performance of a building



# RESEARCH & TESTING

Source: LCCE laboratory, Basque Government. Outdoor testing

Source: Salford University – EH2.0 Indoor testing

# IN-SITU MEASUREMENTS

## Quality check of new build (design performance)

- Calculation versus measurements
- Performance gap

## Justify renovation (actual building performance)

- Before and after measurement
- Quality assurance of renovated construction
- Application of reference building performances

## Identify energy efficiency measures

- Investment versus performance improvement
- Cost optimality criteria
- Renewable energy resources

# DESIGN versus REALITY

Bridging the GAP

Between design figures and real energy performance figures.

**Standardization (CEN, ISO)**

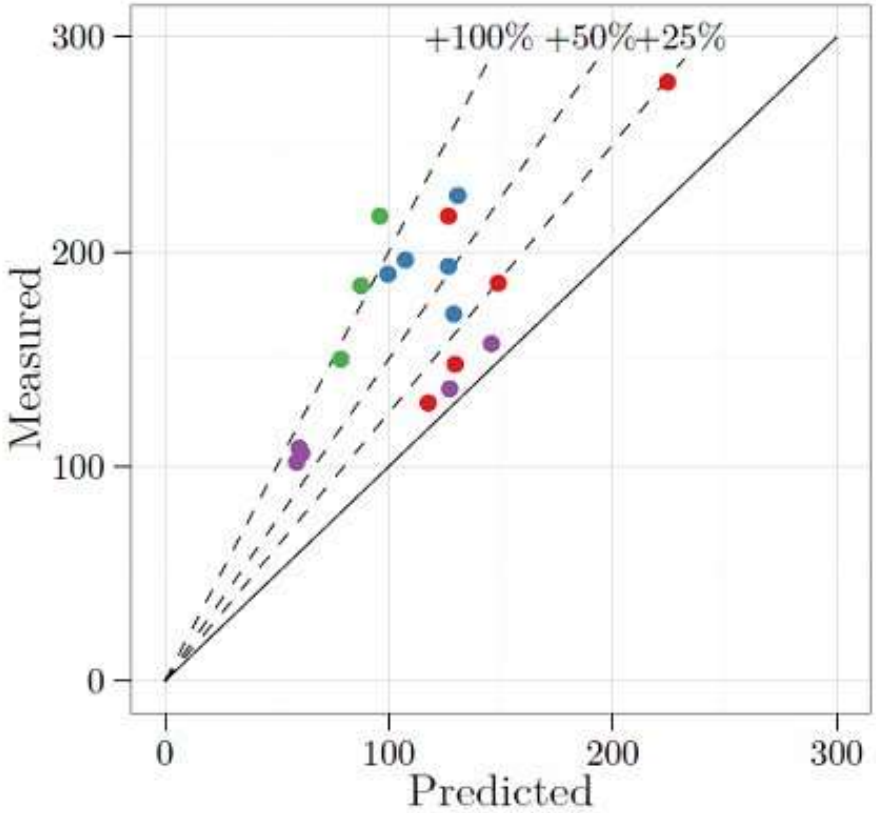
TC371 *Energy Performance of Buildings*

TC89 *Thermal Performance of Buildings and Building Components*

*TC's related to EPBD (ventilation, light, ...)*

IEA EBC Annex 67: The Flexibility Index

IEA EBC Annex 71: In-Situ Measurements



# Assessing the Energy Performance

## METHODOLOGY / IN-SITU MEASUREMENTS ASSSESSMENT

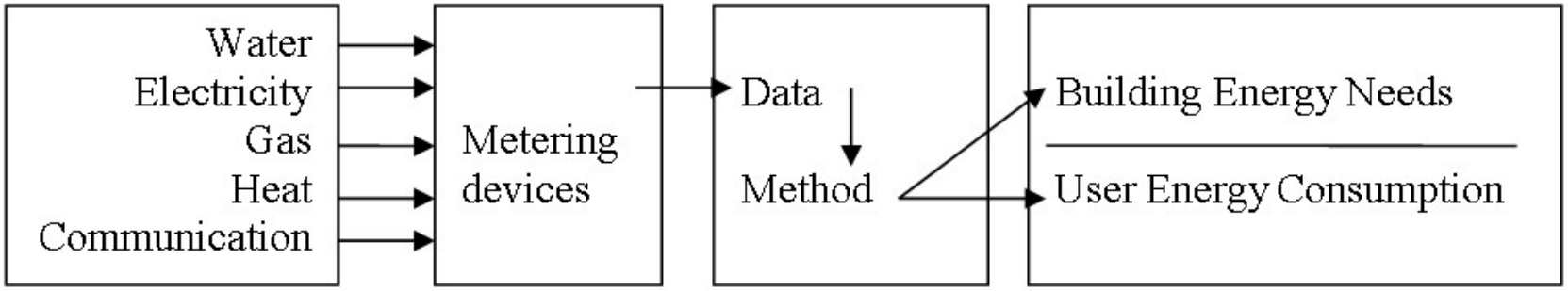
Two approaches can be distinguished

- Both approaches require climate data from the site or a nearby weather station.
- Both approaches require a conversion to reference climate data

1. Co-Heating (short duration)
   - CEN TC89 WG13 is developing a standard
   - Requires unoccupied periods and the installation of a monitoring system

2. Metering data (aggregation, continuous)
   - Electricity, gas, heat, water, …
   - Regular readings with intervals ranging from a few minutes up to daily values

# METERING CONCEPT





Analytical – Statistical method

To split building and user energy demand. Several methods available depending on available data (quality, frequency, holistic, climate, …)

# METERING DATA

Separate from meter readings the part related to

Energy for building performance

- (as defined by EPB: heating, cooling, ventilation, hot water and light)

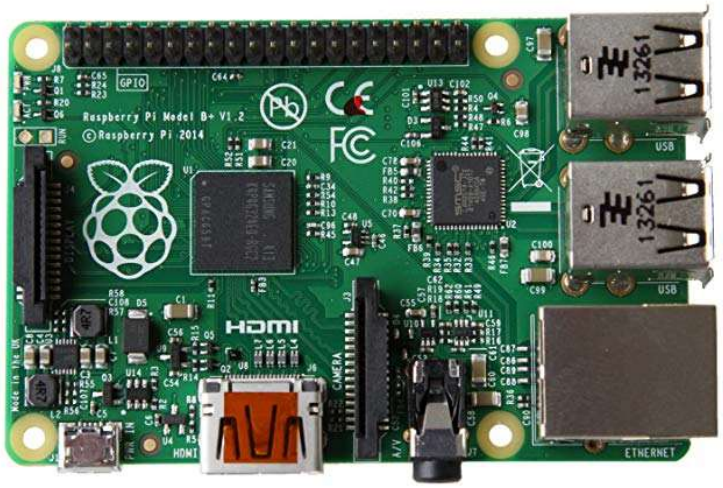
Occupancy energy consumption. Application software

- (appliances, gains, behaviour, non EPB)

Additional data from the Cloud (climate, energy market, …)

Towards intelligent environments;

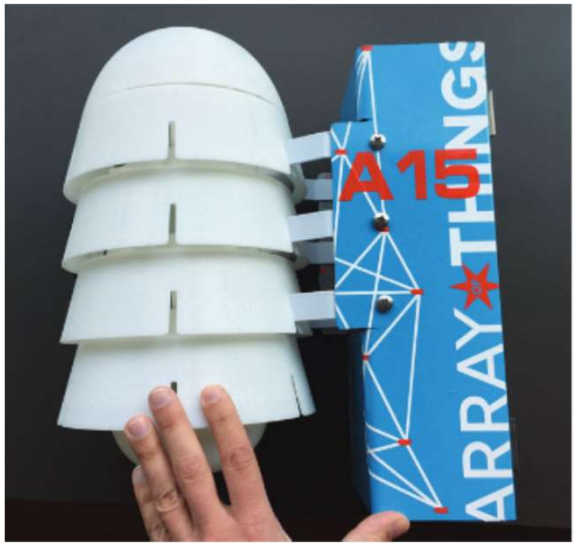
Toon, Quby, etc. devices with ICT





# MONITORING & MEASUREMENTS

- ICT is key factor in energy transition
- Climate, weather, emissions, traffic on a larger urban scale
- Forecasting of energy flows
- Energy pricing



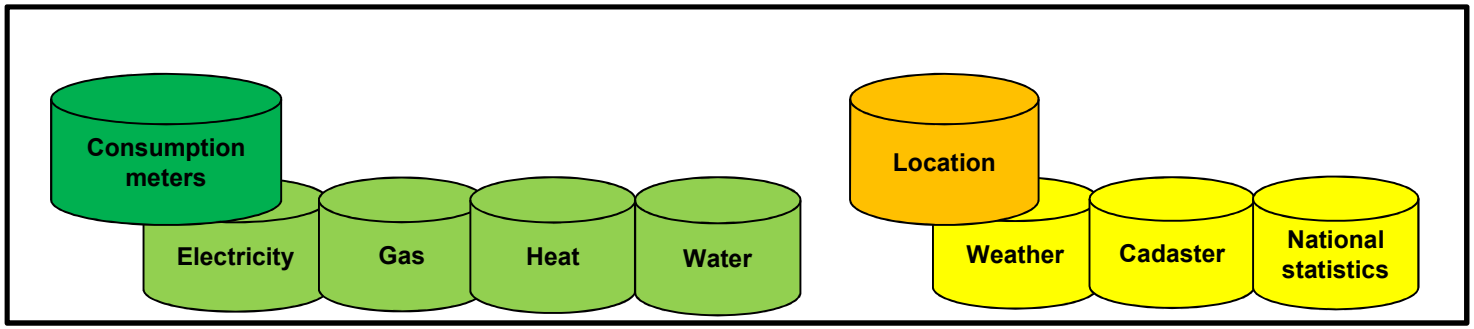

Source: ANL – Array of Things


Source: SlimmeMeterportal.nl

# PROPOSED METHODOLOGY

INIVE

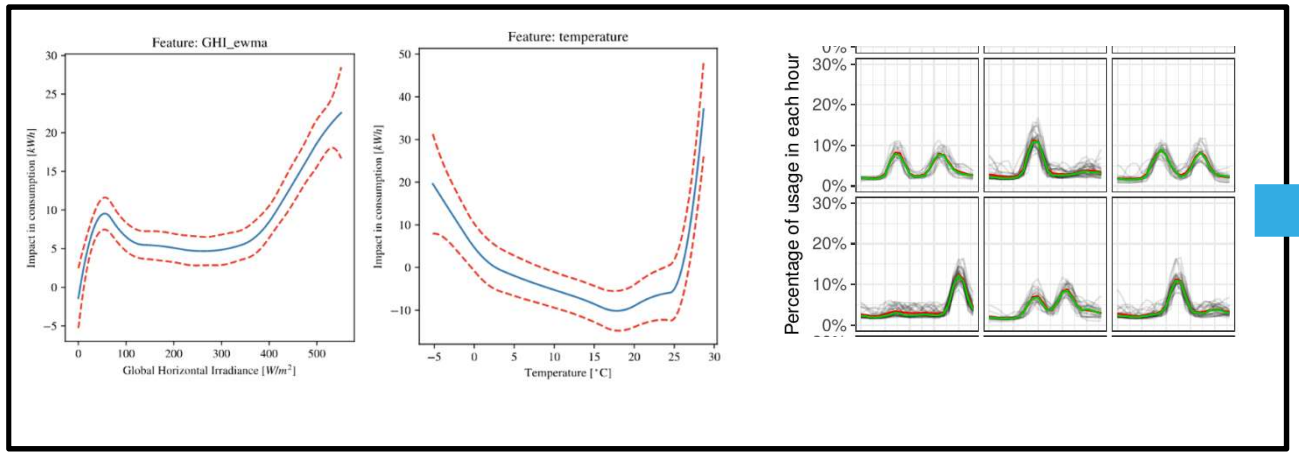
DYNASTEE




Data

Modelling
Clustering

Analytical techniques




Results

# CHANGING PHYLOSOPHY

Thomas Rau is a visionary entrepreneur, architect, innovator, inspirator.

His motto is: '***guided by the future***'.

Buy Light – No lamps; *purchase light* as a service

'pay-per-lux' intelligent *lighting* system

Buy Heat – No fuel; temperature conditioning.

supports the battle against energy poverty.

Somewhat similar is leasing of PV panels.

Let energy **MOVE** with people from Home to Work

# CONCLUSIONS

- no conflict between energy efficiency and emission reductions,
- flexibility and energy efficiency as a whole are more efficient on a larger urban scale,
- energy poverty is an issue,
- energy solutions should be inclusive for all citizens,
- balance between investments in energy efficiency of the building and the energy system based on renewable resources,
- need for real measurements to give evidence for justifying renovation,
- manage the balance of energy demand and supply at the building and urban level

building stock is an essential part of the energy transition