INTELLIGENT ENERGY EUROPE

Typology Approach for Building Stock Energy Assessment

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project duration: June 2009 - May 2012

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I. Project Idea & Objectives

II. Common Typology Structure

III. Outcome / Results

IWU Institut Wohnen und Umwelt — Institute for Housing and Environment

founded 1971, tasks:

- research, in interdisciplinary cooperation, present forms of housing and living conditions;
- contribute to improving the housing conditions of socially weaker groups;
- investigate possibilities of minimized, efficient and environmentally and socially acceptable energy use.

„IWU-Haus": office building from the 1960s refurbished by use of passive house components

40 staff members:

- building engineers
- mechanical engineers
- architects
- economists
- social scientists
- physicists
- ecologists
- jurists

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 Agen	**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**

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Website www.building-typology.eu

I. Project Idea & Objectives

Challenge: „Energy Efficient Building Stock“

assessments and decisions
on European, national, regional level
(governments, municipalities, public funds,
housing companies, associations ...)

models of the building portfolio

showcase & forecast — design

ex post evaluation — + adjust

impact of policies and measures, refurbishment strategies,
legal requirements, funding, … / achieved refurbishment rates,
energy savings, economical consequences, ...

TABULA idea: Typology Approach for Building Stock Energy Assessment

examplary model building:
image of a distinct real building
(geometry, construction elements)
➔ showcase / demonstration
(energy advice, design of political instruments)

set of model buildings:
image of the whole stock
(energy performance + frequencies)
➔ refurbishment strategies
(overall impact of
political instruments)

Strategic Objective:
National Building Typologies
= public data source for bottom-up models

Main Project Objectives

- Elaboration of national building typologies on the basis of a harmonised concept.
- Applications on national level for showcasing and (if possible) for building stock modelling.
- Comparison of the building features, refurbishment measures and energy performance indicators between countries.

Project Steps

- Collect information about already existing building typologies (structure, application fields).
- Develop a common structure for building typologies.
- Fill the structure with data for each participating country and use it in specific national applications (typology brochure).
- Determine and update statistics for buildings and systems.
- Implement a webtool for show-case calculations and use it for dissemination purposes.

II. Common Typology Structure

- **Building Type Matrix**
- **TABULA Reference Calculation Procedure**
- **Common Database**

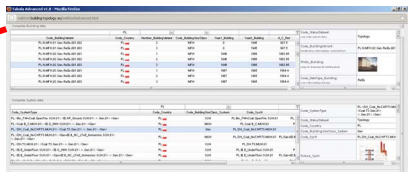
Key Element: The Building Type Matrix

1 classification grid

4 building size classes

construction year classes (individual number)

4 average buildings
datasets

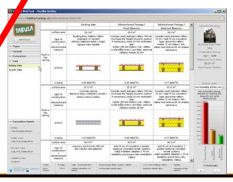


3 statistics / frequencies

Statistic S-1.1: Frequency of building types of the national building stock

Building period	Total number of buildings: Excluded listed buildings and buildings without heating installation			Heated external area [m²] Included heated business area. Excluded listed buildings and buildings without heating installation		
	Single-family houses	Terrace houses	Apartment Blocks	Single-family houses	Terrace houses	Apartment Blocks
Far 1850	35.803	3.632	1.714	17.215.006	478.743	833.196
1851 - 1930	297.832	24.873	41.672	35.706.073	3.237.158	25.458.577
1931 - 1950	134.001	14.204	16.659	16.793.524	1.883.409	14.890.413
1951 - 1960	108.299	15.608	5.574	13.548.084	2.176.005	8.011.232
1961 - 1972	273.139	31.965	8.594	39.052.489	4.649.885	14.264.179
1973 - 1978	147.183	24.163	2.102	22.999.832	3.764.563	4.525.897
1979 - 1998	127.005	81.801	8.647	18.215.274	12.932.598	7.957.695
1999 - 2006	48.836	24.895	3.385	7.809.797	4.117.519	3.838.907
Efter 2007	31.525	13.531	1.642	7.342.484	2.123.698	2.620.386
Total	1.203.623	234.672	87.989	178.682.543	35.363.578	82.400.482

2 example building
picture + envelope data
of an existing building



TABULA Reference Calculation Procedure

Energy need for heating

Standard reference calculation - based on: EN ISO 13790 / seasonal method; standard boundary conditions + relevant national climate data

Energy performance of the supply system

Standard reference calculation - based on: EN ISO 15316 / level B (tabled values); tabled values for heat generation, storage, distribution and auxiliary energy - each for space heating and domestic hot water; determined for each country by use of the relevant national EPC methods

Assessment of energywares

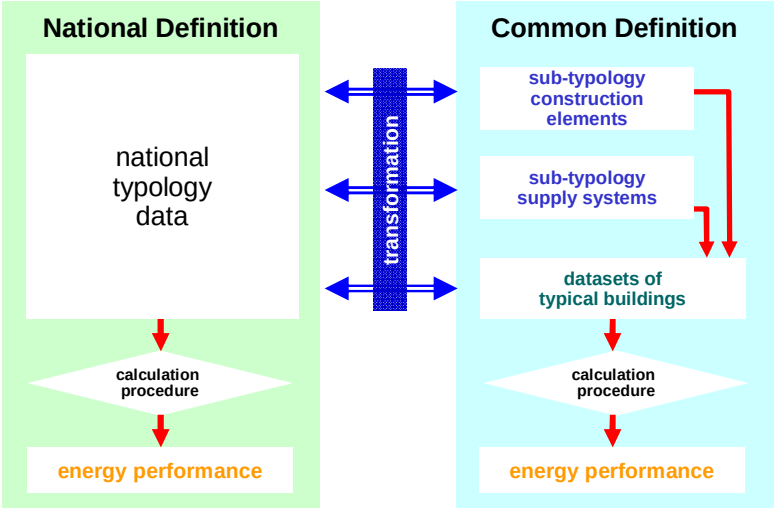
Determination of primary energy demand, carbon dioxide emissions, energy costs

Calibration to the typical level of measured consumption

=> two energy performance indicators:

1. standard reference values (for standardised comparison)
2. adapted values (for realistic assessment of heating costs, energy savings, ...)

Building Database: Two-Track Approach

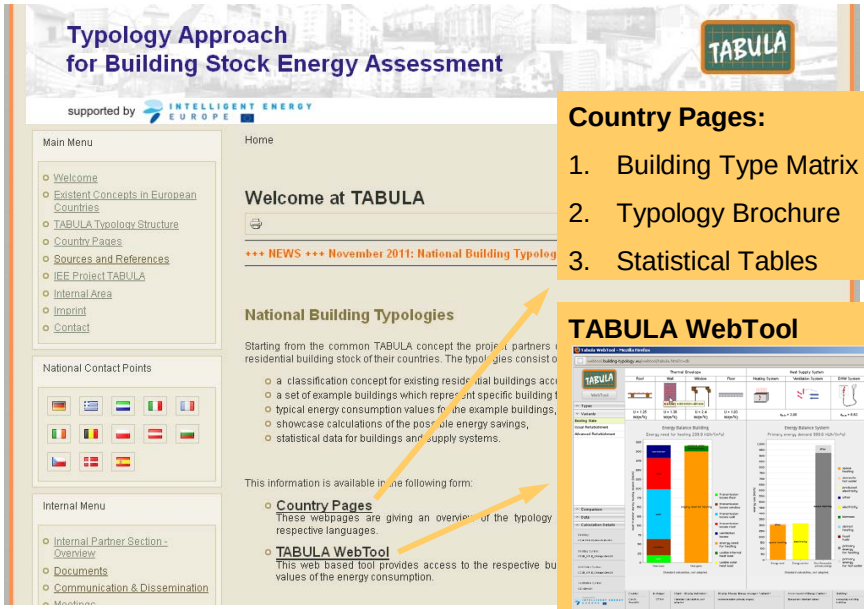


Each TABULA project partner provides and maintains the necessary transformation from one to the other structure for his country.

III. Outcome / Results

- TABULA Synthesis Report (June 2010):
  "Use of Building Typologies for Energy Performance Assessment of National Building Stocks. Existent Experiences in European Countries and Common Approach" in English language (published)
- National Scientific Reports
  in English language (in process)
- National Typology Brochures
  in national languages (partly published)
- further reports dealing with special topics: data collection, national energy balances, non-residential buildings (in process)
- **Publication of national typologies by TABULA website + webtool**
  for each country: classification scheme, datasets, measures, energy savings, frequencies

Online Publication – www.building-typology.eu



Country Pages:

1. Building Type Matrix
2. Typology Brochure
3. Statistical Tables

TABULA WebTool

National Building Type Matrices

	Region	Construction Year Class	Additional Classification	SFH Single-Family House	TH Terraced House	MFH Multi-Family House	AB Apartment Block
1	national (Slovenija)	... 1945	generic (Tipična)	SI.N.SFH.01.Gen	SI.N.TH.01.Gen	SI.N.MFH.01.Gen	SI.N.AB.01.Gen
2	national (Slovenija)	1946 ... 1970	generic (Tipična)	SI.N.SFH.02.Gen	SI.N.TH.02.Gen	SI.N.MFH.02.Gen	SI.N.AB.02.Gen
3	national (Slovenija)	1971 ... 1980	generic (Tipična)	SI.N.SFH.03.Gen	SI.N.TH.03.Gen	SI.N.MFH.03.Gen	SI.N.AB.03.Gen
4	national (Slovenija)	1981 ... 2001	generic (Tipična)	SI.N.SFH.04.Gen	SI.N.TH.04.Gen	SI.N.MFH.04.Gen	SI.N.AB.04.Gen
5	national (Slovenija)	2002 ... 2008	generic (Tipična)	SI.N.SFH.05.Gen	SI.N.TH.05.Gen	SI.N.MFH.05.Gen	SI.N.AB.05.Gen
6	national (Slovenija)	2009 ...	generic (Tipična)				

at – Austria
be – Belgium
cz – Czech Rep.
de – Germany
dk – Denmark
es – Spain
fr – France
gr – Greece
ie – Ireland
it – Italy
pl – Poland
rs – Serbia
se – Sweden
si – Slovenia

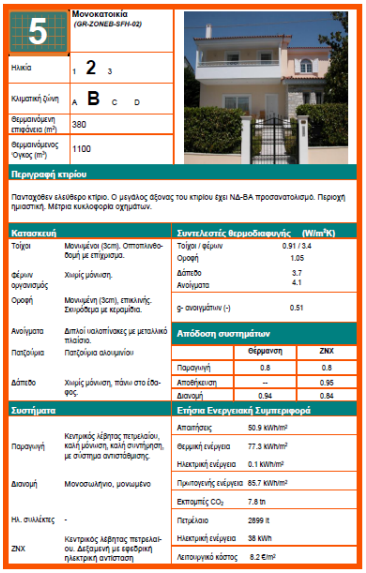
National Typology Brochures

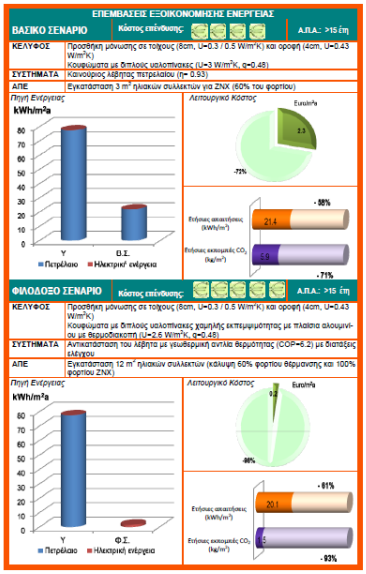
- classification of the national building stock / display of the building type matrix
- frequencies of the building types
- typical energy consumption values of exemplary buildings
- effect of refurbishment measures:
  level “standard” and “advanced”
- building display sheets: existing state + 2 refurbishment packages

written in the language of the respective country.

National Typology Brochures – Building Display Sheets
Example

Greece

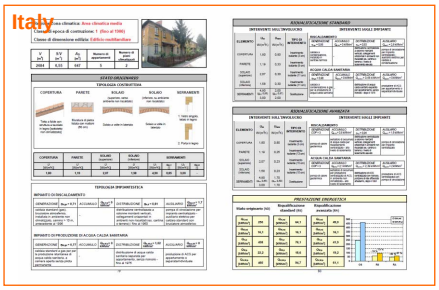




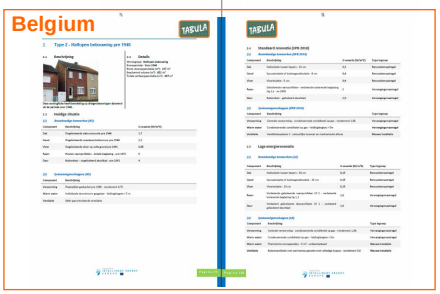
National Typology Brochures – Building Display Sheets
Further Examples

Austria

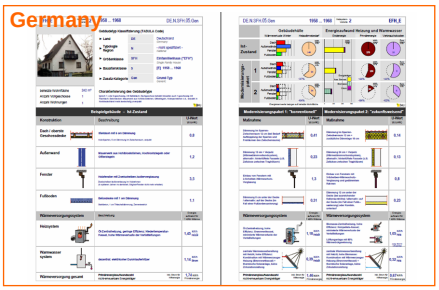
Italy



Belgium



Germany



Statistical Tables – Systematics

Statistical Table	Item
S-1.1	Frequency of building types of the national building stock
S-1.2.1	Percentage of thermally refurbished envelope areas
S-1.2.2	Information on insulation level and window types
S-2.1	Centralisation of the heat supply (for space heating)
S-2.2	Heat distribution and storage of space heating systems
S-2.3	Heat generation of space heating systems
S-2.4	Heat distribution and storage of domestic hot water systems
S-2.5	Heat generation of domestic hot water systems
S-2.6	Solar thermal systems
S-2.7	Ventilation systems
S-2.8	Air-conditioning systems
S-2.9	Control of central heating systems

Statistical Tables – *Example*

Germany

Statistic S-1.1: Frequency of building types of the national building stock

	construction year class	SFH	TH	MFH	AB	sum
		number of buildings (1000)				
1	... 1859	370		50		420
2	1860 ... 1918	1 040	350	380	10	1 780
3	1919 ... 1948	1 280	800	460	10	2 550
4	1949 ... 1957	920	480	390	30	1 820
5	1958 ... 1968	1 580	670	550	60	2 860
6	1969 ... 1978	1 470	650	320	80	2 520
7	1979 ... 1983	750	380	160	30	1 320
8	1984 ... 1994	1 040	540	210	40	1 830
9	1995 ... 2001	1 080	500	200		1 780
10	2002 ...	790	300	70		1 160
sum		10 320	4 670	2 790	260	18 040
fraction		57%	26%	15%	1%	100%

	construction year class	SFH	TH	MFH	AB	sum
		number of dwellings (1000)				
1	... 1859	510		170		680
2	1860 ... 1918	1 370	470	1 490	180	3 510
3	1919 ... 1948	1 720	960	1 920	260	4 860
4	1949 ... 1957	1 240	570	2 000	570	
5	1958 ... 1968	2 150	770	2 800	1 450	
6	1969 ... 1978	1 930	760	1 500	2 480	
7	1979 ... 1983	940	400	990	570	
8	1984 ... 1994	1 230	590	1 060	1 290	
9	1995 ... 2001	1 250	540	1 600		
10	2002 ...	880	310	510		
sum		13 220	5 370	14 040	6 800	
fraction		34%	14%	36%	17%	

	construction year class	SFH	TH	MFH	AB	sum
		living space (million m²)				
1	... 1859	51		13		
2	1860 ... 1918	155	43	112	10	
3	1919 ... 1948	173	91	134	17	
4	1949 ... 1957	127	57	131	31	
5	1958 ... 1968	221	76	197	84	
6	1969 ... 1978	213	78	109	127	
7	1979 ... 1983	111	47	69	39	
8	1984 ... 1994	148	66	76	84	
9	1995 ... 2001	152	62	119		
10	2002 ...	114	37	41		
sum		1465	557	1001	392	
fraction		43%	16%	29%	11%	

	construction year class	SFH	TH	MFH	AB	sum
		TABULA reference area (million m²)				
1	... 1859	56		14		
2	1860 ... 1918	171	47	123	11	

Statistic S-1.2.1: Percentage of thermally refurbished envelope areas

percentages related to building numbers of the respective classes SFH I - MFH II

Percentage of modernised element area (with improved thermal protection)

Building classes	SFH I	SFH II	MFH I	MFH II
	until 1978	1979-1994	until 1978	1979-
walls	20%	7%	26%	
roofs / upper floor ceilings	47%	24%	48%	
basement / cellar ceiling	10%	3%	11%	
windows*	35%	12%	44%	

modernisation of buildings erected after 1995 (SFH III and MFH III) neglected

*percentage of thermal protection glasing (window installation after 1995)

Statistic S-1.2.2: Information on insulation level and window types

S-1.2.2.1: Insulation thicknesses of refurbished Elements

numbers related to modernised elements	
Average values of insulation layer thickness	
walls	8,7 cm
roofs / upper floor ceilings	12,8 cm

Statistic S-2.3: Heat generation of space heating systems

Heat Generator Types

percentages related to: dwellings in all residential buildings of the classes SFH I - MFH III

Heat Generators for Space Heating		SFH			MFH		
		SFH I	SFH II	SFH III	MFH I	MFH II	MFH III
Heat Generators	Energy Carrier						
	District Heating						
	District Heating	1,4%	2,3%	3,6%	12,0%	22,2%	11,6%
	Building / Apartment Heating Systems						
Boilers	Gas	43,6%	48,1%	66,4%	52,5%	61,9%	77,9%
	Oil	39,4%	40,6%	18,7%	25,6%	12,7%	5,2%
	Biomass	4,1%	3,0%	2,9%	2,3%	0,5%	3,2%
	Coal	0,3%	0,0%	0,0%	0,1%	0,0%	0,0%
Heat Pump	Electricity	1,0%	1,7%	6,1%	1,3%	0,0%	1,4%
	Gas	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
CHP Enginge	Gas	0,0%	0,0%	0,0%	0,1%	0,0%	0,3%
direct electric	Electricity	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
	Room Heating Systems						

Additional Activity (5 Partners): Energy Balance of the National Residential Building Stock

- energy balance calculation
- comparison to national energy statistics
- calculation of energy saving potentials

Example

Germany

Calculated energy consumption of the German residential building stock (2009) for space heating and hot water (model calculations)

	SFH I	SFH II	SFH III	MFH I	MFH II	MFH III	total
final energy consumption for space heating (10^9 kWh/a)							
district heating	3,2	1,1	1,0	15,6	6,6	1,4	**28,8**
gas	106,6	22,9	17,6	73,3	19,6	9,6	**249,5**
oil	98,0	19,9	5,1	36,6	4,1	0,6	**164,4**
biomass	32,4	6,0	3,0	7,5	0,4	0,6	**49,9**
coal	2,2	0,0	0,0	0,8	0,0	0,0	**3,0**
electricity	8,0	2,3	1,4	3,9	0,9	0,3	**16,8**
total	**250,4**	**52,2**	**28,1**	**137,6**	**31,7**	**12,4**	**512,4**
final energy consumption for hot water (10^9 kWh/a)							
district heating	0,6	0,3	0,4	2,3	1,1	0,4	**5,1**
gas	18,6	5,7	5,6	12,0	3,3	2,8	**48,1**
oil	14,0	4,2	1,5	5,1	0,7	0,2	**25,7**
biomass	1,5	0,3	0,3	0,5	0,0	0,1	**2,8**
coal	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
electricity	5,1	0,8	0,7	3,5	1,1	0,4	**11,5**
total	**39,8**	**11,3**	**8,5**	**23,4**	**6,2**	**3,9**	**93,0**
total final energy consumption for space heating and hot water (10^9 kWh/a)							
district heating	3,7	1,3	1,4	17,9	7,7	1,8	**33,8**
gas	125,2	28,6	23,2	85,3	23,0	12,3	**297,6**
oil	112,0	24,1	6,7	41,6	4,8	0,8	**190,0**
biomass	33,9	6,3	3,3	8,0	0,5	0,7	**52,7**
coal	2,2	0,0	0,0	0,8	0,0	0,0	**3,0**
electricity	13,1	3,0	2,1	7,4	2,0	0,7	**28,3**
total	**290,1**	**63,4**	**36,7**	**161,0**	**37,9**	**16,3**	**605,4**

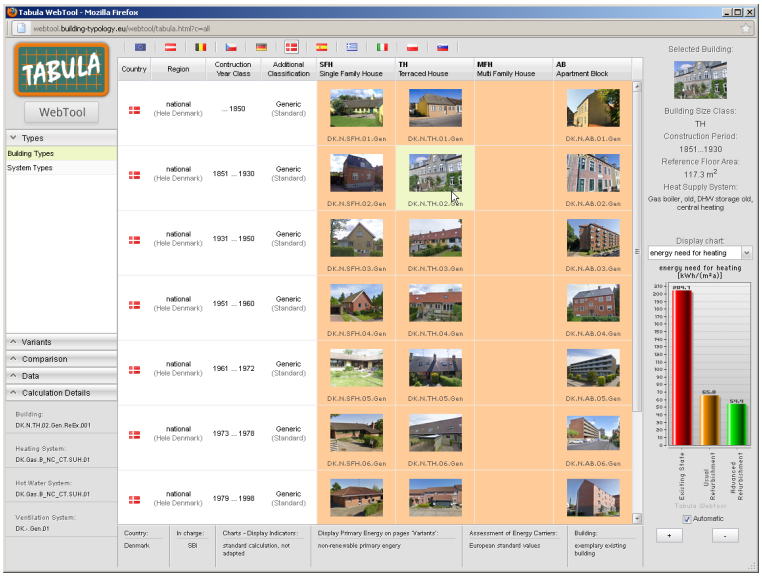
Comparison of model results with national energy statistics (mean values 2005 – 2009

	National Energy Balance				
	Energy Consumption (10^9 kWh)				
	National Statistics average 2005-2009 (Energy Consumption of households)	**TABULA model (first test)**	**deviation**	related to: single value	related to: total value
district heating	43	34	-10	-22%	-1,63%
gas	272	298	25	9%	4,31%
oil	171	190	19	11%	3,29%
biomass	59	53	-6	-10%	-1,00%
coal	11	3	-8	-72%	-1,32%
electricity*	34	28	-6	-17%	-0,96%
Summe	**590**	**605**	16	3%	2,69%

* electricity for heating and hot water (estimations)

IWU

WebTool: Building Types and Exemplary Buildings



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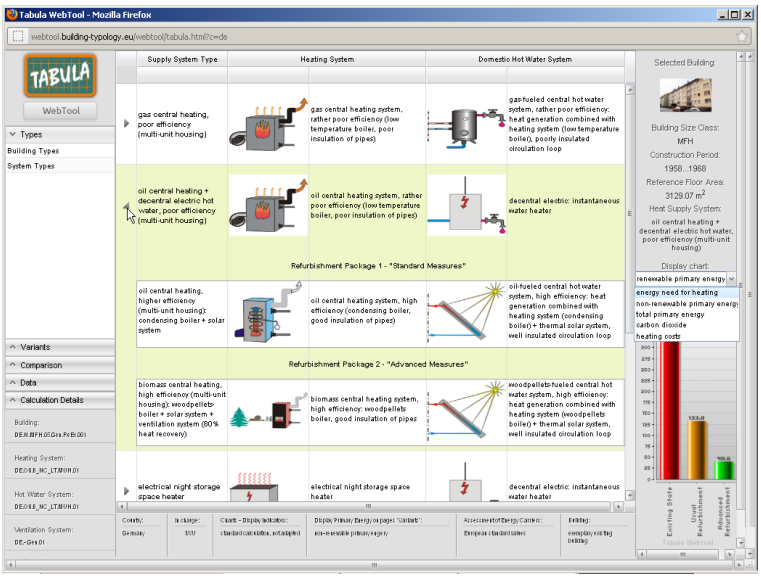
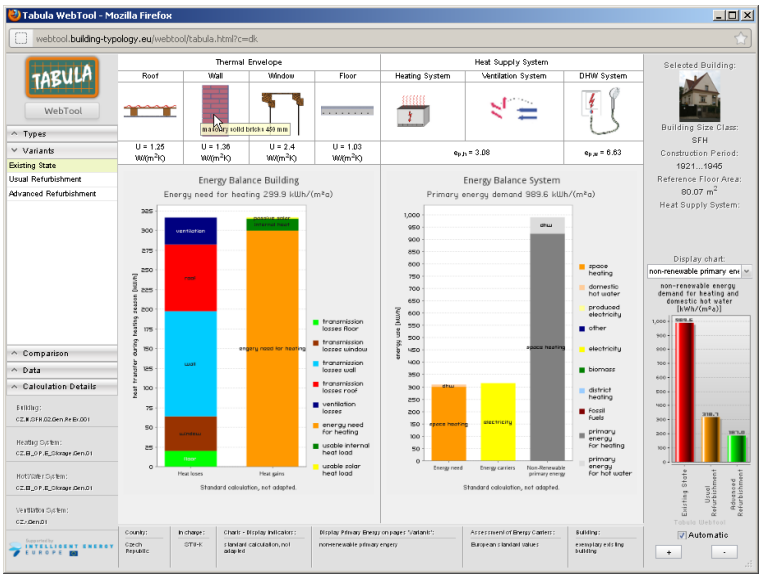
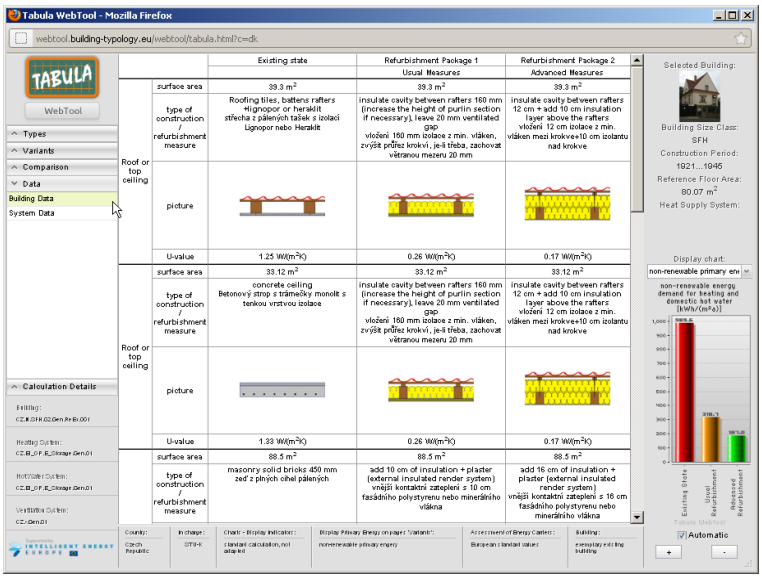
Exemplary Heat Supply Systems



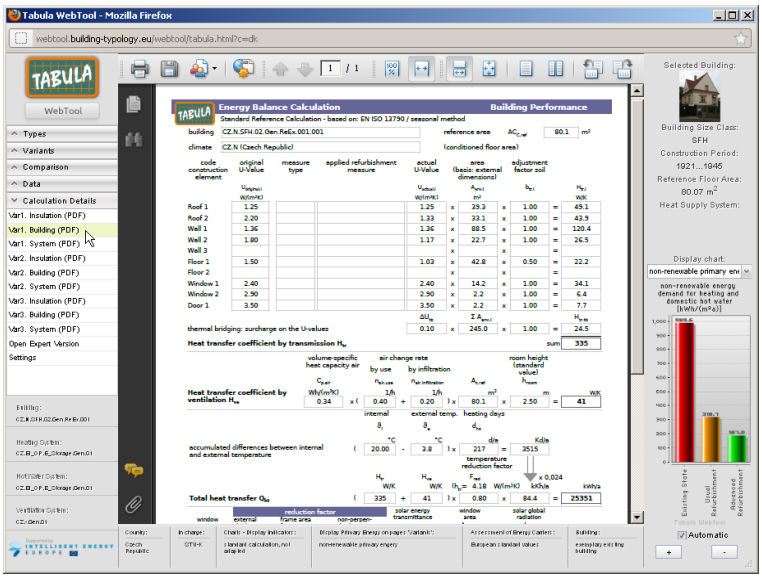
Energy Balance of 3 Variants



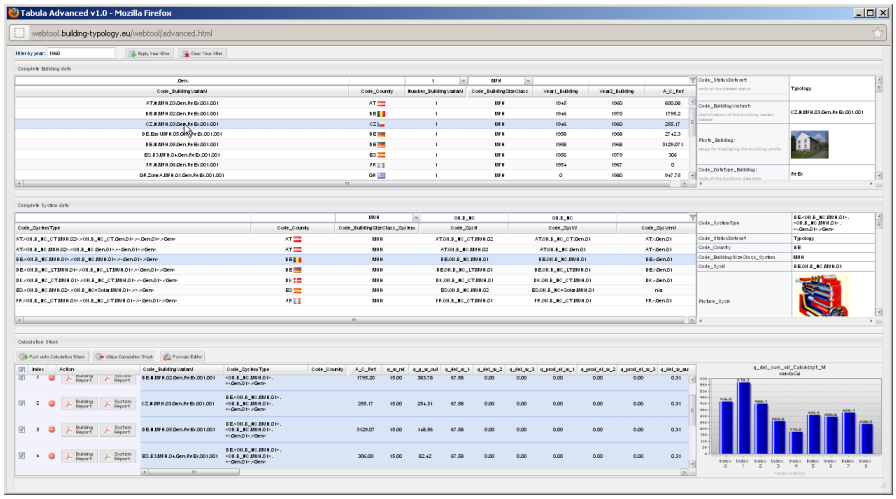
Data Overview for the selected Building



Online Calculation Sheets



WebTool Expert Version



Résumé: Outcome and Benefit of the TABULA Building Typology Concept

- agreed systematics for energy related classification of national residential building stocks
- set of example buildings including datasets
  → showcase calculations (consumer counselling, consequences of political instruments, ...)
- common data structure + calculation procedure
  → simplified exchange of information, cross country comparisons, ...
- set of average buildings + related statistics
  → basis for building stock models (saving potentials, scenarios, impact of policies and measures, ...)