



Towards Innovative Methods
for Energy Performance Assessment and Certification of Buildings

Deliverable 1.4

Report of existing barriers to exploit EPCs and BIM

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Executive summary

This document contains the results of the work carried out in Task 1.4 “Exploitation of EPC data” of Work Package 1 “Context Analysis to Support EPC Workflow” of the TIMEPAC project. The objective of WP1 is to carry out a comparative study of the elements involved in the development of future scenarios to work with enhanced Energy Performance Certification, in each of the four identified stages of the energy performance certification (EPC) data flow: generation, storage, analysis, and exploitation. As a result of this study, possible improvements, vulnerabilities, threats, and risks related to the upgrade of already existing certification schemes are identified. The main objectives of this task were:

- To study the existing methods to generate Energy Performance Certificates from BIM models.
- To examine the possibilities to interlink EPC and BIM databases.

A survey was conducted to find out the current use of BIM software to generate energy performance certificates in six EU countries represented in the consortium. The survey was structured in two parts, one focused on BIM technology and energy efficiency and the second on EPC generation. The responses from the partner organisations provided information on the current status of BIM use in each country, the software used for thermal calculation, as well as the tools for calculating the EPC. Survey participants gave answers based on their own experience and also on information obtained from reports and white papers.

The responses show that BIM is starting to be used for energy certification in some countries, although the technology is not yet widespread. HVAC design programs are more advanced than EPC generation software, as most of them can generate outputs that can be connected to BIM technology. In addition, they use hourly calculation methods that provide more accurate results. The survey results also show that in all countries the EPCs generated by the IT tools are in XML format, which can be uploaded to databases.

1 Introduction

This report contains the results of surveys conducted to find out the current use of BIM software to generate energy performance certificates in six EU countries represented in the consortium.

The survey was structured into two parts, the first focused on BIM technology and energy efficiency and the second on EPC generation. The responses from the partner organisations provided information on the current status of BIM use in each country, the software used for thermal calculation, as well as the tools for calculating the EPC. Survey participants gave answers based on their own experience and also on information obtained from reports and white papers.

2 Research methodology

This section introduces the methodology employed for the BIM implementation analysis, the use of tools for designing HVAC systems and their connection with EPCs. Input and output formats and EPC analysis engines have been analysed to find barriers of interconnection between BIM software, HVAC design systems and EPC calculation tools.

2.1 Methods and tools

In order to meet the objectives of Task 1.4, we have collected information from partners as well as from professionals and public organisations in six countries represented in TIMEPAC using a survey.

EDILCLIMA and CYPE software have been the reference tools to analyse the connectivity of BIM with EPCs. These tools are used to calculate EPCs from a BIM model generated in the design phase.

2.2 Participants

The surveys have been completed by partners with expertise in BIM, HVAC design and EPC generation in the following countries:

- Austria: SERA global, Institute for Sustainable Energy and Resources Availability (SERA).
- Croatia: Energy institute Hrvoje Požar (EIHP).
- Cyprus: Cyprus Energy Agency (CEA).
- Italy: EDILCLIMA SRL (EDILCLIMA).
- Slovenia: Ministrstvo za infrastrukturo (MZI).
- Spain: CYPE SOFT, S.L. (CYPE).

2.3 Implementation

In conducting the survey in the six countries, we pursued the following objectives:

1. To examine and synthesize the most relevant information needed, both by BIM and EPC tools.
2. To find out the level of implementation of BIM technologies in the participating countries, based on existing reports such as the “Encuesta CSCAE sobre implantación de sistemas BIM-2”, carried out in Spain by the Consejo Superior de Colegios de Arquitectos de España (CSCAE).
3. To identify any existing barriers for BIM and EPC connectivity.
4. To analyse and compare the results of the surveys.

2.4 Limitations

The survey was conducted in a limited number of countries, making it difficult to extrapolate the results to a broader European context. The answers about the use of BIM in each country rely on existing reports.

3 BIM software

A preliminary issue was to determine the level of use of BIM for EPC calculation in each participating country. This software is being used in all countries except Cyprus (Table 1).

Table 1. Use of BIM software

Is BIM software used in your country?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Sometimes	x	x				x
Often				x	x	
Always						
Never			x			
Other						

The second question concerned the reasons for using BIM. For most partners, the reason was that it facilitates the design and management of building processes. However, only in Spain and Italy it is for legislative reasons (Table 2).

Table 2. Software used for BIM

Why is BIM software used?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Because there are legal obligations				x		x
Because it is a tool that facilitates the design and management process of the building	x	x		x	x	x
Because there is a market need		x		x		x
Because there are legislative constraints				x		x
Other			x			

4 EPC software

Energy simulation and HVAC system design are both used for EPC generation. The following questions are concerned with the software used for the design of HVAC systems design: spreadsheets, 2D or 3D Graphic User Interfaces (GUIs).

Table 3. Software used for HVAC design

Which software is used for HVAC design?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Spreadsheet				x	x	x
2D GUI software				x	x	x
3D GUI software	x	x				x
Other			x			

The answers reveal that 2D and 3D tools are used in all countries for this HVAC design. Most countries (Austria, Croatia, and Spain) use 3D tools (Table 3).

The next question relates to the calculation methods being used. Until recently, the most commonly used method was the degree days. According to the answers, all countries are now using hourly methods, except Cyprus, either a dynamic method or the hourly method of EN ISO 52016-1 (Table 4). The use of these calculation tools based on hourly data for energy simulation and EPC generation will bring about more accurate results. In addition, it is possible to use climate databases compatible with these calculation methods.

Table 4. Energy simulation methods

Which energy simulation method is used?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Degree days method			x			
Monthly method in accordance with EN ISO 52016-1 or EN ISO 13790				x	x	
Hourly method in accordance with EN ISO 52016-1		x		x	x	x
Dynamic method (e.g., EPlus engine)	x	x				x
Other						

It is also important to know about the input files used by the energy simulation tools (Table 4). In this case, in most countries (Austria, Italy and Spain) the tools used accepted entries in DXF vector format (Table 5). All countries, except Cyprus, have HVAC design tools that can import BIM data in the standard IFC exchange format. In Cyprus, the calculation methods are manual there are no inputs from other applications.

Table 5. Import formats for simulations and HVAC tools

Which import formats are used?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
DXF	x			x		x
XML				x	x	
gbXML				x	x	
IFC	x	x		x	x	x
CSV		x		x		
JSON						
Other			x			

As for the export formats, XML, IFC and CSV are the most used, followed by DXF. JSON is only used in Spain, and gbXML is used in Italy (Table 6).

Table 6. Export formats for simulation and HVAC tools

Which export formats are used?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
DXF	x			x		x
XML			x	x	x	
IFC	x	x			x	x
CSV		x	x	x	x	
JSON						x
Other				gbXML		

According to the survey, spreadsheets are no longer used for EPC generation, and all six countries use 2D and 3D GUI software (Table 7).

Table 7. Software used for the generation of EPCs

Which software is used for the generation of EPCs?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Spreadsheet			x			
2D GUI software	x	x	x	x	x	
3D GUI software	x			x		x
Other						x

The calculation engine used in each country is different, and therefore, it is difficult to compare certifications from different countries (Table 8). Moreover, in some countries the use depends on the regions. A comprehensive report on the use of certification tools can be found in Deliverable 1.1 “Context Analysis of EPC generation”.

Table 8. Calculation engine

Which calculation engine is used?	
Austria	OIB-Guideline 6 is the methodological base for EPC calculation and this Guideline refers to several Austrian standards where ÖNORM B 8110-6 refers to EN ISO 52016-1. ÖNORM B 8110-6 uses the monthly method. Software programmes available on the market have to comply with the provisions of OIB Guideline 6 and the related Austrian standards.
Croatia	These programmes are all based on set of EU norms - EN ISO 13790, EN 15316, DIN V 18599, DIN V 18599 and DIN V 18599.
Cyprus	Cyprus version of the British iSBEM software, called iSBEMcy.
Italy	In Italy, each software company used for EPC purposes has its own engine. Only in two Italian regions a specific and compulsory engine is used.
Slovenia	Slovenian certification experts can choose between 4 commercial software packages to produce an EPC. Each has its own calculation engine, but they must be based on the same calculation method.
Spain	Each certification software can use a different calculation engine in accordance with ASHRAE 140. There are software developed by the public administration (HULC, CE3, CE3X) and by private companies (CERMA, CYPETHERM HE Plus and SG SAVE). Some can be used only in dwellings and others in any type of building.

All countries have tools that allow the EPC to be calculated with the monthly method in accordance with EN ISO 52016-1 or EN ISO 13790 (Table 9). However, most certifiers use the hourly method in accordance with EN ISO 52016-1 or the dynamic method (e.g., EPlus engine).

Table 9. Calculation method

Which calculation method is used?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Degree days method			x			
Monthly method in accordance with EN ISO 52016-1 or EN ISO 13790	x	x		x	x	x
Hourly method in accordance with EN ISO 52016-1						
Dynamic method (e.g., EPlus engine)						x
Other	x					

The next question refers to the connectivity between the BIM model and the certification software. The answers show that manual input is used in four countries (Austria, Croatia, Cyprus, and Spain); and only in one (Austria) is there a direct connection to architectural BIM software.

Table 10. Architectural models connected to the EPC model

How is the architectural model connected to the EPC model?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
Manual introduction	x	x	x			x
With 2D templates in drawing format (JPG, PNG, etc.)					x	x
With 2D template in vector format (DXF)				x		x
With IFC format				x		x
Directly connected to architectural BIM software	x					
Other						

HVAC design software does support the use of BIM technology through an IFC file to generate an EPC. For instance, in Spain, CYPETHERM HE Plus generates the thermal model of the building, the energy simulation and the EPC calculation from an IFC file.

Having proven the variety between the types of models used to connect to the EPC software, a fundamental point of this project is to find a way to connect the information from HVAC and BIM design models to EPC software and to deliver semantic content to the EPC databases. In this case, there is no single import format for data input from the EPC software, which is a major challenge.

Table 11. Import formats for EPCs

Which import formats do you use?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
DXF	x			x		x
XML	x				x	
gbXML	x					
IFC	x			x		x
CSV						
JSON						
Other	APS	None	None			

Regarding the format of the outputs of the certification tools, XML is used in all cases (Table 12); this is an exchange format that facilitates the automatic export/import of content between databases.

Table 12. Export formats for EPCs

Which export formats do you use?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
DXF				x		x
XML	x	x	x	x	x	x
IFC						x
CSV		x		x		
JSON						
PDF	x	x	x	x		x
glTF						x
Other		doc				

Finally, in all countries the EPC includes thermal regulations together with energy calculation reports (Table 13). Only in two countries (Italy and Spain) do the certification tools generate 2D drawings of the thermal model. In addition, most countries, except Croatia, also include measures to improve energy efficiency.

Table 13. Outputs in EPCs

What outputs do you produce?	Austria	Croatia	Cyprus	Italy	Slovenia	Spain
2D drawings				x		x
3D models						
EPC justification report	x	x	x	x	x	x
Thermal regulation justification report	x	x		x	x	x
Energy calculation	x	x	x	x	x	x
Improvement measures	x		x	x	x	x
Other						

5 Use of BIM for energy certification

The following information about the potential of using BIM for energy certification has been provided by the partner organisations. Some of the information has been obtained from reports from associations of planners and public bodies, the buildingSMART association, an open, neutral, non-profit organisation, as well as from interviews with construction industry experts.

5.1 Austria

BIM software is often used in Austria although it is not widespread. There is no legal obligation to use BIM in Austria, neither in public construction projects nor in the private sector. Regarding BIM, the public building sector, specifically the Bundesimmobiliengesellschaft - BIG, Vienna Airport, the Austrian Federal Forests and some provincial building departments are pioneers, e.g., the province of Tyrol. The building department of the province of Tyrol is working on their first BIM pilot buildings.

For upcoming projects, the province of Tyrol intends to incorporate BIM into the standard specifications for tenders. These are public entities that include a facility management department that usually manages its own buildings. The standard specifications for tenders will include BIM coordinators, which are additionally required and will become key persons in the next few years. The aim is to improve transparency and cost tracking in order to control/avoid the - almost usual - massive cost overruns in large-volume public buildings. The cost for BIM consultant services is accepted and is no longer an issue in the tenders.

In the private sector, especially for single-family houses, BIM does not play a role yet. There are very few companies working in this field: only a small number of master builders, architects and prefabricated house providers have recognised the advantages of BIM. The reason is that a high level of effort is needed at the beginning of the project to define the details of the BIM collaboration because standards are either missing, outdated or not feasible in practice. The current IFC 4 standard is not yet suitable for the EPC and, regarding the upcoming IFC 5 standard, collaboration with the working group would probably be necessary to ensure suitability for the EPC.

5.2 Croatia

According to the survey conducted by EIHP, BIM technology is not widespread in the AEC industry in Croatia. BIM software is not mandatory neither in private nor public sectors when designing new buildings or reconstructing buildings. On the other hand, BIM cannot be used for generating EPCs. On a private level, some large developers are demanding the designs in BIM format.

5.3 Cyprus

In Cyprus, there is no use of BIM technology in projects related to energy simulation, HVAC design and EPC generation.

5.4 Italy (Piemonte)

BIM software is often used in Italy, although its use is not widespread. According to the ASSOBIM 2020 survey, more than 50% of the interviewees are using BIM tools, while around 40% are aware of BIM but do not use it. Since 2015, the use of BIM in architectural and engineering offices has steadily increased.

According to the aforementioned survey, BIM is mainly used in the following areas: architectural design (51%); technical systems design (12%); structural design (9%). Only a small percentage (less than 5%) use BIM tools in the energy sector.

In 2017 a Legislative Decree (DM 560/2017) regulated the use of BIM (Article 6: Timing of mandatory introduction of electronic modelling methods and tools for construction and infrastructure). In 2021, some modifications have been introduced through DM 312/2021. According to this regulation, from January 2019, BIM tools are mandatory for complex construction and infrastructure works for an amount equal to or greater than one hundred million euros, and from January 2025 they will be mandatory for construction and infrastructure works for all works over 1 million euros.

According to the OICE report¹, there is an increased use of BIM instruments in public tenders in 2020 (+18% compared to 2019).

According to the ASSO BIM survey, almost 90% of the respondents consider that BIM is important for the management of the information related to the building/infrastructure design and management/maintenance phases because: it allows significant costs savings during the management and maintenance phases (77%); it guarantees better management of the documents (87%); cost optimization (67%); faster order management (66%); the possibility of approaching new sectors and types of projects (62%) and an easier projection on international markets (76%).

5.5 Slovenia

BIM software is used in Slovenia although it is not widespread. Slovenian experts are gradually recognising the benefits of using BIM for design and subsequent management processes. Although there are no legal regulations obliging experts to use BIM, the market has slowly recognised the need to use it. The use of BIM in public works is being promoted by the Ministry of Infrastructure, through the EUBIM Task Group in projects such as the largest infrastructure investment in Slovenia, the 27.1km long railway track between Divača i Koper, that includes 8 tunnels with the total length of tunnel tubes of 37.4km (including service tubes), 2 bridges, 2 viaducts and more than 20 km of access and maintenance roads.

5.6 Spain (Catalonia)

According to data from the BIM survey conducted by the Consejo Superior de los Colegios de Arquitectos de España (CSCAE) among architects, the degree of implementation is still low among architectural firms, especially in small offices (it is only used in 40% of the firms that participated in the survey).

The level of satisfaction of engineers and architects with BIM is high; therefore, we can infer that the number of projects that are designed with BIM will increase.

However, the use of BIM to collaborate with other professionals involved in the design and construction process remains low (only 24%), which means that implementation in the construction industry as a whole is progressing slowly. This is also reflected in the fact that BIM is mainly used in the project phases most closely linked to architectural conception and design (project drafting and 3D modelling) and to a lesser extent in other project phases where there is usually collaboration with other professionals (structures and installations, for example).

In Spain, public administrations are increasingly favouring the use of BIM, which is required in public tenders for new and refurbished buildings. On a private level, some large developers are encouraging the use of BIM through the entire workflow, from design to construction. Also, there are tools for thermal certification and EPC generation that use open BIM formats, such as IFC.

¹ <https://www.oice.it/688246/rapporto-sulle-gare-bim-2020>

5.7 Summary and comparison between countries

In conclusion, BIM is being used in the six countries represented in this study, except Cyprus, with a higher penetration of this technology in Austria, Croatia and Spain, and a lower presence in Italy and Slovenia.

It can also be concluded that the use of BIM software is continuously growing and that the connection with EPC and HVAC design programmes is a clear a direction for the future, especially using open exchange formats such as IFC.

6 Barriers for the connection between BIM and EPC

Currently, there are barriers when connecting BIM technology with EPCs. Firstly, the use of BIM is not yet widespread in most of the countries represented in this project. On the other hand, there is a diversity of architectural modelling software, HVAC design and energy certification. Nevertheless, there are applications to generate the architectural BIM model, such as Allplan, Archicad, CYPE Architecture or Revit, which can export an IFC file to be imported by energy simulation applications and certification tools.

HVAC design software has more possibilities to be connected to BIM architectural models through IFC formats. However, most EPC programmes do not support this format. The information generated by EPCs is varied, except for the XML format, which is used in all cases. Therefore, this seems to be the only means to connect the information generated in EPCs with databases and to create large scale statistical analysis.

One of the challenges of this project is to delve into the connectivity of BIM technology and EPCs. The use of BIM in architectural modelling together with HVAC system design would also facilitate the integration of Building Renovation Passport (BRP) and EPC. Thus, a BIM model could be regularly updated with the renovation measures adopted in accordance with the roadmap foreseen in the BRP.

7 Relation to other tasks

The examination of the barriers for interlinking EPCs and BIM carried out in this study, will help to define Transversal Deployment Scenarios (TDS) in WP2.

- TDS1 - Integration of BIM with EPC. The combination of IFC and DXF format can help to include geometric data that do not appear in the XML format generated by the EPC. However, the 3D visualisation of buildings with the current information generated in both EPC and HVAC design software remains a challenge.
- TDS2 - Enhancing EPC schemas through operational data integration. EPC schemas can be improved by integrating all the information generated in architectural BIM models and HVAC design programmes. With the 3D visualisation of the models, EPCs can be better audited by the public administration. In addition, they become more user-friendly.
- TDS3 - Creating Building Renovation Passports from data repositories. For the creation of a Building Renovation Passport, information from the EPCs, as well from other databases, is needed. The improvement measures are generalised in the output of EPC results and will help in this task. In addition, the 3D model of the building in each of the phases of the actions planned in the Building Renovation Passport makes the document more user-friendly.

- TDS4 - Integration of Smart Readiness Indicators (SRIs) and sustainability indicators in EPC. The connection of BIM and EPC through 3D modelling and HVAC systems can help to include SRIs in the certification. For example, with a 3D model that provides information on surfaces and volumes of building spaces as well as greater detail on the thermal envelope of the building.
- TDS5 - Large scale statistical analysis of EPC databases. The software for the generation of EPCs use XML files for subsequent analysis. This type of file contains limited geometric data about a building. Using a BIM model which includes surface and volume data would improve the quality of the EPC.

8 Conclusions

We have examined the current use of BIM, HVAC system design and EPC generation software in six participating countries, based on the answers provided by partners to the survey we have conducted. The responses show that BIM is starting to be used for this purpose, although this technology is not widespread in all countries. HVAC design programmes are more advanced than EPC generation software, as most of them can generate results that can be connected to BIM technology. In addition, they use hourly calculation methods which provide more accurate results. The results of the surveys also show that EPCs generated by programmes are in an XML format, which can be uploaded to databases.

A challenge of the project will be to use the data from the architectural BIM and HVAC design programmes to improve the information provided by EPC software.

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Annexes

Annex A - Survey template



Task 1.4 Exploitation of EPC data

The goals of this survey are:

1. To study the possible methods and difficulties of generating EPC from BIM models
2. To select the most suitable systems, data formats (both BIM and EPC) and linking methods between databases.

Partner info.

Partner name	
Contact person	

mark with an 'X' the answers you agree on

Part 1 – BIM Software

1. Are BIM softwares used in your country? [Please, chose only one]

- Sometimes
- Often
- Always
- Never
- Other:

Describe the reasons why (50-500 word):

2. Why BIM softwares are used [Multiple choice]

- Because there are legislative constraints
- Because it is a tool that facilitates the design and management process of the building
- Because there is a market need
- Other:

Describe the reasons why (50-500 word):

3. Which software is used for HVAC design? [Multiple choice]

- Spreadsheet
- 2D Graphic User Interface (GUI) software
- 3D Graphic User Interface software
- Other:

Describe the reasons for each of the softwares you have selected (50-500 word):

4. Which energy simulation method is used? [Multiple choice]

- Degree days method
- Monthly method in according with EN ISO 52016-1 or EN ISO 13790
- Hourly method in according with EN ISO 52016-1
- Dynamic method (e.g. EPlus engine)
- Other:

Describe the reasons for each of the method you have selected (50-500 word):

5. Which import formats are used? [Multiple choice]

- DXF
- XML
- gbXML
- IFC
- CSV
- JSON
- Other:

Describe the reasons for each of the formats you have selected (50-500 word):

6. Which export formats are used? [Multiple choice]

- DXF
- XML
- IFC
- CSV
- JSON
- Other

Describe the reasons for each of the formats you have selected (50-500 word):

Part 2 – EPC Software

7. Which kind of softwares are used for the generation of EPCs? [Multiple choice]

- Spreadsheet
- 2D Graphic User Interface (GUI) software
- 3D Graphic User Interface software
- Other

Describe the reasons for each of the kind of softwares you have selected (50-500 word):

8. Which calculation engine is used?

9. Which calculation method is used? [Multiple choice]

- Degree days method
- Monthly method in according with EN ISO 52016-1 or EN ISO 13790
- Hourly method in according with EN ISO 52016-1
- Dynamic method (e.g. EPlus engine)
- Other

Describe the reasons for each of the method you have selected (50-500 word):

10. How is the architectural model connected to the EPC model? [Multiple choice]

- Manual introduction
- With 2D templates in drawing format (jpg, png,...)
- With 2D template in vector format (dxf)
- With IFC format
- Directly connected to architectural BIM software on the market (Allplan, Archicad, Revit,...)
- Other

Describe the reasons for each architectural model connected you have selected (50-500 word):

11. Which import formats do you use? [Multiple choice]

- DXF
- XML
- gbXML
- IFC
- CSV
- JSON
- Other

Describe the reasons for each format you have selected (50-500 word):

12. Which export formats do you use? [Multiple choice]

- DXF
- XML
- IFC
- CSV
- JSON
- PDF
- glTF
- Other

Describe the reasons for each format you have selected (50-500 word):

13. What outputs do you produce? [Multiple choice]

- 2D drawings
- 3D models
- EPC justification report
- Thermal regulation justification report
- Energy calculation
- Improvement measures
- Other

Describe the reasons for each output you have selected (50-500 word):

* Please let us know about any information or question that you consider relevant to the study that has not been covered in this survey