SPAIN

Residential building stock of the Comunitat Valenciana (1940-1980)

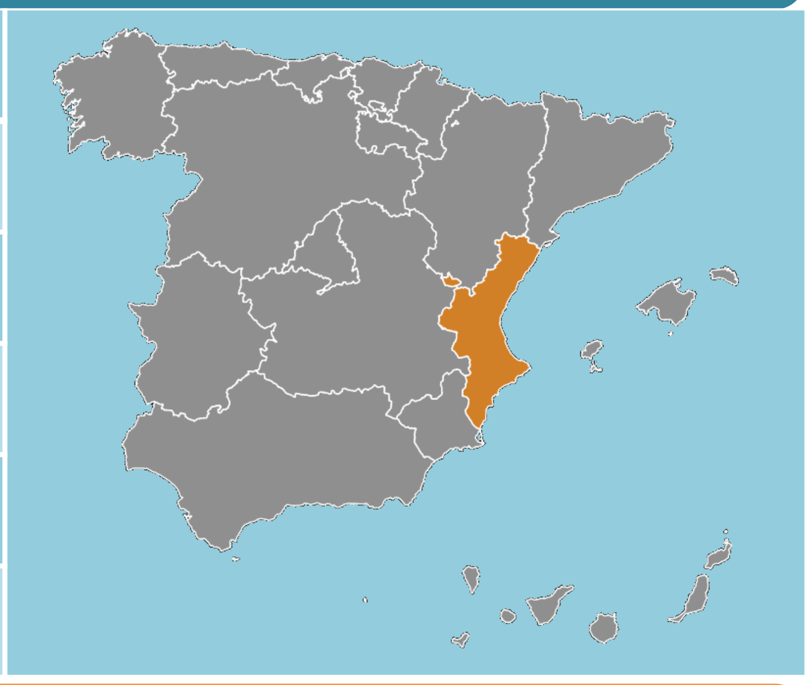
EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

SCALE	Regional
NUMBER OF DWELLINGS	692,641
NUMBER OF BUILDINGS	47,984
NUMBER OF INHABITANTS	1,385,282
m^2 NATIONAL REFERENCE AREA	58.9×10^6 Useful floor area
m^2 EPISCOPE REFERENCE AREA	64.8×10^6

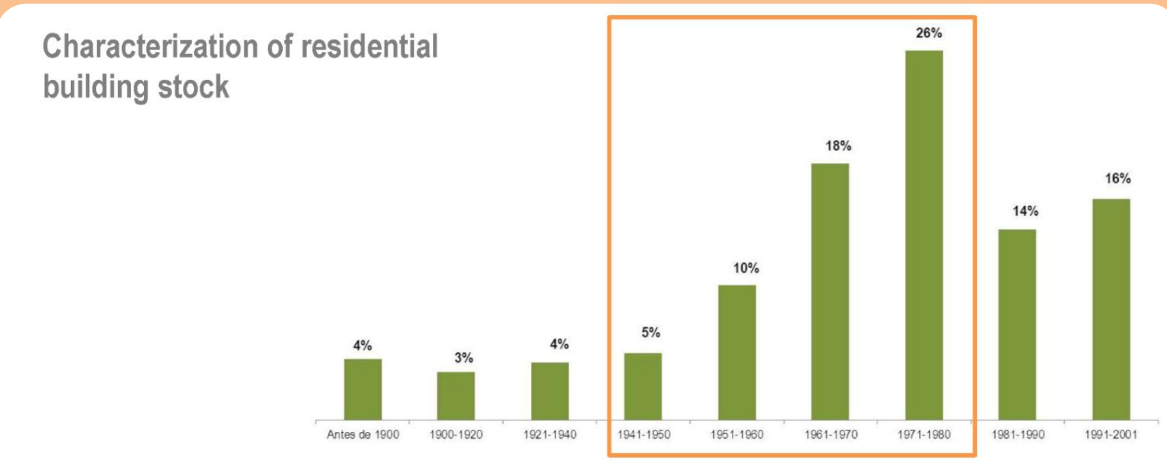


OVERVIEW OF ACTIVITIES

The **main target of the pilot action** was to study and analyze the potential for energy savings and emissions reduction that the residential building stock in the Comunitat Valenciana encloses.

Considering the construction features and state of conservation, this pilot action is focused on multi-family residential buildings, designed mainly as primary residences, **built between 1940 and 1980**. This building stock represents the greatest potential for energy savings due the lack of technical standards in the energy efficiency field when they were built and due to the low investment in conservation and maintenance carried out during their service life. Indeed, the buildings built in this period represent about 50 % of the housing stock.

As there were no particular climate protection targets when the research began, apart from those derived from the EU 20-20-20 Directive, the applicable legislation were the National Plan for Renewable Energies and The National Action Plan for Energy Efficiency. The objectives of these national plans are to reduce 26.4 % of primary energy consumption by 2020 and increase the share of renewable energy.



Year of construction	Number of floors above ground	Dwellings in Single family building	Dwellings in Multifamily buildings
≤ 1960	<4	292.935	325.155
	≥4	97	200.237
1961-1980	<4	200.997	648.751
	≥4	189	515.107
>1980	<4	252.436	325.456
	≥4	444	209.156

FINDINGS OF SCENARIO ANALYSES

The trend scenario consists of the current building stock. Three improvement measures for all scenarios were considered: improving the façades, windows, rooftops and/or a combination of them. Passive measures were selected as they are the improvements that last longer and that require much less maintenance than systems. In economic terms, bearing in mind current policies, it was assumed an investment grant of 50% of the final cost of the different scenarios.

In order to establish the importance of the different improvements on the scenarios, how much energy was saved by applying them individually was studied. **It was proved that modifications on the façade saved double than changing the windows, and three times more than modifying the roofs.**

Six possible scenarios were established between the years 2012 and 2021, the first of them, renewing the 10 % of the existing building stock over a 10 year period, the second renewing the 20 % and renewing 30 %, 40 %, 50 % and 80 % for the rest. The three most relevant scenarios are the 30, 40 and 50 %, as they reduce considerably the energy consumption and are feasible in manpower terms.

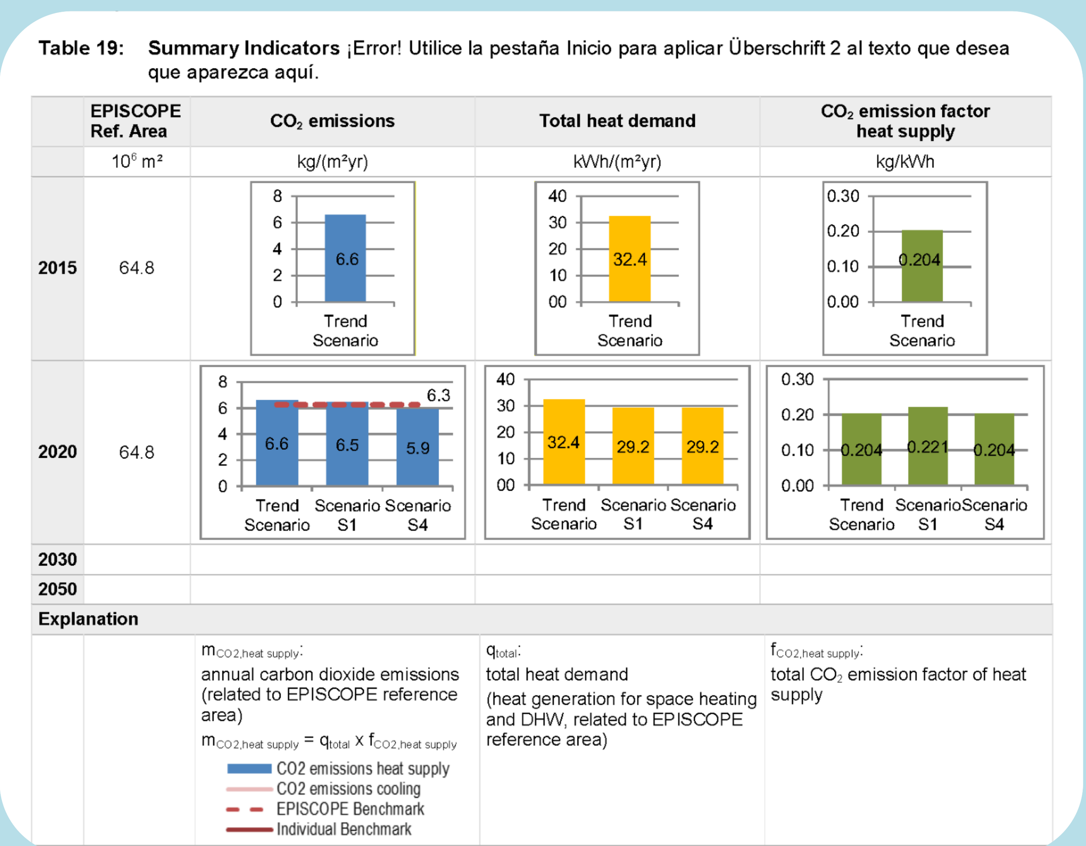


Table 19: **Summary Indicators** ¡Error! Utilice la pestaña Inicio para aplicar Überschrift 2 al texto que desea que aparezca aquí.

	EPISCOPE Ref. Area	CO_2 emissions	Total heat demand	CO_2 emission factor heat supply
	10^6 m²	kg/(m²yr)	kWh/(m²yr)	kg/kWh
2015	64.8	Trend Scenario: 6.6	Trend Scenario: 32.4	Trend Scenario: 0.204
2020	64.8	Trend Scenario: 6.6; Scenario S1: 6.5; Scenario S4: 5.9; 6.3	Trend Scenario: 32.4; Scenario S1: 29.2; Scenario S4: 29.2	Trend Scenario: 0.204; Scenario S1: 0.221; Scenario S4: 0.204
2030				
2050				
Explanation				
		$m_{CO2,heat\ supply}$: annual carbon dioxide emissions (related to EPISCOPE reference area) $m_{CO2,heat\ supply} = q_{total} \times f_{CO2,heat\ supply}$; CO2 emissions heat supply; CO2 emissions cooling; EPISCOPE Benchmark; Individual Benchmark	q_{total}: total heat demand (heat generation for space heating and DHW, related to EPISCOPE reference area)	$f_{CO2,heat\ supply}$: total CO_2 emission factor of heat supply

LESSONS LEARNED & RECOMMENDATIONS

To achieve a significant reduction in final energy consumption for the year 2021, 80 % or more of the building stock should be renewed. This would be more than 55,000 building renewals per year, which is much higher than the current renovation rate and quite difficult to achieve. The investment for this scenario is 1,406 million €. A more plausible scenario is the renovation of 40 % of the considered building stock, with a retrofitting rate of 27,000 buildings per year and energy savings of about 10 %. This would cost around 703 million €. An option that may achieve similar savings whilst intervening in a lower percentage of the building stock would be to propose stricter improvements than those required by current legislation and closer to the NZEB approach, prioritizing renovations that improve insulation at the building envelope.

It has been concluded that the most effective approach to reducing the energy consumption is, for these buildings, the implementation of passive measures which are widely described in the report "Estudio del Potencial de ahorro energético y reducción de emisiones de CO2 en la Comunitat Valenciana".

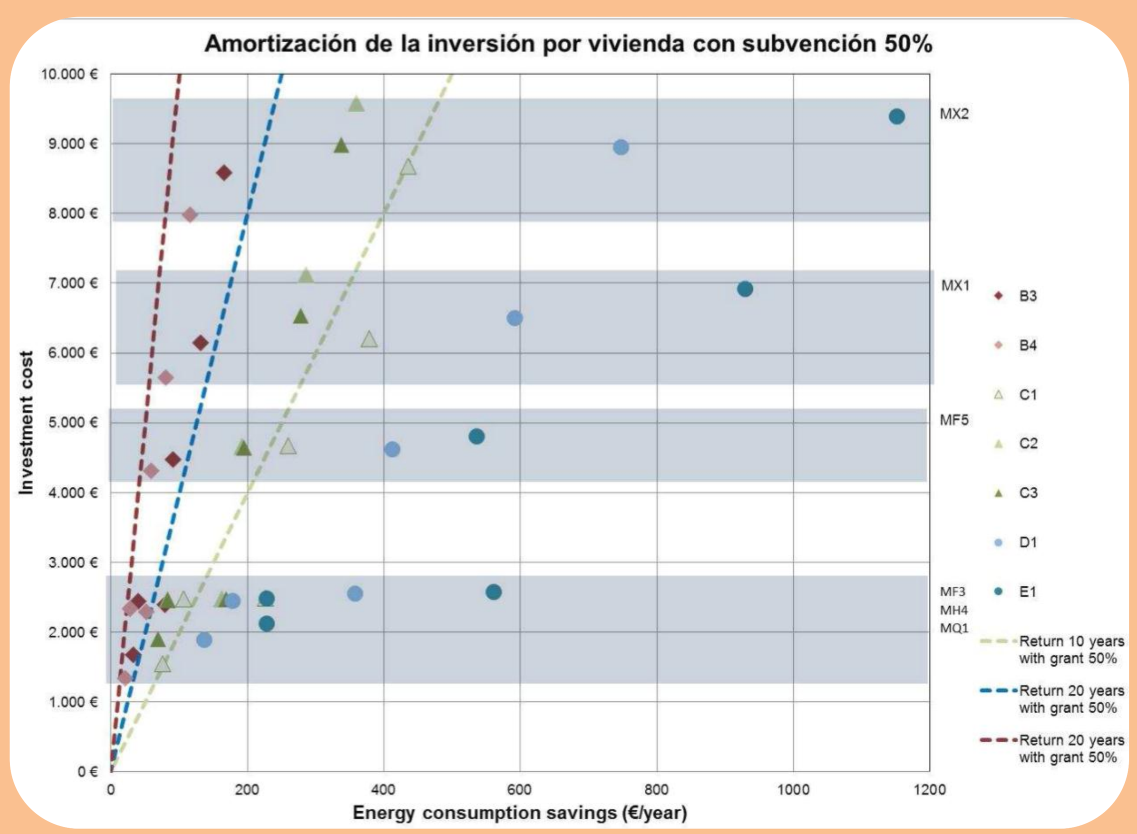


Figure: Private investment amortization for a typical dwelling at the Valencia Region, with a 50% subsidy and with a mean energy consumption

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GENERALITAT VALENCIANA

INSTITUTO VALENCIANO DE LA EDIFICACIÓN

Slovenia

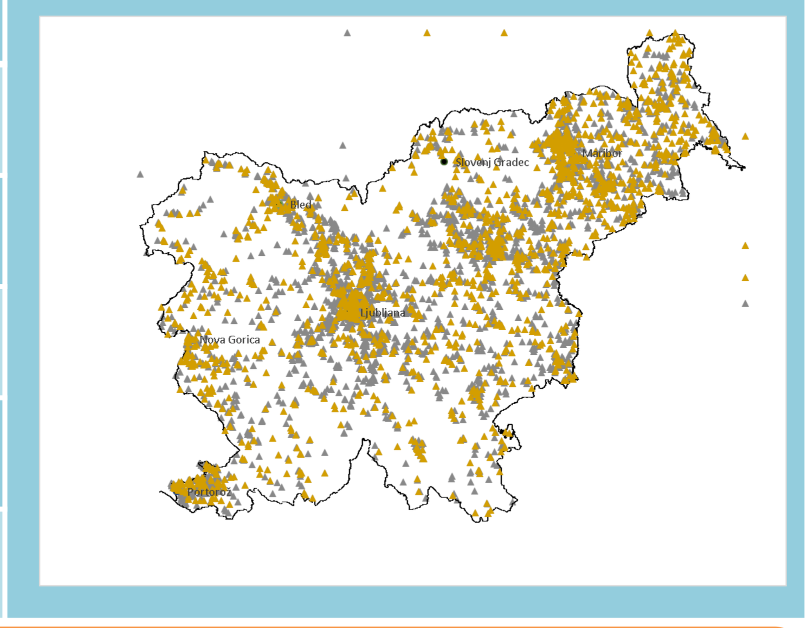
National residential building stock

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

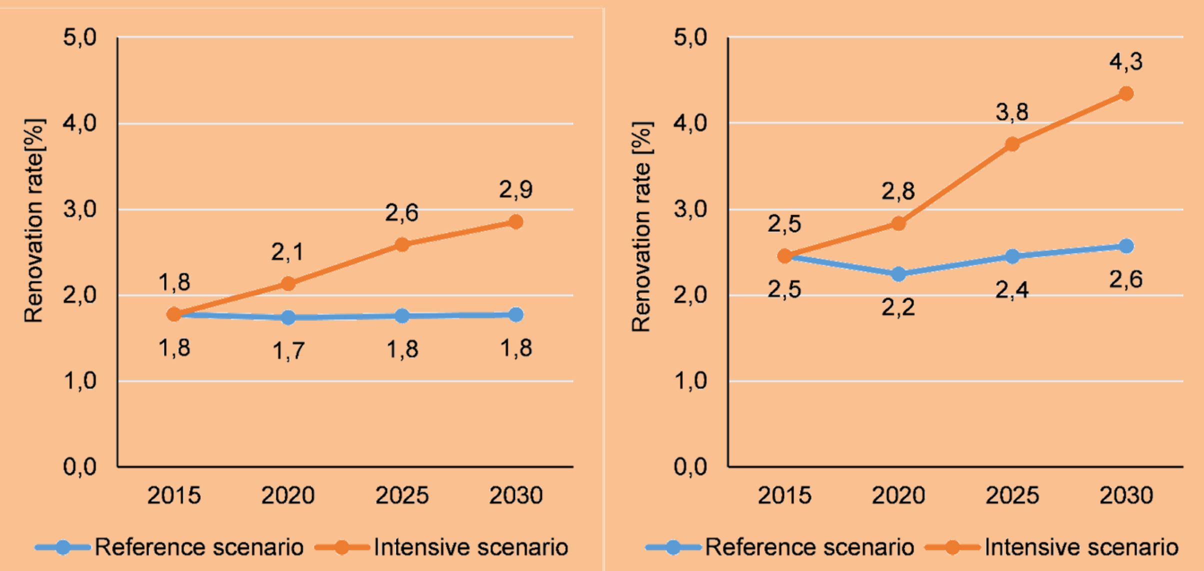
SCOPE

SCALE	National
NUMBER OF DWELLINGS	844.000
NUMBER OF BUILDINGS	523.850
NUMBER OF INHABITANTS	2 million
m^2 NATIONAL REFERENCE AREA	65 million (useful area)
m² EPISCOPE REFERENCE AREA	71 million



OVERVIEW OF ACTIVITIES

The scenario approach uses a calculation model (developed in MO Excel and M Visual basic) with “three layers”. The first layer is a long-term model of the building stock. It quantifies the expected future annual in-use stock of dwellings and reference floor area on the basis of the assumed past and future demand, i.e. the assumed development in persons, persons per dwelling, reference floor area per dwelling, potential for (partial/full/deep) renovation, based on the assumption for renovation and new build rates. It also follows the ageing development of each type/age segment of the stock, with predicted lifetime of a building component and its technologies for heating and DHW, after which the building becomes the potential for renovation. Based on the renovation rates for each age band, buildings per each year, the model identifies the buildings for renovation, respective to their age of construction, based on the time of the last renovation and type. The second layer of the model is an energy and emission layer. The last layer takes into account local or national plans, which can be integrated in a model \ several different ways, e.g. more intensive renovation rates during a specific year due to increased subsidies fund, increased share of grid connections due to network expansion in a city district

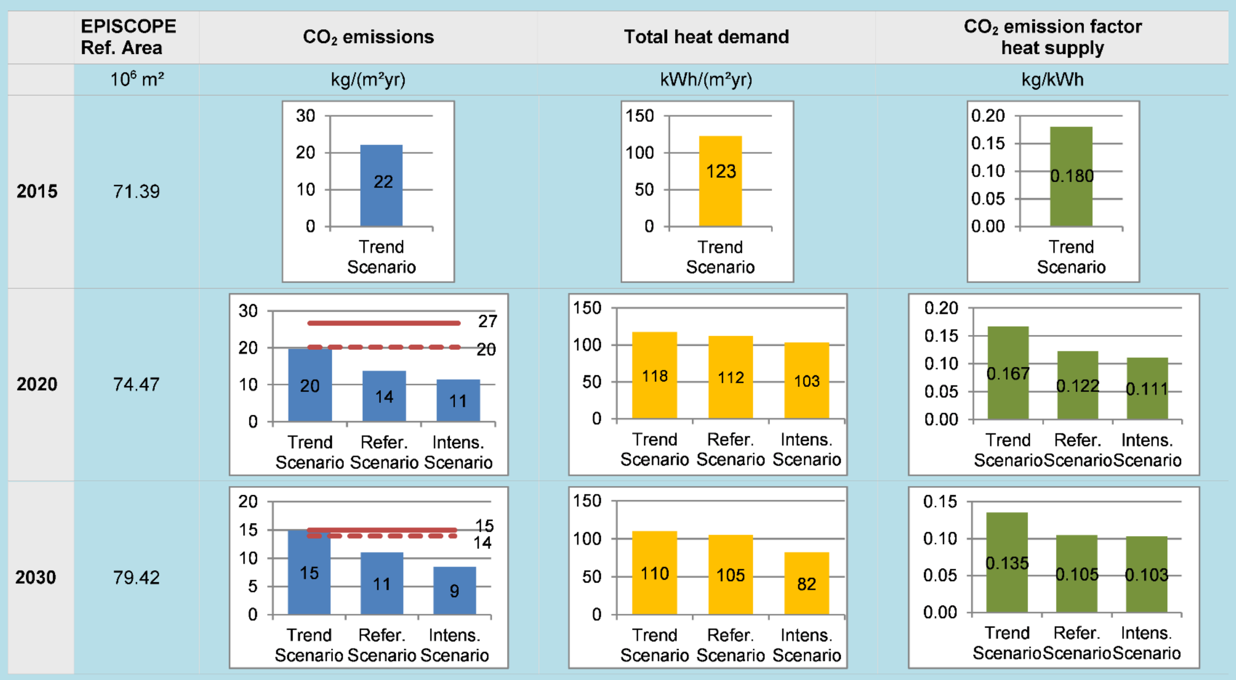


FINDINGS OF SCENARIO ANALYSES

To be able to carry out a comprehensive analysis, all EPCs from the database were studied. In Slovenia, the EPC database collects data on the building stock, refurbishment measures, and the development of energy efficiency in buildings.

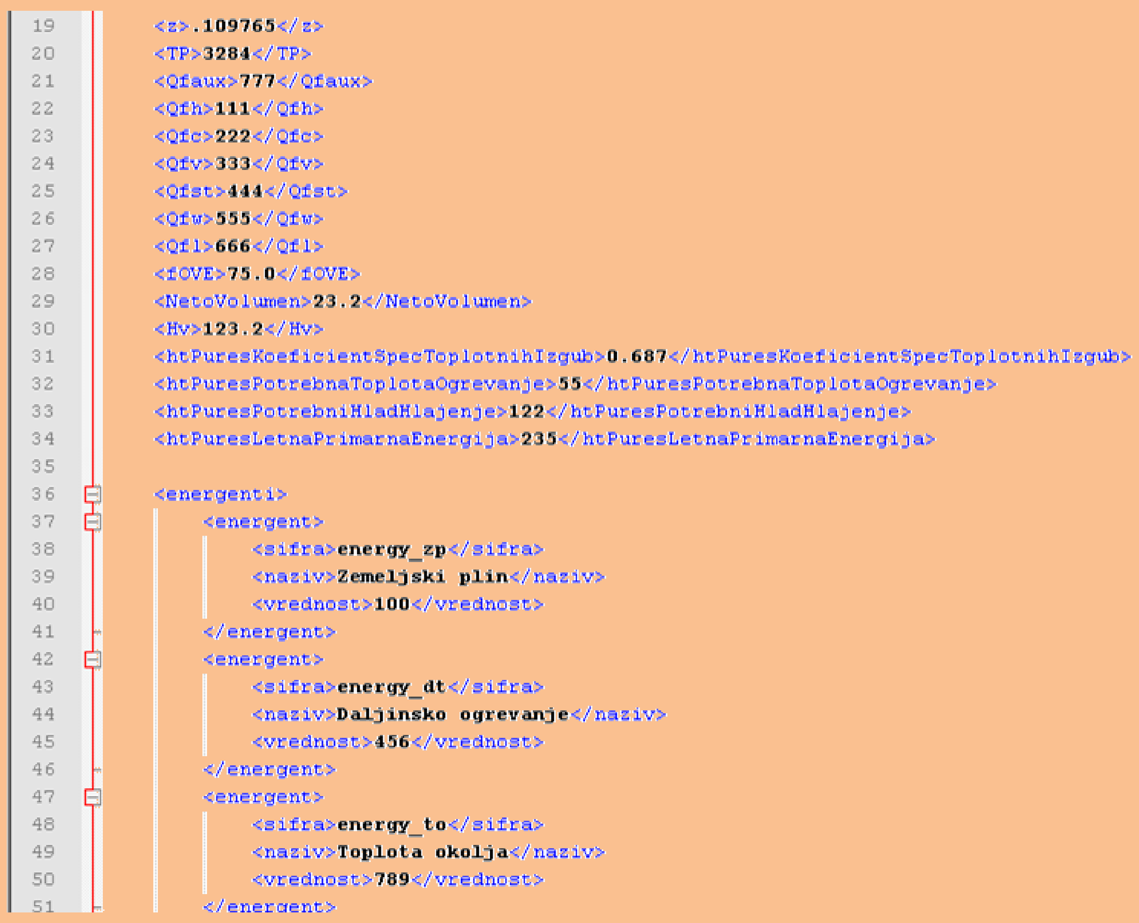
Trend scenarios, reference and intensive scenarios give substantial reductions in total annual heat demand and CO2 emissions compared to 2015. The total average of heat demand decreases from 122.81 kWh/m2/year to a level 103.1 – 117.7 kWh/m2/year in 2020, 82.3 – 110.4 kWh/m2/year in 2030. With the given changes in the energy mix, the overall CO2 emission factor decreases from 0.180 to 0.167 kg CO2/kWh in the trend scenario by 2020, although considerable improvements are recorded in annual CO2 emissions. The latter are reduced from 22.2 kg CO2/m2/year in 2015 to 11.5 – 19.7 kg CO2/m2/year in 2020, 8.5 – 15 kg CO2/m2/year in 2030.

All the observed scenarios show great promise in the fulfilling the contribution to national goals for the reduction of final energy use and GHG emissions. The policy target for the reduction of GHG emissions in buildings by 2030 at least by 70 % compared to 2005 is achieved.



LESSONS LEARNED & RECOMMENDATIONS

Based on EPISCOPE experiences, **ZRMK started building a comprehensive monitoring database on the energy performance of buildings where all the data from the actions associated with the EPBD is collected**. Existing databases (building cadaster, registry of buildings) were linked with new EPBD database that include: data from energy performance certificates, regular inspection of boilers and air conditioning systems, energy management and also with the data from the inspection of central-heating boilers by chimney sweepers and with data on the real-estate market. This is called the *energy registry of buildings* (en-registry, E-REN). The general idea is to collect data about the state of the building each time somebody does regulatory assessment/inspection. This is achieved by electronically collection of the data (XML) and with a specially prepared survey that collects information about the state of the building. During the uploading of new data, an assessor/inspector has the opportunity to check the existing registry data. In the occurrence of data mismatch, e.g. number of storeys, assessor can correct the value. This correction does not erase the old value, but serves as a mark. During data quality check this marks are evaluated, cross data checked and corrected.



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Gradbeni inštitut ZRMK
Building and Civil Engineering Institute

Netherlands

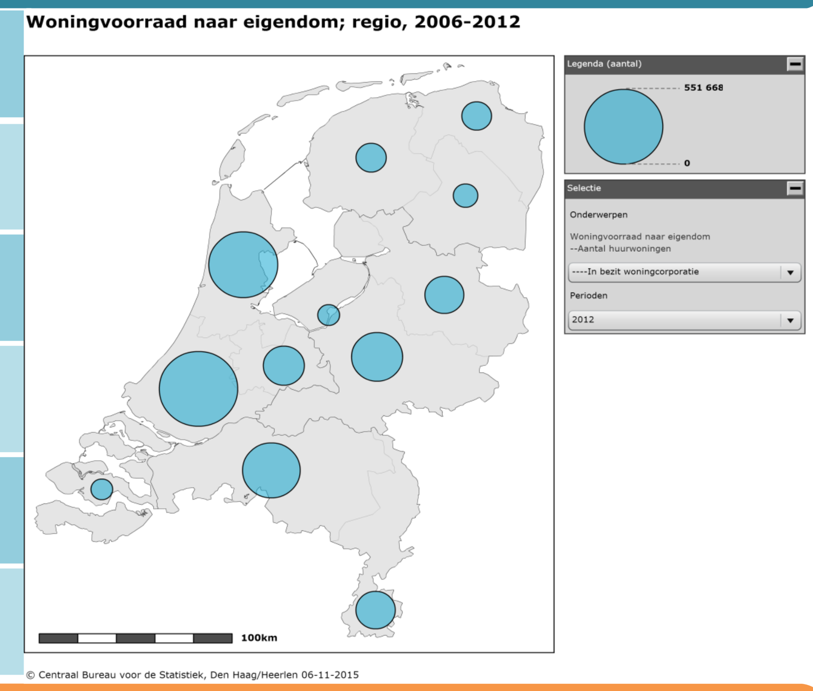
Non-profit rental housing stock

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

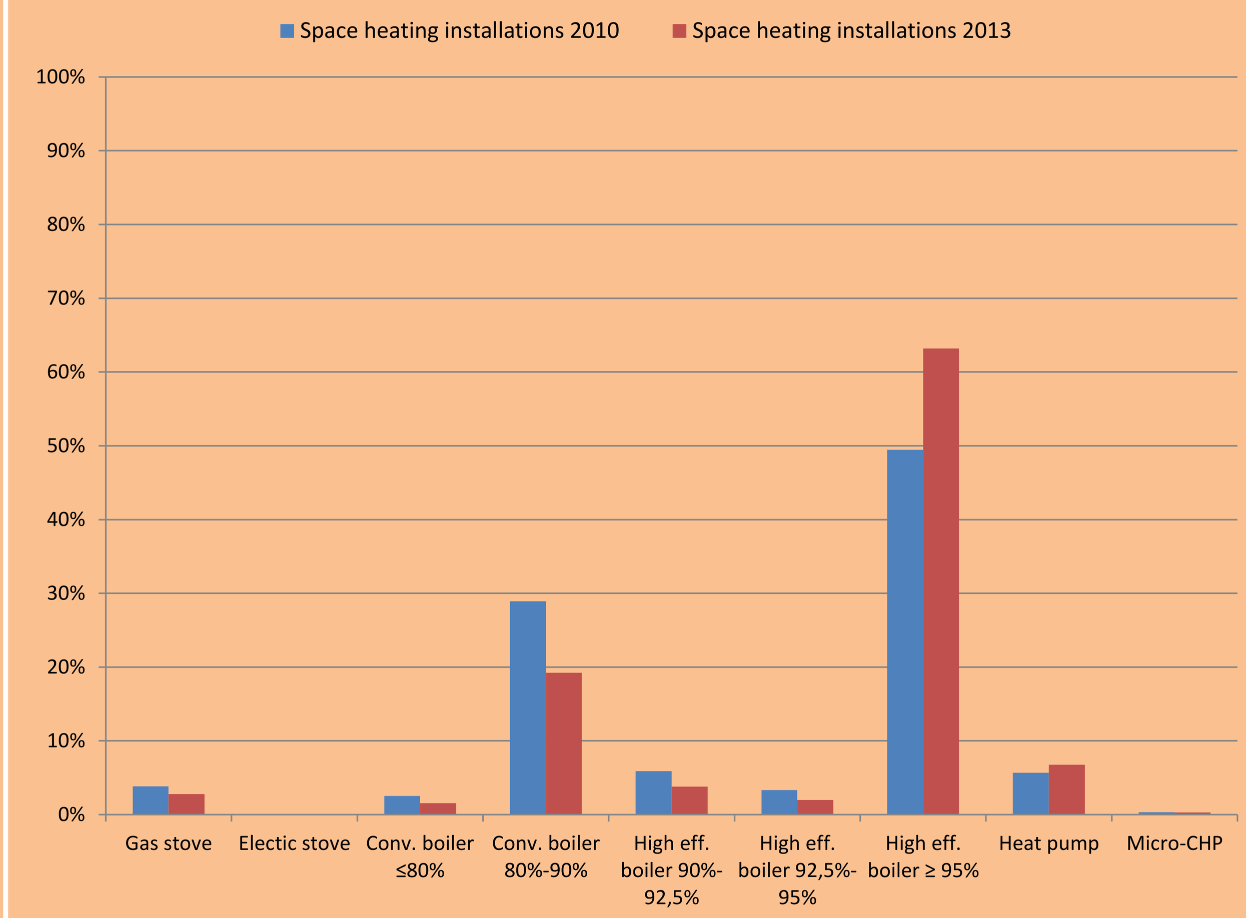
SCOPE

SCALE	Non-profit Rental Housing Stock at a National scale
NUMBER OF DWELLINGS	2 236 587
NUMBER OF BUILDINGS	Not available
NUMBER OF INHABITANTS	4,9 million
m² NATIONAL REFERENCE AREA	190 210 506 [useful floor area]
m² EPISCOPE REFERENCE AREA	210 655 550 [useful floor area]



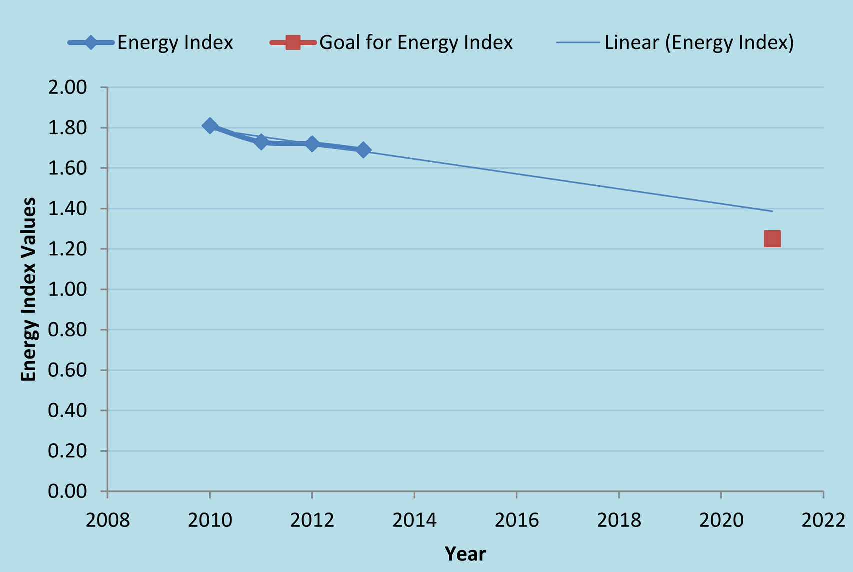
OVERVIEW OF ACTIVITIES

- Monitoring the energy improvements and their pace for consecutive years (2010 – 2014)
- Using the **SHAERE** database:
    - A collective database containing 60% of the dwellings in the sector
    - Data: **insulation** of envelope, energy **installations**, the **energy performance** coefficient, registration of energy label etc.
    - The variables are categorized per property (address based)

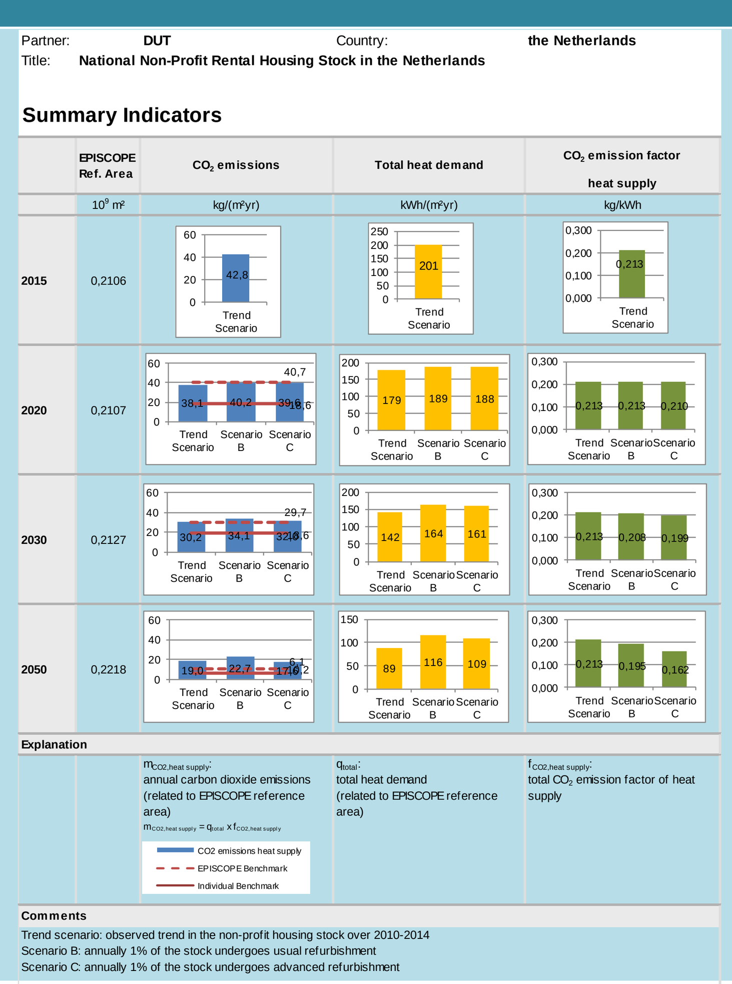


FINDINGS OF SCENARIO ANALYSES

- The **trend scenario** follows the average energy improvement rate of the Dutch non-profit housing stock over the years 2010-2014.
- **Scenarios B and C** are based on the development of the size of the sector and a usual refurbishment or an advanced refurbishment, as defined in the TABULA data base.



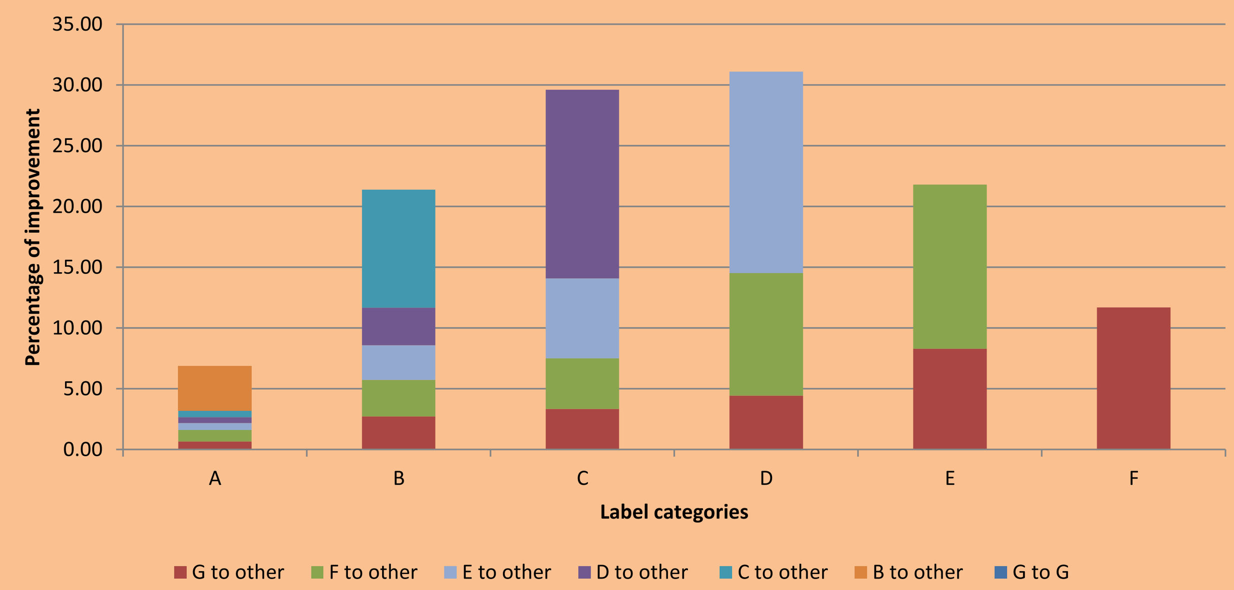
The results show that with either scenario the renovation pace and progress are too slow to achieve the goals for the reduction of the energy consumption.



LESSONS LEARNED & RECOMMENDATIONS

- There is a bias towards conventional solutions / measures applied
- Small changes of the energy efficiency of the dwellings whereas the major or deep renovations hardly took place (nZEB level)
    - Dwellings with major improvements are 3% of the dwellings

Do we need more **"conventional"** renovations applied to larger parts of the building stock or **"deeper"** renovations reaching high performance to a smaller part of the housing stock?



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TU Delft Delft University of Technology

Norway

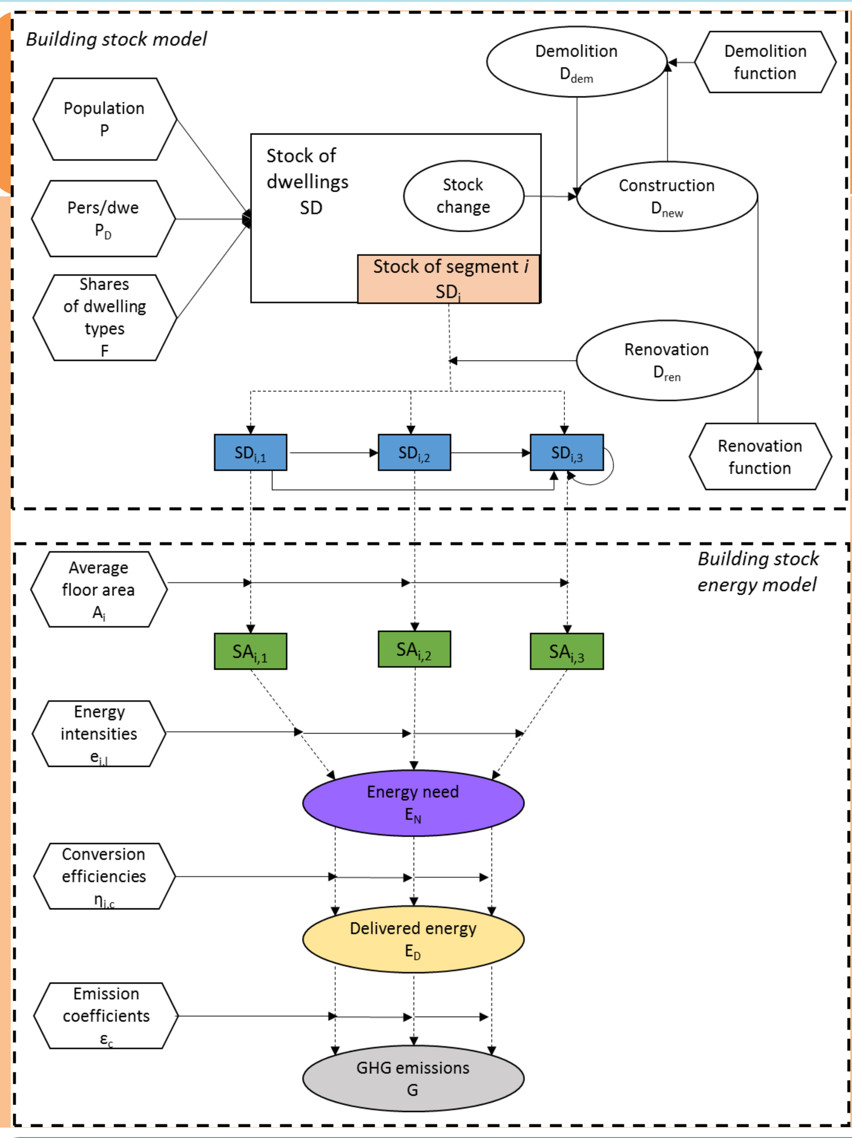
National dwelling stock

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

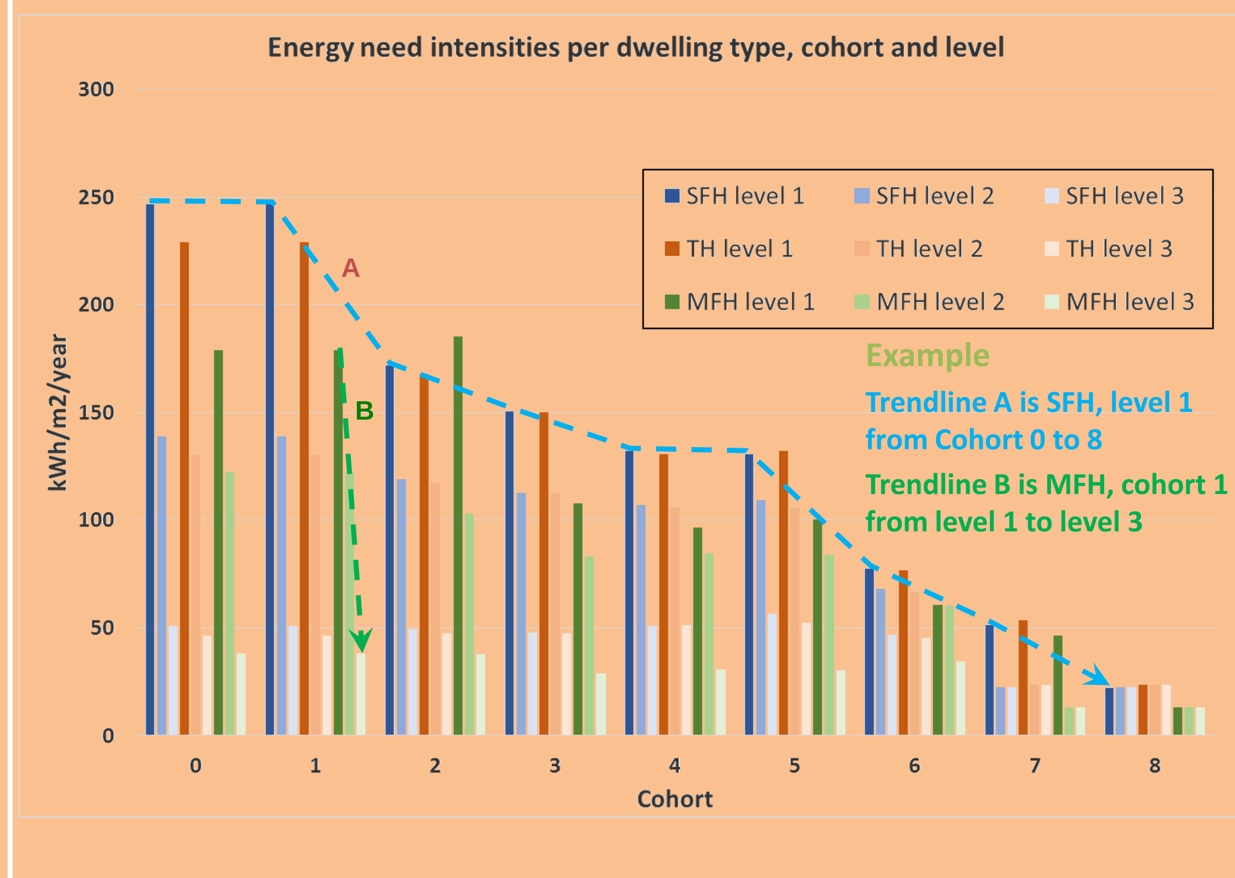
SCOPE

SCALE	National (2013)
NUMBER OF DWELLINGS	2.47 million
NUMBER OF BUILDINGS	1.51 million
NUMBER OF INHABITANTS	5.11 million
m² NATIONAL REFERENCE AREA	313 million m² [gross floor area]
m² EPISCOPE REFERENCE AREA	266 million m²

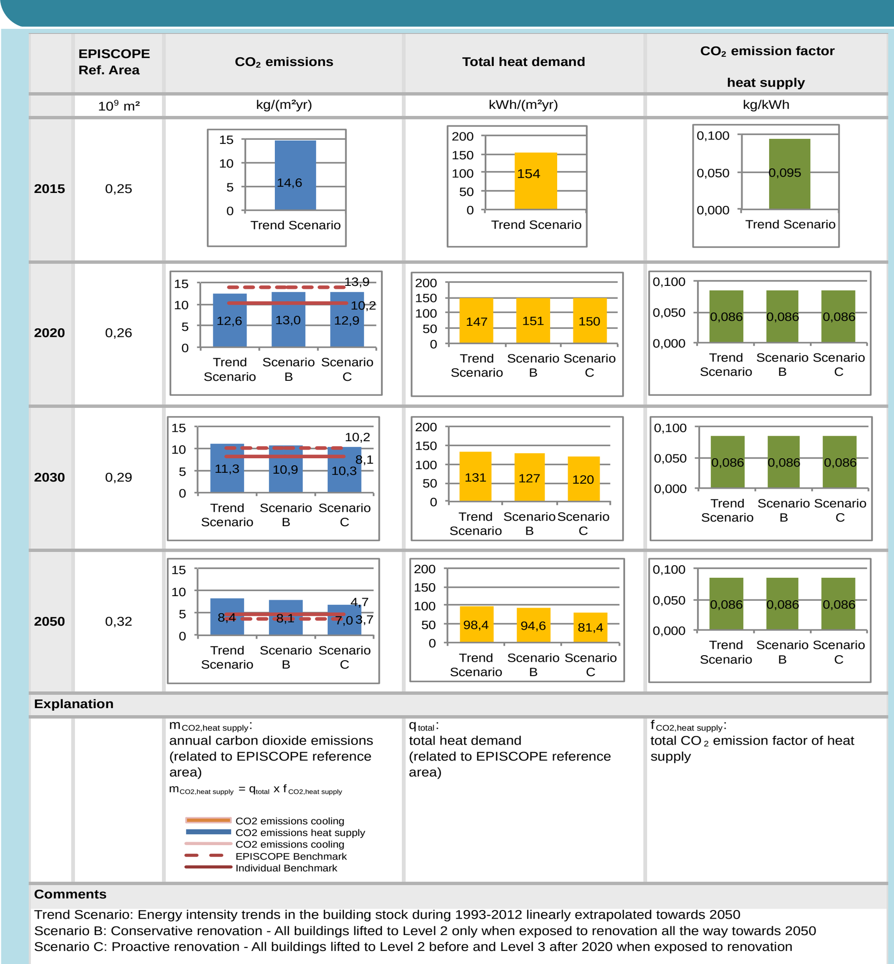


OVERVIEW OF ACTIVITIES

- Dynamic segmented dwelling stock model used to model the development in the dwelling stock size and composition
- Renovation activity estimated as the need for maintenance of an ageing stock. Renovation cycle of 40 years
- Renovation rate is a model output
- New built after 2020 by Passive house standard
- Assuming moderate future change in energy mix
- Scenario 1 - «Conservative»: Existing buildings renovated to Level 2 towards 2050
- Scenario 2 - «Proactive»: Existing buildings renovated to Level 3 from 2020 to 2050

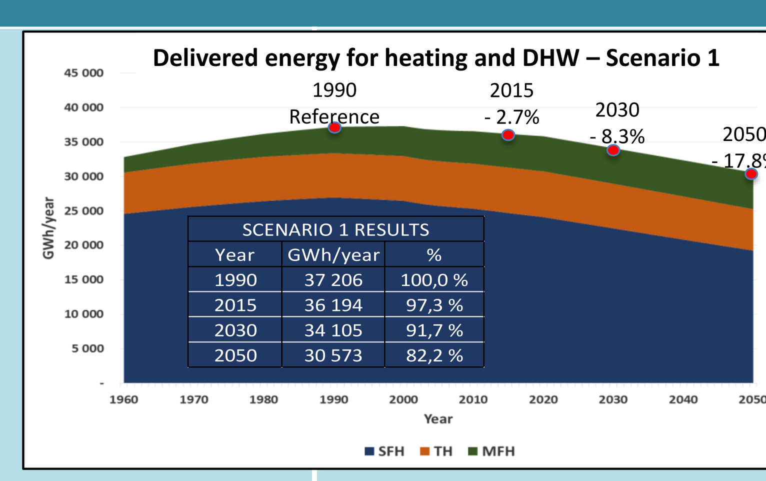


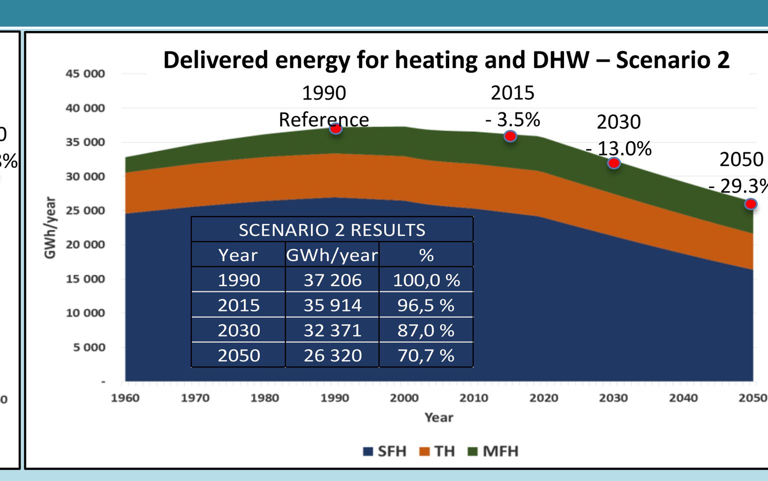
SCENARIO RESULTS

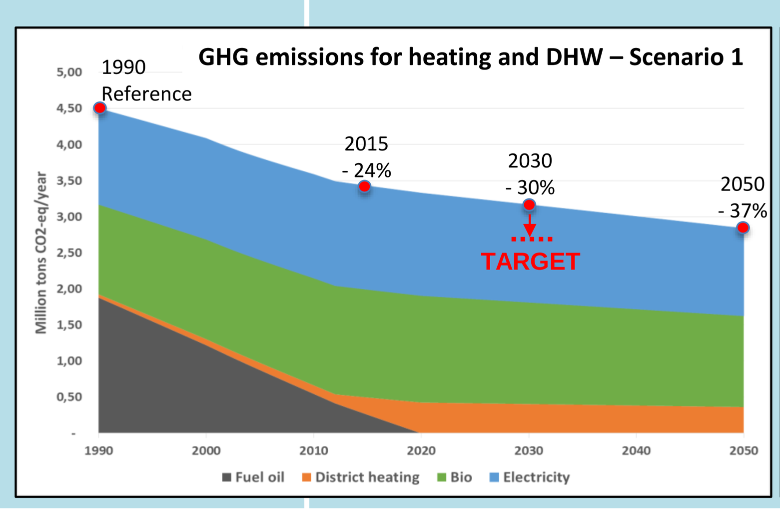


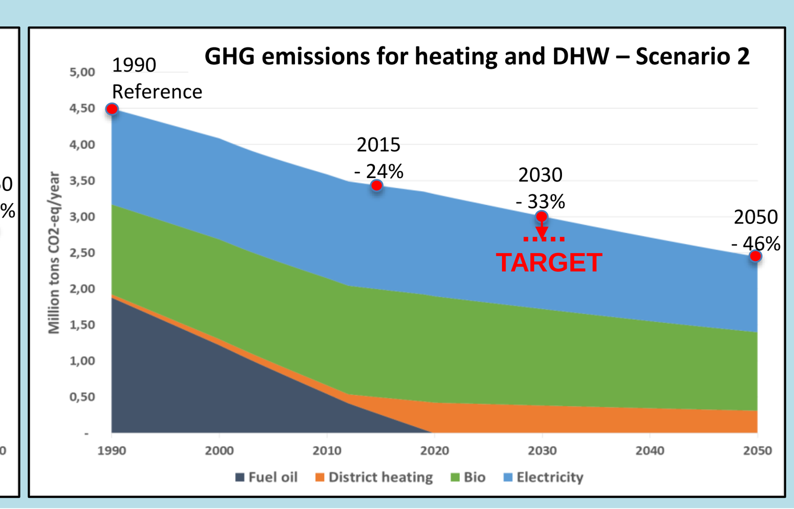
- Annual model results 1960-2050 (Reference: 1990)
- The two scenarios show somewhat different results for delivered energy in 2015, 2030 and 2050
- However, even in the proactive scenario (S2) delivered energy is reduced by only some 13 % (2030) and 30% (2050) compared to 1990

- GHG emission reduction potential:
  - National target is 40% reduction by 2030 for all sectors combined
  - Energy saving potential in Scenario 1 and Scenario 2 is significantly below 40%
  - Important future role of onsite energy generation (heat pumps + solar)









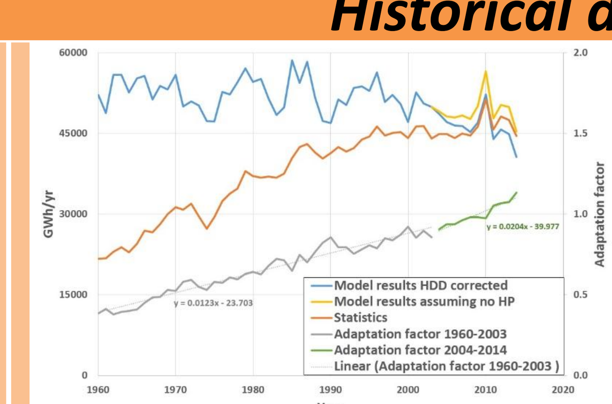
LESSONS LEARNED & RECOMMENDATIONS

- There is a strong need for dynamic bottom-up detailed dwelling stock models to be used in energy analyses
- The «natural» renovation rate resulting from the need for maintenance of the ageing stock is expected to be rather stable at levels of 1.2-1.3 % towards 2050
- There is already a large share of clean electricity in the energy mix of Norwegian dwellings. This makes further decarbonization of the energy mix difficult

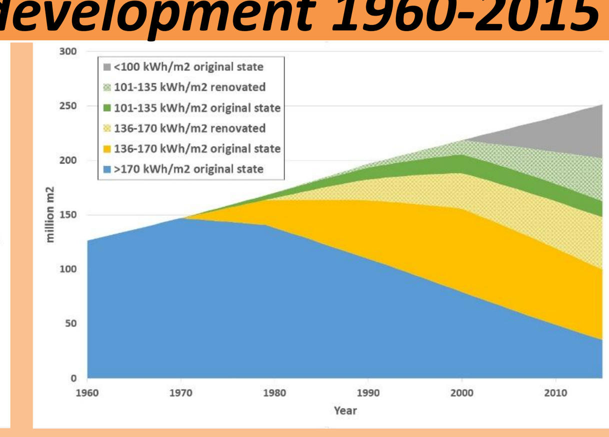
Development 1960-2015:

- More energy-efficient dwellings through renovation and new construction
- Large savings due to use of more efficient energy carriers and heating systems
- Changes in user heating culture have cancelled out the energy savings in the system
- 1960-2003: Stable delivered energy intensity per m², increasing per person
- 2004-2015: Decreasing delivered energy intensities per m² and per person after introduction of HP

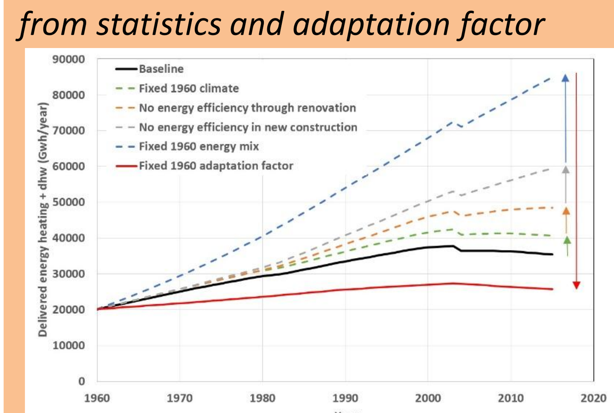
Historical development 1960-2015



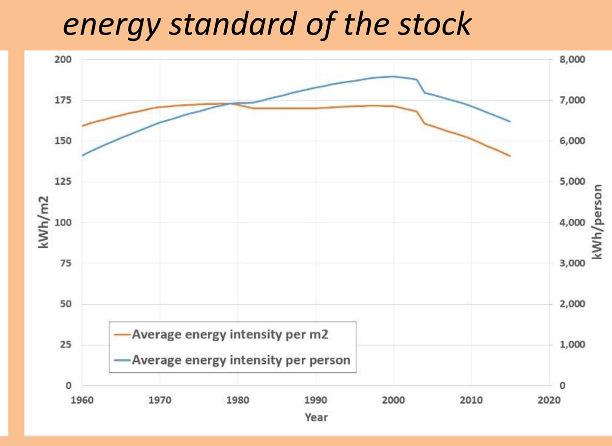
Simulated energy demand, energy demand from statistics and adaptation factor



Heated floor area and development in energy standard of the stock



Importance of changes in outdoor climate, energy efficiency, energy mix and user behavior



Development in delivered energy per m² and per person

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EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

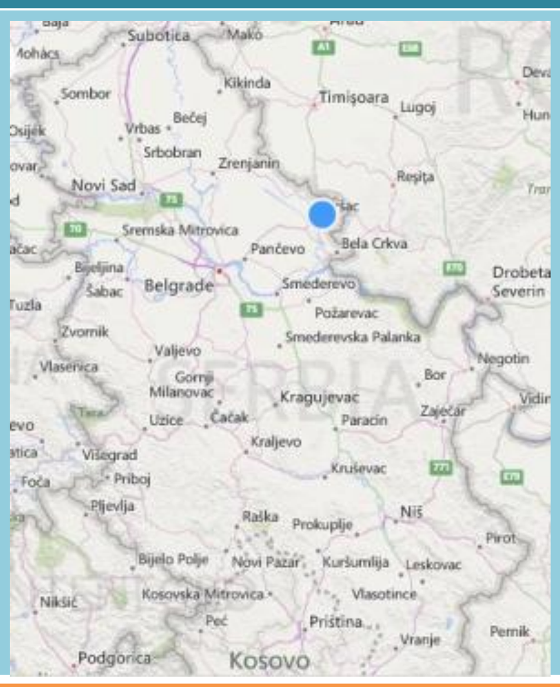
[Serbia]

[Building stock in municipality of Vršac]

STATUS: 10/2015

SCOPE

SCALE	Local – municipality of Vršac, located in the Vojvodina region, Banat district
NUMBER OF DWELLINGS	16835
NUMBER OF BUILDINGS	14000
NUMBER OF INHABITANTS	52026
m² NATIONAL REFERENCE AREA	1 489 278 (net living area)
m² EPISCOPE REFERENCE AREA	1 638 206



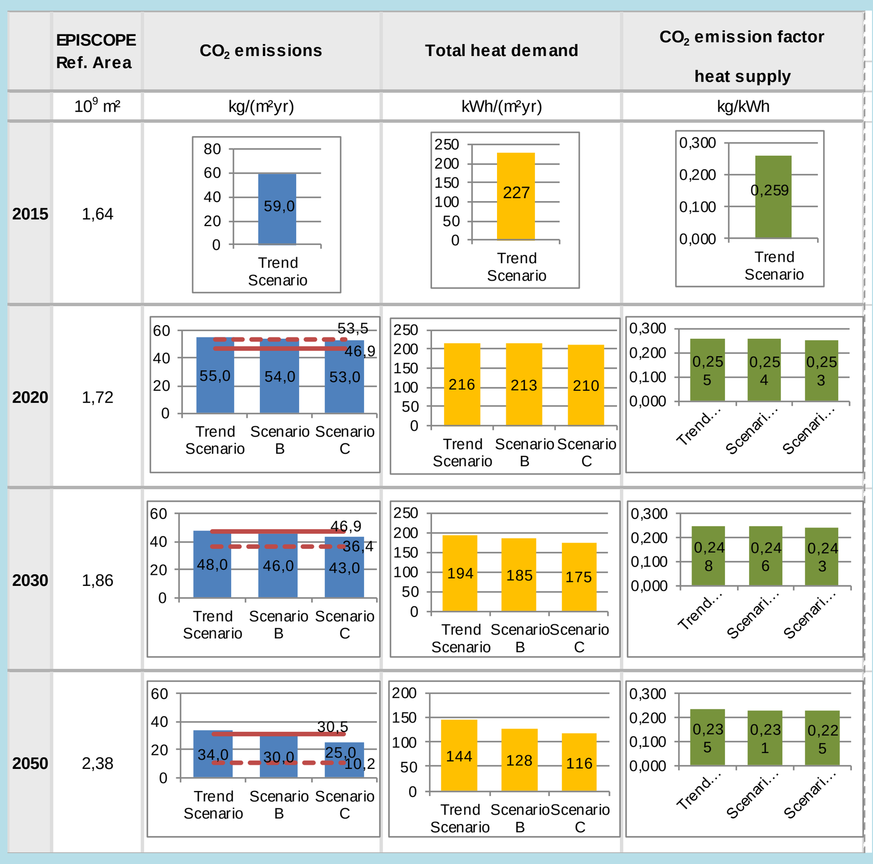
OVERVIEW OF ACTIVITIES

One of the main goals of pilot project was development of adequate methodology for data acquisition and local matrix formulation. Methodologically, two different approaches have been developed in order to derive a local typological matrix: top-down and bottom up.

In the **top-down method**, data from the national typology is being used and expert projections are done for the local level. Applicability of the typology is directly influenced by the extent of the existing databases and other data sources available locally: cadaster, district heating companies, energy utility companies etc. as well as the expertise of the team conducting the work. The **bottom-up method**, an *in the field approach* where new methodology has been developed enabling adequate data acquisition serving as a reliable base for future work. This approach enables different size municipalities to define, execute and evaluate locally programmed censuses covering for the diversity and individuality of their building fund. Bottom-up combines statistically relevant and, at the same time, urbanistically and architecturally representative approaches, in the formulation of census which has to be executed in the field. The image shows zoning map based on building characteristics used for data acquisition in bottom-up method.

FINDINGS OF SCENARIO ANALYSES

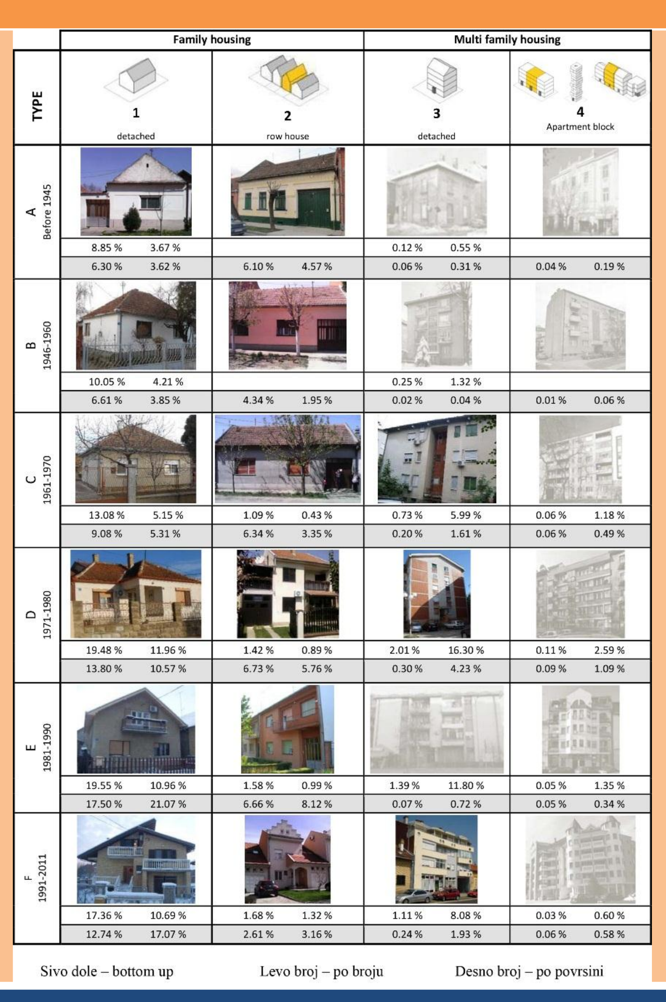
In defining different scenarios, a key role was played by the data related to refurbishment rates and by the structure of energy carriers obtained from field research, defining the base case local building stock model. Following the current trend with an annual demolition rate which is almost negligible (0,1%), modelling of the building stock was executed based on three major segments: new stock, refurbished stock and unrefurbished stock. The refurbishment rate for each building type was determined, by combining identified refurbishment actions, reducing the initial projections of the energy performance by 10%. Energy demand for heating for each defined scenario is determined counting the influence of improvement measures in the refurbished stock and the expected improved benchmarks for thermal envelope in new buildings. Projections for CO_2 emissions and emission factor of heat supply relies on relevant data on the structure of energy carriers and heating systems efficiency, and further estimations of their improvements and replacements. These estimations were done rather optimistically, with transit to biomass, except the part already using gas, which is dominant in this municipality, especially in multifamily buildings. The image shows that the individual benchmarks are achievable only by implementing scenarioa B and C in 2030, and scenario C in 2050, while, EPISCOPE benchmark values have been proven unachievable for 2030 and 2050, and potentially achievable for 2020



LESSONS LEARNED & RECOMMENDATIONS

By comparing the gained results we proved the assumed uncertainty of the top-down method for locally representative types. Some of the building types were not part of the top-down matrix but after a field bottom-up survey they proved to be of high significance accounting for more than 10% of the total building fund. This phenomena appears as the consequence of the uneven distribution of the initial sample used for the national typology definition and top-down method. On the other hand, for the types that are most common both methodological approaches are giving similar results. The image presents the final typology matrix derived from bottom-up methodology.

The pilot project for the municipality of Vršac has enabled us to develop a specific methodology that proves to be a solid base for an energy related planning in the residential sector at local level. Deriving of typical buildings and definition of improvement levels proves to be a good method for improving the building fund. On the other hand, specific conditions valid for one municipality influence the results, thus limiting its universality, especially when estimating the heating systems and energy carriers used. Overall CO2 emission indicators are dominantly influenced by the energy carrier, and any projections are quite uncertain both in terms of improvement of the systems and of fuels selection.



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EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

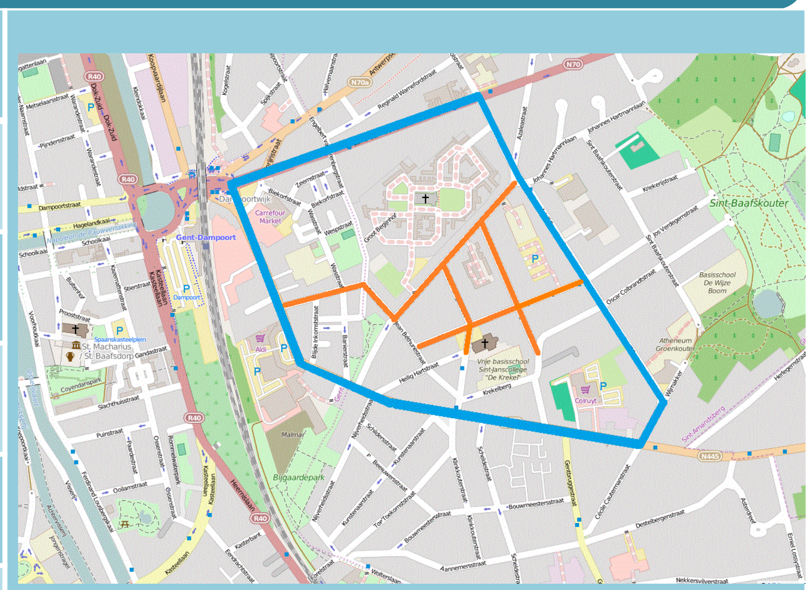
Belgium

Housing blocks in the Sint-Amandsberg district of the city of Ghent

STATUS: 10/2015

SCOPE

SCALE	local
NUMBER OF DWELLINGS	200
NUMBER OF BUILDINGS	200
NUMBER OF INHABITANTS	500
m² NATIONAL REFERENCE AREA	38,40 · 10³, gross floor area
m² EPISCOPE REFERENCE AREA	32,64 · 10³



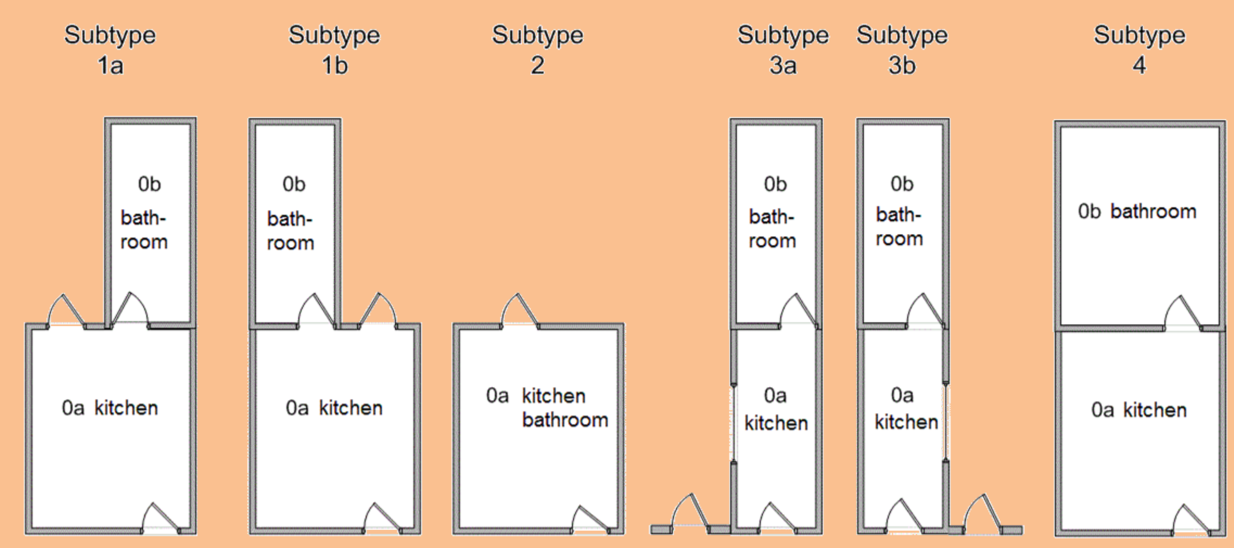
[© OpenStreetMap contributors]

OVERVIEW OF ACTIVITIES

For the selected dwellings a theoretical energy use was calculated with a model based on the Flemish EPB calculation methodology. However, where EPB only is a single zone model, the model used is a multi-zone model, taking into account different uses and physical characteristics of different zones. Also the user behaviour is taken into account by looking at the users' presence in the building, their temperature preferences and ventilation habits. This bottom-up approach of the energy use for space heating was compared to the actual energy consumption.

Renovation strategies for the dwellings, including nZEB, were examined, taking into account primary energy, CO_2-emissions and energy costs for space heating.

The analysis leading to renovation strategies will help the city of Ghent reach the goals of its Sustainable Energy Action Plan. **Ghent wishes to continue to play a pioneering role on environmental issues, and aspires to become a climate neutral city by 2050.**



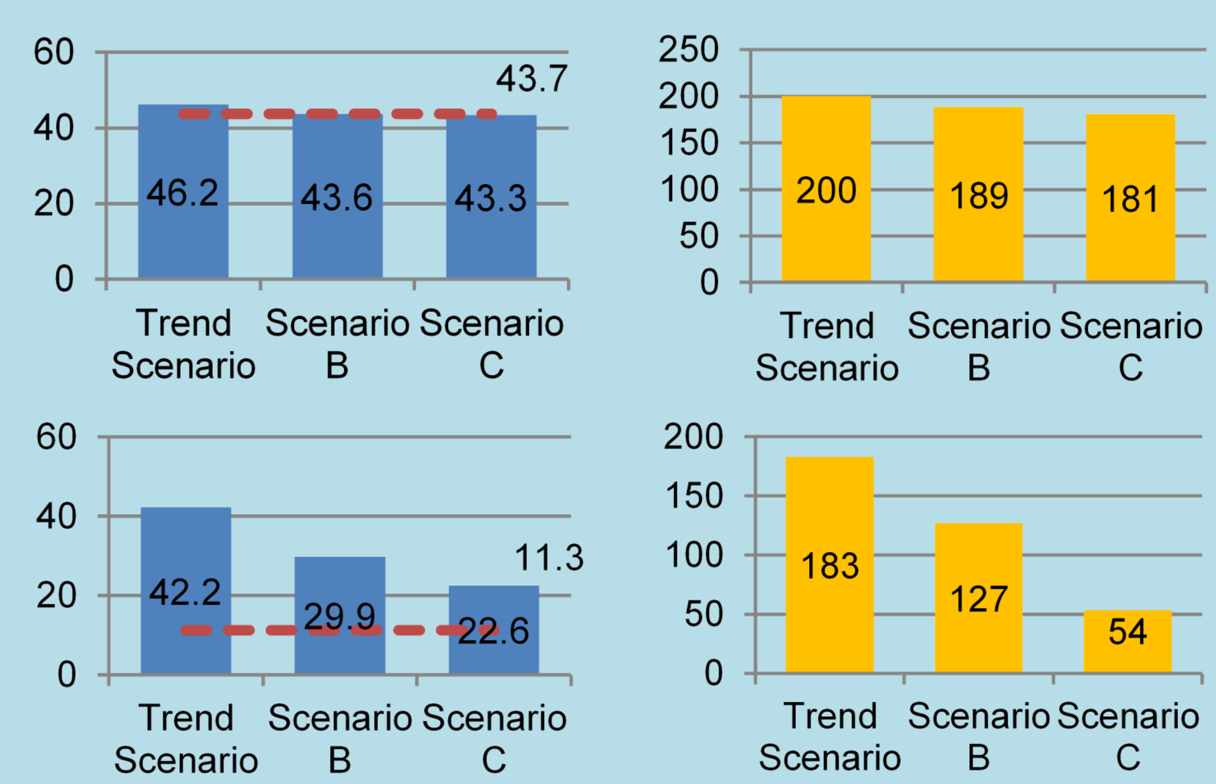
FINDINGS OF SCENARIO ANALYSES

The investigated renovation strategies for dwellings consist of a more economic user profile, 'no regret' renovation measures or nZEB renovation. "No regret" renovation measures include replacement of single glazing, placing roof insulation and installing a condensing boiler. Nearly Zero Energy renovations include a thorough insulation of roofs, walls and partition walls, a heat pump, a mechanical ventilation system with heat recovery and optimized user behaviour. Calculations show an average saving potential of 26% for the 'no regret' scenario and 74% for the nZEB scenario.

For the trend scenario, it was assumed that only 'no regret' renovations were done and the renovation rate stayed at its current rate of 0,7%. Scenario B takes into account a renovation rate of 3,8% with 80% 'no regret' renovations and 20% nZEB renovations. Scenario C has a renovation rate of 2,3%, which is slower than B, but still 3 times higher than the current rate, but only takes into account nZEB renovations.

Results show the need to encourage in-depth renovations, even though homeowners might be easier to convince to undertake a 'no regret' renovation. Lock-in effects should be avoided.

CO_2 emissions and Total Heat Demand 2020 - 2050



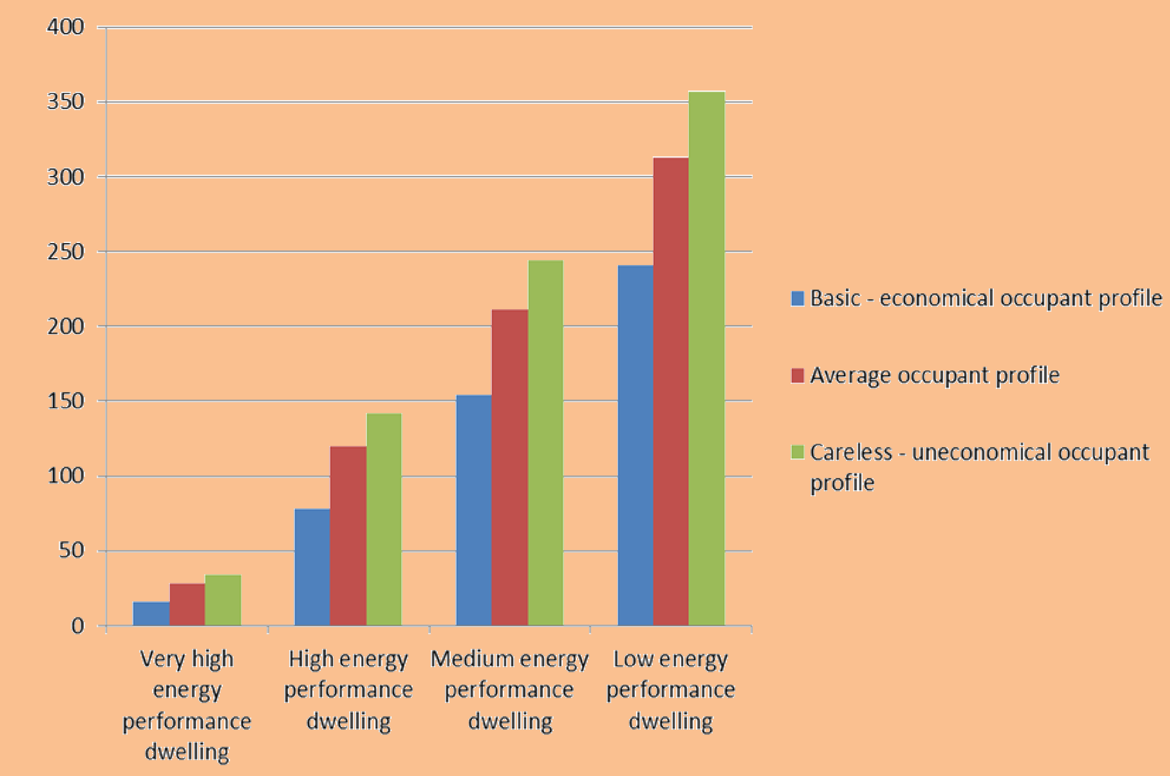
LESSONS LEARNED & RECOMMENDATIONS

Besides the physical renovation works, also behavioural change can contribute to energy savings in the built environment.

User behaviour includes aspects that can be optimized like set point temperatures for heating and cooling, setback temperatures and the frequency of opening windows and doors, but also include aspects like the family composition and the presence of dwelling occupants.

A theoretical exercise was made, investigating the influence of different user profiles in houses with different energy standards. **Results show that even in dwellings with very high energy performance, user behaviour can influence the final energy consumption to a large extent.**

Raising awareness thus remains important.



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vito

England

Monitoring of the National Residential Building Stock

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

SCALE	National
NUMBER OF DWELLINGS	~22.7 million
NUMBER OF BUILDINGS	~21 million
NUMBER OF INHABITANTS	~54 million
m^2 NATIONAL REFERENCE AREA	2.1×10^9 m^2 (Living area)
m^2 EPISCOPE REFERENCE AREA	2.1×10^9 m^2

Examples of the English Housing Stock (from top left clockwise): 1. Pre 1850 thatched cottage; 2. 1919-1944 3 bed semi-detached; 3. 1965-1980 social housing low rise flats; 4. Modern housing development of mixed terrace housing.

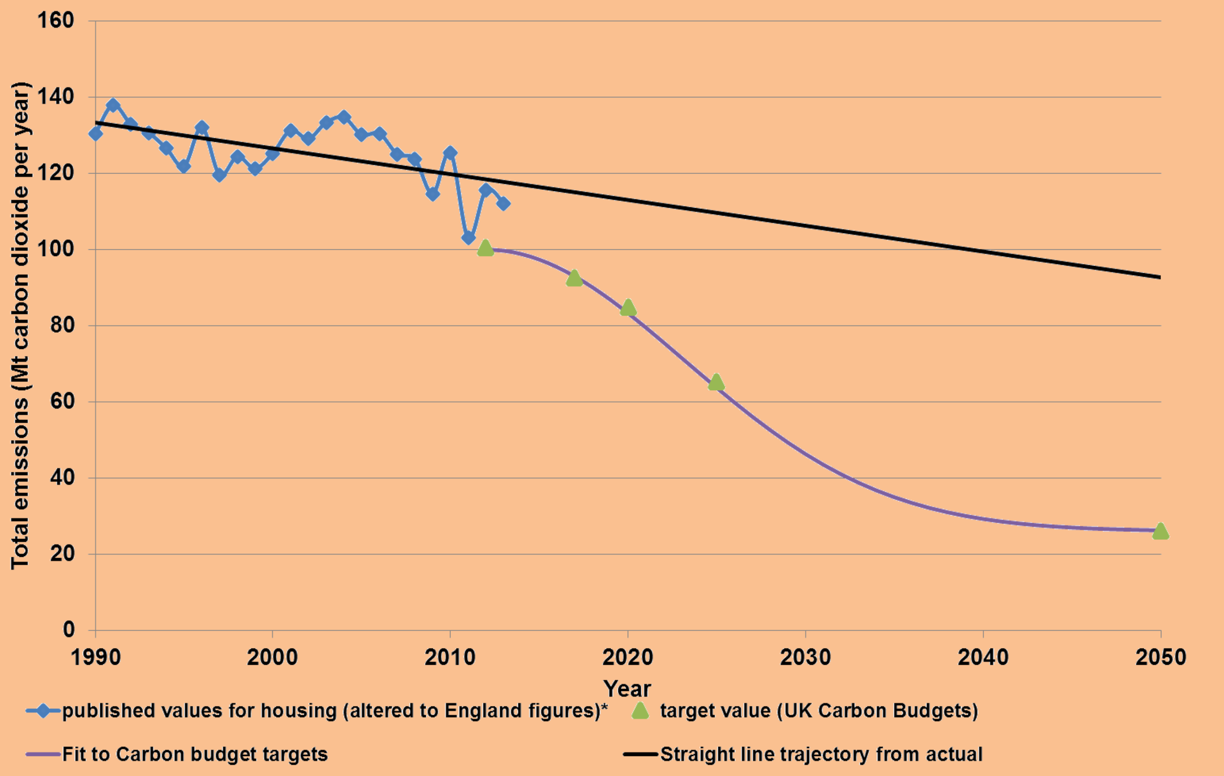
OVERVIEW OF ACTIVITIES

England's housing stock is among the oldest in Europe, with more than one third built before 1945. UK Government targets to reduce national greenhouse gas emissions (from all uses) by **80% by 2050** when compared to the position in 1990. Progress towards this target has already been made in the housing stock through improvements in energy efficiency. Significant further improvements, however, are required in the housing stock to meet the 2050 targets.

In this project, **English Housing Survey** data from 2012 is used to calculate the potential for the installation of a number of energy efficiency improvements, and these improvements are applied in four scenarios representing 2050.

These scenarios use the BRE Domestic Energy Model (**BREDEM**) and its derivative the UK Standard Assessment Procedure (**SAP**). Factors such as population and emission factor changes have been taken into account. A **modelled–to-real ratio** has been calculated and applied to the scenarios to adjust national emissions to be closer to the actual emissions.

Estimates of carbon dioxide emissions from 1990, and carbon budget targets to 2050 for residential combustion



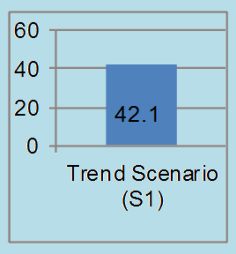
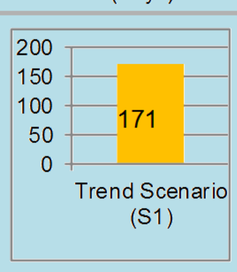
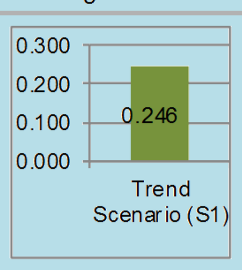
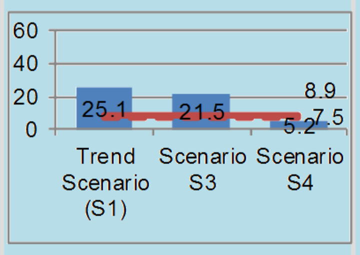
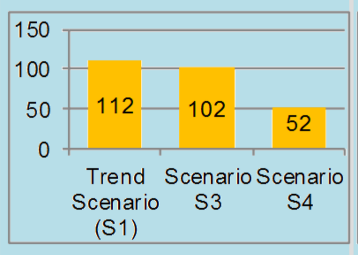
FINDINGS OF SCENARIO ANALYSES

Base modelling of the 2012 EHS data gave **total CO_2 emissions to be 124Mt/year**, this equates to approximately 5,700 kg of CO_2 per household per year in England in 2012.

Applying a modest improvement package (S1) lowered the CO_2 emissions by 34% from 1990 levels. Two moderately ambitious scenarios both gave savings of approximately 50% from the baseline CO_2 1990 figure. These scenarios still rely mainly on the existing main gas network for heating, and include moderate levels of fabric efficiency improvements.

The targets for 2050 are only met by the most ambitious scenario (S4) which saves 88% from 1990 CO_2 levels. This scenario involves high levels of insulation in all properties, and a market shift in heating to **electric heat pumps**, and an associated **decarbonisation of electricity** energy production.

Summary Indicators

	EPISCOPE Ref. Area	CO_2 emissions	Total heat demand	CO_2 emission factor heat supply
	10^9 m²	kg/(m²yr)	kWh/(m²yr)	kg/kWh
2012	2.10			
2050	2.94			

LESSONS LEARNED & RECOMMENDATIONS

The targets to 2050 will only be met by a **step-change** in the current trends relating to insulation and heating in England.

Reaching a near 100% saturation level of a number of some insulation measures (e.g. loft insulation and double glazing) may be conceivable following current trends. Others such as solid wall insulation currently have **significant barriers** to market penetration. **Market changes will be required** in the general heat supply structure. A move to electric heating and lower carbon electricity generation on a national scale will be needed.

Incentives are likely to be needed to implement the required number of installations of insulation, PV, solar water heating, heat pumps and similar technology required if the 2050 targets are to be met. These changes in installation rates are unlikely to happen quickly enough on their own. **Barriers** to implementation of these technologies include inconvenience, aesthetics and cost to the homeowner.

Ongoing **monitoring and analysis** will be needed to assess progress towards the required reductions in CO_2. This is imperative to help **target and analyse** the effectiveness of current strategies, and to **inform** what further needs to be implemented to reach the 2050 targets.

Rates of improvement required to meet scenario results by improvement type

Improvement	Description	2050 (linear rate per year 2012-2050)	% of all stock per year	Achieveable at current rates?
Loft insulation	Standard: under 150mm	127,810	0.58%	Yes
	Standard: over 150mm	213,055	0.97%	Yes
	Hard to treat: under 150mm	21,835	0.10%	Yes
	Hard to treat: over 150mm	92,565	0.42%	Yes
Cavity wall insulation	Standard	111,382	0.51%	Yes
	Hard to treat	29,505	0.13%	Yes
Solid wall insulation	Standard	25,819	0.12%	Yes
	Hard to treat	135,181	0.62%	No
Double glazing	Over 50%	65,512	0.30%	Yes
	Under 50%	59,086	0.27%	Yes
Solar water heating		376,478	1.72%	No
Photovoltaics		378,418	1.73%	No
Mains gas boiler	Standard scenario	251,562	1.15%	Yes
	Alternative scenario	58,882	0.27%	Yes
Heat pump	Standard scenario	67,350	0.31%	No
	Alternative scenario	454,583	2.07%	No

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Ireland

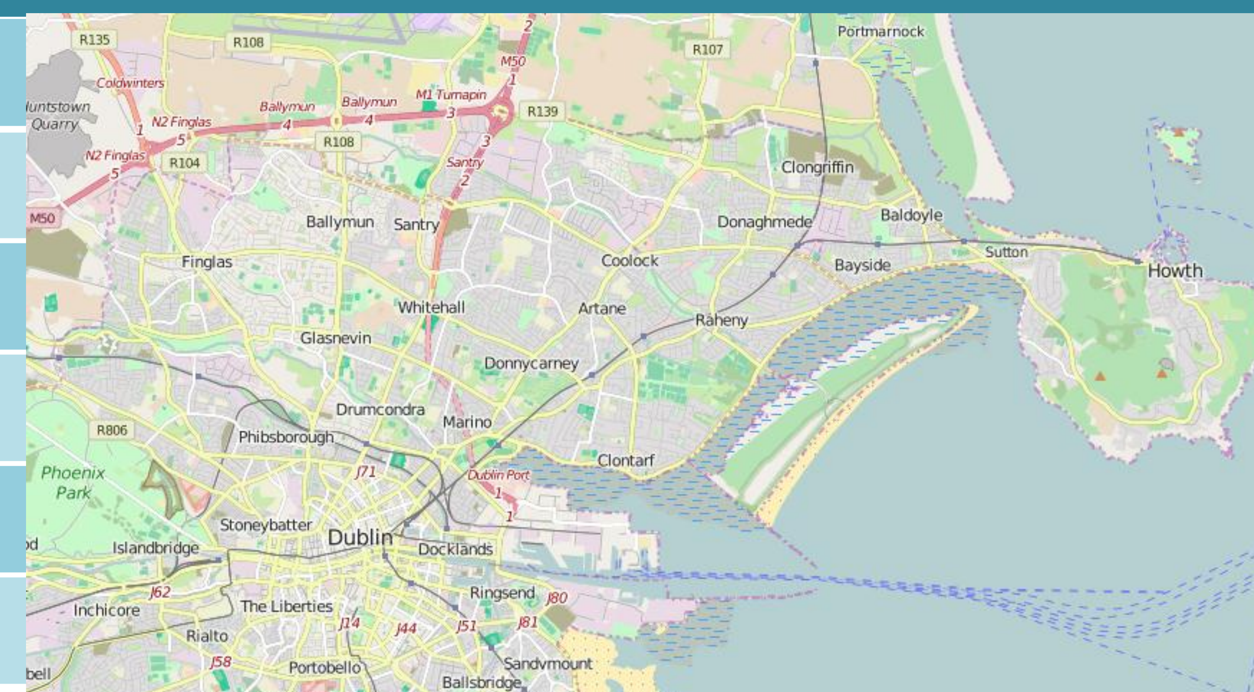
building stock – Northside of Dublin City

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 11/2015

SCOPE

SCALE	Local
NUMBER OF DWELLINGS	133,431
NUMBER OF BUILDINGS	93,058
NUMBER OF INHABITANTS	307,000
m² NATIONAL REFERENCE AREA	11,142,100, (internal floor area.)
m² EPISCOPE REFERENCE AREA	11,429,519



OVERVIEW OF ACTIVITIES

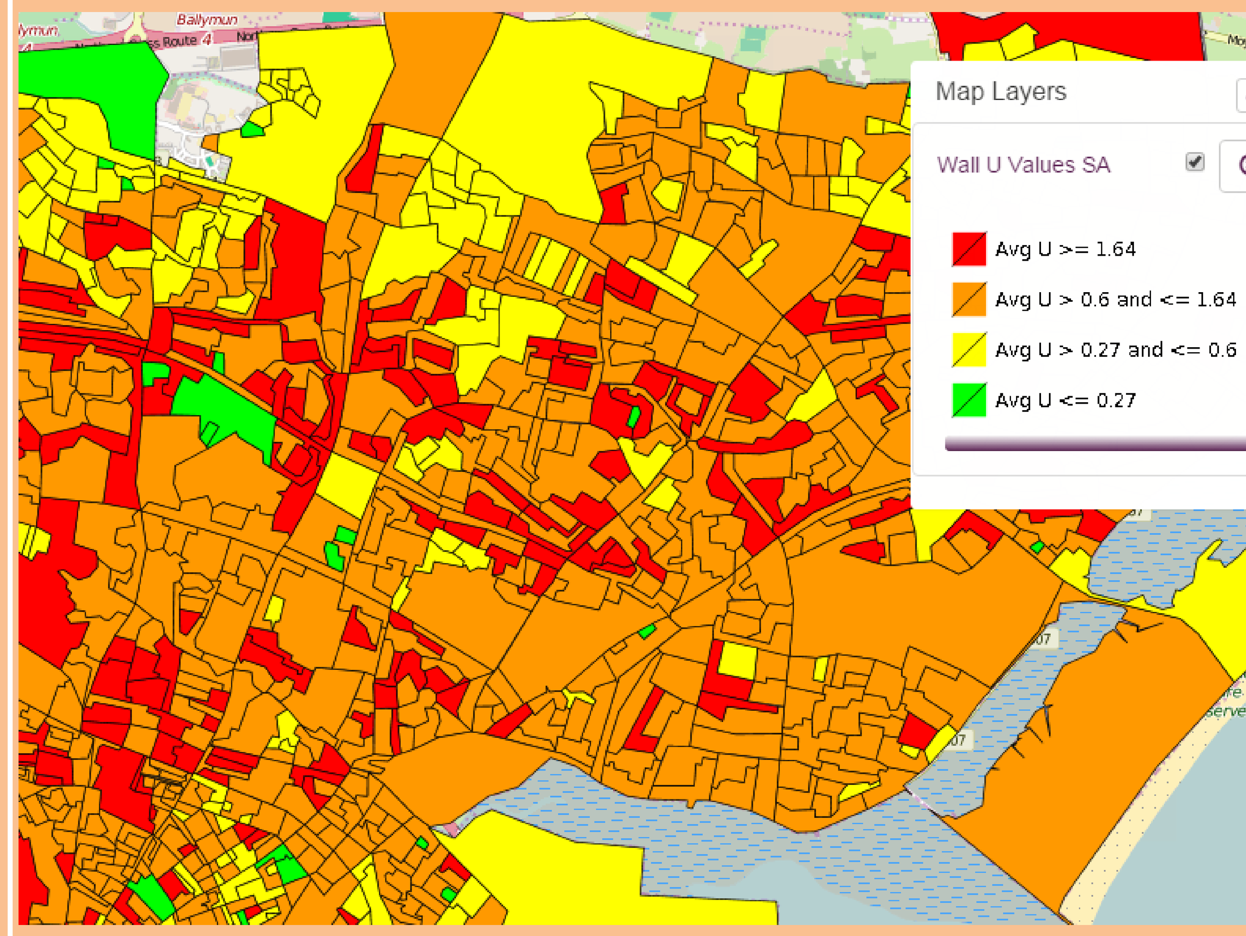
The aim of the pilot action is to establish the current energy status of the stock, the refurbishment conducted to date, the current annual refurbishment rates and to assess the current and predicted trends against the national targets set for 2020, 2030 and 2050.

The national target is to reduce CO_2 emissions from 1990 levels by 80 % by 2050. The National Energy Efficiency Action Plan (DCENR 2014) set an energy efficiency saving target of 20 % by 2020 from the average unadjusted final energy consumption 2001-2005, expressed as primary energy equivalent.

3 key data sources were used to analyse the building stock and its refurbishment status:

- National EPC database as 33% of dwellings have EPCs (based on data at February 2015)
- Field survey of 100 dwellings conducted to cross-check the EPC database analysis
- Local and National energy efficiency upgrade programmes

An EPC mapping tool was created featuring 20+ mapping views – see wall U value energy bands map on right.

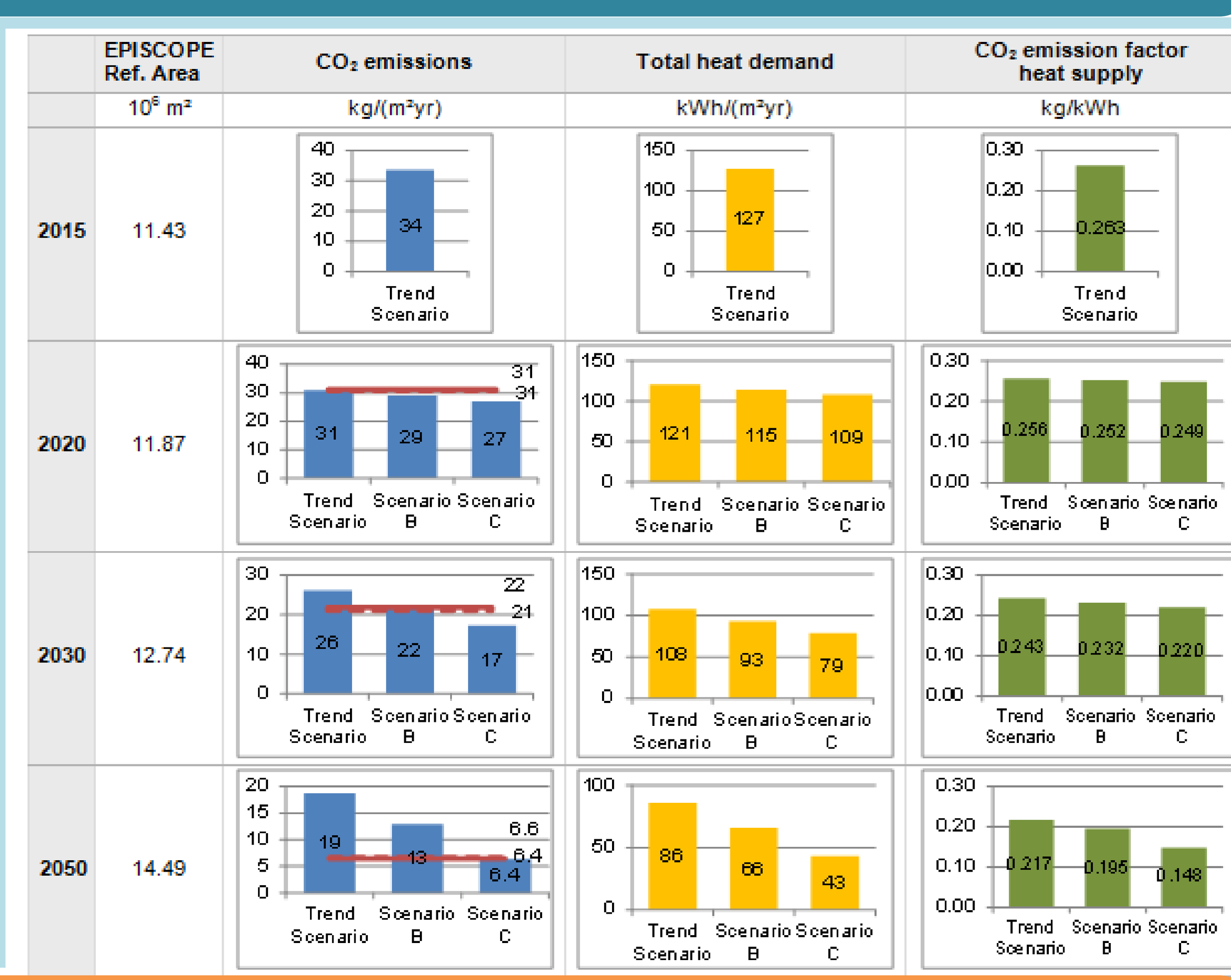


FINDINGS OF SCENARIO ANALYSES

- Trend Scenario – 48% reduction in CO_2 by 2050: based on energy use predicted from the current EPC database, calibrated for measured energy use. Assumes that the existing stock will be refurbished at the aggregate rates from EPC and field survey and that 1,000 new dwellings to NZEB standard will be added to the stock each year.

- Scenario B - 60% reduction in CO_2 by 2050: assuming (1) 25 % of the stock will have undergone a deep retrofit by 2050 by adopting ambitious fabric upgrades and switching to renewable technologies including heat pumps for space and water heating, (2) the carbon content of the electrical supply will have been reduced by 30 % by 2050.

- Scenario C - 80% reduction in CO_2 by 2050: assuming (1) 75 % of the stock will have undergone a deep retrofit by 2050, and (2) the carbon content of the electrical supply will have been reduced by 65 % by 2050.



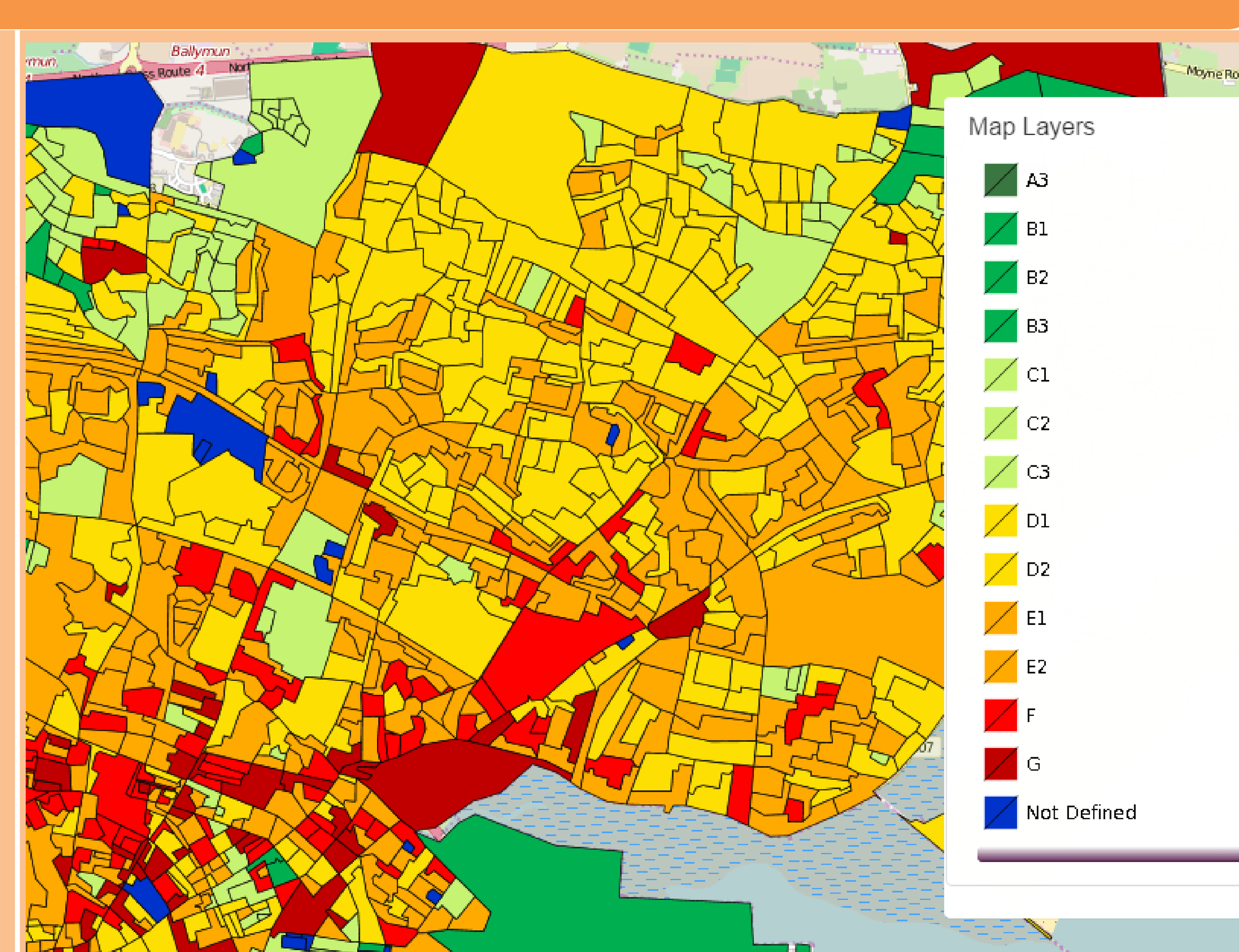
LESSONS LEARNED & RECOMMENDATIONS

<u>Lessons:</u>

- When taking trends via the EPC database, a formal process is required to download and store EPC database records each year at a set date.
- The EPC database records alone will not accurately indicate energy refurbishment trends but are an important data source.

<u>Recommendations:</u>

- A national housing energy efficiency/ house condition survey should be established to comprehensively track the energy efficiency of the residential housing stock and enable scenario forecasting to 2020, 2030 and 2050.
- A detailed study should be conducted to record measured energy use in residential buildings on an ongoing basis.
- In future revisions of NEEAP, specific targets for reduction in energy demand and CO_2 should be set for the residential sector for 2020, 2030 and 2050 to give sector-specific targets.
- The analysis conducted on the EPC database for the EPISCOPE Pilot Action should also be continued, further developed and cross-referenced to the recommended field survey and the measured energy consumption data processes.



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EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

Greece

Hellenic residential building stock

STATUS: 10/2015

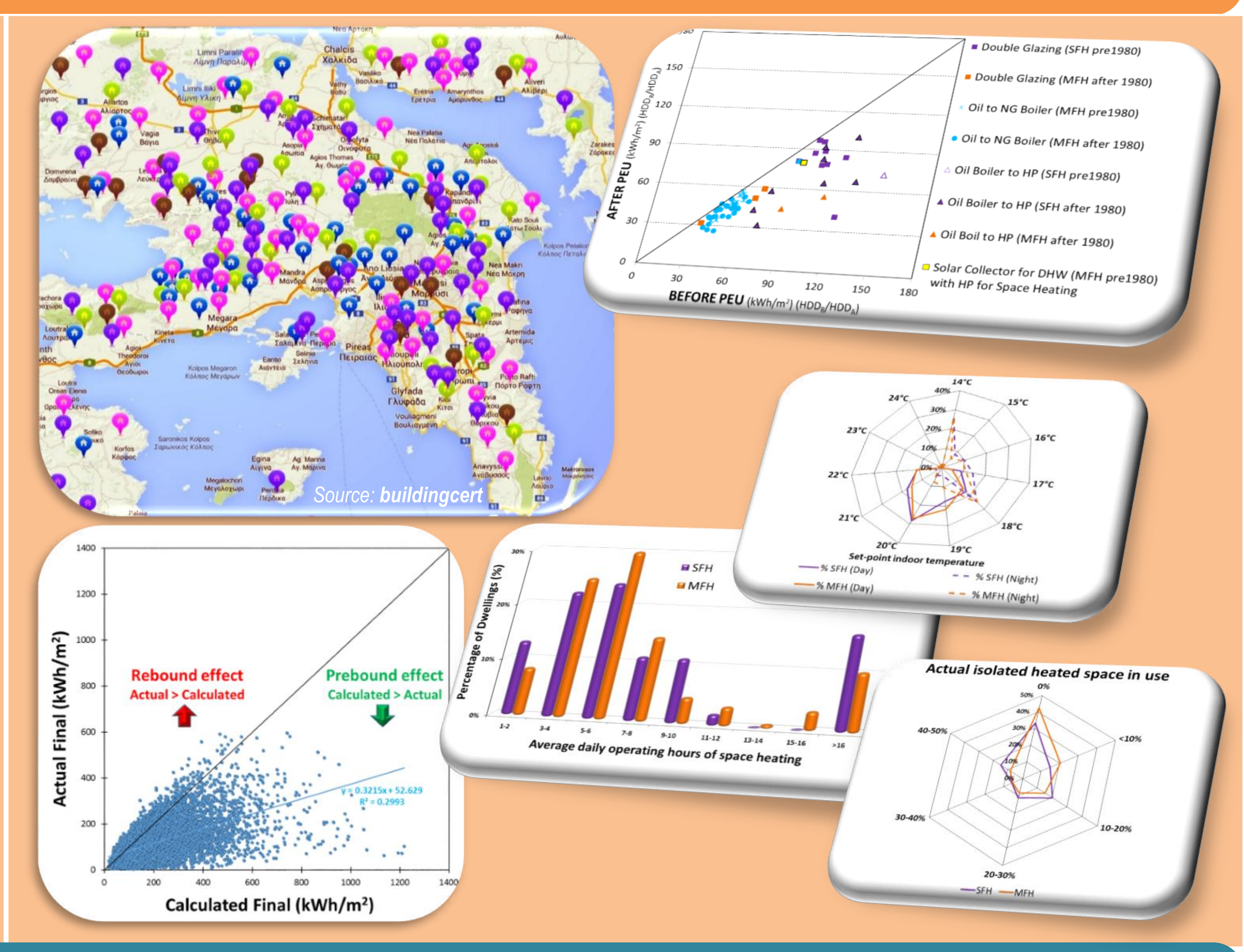
SCOPE

SCALE	National
NUMBER OF DWELLINGS	4,122,088 inhabited (~ 6.3 million total)
NUMBER OF BUILDINGS	2,534,177
NUMBER OF INHABITANTS	10,816,286 resident population
m^2 NATIONAL REFERENCE AREA	399,619,569 gross floor area inhabited (~ 486 million total)
m^2 EPISCOPE REFERENCE AREA	251,117,043 living floor area (~ 309 million total)


Source: buildingcert

OVERVIEW OF ACTIVITIES

- **Map** the energy performance of Hellenic residential buildings using the **EPC** database
- Derive **empirical factors** for the adaptation of the **calculated** to the **actual** energy consumption
  - Exploitation of **EPC** database (buildingcert)
  - Carry out a **field study** in ~200 dwellings
- Explore the **impact** of the most commonly adopted energy saving measures on the actual energy performance of residential buildings (**field study** in ~80 dwellings)
- Perform an exhaustive analysis of available **statistical data** on the energy-related characteristics of the building stock
- Investigate existing sources for deriving current **modernization trends**
- **Set up a building stock model** and perform **scenario analysis** for the years up to 2030
- Analyse results for the years 2012 (reference year), 2015, 2020 and 2030
- **Assess** the viability of different energy saving strategies towards achieving the national goals for 2020 and 2030



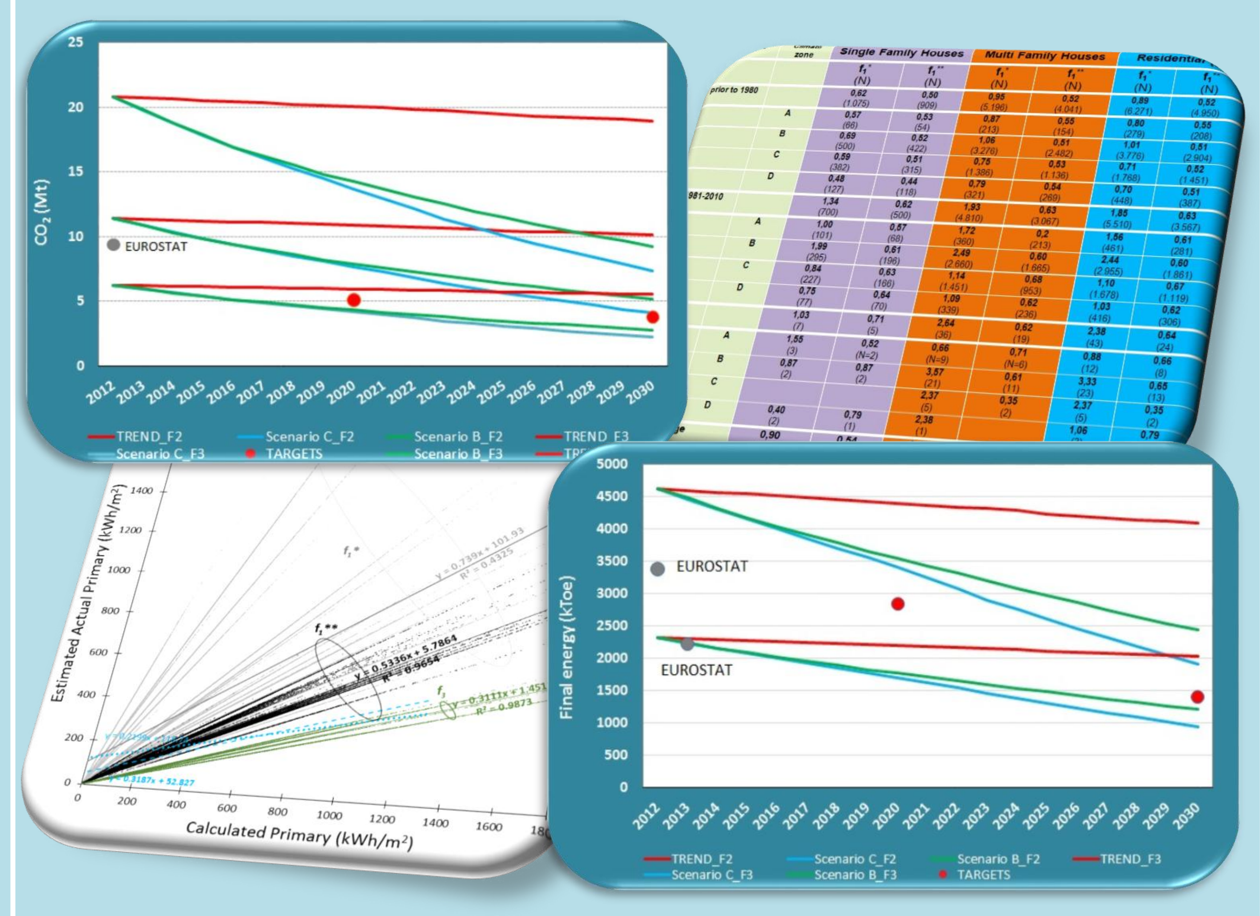
FINDINGS OF SCENARIO ANALYSES

- Adaptation of calculated to actual energy consumption: ***f(actual/calculated)***

Three sets of *empirical factors* to approach different attitudes towards energy consumption

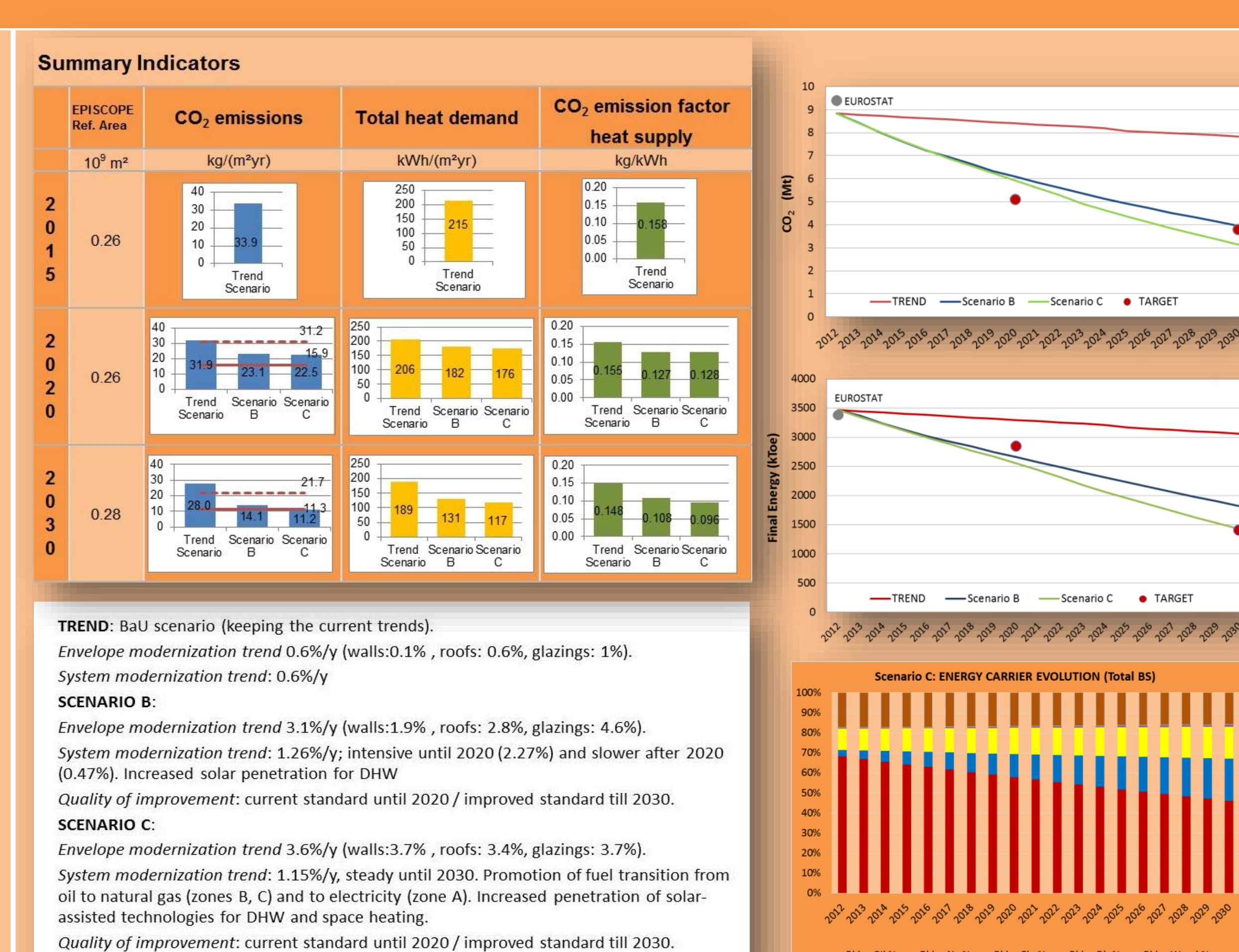
- **Set 1** (factors f_1*) : based on EPC data from ~12000 dwellings (raw data)
  Adaptation to the upper level of consumption - seen as an ***upper bound***
- **Set 2** (factors f_1**) : based on EPC data from ~8000 dwellings (filtered data)
  Adaptation to the average level of consumption, approaching the ***general trend*** in actrual energy use
- **Set 3** (factors f_2) : based on data from the field study carried out by NOA including ~80 dwelings
  Adaptation to a conservative energy use reflecting the current energy consumption trends (reduction of the heated area, temperature setpoint and operating hours of the heating system) imposed by the economic recession – seen as a ***lower bound***

RECOMMENDATION: ***Regular update*** of the empirical adaptation factors using data from the EPC database will significantly improve their reliability.



LESSONS LEARNED & RECOMMENDATIONS

- Current energy consumption and CO_2 emissions are already below the national targets for 2020, due to the recent economic decline. However, the recession scenario implies poor indoor environmental conditions, which is unacceptable as a future outlook.
- A **business-as-usual** scenario continuing the modernization trends of the last decade **would not be sufficient** to achieve the national goals set for 2020 and 2030
- Given the current state of the Greek economy, the national **goals of 2020** are **too ambitious**
- An effective strategy towards achieving the 2030 targets should target the quality of **both envelope** & **system installations** of the building stock
- Current **refurbishment trends** should be **doubled**, involving both envelope insulation & system modernizations
- The promotion of **fuel change** from oil to natural gas and the **penetration of solar assisted technologies** for space heating and DHW preparation are **promising strategies** towards achieving the national goals



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Italy

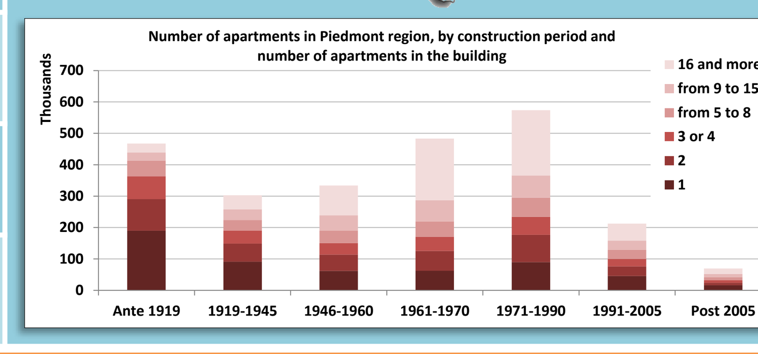
Monitoring of Piedmont regional housing stock

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

SCALE	Regional
NUMBER OF DWELLINGS	2.44 millions
NUMBER OF BUILDINGS	0.94 millions
NUMBER OF INHABITANTS	4.36 millions
m² NATIONAL REFERENCE AREA	214 millions (conditioned floor area)
m² EPISCOPE REFERENCE AREA	214 millions



OVERVIEW OF ACTIVITIES

- **Data collection and processing from census, surveys and EPCs**

A statistical analysis was carried out on the database containing the issued regional EPCs. It is the main data source of monitoring indicators for the pilot action. Information covers the state of thermal building insulation and heat supply, the frequency of the heat generators (for space heating and DHW), the energy carriers and the technologies using renewable energy sources in Piedmont.

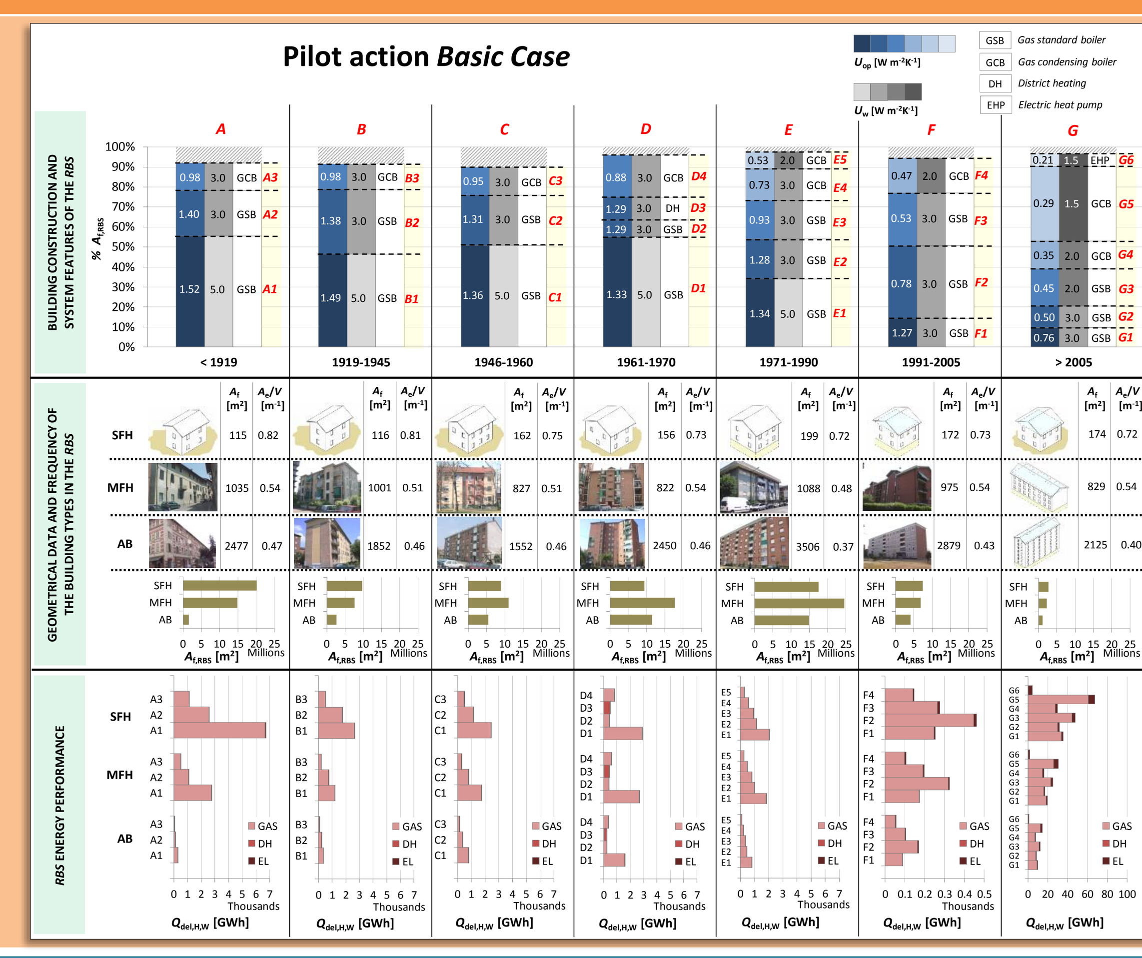
- **Definition and energy performance assessment of the *Basic Case***

The *Basic Case* (BC) represents the current state of the regional housing stock. It was defined through combinations of walls and windows *U*-values and heating system types for each construction period. Each combination represents a percentage of the total residential building stock (RBS) floor area.

The *Basic Case* was modelled using the geometry of building types from the *TABULA* project and its energy performance was assessed by applying a national standard calculation method (UNI/TS 11300).

- **Definition and energy performance assessment of some relevant refurbishment scenarios**

[See section below].



FINDINGS OF SCENARIO ANALYSES

The following scenarios of the regional housing stock energy refurbishment were concerned:

- ***Trend Scenario*** (TDS): the RBS floor area yearly refurbished follows the current trend, the types of refurbishment measures are those commonly applied in Piedmont and their performance parameters are established by the current legislation. The climate protection targets are not achieved.
- ***Cost-Optimal Scenario*** (COS): the RBS floor area yearly refurbished follows the current trend, the types of refurbishment measures and their parameters are defined by means of the cost-optimal methodology (Article 5 of Dir. 2010/31/EU). The climate protection targets are not achieved.
- ***Target Scenario 2020-2030-2050*** (TS1): the CO_2 emissions of the RBS are set as an objective for 2020, 2030 and 2050. A yearly global refurbishment rate of 1.26% (2016-2020), 2.44% (2021-2030) and 1.88% (2031-2050) of RBS floor area is obtained to meet the targets.
- ***Target Scenario 2050*** (TS2): the CO_2 emissions of the RBS are set as an objective for 2050. An average yearly global refurbishment rate of 1.88% of RBS floor area is obtained.

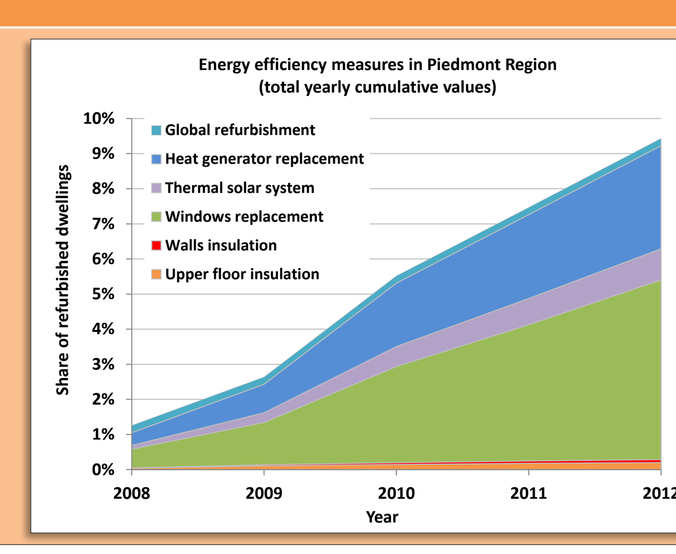
The national climate protection targets were derived from a report of ENEA (the national energy agency) which presents scenarios and strategies towards a *low carbon country*.

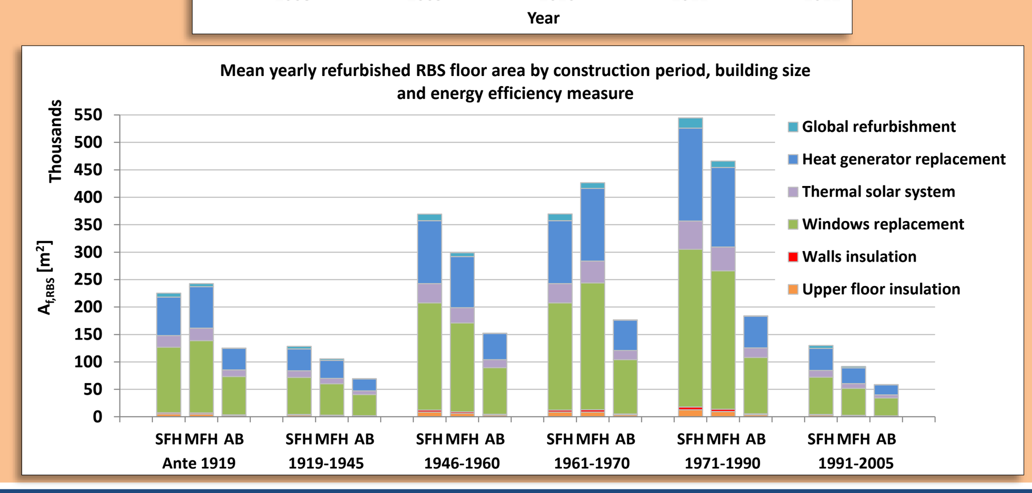
Final energy by fuel, gross calorific value [GWh/yr]

	2015	2020				2030				2050			
Scenario	BC	TDS	COS	TS1	TS2	TDS	COS	TS1	TS2	TDS	COS	TS1	TS2
natural gas	63990	62961	62809	59845	56947	60845	60464	43425	42746	57045	56502	17918	17804
liquid gas	0	0	0	0	0	0	0	0	0	0	0	0	0
oil	0	0	0	0	0	0	0	0	0	0	0	0	0
coal	0	0	0	0	0	0	0	0	0	0	0	0	0
wood / biomass	0	0	0	0	0	0	0	0	0	0	0	0	0
district heating	1125	1123	1123	1123	1123	1121	1121	1121	1121	1069	810	190	269
electric energy (used for heat supply)	915	947	1037	947	947	1003	1281	1003	1003	1116	1766	1112	1116

LESSONS LEARNED & RECOMMENDATIONS

- The average annual rate of retrofitted dwellings in Piedmont is around 2%, considering partial refurbishment actions. The most commonly applied measures are windows and heat generator replacements, while the least applied measures are external walls and upper floor insulation. The annual global building renovations just concern 0.1% of the housing stock floor area. This current trend has revealed to be not sufficient to reach the CO_2 emissions targets.
- The effective trend to achieve the climate protection targets would consist of an average yearly global refurbishment rate of 1.88% of the regional residential building stock floor area, even applying common technologies and energy efficiency requirements in force today.
- The local administrators should be boosted at:
  - promoting large-scale interventions by means of incentives that encourage a global building refurbishment and identifying guidelines for technical and economic feasibility,
  - improving the monitoring of the housing stock, by increasing the availability and the quality of data, in order to reduce the use of model assumptions, develop and update the scenario analyses, and obtain more reliable results on the energy saving and CO_2 reduction potentials.





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EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

Austria

The residential buildings in Salzburg-Austria

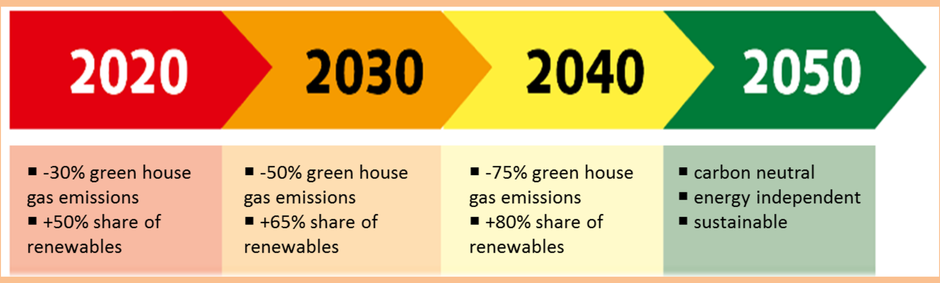
STATUS: 10/2015

SCOPE

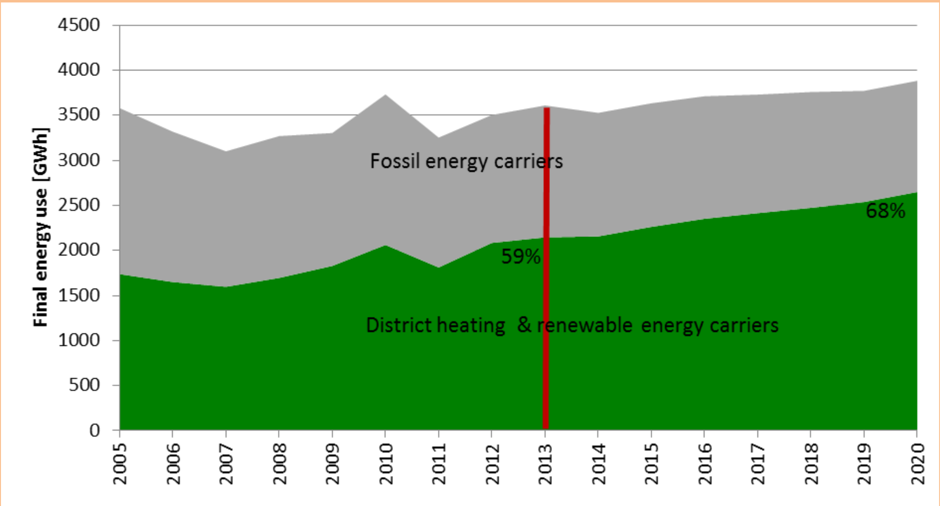
SCALE	regional
NUMBER OF DWELLINGS	> 282,800
NUMBER OF BUILDINGS	> 120,400
NUMBER OF INHABITANTS	> 534,270
m² NATIONAL REFERENCE AREA	~20.9 million (living area)
m² EPISCOPE REFERENCE AREA	~23 million

OVERVIEW OF ACTIVITIES

- **Identification** of energy goals of the Province of Salzburg until 2050 for the building stock
  - short, middle and long term goals
- **Collecting** information about the residential buildings in Salzburg
  - Number, size, age band according to the Austrian residential building typology, renovation and demolition rate
- **Evaluation** of the data available in the Energy Performance Certificate Database ZEUS
  - Average U-value before and after renovation, type of energy carrier, energy performance before and after renovation
- **Analysing** information on the real energy consumption for space heating and domestic hot water
  - Statistical data for the use of energy in the residential sector for Salzburg plus available data uploaded to ZEUS in the energy accounting programme
- **Development** of scenarios and their evaluation for reaching the goals



Short, middle and long term goals of the Province of Salzburg

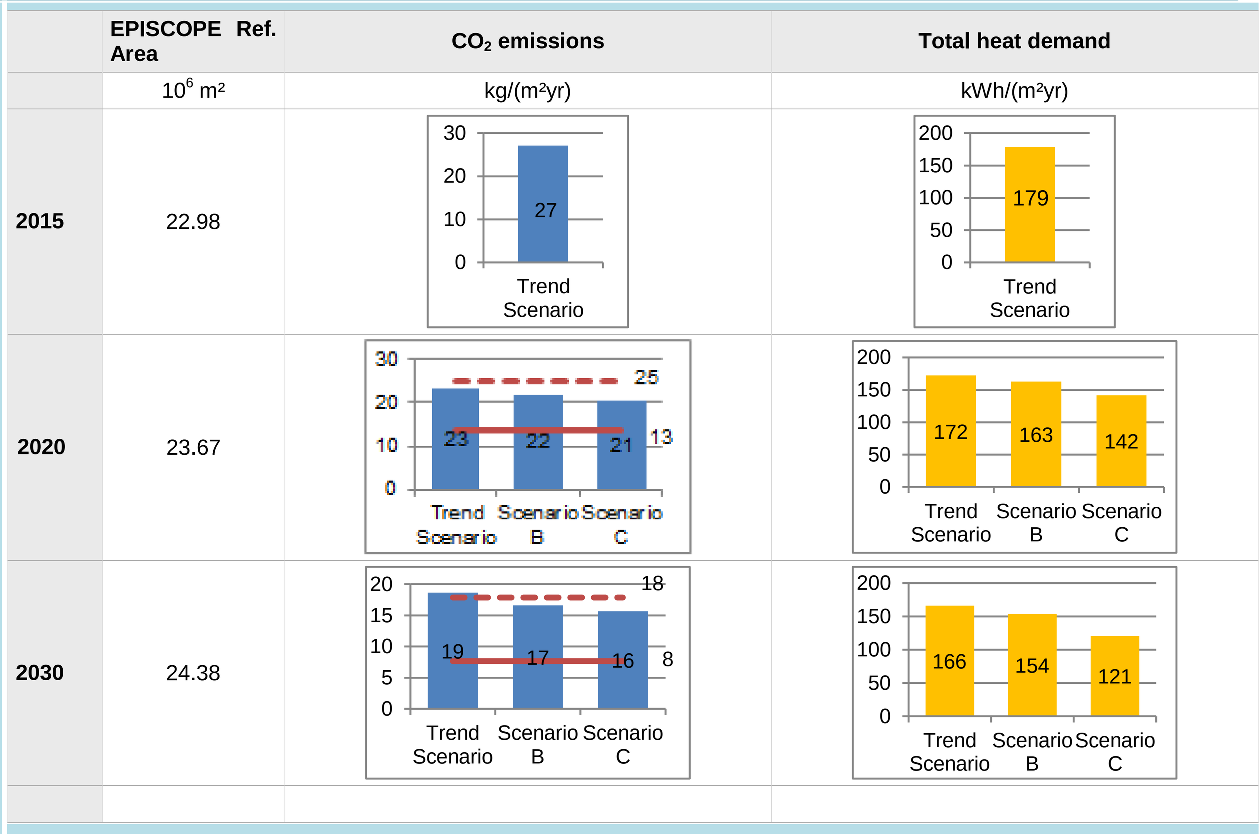


Share of district heating and renewable energy carriers in the space heating of residential buildings and its trend till 2020

FINDINGS OF SCENARIO ANALYSES

Findings of the scenario analyses until 2030:

- Business as usual:
  - Development of energy used in the residential building sector with the current measures could reduce CO_2-emissions by 31%
- Scenario B)
  - Increasing the renovation rate from 1% up to 3% with focus on the buildings built before 1980 could result in a 38% reduction of CO_2-emissions
- Scenario C)
  - Increasing the share of renewable energy carriers significantly could reduce CO_2-emissions between 35% and 42% if:
    - If the biomass and heat pumps are installed more in the single family house sector
    - If district heating is used as main energy carrier in the multi family house sector



Summary Indicators

LESSONS LEARNED & RECOMMENDATIONS

In Salzburg, 65% of buildings were built before 1980. Concerning the quality and life cycle of building elements and heating systems such as windows and boilers, this category has a large potential for implementing energy efficiency measures.

- There is a need not only to change the energy carrier from fossil fuels to renewables, but also to reduce the final energy consumption, since the potential of renewable energy sources is limited
- Subsidies play an essential role in achieving the goals
- Increasing the inspection of energy efficiency measures and the implementation of smart metering
- Increasing installation rate of solar thermal panels and PV systems
- Replacing fossil energy carriers with renewables systems
- Increasing the number of information campaigns related to energy efficiency in buildings, compliance issues and also user behaviour
- Accelerating the training programmes for professionals

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AUSTRIAN ENERGY AGENCY

Cyprus

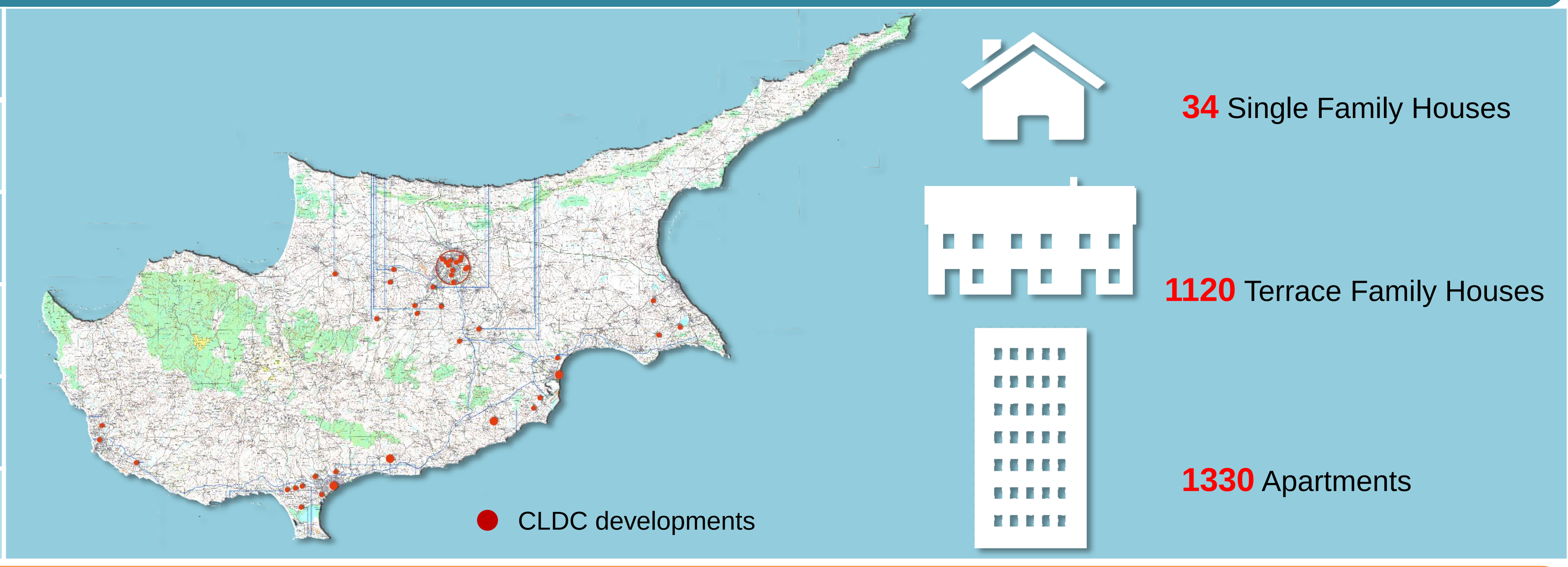
Cyprus Land Development Corporation

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 11/2015

SCOPE

SCALE	Local
NUMBER OF DWELLINGS	2484
NUMBER OF BUILDINGS	606
NUMBER OF INHABITANTS	9936
m² NATIONAL REFERENCE AREA	261680 (useful floor area)
m² EPISCOPE REFERENCE AREA	261680



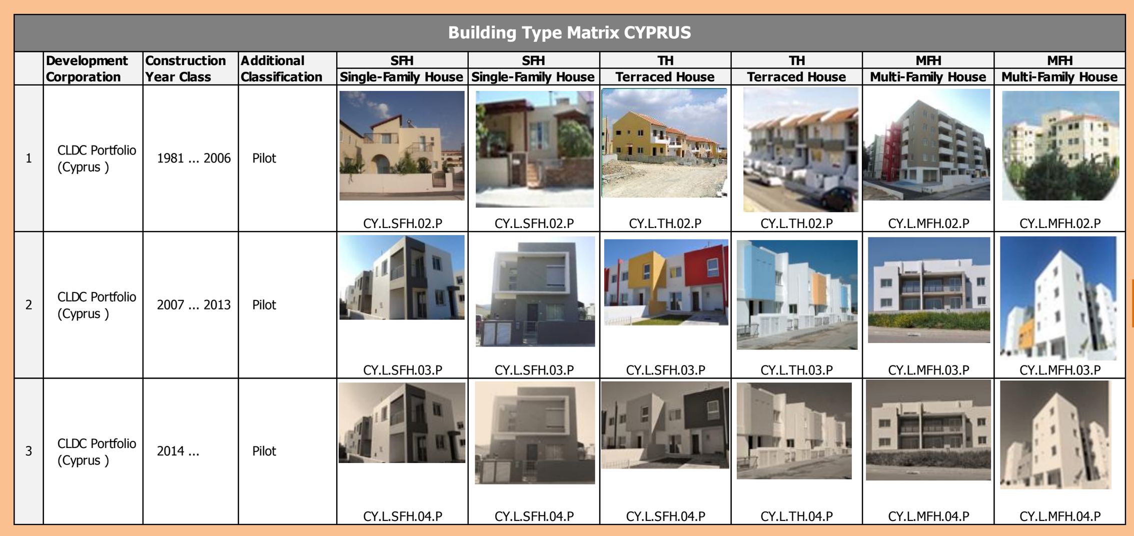
OVERVIEW OF ACTIVITIES

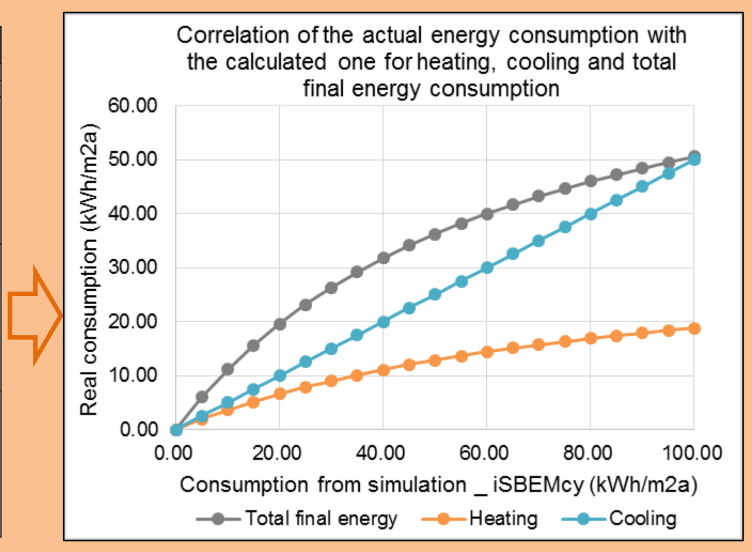
I. **The building stock was divided into categories** based on the typology of the dwellings (SFH, TH or MFH) and the chronological period of construction.

II. The current **energy performance** and the **refurbishment rate** of the existing dwellings was found through **onsite observation, questionnaire surveys** and **collection of the electricity consumption data** (bills).

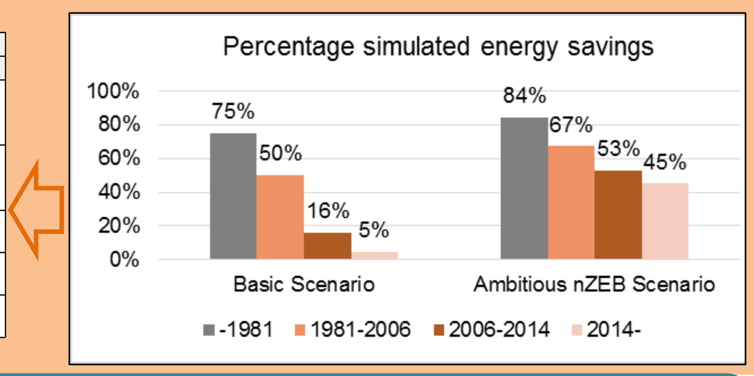
III. **The buildings to be constructed in the future were divided in two categories:** a) Improved, compared with the current, minimum requirements and b) nZEB standard, as specified by the energy Directives to be followed. IV. The **energy performance** of the dwellings (existing and future) was also calculated through **simulations. Various refurbishment scenarios** were applied for optimised energy performance and cost effectiveness.

V. **Future upgrading Scenarios (Trend, Moderate and Ambitious-nZEB) were developed** based on the observed trends, the efficiency of the various refurbishment scenarios and the use of RES in the electricity production.





Future Energy Upgrading Scenarios	Trend Scenario			Moderate Scenario			Ambitious (nZEB) Scenario		
	2020	2030	2050	2020	2030	2050	2020	2030	2050
Total Percentage of dwellings with roof U-value <0.75W/m2K, windows U-value <3.2W/m2K and walls U-value <1.39W/m2K /total stock	28%	26%	20%	33%	46%	55%	26%	19%	5%
Total Percentage of dwellings with roof U-value <0.4W/m2K, windows U-value <2.25W/m2K and walls U-value <0.4W/m2K /total stock (nZEB)	0%	18%	45%	0%	18%	45%	8%	45%	95%
Onsite RES contribution for heating (%) in the complete building stock	44%	49%	53%	46%	56%	78%	45%	58%	84%
Onsite RES contribution for cooling (%) in the complete building stock	0%	2%	7%	3%	17%	50%	0%	18%	70%
RES contribution in the grid electricity production (%) in the complete stock	13%	24%	46%	13%	24%	46%	17%	34%	64%

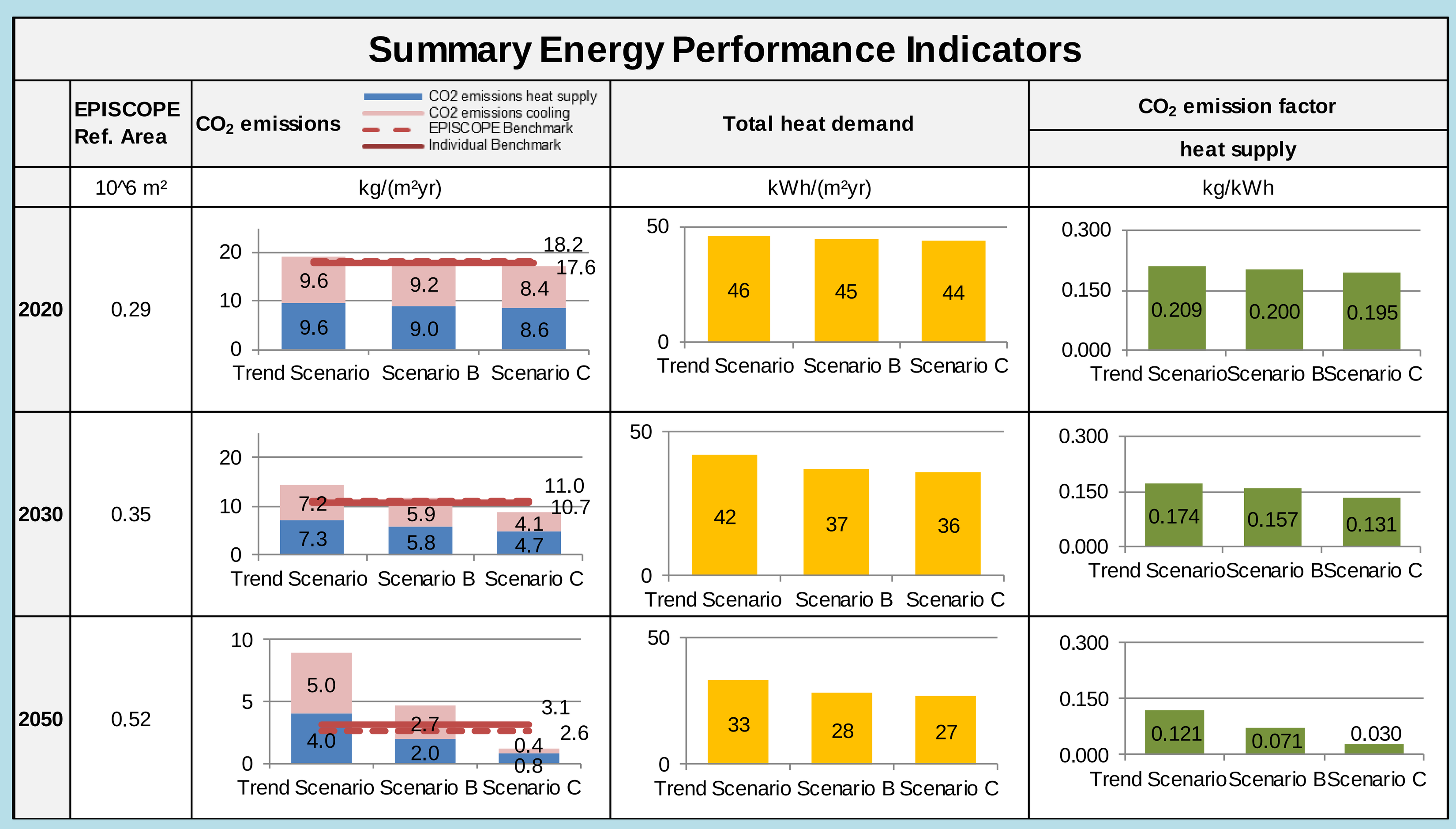


FINDINGS OF SCENARIO ANALYSES

The current trend of energy refurbishment (including new nZEB constructions after 2020), as depicted in the **Trend Scenario**, **is proven inadequate** for reaching the national climate protection targets and the EPISCOPE targets.

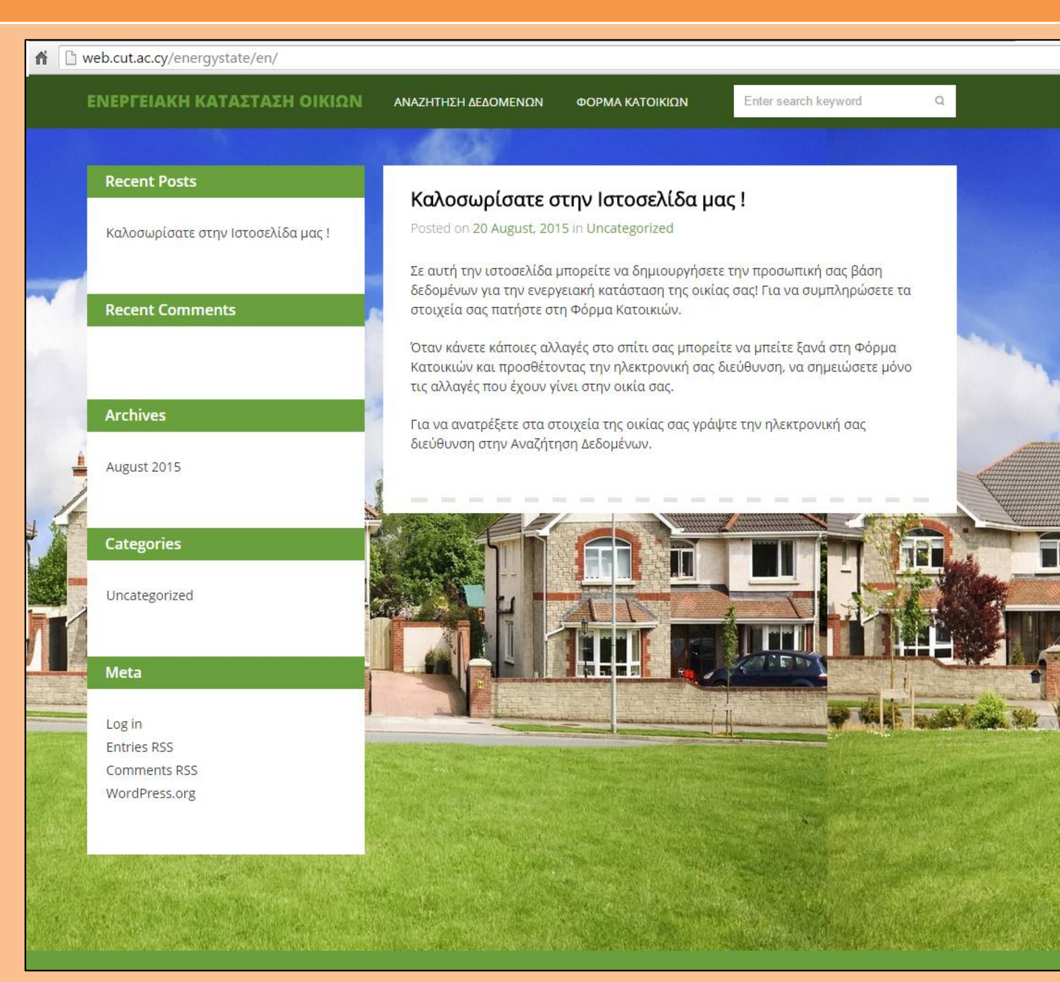
The **Moderate Upgrading Scenario (B)**, implementing a moderate building envelope refurbishment, combined with RES (Solar thermal) for heat supply is approaching the 2020 and 2030 targets of EPISCOPE, **with increasing deviation from the desirable results as we move from 2020 to 2050**.

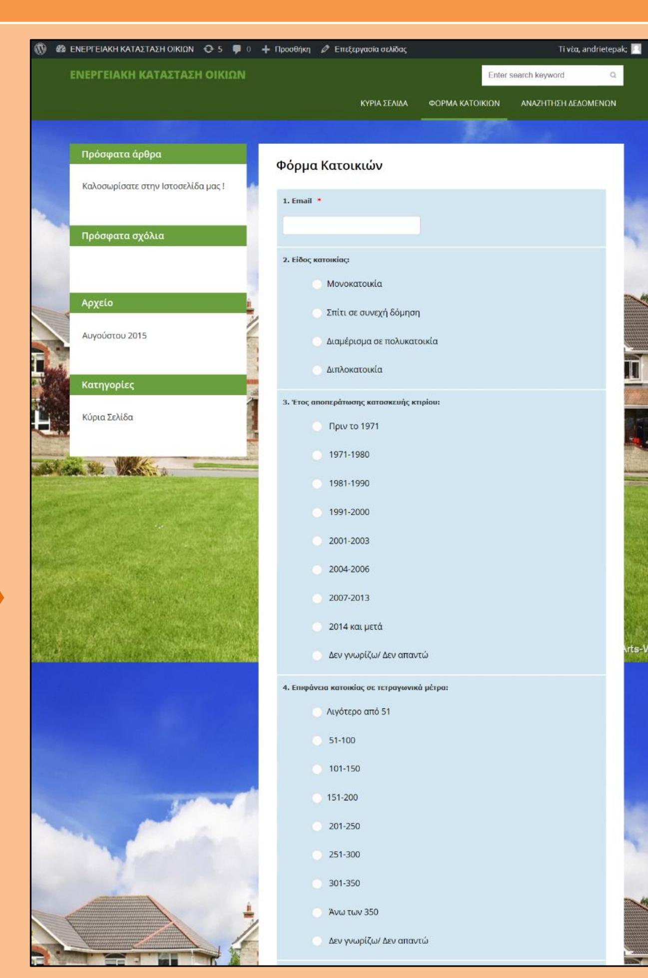
A combination of ambitious building envelope refurbishment measures (nZEB standard) and RES for heat supply, included in the **Ambitious Upgrading Scenario (C)**, with additional contribution of RES in the grid electricity supply, **constitutes a feasible solution to reach the CO2 emission targets**.



LESSONS LEARNED & RECOMMENDATIONS

- The **introduction of RES and specifically PV**, for the energy production, is currently the most **effective means of decarbonisation in Cyprus**.
- The efforts in Cyprus of **minimizing the CO₂ emissions** should focus on the **reduction of energy consumption for heating and cooling**, since cooling is responsible for more than half of the CO₂ emissions in 2015.
- The **most significant gap** presented in the **energy related information** concerns the data of the **energy consumption per energy carrier**.
- The **creation of a monitoring system**, in which the **fossil fuel energy suppliers will keep a detailed record about the served households**, is an effective way of bridging the energy information gap.
- The **questionnaire used by the Cyprus Statistical Service** for the housing sector energy profile, **is inadequate and should be upgraded**.
- The team developed an **online accessible database**, in which the house owners could **create and update the energy profile of their home**.





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Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

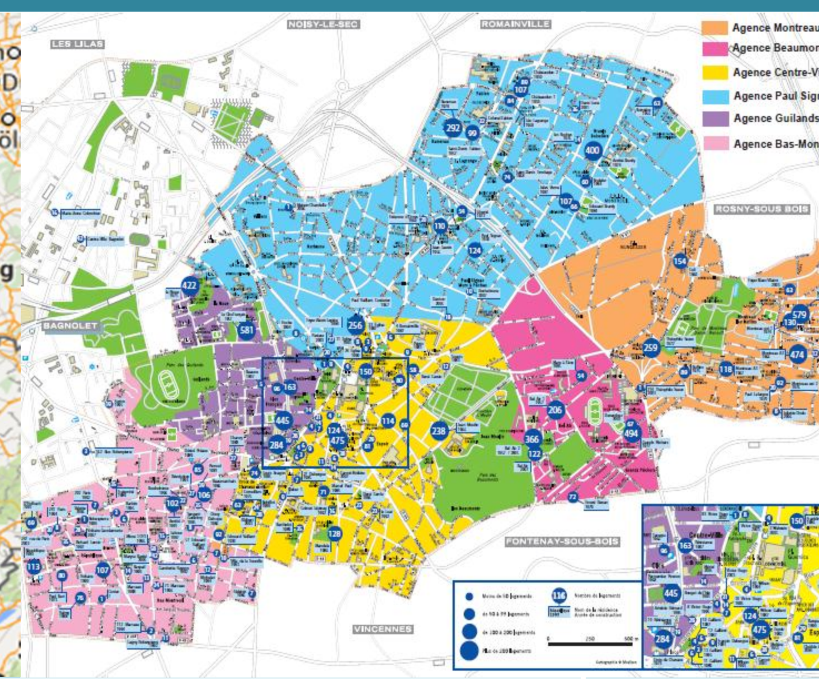
France

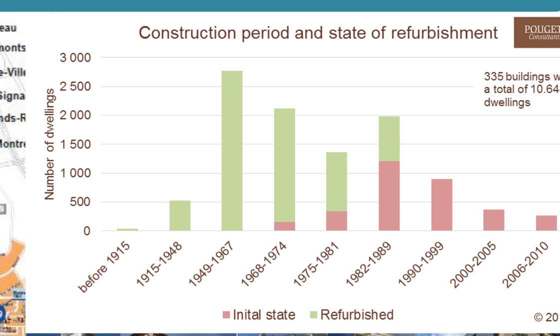
Building stock of the social housing company “Office Public de l’Habitat Montreuillois” (OPHM)

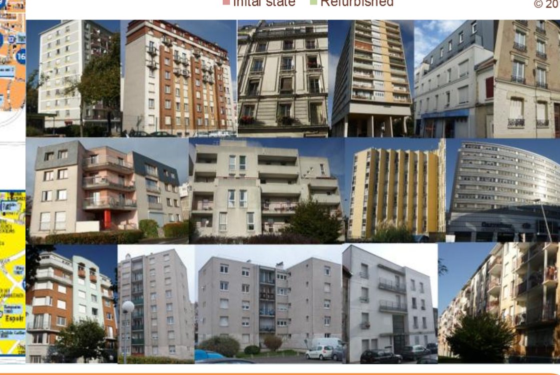
SCOPE

Values from 2013

SCALE	Local
NUMBER OF DWELLINGS	10’648
NUMBER OF BUILDINGS	335
NUMBER OF INHABITANTS	About 30’000
m² NATIONAL REFERENCE AREA	677’172 m² (living area)
m² EPISCOPE REFERENCE AREA	744’890 m²







OVERVIEW OF ACTIVITIES

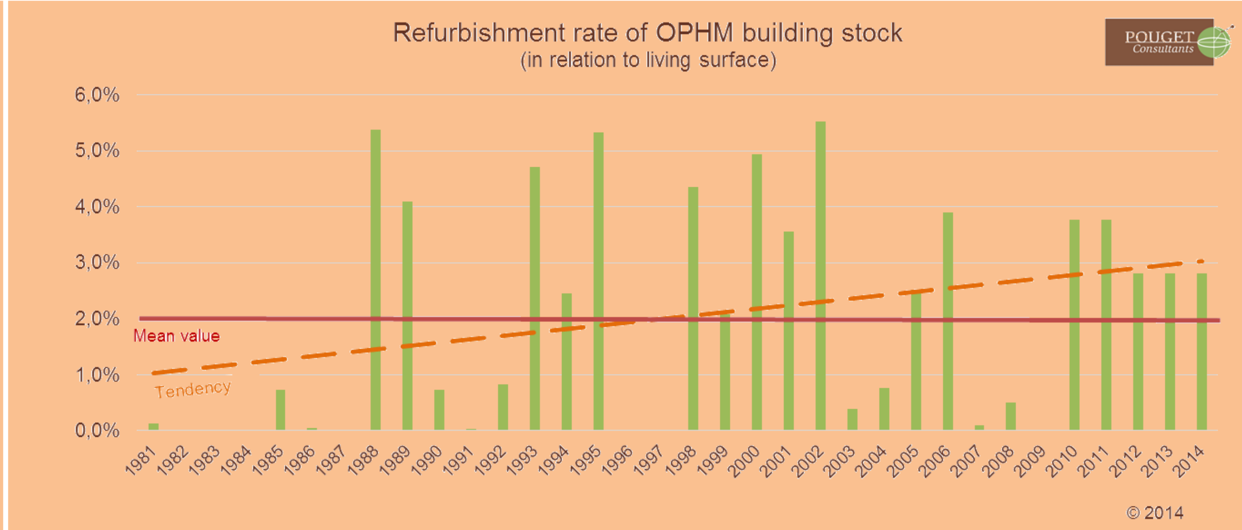
Activities of OPHM

OPHM has an ambitious program of new constructions and delivers every year about 150 new social dwellings, that corresponds to a construction rate of 1.4% per year. The French government aims to raise the construction rate from presently 1.0% up to 1,5% = 500 000 new dwellings every year.

The average refurbishment rate of the OPHM building stock during the ten last years was about 2%. In the period of 2012 to 2014 the OPHM refurbished 1 010 dwellings, corresponding to a refurbishment rate of 3% every year. The refurbishment rate of the French building stock is less then 1%.

Planned activities during the partnership of OPHM and POUGET *Consultants*

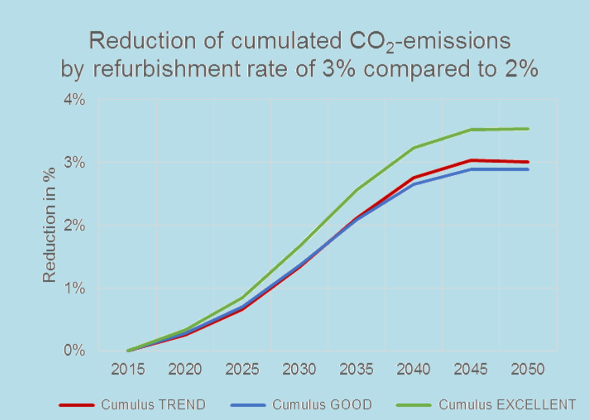
- Consulting the OPHM on the refurbishment strategy for the next 5 years
- Consulting the OPHM on the energy supply strategy for their building stock
- Definition of most important refurbishment measures and evaluation of their cost optimized levels
- Monitoring of the energy consumptions of a refurbished building group during 2 years

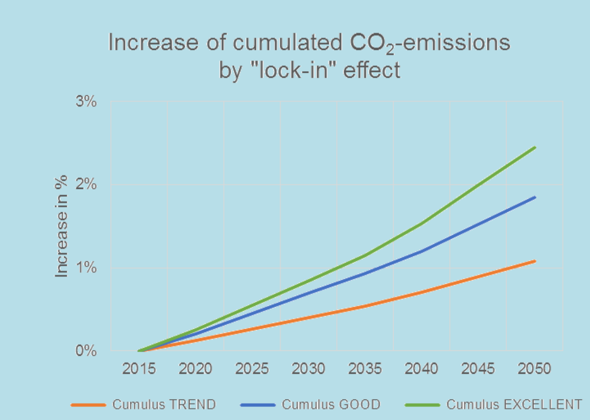


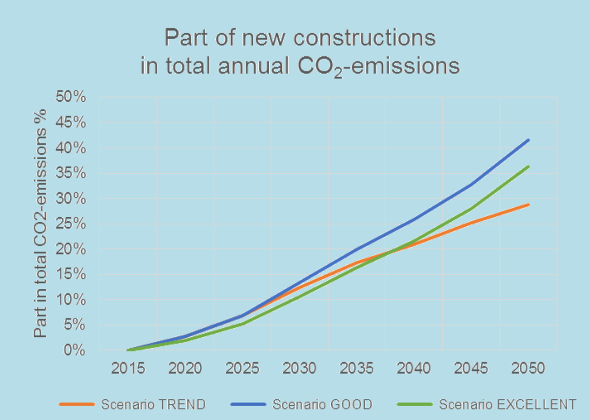
U-value of the element [W/(m².K)]		Thermal performance in case of refurbishment		
		TREND OPHM's current average level	GOOD "BBC-Rénovation" label	EXCELLENT "EnerPHit" level (Climate zone H1a)
Construction element	Ceiling	0,20	0,12	0,12
	Roof	0,20	0,12	0,12
	Wall	0,25	0,20	0,15
	Floor	0,35	0,27	0,20
	Window	1,40	1,30	0,80
	Door	2,00	1,50	1,00

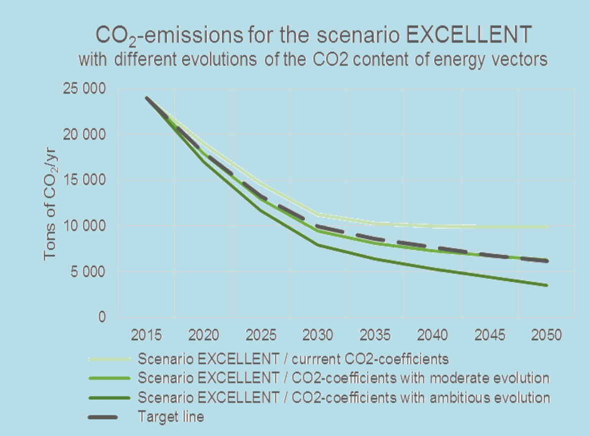
FINDINGS OF SCENARIO ANALYSES

- To increase refurbishment rate from 2% to 3% will reduce cumulated CO2-emissions until 2050 by about 3%.
- The “lock-in” effect leads to a increase of cumulated CO2-emissions until 2050 from 1% to 2.5% depending on the scenario.
- The part of the buildings constructed after 2015 in the annual CO2-emissions in 2050 will be important (between 29% and 42% depending on the scenario).
- The intended reduction of CO2-emissions needs an energy transition towards renewables energies so that the CO2-content of the energy vectors decrease drastically.







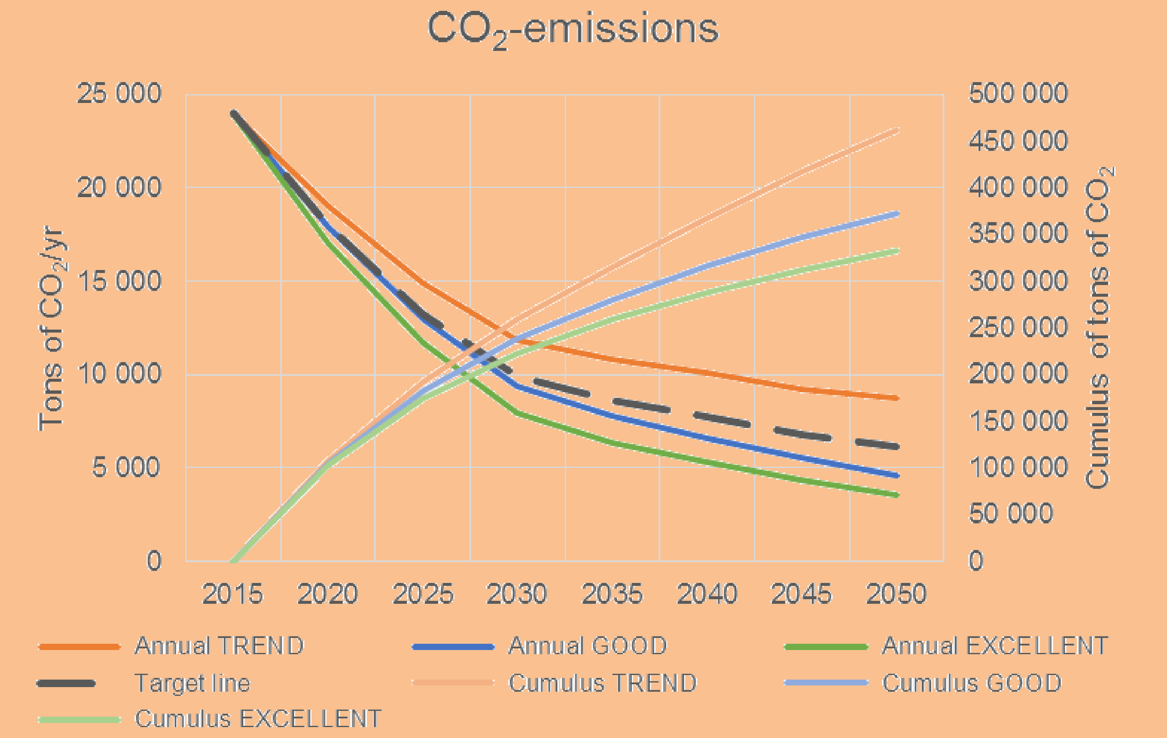


LESSONS LEARNED & RECOMMENDATIONS

The objective to limit the CO_2-emissions during the next 35 years and to divide annual CO_2-emissions by 4 compared to 1990 can only be reached by combining of three measures:

- Realisation of deep renovations (Passive House level) whenever this is possible
  Triple glazed windows and heat recovery on ventilation systems make the difference
- New constructions has to be built in the Passive House standard
- The CO_2 content of the energy supply has to be reduced drastically until 2050
  - Switch to more urban heating
  - Replace direct electric heating by heat pump systems
  - Integrate solar thermal systems and PV panels in the refurbishment strategy

Today, OPHM can’t realise these measures thoroughly for economical reasons. The integration of an economical approach to optimize the refurbishment strategy is essential to fully apply the recommended measures at the latest from 2020 onwards.



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DENMARK

Local initiative extrapolated to the national context

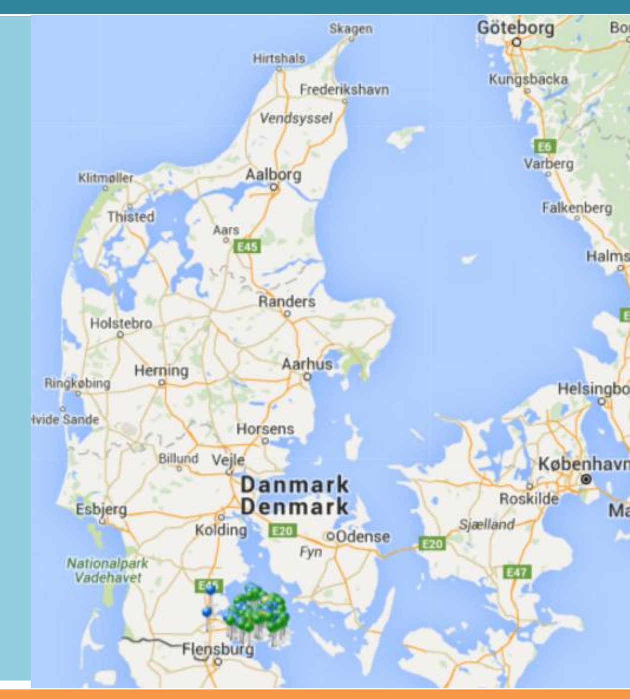
EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

SCALE	Local scaled to national level
NUMBER OF DWELLINGS	2 636 586
NUMBER OF BUILDINGS	1 547 037
NUMBER OF INHABITANTS	5 678 348
m² NATIONAL REFERENCE AREA	304 749 000 m² – gross heated floor area
m² EPISCOPE REFERENCE AREA	259 036 650 m²

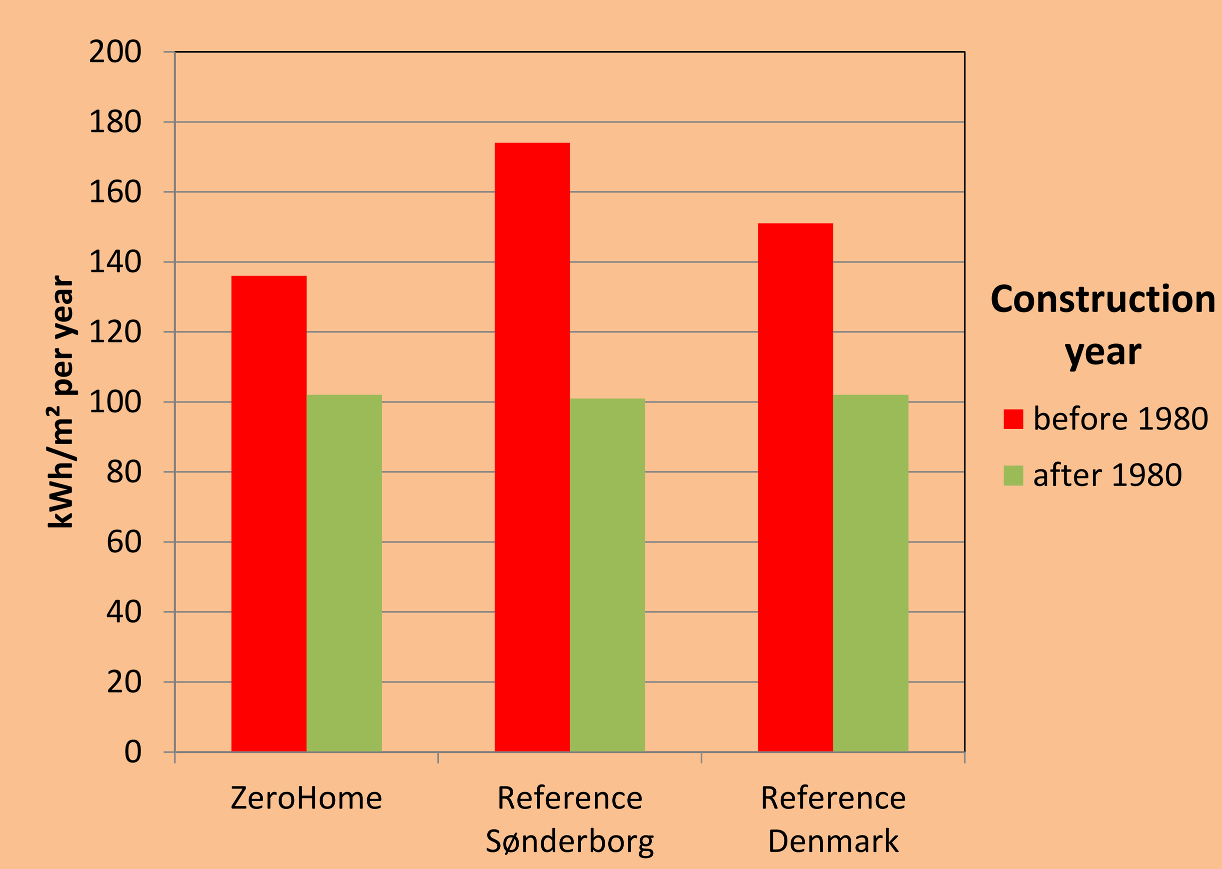


OVERVIEW OF ACTIVITIES

In the municipality of Sønderborg, in the southern part of Jutland, there is a shining example initiated in 2007, ProjectZero, of a local initiative that has resulted in extensive energy savings in residential buildings and at the same time created local jobs. **The intention with the pilot is to investigate the possible energy reduction in Denmark if the same approach was made for the entire Danish building stock.**

Deployment of this methodology on a national scale will not be straightforward as it requires strong local support. In Sønderborg the local business and clean-tech companies have strongly supported the project. Additionally, one of the driving forces has been the creation of something unique among the local residents and the feeling to be able to create local unity. This cannot easily be scaled up.

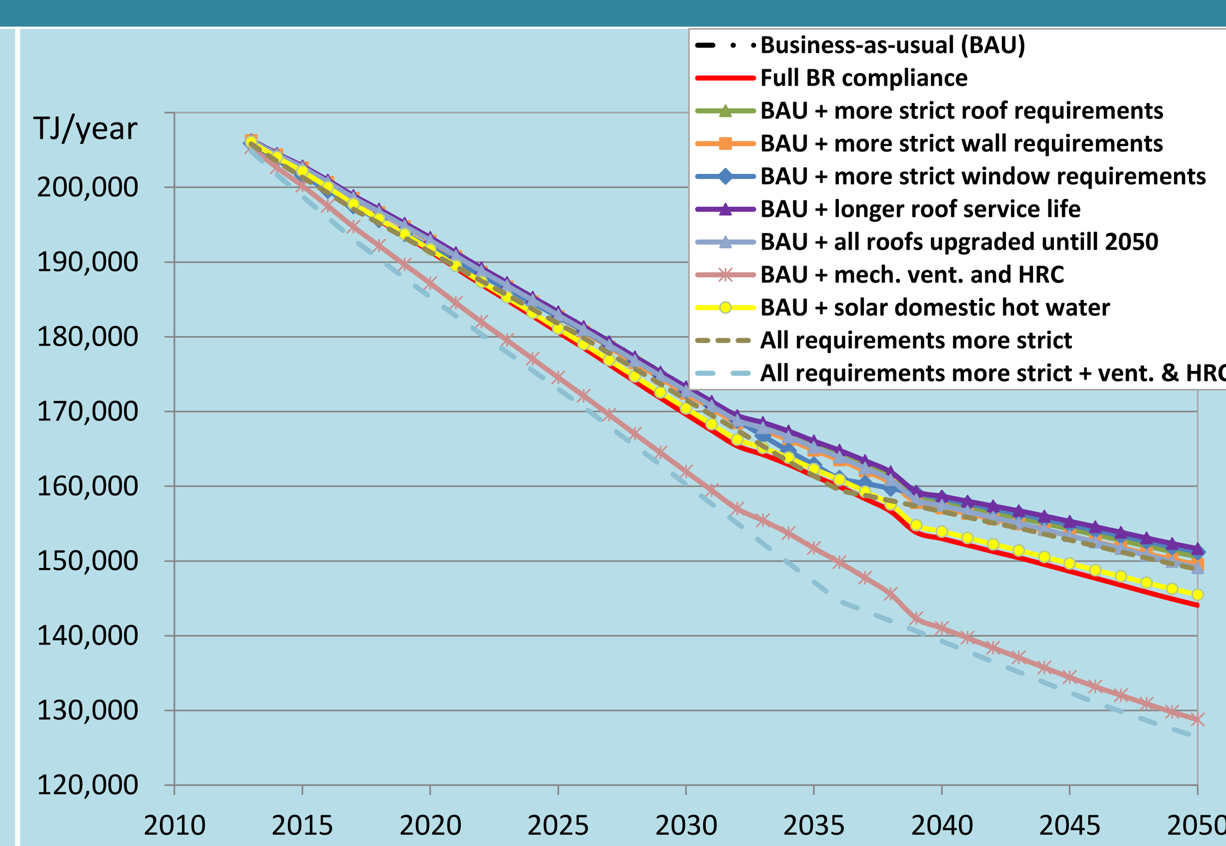
Nevertheless, playing with the idea about a nationwide dissemination will demonstrate the possibilities for energy savings and creation of local jobs if a community strives for a common goal. It is the aim of the government that Danish buildings should be free of fossil fuels by 2035. To be able to reach that goal, it is estimated that the energy consumption in the existing building stock should be reduced by a minimum of 50 % and business-as-usual may not be sufficient.



FINDINGS OF SCENARIO ANALYSES

Registered energy consumption, in the national Building and Dwelling stock register, in the ZeroHome homes in Sønderborg from the construction period before 1980 show an average energy consumption of 136 kWh/m² per year. The national average for single family homes constructed in the same period is 151 kWh/m² per year. Energy consumption on the ZeroHome group is thus significantly lower than the national average. Compared to the national average, ZeroHome homes, have obtained a reduction in energy consumption of 10%, and compared to the reference group of homes in Sønderborg a reduction of 28%. This is not in line with the needs for energy savings in the Danish tertiary sector until 2050, but in line with what can be expected for energy upgrading of building components when making a renovation according to the requirements laid out in the Danish Building Regulations 2010.

The business-as-usual scenario for energy upgrading of the existing building stock (when replacing or upgrading building elements), will deliver energy savings of around 28%. Analyses of impact from various tightenings of the building energy requirements will improve the results significantly. Such tightenings are implemented in the new 2015 Danish Building Regulations.

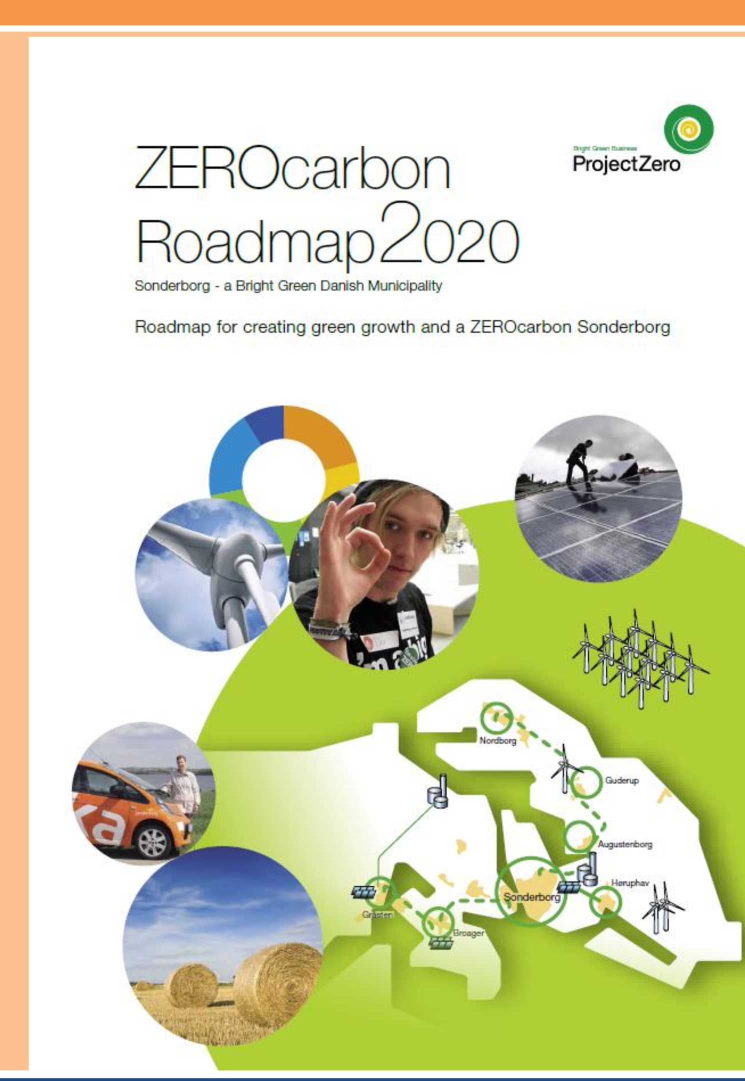


LESSONS LEARNED & RECOMMENDATIONS

The overall goal of ProjectZero is to get the entire Sønderborg-area involved in the vision of creating a CO_2-neutral growth area before 2029, creating and demonstrating new solutions, robust measurable CO_2 reductions, new green jobs and a talented generation of young people. The public-private partnership – ProjectZero – was created to inspire and drive Sønderborg´s transition to a ZERO carbon community by 2029, based on improved energy efficiency, conversion of energy sources into renewables and by creating participation of all stakeholders to reach the ambitious goal: **CO_2-neutral growth and sustainable urban development.**

Since 2009, about 1,200 homeowners have received free energy advice and more than 900 homeowners have already made contracts with local resources for the implementation of building energy upgrading. In total, there are about 18,600 homeowners in the Sønderborg municipality. Additionally, ProjectZero has attracted significant capital investments from industry and created around 1000 new jobs every year, both in the local area and in Denmark as a whole.

The main **reason for success** is that the ProjectZero approaches CO_2-reduction holistically, ensuring an unbroken chain: building owner, energy expert, local designers, craftsmen, and banks to ease implementation of energy saving measures in homes.



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DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

Germany

National Residential Building Stock

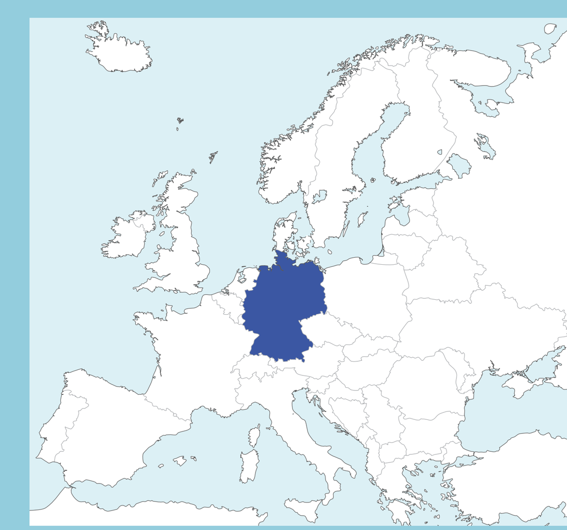
EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

SCALE	national
NUMBER OF DWELLINGS	38.8 million
NUMBER OF BUILDINGS	18.2 million
NUMBER OF INHABITANTS	75.8 million
m^2 NATIONAL REFERENCE AREA	3.54 billion (living space)
m^2 EPISCOPE REFERENCE AREA	3.89 billion



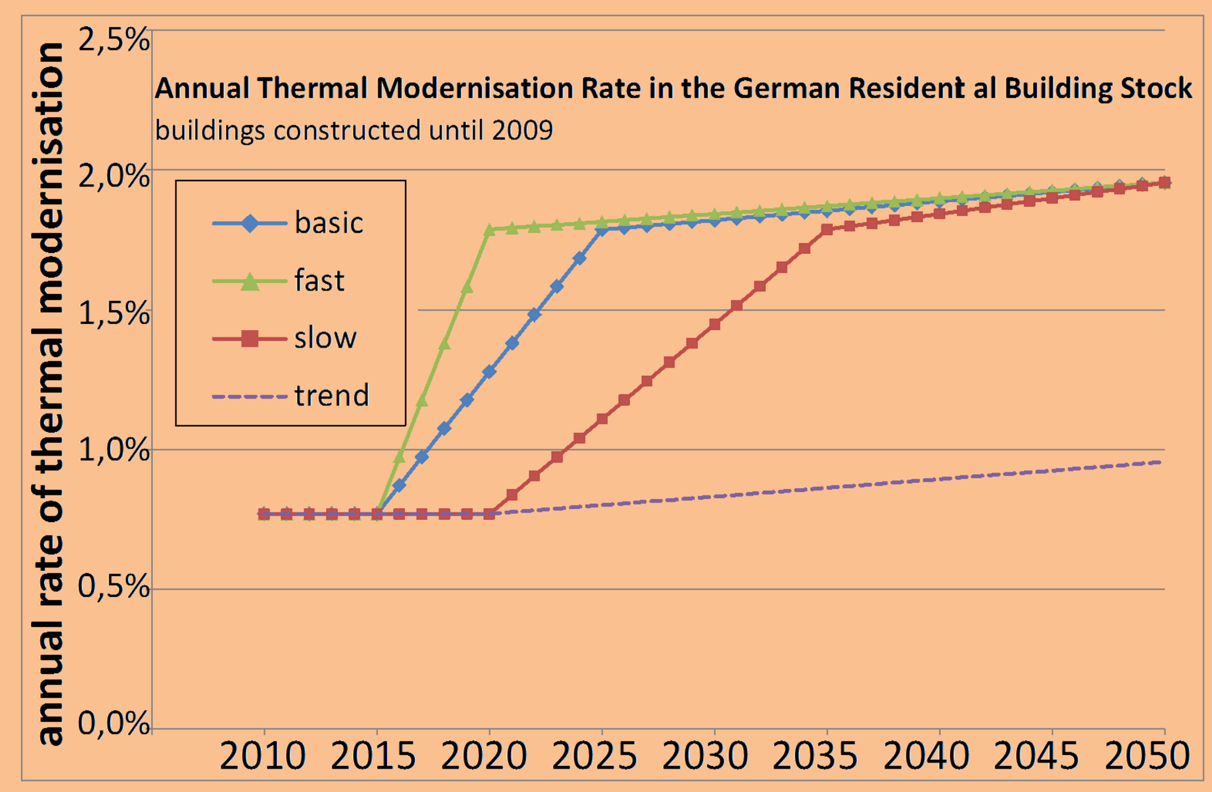
OVERVIEW OF ACTIVITIES

Scenario Analysis of the German residential building stock

- Climate protection target range in 2050: from -80 % to -95 % CO_2 compared to 1990
- Questions: How can the targets be kept at all? How fast must CO_2 saving measures evolve?
- Definition of 4 scenarios: trend scenario and 3 target-oriented scenarios (basic, slow, fast)
- Transition period in 3 target-oriented scenarios - linear step-by-step development:
  - doubling of annual rate of thermal modernisation (area weighted mean of all building elements)
  - new structure of newly installed heating systems (gas/oil boilers -> CHP, heat pumps, biomass)
- Transition period duration: 10 years (basic), 5 years (fast), 20 years (slow, 5 years delay + 15 years)
- Structural changes of district heat and electricity generation: > 50 % renewables in 2050

Concept for a regular monitoring of the progress of thermal insulation and heat supply

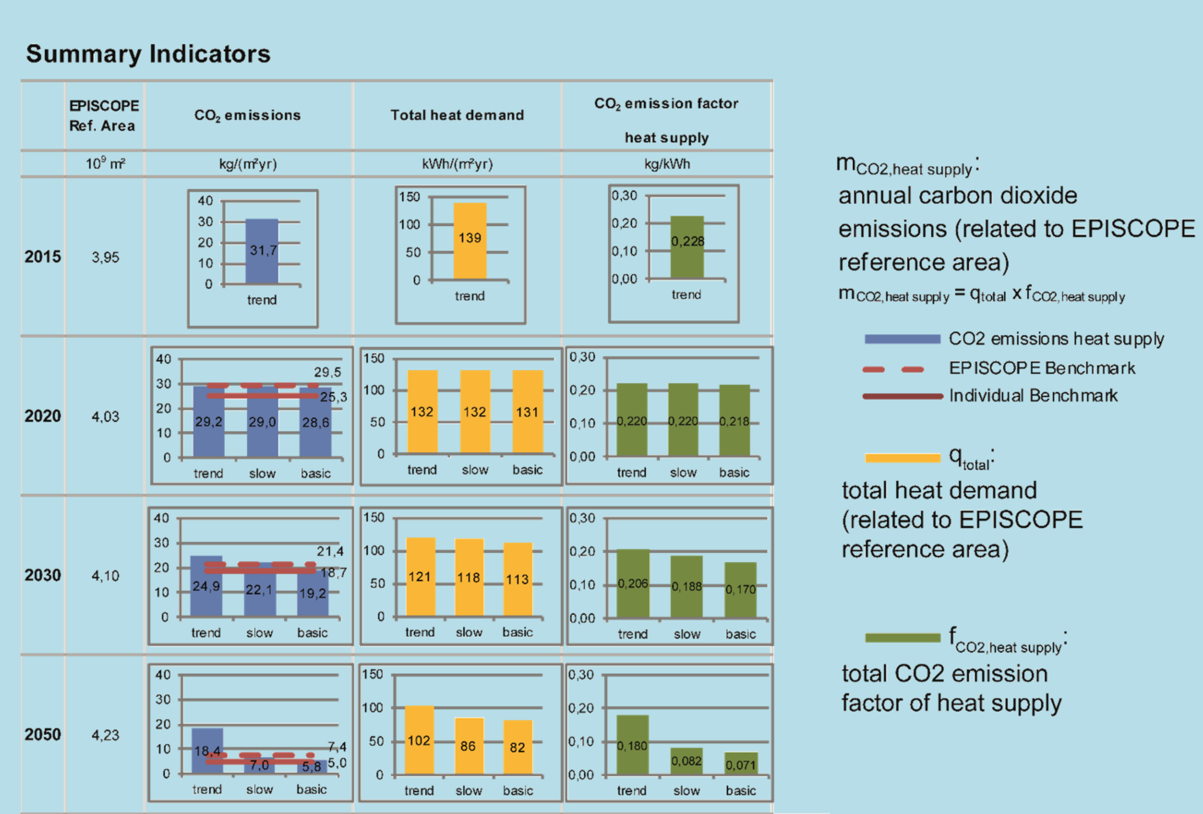
Existing data: Survey of > 7000 residential buildings from 2010



FINDINGS OF SCENARIO ANALYSES

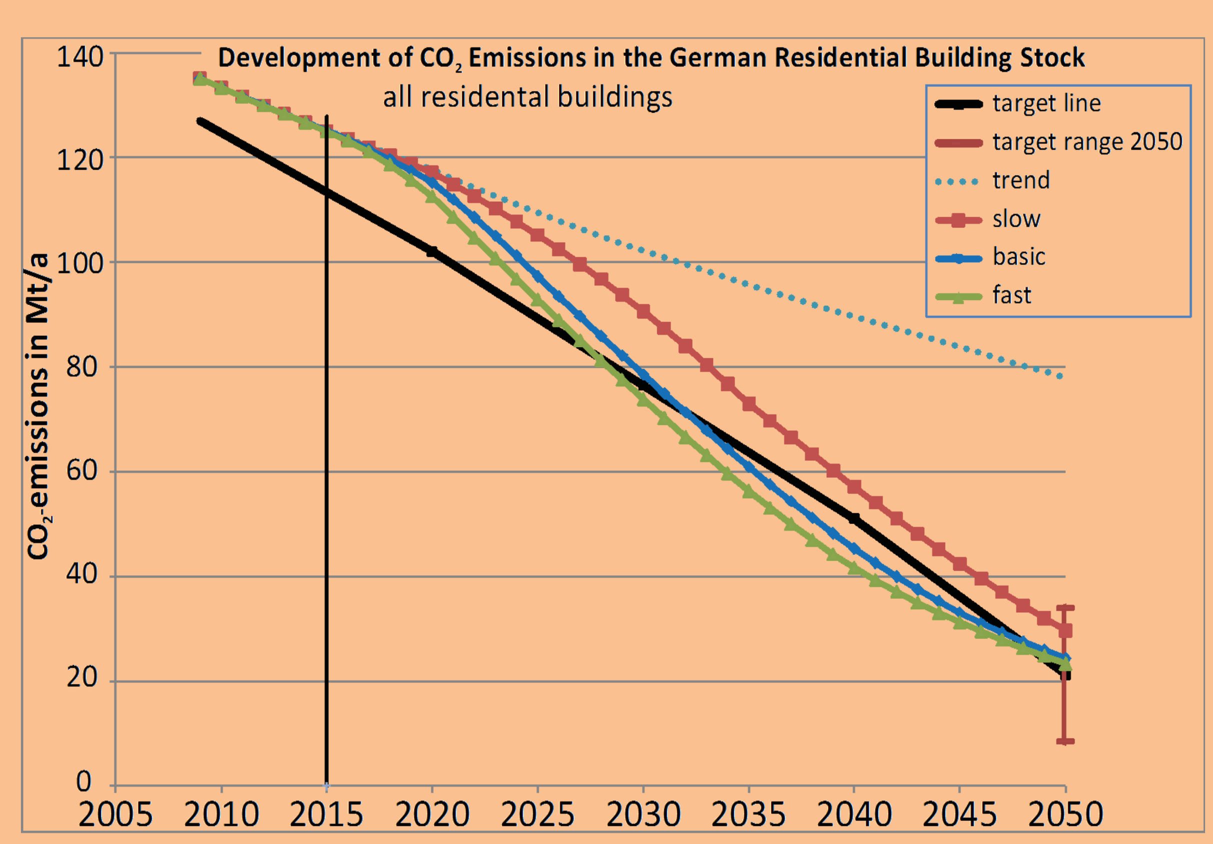
- Scenario "trend" is missing the target range in 2050
- Scenario "slow" is reaching the upper limit of the target range only
- Scenarios "basic" and "fast" approach the mean of the target range
- Cumulative emissions of the target line 2016 - 2050:
  - scenarios "trend" and "slow": clear overrun (+46 % / +16 %)
  - scenarios "basic" and "fast": (almost) keeping (+4 % / -1 %)
- Less favourable results considering all greenhouse gases (CO_2 equivalents)
- Assumed biomass potential of 100 TWh/a (lower calorific value):
  almost kept in basic and fast scenarios, slight overrun (< +10 %) in slow and trend scenarios

=> Scenario "basic" can provide orientation
(scenario "fast" might be too optimistic)



LESSONS LEARNED & RECOMMENDATIONS

- **Trend development is missing all targets => a clear change of course is necessary**
- **10 years targets: Continuous progress towards**
  - doubling the annual rate of building thermal modernisation
  - introducing a new structure among the newly installed main heat generators (pushing back gas and oil boilers, alternative systems > 90 %)
  - doubling the installation rate of solar systems (solar thermal or photovoltaics + heat pumps)
- **Long term targets**
  - > 75 % modernisation progress of thermal building insulation
  - heat supply in winter mainly by heat pumps and CHP
  - restructuring of electricity / district heating sectors towards > 50 % renewables
  - avoiding of fuel use (fossil / biomass) in summer
- **Regular monitoring scheme should be installed**
- **Target-oriented political instruments must come into effect at short term**



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IWU Institut Wohnen und Umwelt

Hungary

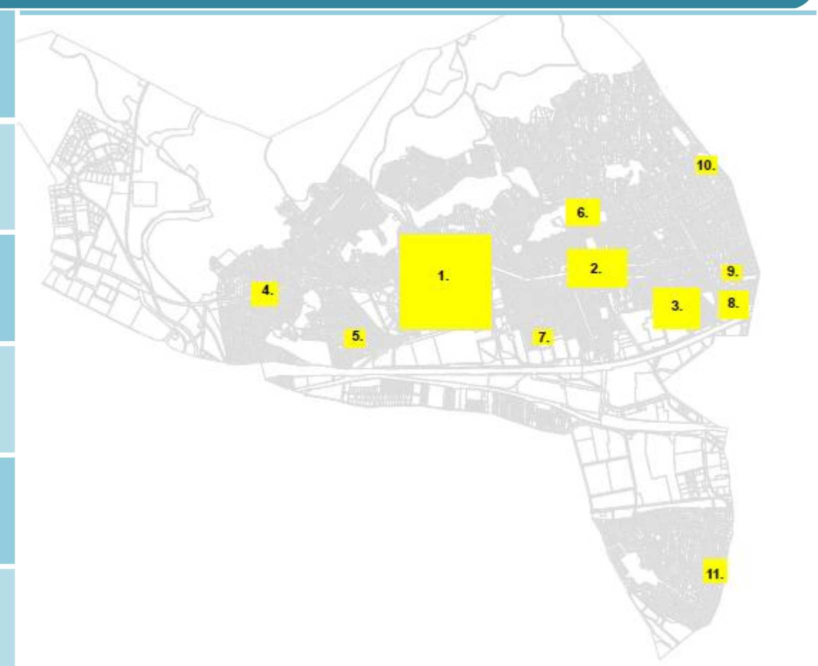
Budaörs

Co-funded by the Intelligent Energy Europe Programme of the European Union

STATUS: 10/2015

SCOPE

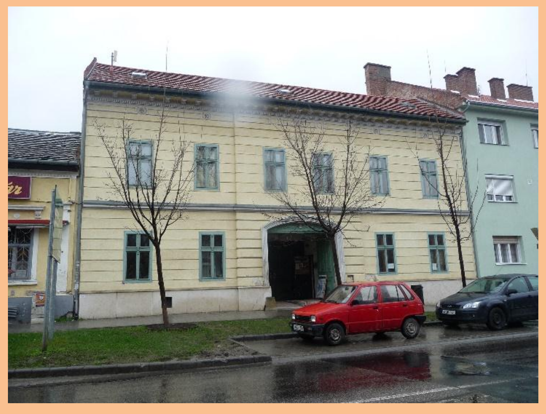
SCALE	Local
NUMBER OF DWELLINGS	10 000
NUMBER OF BUILDINGS	6 000
NUMBER OF INHABITANTS	24 000
m² NATIONAL REFERENCE AREA	1 311 000 useful floor area
m² EPISCOPE REFERENCE AREA	1 311 000

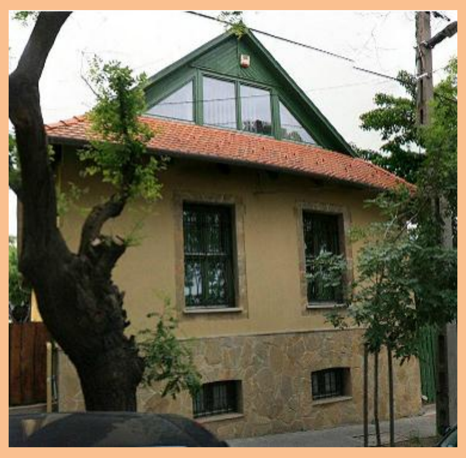


OVERVIEW OF ACTIVITIES

The objectives of this Pilot Action were the following:

1. Tracking refurbishment rates and progress in energy saving through an area-based approach. Gathering data about the building stock of the test area in particular on the current state of buildings. Data sources: GIS systems, database of the local government (mainly public buildings) and that of the housing association. We have determined the current retrofit rates on the basis of selected completed or ongoing projects, taking into account national standards
2. Identifying the efforts required for refurbishment to NZEB levels by mapping typologies
3. Elaborating guidance material for local stakeholders and other housing companies, municipalities and national stakeholders

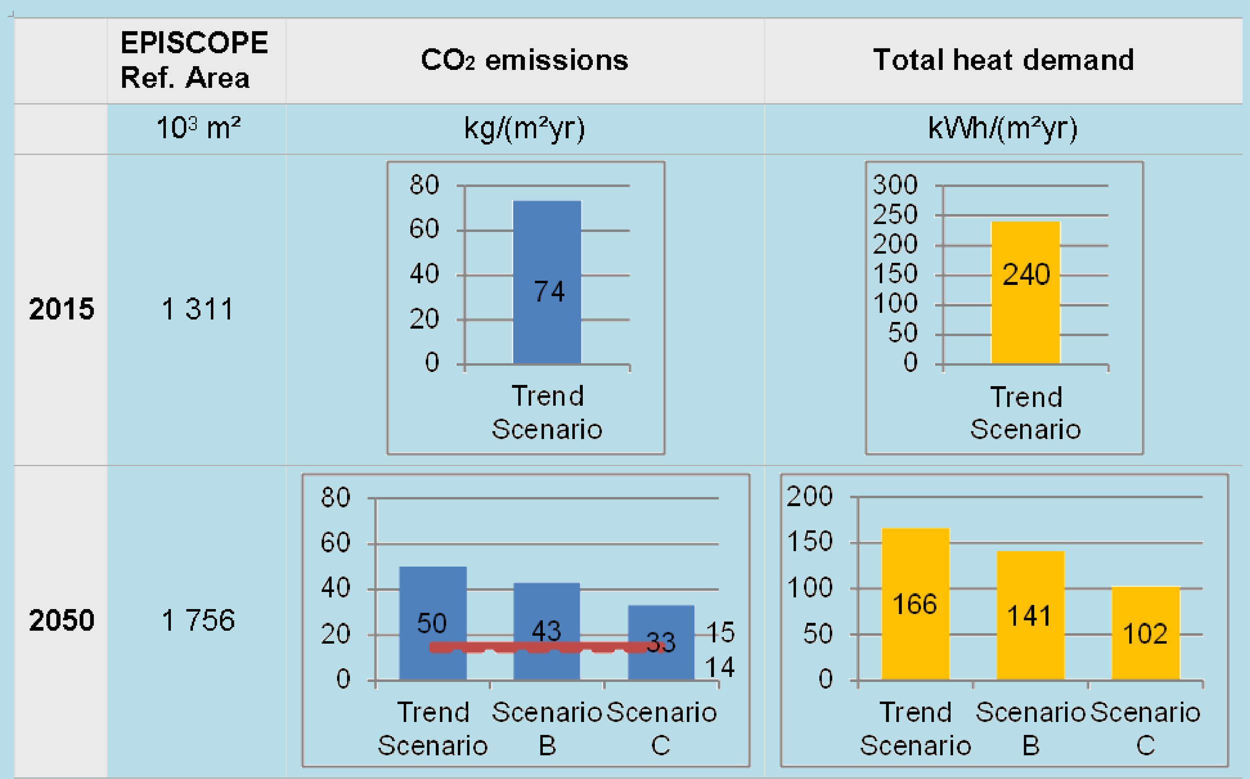




FINDINGS OF SCENARIO ANALYSES

To model potential future states, we have investigated 3 scenarios (Trend, B and C, with increasing commitment to refurbishments and NZEB standards). In summary, our results show that even the most ambitious scenario is insufficient to achieve 2050 targets (although 2030 target can be met this way). It should be noted that the 2050 values are only indicative – there are no nationally approved targets yet. The main reason for this is the considerable increase in building stock over the assessed period (by roughly 25%). The area selected for the pilot is in a unique position – such an expansion of the building stock is not expected elsewhere, therefore it may be reasonable to:

1. Define less ambitious targets for Budaörs
2. Be slightly more optimistic in terms of meeting the 2050 goals on a national level



LESSONS LEARNED & RECOMMENDATIONS

According to our analysis, the targets set for 2050 could only be reached with a refurbishment rate well over 3%, which is unrealistic, even for such a relatively wealthy town Budaörs. Achieving the targets would require much more significant subsidy actions. The CO_2 and energy saving goals are particularly challenging for Budaörs because it is foreseen that the city will continuously grow in the future. In the BAU scenario, emissions and energy consumption are projected to increase.

It is recommended that Budaörs elaborate an energy and carbon-dioxide saving strategy and action plan. It should cover not only the residential buildings, but also the commercial sector, because Budaörs has an important commercial area and an industrial park.

It is also recommended to build pilot nearly zero energy buildings, particularly in the public sector to provide best practice examples. Communication actions on the significance of energy efficiency would also be necessary particularly because many of the building owners have the financial means to carry out energy efficiency actions without additional financial support.

	2015	2020		2030		2050	
Absolute figures	Trend Scenario	Trend Scenario	Scenario C	Trend Scenario	Scenario C	Trend Scenario	Scenario C
natural gas	214	217.8	190.3	217.4	141.5	198	54.8
liquid gas	0	0	0	0	0	0	0
oil	0	0	0	0	0	0	0
coal	0	0	0	0	0	0	0
wood / biomass	55.9	56.9	60.7	56.7	66.6	51.6	61.1
district heating	13	12.9	12.6	12.8	12	11.4	9.2
electric energy (used for heat supply)	9.8	10	9.5	10	8.7	9.1	5.9

Final energy by fuel of the residential building stock, Budaörs, gross calorific value [GWh/yr]

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MŰEGYETEM 1782

EPISCOPE

Co-funded by the Intelligent Energy Europe Programme of the European Union

Czech Republic

Municipal housing stock of Havířov

STATUS: 10/2015

SCOPE

SCALE	Local – Municipal housing stock of Havířov, Czech Republic
NUMBER OF DWELLINGS	7,577
NUMBER OF BUILDINGS	225
NUMBER OF INHABITANTS	17,600
m² NATIONAL REFERENCE AREA	378,100 m² [Conditioned area]
m² EPISCOPE REFERENCE AREA	415,909 m²

OVERVIEW OF ACTIVITIES

Data acquisition

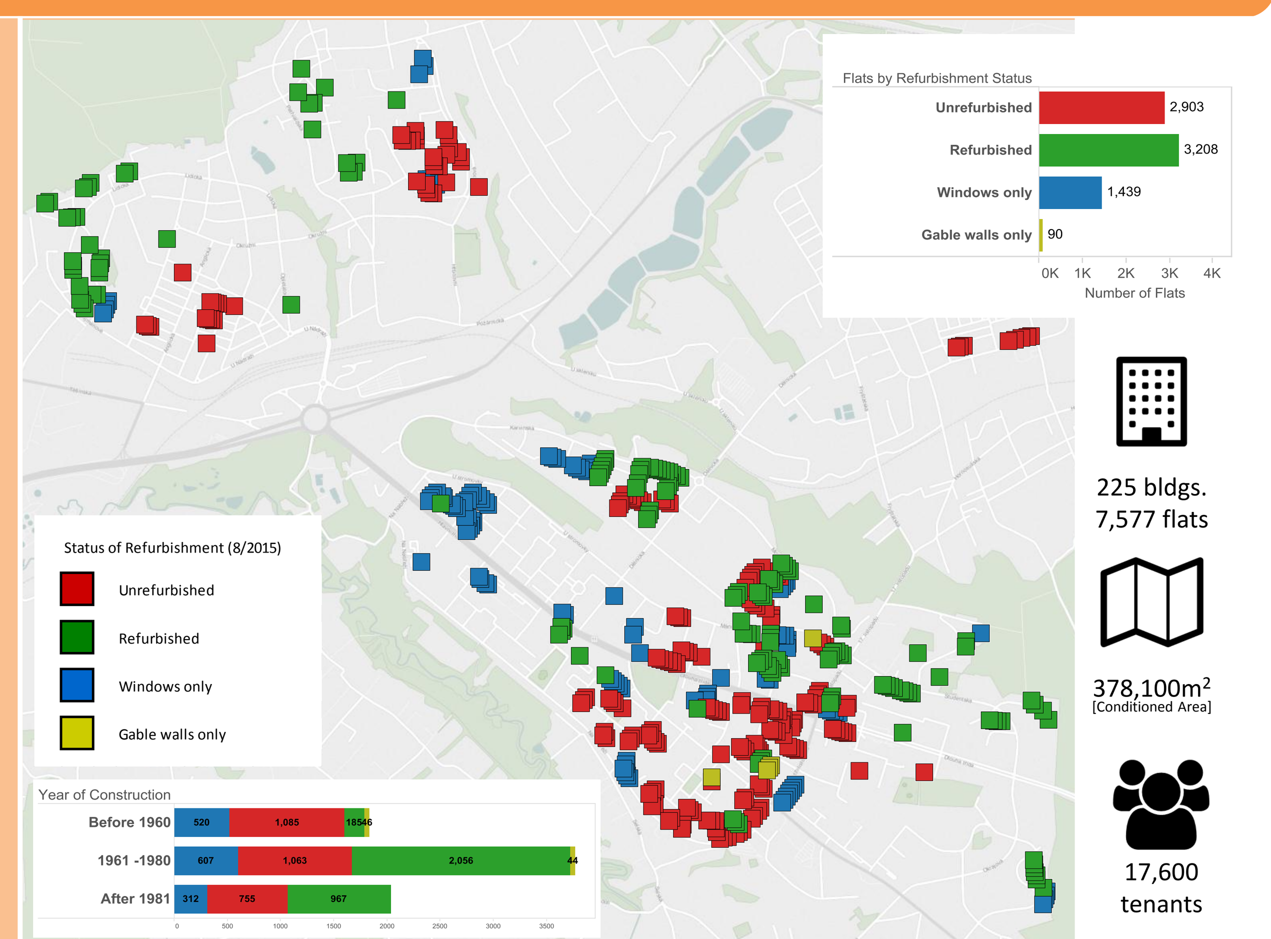
- Analysis of data about actual energy consumption for space heating at building / small district level
- Analysis of data about building envelope characteristics and refurbishment status at building level

Model set-up

- Clustering of the housing stock according to the national building typology:
    - 3 age periods (before 1960, 1961 – 1980, after 1981);
    - 2 size groups (MFH: Multi-family houses, and AB: apartment blocks)
- Setting up the models of "average" (synthetic) buildings for each cluster by adopting average geometrical and physical parameters for these "average" buildings

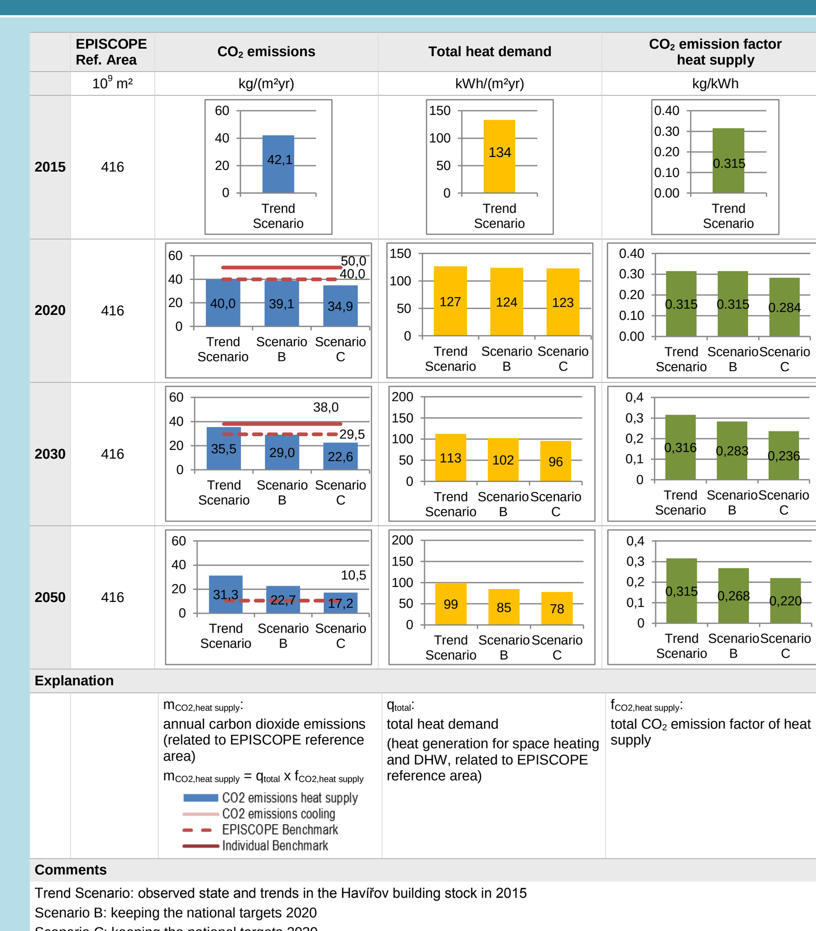
Scenario definition

- Is the current speed of renovation of the housing stock sufficient to meet the 2020 national targets?
- What optimized refurbishment strategies are needed to achieve targets for 2030 and 2050?



FINDINGS OF SCENARIO ANALYSES

- The current trend of energy refurbishment is sufficient to comply with the EPISCOPE and the national climate protection targets only until 2020.
- However, this trend is not acceptable as a long term strategy and there is a necessity to apply more efficient and intense energy saving measures.
- The largest energy saving potential is in the MFH II and AB II categories (1961 – 1980). This group accounts for 54% of the municipal housing stock by number of flats, and only about 50% has been renovated so far.
- Maintaining the high share of district heating will help achieving the targets, provided that the DH network continues being retrofitted with pressure-independent heat exchange stations.
- The progressive adoption of renewable energy sources as well as switching to less polluting fuels other than black coal would substantially decrease the primary energy demand.



LESSONS LEARNED & RECOMMENDATIONS

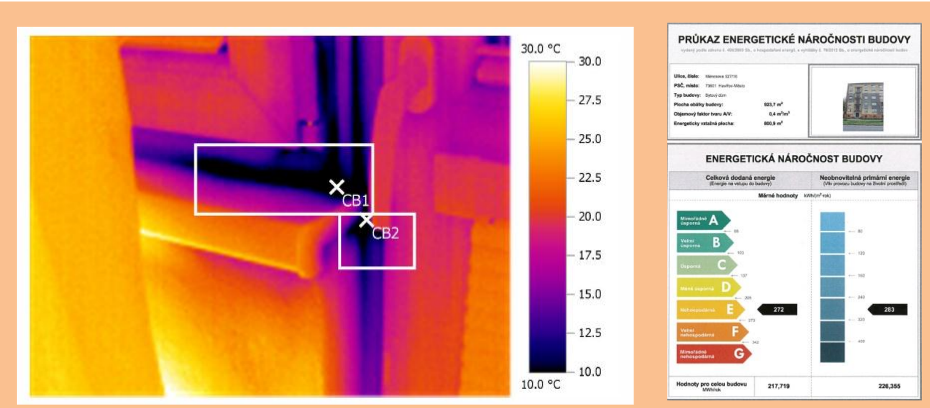
Lessons Learned

- Refinement and validation of the data sources are needed in order to increase the reliability of projections
- Deep renovation strategies are needed to achieve the targets
- It is needed to further explore the possibilities of modern technologies and the use of renewable energy sources:
    - Ventilation with heat recovery
    - Micro combined heat and power (micro-CHP)
    - Solar energy as the most suitable RES for the production of DHW in historical ("SORELA") buildings and high-rise buildings where the heat losses in distribution pipes are rather high.

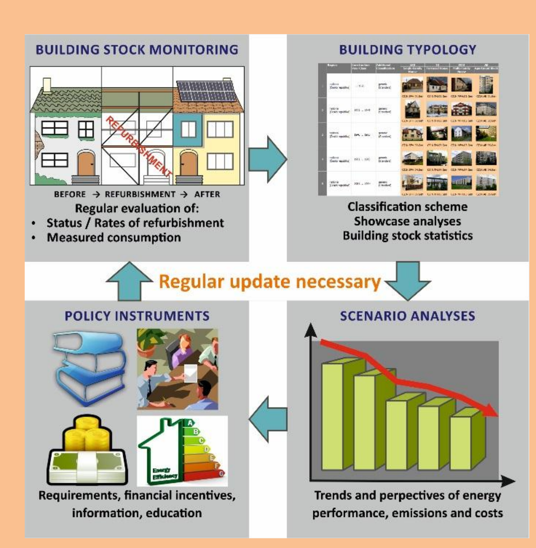
Recommendations

- Further analyse the overall housing stock of the city based on this pilot action
- Consider tenants' behaviour – to what extent it influences energy consumption? Improve users' behaviour through raising awareness and through motivation on savings
- Take into account the important role of split incentives between owners and tenants
- Identify barriers to deep renovation (bureaucratic, legal, financial instruments, etc.)
- Identify enablers to deep renovation (subsidy policies, deep renovation premiums, etc.)

VALIDATION



TRACKING OF THE REFURBISHMENT PROCESS



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