Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks



Application of Energy Performance Indicators for Residential Building Stocks

Experiences of the EPISCOPE project

(Deliverable D4.1b)

EPISCOPE Project Team March 2016



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The focus of the EPISCOPE project (April 2013 ... March 2016, supported by the IEE programme) is on mapping, monitoring and modelling of European housing stocks. Two branches were followed:

- The predecessor IEE project TABULA was continued during EPISCOPE. National building typologies were elaborated or improved.
- In case studies on national, regional or local level building stocks energy balance models were elaborated and scenarios for future energy saving and climate protection were calculated. Examinations are based on available empirical data, concepts for improving the information base were developed.

A major task of the project was to collect basic data on the building stocks concerned and to provide understandable information and calculation results. In this context, but also for the purpose of comparisons, energy performance indicators played a central role at different stages of the project. In particular, indicators for building stocks (and not for single buildings only) had to be considered.

Chapters 1.1 and 1.2 give an overview of the basic ideas and the concrete approaches which were followed in the EPISCOPE project. Some more details were already documented in an earlier report [EPISCOPE Project Team 2014]. In chapters 2 and 3 the concepts of "Summary Indicators" and "Average Buildings" are introduced which had not yet been elaborated in the former report.

1.1 Principles of energy performance indicators for residential building stocks

Energy performance indicators of residential building stocks can either describe existing empirical data of a building stock or the input and outcome of building stock modelling. In EPI-SCOPE both types of quantities are clearly separated by distinguishing monitoring indicators and scenario indicators:

- "Monitoring Indicators" are empirically justified. They are always based on reliable primary data on the observed building stocks. Due to a lack of empirical information they may draw an incomplete picture of the building stocks.
- "Scenario Indicators" describe the input data as well as the results of scenario analysis. Based on the monitoring indicators and additional assumptions they provide a complete picture of model analysis.

There is a direct link between monitoring and scenario indicators: A subset of the scenario indicators describes the building stock in its current state which is usually at the same the "basic case", i. e. starting point of model formation and scenario analysis. Those **basic case indicators** should as far as possible be based on the monitoring indicators (i.e. on reliable data), but often additional assumptions will be necessary to fill information gaps. The scenario indicators of future years of modelling will anyway largely be based on such assumptions.

The regular collection of reliable and representative primary data is seen as a key instrument of climate protection strategies: Those strategies are based on more or less uncertain projections and scenarios. Furthermore, the effect of climate protection instruments can hardly be predicted. Therefore, the whole process needs a regular "earthing" by observing the real development as shown in Figure 1: Monitoring is delivering necessary input data for model formation and calculation of (trend) scenarios. At the same time it is a success control of the effect of climate protection policies in the past.



Figure 1: The role of monitoring in climate protection strategies

In the EPISCOPE Synthesis Report No. 4 the issue of collecting representative data and monitoring building stocks is discussed in general and in particular for the EPISCOPE case studies [EPISCOPE Project Team 2016a]. For the success of such approaches it is crucial to be transparent about which parts of the applied information are based on (completely) reliable primary data and which are (at least partly) based on model assumptions. This is the reason why the clear separation of monitoring indicators (which are based on empirical data) and scenario indicators (which are widely based on assumptions) is emphasised in the indicator scheme.

A further distinction is made between **structural indicators** and **energy balance indicators**. Structural data concerns the "physical" state of the building stock in general (like construction age bands, types of wall construction, for example) and in particular with respect to energy efficiency (fraction of insulated building elements, average quality of insulation, structure of applied main heating systems, fraction of solar thermal systems, see Figure 2). With regard to monitoring indicators, structural data is needed as input for model formation, but also for success control of climate protection strategies. Observing only the energy consumption of building stocks (e.g. consumption of the different energy carriers) would not provide the necessary information to assess the reasons of the development. Moreover data on energy consumption of building stocks are often difficult to handle because of uncertainties of weather correction, for example. In EPISCOPE structural as well as energy balance indicators were considered at the level of monitoring as well as scenario indicators.





Figure 2: Structural indicators / state and trend indicators

Especially among the structural indicators a further separation of **state indicators** and **trend indicators** is made. This concerns in the first place the monitoring indicators (as described below), but in principle it applies also to scenario indicators (also of future years and future time periods).

The state indicators describe the building stock in its actual state, for example answering the question "How many walls have already been insulated?" This kind of data delivers basic information for energy balance models of buildings stocks, defining the status quo and starting point of scenario calculations. At the same time the state indicators show which progress of energy efficiency measures could already achieved, i.e. they serve for success control of climate protection policies in the past.

On the other hand trend indicators answer questions like "How many walls are insulated every year?" They provide input for the definition of trend scenarios. From a more general point of view they show if the current speed of implementing energy efficiency measures or renewable energies in the building sector is sufficient to reach the future targets or if an acceleration will be necessary.

1.2 Application of energy performance indicators of building stocks in the EPISCOPE project

Figure 3 provides an overview of the application of energy performance indicators at different levels during EPISCOPE. In the following, the procedure will be explained step by step.



Figure 3: Overview of the EPISCOPE scheme of building stock energy performance indicators

Presentation of national empirical data at the TABULA website

Already in the predecessor IEE project TABULA which was focused on the elaboration of residential building typologies, national statistical data was collected and presented at the project website. In the "typology" branch of EPISCOPE, the TABULA project was continued by updating building typologies and extending the underlying concept to further countries. In that framework also new or updated statistical data of the national residential building stocks was collected. Both projects are presented on a common website¹. The statistical data on national building stocks is documented at the TABULA country pages².

For data presentation a common scheme is applied distinguishing between different types of statistical data [TABULA Project Team 2010]. Even if under the given headlines the partners were very free to choose their own way of data presentation and indicators, the scheme can be seen as a first rough approach of a monitoring indicator concept.

Compiled during both projects, TABULA and EPISCOPE, statistical data from 20 European countries is now available at the project website.

Presentation of national empirical data at the BPIE data hub

The BPIE data hub is a comprehensive internet information platform about energy efficiency in European building stocks³. During the EPISCOPE project the data of the national residen-

¹ <u>www.episcope.eu</u>

² <u>http://episcope.eu/building-typology/country/</u>

³ <u>http://www.buildingsdata.eu/</u>



tial building stocks was transferred to this interactive tool. Those partners who carried out their EPISCOPE case studies on national (i.e. not on regional or local) level delivered more detailed supplementary data. The input from EPISCOPE / TABULA is presented in a separate section of the data hub ("EPISCOPE tool"⁴).

More information on the data hub and the data transfer is provided in [EPISCOPE Project Team 2016a, chapter 3].

Indicators on expert level

In the EPISCOPE case studies, which were applied to national, regional or local level, a detailed analysis of residential building stocks was carried out including evaluation of monitoring data, elaboration of building stock energy balance models and the implementation of scenario analysis. To make concepts of that type transparent and comparable on an expert level an indicator scheme was elaborated at an early stage of the EPISCOPE project. It is documented in detail in a separate report [EPISCOPE Project Team 2014]. The scheme includes all types of indicators (monitoring as well as scenario indicators, structural and energy balance indicators, state and trend indicators).

In contrast to the statistics scheme at the TABULA website the structural monitoring indicators are more precisely defined to facilitate comparison between the projects. Moreover, they are fairly harmonised with the scenario indicators which document the input and the results of scenario analysis.

Due to the large variety of individual characteristics of building stocks and scenario models it was not intended to predefine the exact data format of the concerned quantities and the way of partitioning the respective building stocks. So the harmonised concept is open for individual adaptations. Explanations should be provided to make such deviations transparent.

In future applications the original concept documented in [EPISCOPE Project Team 2014] can serve as a basis. During the EPISCOPE case studies experiences were made which leaded to some extensions and clarifications, for example:

- Ventilation heat recovery should be explicitly included as an additional line in the energy balance scheme [ibidem, chapter 3.3], either at the "demand-side" or at the "supply-side" (recommended) of the energy balance.
- A scheme for the documentation of some basic model parameters like the assumed mean indoor temperatures and climate parameters should be added to the scenario indicator scheme.

Further small modifications and adaptations were made. They have been considered in the final versions of the "EPI Tables" (see below).

Summary Indicators

The summary indicators form a simplified and condensed indicator scheme aiming at providing basic information of the scenarios at a glance and also easy to understand for "nonexperts" – that means an audience which cannot get into details of the applied models, parameters and indicators. First ideas of such a scheme were already presented in [ibidem] and then concretised in the course of the project. It was decided to concentrate on the most relevant outcome of scenario analysis only to keep the scheme simple and illustrative: The CO_2 emissions (overall outcome), the total heat demand (= heat output of heat generators,

⁴ <u>http://www.buildingsdata.eu/data-sources/episcope-data</u>



solar systems and heat recovery) and the CO_2 emission factor of heat supply. The total heat demand is reflecting the quality of the building fabric the CO_2 emission factor the quality of the supply system including the processes for producing and transporting the energywares. A more detailed introduction to the summary indicators is given in chapter 2.

Connection to the "Average Buildings" Concept

The average buildings scheme is a special and more elaborated version of the structural scenario state indicators. Here the complete building stock is divided in a manageable number of subsets, each of which is represented by a synthetical building. These buildings represent average values of the building stocks' subsets and can be used for energy balance calculations and simplified model formation of building stocks.

The average buildings concept provides a link between model calculations for building stocks (e.g. the EPISCOPE case studies) and the TABULA typology approach.

In EPISCOPE this was carried out for the basic case, i. e. the starting point of the scenarios: All partners translated the basic case to the average buildings scheme. Then energy balance calculations of the average buildings were carried out with the TABULA tool. The results (weighted by the size of the subsets which were represented by the average buildings) were than compared to the results of the partners' individual model calculations.

Chapter 3 provides more detailed information of the definition and application of average buildings. The average buildings reflecting the basic case of all case studies can be viewed by means of the "Building Stock" area of the TABULA WebTool⁵.

1.3 Published EPI-Tables

The energy performance indicators described above have been determined by EPISCOPE partners and are publicly available in form of "EPI Tables" for a number of case studies at the EPISCOPE website⁶. The "EPI Table" is a sort of data appendix for the national reports summarised in [EPISCOPE Project Team 2016b] and [EPISCOPE Project Team 2016c]. They also include textual explanations of individual adaptations and describe the quality of empirical data sources: To which extent is data reliable, representative and up-to-date? Are there remaining uncertainties?

The template for these EPI-tables is available at the download area of the EPISCOPE website⁷ – for experts who wish to use the harmonised EPISCOPE structure for reporting the input and output numbers of their scenario calculations.

⁵ <u>http://webtool.building-typology.eu/</u>

⁶ <u>http://episcope.eu/monitoring/case-studies/</u>

⁷ <u>http://episcope.eu/communication/download/</u>



2 Summary Indicators

The summary indicators can give a first and basic overview of the results of scenario analyses of residential building stocks. In EPISCOPE they were applied to the case studies to make the results transparent and comparable. Figure 4 shows an example.



Figure 4: Summary Indicators: Example

The central indicator is $m_{CO2,heat supply}$, that means the CO_2 emissions (related to the EPI-SCOPE reference area) which are caused by heat supply (for heating and hot water, including auxiliary electric energy, also for ventilation). Not only the on-site CO_2 emissions of heating systems but also the CO_2 emissions for district heating and for electricity production

Application of Energy Performance Indicators

(used for heat supply and auxiliary energy) are being considered. But only pure CO₂ emissions are taken into account, equivalents of other greenhouse gases are not included⁸.

Further indicators are the total heat demand q_{total} (related to the EPISCOPE reference area⁹) and the total CO₂ emission factor of heat supply $f_{CO2,heat supply}$. They document the overall outcome of the buildings (demand-side) and the applied heat supply technologies (supply side) to the CO₂ emissions.

The three quantities are related by the following equation:

 $f_{CO2, heat supply} = m_{CO2, heat supply} / q_{total}$

 q_{total} is the sum of the energy need for heating and DHW and of the heat distribution and emission losses. It is equal to the total heat output of heat generators, solar systems and heat recovery.

In the diagram of $m_{CO2,heat supply}$ also benchmarks are shown:

- dashed lines: common EPISCOPE benchmarks (see explanations below)
- continuous lines (optional): individual benchmarks of the pilot actions

The CO₂-emissions $m_{CO2,cooling}$ for cooling / air conditioning are usually not included. They may optionally be added in the scheme as an additional bar (see example below for the trend scenario 2015. But the cooling energy demand and the CO₂ emission factor of cold generation are not considered in the concept so far. So q_{total} and f_{CO2,heat} supply are always related to heat supply only (excluding cooling/air conditioning). If $m_{CO2,cooling}$ is added in the diagram, the benchmarks may be either related to the total CO₂ emissions ($m_{CO2} = m_{CO2,heat}$ supply + $m_{CO2,cooling}$) or to heat supply only ($m_{CO2,heat}$ supply). In the diagram additional information has to be provided about which of the two options applies.



Figure 5: Introduction of CO₂ emissions for cooling to the summary indicators (optional)

EPISCOPE benchmarks

To enable comparisons between different scenarios and building stocks the following benchmarks are defined:

benchmark 2020 = 0,95 x m_{2015} x $A_{ref,2015}$ / $A_{ref,2020}$ ("2015 minus 5%") benchmark 2030 = 0,70 x m_{2015} x $A_{ref,2015}$ / $A_{ref,2030}$ ("2015 minus 30%") benchmark 2050 = 0,25 x m_{2015} x $A_{ref,2015}$ / $A_{ref,2050}$ ("2015 minus 75%")

⁸ In principle the scheme could also be applied to the total greenhouse gas emissions with CO₂ equivalents. But in the project it turned out that information of CO₂ equivalents might sometimes not be easily available.

⁹ Because of differing national definitions of reference area (e. g. living space) a common TABULA / EPISCOPE reference area was introduced [TABULA Project Team 2013].



with: $m_{2015} = m_{CO2,heat supply,2015}$ (area-related CO₂ emissions of the year 2015) A_{ref,year} = EPISCOPE reference area of the building stock in the observed year

The benchmarks are derived from a rough and straightforward translation of general EU climate protection targets: EU has decided a 20 % emission reduction until 2020 and a 40 % reduction until 2030 (compared to 1990). A not officially decided but widely agreed minimum climate protection target for industry countries until 2050 is a reduction of 80 % (again related to 1990) [COM 2011].

According to [UBA 2014] the EU greenhouse gas emissions were reduced by around 12 % (energy-related emissions) or 15 % (all emissions without land use changes) in the period 1990 to 2012. Carrying out a short extrapolation one could assume that until 2015 an emission reduction of 13 % (energy-related) / 17 % (all) – or roughly speaking altogether of 15 % would be reached (related to 1990). So the gap to be closed until 2020 / 2030 / 2050 would be 5 % / 25 % / 65 % (related to 1990) – or (rounded) 5 % / 30 % / 75 % related to the emission level of the year 2015. This defines the EPISCOPE benchmarks above.

Of course the role of the benchmarks may not be over-interpreted (and that is the reason why they are called "benchmarks" and not "targets"): The straightforward breakdown of EU global emission targets to the CO_2 emissions of concrete (even local) residential building stocks does not consider the individual situation and reductions potentials compared to other countries with other climates, other sectors (like industry or traffic) or other building stocks. So a "really fair" burden sharing of emission targets – if it could ever be found – might lead to different numbers. But the EPISCOPE benchmarks provide the rough common scale which is necessary for getting a "quantitative understanding" of the situation in the observed international building stocks.



3 Concept of "Average Buildings"

The determination of energy performance indicators includes a certain effort of summarising and condensing. The EPISCOPE idea of "Average Buildings" is to take advantage of the existence of the scenario indicators from building stock models to set up a very simple calculation scheme: The total values of all relevant input, interim and output quantities (number of dwellings, floor area, envelope area, energy need for heating, final energy consumption, ...) are divided by the number of buildings counted in the building stock subgroup. So, "average buildings" are defined, which are theoretical (synthetical) buildings with geometrical and thermo-physical characteristics equal to the average of the building stock subset which they represent. The annual energy balances for heating and DHW of average buildings are calculated in the same manner as for real buildings. Projections to the building stock can be done by multiplying the single average building related figures with the total number of buildings included in the investigated stock.

The advantages of the definition and calculation of "average buildings" are:

- for the making of a model: The simplified parallel calculation enables plausibility controls of more complex models.
- for the communication of results: The statements about the total building stock are more seizable, large numbers can be pictured. The datasets can also be used in conventional EPC rating software.
- for the practical relevance of the model output: The results can be used as benchmarks to compare features and energy consumptions of distinct real buildings. Projections can be easily done for other subsets of the same building stock.

Against that background the EPISCOPE experts decided to use the average buildings concept for dissemination of parts of their results: For all case studies the basic case (existing state) was transformed to the TABULA data structure, entered in the TABULA.xlsm master file to be displayed in form of average buildings by the "Building Stocks" section of the TAB-ULA WebTool¹⁰. Thus, the documented average buildings provide a rough picture of the starting point of scenario calculations.

The WebTool section "Building Stocks" includes the following areas

- Menu item "Overview": This table displays the key values of the observed building stocks in the present state. These are the scale level, the basic data (e.g. reference areas), the calculation results from the TABULA WebTool and from the individual building stock models.
- Menu items for the case studies of the different countries, subsumed under "National", "Regional" and "Local". Here the TABULA building stock calculation can be viewed – including all input and output data. This calculation is performed using standard TABULA boundary conditions. At the end the relation of the results from the individual building stock model and from the TABULA standard calculation is determined. Under the precondition that the scenario models are validated or calibrated by real consumption values the relation separate model to simplified TABULA provides ratios for the calibration of the TABULA calculation to the typical level of measured consumption (for the given average state of the building stock subgroups).

An example for the average buildings calculation can be found in Appendix B.

¹⁰ <u>http://webtool.building-typology.eu</u>

Concept of "Average Buildings"

gies		EPISCOPE Ca	ase Studies – Presentation of the s	tarting point da	ta for the sce	narios ("basic c	ase")			
J Typolog	TABULA	Country	Represented Building Stock	TABULA Calculation PDF	Scale	Year represented	Number of dwellings	Number of buildings	National Reference A	<u> </u>
Building	TABULA WebTool	DK	Projectzero acmunicipaitty or Sønderborg, Denmark	VIEW PDF >>	LUCAI	2015	307.0	363.0	61.4	GR / Greece Greek residential building
cks	Exemplary Building	Dic								stock
ding Sto	Stocks (Present State)	ES	Comunidad Valenciana housing stock	View PDF »	Regional	2015	692.6 x 10 ³	47.9 x 10 ³	58.9	Scale National
Build	· Overview	L	Local building stock of OBH	View PDE x	Local	2015		226.0		National
e	Case studies	FR	Montreuillois (OPHM), France	VIEW PDI //	LUCAI	2015	10.3 x 10 ³	330.0	/91./	Year represented
ert Are	National		English Housing	View PDF »	National	2012	22.7 x 10 ⁶	17.4 x 10 ⁶	2.2>	2015
å	DE Germany	GB								Total reference floor
out	DK Denmark									area
Abo	• GB England	5	Greek residential building stock	View PDF »	National	2015	5.1 × 10 ⁶	1.2 x 10 ⁶	486.3	308.8 x 10 ⁶ m ²
	GR Greece	GR								Number of buildings
	• NL Netherlands		Local building stock of Budaors, Hungary	View PDF »	Local	2015	12.4 x 10 ³	9.1 x 10 ³	1.3>	1.2 x 10 ⁶
	• NO Norway									Number of dwellings
	 SI Slovenia 	IE	Housing Stock on Northside of Dublin City, Ireland	View PDF »	Local	2015	134.0 x 10 ³	134.0 x 10 ³	11.8	5.1 x 10 ⁶
	Regional		Residential building stock of	View PDF »	Regional	2015	2.3 x 10 ⁶	701.2 x 10 ³	214.1	NOA model of the Greek
	AT Austria	π	Piedmont region, Italy				2.5 × 10	701.2 × 10	217.1	residential building stock
	• ES Spain	-	National Housing Stock of Slovenia	View PDF »	National	2015	850.6 x 10 ³	357.3 x 10 ³	64.9	Link to publication
	IT Italy	SI 4		4	•					Open in new Tab »

Figure 6: Overview table of the "Building Stocks" section of the TABULA WebTool (http://webtool.building-typology.eu/)

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Figure 7: Example of an "Average Buildings" calculation in the "Building Stocks" section of the TABU-LA WebTool (<u>http://webtool.building-typology.eu/</u>) Above: Building Stocks Statistics / scenario indicators (extract) Below: Comparison of the simplified building stock calculation with the individual scenario model



References

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4 References

Sources / References

Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[COM 2011]	European Commission (2011): Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: A Roadmap for moving to a competitive low carbon economy in 2050. Available at: <u>http://eur- lex.europa.eu/resource.html?uri=cellar:5db26ecc- ba4e-4de2-ae08- dba649109d18.0002.03/DOC_1&format=PDF</u> [2015-06-08]	With its "Roadmap for moving to a competitive low-carbon economy in2050" the European Com- mission is looking beyond the 2020 objectives for climate and energy and sets out a plan to meet the long-term target of reducing domestic emissions by 80 to 95 % by mid-century.
[EPISCOPE Project Team 2014]	Diefenbach, N., Loga, T., Stein, B. (ed.) (2014): Energy Performance Indicators for Building Stocks. First version / starting point of the EPI- SCOPE indicator scheme, March 2014. Available at: http://episcope.eu/fileadmin/episcope/public/docs/r eports/EPISCOPE Indicators FirstConcept.pdf [2015-12-18]	EPISCOPE report (working paper) on energy performance indicators for building stocks, first version / starting point
[EPISCOPE Project Team 2016a]	Stein, B., Loga, T., Diefenbach, N. (ed.) (2016): Tracking of Energy Performance Indicators in Residential Building Stocks – Different Approach- es and Common Results. EPISCOPE Synthesis Report No. 4, Institut Wohnen und Umwelt, Darm- stadt; available at: http://episcope.eu/fileadmin/episcope/public/docs/r eports/EPISCOPE SR4 Monitoring.pdf	EPISCOPE Synthesis Report No. 4 on the availa- bility and quality of data sources with regards to the EPISCOPE case studies, suggestions for improvements and regular monitoring approaches
[EPISCOPE Project Team 2016b]	Stein, B., Loga, T., Diefenbach, N. (ed.) (2016): Scenario Analyses Concerning Energy Efficiency and Climate Protection in Local Residential Build- ing Stocks. Examples from Eight European Coun- tries – EPISCOPE Synthesis Report No. 2, Institut Wohnen und Umwelt, Darmstadt; available at: http://episcope.eu/fileadmin/episcope/public/docs/r eports/EPISCOPE SR2 LocalScenarios.pdf	EPISCOPE Synthesis Report No. 2 on scenario analyses in local building stocks (portfolios of housing companies, municipalities, city quarters)
[EPISCOPE Project Team 2016c]	Stein, B., Loga, T., Diefenbach, N. (ed.) (2016): Scenario Analyses Concerning Energy Efficiency and Climate Protection in Regional and National Residential Building Stocks. Examples from Nine European Countries – EPISCOPE Synthesis Report No. 3, Institut Wohnen und Umwelt, Darm- stadt; available at: http://episcope.eu/fileadmin/episcope/public/docs/r eports/EPISCOPE_SR3_RegionalNationalScenari os.pdf	EPISCOPE Synthesis Report No. 3 on scenario analyses in regional and national residential build- ing stocks
[TABULA Project Team 2010]	Loga, T.; Diefenbach, N. (ed.) (2010): Use of building typologies for energy performance as- sessment of national building stocks. Existent Experiences in European Countries and Common Approach. First TABULA Synthesis Report, Institut Wohnen und Umwelt, Darmstadt; Available at: http://www.building- typolo- gy.eu/downloads/public/docs/report/TABULA_SR1 .pdf [2016-02-03]	TABULA Synthesis Report No. 1 summarising existing experiences, application fields and target groups for building typologies as well as a defini- tion of a common typology structure used in the framework of the TABULA and EPISCOPE pro- jects
[TABULA Project Team 2013]	Loga, T.; Diefenbach, N. (2013): TABULA Calcula- tion Method – Energy Use for Heating and Domes- tic Hot Water. Reference Calculation and Adapta- tion to the Typical Level of Measured Consump- tion.Institut Wohnen und Umwelt, Darmstadt. Available at: http://episcope.eu/fileadmin/tabula/public/docs/rep ort/TABULA CommonCalculationMethod.pdf [2015-09-17]	Description of the calculation method developed in the course of the IEE project TABULA



Reference shortcut	Concrete reference (in respective language)	Short description (in English)
[UBA 2014]	Umweltbundesamt (2014): Treibhausgas- Emissionen der EU-15 nach Quellkategorien in Mio. t CO ₂ -Äquivalenten. Available at: <u>http://www.umweltbundesamt.de/sites/default/files/</u> <u>medien/384/bilder/dateien/2 tab thgemi-</u> <u>eu15 kategorien 2014-08-14.pdf</u> [2015-06-08] Based on: European Environment Agency (EEA) (2014): Annual European Union greenhouse gas inventory 1990–2012 and inventory report 2014. Submission to the UNFCCC Secretariat, Publica- tions Office of the European union, Luxembourg	Table summarising EU-15 greenhouse gas emissions in CO_2 -equivalents by source categories; Results in- and excluding Land Use activities and Land-Use Change and Forestry (LULUCF) activities



Appendix A: Example of "EPI Tables"

EPISCOPE Case Study GB-N Energy Efficiency Scenarios to 2050: England

Documentation of Energy Performance Indicators

More information about case studies at: www.episcope.eu/monitoring/case-studies/





Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks



EPISCOPE Case Study: Energy Efficiency Scenarios to 2050: England

"EPI Tables"

Documentation of Energy Performance Indicators

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Template for Documentation of Energy Performance Indicators ("EPI Tables")

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The template for documentation of energy performance indicators has been prepared in the framework of the project EPISCOPE which was mainly funded by the programme Intelligent Energy Europe. The purpose is to report in a concerted way on input and output data of the building stock models and scenario calculations.

The usage of the EPI concept as well of this workbook by third parties is intended and desirable.



Energy Performance Indicator Tracking Schemes for the Continuous Optimisation of Refurbishment Processes in European Housing Stocks



Contract N°: Coordinator: Project duration: IEE/12/695/SI2.644739 – EPISCOPE Institut Wohnen und Umwelt, Darmstadt / Germany April 2013 - March 2016 Co-funded by the Intelligent Energy Europe Programme of the European Union

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General Information

General Information about the monitoring and scenario data documented in this workbook

Country	GB/ENG Great Britain (England only)
Building stock	National residential building stock
Person in charge Org <i>a</i> nisation Address Country URL	Jack Hulme BRE, Building Research Establishment Bucknalls Lane, Garston, Watford, Herts. UK <u>www.bre.co.uk</u>
Date	2016-03-09
Documented study	

EPISCOPE Pilot Project: England

Explanations

Monitoring Indicators

The monitoring indicators are based on published data from the English Housing Survey (principally dating from 2011). This is a high quality dataset, used for National Statistics in the UK.

See https://www.gov.uk/government/collections/english-housing-survey

Scenario Indicators

Scenario <1> National report scenario 1 (Trend scenario)

The trend scenario is based on installing those measures which are currently being installed, and have been installed under current energy efficiency schemes and programmes. See National Report for more details

Scenario <2> National report scenario 4 (Ambitious - Long Term Scenario)

See National Report for details.

This scenario is the most ambitious modelled, and includes a comprehensive programme of energy efficiency improvements, including wide scale fuel switching to electric heat pumps accompanied by decarbonisation of the electricity grid.

See National Report for details.

Further scenarios not documented in this workbook

National report scenario 2 and 3 which are long-term scenarios including insulation and boiler upgrades, but without large scale fuel switching except for off-gas network properties.

Energy Balance Indicators

Figures correspond to the ouptuts from Scenarios 1 and 2 and include adjustments using "real ratio" technique. See national report for details.

Basic Case Details - Scenario and Energy Balance Indicators by Building Type

Nine building types are used for the definition of the TABULA "average buildings".

Summary Indicators

Information about the summary indicators can be found in the description of the England national report.

References

[1] Summers, C & Hulme, J; EPISCOPE Pilot Project: England. September 2015.

http://episcope.eu/fileadmin/episcope/public/docs/pilot_actions/GB_EPISCOPE_NationalCaseStudy_BRE.pdf

[2] The English Housing Survey.

https://www.gov.uk/government/collections/english-housing-survey

M.1 Basic data of the building stock	Complete building stock
	bs
number of buildings	N/A
number of apartments	~22 million
national reference area [10 ⁸ m²]	2.1
sources / remarks	EHS data (2010-2013).

M.2.1 Building insulation: Basic information state and trends of modernisation		
	Complete building stock	
walls		
insulation improved (from original state)	~40%	
insulation improved (area-weighted)	-	
average thickness of improved insulation	N/A	
annual rate of insulation improvement	2.00%	
annual rate of insulation improvement (area-weighted)	-	
average thickness of insulation (recent modernisation)	-	
roofs / upper floor ceilings		
insulation improved (from original state)	~90%	
insulation improved (area-weighted)	-	
average thickness of improved insulation	Unknown	
annual rate of insulation improvement	4.00%	
annual rate of insulation improvement (area-weighted)	-	
average thickness of insulation (recent modernisation)	270mm	
ground floors / cellar ceilings		
insulation improved (from original state)	Very low	
insulation improved (area-weighted)	Very low	
average thickness of improved insulation	Very low	
annual rate of insulation improvement	Very low	
annual rate of insulation improvement (area-weighted)	Very low	
average thickness of insulation (recent modernisation)	Very low	
windows		
insulation improved (from original state)	~75%	
insulation improved (area-weighted)	-	
average quality of improved windows		
annual rate of insulation improvement	3.00%	
annual rate of insulation improvement (area-weighted)	-	
average quality of improved windows (recent modernisations)		
sources / remarks:		
EHS data (2010-2013).		
https://www.gov.uk/government/collections/english-housing-survey		

M.2.2 Building insulation: Detailed information of the actual sta	te
	Complete building stock
levels of wall insulation (area-weigthed):	
Cavity Uninsulated (U ~ 1.7)	~25%
Cavity Insulated (U ~ 0.5)	~40%
Solid Uninsulated (U ~ 2.1)	~30%
Solid Insulated (U ~ 0.5)	<0.5%
roofs / upper floor ceilings	
Flat roof or no loft	~10%
None	<5%
< 100mm	~15%
100 to 150mm	~25%
> 150mm	~50%
ground floors / cellar ceilings	
Insulated floors	Very low
windows	
Full double glazing	~75%
More than half double glazing (not full)	~10%
Less than half double glazing	~5%
No double glazing	~10%
sources / remarks	
EHS data (2010-2013).	
https://www.gov.uk/government/collections/english-housing-survey	

M.3.1 Main Heat Supply Systems for Space Heating		
		modernisation
	Complete building stock	Complete building stock
M.3.1.1 Centralisation of space heating system		net modernisation rates
district heating	Very low	Verylow
building / apartment heating	95%	+ < 1% per annum
room heating	5%	- < 1% per annum
M.3.1.2 Main energy carrier for space heating		net modernisation rates
district heating	Very low	Very low
gas (natural / liquid gas)	~85%	+ < 1% per annum
oil	~5%	+ < 1% per annum
coal	Very low	Very low
wood/biomass	Very low	Very low
electricity	~10%	- < 1% per annum
M.3.1.3. Main heat generation system for space heating		gross modernisation rates
condensing boiler system	30%	+ approx 7% per annum
non-condensing boiler system	60%	- Approx 7% per annum
room heater	~5%	- < 1% per annum
storage radiators	~5%	Approx 0%
other (communal, warm air, other)	Very low	Very low
sources / remarks		
EHS data (2010-2013).		
https://www.gov.uk/government/collections/english-housing-survey		

M.3.2 Special Systems (additional systems of special interest for space heating, hot water supply, ventilation, including photovoltaics)				
		modernisation trends (gross rates)		
	Complete building stock	Complete building stock		
solar thermal systems	Very low	Verylow		
for hot water supply only	Very low	Verylow		
for heating and hot water supply	Very low	Verylow		
photovoltaic systems	Very low	Verylow		
ventilation systems				
(for buildings/apartments, not only kitchen/WC ventilation)	Very low	Verylow		
with heat recovery	Very low	Verylow		
without heat recovery	Very low	Verylow		
sources / remarks				
EHS data (2010-2013).				
https://www.gov.uk/government/collections/english-housing-survey				

M.3.3 Main System of Hot Water Supply	
apart from additional solar thermal systems (see above)	
	Complete building stock
M.3.3.1 Main Energy carrier for hot water supply	
district heating	Very low
gas	~85%
oil	~5%
coal	Very low
wood/biomass	Very low
electricity	~10%
M.3.3.2 Main heat generation system for hot water supply	
hot water generation combined with heating system:	
separate system of hot water generation:	
- direct electric heat generation	~10%
- electric heat pump	0%
- combustion of fossil fuels	~90%
- combustion of wood/biomass	0%
sources / remarks	
EHS data (2010-2013).	
https://www.gov.uk/government/collections/english-housing-survey	

M.4 Final Energy balance: Measured values	Complete building stock
energy consumption in TWh/a (10 ⁹ kWh/a)	
district heating	5
gas	2465
oil	261
coal	74
wood/biomass	58
electricity	937
sources / remarks	
Energy Consumption in the UK data (adjusted to England)), 2011.
https://www.gov.uk/government/collections/energy-consun	nption-in-the-uk

Trend scenario (National report scenario 1)			
	2012:	2050	Pomarka
	Basic Case	2030	Remarks
	bs ₂₀₁₂ = bs _{2012/2012}	bs 2012j2050	
Number of buildings	N/A	N/A	Analysis completed as dwellings
Number of dwellings	21.9	30.7	
National reference area [10 ⁹ m²]	2.1	2.94	
TABULA/EPISCOPE reference area [10 ⁹ m ²]	2.1	2.94	
Building insulation: state of modernisation			
Walls			percentages related to
insulation installed	42%	61%	Number of dwellings
Roofs / upper floor ceilings			percentages related to
insulation improved (from original state)			Number of dwellings with some
	83%	85%	insulation
Ground floors / cellar ceilings			percentages related to
insulation improved (from original state)	0%	0%	Number of dwellings
Windows			percentages related to
insulation improved (from original state)			Number of dwellings with double
	90%	90%	glazing
Building insulation: Detailed information			
levels of wall insulation:			percentages related to
Cavity insulated	40%	60%	Number of dwellings
Cavity uninsulated	28%	9%	
Solid insulated	2%	2%	
Solid uninsulated	28%	28%	
Other	2%	2%	
levels of roof/upper floor ceiling insulation:			percentages related to
No loft	13%	13%	Number of dwellings
None	4%	3%	
0-99mm	15%	4%	
100-199mm	34%	10%	
200-300mm	25%	3%	
>300mm	9%	68%	
levels of window insulation:			percentages related to
Double glazed	90%	90%	Number of dwellings
Single glazed	11%	11%	
Main Heat Supply Systems for Space Heating			
Centralisation of space heating system	2%		percentages related to
district heating	2%	2%	Number of dwellings
building / apartment heating	95%	95%	
room heating	3%	3%	
Main energy carrier for space heating			percentages related to
district heating	2%	1.8	Number of dwellings
gas (natural / liquid gas)	85%	84./	
	4%	2.1	
coal	1%	0.3	
alactriaity	9%	10.9	
electricity Main heat generation system for space heatin	3%	10.8	percentages related to
district heating	y 2%	294	Number of dwollings
boiler system	270	88%	
storage radiators	6%	6%	
warm air system		1%	
room heaters	3%		
heat pumps	0%	0%	
Special Systems			percentages related to
solar thermal systems	1%	1%	Number of dwellings
photovoltaic systems	1%	1%	
remarks	•		
Modelling was undertaken to 2050 only (2020 and	d 2030 data not available)		
	,		

Trend scenario (National report scenario 1)	Residential Buildings constru		
	2012: Basic Case	2050	
	bs ₂₀₁₂ = bs _{2012/2012}	bs 2012/2050	
Internal and external boundary conditions for			
energy balance calculation			
Directly heated part of the reference floor area	100	100	in %
Daily operating time of heating system	8hrs weekday, 16hrs weekend	8hrs weekday, 16hrs weekend	h/d
Set-point temperature heating system	21	21	°C
Average temperature directly heated part	21	21	°C (heating period)
Average temperature not directly heated part	N/A	N/A	°C (heating period)
Climate dataset	SAP 2012	SAP 2012	
Length of heating period	8	8	Months
Adaptation factor final energy (for calibration			
to typical level of measured consumption)			
fuels	Variable factor	Variable factor	Factor varied based on energy performance of dwelling
district heating	Variable factor	Variable factor	Factor varied based on energy performance of dwelling
electric energy	Variable factor	Variable factor	Factor varied based on energy performance of dwelling

Ambitious Long Term (National Report Scenario 4)	Residential Buildings const	ructed before 2012	
	2012:	2050	Pomarko
	Basic Case	2030	Remarks
	bs ₂₀₁₂ = bs _{2012/2012}	bs 2012/2050	
Number of buildings	N/A	N/A	Analysis completed as dwellings
Number of dwellings	21.9	30.7	
National reference area [10 ⁹ m²]	2.1	2.94	
TABULA/EPISCOPE reference area [10 ⁹ m ²]	2.1	2.94	
Building insulation: state of modernisation			
Walls			percentages related to
insulation installed	42%	94%	Number of dwellings
Roofs / upper floor ceilings			percentages related to
insulation improved (from original state)	83%	88%	Number of dwellings
Ground floors / cellar ceilings			percentages related to
insulation improved (from original state)	0%	0%	Number of dwellings
Windows			percentages related to
insulation improved (from original state)	90%	100%	Number of dwellings
Building insulation: Detailed information			-
levels of wall insulation:			percentages related to
Cavity insulated	40%	65%	Number of dwellings
Cavity uninsulated	28%	4%	
Solid insulated	2%	29%	
Solid uninsulated	28%	1%	
Other	2%	2%	
levels of roof/upper floor ceiling insulation (area-weigthe	ed):		percentages related to
No loft	13%	13%	Number of dwellings
None	4%	0%	
0-99mm	15%	0%	
100-199mm	34%	0%	
200-299mm	25%	0%	
>300mm	9%	88%	
levels of window insulation (area-weigthed):			percentages related to
Double glazed	90%	100%	Number of dwellings
Main Heat Supply Systems for Space Heating			
Centralisation of space heating system			percentages related to
district heating	2%	2%	Number of dwellings
building / apartment heating	95%	98%	
room heating	3%	0%	
Main energy carrier for space heating			percentages related to
district heating	2%	1.8	Number of dwellings
gas (natural / liquid gas)	85%	19.6	
	4%	0	
wood/hiemace	170	03	
alostriaity	070	0.3	
Main boot generation system for energy besting	5 //	10.4	percentages related to
district heating	2%	20%	Number of dwellings
hoiler system	88%	2/0	
storage radiators	6%	20%	
warm air system	1%	1%	
room heaters	3%	3%	
heat pumps	0%	78%	
Special Systems			percentages related to
solar thermal systems	1%	68%	Number of dwellings
photovoltaic systems	1%	68%	
remarks			
Modelling was undertaken to 2050 only (2020 and 2030 date	a not available)		

Ambitious Long Term (National Report Scenario 4)	Residential Buildings const		
	2012: Basic Case	2050	
	bs ₂₀₁₂ = bs _{2012 2012}	bs 2012/2050	
Internal and external boundary conditions for energy			
balance calculation			
Directly heated part of the reference floor area	100	10	0 in %
Daily operating time of heating system	8hrs weekday, 16hrs weekend	8hrs weekday, 16hrs weekend	h/d
Set-point temperature heating system	21	2	1 °C
Average temperature directly heated part	21	2	1 °C (heating period)
Average temperature not directly heated part	N/A	N/A	°C (heating period)
Climate dataset	SAP 2012	SAP 2012	
Length of heating period	8		8 d/a
Average external air temperature during heating period			°C
Adaptation factor final energy (for calibration to typical			
level of measured consumption)	Variable factor	Variable factor	
fuels	Variable factor	Variable factor	
district heating	Variable factor	Variable factor	
electric energy			

Trend sce	nario (National report scenario 1)	2012: Basic Case	2050	
		bs ₂₀₁₂	bs ₂₀₅₀	
TABULA/	EPISCOPE reference area [10 ⁹ m ²]	2.10	2.94	
Required	heat amounts			
Q _{nd}	Net heat need (space heating and DHW)*	132012.44	131062.31	
Q _{total}	Supplied heat (space heating and DHW)**	190201.56	173649.91	
Final ener	gy demand by energy carrier (delivered energy, gross calorific value)			
1	natural gas	161166.58	150128.23	
2	liquid gas	911.25	644.50	
3	oil	8890.62	5091.80	
4	coal	7349.05	4886.61	
5	wood / biomass	419.88	418.15	
6	district heating	294.19	293.78	
7	electric energy (used for heat supply)***	11169.98	12186.83	
Sum of en	ergy carriers (1-7)	190201.56	173649.91	
CO ₂ emiss	sions (e.g. in million tons / year)	124	86.2	

Remarks:

*) Energy need for heating and DHW

**) Total amount of heat generated by technical installations in the building (for heating and DHW: sum of net heat need + storage losses + distribution and emission losses + heat recovered by ventilation systems).

***) e.g. auxiliary electric energy for control, pumps, fans of heat supply and ventilation systems is included Modelling was undertaken to 2050 only (2020 and 2030 data not available)

Indicato	rs Related to the Reference Area	2012: Basic	
in kWh/(n	ı²a)	Case	2050
Trend sc	enario (National report scenario 1)	bs ₂₀₁₂	bs ₂₀₅₀
TABULA/	EPISCOPE reference area [10^9m ²]	2.1	2.94
Required	heat amounts		
Q _{nd}	Net heat need (space heating and DHW)*	62.86	44.58
Q _{total}	Supplied heat (space heating and DHW)**	90.57	59.06
Final ene	rgy demand by energy carrier (delivered energy, gross calorific value)		
1	natural gas	76.75	51.06
2	liquid gas	0.43	0.22
	oil	4.23	1.73
4	coal	3.50	1.66
ц,	wood / biomass	0.20	0.14
ť	district heating	0.14	0.10
7	electric energy (used for heat supply)***	5.32	4.15
Sum of e	nergy carriers (1-7)	90.57	59.06
CO ₂ emis	sions (in kg / m² / year)	59.05	29.32

Remarks:

*) Energy need for heating and DHW

**) Total amount of heat generated by technical installations in the building (for heating and DHW: sum of net heat need + storage losses + distribution and emission losses + heat recovered by ventilation systems).

**) e.g. auxiliary electric energy for control, pumps, fans of heat supply and ventilation systems is included

2012: Basic Case bs ₂₀₁₂ 2.10	2050 bs ₂₀₅₀
bs ₂₀₁₂ 2.10	bs ₂₀₅₀
bs ₂₀₁₂ 2.10	bs ₂₀₅₀
2.10	
	2.94
132012.44	123645.04
190201.56	81883.31
oss calorific value)	
161166.58	29105.99
911.25	2.72
8890.62	0.00
7349.05	374.89
419.88	376.06
294.19	290.08
11169.98	51733.56
190201.56	81883.31
124	16
	132012.44 190201.56 oss calorific value) 161166.58 911.25 8890.62 7349.05 419.88 294.19 11169.98 190201.56

Remarks:

*) Energy need for heating and DHW

**) Total amount of heat generated by technical installations in the building (for heating and DHW: sum of net heat need + storage losses + distribution and emission losses + heat recovered by ventilation systems).

***) e.g. auxiliary electric energy for control, pumps, fans of heat supply and ventilation systems is included

Indica	ators Related to the Reference Area	2012: Basic Case	
in kWh	l/(m²a)		2050
		bs ₂₀₁₂	bs ₂₀₅₀
TABUL	A/EPISCOPE reference area [10^9m ²]	2.1	2.94
Requir	ed heat amounts	1	
Q _{nd}	Net heat need (space heating and DHW)*	62.86	42.06
Q _{total}	Supplied heat (space heating and DHW)**	90.57	27.85
Final e	nergy demand by energy carrier (delivered energy	/ gross calorific value)	
	1 natural gas	76.75	9.90
	2 liquid gas	0.43	0.00
	3 oil	4.23	0.00
	4 coal	3.50	0.13
	⁵ wood / biomass	0.20	0.13
	⁶ district heating	0.14	0.10
	7 electric energy (used for heat supply)***	5.32	17.60
Sum o	f energy carriers (1-7)	90.57	27.85
oun o			

Remarks:

*) Energy need for heating and DHW

**) Total amount of heat generated by technical installations in the building (for heating and DHW: sum of net heat need + storage losses + distribution and emission losses + heat recovered by ventilation systems).

**) e.g. auxiliary electric energy for control, pumps, fans of heat supply and ventilation systems is included Modelling was undertaken to 2050 only (2020 and 2030 data not available)

Year			2012	2050
Reference	National reference area	[m²]	2 100 000 000	2 940 000 000
area	EPISCOPE reference area	[m²]	2 100 000 000	2 940 000 000
	<1> Scenario "Trend"	kg/m²yr	42	25.0
CO ₂ emissions	<2> Scenario ''Target- oriented / basic''	kg/m²yr		5.0
	EPISCOPE benchmark	kg/m²yr		8.0
	National benchmark	kg/m²yr		9.0
Total heat	<1> Scenario "Trend"	kWh/(m²yr)	171	112
demand	<2> Scenario ''Target- oriented / basic''	kWh/(m²yr)		52
CO ₂ emission	<1> Scenario "Trend"	kg/kWh	0.246	0.223
factor heat supply	<2> Scenario ''Target- oriented / basic''	kg/kWh	-	0.096

Values related to EPISCOPE Reference Area

TABULA Average Buildings

EPISCOPE Monitoring Indicators

Details

Building Stock **GB** National English Housing Year 2012

Annotations to this sheet

3	4	5	6	7	8	9	10
TH.04-08	SFH.01	SFH.02-03	SFH.04-08	AB.01	AB.02-03	AB.04-08	
	3 TH.04-08	3 4 TH.04-08 SFH.01	3 4 5 TH.04-08 SFH.01 SFH.02-03 	3 4 5 6 TH.04-08 SFH.01 SFH.02-03 SFH.04-08 Image: Comparison of the symptotic comparison of the symptot comparison of the symptot comparison of the symptot comparison o	3 4 5 6 7 TH.04-08 SFH.01 SFH.02-03 SFH.04-08 AB.01 Image: A state of the	3 4 5 6 7 8 TH.04-08 SFH.01 SFH.02-03 SFH.04-08 AB.01 AB.02-03 Image: Comparison of the symptotic comparison of the symptot comparison of the symptot comparison of the symptot compariso	3 4 5 6 7 8 9 TH.04-08 SFH.01 SFH.02-03 SFH.04-08 AB.01 AB.02-03 AB.04-08 Image: A state of the

Main English building type and age merged into smaller type and age band to give 9 average building types, bre model

General Data

Building type /

	Total											
Number of buildings	17 428	2 771	5 601	4 020	522	1 305	2 862	135	76	137	10/	^3
Number of dwellings	22 720	2 970	5 800	4 270	570	1 430	3 070	930	1 120	2 560	10/	^3
Floor area national		305	511	344	113	195	413	67	67	148	10/	^6 m²
Floor area TABULA	2 163	305	511	344	113	195	413	67	67	148	10/	^6 m²

Building Insulation

Original state / not refurbished fraction of the envelope area

U-values of the original state

Roof	0.88	0.64	0.52	0.88	0.64	0.52	0.32	0.32	0.19	1	W/(m²K)
Wall	1.93	1.77	0.93	1.93	1.77	0.93	1.93	1.77	0.93	1	W/(m²K)
Window	4.06	3.59	3.74	4.13	3.62	3.89	4.22	3.71	4.25	1	W/(m²K)
Floor	0.59	0.59	0.59	0.72	0.72	0.72	0.45	0.45	0.45	1	W/(m²K)

Refubishments (averages)

Refurbished fraction of envelope areas

	-									
Roof	42%	55%	56%	52%	56%	60%	7%	13%	19%	
Wall	11%	52%	54%	17%	55%	57%	7%	40%	46%	
Window	62%	76%	74%	57%	75%	81%	48%	86%	91%	
Floor										
Total (indicative)	23%	43%	43%	26%	43%	46%	11%	41%	48%	
U-values of the refurbished f	raction (a	averages)	I							_
Roof	0.16	0.15	0.15	0.16	0.15	0.15	0.12	0.12	0.10	W/(m²K)
Wall	0.74	0.47	0.31	0.74	0.47	0.31	0.74	0.47	0.31	W/(m²K)
Window	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58	2.58	W/(m²K)
Floor										W/(m²K)
										-

Main Heat Supply Systems

Ventilation Systems with Heat Recovery

,	/	
Occurances		

Heating Systems

	Occurances or Fractions of Produced Heat Gas B C Q0% 100% 90% 50% 90% 90% 80% 85% 60%														
1	Gas	B_C	С	90%	100%	90%	50%	90%	90%	80%	85%	60%			
2	El	E_Storage	D	10%		10%	10%			20%	15%	40%			
3	Oil	B_C	С				40%	10%	10%						
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															
16															
10															
10															
20															
	Sum			100%	100%	100%	100%	100%	100%	100%	100%	100%			
	ther	eof central		90%	100%	90%	90%	100%	100%	80%	85%	60%			
		decentra	l	10%		10%	10%			20%	15%	40%			
	Other	Systems													

DHW Systems

	Occurances or Fractions of Produced Heat Gas B_C C 90% 90% 50% 80% 80% 90% 60%														
1	Gas	B_C	С	90%	95%	90%	50%	80%	80%	80%	90%	60%			
2	El	E_Immersi	С	10%	4%	10%	10%	10%		20%	10%	40%			
3	Oil	B_C	С		1%		40%	10%	10%						
4															
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20	Curre			1000/	1009/	1000/	1009/	1009/	000/	1009/	1000/	1000/			
	sum .			100%	100%	100%	100%	100%	90%	100%	100%	100%			
	ther	eof central		100%	100%	100%	100%	100%	90%	100%	100%	100%			
		decentra	l												
	Other	Systems							10%						

All energy quantities in GWh/a

bre model of English housing

fuels related to gross calorific value

			Ju 11		ine raide								
												Total	per m²
Net heat need		59 100	86 200	47 100	22 700	33 100	53 500	13 100	10 900	16 900	0	342 600	158
Produced heat		80 700	116 600	61 700	31 700	45 900	72 900	16 000	13 300	19 000	0	457 800	212
Gas	1.00	71 100	111 000	57 500	15 800	39 200	63 400	12 200	11 100	12 400	0	393 700	182
Oil	1.00	4 100	1 500	500	12 200	3 800	7 400	100	36	50	0	29 686	14
Coal	1.00	0	0	0	0	0	0	0	0	0	0	0	0
Bio	1.00	0	0	0	0	0	0	0	0	0	0	0	0
DH		0	0	0	0	0	0	0	0	0	0	0	0
El		3 300	2 200	3 300	1 500	1 400	1 200	3 000	1 400	5 400	0	22 700	10
Other / not specifie	d	0	0	0	0	0	0	0	0	0	0	0	0
Sum final energ	JY	78 500	114 700	61 300	29 500	44 400	72 000	15 300	12 536	17 850	0	446 086	206
per m²		257	224	178	261	228	174	228	187	121			
CHP electr. pro	ducti	0	0	0	0	0	0	0	0	0	0	0	0

Version: 2016-01-21



Appendix B: Example of "Average Buildings" Calculation

EPISCOPE Case Study SI-N National Housing Stock in Slovenia

Simplified TABULA Building Stock Model

www.episcope.eu/monitoring/average-buildings



Building Stock Details Iterm National Housing Stock of Slovenia Year 2015 Annotations to this sheet Image: Stock of Slovenia	PILLA Avera	age B	Buildi	ngs				Er	nergy	Need	l for	Hea	ting		
Details Zetk mode Annotations to this sheet	Building St	ock SI	Nation	nal N	ational Ho	ousing St	ock of Slo	ovenia				Year	2015		
Annotations to this sheet I 2 3 4 5 6 7 8 9 10 Building type Implicit all string stri	Details	ZF	RMK model												
Anotations to this sheet I 2 3 4 5 6 7 8 9 10 Building type Image: the start of the															
1 1 2 3 4 5 6 7 8 9 10 Building type Impact and the second secon	Annotations to this sh	leet													
Building type SPI-Truck			1	2	3	4	5	6	7	8	9	10			
During type 0 <th< td=""><td>Duilding true</td><td></td><td>SFH-TH.01</td><td>SFH-TH.03</td><td>SFH-TH.05</td><td>MFH-AB.01</td><td>MFH-AB.03</td><td>MFH-AB.05</td><td></td><td></td><td></td><td></td><td></td></th<>	Duilding true		SFH-TH.01	SFH-TH.03	SFH-TH.05	MFH-AB.01	MFH-AB.03	MFH-AB.05							
Statemod Stat	Building type		02	04	06	02	04	06							
Detaset 2015/001_2015/01_2015/01_2015/01_0015/01 2015/001_0015/01 2015/001_0015/01 thermal Envelope Average Building Basic data TABULA average buildings Pior area national 137,1 137,1 136,0 176,0 2005,0 600,0 m² Roof area national 137,1 135,0 136,0 176,0 2005,0 600,0 m² Roof area national 137,1 135,0 136,0 136,0 137,0			SLNational	SLNational	SI.National	SL.National	SLNational	SI.National							
Image: Description of the descriptis the description of the description of the descri	Dataset		.2015.001.	.2015.001.	.2015.001.	.2015.001.	.2015.001.	.2015.001.							
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If our area rational 147,11 17,11	Basic data									TABULA av	/erade b	ouildinas			
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Number of dwellings 1,33 1,34 0,89 39,80 60,51 98,28	Floor area nation	al	133,7	137,3	136,7	1763,6	2804,5	5527,3					m²		
The Under Proceed State and dimensions) TAUUA average buildings mage to the original state Building stock model - state indicators Roof Stock model - state indicators Roof Building stock model - state indicators Roof Building stock model - state indicators Roof Advise fraction of envelope areas Building stock model - state indicators Roof Stock model - state indicators Nord Colspan= 2" Building stock model - state indicators Roof Colspan= 2" Building stock model - state indicators Roof Building stock model - sta	Number of dwelli	ings	1,53	1,34	0,89	39,80	60,51	98,28							
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TABULA standard calculation procedure Heat transfer by transmission 440 224 197 3512 4358 2929 M/K related to surface area 1,00 0,57 0,39 1,58 1,49 0,50 M/K related to surface area 2,99 1,49 1,31 1,81 1,41 0,48 M/K Annual energy balance building TABULA standard calculation procedure Transmission heat losses 193,4 102,0 90,5 129,7 102,7 37,5 KWh/(m²k Ventilation heat losses 33,0 35,0 26,4 36,5 37,1 29,7 KWh/(m²k Usable solar gains -12,0 -7,5 -9,1 -6,7 -8,1 -6,4 KWh/(m²k Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,3 KWh/(m Energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m Net energy need for heating 200,6 115,4 <t< td=""><td>Accum. temp. diff. ext. t</td><td>o int. temp.</td><td>3234</td><td>3234</td><td>3234</td><td>3234</td><td>3234</td><td>3234</td><td></td><td></td><td></td><td></td><td>Kd/a</td></t<>	Accum. temp. diff. ext. t	o int. temp.	3234	3234	3234	3234	3234	3234					Kd/a		
Heat transfer by transmission 440 224 197 3512 4358 2929 W/K W/K related to surface area 1,00 0,57 0,39 1,58 1,49 0,50 W/K W/K related to surface area 2,99 1,49 1,31 1,81 1,41 0,48 W/K W/K Annual energy balance building TABULA standard calculation procedure TABULA standard calculation procedure KWh/(m²k Transmission heat losses 193,4 102,0 90,5 129,7 102,7 37,5 KWh/(m²k Usable solar gains -12,0 -7,5 -9,1 -6,7 -8,1 -6,4 KWh/(m²k Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,3 KWh/(m KWh/(m Energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m	Envelope				_	_		TAE	BULA stan	dard calcul	ation pr	ocedure			
related to surface area related to surface area related to ref. floor area 1,00 0,57 0,39 1,58 1,49 0,50 M W/(m²k W/(m²k Annual energy balance building Transmission heat losses Ventilation heat losses 193,4 102,0 90,5 129,7 102,7 37,5 KWh/(m²k Usable solar gains 1-12,0 -7,5 -9,1 -6,7 -8,1 -6,4 KWh/(m²k Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,1 -14,3 KWh/(m Energy need for heating recovered by vent. system Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m	Heat transfer by tra	nsmissio	n 440	224	197	3512	4358	2929					W/K		
related to ref. floor area 2,99 1,49 1,31 1,41 0,48 Image: Marce Straight	related to surface	e area	1,00	0,57	0,39	1,58	1,49	0,50					W/(m²K		
TRABULA standard calculation procedure Transmission heat losses 193,4 102,0 90,5 129,7 102,7 37,5 Image: Colspan="4">KWh/(m Ventilation heat losses 33,0 35,0 26,4 36,5 37,1 29,7 Image: Colspan="4">KWh/(m Usable solar gains -12,0 -7,5 -9,1 -6,7 -8,1 -6,4 Image: Colspan="4">KWh/(m Usable internal gains -13,8 -14,1 -14,1 -14,1 -14,3 Image: Colspan="4">KWh/(m Energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 Image: Colspan="4">KWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 Image: Colspan="4">KWh/(m	related to ref. flo	or area	2,99	1,49	1,31	1,81	1,41	0,48					W/(m²K		
Iransmission heat losses 193,4 102,0 90,5 129,7 102,7 37,5 KWh/(m Ventilation heat losses 33,0 35,0 26,4 36,5 37,1 29,7 KWh/(m Usable solar gains -12,0 -7,5 -9,1 -6,7 -8,1 -6,4 KWh/(m Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,1 -14,3 KWh/(m Energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 KWh/(m	Annual energy bala	nce buil	ding			10		TAE	BULA stan	dard calcul	ation pr	ocedure			
Ventulation near losses 35,0 35,0 26,4 36,5 37,1 29,7 KWh/(m Usable solar gains -12,0 -7,5 -9,1 -6,7 -8,1 -6,4 kWh/(m Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,1 -14,3 kWh/(m Energy need for heating recovered by vent. system 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m	Transmission hea	at losses	193,4	102,0	90,5	129,7	102,7	37,5					kWh/(m		
Usable internal gains 12,0 7,1 -7,1 -0,1 -0,1 -0,1 -0,1 Wh/(m Usable internal gains -13,8 -14,1 -14,0 -14,1 -14,1 -14,3 kWh/(m Energy need for heating recovered by vent. system 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m	Ventilation heat I	usses	-12.0	35,0 _7 =	26,4	36,5	5/,1 _Q 1	-6.4					kWn/(m		
Energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m	Usable internal a	ains	-13.8	-14 1	-14 0	-14 1	-14 1	-14 3					kWh/(m		
recovered by vent. system kWh/(m Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m	Energy need for he	ating	200,6	115,4	93,8	145,4	117,5	46,5					kWh/(m		
Net energy need for heating 200,6 115,4 93,8 145,4 117,5 46,5 kWh/(m	recovered by ver	nt. system	1	, ,		, 1	,0	,.					kWh/(m		
	Net energy need fo	r heating	200,6	115,4	93,8	145,4	117,5	46,5					kWh/(m		

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		vera	ge B	uildi	ngs				B	uil <u>di</u> i	n <u>g St</u>	oc <u>k S</u>	Statis
BU		ilding Stor	-k CT	Nation		ational He	ucing Str		vonia				Year
	Du	inding Stor	.K 51	Nation			Jusing Sto	JCK OF SIC	venia				, cui
	De	etails	ZR	MK model									
Ann	otations t	o this shee	et										
				1	2	3	4	5	6	7	8	9	10
Build	ding type			02	04	06	02	04	06				
tal	Buildin	g Stock	K						Bu	uilding sto	ock model	- state ir	ndicators
Nun	nber of bu	ildings	10 ⁰	140 509	164 741	44 631	4 262	2 800	366				
Nun	nber of dv	vellings	10 ⁰	214 701	221 186	39 684	169 624	169 426	36 008				
Floo	or area nat	tional	10 ⁶ m ²	19	23	6	8	8	2				
Floo	or area TA	BULA	10 ⁶ m ²	21	25	7	8	9	2				
entil	ation S	ystems	with	Heat R	ecove	ry			Βι	ilding sto	ock model	- state i	ndicators
	Occuran	ices		0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%
eatir	ng Syst	ems		of Duod	und Ha	- •			D.	ulding et		stata i	adicatora
1	Bio	R WP	actions	31%	исеа не 31%	30%	26%	26%	32%	linding su		- state II	luicators
2	DH	TS	C	1%	2%	4%	3%	4%	0%				
3	FI	HP Air	C	15%	15%	14%	17%	15%	15%				
4	Oil	B NC C	тс	19%	19%	17%	16%	15%	18%				
5	Coal	B NC L	T C	8%	7%	9%	9%	9%	8%				
6	Gas	B C	С	15%	15%	16%	18%	19%	17%				
7													
8													
9													
10													
11			_										
12			_										
13			_										
14			_										
15			_										
17													
18													
19													
20													
	Sum			90%	89%	90%	89%	88%	91%				
	there	eof centra	al	90%	89%	90%	89%	88%	91%				
		decer	ntral										
	Other S	Systems		10%	11%	10%	11%	12%	9%				
-w	System	IS		_									
	Occuran	nces or Fr	actions	s of Prod	uced He	at	110/	1101	Bu	ilding st	ock model	- state in	ndicators
1		B_NC	C	18%	10/	1/%	11%	11%	16%				
2	DH	IS B.C	0	1%	1%	4%	2%	3%	0%				
ک ک	Gas	вС	C	2%	2%	4%	2%	2%	5%				

1	Oil	B_NC	С	18%	1/%	1/%	11%	11%	16%		
2	DH	TS	С	1%	1%	4%	2%	3%	0%		
3	Gas	B_C	С	2%	2%	4%	2%	2%	5%		
4	Gas	G_IWH_NC	С	1%	1%	1%	1%	1%	1%		
5	Bio	B_C	С	11%	10%	11%	10%	11%	9%		
6	Bio	B_WP	С	20%	19%	19%	15%	13%	17%		
7	Bio	B_WP	С	7%	8%	8%	3%	5%	9%		
8	El	HP_Ground	С	1%	2%	2%	1%	1%	3%		
9	El	HP_Air	D	13%	13%	10%	11%	13%	17%		
10	Gas	G_IWH	С	1%	1%	1%	1%	1%	1%		
11	El	E	D	3%	4%	3%	13%	15%			
12	-	Solar	С	7%	8%	6%	6%	7%	5%		
13	Coal	B_NC_CT	С	7%	6%	9%	7%	7%	7%		
14	Gas	G_Tank	D	1%	1%	1%	8%	4%	4%		
15	Oil	B_NC_LT	С	5%	7%	5%	11%	6%	8%		
16											
17											
18											
19											
20											
	Sum			100%	100%	100%	100%	100%	101%		
	thereof central			82%	82%	87%	69%	67%	80%		
	decentral			18%	18%	13%	31%	33%	21%		
	Other !	Systems							-1%		

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	Building Stock	SI	Nation	al Na	tional Ho	using Sto	ock of Slov	enia				Year	20:
	Details	ZR	RMK model			-							
Annotati	ions to this sheet												
Annotati							_		_			10	
			1	2	3	4	5	6	/	8	9	10	1
Building	type		SFH-TH.01	SFH-TH.03-	SFH-TH.05	MFH-AB.01	MFH-AB.03 M	1FH-AB.05					
			02	01		02	01						
ating S	Systems												
Heat de	emand / heat ge	nera	ation					TABUL	A stan	dard cal	culation p	rocedure	
Ene	rgy need for heati	ng	200,6	115,4	93,8	145,4	117,5	46,5					kWh/
Net	en, need for neat	ing	200,6	115,4	93,8	145,4	117,5	46,5			system i	 ndicators	Kvvn/
Cen	itral systems	C	22,5	12,0	6,0	22,5	12,0	6,0		TADOLA	System		kWh/
Dec	central systems	D											kWh/
Auxilia	ary energy									TABULA	system i	ndicators I	LWb/
Cen	itral systems (avera	C	2,7	2,7	2,7	2,7	2,7	2,7					kWh/
Dec	central systems	D											kWh/
Energy	expenditure fac	tors	(fuels: rel	ated to g	ross calo	rific value	∋)			TABULA	system i	ndicators	
1 Bi	io B WP	C	2,00	1,20	1,20	2,00	1,20	1,20					
3 E	HP Air	Ċ	0,36	0,36	0,36	0,36	0,36	0,36					
4 0 5 C	oal B NC CT	C C	1,20 1,10	1,20 1,10	1,20 1,10	1,20 1,10	1,20	1,20					
6 G	as B C	Č	1,07	1,07	1,07	1,07	1,07	1,07					
8													
10													
11		-											
13													
14													
16		-											
18													
20													
Deliver	ed Energy							TABUL	A stan	dard cal	culation p	rocedure	
1 Bi	io B WP	C	446,2	153,5	120,3	335,8	156,0	63,3					kWh/
2 D 3 E	I HP Air	C	79,7	45,5	35,7	60,0	46,3	18,8					kwn/
4 0 5 C	oal B NC CT	C C	267,7	152,8	119,8 109,8	201,5	155,4 142,5	63,0 57,8					kWh/ kWh/
6 G	ias B C	С	238,7	136,3	106,8	179,6	138,6	56,2					kWh/
8													kWh/
10													kWh/
11 12		-											kWh/
13		-											kWh/
15													kWh/
17													kWh/
18 19													kWh/ kWh/
20													kWh/
Deliver	ed Energy - wei	ghte	d by freq	uencies		_		TABUL	A stan	dard cal	ulation p	rocedure	
1 Bi 2 D	io B WP	C	138,2	47,4	35,9 4.0	86,8 5.1	40,5	20,2					kWh/
3 El	HP Air	Č	12,1	6,9	4,8	10,2	6,9	2,8					kWh/
5 C	oal B NC LT	C	19,2	10,1	20,8	17,1	13,4	4,6					kwn/ kWh/
6 G 7	ias B C	С	36,9	20,6	17,6	32,9	26,5	9,7					kWh/
8													kWh/
10													kwn/
11 12		-											kWh/
13													kWh/
15													kwn/ kWh/
16 17													kWh/
18													kWh/
20													kwn/
Electric	ty production h		1P					TARI	A stan	dard cal	rulation n	roceduro	
								ADOL					kWh/
		-											kWh/

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Appendix B: Example of "Average Buildings" Calculation

Building Stock Details Text mode Text mode Anotations to this sheet 1 2	AllA	Average	e B	Buildin	gs				Deliv	vered	En	ergy	for I	OHW
Details PROVE WORK Anotations to this sheet Image of the two	E	Building Stock	SI	Nationa	Nat	ional Hou	sing Stoc	k of Slov	renia				Year	2015
Annotations to this sheet 1 2 3 4 5 6 7 8 9 1.0 Shifting type Shifting S	[Details	ZR	RMK model										
L 2 3 4 5 6 7 8 9 10 building type All that is in that is the that is	Annotations	to this sheet												
a transmission of the set of th				1	2	3	4	5	6	7	8	0	10	
Building type End (SP thus) SP thus) SP thus (SP thus) SP thus (SP thus) TABULA standard calculation procedure W Systems TABULA standard calculation procedure TABULA standard calculation procedure KWM/(m Destry need for DHW D 0.0 1.0 <th1.0< th=""> 1.0 1.0</th1.0<>					2		- T			/	0	5	10	1
Average Average <t< td=""><td>Building typ</td><td>e</td><td></td><td>SFH-TH.01- SF 02</td><td>H-TH.03- S 04</td><td>66 FH-TH.05</td><td>FH-AB.01 M 02</td><td>04</td><td>4FH-AB.05 06</td><td></td><td></td><td></td><td></td><td></td></t<>	Building typ	e		SFH-TH.01- SF 02	H-TH.03- S 04	66 FH-TH.05	FH-AB.01 M 02	04	4FH-AB.05 06					
W System TABL/LA standard calculation procedure Energy need for DHW 10,0														
TABULA standard calculation procedure TABULA standard calculation procedure TABULA system indicators Central systems D O. TABULA system indicators Central systems C 1.7 TABULA system indicators TABULA standard calculator	W Syste	ms												
energy heed for Univ [L30] [L30] <th[l30]< th=""> [L30] [L30]</th[l30]<>	Heat dema	and / heat ge	nera	ation	10.0	10.0	15.0	15.0	TABL	JLA standa	rd calo	culation p	rocedure	LAND //
Central systems C 1,1 1,5 1,1 1,5 1,1 1,5 1,1 1,5 1,1 1,5 1,1 1,5 1,1 <	Distributio	on + storage lo	sses	10,0	10,0	10,0	15,0	15,0	15,0	T/		svstem i	l ndicators	Kvvn/(m
Decentral systems D 0, 0, 8 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 2 1, 7 <td>Central</td> <td>systems</td> <td>С</td> <td>1,1</td> <td>1,5</td> <td>1,5</td> <td>1,1</td> <td>1,5</td> <td>1,5</td> <td></td> <td></td> <td>Jysterri</td> <td></td> <td>kWh/(m</td>	Central	systems	С	1,1	1,5	1,5	1,1	1,5	1,5			Jysterri		kWh/(m
Auxiliary streng C 1,7	Decent	ral systems	D	0,8	1,2	1,2	0,8	1,2	1,2					kWh/(m
Decentral systems D 1,7	Central	svstems	С		1,7	1,7	1,7	1,7	1,7	17	ABULA	system i	ndicators	kWh/(m
TABULA system indicators	Decent	ral systems	D		1,7	1,7	1,7	1,7	1,7					kWh/(m
1 01 B. NC C 1.35 <th1.35< th=""> 1.35 1.35<td>Energy ex</td><td>penditure fac</td><td>tors</td><td>(fuels: relat</td><td>ted to gr</td><td>oss calori</td><td>fic value)</td><td>)</td><td></td><td>T</td><td>ABULA</td><td>system i</td><td>ndicators</td><td></td></th1.35<>	Energy ex	penditure fac	tors	(fuels: relat	ted to gr	oss calori	fic value))		T	ABULA	system i	ndicators	
1 0 as b C 1	1 Oil	B NC	C	1,35	1,35	1,35	1,35	1,35	1,35					
Bob C (WT NC L) Lib Lib <thlib< th=""> Lib <thlib< th=""> <thli< td=""><td>3 Gas</td><td>BC</td><td>C</td><td>1,18</td><td>1,18</td><td>1,18</td><td>1,18</td><td>1,18</td><td>1,18</td><td></td><td></td><td></td><td></td><td></td></thli<></thlib<></thlib<>	3 Gas	BC	C	1,18	1,18	1,18	1,18	1,18	1,18					
6 Bio B WP C 200 2.00 2.00 2.00 2.00 2.00 8 E HP Ground C 0.29 <th0< th=""> 0.29 0.29 <</th0<>	4 Gas 5 Bio	B C	C	0,98	1,18 0,98	0,98	0,98	1,18 0,98	1,18 0,98					
6 E. HP Ground C 0.29 0.20 <	6 Bio 7 Bio	B WP B WP	C C	2,00	2,00	2,00 1,20	2,00	2,00 1,20	2,00					
10 Case C V/X00 V/X00 </td <td>8 El 9 Fl</td> <td>HP Ground</td> <td>C</td> <td>0,29</td> <td>0,29</td> <td>0,29</td> <td>0,29</td> <td>0,29</td> <td>0,29</td> <td></td> <td></td> <td></td> <td></td> <td></td>	8 El 9 Fl	HP Ground	C	0,29	0,29	0,29	0,29	0,29	0,29					
11 D LOU LOU <thlou< th=""> <thlou< th=""> <thlou< th=""></thlou<></thlou<></thlou<>	10 Gas	GIWH	C	1,00	1,00	1,00	1,00	1,00	1,00					
13 Coal B NC CT C 1.20 <td>11 El 12 -</td> <td>Solar</td> <td>C</td> <td>1,00</td> <td>1,00</td> <td>1,00</td> <td>1,00</td> <td>1,00</td> <td>1,00</td> <td></td> <td></td> <td></td> <td></td> <td></td>	11 El 12 -	Solar	C	1,00	1,00	1,00	1,00	1,00	1,00					
15 0it 6 NC LT C 1,10 1,11 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,15 11,13 11,35 13,2	13 Coal 14 Gas	B NC CT G Tank	C	1,20	1,20	1,20	1,20	1,20	1,20					
17 1	15 Oil	B NC LT	č	1,10	1,10	1,10	1,10	1,10	1,10					1
13 13<	17													
20 TABULA standard calculation procedure 1 Oil B NC C 15,5 15,5 21,8 21,2 22,3 22,3 22,3 22,3 WhV/m 3 Cas B NC C 13,1 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,5 13,6 13,0 13,5 13,5 16,2 WW/m S S	18 19													
Delivered Energy TABULA standard calculation procedure 1 Dil B NC C 15.5 15.5 15.5 16.5 16.5 N/N 3 Gas B C C 13.1 13.5 <td>20</td> <td></td> <td>]</td>	20]
1 0H B NC C 13.0 15.5 21.8 22.3 KWM/(m 3 Gas B C C 11.1 11.5 11.5 16.5 KWM/(m 4 Gas Gas C C 13.1 13.5 13.6 13.0 </td <td>Delivered</td> <td>Energy</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>TABL</td> <td>JLA standa</td> <td>rd calo</td> <td>ulation p</td> <td>rocedure</td> <td></td>	Delivered	Energy							TABL	JLA standa	rd calo	ulation p	rocedure	
31 Gas B C C 13.1 13.5 13.5 13.6 19.0 HVM/(m 5 Bio B C C 10.9 11.3 11.3 15.8 16.2 16.2 KWM/(m 6 Bio B WP C 22.30 23.2 33.0 KWM/(m 8 EI HP Grunc C 3.3 3.3 4.6 4.7 KWM/(m 9 EI HP Air D 3.9 4.0 4.0 5.6 5.8 5.8 KWM/(m 11 EI Solar C 13.3 13.8 13.8 13.8 16.2 16.2 KWM/(m 12 Coal B NC CT C 13.3 13.8 13.8 19.3 19.8 19.8 KWM/(m 14 Gas G Tank D 10.8 11.2 11.2 15.8 16.2 16.2 KWM/(m 14 Gas	1 Oil 2 DH	TS TS	C	15,0 11,1	15,5 11,5	15,5	21,8 16,1	22,3	22,3					kWh/(m kWh/(m
5 Bio B C C 200 11.3 11.1 11.1 11.5 11.1 11.1 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 11.3 <td>3 Gas 4 Gas</td> <td>G IWH NO</td> <td>C</td> <td>13,1</td> <td>13,5 13,6</td> <td>13,5 13,6</td> <td>18,9 19.0</td> <td>19,4 19,5</td> <td>19,4</td> <td></td> <td></td> <td></td> <td></td> <td>kWh/(m</td>	3 Gas 4 Gas	G IWH NO	C	13,1	13,5 13,6	13,5 13,6	18,9 19.0	19,4 19,5	19,4					kWh/(m
o Dio B WP C 12.4 13.9 13.0 13.0 13.0 </td <td>5 Bio</td> <td>B C</td> <td>Č</td> <td>10,9</td> <td>11,3</td> <td>11,3</td> <td>15,8</td> <td>16,2</td> <td>16,2</td> <td></td> <td></td> <td></td> <td></td> <td>kWh/(m</td>	5 Bio	B C	Č	10,9	11,3	11,3	15,8	16,2	16,2					kWh/(m
8 El HP Air D 3,2 3,3 3,3 4,6 4,7 4,7 KWN/m 10 Gas G IWH C 11,1 11,5 11,5 16,5 KWN/m 11 EI E D 10,8 11,2 11,2 15,5 KWN/m 12 - Solar C - - KWN/m 13 Coal B NC CT C 13,3 13,8 19,3 19,8 19,8 14 Gas G Tank D 10,8 11,2 11,2 15,8 16,2 16,2 KWN/m 15 Oil B NC LT C 12,7 12,7 17,7 18,2 18,2 KWN/m 19 KWN/m KWN/m 10 B NC C 2,7 2,6 2,6 2,4 2,5 3,5 KWN/m 2 DH TS C <td< td=""><td>7 Bio</td><td>B WP</td><td>C</td><td>13,4</td><td>13,9</td><td>13,9</td><td>19,4</td><td>19,9</td><td>19,9</td><td></td><td></td><td></td><td></td><td>kWh/(m</td></td<>	7 Bio	B WP	C	13,4	13,9	13,9	19,4	19,9	19,9					kWh/(m
10 Gas G TWH C 11,1 11,5 16,1 16,5 KWH/(m 12 - Solar C 11,2 11,2 15,8 16,2 16,2 KWH/(m 13 Coal B NC CT C 13,8 13,8 19,8 19,8 KWH/(m 14 Gas G Tank D 10,8 11,2 12,7 12,7 12,8 16,2 KWH/(m 15 Oil B NC LT C 12,2 12,7 12,7 17,7 18,2 18,2 KWH/(m 16	8 El 9 El	HP Ground HP Air	C D	3,2	3,3	3,3	4,6 5,6	4,7	4,7					kWh/(m kWh/(m
11 11<	10 Gas	G IWH	C	11,1	11,5	11,5	16,1	16,5 16,2	16,5					kWh/(m
13 Coal B, NC, C1 C 13,3 13,6 13,7 13,6 13,7 13,6 13,7 13,6 13,7 13,6 13,7 13,6 13,7 13,6 14,7 14,7 14	12 -	Solar	C	12.2	12.0	12.0	10.2	10.2	10,2					kWh/(m
15 Oil B NC LT C 12.2 12.7 12.7 17.7 18.2 18.2 kWh/(m 16 Image: Construction of the standard constend of the standard construction of the standard construction of	13 Coar 14 Gas	G Tank	D	10,8	11,2	11,2	19,5	19,8	19,8					kwn/(m
17 18 10 11 <td< td=""><td>15 Oil 16</td><td>B NC LT</td><td>С</td><td>12,2</td><td>12,7</td><td>12,7</td><td>17,7</td><td>18,2</td><td>18,2</td><td></td><td></td><td></td><td></td><td>kWh/(m kWh/(m</td></td<>	15 Oil 16	B NC LT	С	12,2	12,7	12,7	17,7	18,2	18,2					kWh/(m kWh/(m
Delivered Energy - weighted by frequencies TABULA standard calculation procedure 1 Oil B NC C 2,7 2,6 2,6 2,4 2,5 3,5 KWh/(m 2 DH TS C 0,1 0,2 0,5 0,3 0,4 0,1 KWh/(m 3 Gas B C C 0,1 0,2 0,2 0,2 0,1 0,4 0,1 KWh/(m 4 Gas G IWH NC C 0,1 0,1 0,2 0,2 0,1 KWh/(m 5 Bio B C C 1,2 1,1 1,3 1,5 1,7 1,4 KWh/(m KWh/(m KWh/(m S Bio B C 0,9 1,1 1,1 0,6 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1 0,1	17													kWh/(m
Zou L <thl< th=""> L <thl< th=""> <thl< th=""></thl<></thl<></thl<>	19								_					kWh/(m
TABULA standard calculation procedure 1 Oil B NC C 2,7 2,6 2,6 2,4 2,5 3,5 kWh/(m 3 Gas B C C 0,1 0,2 0,5 0,3 0,4 0,1 kWh/(m 4 Gas G C 0,1 0,1 0,2 0,2 0,2 0,1 kWh/(m 4 Gas G IWH NC C 0,1 0,1 0,2 0,2 0,1 kWh/(m 5 Bio B C C 1,2 1,1 1,3 1,5 1,7 1,4 kWh/(m 6 Bio B WP C 0,9 1,1 1,0 0,1 0,1 0,1 kWh/(m wWh/(m 10 Gas G WWh/(m W/m 10 Gas G WW/(m W/m 10 10,1 0,2 0,2 0,2 0,2 10,1 10,1	20	_			-								1	_KVVN/(M
2 D. Ito 3 2.12 2.72 3.72 1.72 3.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.72 1.71 1.74 1.73 1.73 1.73 1.71 1.74 1.72 1.71 1.74 1.71 1.74 1.72 1.71 1.74 1.72 1.71 1.74 1.72 1.71 1.74 1.72 1.71 1.74 1.72 1.72 1.73 1.71 1.74 1.7	1 Oil	Energy - weig	jhte	d by frequ	encies	2.6	24	25	TABL	JLA standa	rd calo	culation p	rocedure	k\Mh/(m
Society C 0,3 0,3 0,4 0,4 1,0 KWh/m 4 Gas G WH NC C 0,1 0,2 0,2 0,1 kWh/m 5 Bio B C C 1,2 1,1 1,3 1,5 1,7 1,4 kWh/m 6 Bio B WP C 4,5 4,3 4,4 4,7 4,3 5,5 kWh/m 7 Bio B WP C 0,9 1,1 1,0	2 DH	TS	č	0,1	0,2	0,5	0,3	0,4	0,1					kWh/(m
5 Bio B C C 1,2 1,1 1,3 1,5 1,7 1,4 KWh/(m 6 Bio B WP C 4,3 4,4 4,7 4,3 5,5 KWh/(m 7 Bio B WP C 0,9 1,1 1,1 0,6 1,0 1,8 KWh/(m 8 El HP Ground C 0,0 0,1 0,1 0,1 0,1 KWh/(m 9 El HP Air D 0,5 0,5 0,4 0,6 0,8 1,0 KWh/(m 10 Gas G IWH C 0,1 0,1 0,2 0,2 KWh/(m 11 El E D 0,4 0,3 2,0 2,5 KWh/(m 12 - Solar C 1,0 0,1 1,1 1,3 KWh/(m 14 Gas G Tank D 0,1 0,1 1,2 0,7 0,7 <td< td=""><td>3 Gas 4 Gas</td><td>G IWH NO</td><td>C</td><td>0,3</td><td>0,3</td><td>0,5</td><td>0,4</td><td>0,4</td><td>0,1</td><td></td><td></td><td></td><td></td><td>kwn/(m kWh/(m</td></td<>	3 Gas 4 Gas	G IWH NO	C	0,3	0,3	0,5	0,4	0,4	0,1					kwn/(m kWh/(m
T Bit T Dis Dis <thdis< th=""> <thdis< th=""> <thdis< th=""></thdis<></thdis<></thdis<>	5 Bio	B C B WP	C	1,2	1,1	1,3 4,4	1,5	1,7	1,4					kWh/(m
o tr in r ological control ologicontrol ological contro	7 Bio	B WP	C	0,9	1,1	1,1	0,6	1,0	1,8					kWh/(m
10 Gas G IWH C 0,1 0,1 0,1 0,2 0,2 0,2 0,2 Wh/m 11 El E D 0,4 0,4 0,3 2,0 2,5 KWh/m 12 - Solar C - - KWh/m 13 Coal B NC CT C 1,0 0,9 1,2 1,3 1,4 1,3 KWh/m 14 Gas G Tank D 0,1 0,1 0,1 1,2 0,7 0,7 KWh/m 15 Oil B NC LT C 0,6 0,9 0,7 1,9 1,1 1,5 KWh/m 16 - - - - - - KWh/m 18 - - - - - - KWh/m 19 - - - - - - KWh/m TABULA standard calculation procedure KWh/m - - - - - - KWh/m	9 El	HP Ground	D	0,0	0,1	0,1	0,0	0,1	1,0					kwn/(m
12 - Solar C i <td>10 Gas 11 El</td> <td>G IWH E</td> <td>C D</td> <td>0,1</td> <td>0,1 0,4</td> <td>0,1 0,3</td> <td>0,2 2,0</td> <td>0,2 2,5</td> <td>0,2</td> <td></td> <td></td> <td></td> <td></td> <td>kWh/(m kWh/(m</td>	10 Gas 11 El	G IWH E	C D	0,1	0,1 0,4	0,1 0,3	0,2 2,0	0,2 2,5	0,2					kWh/(m kWh/(m
Iso Gora D NC C1 C 1,0 1,2 1,7 1,3 KWh/(m 14 Gas G Tank D 0,1 0,1 1,2 0,7 0,7 KWh/(m 15 Oil B NC LT C 0,6 0,9 0,7 1,9 1,1 1,5 KWh/(m 16 KWh/(m 16 KWh/(m 16 KWh/(m 17 KWh/(m 19 KWh/(m 20 KWh/(m TABULA standard calculation procedure KWh/(m KWh/(m	12 - 13 Cool	Solar B NC CT	C	1.0	0.0	1 2	1 2	1 4	1 2					kWh/(m
15 OII B NC LT C 0,6 0,9 0,7 1,9 1,1 1,5 KWh/(m 16 -	14 Gas	G Tank	D	0,1	0,9	0,1	1,2	0,7	0,7					kWh/(n
17 18 19 20 Electricity production by CHP TABULA standard calculation procedure KWh/(m	15 Oil 16	B NC LT	С	0,6	0,9	0,7	1,9	1,1	1,5					kWh/(m kWh/(m
19 10 <	17													kWh/(m
201 Image: Constraint of the standard calculation procedure Electricity production by CHP TABULA standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constraint of the standard calculation procedure Image: Constandard calculation procedure <t< td=""><td>19</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>kWh/(m</td></t<>	19													kWh/(m
Electricity production by CHP TABULA standard calculation procedure Wh/(m KWh/(m KWh/(m KWh/(m)))	20													_kWh/(m
Image: Contract of the	Electricity	production b	y C⊦	1P	1				TABL	JLA standa	rd calo	ulation p	rocedure	LAND 11
KWh/(m														kwn/(m kWh/(m
														kWh/(m

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TAPI II	A /	vera	ge B	Buildi	ngs		Sim	plifie	d Bu	ildin	g Sto	ck Pi	r oje c	tion
APA	B	uilding Sta		Nation	al Na	tional Ho	using St	ock of Slo	venia				Year	2015
		anding Ste		Millimedal			Jushing Sto		venia					2015
	D	etalis	25	Mik model										
Anno	otations t	this she	eet											
Total E	Buildin	g Stoc	k	1	2	3	4	5	6	7	8	9	10	Total
Duile	the sector sector			SFH-TH.01-	SFH-TH.03-	SFH-TH.05-	MFH-AB.01	MFH-AB.03	MFH-AB.05					
Build	ling type			02	04	06	02	04	06					
Flo	oor area	TABULA	10 ⁶ m ²	21	25	7	8	9	2	0	0	0	0	71
						All energ	gy quant	ities in	GW	h/a				
Heatin	ng Syst	tems												
Hea	t Dema	nd for He	eating			TABU	LA standa	rd calcula	ation pro	cedure / r	projection	to buildir	na stock	Total
	Energy r	need for h	eating	4 145	2 871	630	1 202	1 015	104					9 966
	Net en. i	need for h	neating	4 145	2 871	630	1 202	1 015	104					9 966
	Produced	d heat		4 564	3 135	666	1 369	1 106	116					10 956
Deli	vered E	nergy TA	BULA			TABU	LA standa	rd calcula	ation pro	cedure / r	proiection	to buildir	na stock	Sum
1	Bio	B_WP	С	2 857	1 180	241	718	350	45				. <u>g</u>	5 390
2	DH	TS	С	59	51	27	43	41	1					221
3	El	HP_Air	C	250	171	32	84	60	6					603
4	Oil	B_NC_	ст с	1 069	713	140	266	204	26					2 418
5	Coal	B_NC_	LT C	398	253	65	142	116	10					983
6	Gas	B_C	С	764	512	118	272	229	22					1 916
7														
8														
9														
10														
11														
12														
14														
14														
15														
17														
18														
19														
20														
Ī	Not sp	ecified sy	stems	410	325	62	127	120	10				ĺ	1 053
	Auxilia	ry energy		50	60	16	20	21	5					172
	CHP electr. productio													0

DHW Systems

36

	y sten												
Hea	t Dema	nd for DHW				TABUL	A standa	rd calcul	ation prod	cedure / p	rojectio	n to building s	tock Total
Energy need for DHW			207	249	67	124	130	33				810	
Produced heat				228	285	77	132	142	37				901
Deli	ivered E	nergy TABUI	A			TABUL	A standa	rd calcul	ation prod	cedure / p	rojectio	n to building s	tock Total
1	Oil	B_NC	С	55	64	18	20	21	8				186
2	DH	TS	С	3	4	3	3	4	0				17
3	Gas	B_C	С	7	8	3	3	3	2				26
4	Gas	G_IWH_NC	С	3	4	1	2	2	0				12
5	Bio	B_C	С	24	28	8	13	15	3				92
6	Bio	B_WP	С	94	106	30	39	37	12				318
7	Bio	B_WP	С	19	27	8	5	9	4				70
8	El	HP_Ground	С	1	1	0	0	0	0				4
9	El	HP_Air	D	11	13	3	5	7	2				40
10	Gas	G_IWH	С	2	3	1	1	1	0				9
11	El	E	D	7	11	2	17	21	0				58
12	-	Solar	С	0	0	0	0	0	0				0
13	Coal	B_NC_CT	С	20	22	8	10	12	3				75
14	Gas	G_Tank	D	2	3	0	10	6	2				22
15	Oil	B_NC_LT	С	13	23	4	16	10	3				70
16													
17													
18													
19													
20													
	Not sp	ecified system	IS	0	0	0	0	0	0				0
	Auxilia	ry energy		0	42	11	14	15	4				86
	CHP e	lectr. production	on										0

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Appendix B: Example of "Average Buildings" Calculation

TAPILLA	Avera	ige I	Buildi	ngs		Summary and Comparison							
INDUC.	Building Sto Details	ock SI	Nation	nal N	ational Ho	ousing Sto	ock of Slo	venia				Year	2015
Annotation	ns to this she	eet											
Total Build	ling Stoc	1	2	3	4	5	6	7	8	9	10	Total	
Building ty	vpe	SFH-TH.0 02	1- SFH-TH.03- 04	SFH-TH.05 06	MFH-AB.01 02	MFH-AB.03 04	MFH-AB.05 06						
Floor area TABULA	10 ⁶ m ²	2:	L 25	7	8	9	2	0	0	0	0	71	

Total Heat Need and Final Energy All energy quantities in GWh/a Heating + DHW

Simplified TABULA projection			fuels relat	ed to gros	s calorific	value	TAB	TABULA standard calculation procedure					per m²
Net heat need		4 352	3 119	697	1 326	1 144	137					10 776	151
Produced heat		4 793	3 420	743	1 501	1 248	152					11 857	166
Gas		777	528	123	288	241	26					1 984	28
Oil		1 138	801	161	302	235	37					2 674	37
Coal		417	275	73	152	127	13					1 058	15
Bio		2 993	1 341	286	775	411	64					5 870	82
DH		62	55	30	45	45	1					237	3
El (incl. aux. en.)		320	297	65	140	123	18					964	14
Other / not specifi	ed	410	325	62	127	120	9					1 053	15
Sum final energy		6 116	3 623	802	1 829	1 302	168	0	0	0	0	13 840	194
CHP electr. producti	on	0	0	0	0	0	0					0	0

Separate individual model]	
or total metered		fuels related to gross calorific value										1	I
consumption		factors for	conversio	n to gross	calorific v	alue (TABl	JLA standa	ard)	bui	lding stoo	k model	Total	per m ²
Net heat need		2 906	2 721	284	868	736	97					7 611	107
Produced heat		3 192	2 970	314	1 006	794	103					8 379	117
Gas	1,00	420	506	136	167	201	54					1 485	21
Oil	1,00	443	533	144	178	214	58					1 570	22
Coal	1,00	1	1	0	0	0	0					2	0
Bio	1,00	1 477	1 778	480	653	786	212					5 385	75
DH		250	301	81	101	121	33					886	12
El		287	346	93	122	147	40					1 036	15
Other / not specif	ied	136	164	44	32	38	10					425	6
Sum final energy		3 013	3 628	979	1 253	1 509	407	0	0	0	0	10 789	151
CHP electr. producti	on	0	0	0	0	0	0					0	0

Ratio of individual model or total metered consumption to simplified TABULA projection (TABULA balance calibration factors)

(TABULA balance ca	libra	ation fac	tors)							Total
Net heat need		67%	87%	41%	65%	64%	71%			71%
Produced heat		67%	87%	42%	67%	64%	68%			71%
Gas		54%	96%	110%	58%	84%	208%			75%
Oil		39%	67%	89%	59%	91%	156%			59%
Coal		0%	0%	0%	0%	0%	1%			0%
Bio		49%	133%	168%	84%	191%	330%			92%
DH		405%	548%	269%	222%	272%	4467%			373%
El		90%	116%	143%	87%	119%	221%			108%
Other		33%	50%	71%	25%	32%	113%			40%
Sum final energy		49%	100%	122%	69%	116%	242%			78%
CHP electr. productio	on									

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