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NEWSLETTER

STREAMER

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1. INTRODUCTION

You just opened the last newsletter from the STREAMER project. As you may recall, the STREAMER project has addressed the design of energy-efficient hospitals. Designing is a complex task since many decisions have to be made, both major and minor. The multitude of stakeholders with various interests does not make this task easier.

Designing hospitals is even more challenging! When I started working on this wonderful project 4 years ago, of course I knew about hospitals because I had visited a number of them – either as a visitor, or, fortunately not too often, as a patient. It is hard to really appreciate the complexity of such a building when you are just a visitor, or even when you are just a patient. I have really come to admire the men and women who run these communities on a daily basis, and I have also come to admire the people who can design such complex buildings. The amount of information, aspects, and considerations to take into account is simply overwhelming.

Fortunately, the STREAMER project did not have to start from scratch. Many work had already been done on developing BIM, both standards and tools, a lot of experiences and insights on hospital design was available, and specifically for the energy aspect, we had access to information on many technological solutions to reduce energy consumption. However, bringing all this together really took some time. I think the consortium has managed to do this in a beautiful way.

This last newsletter cannot do justice to all of STREAMER's insights and results. However, a short introduction into the STREAMER approach is given. Additionally, we will give an overview of the results that we are most proud of. These are the results that will be exploited by the individual STREAMER partners; the results will be maintained, expanded and applied in real-world projects whenever possible.

Freek Bomhof



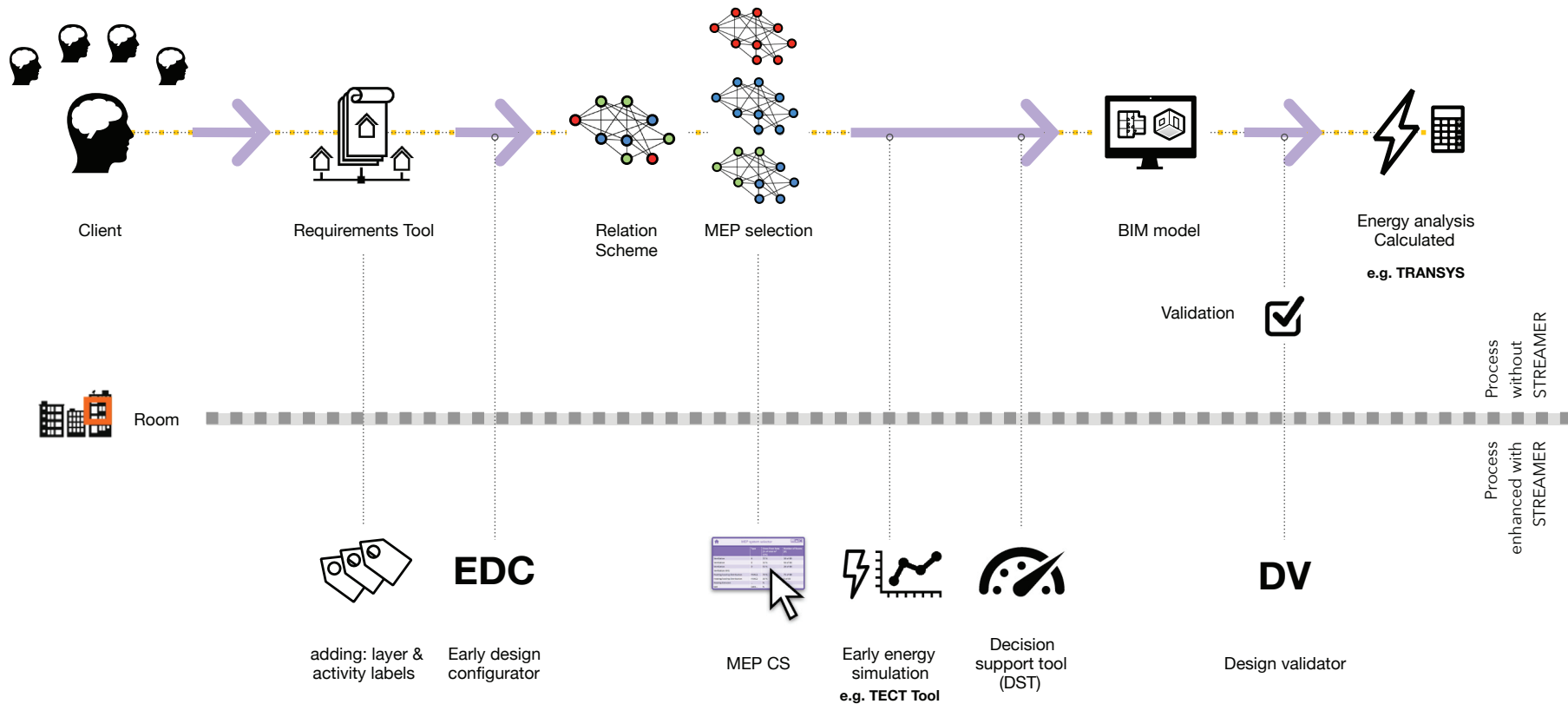
2. STREAMER APPROACH



The official goal of the STREAMER project is to help achieve up to 50% energy reduction in hospitals. Discussing this goal, some experienced designers in the STREAMER team remarked that in many cases, this 50% reduction was easily reached. You just had to make the right decisions regarding choice of technology – there are so many Energy Efficient Building technologies and efficient Mechanical Electrical & Plumbing technologies available!

However: in practice, design teams do not have the time to make such optimal decisions because elaborating all possible choices is just too costly. Or, design decisions made in earlier stages inhibit the usage of optimal solutions in later stages. This observation caused the STREAMER project to focus on early design stages, and to help design teams create design alternatives that can quickly be compared and evaluated.

A 'participatory design process' has been defined that outlines the steps needed to involve all relevant stakeholders.



The STREAMER design process starts with the Program of Requirements (PoR), that defines how many rooms of which types are needed; some 'standard' sets of requirements have been identified for hospitals, which will speed up this part of the process. The STREAMER approach enhances this PoR with Semantic Labels: these labels are a way to already attach default or standard values to rooms. This is important because it enables subsequent algorithms to 'reason' about the design. This 'reasoning'

is done using Design Rules, stored in a database. A process has been defined on knowledge capturing: how to proceed when experts from various sides are interviewed?

An important tool in the STREAMER approach is the Early Design Configurator (EDC). This tool automatically produces designs for floorplans, taking the PoR as a starting point, applying the Design Rules, and respecting the spatial constraints (building outer shell, fixed rooms or corridors).



Based on the floorplan layout, choices can now be made for Mechanical, Electrical & Plumbing (MEP) systems, and Energy Efficient Building (EeB) façade technologies. A tool has been designed to help the design team create optimal clusterings and choices for these technologies. At this stage, Semantic Labels that apply to MEP and EeB technologies have been defined as well, just as design rules that can apply designers' knowledge to the actual choice of technologies.

These design variants can then be simulated using energy calculation tools. Traditionally, this would have been very difficult due to lack of detailed information, but thanks to the STREAMER Semantic Labels, appropriate standard values can be used to reach a best estimate of energy performance in this early design stage.

Finally, the Decision Support Tool can compare all design variants and evaluate them based on a set of Key Performance Indicators (KPI). In the STREAMER project, most attention has been paid to the energy-related KPIs, but also financial (Life Cycle Costing) and Quality-related KPIs can be taken into account.

The STREAMER approach heavily relies on data exchange between tools. This makes it imperative that the data can be trusted and that the tools can work with it. The BIM Q tool can check that the data in IFC files can be validated: is the right information contained in it?

One last aspect is the placement of the building in the neighbourhood. Since a building never operates on its own, a lot can be won when smart combinations of energy production, storage, transmission and usage are identified. We developed a process using the QGIS viewer to methodically identify any energy-related opportunities in the neighbourhood, based on available Geographic Information System (GIS) data.

Using the methods and tools in this way, a design team is able to create design variants in a much quicker way, and is supported to take decisions in early design stages, thus maximising the possibility to actually reach the 50% energy reduction. The methods and tools have been tested and validated in various combinations at the four pilot project locations in Italy, France, UK and the Netherlands.

The following section in this newsletter takes a closer look at the tools and methods that implement the STREAMER approach.



MAIN RESULTS

This section describes the major results of the STREAMER project. Most of these tools and methods work together, and they address different steps and aspects of the STREAMER approach outlined in chapter 2.

3A. METHOD: DATABASE OF REQUIREMENTS FOR HOSPITAL ROOMS

When working on the pilot projects, it has become apparent that requirements gathering is a time-consuming process. In some cases, requirements are based on regulations, sometimes on former experiences, or sometimes just because it was best practice at the time.

STREAMER Partner RNS has identified that a lot of time can be won by using a standard list of requirements that are relevant in a hospital setting, as is already in use in Sweden. They started to explore if such standards can be developed for use in (at least) the Netherlands, thus leading the way in this field. Eventually such a list may be handed over to an emerging group of collaborating

hospital facility managers. The databases of Sweden and the Netherlands may then serve as examples for wider European uptake.

The advantage of such a database is that it captures expert knowledge, reduces time consuming data collection for requirements, and reduce risk for development of projects as requirements are commonly accepted and proved to be sufficient. Additionally, employees of hospitals will have lesser need for adaptation when employed in another hospital because of standardization. In operation theatres, this can reduce risks in wayfinding for a surgeon for example.

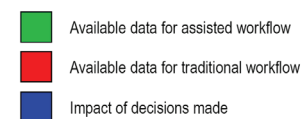
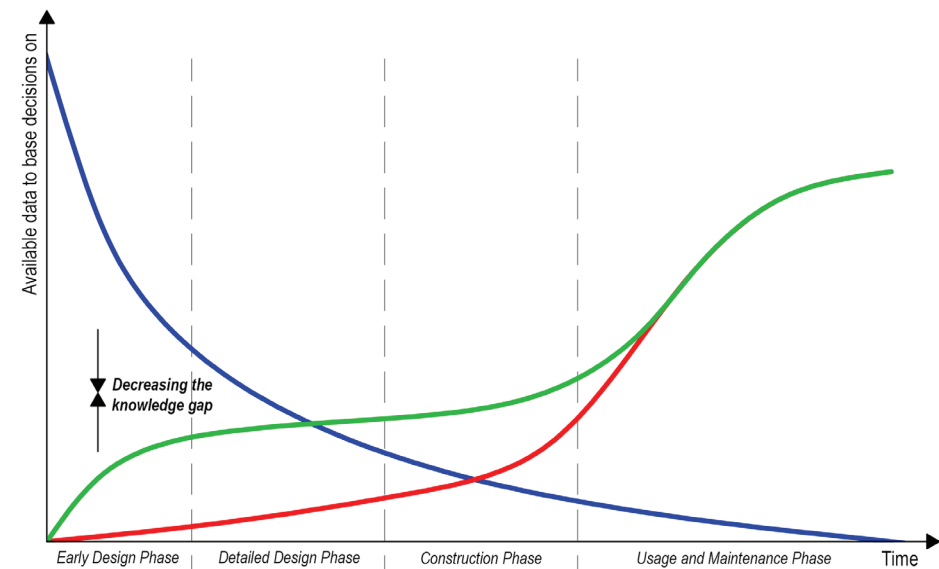
3B. METHOD: SEMANTIC LABELS DESIGN METHODOLOGY

The Semantic Labeling approach is one of the methodological core concepts introduced by STREAMER. In short, the semantic labels fill the gap between the (often very coarse) requirements and characteristics used in early design stages on one hand, and the much more detailed specifications that are usually only known in much later design stages. This makes it possible to evaluate a design in the early design stage.

The semantic labels provide characteristics of the major components of the hospital, grouped in more or less 'standard' categories. The STREAMER tools are then able to 'reason' with these categories, for instance the Design Rules make heavy use of these. Also, two tools use the Semantic Labels for initial estimation of energy demand.

Using the semantic labels in the so-called 'assisted workflow' (making use of additional information and tooling) leads to better information in early design stages, where the impact of design choices is usually high.

Semantic labels are defined for Access and Security (to identify rooms that are public, or restricted access), for Comfort class (in terms of noise, temperature and light), Construction (minimum dimensions), Equipment (being able to support specialized equipment), Hygienic class (very high for operating theatres, for instance) and User profile (office hours, 24/7).



3C. METHOD: DATABASE OF DESIGN RULES

The Design Rules are used in the Early Design Configurator and the Rule-based checking toolkit. Design rules are meant to capture experience and knowledge in a way that can be 'calculated' by computer programs.

A design rule works upon the rooms in the Program of Requirements and its associated characteristics. For instance, using a design rule it is possible to specify that patient rooms and offices should not be mixed. Or, that a preparation room should be close to a surgery room.



The database of design rules thus captures expert knowledge, and as such it is complementary to the other STREAMER result 'database of requirements'.

Examples of these design rules are:

- Functional area with (name equals "Admission") must be contained in the lowest story;
- Functional area with (name equals "MedicalArchive") must be contained in the highest story;
- Functional area with (name equals "LowCareWard") must be clustered horizontally and vertically;
- Traveling distance between space with (name equals "PatientRoom") and space with (name equals "NursingStation") is less than 20.0 m;
- Space with (HygienicClass equals "H5") must be clustered horizontally and vertically;

The design rules are meant to be readable by humans, while at the same time easily interpretable by computers.

3D. TOOL: EARLY DESIGN CONFIGURATOR (CONFIGURATOR OF PARAMETRIC DESIGN SOLUTIONS)

The Early Design Configurator has emerged to become one of the most prominent results of STREAMER. The tool is based on the observation that in early design, usually choices are made that cannot be easily changed later on, but which have a considerable impact on the building's performance – notably energy efficiency, but other aspects as well. Usually, an experienced architect can make an early design that is expected to fit the customer's requirements. However, making such a design is costly; only one variety is usually made. The Early Design Configurator automates this process to a high degree, so it is easy to create multiple designs that can be evaluated and compared.

The Early Design Configurator takes input from three sources:

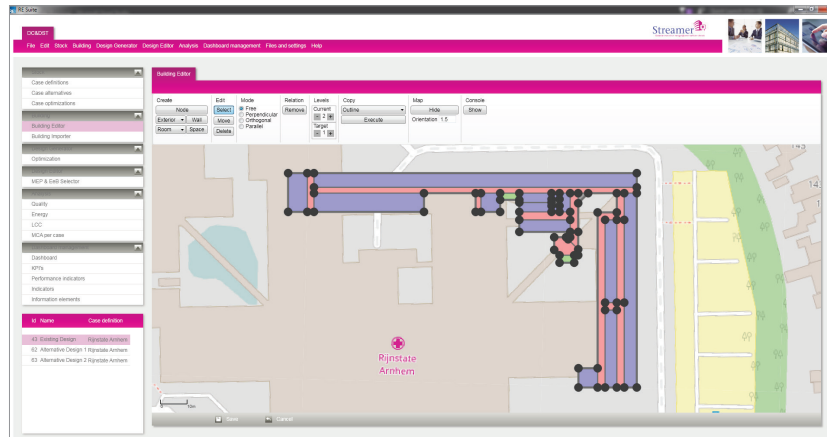
- The Program of Requirements identifying the customer's requirements: how many rooms, how large, which characteristics. This PoR is enhanced with the STREAMER Semantic Labels: these provide a shorthand way to quickly identify the main characteristics of rooms, even when more detailed specifications are not yet available.
- The building's outer shell (the form), and any restrictions in the floor plan. The size of the building is usually already defined (otherwise, the designer first has to make a choice

for this) for instance in a refurbishment scenario. Also, some rooms, corridors, stairs, elevators or other elements are fixed and cannot be changed.

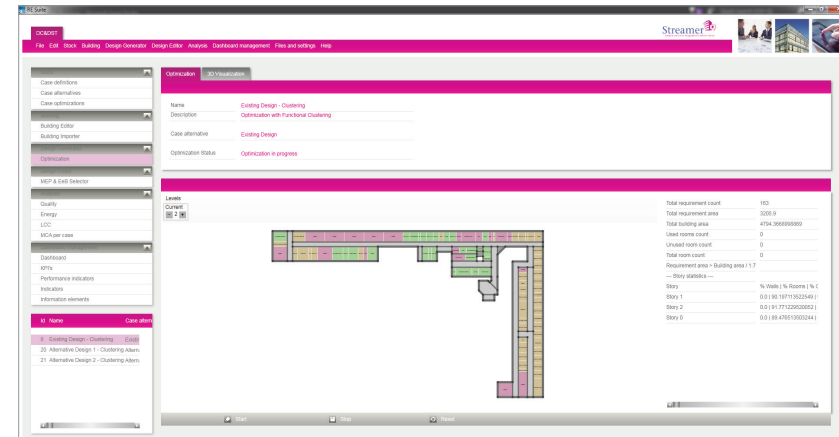
- Design rules that have encapsulated the architect's knowledge. These design rules are expressed using the STREAMER semantic labels and may contain specific experiences, wishes or principles. For instance, a rule can state that the distance between specific rooms may not be more than a maximum, or that some rooms should be on the same floor, or near to the elevator, or that office rooms and patient rooms should not be mixed.

Based on these inputs, the EDC starts making designs automatically. A design should fulfill the outer shell and fixed room restrictions as a hard condition, and makes successive new design variants that fulfill the PoR and the design rules increasingly well. The algorithm used for this optimization is known as „Evolutionary Programming“, a technique from the field of Artificial Intelligence that optimizes a solution by continuously “trying” different designs.

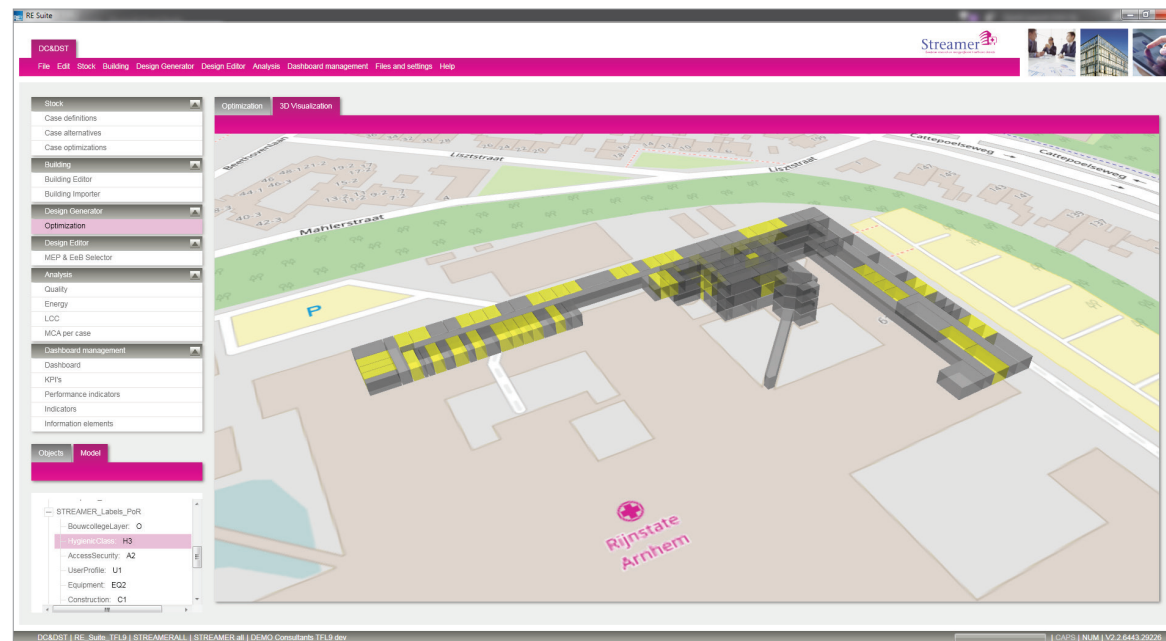
Design variants can be created by re-running the algorithm with adjusted preferences in design rules (which rule should take precedence).



Defining the building outer shell, and fixed rooms.



The optimizer at work. The colors indicate different space types.



The optimized building model exported to IFC.

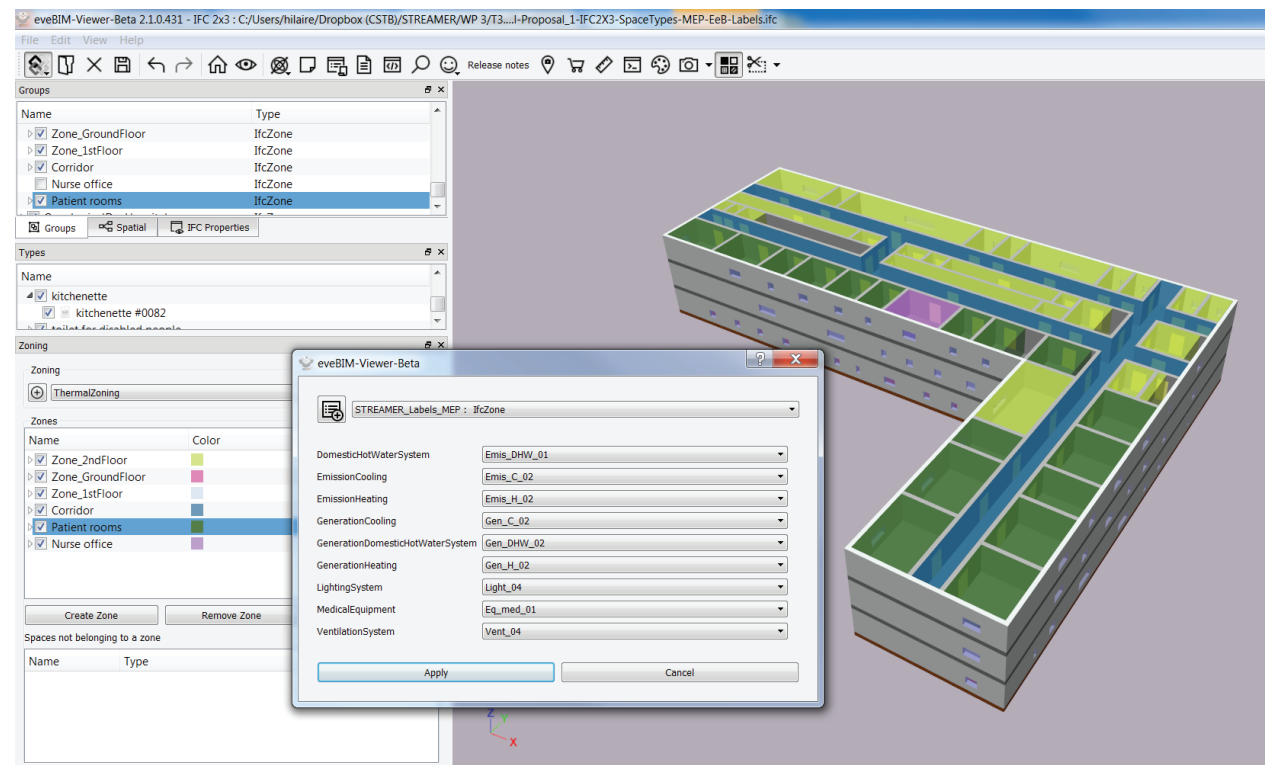


3E. TOOL: MEP / EEB SELECTION

One major result of the STREAMER project is to be able to assess a design in an early phase, when normally not much information is yet available. This is especially true for MEP (Mechanical, Electrical and Plumbing) systems, that have a huge impact on the energy performance of a building, but which are usually taken into consideration in relatively late design stages.

One piece of information that STREAMER has added in early design stages, is a Semantic Label for each room, which gives basic information on the way this room will be used. This label already indicates a first way to make the choice for MEP systems smaller: some MEP systems are simply incompatible with the future usage of rooms. For instance, radiators (for heating) are usually not allowed in surgical theatres because they cannot be cleaned satisfactorily. The same goes for natural ventilation (opening the window).

Both for EeB and MEP systems, the STREAMER project has defined labels as well. These labels enable the energy calculation tools to make much more educated guesses (using default or standard values) with respect to energy characteristics of rooms, MEP and EeB Façade technologies.



Making choices for zones and rooms

3F. TOOL: RULE-BASED CHECKING TOOLKIT

The rule-based checking toolkit uses the Database of Design Rules to verify that a design is still valid. During the design, the designers may have made changes to the output of the Early Design Configurator that may violate some rules. The Early Design Configurator creates an automatic design that is as much as possible according to the Design Rules, but subsequently it may be needed to adapt the design manually. Maybe because of the choice of MEP systems, maybe because of other considerations that were not included in the design rules.

This tool is complemented with another tool which enables editing the set of design rules. This editor is rather basic; it helps the user to formulate design rules that are syntactically correct, but it does not have an extensive Graphical User Interface, since it is expected that the information will be entered by IT specialists and will not be updated very frequently.

3G. TOOL: TNO ENERGY CALCULATION TOOL (TECT)

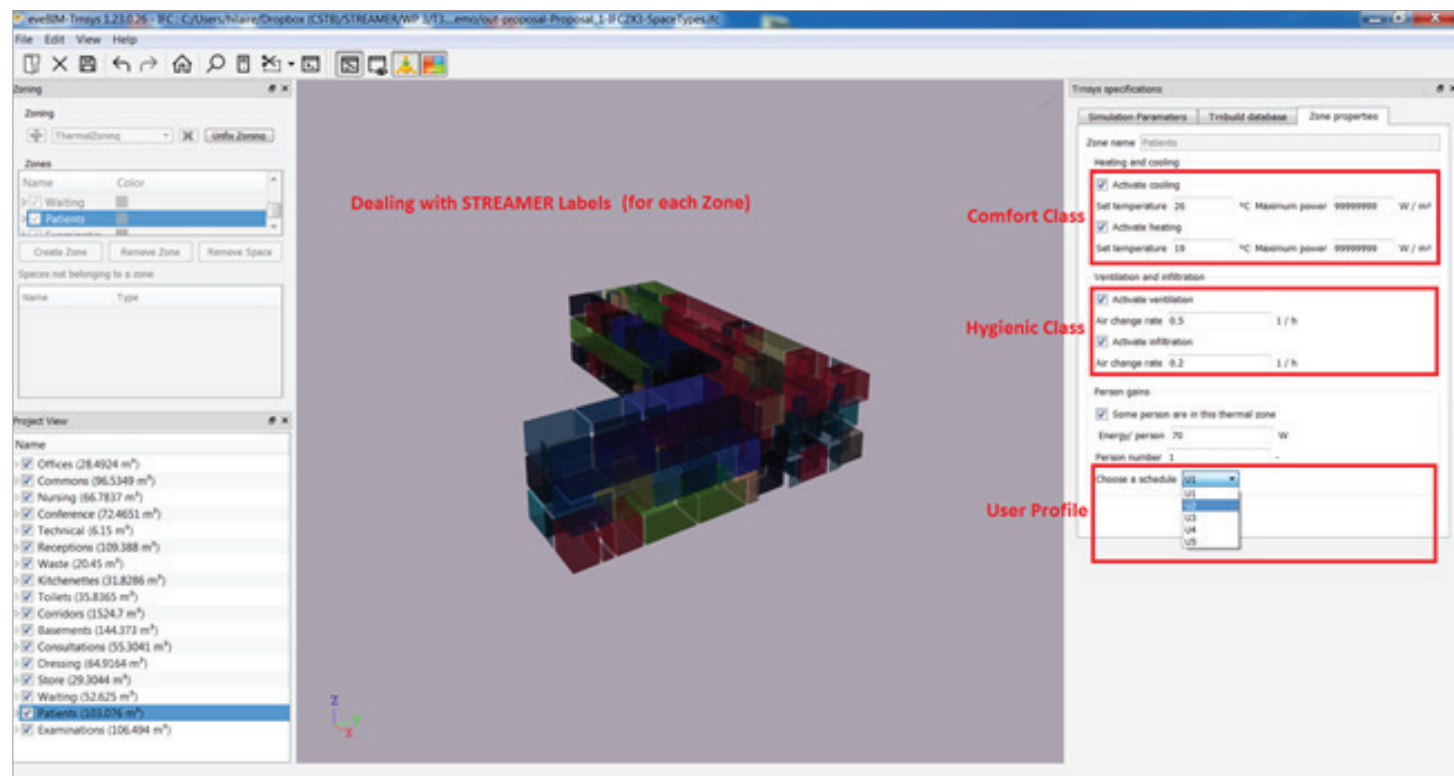
In order to evaluate the energy performance of buildings, a tool has been created that is exactly based on the relatively recently defined standard EN ISO 16798-1. The tool that has been used for STREAMER makes explicit use of the Semantic Labels. The tool calculates the energy demand for each room and for each hour in a year, and it takes as inputs:

- The IFC file that contains the design of the building, also containing the STREAMER Semantic labels for each room so that default values can be used;
- A configuration file, also containing default values for spaces and façade;
- Climate conditions as defined by EN ISO 16798-1.

The energy demand information is written back into the IFC file, and the information can be read and evaluated in the Decision Support Tool.

3H. TOOL: ENERGY INTERMEDIATE TOOL (EVEBIM-TRNSYS)

A special tool has been developed in order to enable two existing tools (eveBIM, a viewer, and trnSYS, an energy calculation tool) to make use of the STREAMER labels.

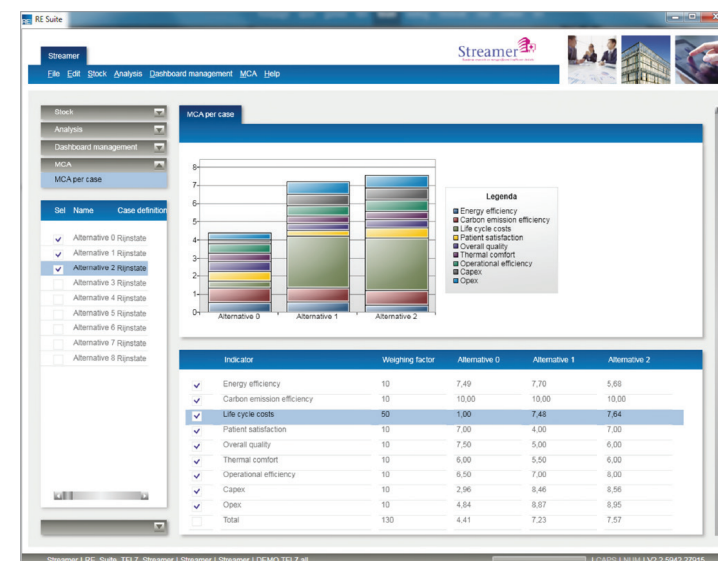
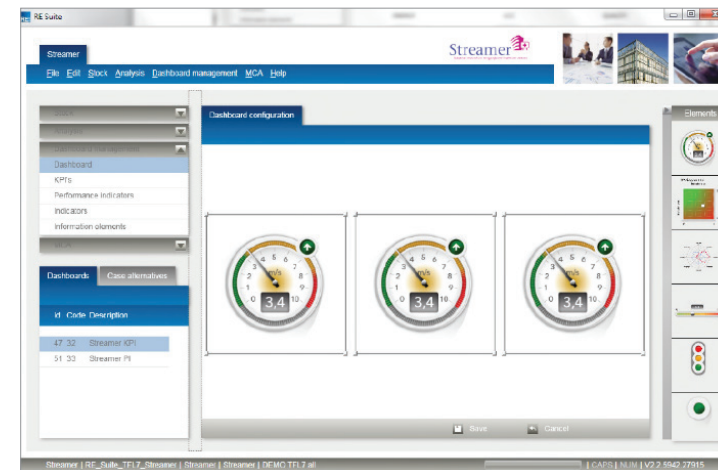


3I. TOOL: DESIGN SUPPORT AND VALIDATION TOOL

The Decision Support tool helps design teams to evaluate different design alternatives. The tool reads information from many different sources and can perform multi-criteria analysis against a set of STREAMER Key Performance Indicators, addressing energy efficiency, total cost of ownership, and quality.

The tool contains a user-configurable dashboard that enables the selection of different KPIs. It also contains extensive viewing capabilities to study the different design alternatives in more detail.

The tool integrates information from all other STREAMER tools. It can read building designs in the IFC standard format, including information that has been added by energy simulation tools. Financial information (Life Cycle Costing) is calculated based on key figures. The tool is designed in such a way that other relevant information that can be included in a BIM, such as operational quality or safety, can also be included in the definition of Key Performance Indicators.



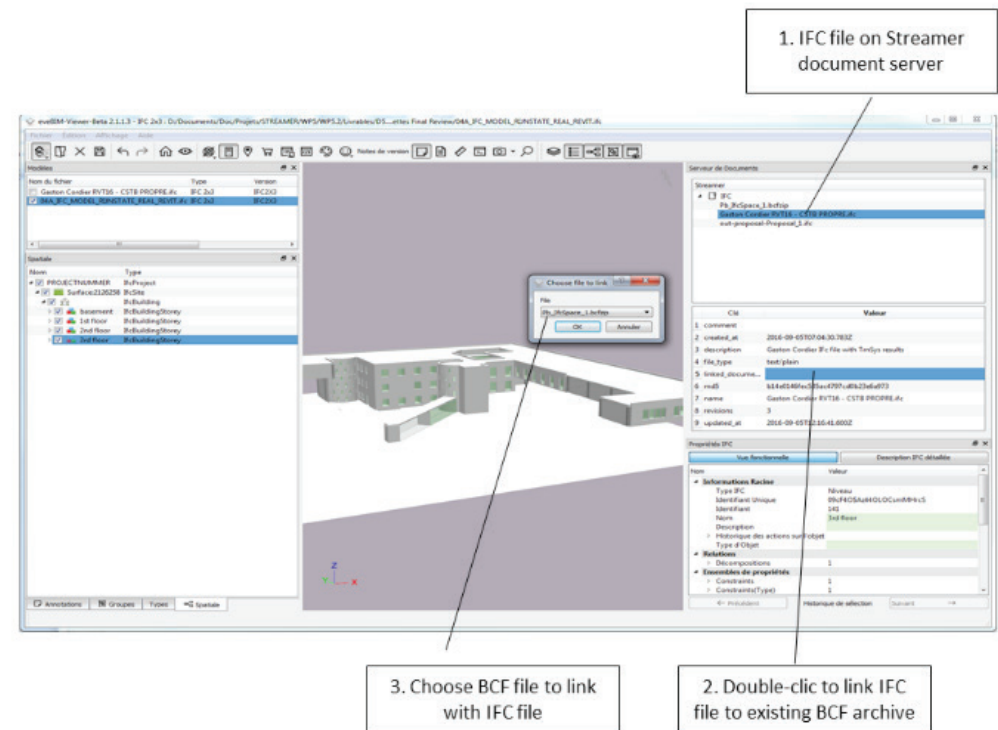
3J. TOOL: PLM SOLUTIONS INTEGRATED WITH BIM & GIS

PLM, or Product Lifecycle Management, is the glue between all the different tools and data. All the documentation, models, computation results are stored on the server, accessible at any time by any actor and will be visible through any solution that will implement the PLM API. One of the main advantage of combining PLM and BIM is that PLM solution supports validation processes. Each kind of document can be integrated into a completely customizable circuit. Only PLM administrators can have access to such processes definition.

The PLM tool is based on existing software that has been enhanced in a number of ways:

- An API has been defined that enables other tools (specifically the STREAMER tools) to directly access the PLM functionality.
- A possibility to work with the BIM Collaboration Format (BCF) has been included. BCF enables the tracking of changes to designs.

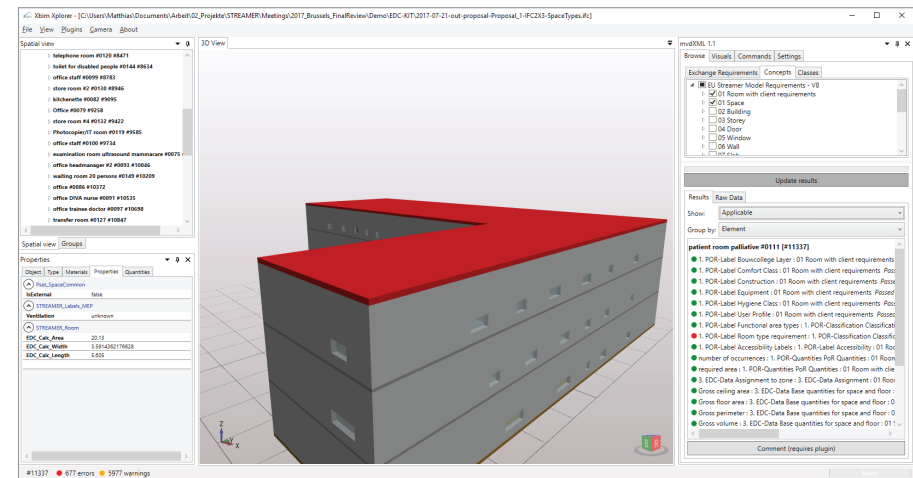
Integration with the eveBIM tool (of CSTB) is tight. Various plugins allow for the usage of BCF connected to IFC files.



3K. TOOL: BIMQ REQUIREMENTS MANAGEMENT AND MVDXML-BASED MODEL CHECKING

The STREAMER workflow is a typical example of Architecture, Engineering & Construction (AEC) design processes that require collaboration of different domains. Data exchange between different tools is enabled by the use of Building Information Modelling (BIM) and open standards, namely IFC and the BIM collaboration Format (BCF). An increasingly important aspect of BIM-based projects is quality control of shared BIM models. A set of tools have been developed to (1) specify and manage BIM data requirements, also known as Level of Development (LOD) and Level of Information (LOI), and (2) automatically check BIM-IFC files against those requirements based on the open mvdXML format.

The BIMQ Guide was developed by the partner AEC3 (<http://www.aec3.com/de/kompetenzen/BIM-Q-Database.htm>) and is a web-based solution used to capture Exchange Information Requirements (EIR, see also ISO 19650-1) within the STREAMER workflow (early design of hospitals). The tool itself is very flexible and can be used from simple requirement configurations based on predefined specifications to full complexity starting from scratch including the needs to provide technical details such as the mapping of end-user requirements to the BIM-IFC data structure.



A prototype implementation for mvdXML-based model checking has been developed as a plug-in for the xBIM IFC viewer (<http://docs.xbim.net/downloads/xbimexplorer.html>). The implementation is mainly designed to allow individual stakeholders to independently verify the conformity of received and produced BIM-IFC models against the agreed exchange requirements and concept roots in a user friendly visual 3D environment as shown in the screenshot.

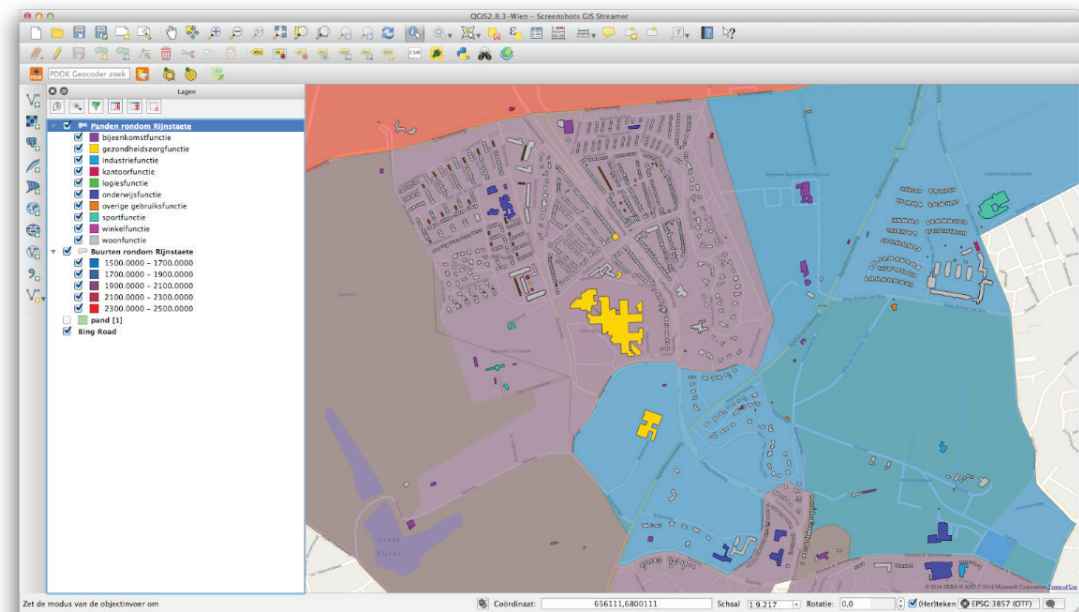
To enable a complete collaboration workflow between stakeholders the MVD user interface component has been designed to allow the interactive analysis of models. Visual color coding styles have been developed to allow rapid traffic-light model inspection in the 3D viewer of passing and failing requirements.

3L. TOOL AND METHOD: ENERGY MAPPING VIEWER (QGIS)

A method has been developed, working with an existing tool (QGIS) which is intended to enhance the workflow around using the tool in situations where various energy sources or users are present in a larger area.

It is possible to view characteristics of a neighbourhood without having to interview people or companies. This means the decision field can be narrowed beforehand. As an extra bonus, lower governments such as provinces or municipalities are in need of this kind of data visualization to be able to make decisions regarding the energy transition. Usually these actors have GIS data but do not combine them themselves for analyses.

The method follows a step-by-step approach in which publicly available (open) data is used, along with GIS and BIM information, and where energy supply, energy demand and energy transportation opportunities are compared, in order to be able to select a number of combinations that can then be analysed in cost-benefit scenarios, also taking into account other (non-technical) parameters.





4. MORE INFORMATION

Of course, you can refer to our website for much more detailed information: www.streamer-project.eu

Also, we have created a short (about 4 minutes) video that gives an overview of the STREAMER project in a way that can be understood by non-experts. A link to this video can be found on our website.

-  [DOWNLOAD PDF](#)
-  [STREAMER WEBSITE](#)

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