SméO, a sustainability assessment tool targeting the 2000 Watts society

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ABSTRACT

Switzerland has adopted the concept of the 2000 Watts society as a long term target, with an intermediate objective for 2050: a reduction of the average energy consumption per person from 6300 to 3500 watts, including a maximum of 2000 watts of non-renewable energy. Following this concept, the SIA (Swiss Society of Engineers and Architects) has developed energy consumption targets for the built environment: embedded energy of materials, operating energy (heating, domestic hot water, electricity, air conditioning) and mobility.

In order to achieve these targets in all projects of new buildings or renovations, the Canton of Vaud and the City of Lausanne have adopted and included them into SméO, a decision-making tool for the sustainability assessment of building or neighborhood projects. This paper presents the methodology applied by the tool for the energy assessment. The methodology is entirely based on building standards and norms for all the domains where these exist. In the other cases, assumptions have been made.

The evaluation follows the entire project. For the first stages of the project where energy calculations have not been done yet, the tool offers default values for energy consumption, mobility and embedded energy based on the characteristics of the project. Hence, the project can be optimized from the very beginning of the process. SméO being a free web platform, results can be shown and easily communicated to all stakeholders.

Keywords: Assessment tool, 2000 Watts society, energy targets, project optimization, communication

INTRODUCTION

Energy consumption of the built environment represents 31% of the total energy consumption in the world (GEA, 2012), and 47% in Switzerland. Hence, energy efficiency in buildings can have a great impact on the path toward a sustainable energy system. The Swiss Federal Institutes of Technology have developed the “2000 Watts society” concept (Novatlantis, Swissenergy, & SIA, 2011), which states that by 2150, our energy consumption should be reduced from 6300 to 2000 watts, among which 75% renewable energies, and greenhouse emissions reduced from 8.6 to 1 tone/pers.yr. This concept has been adopted by the Swiss government to face the energy challenge.

The 2000 Watts objective includes all energy consuming sectors: industry, alimentation, services, transport, building, etc. The SIA (Swiss Society of Engineers and Architects) has developed energy targets for new buildings and renovations. The technical report SIA 2040 “SIA Energy Efficiency Path” (SIA, 2011) establishes the energy consumption limits for embedded energy, operating energy and mobility to reach the global intermediate target of 440 MJ/m^2 for 2050. As this goal represents the mean energy consumption for 2050 for the built environment, all new buildings and renovations should at least reach this target to really progress toward this objective. Hence, project managers need to know the performance of their project and adapt it to the targets. Assessment tools are then needed to do so, to inform stakeholders and to communicate with experts and investors.

BUILDING PERFORMANCE ASSESSMENT TOOLS

A high number of energy assessment tools for buildings have been developed (Annex31, International Energy Agency, & Energy Conservation in Buildings and Community Systems, 2001; Haapio & Viitaniemi, 2008). For its part, The SIA has developed a tool to calculate the energy consumption for embedded energy, operating energy and mobility for buildings (new and refurbished) (SIA, 2013). In addition, the Federal Office of Energy (OFEN) has developed a tool to evaluate neighborhoods (OFEN, 2013), also in regards with the 2000 Watts society.

Nevertheless, the design process is guided by a high number of objectives such as comfort, return on investment, health, etc. Energy is an important criterion but other aspects are also relevant. Energy efficiency without comfort being meaningless, the optimal solution needs to be found. Several tools consider the fact that the built environment is affected by economic, social and environmental aspects, pursuing a holistic and sustainable vision of building projects. In Switzerland there are two main methods: SméO and SNBS. SméO is a decision-making method, a free web platform based program (www.smeo.ch) which allows stakeholders to assess the sustainability of their projects, to compare scenarios and to communicate results. It has been developed by the Canton of Vaud and the City of Lausanne in 2009. The Sustainable Construction Network Switzerland (NNBS) has developed in 2013 the SNBS: the Swiss standard for sustainable buildings. The tool is presented as an excel sheet for the calculations of different indicators (SNBS, 2013), therefore the use of the tool is less accessible to non-experts. On the path toward the 2000 Watts society, a decision-making tool accessible to a broad public would be necessary to help decision-makers optimize their project through the whole development process. In this sense, SméO is a decision-making tool, user-friendly, adapted for non-experts (Roulet & Liman, 2009). It is the optimal instrument to enable the implementation of the 2000 Watts society in the built environment.

SMEO & THE “2000 WATTS SOCIETY”

SméO, sustainability assessment tool

SméO provides an indicator system assessing sustainability at the different stages of a project, from the first idea to the construction and usage of buildings and neighborhoods. It considers the entire life cycle of the building, being renovated or built. Following the SIA 112/1 “Sustainable construction – Building” recommendation, the domains evaluated are: Governance, Resources, Site and architecture, Community, Cost and finances, Land and landscape, Infrastructures, Building concept, Materials, Worksite management, Investment, Integration, Identity, Viability, Security, Comfort and health, Energy, Water and Waste, Return on investment, Technical equipment maintenance and deconstruction at the end of life. Each domain is evaluated by several indicators; these can be either quantitative or qualitative and they vary depending on the project’s type and scale. The tool provides two or three thresholds (Riera Pérez & Rey, 2013):

1. Limit value: boundary between acceptable (yellow), and unacceptable, due to incompatibilities with either common practice or with legal requirement (red).
2. Target value: boundary between acceptable and best practice (green).
3. Veto (black), only for some indicators which can have a negative impact on the entire project

Results of each indicator are aggregated according to the Hermione methodology (Flourentzou, 2001).

Each user has its own account where she/he can register and assess several projects, as shown in figure 1**.** Projects can be shared with other users. Project with titles in blue have been shared with other users. The ones in red correspond to projects created by another user and shared with the user of this account. Column A shows different functions related to the project: “Create a new project”, “My projects”, “Share projects” and “Energy prices”. This last function is used to calculate the cost of

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the operating energy per year. For each project, one has access to the information in line B: First, "General characteristics". Second, the "project analysis" showing the assessment of the different domains. Third, "Complete results" presenting the assessment for all the stages of the project, the economic impact and the environmental impact, including the performance of the project with respect to the 2000 Watts society framework are communicated. Finally, C is used to compare different projects.

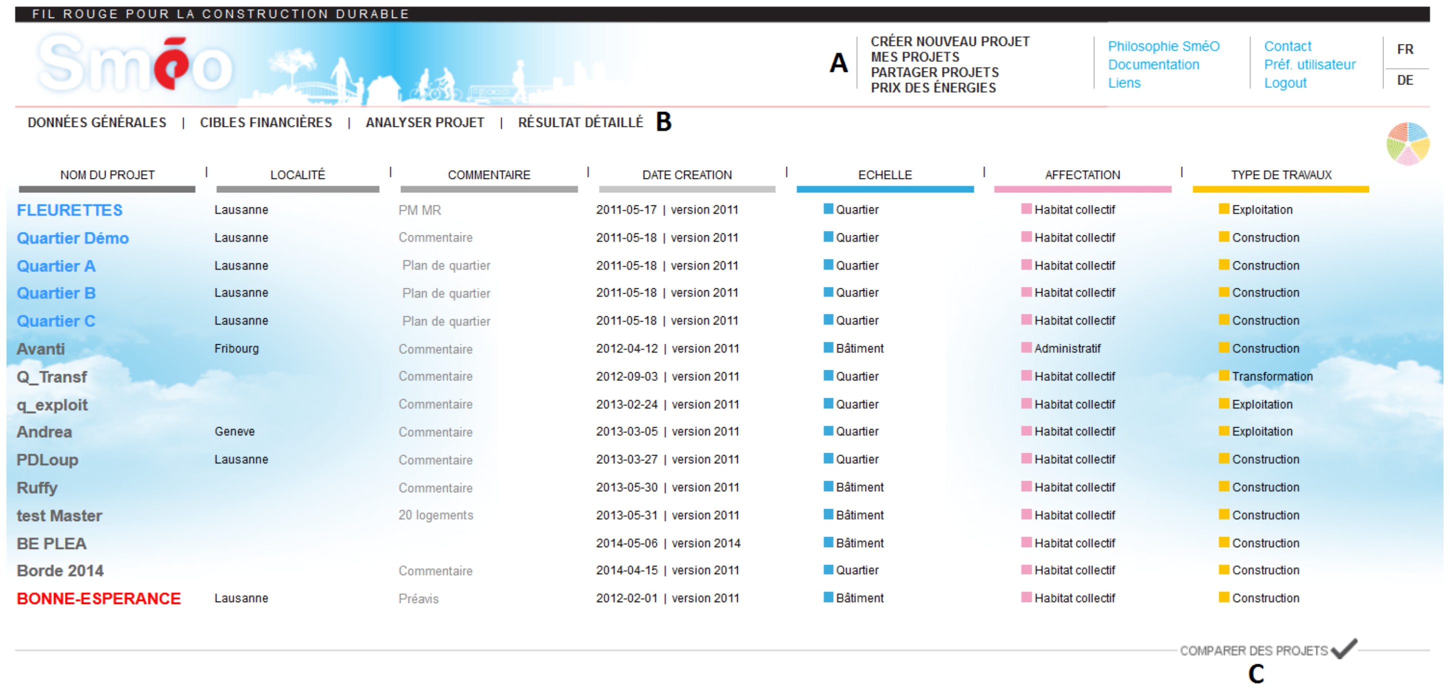

Figure 1 SméO user interface

2000 Watts society targets

The 2000 Watts targets for the built environment developed by the SIA (table 1) marry the ambition of a society to reduce its energy consumption to 1/3 and the technical feasibility (Heeren, Wallbaum, & Jakob, 2012).

Table 1. 2000 Watts society targets for 2050, by SIA 2040

	NRE (MJ/m^2 ERA yr.)			GWP ($KgCO_2$ eq./m^2 ERA yr.)		
	Embedded	Operating	Mobility	Embedded	Operating	Mobility
New	110	200	130	8.5	2.5	5.5
Renovation	60	250	130	5.0	5.0	5.5

Method applied by SméO for the assessment of the 2000 Watts society

The program calculates NRE (Non-Renewable Energy), GWP (Global Warming Power) and also UBP (Eco-points) per m^2 ERA: Energy Reference Area, from the first stages of the project, even if the 2000 Watts society doesn't include UBP. The methods to calculate the embedded energy, operating energy and mobility are exposed below.

Embedded energy. The method applied is based on the technical report SIA 2032 "The buildings' embedded energy", which calculates the energy needed for all components, considering their lifecycle and a time period of 60 years to write off the total embedded energy of the building. The method differentiates two sectors: heated areas and non-heated areas. The main features of the building required for the calculations are the ones in Table 2, for which the tool suggests several default values.

Table 2. Considered components in the calculation of the embedded energy

Heated areas	Non-heated areas
Façade	Excavated volume
Lower and intermediate slabs	Basement slab
Roof	Bearing walls and partitions
Walls	Intermediate slabs
Windows	
Window frames	
Level of technical equipment	

The environmental impacts (NRE, GWP, UBP) per m^2 for each option are calculated by a LCA (Life Cycle Assessment) program: Lesosai (http://www.lesosai.com) and Eco-Bat (http://ecobat.heig-vd.ch). There are two levels of technical equipment: high or low. The first level corresponds to a high-tech building. The second level corresponds to a standard building based on legal requirements.

Target values defined by the SIA 2040 deal with households, economic activities and schools buildings. The values for the other uses have been adapted: the target for economic activities is also applied for commercial surfaces, hospitals and industries, and the target for households to stocks, sports facilities, swimming pools and space for events. These embedded energy values refers to the building. Special technical equipment for swimming pools or hospitals should be evaluated separately.

Operating energy. The impact of the operating energy is the result of the consumption and the energy production system for heating, residential hot water, electricity and cooling. The conversion factor from final energy to NRE, GWP and UBP are drawn from the KBOB LCA data (KBOB, 2012).

For the first stages of the project SméO estimates the impact based on the targeted energy standard:

1. Legal requirements
2. Minergie® standard or equivalent
3. Minergie-P® standard (2000 Watts society compatible)

The tool calculates the energy demand following the SIA norm 380/1: "Thermal energy in buildings" which adapts to the different surface uses: residential, commercial, etc. This normative energy demand is reduced depending on the energy standard targeted. The energy production is also adapted to the standard. For Minergie-P® the heat production proposed by the tool is wood-pellets. For the Minergie® standard, production is through a heat pump, with 30% of solar thermal for domestic hot water. Finally, for the application of the legal requirements, the production system is a condensing gas boiler. The electricity source is slightly adapted: projects in accordance with legal requests are supplied by Swiss electricity network (MIX Swiss). For Minergie® and Minerige-P® projects, 20% and 30% of photovoltaic cells production is added, respectively.

For the operating energy, SméO evaluates not only NRE and GWP but also the final energy consumption for heating (see table 3) and the percentage of renewable energy for heating, domestic hot water and electricity of new buildings, see figure 2**.** The operating energy assessment for renovation or transformation projects is based only on the total NRE and GWP because existing building are very diverse, with specific objectives for each energy use. The percentage of renewable energy must be more important since the consumption increases in order to reach the NRE target. The increase in energy consumption is relative to the normative value: $Q_{h,li}$, Q_{ww} and Q_{el} for heating, domestic hot water and electricity respectively, calculated by the SIA 380/1 norm. $Q_{h,eff}$ is the energy need for heating taking into account the energy recovery.

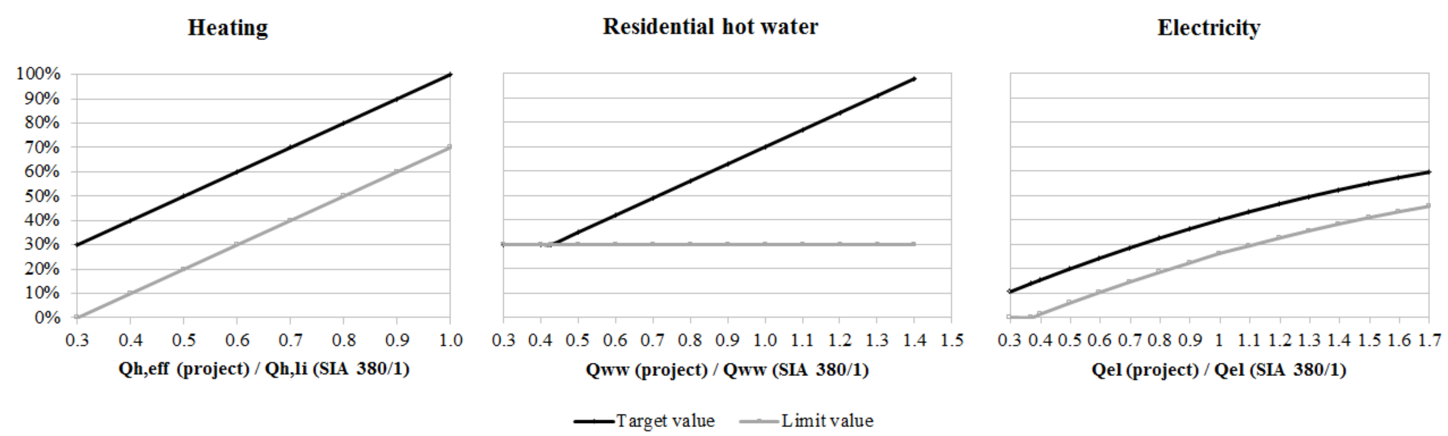

Figure 2 Part of renewable energy limit values for operating energy

Table 3. Assessment of Q_h. (Q_h : final energy for heating, $Q_{h,li}$: legal value fixed by the SIA 380/1 norm)

Assessment limits	New buildings	Renovated buildings
Best practice (green)	$Q_h < 0.6\ Q_{h,li}$	$Q_h < 0.8\ Q_{h,li}$
Acceptable (yellow)	$0.6\ Q_{h,li} < Q_h < 0.9\ Q_{h,li}$	$0.8\ Q_{h,li} < Q_h < Q_{h,li}$
Unacceptable (red)	$0.9\ Q_{h,li} < Q_h < Q_{h,li}$	$Q_{h,li} < Q_h < 1.1\ Q_{h,li}$
Veto (black)	$Q_{h,li} < Q_h$	$1.1\ Q_{h,li} < Q_h$

Mobility. The applied method is based on the technical report SIA 2039 "Mobility - Energy Consumption of Buildings according to their Location". The method weights the Swiss average energy consumption for mobility by several correction factors related to the context and facilities. "The correction factors are obtained from a statistical analysis of the federal micro-census of 2005 (OFS & ARE, 2007) and vary depending on the surface uses. They are:

1. Location: located in downtown/business area
2. Access and quality of public transport
3. Distance to a shopping center
4. Availability of a car
5. Availability of parking for cars and bikes
6. Availability of public transportation passes." (Riera Perez & Rey, 2013).

If users are identified, the SIA 2039 recommends a much precise calculation taking into account the distance and means of transport employed by the occupants.

The target values for the surface uses that are not included in the SIA 2040 have been defined by separating energy for employees and for visitors or customers. Employees' mobility is the one defined for economic activities in the SIA 2040. Visitors or customers' mobility have been taken from the mode of mobility (distance and mode of transportation) defined by the federal micro-census of 2005, differentiating mobility for shopping and for leisure. The assumption is that commercial activities generate the shopping type mobility. Restaurants, sport facilities and meeting spaces generate leisure type mobility. Finally hospitals generate the same mobility as an average inhabitant as we assume that patients going to the hospital go from home and return back home. The same energy reduction (energy saving in percentage of the Swiss mean value), is asked for all land use surfaces.

RESULTS

As a decision-making tool dealing with multi-disciplinary assessment, the communication of results is important. Figure 2 shows the graphics presenting the projects toward the 2000 Watts society. On the left side, total NRE and GWP graphs inform the user about the completion of the 2000 Watts target, corresponding to the green line. The two columns differentiate the actual impact with the one for 2050, considering technological improvements of vehicles. On the right side, the contribution of each energy use is detailed in order to help decision-makers focus on the bigger impact.

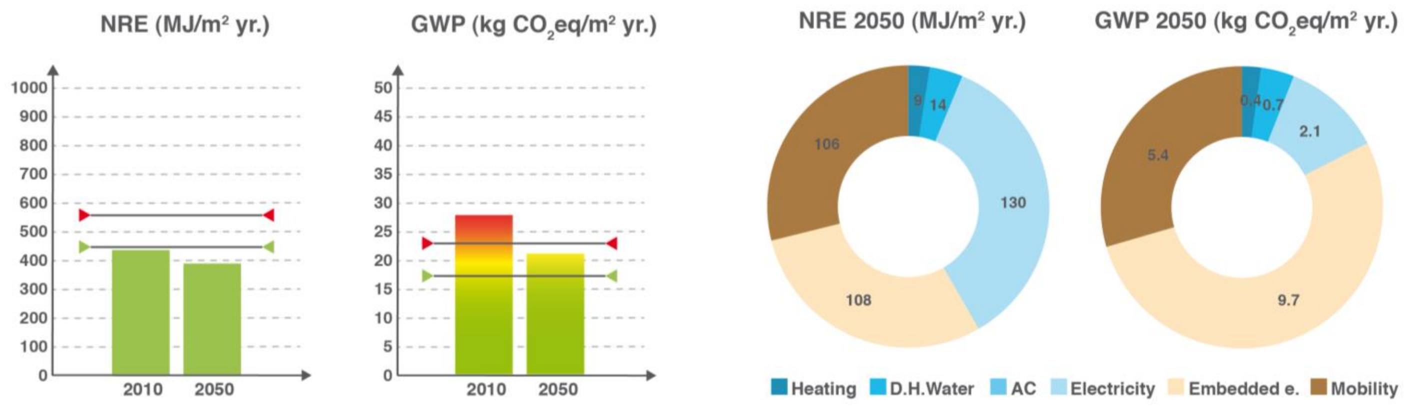

Figure 2 SméO results: 2000 Watts assessment and contribution of each energy use to the whole impact.

CONCLUSIVE DISCUSSION

Because SméO is intended to all project managers, the web page offers documentation presenting the calculation method, references and a user guide. A decision-making tool can be used in very different ways; results highly depend on the input data since no verification is done in comparison to a certification process. Thus, using a tool like SméO is judicious only if the project manager seeks a sustainable building development. Therefore, the tool presented is an instrument to contribute to the 2000 Watts society, but other ways need to be found to implement the energy reduction target such as modifying the energy legislation and urban planning regulations.

In Switzerland, the SIA has an important influence on the normative domain because of its capacity to promote innovative answers for new challenges. Since environmental, cultural and legal aspects change from one country to another, the method would need to be adapted prior to its use in a different context (Singh, Murty, Gupta, & Dikshit, 2012) in order to guide towards appropriate targets. Therefore, identifying the regional specific challenges, standards and solutions would be needed to adjust the tool.

The user of a building can highly influence the energy consumption and some papers have shown that going from 6000 Watts to 2000 Watts cannot be done without the contribution of the occupant behavior. Hence, new developments are necessary to follow the real energy consumption during the lifetime of buildings.

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