TABULA – RESIDENTIAL BUILDING TYPOLOGIES IN 12 EUROPEAN COUNTRIES – GOOD PRACTICE EXAMPLE FROM THE CZECH REPUBLIC

Tomáš VIMMR
STÚ – K, Czech Republic, t.vimmr@stu-k.cz

Tobias LOGA
IWU – Institut Wohnen und Umwelt, Germany, t.loga@iwu.de

Nikolaus DIEFENBACH
IWU – Institut Wohnen und Umwelt, Germany, n.diefenbach@iwu.de

Britta STEIN
IWU – Institut Wohnen und Umwelt, Germany, b.stein@iwu.de

Lucie BACHOVÁ
STÚ – K, Czech Republic, l.bachova@stu-k.cz

Summary

A common concept for residential building typologies has been developed and implemented in 13 European countries during the IEE project TABULA. It consists of a systematics for the classification of national housing stocks, a database of exemplary buildings, a common energy balance procedure and a frame for housing stock statistics. The features of typical buildings and heat supply systems and the potential energy savings by different kinds of measures can be explored with a special webtool. The residential building typologies can be utilised in the field of energy advice, for the development and assessment of legal requirements, and also as a basis of models for elaboration and validation of national energy saving strategies.

Keywords: building typology, energy savings, energy balance, refurbishment measures, building stock

1 Strategy and Method

In the European building sector the long-term climate protection targets can only be attained by considerably increasing the refurbishment rates as well as the energy quality of the implemented measures. Passive house or at least low-energy building components must therefore be promoted as highly recommended upgrade measures whenever possible. The dissemination of refurbishment standards beyond the national requirements can efficiently be supported by building typologies. Concept of exemplary buildings representing different national building types is used for showcasing the effect of standard and advanced refurbishment measures. Furthermore, the building typology provides a framework for assessing and measuring the effects of the refurbishment process in different segments of the building stock.

Project Partners

IWU	Institut Wohnen und Umwelt / Institute for Housing and Environment	**Germany**
NOA	National Observatory of Athens	**Greece**
ZRMK	Building and Civil Engineering Institute ZRMK	**Slovenia**
POLITO	Politecnico di Torino - Department of Energetics	**Italy**
ADEME	Agence de l'Environnement et de la Maîtrise de l'Energie / French Energy and Environment Agency	**France**
Energy Action	Energy Action Limited	**Ireland**
VITO	Flemish Institute of Technological Research	**Belgium**
NAPE	Narodowa Agencja Poszanowania Energii SA / National Energy Conservation Agency	**Poland**
AEA	Austrian Energy Agency	**Austria**
SOFENA	SOFIA ENERGY AGENCY	**Bulgaria**
MDH	Mälardalens univeristy	**Sweden**
STU-K	STU-K	**Czech Rep.**
SBi	Danish Building Research Institute	**Denmark**

Associated Partners

IVE	Instituto Valenciano de la Edificación (IVE)	**Spain**
Univ. Belgrade	Univerzitet u Beogradu - Arhitektonski fakultet / University of Belgrade - Faculty of Architecture	**Serbia**

Fig. 1 *Overview of the TABULA project partners*

Fig. 2 *Example of National "Building Type Matrix" Slovenia (www.building-typology.eu/country/typology-si.html)*

2 Classification of National Building Stocks by a „Building Type Matrix“ and Exemplary Buildings

Over the last few decades building typology approaches have been used in several European countries. At the beginning of the TABULA project a review of these existing experiences was carried out [3]. On this basis a common concept for the national building typologies was developed. The basic classification scheme is a “Building Type Matrix” which divides the national housing stocks by size and age (see example in Fig. 2) The columns define the four common building size classes "SFH" (single-family houses), "TH" (terraced houses), "MFH" (multi-family houses) and "AB" (apartment blocks). The rows of the matrix reflect subsequent national construction periods separately defined for each country.

To each building type (cell of the classification grid) an exemplary building is assigned which is represented by a photo and the thermal envelope data. Also typical systems of heating and hot water supply are considered. The exemplary building is supposed to be a typical representative of the building type, meaning that it has features which can commonly be found in houses of the respective age and size class. However, the properties of the exemplary building are not necessarily representative in a statistical sense.

In some countries a regional differentiation of the housing typologies was made to consider significant differences in climatic conditions and respective building characteristics.

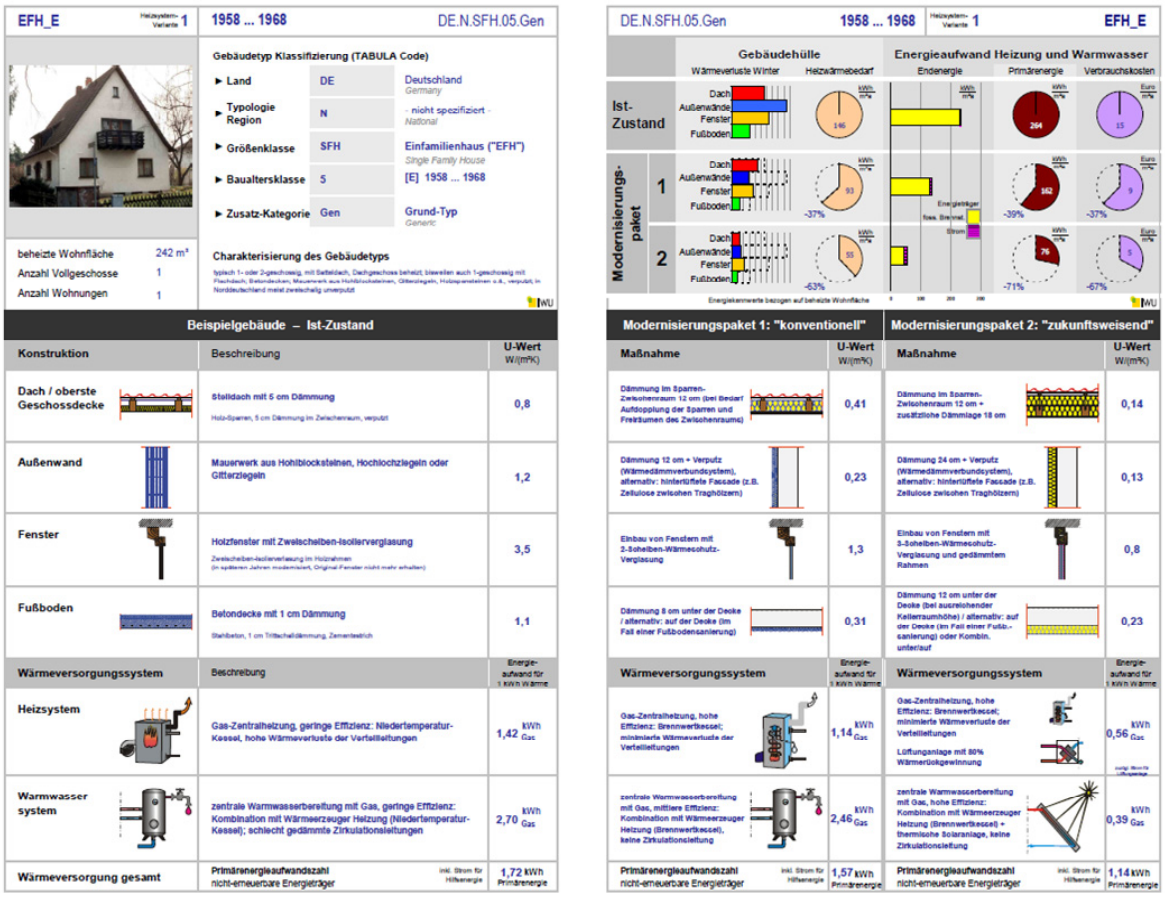

Fig. 3 *"Building Display Sheet" – existing state of an exemplary building and impact of refurbishment measures (extract from the German typology brochure [1])*

3 National Typology Brochures

For each country a "National Typology Brochure" has been elaborated in the respective language which contains different elements of the typology:

- the classification of the national residential building stock (building type matrix);
- frequencies of the building types and heat supply system types;
- "Building Display Sheets": a double page for each exemplary building showing the existing state of the building and the possible energy savings that can be reached by standard and advanced measures (see example in Fig. 4).

Two packages of energy conservation measures are defined for each country:

- "**Standard Measures**" (usual refurbishment): Package of measures for upgrading the thermal envelope and the heat supply system which are commonly realised during refurbishment; typically reflecting the national requirements for renovations.
- "**Advanced Measures**" (ambitious refurbishment): Package of measures for upgrading the thermal envelope and the heat supply system which are usually only realised in ambitious renovation projects; typically reflecting refurbishments on the level of passive house components.

The calculation of the energy consumption and energy savings for heating and hot water supply was carried out by the partners on the basis of national procedures.

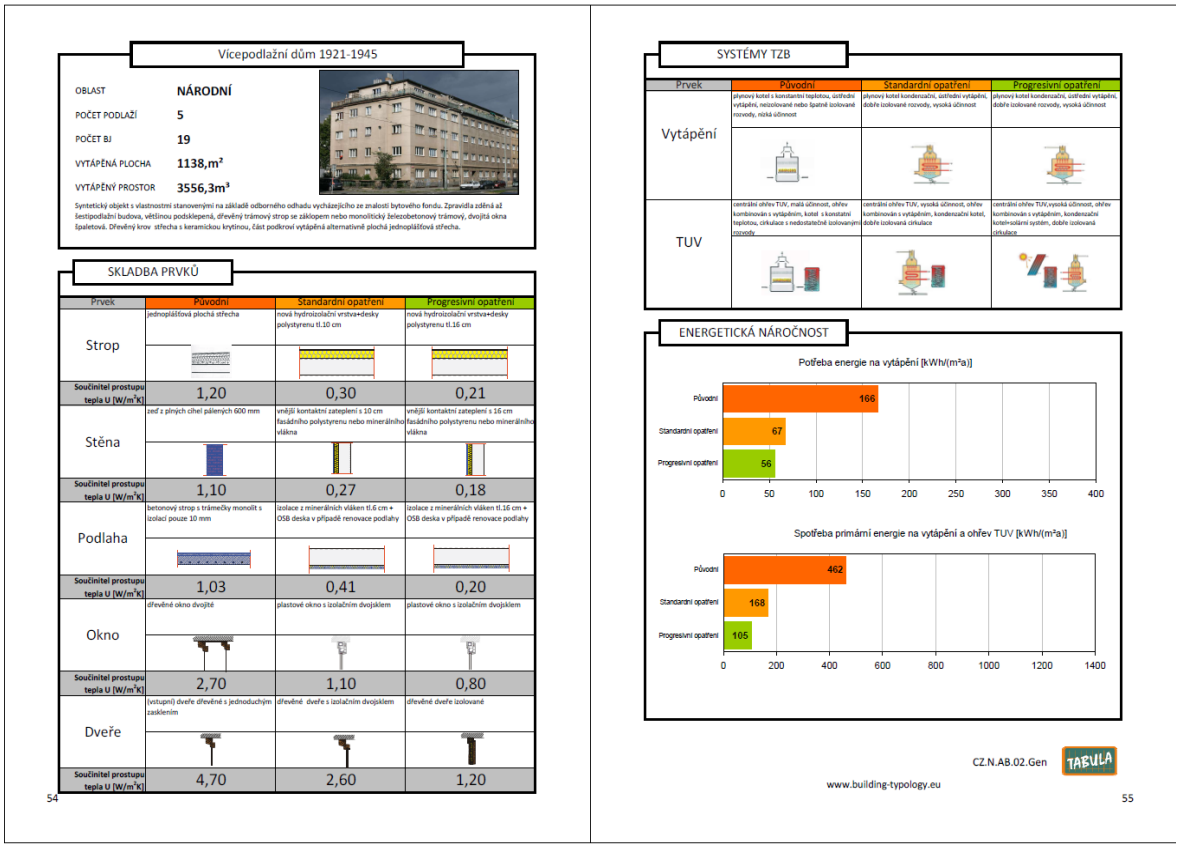

Fig. 4 *Building Display Sheet from the Czech Building Typology Brochure*

4 Tabula WebTool

For information exchange on the European level the "TABULA WebTool" has been developed (http://webtool.building-typology.eu). It enables online calculations of the exemplary buildings from all countries. It is based on a simple and transparent reference procedure for calculating the energy need, the energy use by energyware and the energyware assessment (primary energy, carbon dioxide, costs). The energy balance and the boundary conditions is based on the relevant CEN standards. A number of simplifications and adaptations facilitate the calculation of scenarios for housing stock samples, including an easy variation of supply system types. To enable a realistic assessment of energyware and heating costs savings an option to calibrate the calculated energy use to the typical levels of actual consumption is being provided. An example of a residential building typology, displayed by the TABULA WebTool is shown in Fig. 5 for the case of Danish typology.

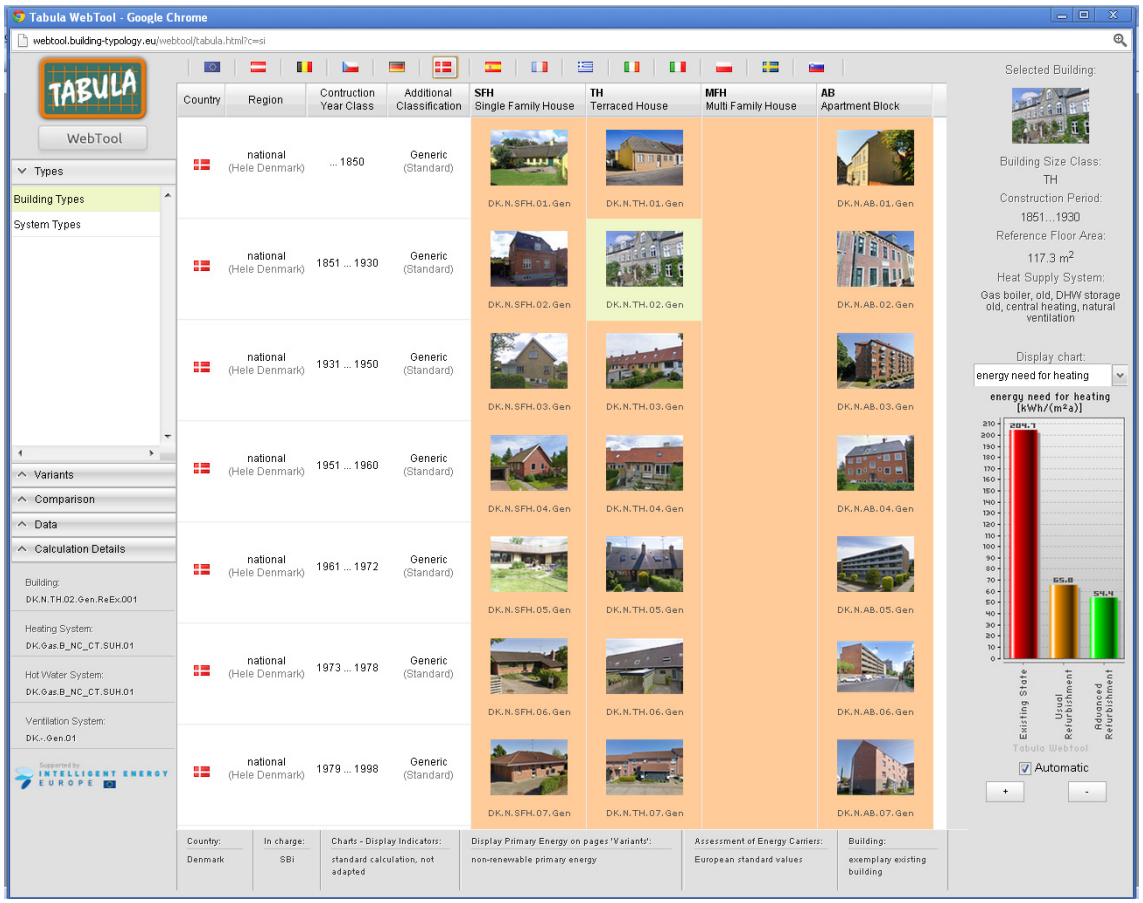

Fig. 5 *Danish Residential Building Typology, displayed by the TABULA WebTool*

In order to find a realistic basis for this calibration some of the project partners provided statistical analyses for large numbers of existing buildings showing the measured energy consumption as a function of the calculated results. An example from Belgium is given in Fig. 6.

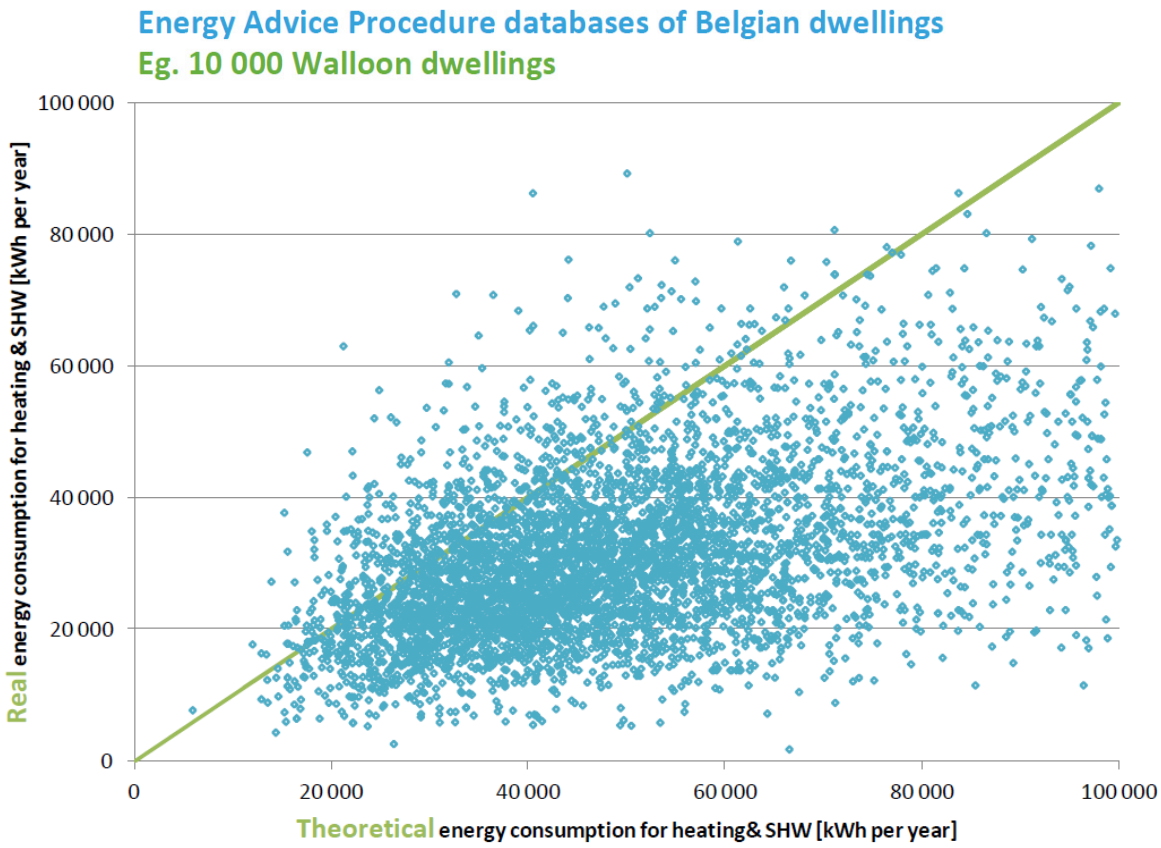

Fig. 6 *Measured vs. calculated energy consumption for space heating and DHW. Example from Belgium (circa 10 000 dwellings) [2]*

5 Cross-Country Comparison of Typical Buildings and Heat Supply Systems

An analysis of typological data included in the TABULA database has been performed to compare the energy related properties of buildings between the different countries. The following evaluations and cross-country comparisons have been realised:

- Average thermal envelope areas per m² reference floor area of the exemplary buildings, including dependencies on basic geometrical parameters;
- U-values by envelope type and construction period;
- energy performance indicators of heat supply components (see example in Fig. 7)

The results of the analyses can inter alia be used for a quality check of building and supply system data.

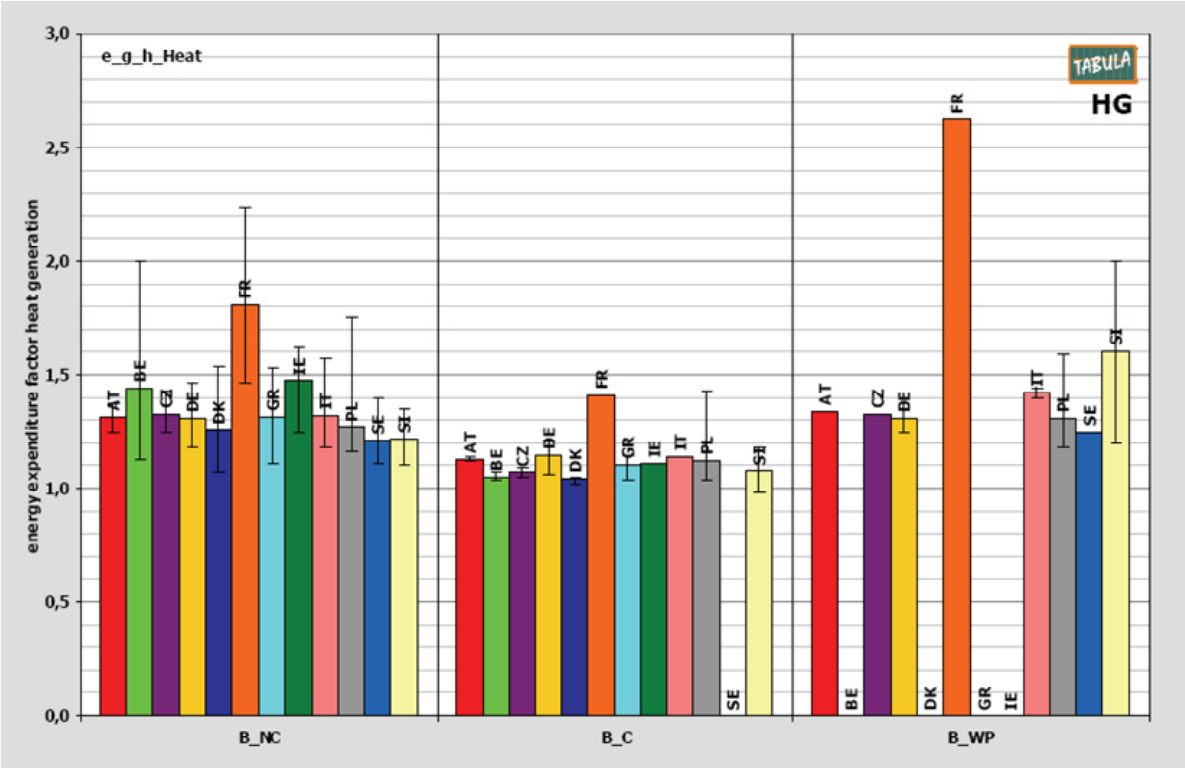

Fig. 7 *Comparison of system data between different countries.*
Example: energy expenditure factors (reciprocal values of annual mean boiler efficiency) of non-condensing, condensing and wood pellet boilers ("B_NC", "B_C", "B_WP") [5]

6 Models of the National Housing Stock

Building typologies can be used to create bottom-up models for the calculation of the energy consumption of the national building stocks. A typical application field is the investigation of energy saving potentials for a national or regional building stock as well as the design and evaluation of instruments and political strategies. In case of Czech Republic six reference building categories were created based on statistical values obtained from the national public database. The energy balance model was created on basis of the statistical data collected mainly from the National census 2001 and from the Microcensus ENERGO 2004. The delivered energy and the energy demand for space heating of the considered six groups of buildings was calculated using national calculation method. There was no national methodology available to calculate the national balance however the calculated results could be compared with the data published by the Ministery of Industry and trade and with PORSENNA report data (2007). The total calculated energy used for heating, DHW and lighting of the housing stock is 204,7 PJ. PORSENNA estimation for the year 2007 was 199 PJ. The table published by the Ministry of Industry and Trade in 2007 shows total energy consumption for the heating and DHW which is 214,75 PJ. The deviation of calculated result was ±2,5%.

7 Non-residential building

Apart from introducing or further developing of typologies for residential buildings, four European partners of the TABULA project (AEA/Austria, IWU/Germany, NOA/Greece, NAPE/Poland) have also dealt with national approaches for non-residential building typologies.

Because of the broad variety of uses and associated characteristics, setting up a typology for the non-residential sector is rather complex. It is therefore important to consider both, practicability of and data availability for such a structure.

In the reporting countries, available data sources and the knowledge about the non-residential building stock differ. In general, data from official statistics are fairly poor. For this reason, further knowledge is generated through national and European projects, energy audits and studies, e.g. in the framework of consulting activities. In Germany studies concerning the structure of a non-residential building typology, benchmarks, and end energy uses in the tertiary sector have been carried out. In Austria and Poland databases to collect benchmarks or data from energy certificates have been set up in the more recent past.

As there is a large variety of building uses and operational characteristics in the tertiary sector, it is necessary to classify buildings according to their use rather than their size. Accordingly, a preliminary classification (for example by TABULA partner NOA from Greece) could include the following building categories: schools, offices/commercial, hotels and hospitals. These categories define columns and subsequent national construction periods separately defined for each country represent rows of the non-residential building type matrix.

8 Conclusions

Building typologies are a good means to combine communication about refurbishment measures for single buildings with the overall building stock scope. The basic concept developed during TABULA can in the future be applied in different countries not only on the national level, but also for the assessment of regional and local housing stock subsets.

The selected building typology approach with above described calculation models has contributed to energy balance analysis of the national building stocks and enabled to estimate the energy saving potential and the potential for reduction of CO_2 emissions. The perspectives are mainly seen in the application of the same approach for fast and reliable analysis of different scenarios looked at the housing stock.

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