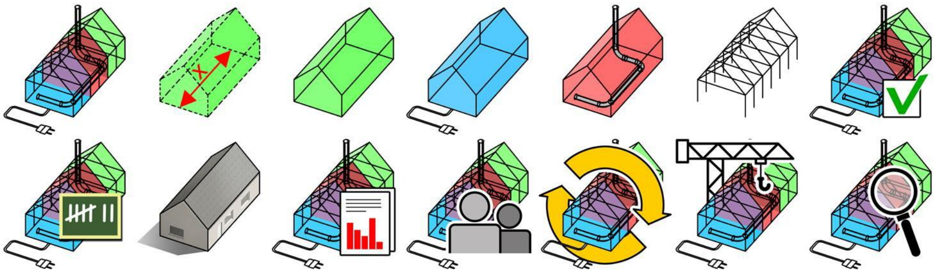

COBIM

Common BIM Requirements 2012

v 1.0

Series 10

Energy analysis

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Foreword

The publication series "Common BIM Requirements 2012" is the result of a broad-based development project entitled *COBIM*. The need for these requirements arises from the rapidly growing use of BIM in the construction industry. During all phases of a construction project, the parties to the project have a need to define more precisely than before what is being modeled and how the modeling is done. "Common BIM Requirements 2012" is based on the previous instructions of the owner organizations and the user experiences derived from them, along with the thorough experience the writers of the instructions possess on model-based operations.

The parties to the project are: **Funding providers:** Aitta Oy, Larkas & Laine Architects Ltd, buildingSMART Finland, City of Espoo Technical and Environment Services, Future CAD Oy, City of Helsinki Housing Production Office, City of Helsinki Premises Centre, University of Helsinki, Helsingin Yliopistokiinteistöt Oy, HUS Kiinteistöt Oy, HUS Premises Centre, ISS Palvelut Oy, City of Kuopio Premises Centre, Lemminkäinen Talo Oy, Micro Aided Design Ltd. (M.A.D.), NCC companies, Sebicon Oy, Senate Properties, Skanska Oy, SRV Group Plc, Sweco PM Oy, City of Tampere, City of Vantaa Premises Centre, Ministry of the Environment. **Written by:** Finnmap Consulting Oy, Gravicon Oy, Olof Granlund Oy, Lemminkäinen Talo Oy, NCC companies, Pöyry CM Oy, Skanska Oyj/VTT Technical Research Centre of Finland, Solibri, Inc., SRV Rakennus Oy, Tietoa Finland Oy. **Management:** The Building Information Foundation RTS.

The requirements were approved by an executive group consisting of parties to the project. The executive group acted as committee TK 320 of the Building Information Foundation RTS, and as such, participated actively in developing the content of the requirements and asking for comments from the members of the executive group and from interest groups.

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1 Main objectives of building information modeling

Property and construction modeling aims to support building lifecycle process that is of high quality, efficient, safe and in compliance with sustainable development. Building Information Models (BIM) are utilized throughout the building's life cycle, starting from initial design and continuing during use and facility management (FM) after the construction project has concluded.

BIM enables the following, for example:

- Provision of support to the investment decisions by comparing the functionality, scope and costs of the solutions.
- Energy, environment and lifecycle analyses for the purpose of comparing solutions, design and objectives of facility management follow-up.
- Design visualization and analysis of construction feasibility.
- Enhancement of quality-assurance and data exchange and making the design process more effective.
- Utilization of building project data during use and facility management activities.

To make modeling successful, project-specific priorities and objectives must be set for models and model utilization. Project-specific requirements will be defined and documented on the basis of the objectives and general requirements set in this publication series.

General objectives of BIM include, for example, the following:

- To provide support for the project's decision-making processes.
- To have the parties commit to the project objectives by means of using the BIM.
- To visualize design solutions.
- To assist in design and the coordination of designs
- To increase and secure the quality of the building process and the final product.
- To make the processes during construction more effective.
- To improve safety during construction and throughout the building's lifecycle.
- To support the cost and life-cycle analyses of the project.
- To support the transfer of project data into facility management during operation.

"Common BIM Requirements 2012" covers targets for new construction and renovation, as well as the use and facility management of buildings. The minimum requirements for modeling and the information content of models are included in the modeling requirements. The minimum requirements are intended to be used in all construction projects where the use of these requirements is advantageous. Besides the minimum requirements, additional requirements can be presented on a case-specific basis. Modeling and content requirements must be presented in all design contracts in a binding and consistent manner.

The publication series “Common BIM Requirements 2012” consists of the following documents:

1. General part
2. Modeling of the starting situation
3. Architectural design
4. MEP design
5. Structural design
6. Quality assurance
7. Quantity take-off
8. Use of models for visualization
9. Use of models in MEP analyses
10. Energy analysis
11. Management of a BIM project
12. Use of models in facility management
13. Use of models in construction
14. Use of models in building supervision

In addition to the requirements for each domain, each party in a BIM project must be acquainted at least with the general part (Series 1) and the principles of quality assurance (Series 6). The person in charge of the project or the project's data management must have comprehensive command of the principles of BIM requirements.

2 Introduction

Series 10 of “Common BIM Requirements 2012”, ”Energy analysis”, addresses essential tasks during design and construction regarding energy efficiency and management of indoor conditions and also start-up stages which are important for feasibility testing. This perspective highlights the best possible virtual management of energy efficiency and requirements, already during design and construction, by utilizing information models in multiple ways. One important objective is also to ensure that the verification of the energy efficiency of a building can be done at an early enough stage within the warranty period.

This document defines the requirements of how information models are used in energy analyses during design, construction and operation. Energy analyses are an important tool to guide design in terms of energy efficiency and the use of information models enables this in more systematic, transparent and in many cases also more efficient ways compared to traditional methods. However, the most important benefit from utilizing BIM is to support the use of correct information in calculations.

Energy analysis apply to the whole building, space types and actual spaces, MEP system or its part. A comprehensive description of energy analyses is presented in the book published by ProIT “Tuotemallintaminen talotekniikkasuunnittelussa” (“Product modeling in MEP design”) [1].

In this document, both energy efficiency calculations and internal environment condition analyses are regarded as energy analyses. Some special indoor conditions calculations, such as computational fluid dynamics (CFD) and lighting simulations, are discussed in Series 9, ”Use of models in MEP analyses”.

This document is applied to the extent utilization of BIM is included in tender and contract documents. The actual party to perform the energy analyses (energy consultant, life cycle planner, MEP planner) may vary between different projects and even between different stages of a project. This document has no references to the specific disciplines performing these tasks.

3 Energy analyses in different stages of the project

Achieving the condition and energy targets can be affected by architectural, structural and system solutions. The cooperation between designers is therefore important from the very start of the project in order to find an optimal total solution. The analysis of energy efficiency, life cycle effects and spatial conditions supports significantly this collaboration.

This document includes both energy and indoor environment calculations as part of energy analyses. There are many reasons for the inclusion of conditions in the requirements:

- In managing energy efficiency, the requirement management of both energy consumption and internal conditions hold a key position.
- Indoor conditions and energy efficiency have a natural link, because major part of energy is used for creating conditions according to the needs.
- Building energy regulations 7/2012 [2] emphasize the importance of constancy of conditions.
- The international term “energy analysis” has, in addition to the analysis of energy consumption, become known to include simulation of thermal and lighting conditions and following from these the requirements for air-conditioning.

The potential utilization of energy analyses covers all stages of the project from conceptual design to construction and commissioning. Additionally, potential utilization for operation and maintenance are addressed. Figures 1a and 1b show potential utilization ways for energy analyses during different project stages. They specify also the needed initial data.

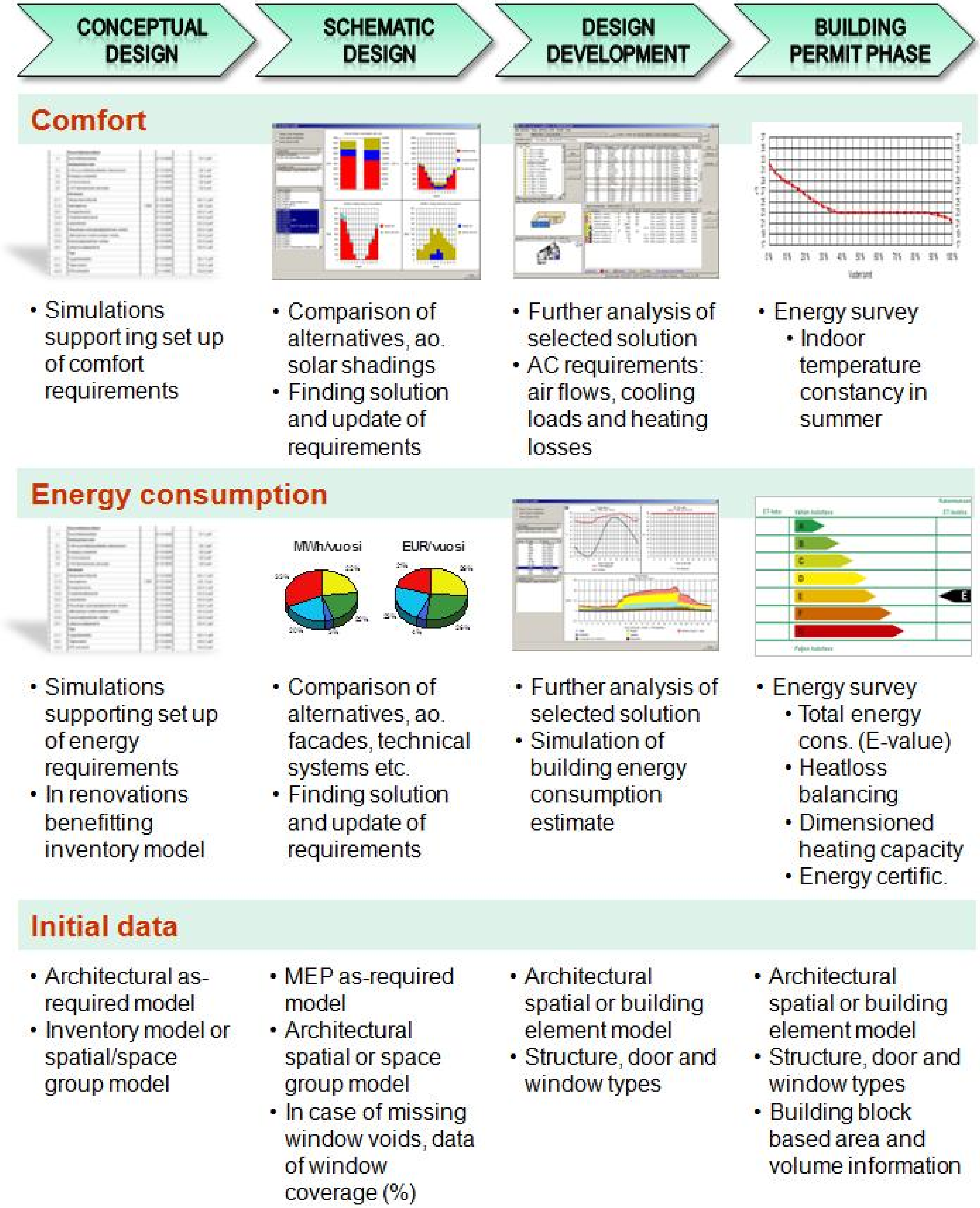


Figure 1a. Energy analyses in different stages of the project, part 1/2

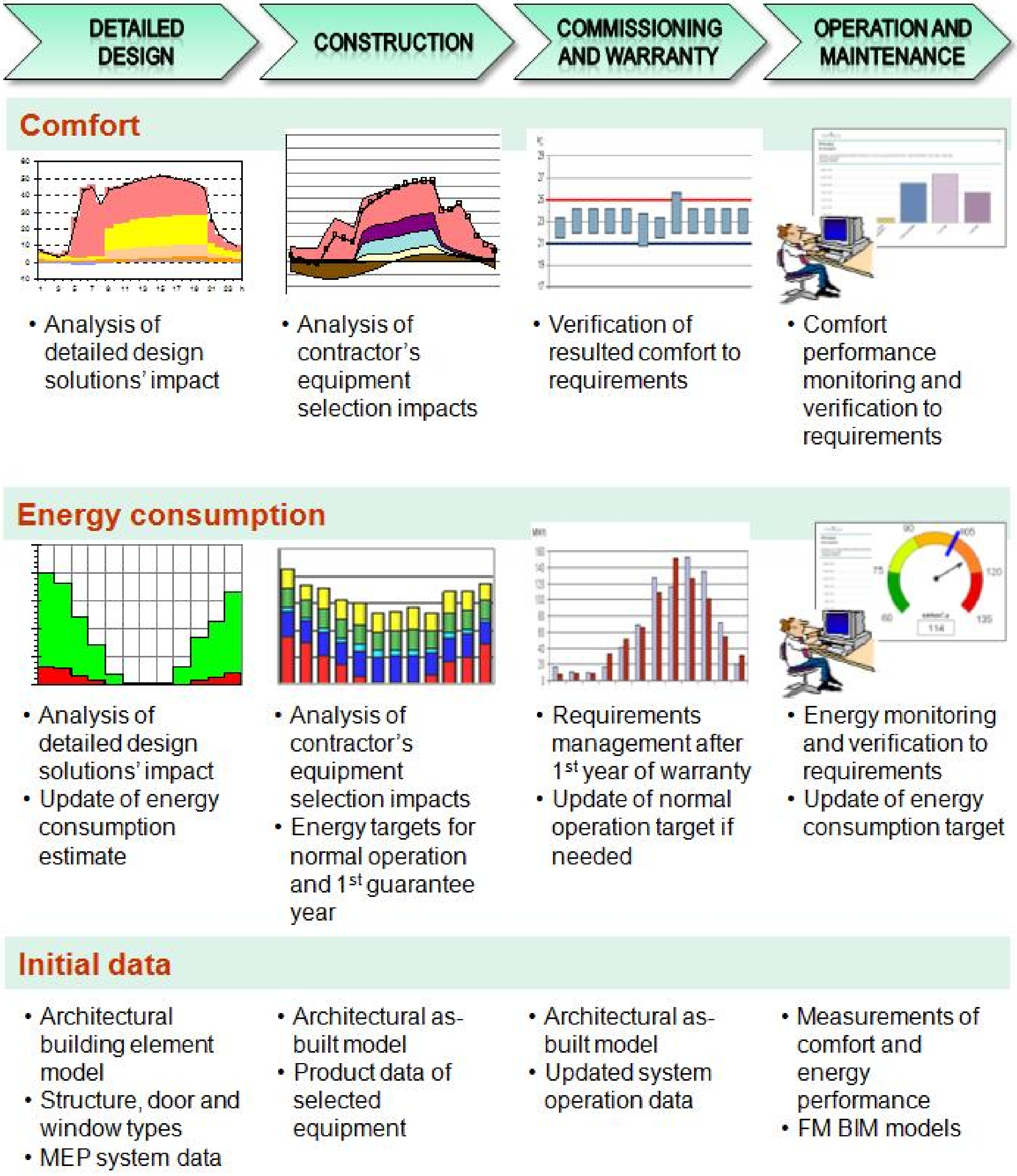


Figure1b. Energy analyses in different stages of the project, part 2/2.

The following chapters describe the utilization of BIM in more detail in energy analyses at different project stages. The tasks described here are executed to the extent agreed in tender and contract documents.

Actual detailed requirements for utilization of information models in energy analyses are given in Chapter 4, “BIM and energy analysis programs”.

3.1 Conceptual design

Requirement

Where an inventory model has been created in renovation projects, it is used for analysis of energy efficiency and alternative comparisons to improve energy economy.

As a minimum, the model is utilized as a source of information for the geometry of the building envelope. The inventory model is described in Series 2,”Modeling of the starting situation”.

Guideline

Energy analyses done in conceptual design support target setting for both the building’s energy efficiency and indoor conditions.

With particularly demanding energy efficiency targets, energy analyses should be performed already in conceptual design utilizing BIM. Either architect’s spatial or space group model can be used here. If these are not available, a separate geometry model created for energy analysis should be used.

Energy analyses are used to study alternative solutions based on space program mathematically and the used initial data and assumptions is documented. Analyses can be used for testing whether energy consumption targets, based on reference values or reference projects, are realistic and achievable. Target setting with the help of energy analysis takes better account of special features of the project and enables identification of the main factors for energy efficiency at an early stage.

3.2 Schematic design

Requirement

Preliminary energy consumption and condition simulations are made in schematic design to compare different facade, solar protection and technical system solutions.

The indoor conditions of the chosen solution are calculated at least for different space types and the building energy consumption, and targets are updated accordingly.

Architect’s spatial or space group model is used as an initial data. Additionally, MEP requirements model is required as initial data (see Series 4, “MEP design”)

Guideline

If structural types have not yet been defined in the schematic design, values from regulations or structures based on the project’s special requirements can be used.

If the architect’s model lacks window openings (see Series 3,”Architectural design”), data about area specific window provisions (the surface area of the windows in relation to the floor area or the outside wall area) is required. Based on this information, some energy analysis programs can add the corresponding win-

dow openings into the energy analysis software's own calculation model automatically. The same feature can also be utilized to create easily different scenarios of window openings from the same architect's model (utilization example in Figure 2).

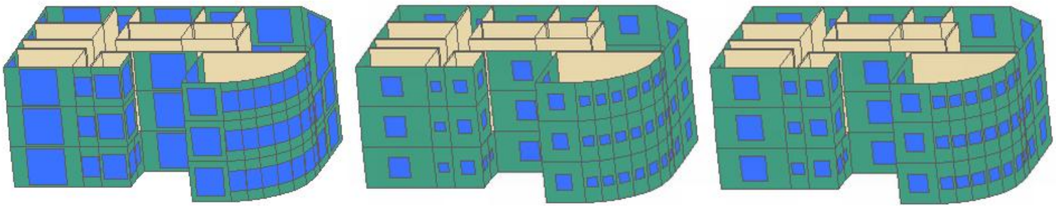


Figure 2. Adding window openings missing from the architect's model in the energy analysis software (RIUSKA) based on area specific window provision data and creating different scenarios: large window surfaces on the left, window surface area of 15% of the outer wall in the middle, and on the right, window sizes optimised from energy point of view.

When analyzing the results it is important to note to which degree they are based on assumptions and to which degree on already agreed solutions. Therefore, the used initial data and assumptions in energy analysis have to be documented clearly with corresponding analysis results.

In order to study energy analyses critically the format of initial data and simulation results is also very important. The recommendation is to use the Finnish National Building Code Part D3 (2012), "Building energy efficiency", the format and data content of tables 12 and 13 as far as the information is available. Presenting the data in an unified way also at other stages as well as in the planning permission stage facilitates the total evaluation of energy simulation regardless of which simulation program has been used. Some energy simulation programs include ready report templates which follow the definitions of the aforementioned tables. Respective initial data and output reports from RIUSKA energy simulation program can be found in Appendices 1 and 2.

3.3 Design development

Requirement

In general design, MEP designer defines air-conditioning needs (ventilation, heating and cooling needs) by using comfort simulation. The simulation is done at least for all different space types.

Architect's spatial model or building element model is used as initial data.

Guideline

The objective of energy analyses in the design development phase is to simulate the effect of the design development from both conditions and energy consumption point of view. Air-conditioning requirements should be calculated separately for all spaces to take into account differences, such as those caused by orientation etc.

In addition to the architect's model more detailed initial data is required on structural, door and window types used.

3.4 Building permit phase

Requirement

Energy survey is required for building permit, where as BIM based energy analysis has to include at least the following:

- Total energy consumption, E-value
- Energy certificate
- Room temperature constancy during summer time

Architect's spatial or building element model is used as initial data.

Guideline

It is also possible to utilize BIM based energy analysis to produce the necessary information needed in the following parts of the energy survey:

- *Heat loss balancing*
- *Dimensioned heating capacity*

Energy survey has to contain building block specific area and volume information, which the architect will typically define with the help of the model. In terms of the energy survey, it is also important that this information can be used in the energy analysis. Some energy analysis programs can also import area and volume information from BIM, but the details should be agreed with the architect.

It is natural to use National Building Code Part D3 (2012),"Building energy efficiency"), the format and information content given in tables 12 and 13 or corresponding report templates in energy simulation programs (Appendices 1 and 2).

3.5 Detailed design

Requirement

The requirements for energy analyses depend on the changes in detailed design. Updating energy analyses is a requirement, when changes potentially have a significant effect on comfort or energy efficiency compared to the previous phase results.

Guideline

As an example of a significant change, where the update of energy analyses is necessary, is a change of window types or solar shading structures.

It is recommended to utilize BIM for energy analyses also at this phase. The architect's building element model can be used as initial data. In terms of MEP system data, MEP system service areas can be utilized from BIM if a higher level class 2 has been chosen in MEP design (see Series 4,"MEP design").

3.6 Construction

Requirement

At the end of the construction phase the energy consumption target is calculated for the future use of the building. Changes during the construction are taken into account in the calculations. The target definition can be made on two different levels of which level 1 is the minimum requirement:

- Level 1: Energy consumption target is defined for normal operation

- Level 2: Energy consumption target is defined both for normal operation and for the 1st year during start-up, which enables building energy efficiency target verification already during the warranty period.

The as-built model is used as initial data.

Guideline

The objective of the energy analyses during the construction phase is to analyse equipment choices made by contractors and to define the energy consumption targets for the future operation of the building.

The target for normal operation cannot be used to verify energy efficiency during the warranty period due to the building technology systems' non-typical usage profiles during the 1st year of operation. E.g, ventilation is typically used during the 1st year 24 hours a day to eliminate material emissions and thus keep good air quality. Hence, verification of energy efficiency is usually postponed beyond the warranty period. However, level 1 is very suitable for projects where the use profiles of the systems during the 1st year do not deviate from the normal operation or where the significance of deviations is negligible.

At level 2, a separate energy consumption target is calculated for the 1st year, which enables to confirm an energy efficient operation already during the warranty period. In calculating the 1st year's energy consumption target, aforementioned non-typical MEP systems' usage profiles are used.

The target for normal operation should be updated after the first year of warranty period, when the actual use of the building is known better.

3.7 Commissioning and warranty period

Requirement

During the warranty period the energy consumption target is updated for normal operation of the building. By this time, the actual use of the building is better understood and this is taken into account in the calculations.

As a minimum requirement, the usage profiles and other assumptions used in the energy consumption target calculation for normal operation in the construction phase, are reviewed and if necessary, the normal operation target calculation is updated.

The as-built model is used as initial data.

Guideline

During the commissioning and warranty period, the aim is to ensure that the operation of the building is according to targets both in terms of comfort and energy efficiency. During the building start-up (typically the 1st year) the MEP systems are fine-tuned according to the actual use of the building. The objective for energy analyses during the warranty period of the building is to create the basis for target monitoring during operation and maintenance. At the end of the building start-up, the actual use of the building is also understood better and by then, there are more detailed initial data available for updating the target.

3.8 Operation and maintenance

Requirement

There are no requirements for energy analyses.

Guideline

During operation and maintenance, the aim is to ensure that the building operates according to the targets by monitoring indoor conditions and energy consumption. By using energy analyses, the effects of the changes occurred in the operation can be updated to the targets. Additionally, energy analyses can be utilized in cases of malfunctions and in resolving their causes and comparing repair options.

4 BIM and energy analysis programs

Utilizing BIM in energy analysis programs has been possible already for quite some time. However, there have been serious deficiencies in defining the needed information content important for energy analyses and particularly in the quality of the implementation of data interfaces by the BIM authoring programs used by architects.

The requirements for the information content in a model in terms of energy analysis can be presented quite simply, but this does not always guarantee the success of data transfer. Therefore, in utilizing an information model, especially an architect's model, it may still be necessary to explore supplementary workarounds.

The following describes the detailed requirements for the utilization of BIM to support energy analysis needs from the Chapter 3, divided into requirements for energy analysis programs as well as for data transfer.

4.1 Energy analysis programs

Requirement

The requirement for programs used for energy analyses is that they can import IFC files (version 2x3 or newer). More detailed requirements for the model information content and the data exchange is presented in Chapter 4.2, "Information exchange requirements for energy analysis".

The second requirement for programs used for energy analyses is capability for dynamic calculation, which means:

- the program takes into account the energy that is stored in the structures
- the calculation covers a whole year and uses a maximum of one hour time step using annual weather data according to the building location
- the program takes internal loads and their time profiles into account.

Guideline

Building energy regulations 2012/7 include, in addition to the aforementioned requirement for dynamic calculation, also a requirement that the program used has to be validated according to different international standards or tests.

Nordic organizations responsible for contracting and maintenance of public buildings, Senate properties and Statsbygg, have published a Nordic Energy validation [4], which tests energy analysis software BIM utilization capabilities on a wider basis. Hence, it is recommended that the program used has passed also the Nordic energy validation. By the publication date, this validation has been passed by RIUSKA [5] and IDA ICE [6] programs.

4.2 Information exchange requirements for energy analysis

Energy analysis process and the related information exchange requirements are shown in Figure 3. The related requirements are discussed in the following chapters in more detail.

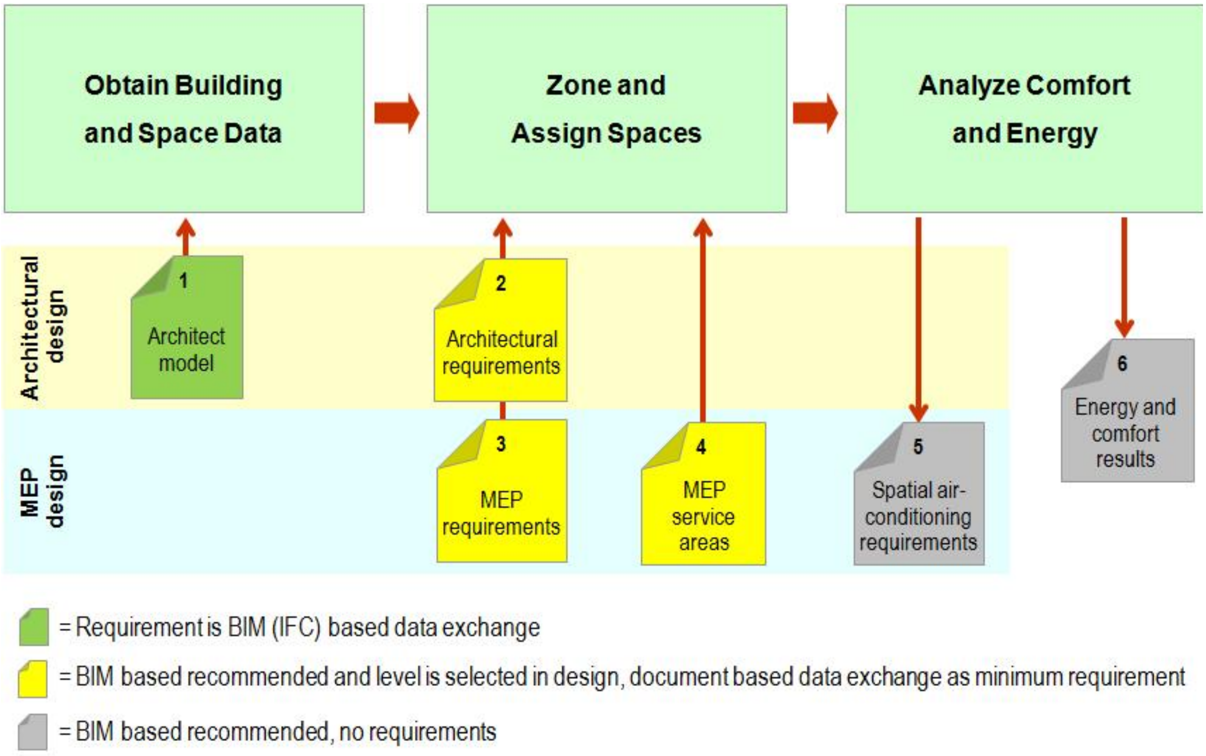


Figure 3. Energy analysis process and related information exchange needs and requirements.

4.2.1 Architectural model

Requirement

The most important initial data to be utilized in energy analysis is the architectural BIM in the different phases of the project (space group, spatial, building element and as-built model). The main requirement for the data content in IFC file is that it includes both of the following views defined in the IFC standard:

- Coordination view (view for collaboration between the architect, structural designer and MEP designer) [7]
- Space boundary add-on view (defines space surfaces and their connection to structures, openings etc.) [8]

Other information content requirements are defined in Series 3, ”Architectural design”.

If it is not possible to generate an architectural BIM that fulfils the previously stated requirements, due to software or justified modeling reasons, the provider of the energy analysis can create a separate geometry model that fulfils the above mentioned requirements. In this case, the minimum requirement is that the space names and codes used in the architect model are kept unchanged.

Guideline

By using the space boundaries of the architect model the energy analysis program can interpret common situations such as where a roof is shared by a cold external area and a heated area.

The following lists some of the most important non-software dependent instructions to create an energy analysis compliant architect IFC model:

- *In IFC Export, "Space Boundaries" has to be selected. The spaces have to be modeled so that the architect program examines the environment itself and creates the space object based on that and thereby creates relationships between the space object and the structures.*
- *The spaces have been modeled so that space boundaries can be created (E.g. ArchiCAD: "Inner Edge definition method", ACA: "Associative Freeform Space").*
- *The space object has to have the height of a whole storey, not limited to, for example, to the lower ceiling surface. Spaces that comprise a number of storeys should be modeled by story, as their transfer for the energy analysis program will at this point be more reliable.*
- *For the energy analysis IFC export, overlapping spaces, such as the gross area space object, which would cover actual spaces, must not be included. Otherwise the capability of the model to produce correct space boundary information in the IFC export is seen as problematic at the time of publishing these guidelines.*
- *The structures must have type identifiers (US1, VS2 etc.) and they must correspond to the structural library of the structural designer.*

The Space Boundaries of the architect model are formed from an internal room view, so they lack the parts from the external surfaces to wall and floor partitions. Because energy calculation has to take the whole area of the external envelope into account, a feature has to be used in the energy analysis program which fills the gaps in the external surfaces (Figure 4).

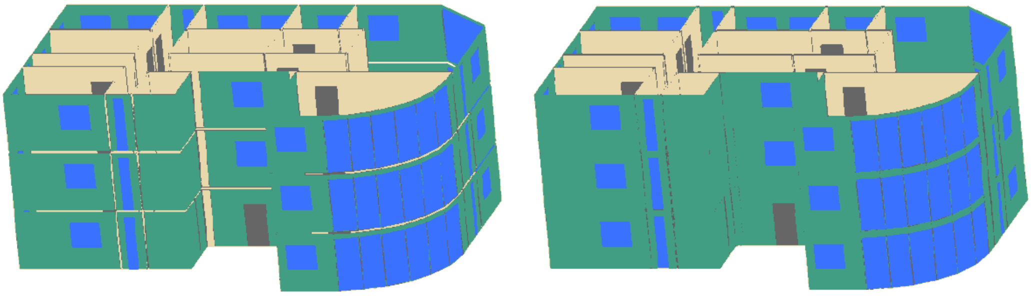


Figure 4. On the left, a situation where the IFC model has been imported into the energy analysis program using only the Space Boundary information. Hence, there are gaps in the wall and floor partitions. On the right, the situation where the energy analysis program's (RIUSKA) gap filling feature has been used, achieving full external surface.

If it is necessary to create a separate energy analysis compliant geometry model based on the architect model, it is recommended that the space global unique identifiers (GUID) [9] are kept unchanged. This enables a comparison between model versions for example in requirements management and exporting the energy analysis results back to the architect model. Appendix 1 presents an operation description required for this purpose by using MagiCAD Room program [10].

4.2.2 Architectural requirements

Requirement

The minimum requirement is to transfer the architect’s spatial programme (as-required model) as a document format for energy analysis initial data purposes. For further details, see Series 3,”Architectural design”.

Guideline

If the architects’s as-required model has been created in BIM format, it may be possible to utilize it in the energy analysis program.

4.2.3 MEP requirements

Requirement

The requirement is to transfer the MEP target information (MEP as-required model) as a document format for energy analysis initial data purposes. For further details, see Series 4,”MEP design”.

Guideline

If the MEP as-required model has been created in BIM format (level 2, Series 4), it may be possible to utilize it in the energy analysis program.

4.2.4 MEP service areas

Requirement

The minimum requirement is to transfer the MEP system service area information as a document to support the initial data needs of the energy analysis. For further details, see Series 4, ”MEP design”. This only applies to energy analyses in the stage where MEP service areas have been defined.

Guideline

If MEP service areas have been defined based on BIM, their utilization may be possible in the energy analysis program.

4.2.5 Spatial air-conditioning requirements

Requirement

There are no requirements regarding the export of sized spatial air-conditioning requirements (ventilation, heating and cooling needs) information to BIM.

Guideline

Energy analyses programs can be used in MEP design additionally to simulating indoor conditions also for the sizing of air-conditioning requirements based on the MEP comfort requirements. This is also the minimum requirement for space types during the general design (Chapter 3.3).

From comfort simulation results the following can be exported back to the BIM and thus create the necessary initial data needed in the system network modeling by the HVAC designer:

- *Spatial air flow requirements*
- *Spatial heating capacity needs (heating losses)*
- *Spatial cooling capacity needs (cooling loads)*

In some HVAC system network modeling programs these air-conditioning requirements can be imported as technical initial data in IFC format to support the selection of terminal equipment (Figure 5).

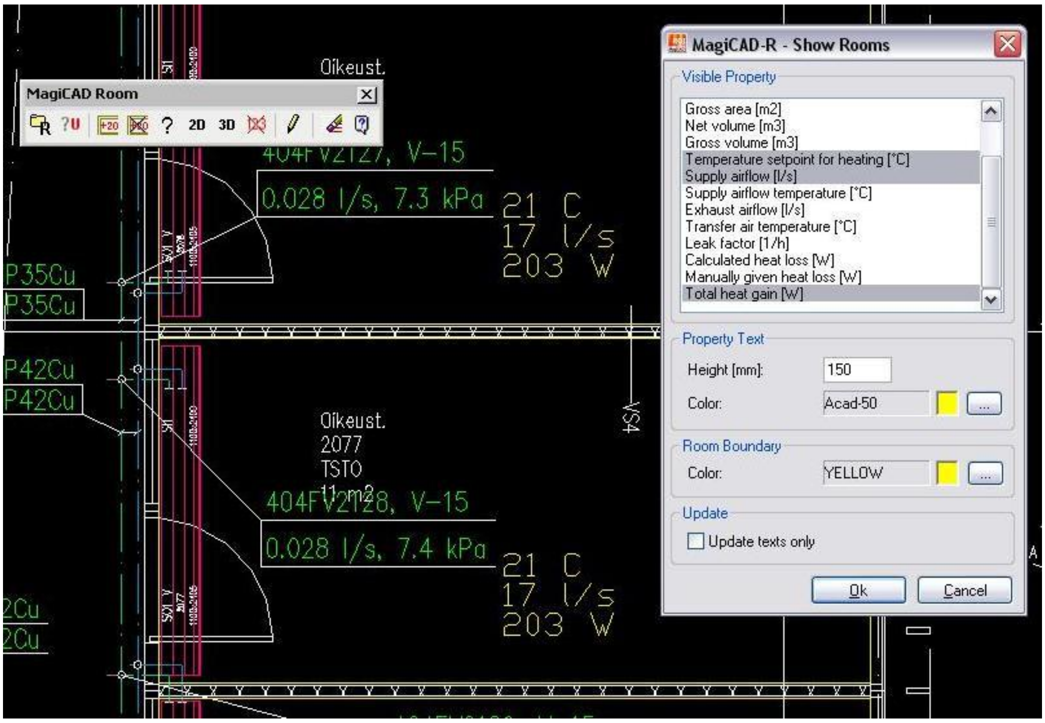


Figure 5. The air-conditioning requirements information, sized by comfort simulation in energy analyses program and exported to BIM, can be imported into MEP authoring program (MagiCAD) in IFC format as initial data for HVAC system design.[1]

When air-conditioning requirements have been calculated by BIM based energy analysis programs the results can be easily obtained even as a plain document based output in a structured format. However, it is important for analyzing the results that initial data and information about how much they rely on assumptions or agreed solutions, have been documented clearly with the analysis results.

4.2.6 Energy and comfort results

Requirement

There are no requirements regarding the export of energy and comfort simulation results to BIM.

Guideline

The results of energy and comfort simulations can be exported to the BIM, e.g. to support the project's requirements management. For the moment, the export into IFC file is limited to a few spatial parameters, which are important for managing indoor conditions (utilization example in Figure 6):

- *Simulated minimum temperature during heating period*
- *Simulated maximum temperature during cooling period*

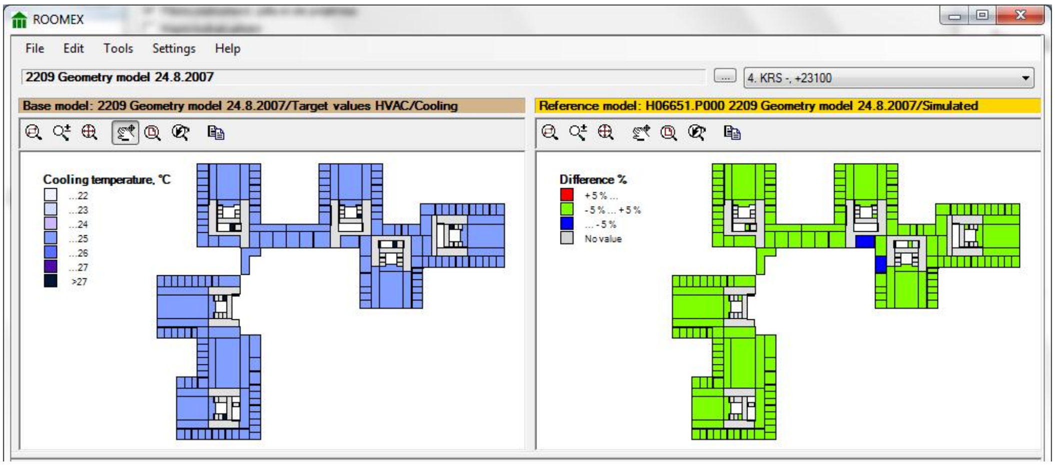


Figure 6. Utilization of an energy analysis program's comfort simulation results in BIM-based requirements management application (RoomEx), where analysis results are visually compared against targets.

When energy and comfort simulations have been performed by BIM based energy analyses programs, the results can be easily obtained even as a plain document based outputs in a structured format. However, it is important for analyzing the results that initial data and information about how much they rely on assumptions or agreed solutions, have been documented clearly with the analysis results.

5 Reference list

1. Laine, T. Tuotemallintaminen talotekniikkasuunnittelussa. ProIT-sarja, ("Product modeling in MEP design. ProIT series"). Rakennusteollisuus RT ry, Helsinki, 2007.
2. Ympäristöministeriö. Uudet rakentamisen energiamääräykset annettu. Uudisrakentamisessa siirrytään 1.7.2012 alkaen kokonaisenergiatarkasteluun. ("New building energy regulations published. In new construction, total energy review is adopted from 1. July 2012") http://www.ymparisto.fi/default.asp?contentid=380376&lan=fi&clan=fi
3. TELU2012, Rakennushankkeen johtamisen ja suunnittelun tehtäväluettelot, uudet (vielä lausunnolla olevat) tehtäväluettelot ("Scope of Work for management and design in construction project, new (still in progress) task lists"), http://www.rakli.fi/linkit/kehitysjaprojektit/telu2012/
4. Hietanen, J. IFC independent MVD description. 2011. http://www.blis-project.org/IAI-MVD/MVDs/NOW-001/Overview.pdf
5. Granlund Oy. RIUSKA comfort and energy simulation. http://www.granlund.fi/en/services/granlund-software-applications/riuska/
6. Equa. IDA Indoor Climate and Energy 4.0. http://www.equa.se/eng.ice.html
7. BuildingSMART. Coordination view version 2.0. http://buildingsmart-tech.org/specifications/ifc-view-definition/coordination-view-v2.0
8. BuildingSMART. Space Boundary Summary. http://buildingsmart-tech.org/specifications/ifc-view-definition/space-boundary-addon-view
9. BuildingSMART. IFC GUID Summary. http://buildingsmart-tech.org/implementation/get-started/ifc-guid
10. Progman Oy. MagiCAD Room. http://www.magicad.com/en/content/magicad-room

GRANLUND Granlund Software RIUSKA

BUILDING ENERGY CONSUMPTION
E-VALUE CALCULATION INPUT DATA

Document No.			
Project No.	H07603.P000		
	Date	Created/checked by	
Latest revision			
Created	22.3.2012	kba	

Building type		
Construction year		
Heated net area	4 000,0	m^2

Infiltration q50	0	$m^3/(h,m^2)$

Building envelope	A m^2	U $W/(m^2,K)$	U A W/K	%
External walls	1 941,0	0,17	329,91	30,0
External roof	2 093,2	0,09	192,42	32,4
Ground floor	2 078,0	0,16	332,41	32,2
Windows	348,6	1,00	348,61	5,4
External doors	0,0	0,00	0,00	0,0
Heat bridges				0,0

Windows according to azimuth	A m^2	U $W/(m^2,K)$	G-value -
North	54,3	1,00	0,50
North-East	0,0	0,00	0,00
East	77,1	1,00	0,50
South-East	0,0	0,00	0,00
South	69,9	1,00	0,50
South-West	98,2	1,00	0,50
West	49,1	1,00	0,50
North-West	0,0	0,00	0,00
Skylight windows	0,0	0,00	0,00
	348,6		

Ventilation system	Air flow rate supply/exhaust $(m^3/s)/(m^3/s)$		System SFP value $kW/(m^3/s)$	HRU temp. efficiency -	Freezing prevention °C
301 Päiväkoti	2,6	2,6	2,1	75	-5
302 Koulu	5,3	5,3	2,1	75	-5
303 Keittiö	0,3	0,3	2,1	40	0
304 Liikuntasalitilat	2,4	2,4	2,1	60	0
320 WC Koulut	0,2	0,2	0,7	0	-5
321 WC Päiväkoti	0,3	0,3	0,7	0	-8
322 Jätehuone	0,0	0,0	0,5	0	-5
323 Porras	0,1	0,1	0,3	0	-5
324 Hissikuilu	0,0	0,0	0,3	0	-5
Ventilation system	11,3	11,3	2,0		

Heating system	Production efficiency -	Heating syst. efficiency -	Heating COP¹ -	Auxiliary syst. electricity² W
Heating of spaces and AC system				0
Hot domestic water				

¹annual average heating COP for the heat pump

²can be included in the annual average heating COP of the heat pump systems

Cooling system	Cooling season weighted cooling COP, -

Hot domestic water usage	$m^3/(m^2,a)$	total m³/a

Internal thermal loads	Occupancy W/m^2	Equipment W/m^2	Lighting W/m^2	Utilization rate -

Date Signature Signature clarification

BUILDING ENERGY CONSUMPTION
E-VALUE CALCULATION RESULTS

Document No.			
Project No.	H07603.P000		
	Date	Created/checked by	
Latest revision			
Created	22.3.2012	kba	

Building type		
Construction year		
Heated net area	4 000,0	m^2

E-value	137,0	kWh/(m²,a) (kWh per heated building net area)

E-value details	Purchased ene.	Primary energy factor	Primary energy factor weighted energy	
	kWh/a	-	kWh/a	kWh/(m^2,a)
Electricity	206 772	1,70	351 512	88
District heating	280 512	0,70	196 358	49
District cooling	0	0,40	0	0
Renewable fuel	0	0,50	0	0
Fossil fuel	0	1,00	0	0
			0	0
Total	487 284	4,3	547 870	137

Renewable energy	kWh/a	kWh/(m^2,a)
Solar electricity	0	0
Solar heat	0	0
Wind electricity	0	0
Heat source heat energy taken by the heat pump	0	0

Building technical systems energy consumption	Electricity kWh/(m^2,a)	Heat kWh/(m^2,a)	District cooling kWh/(m^2,a)
Heating system	-		
Space heating¹			
Supply air heating			
Hot domestic water			
Ventilation system electricity consumption		-	
Cooling system			
Equipment and lighting		-	
Total	0,0	0,0	0,0

¹heating of supply air heating in space and heating or replacement air belongs to the space heating

Energy net need	kWh/a	kWh/(m^2,a)
Space heating²	164 654	41,2
Supply air heating³	58 642	14,7
Hot domestic water	48 800	12,2
Cooling	0	0,0

²includes heating of infiltration air, replacement air and supply air in space

³calculated with heat recovery

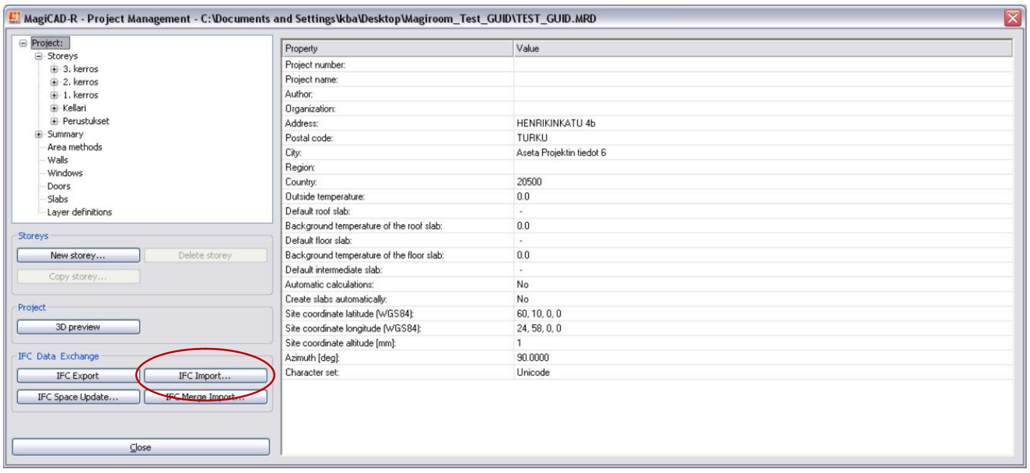
Thermal loads	kWh/a	kWh/(m^2,a)
Sun	41 267	10,3
Occupancy	65 170	16,3
Equipment	37 238	9,3
Lighting	83 850	21,0

Simulation tool name and version number RIUSKA 4.8.3

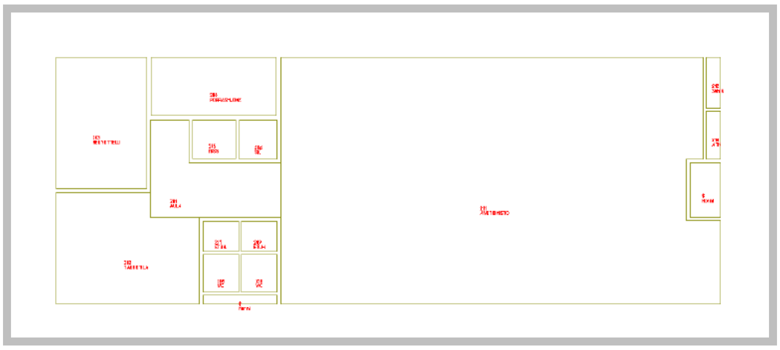
Date Signature Signature clarification

Guideline for the utilization of architectural BIM in creating energy analysis compliant geometry model by using MagiCAD Room software

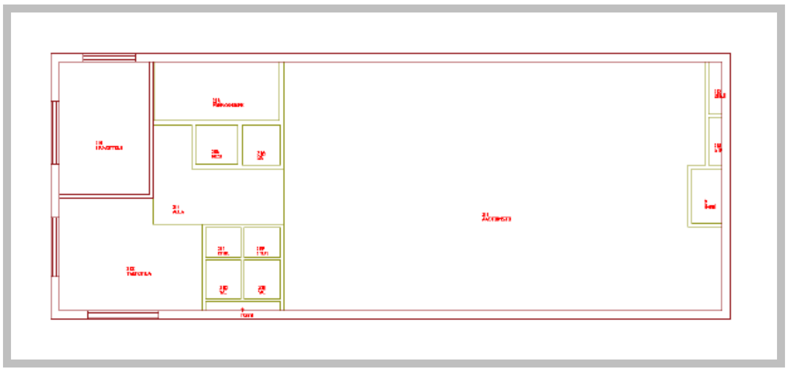
1. Reading (IFC import) from the architectural model 2D space footprint and spatial data (inc. GUID)



2. Space footprint, room information and list of floors are transferred as the modeling basis to the MagiCAD Room desktop



3. Modeling of walls by MagiCAD Room on the basis of imported 2D footprints and adding windows and doors



4. Saving (IFC export) energy analysis complient BIM, where the space names, codes and GUID equal to the architectural model