ENERGY

Management of urban energy systems

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In industrialized countries, more than two-thirds of the energy is consumed in urban areas. Hence, energy sobriety calls for special attention to urban planning, especially regarding energy aspects.

In March 2007, all the member-states of the European Union (EU) have agreed on a set of objectives called "3x20", in order to reach the goals set by the European energy/climate policy, which are:
1) a 20% cut in the total (primary) energy consumption;
2) a 20% cut in greenhouse gas emissions, mainly CO_2;
3) bringing up to 20% the contribution of renewable energy sources in the energy mix (electricity, district heating…).

Those objectives are to be achieved by 2020 all over EU. As for Switzerland, its objectives are threefold, and very similar to the ones to be achieved in Europe: 1) lowering the fossil energy consumption by 1.5% per year in relation to the one of the year 2000, 2) stabilizing the electricity consumption at the level of 2006 consumption, 3) increasing by 50% the part of renewable-energy sources in relation to the total energy consumption.

Since currently around 70% of the energy is consumed in urban and peri-urban areas, improving transport and buildings' efficiency has become a major challenge for the current energy and climate policies. Due to this extremely high concentration of energy, more and more consumers in cities are setting up programs for sustainable development projects: the number of examples is increasing (BedZed in London, Vauban in Freiburg, Germany…), but they are still far too insubstantial in regards to both the still growing number of conventional energy-guzzling new urban projects and the non-retrofitted areas.

Various land-planning projects have been carried out in local communities both in Switzerland and the EU, and many more are being planned. However, it soon became obvious that reliable calculation methods using models and energetic optimization approaches were needed. Currently, their scope of application is very limited due to the tremendous complexity of such models, and also due to missing structural data on energy consumption of the majority of town infrastructures. In addition, the use of evaluation and statistical methods, while often the only available possibility, can be extremely imprecise or inaccurate.

As a consequence, the Energy Center of the École Polytechnique Fédérale de Lausanne (EPFL Energy Center) decided to launch, or to get involved in, a wide spectrum of projects in order to address this issue. The different considered approaches as well as the extent of the projects in terms of geographical scales illustrate the formidable complexity associated with every project and its own unique features.

Management of energy systems in urban areas (MEU), http://meu.epfl.ch/

"MEU" is the acronym for 'Innovative tools for planning and management of energy systems in urban areas'. The main goal is to marshal and federate existing methods and models in order to validate an integrated methodology for planning and energy management at the urban level. It will provide urban decision- and policy-makers with a decision-support tool enabling them to evaluate and compare different planning scenarios, for both building rehabilitation and development. A web platform will gather all the pertinent information and allow:
- a concrete and efficient support for energy planners, both for the follow-up monitoring and for the forecasting of retrofitting projects or new constructions;
- to evaluate the impact of the regulatory framework (laws, subsidies…) on decisional processes and on energy supply systems design;
- to evaluate the strengths, weaknesses and potential market opportunities for different energy supply schemes and business models.

The first step is to determine the current consumption of buildings and industrial sites in order to obtain a precise assessment of the energy demand and supply of a given territory. Since this project is focusing on the scale of a neighborhood or an urban zone, a detailed list of all energy consumption value in each building is necessary, i.e. heat, domestic hot water and so on, as well as the supply areas of existing energy networks. The calculation can be performed either directly from the energy consumption values, if they are known, or using buildings' structural data, by way of existing tools such as CitySIM, also developed at EPFL. The latter will allow to model and estimate the buildings' energy demand, if energy consumption cannot be directly measured.

The first stage of the project has been dedicated to evaluating the available data versus data obtained from simulation models, available statistics or reference values. Structural data such as building utilization, surfaces and

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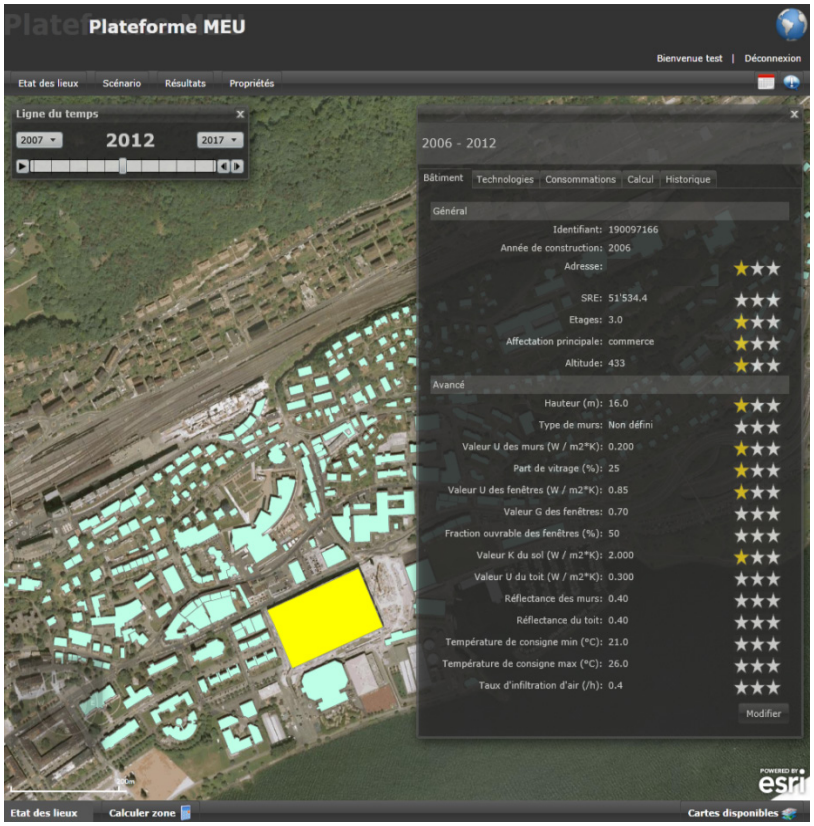

Figure 1 | Visualization of the MEU platform, with the timeline on the top left corner

energetic agents are often available from the city authorities while additional consumption data can be collected from local energy utility companies. Different methods of evaluation and computational shortcuts can sometimes provide reasonable values for the thermal requirements of the buildings. All the information concerning the buildings (address, energy reference area or structural parameters such as walls and windows isolation) can be displayed on the platform, as shown in Figure 1.

The MEU platform has two very different modes: 1) a time-dependent snapshot of the real energy situation in the specified area of interest (reference state), 2) a scenario mode, where scenarios are entirely built by the users in order to visualize any changes on the real situation. The modifications to the reference state can affect both energy supply and demand: for example, the platform allows visualizing the impacts of a conversion from oil boilers to district heating, or of the change of a building's energy consumption if it is entirely or partially retrofitted. Finally, the platform also allows calculating the related CO_2 emissions for both modes, and thus notably evaluating the impact of renewable energies in terms of energy-climate objectives.

The platform MEU is a tool constructed in a bottom-up way, meaning in collaboration with experts from cities (La Chaux-de-Fonds, Lausanne, Martigny and Neuchâtel) and local multi-energy businesses, which will be precisely the future users. The public and the academic world have cooperated throughout the various stages of the project, and the following features represent the major achievements of such a project:

- A software tool for decision support in the field of energy planning has been developed in order to answer the needs of cities through an interactive mapping approach and through the building of a data structure toward managing the energy complexity of an urban area.
- A database able to take into account the complexity of urban energy systems, while offering broad functions in terms of geo-referencing and time-evolution management has been developed, at the same time referencing the current energy configuration of urban zones.

The strength of this project is to enable cities and multi-energy distribution companies to not always resort to external mandates to assess the impact of energy development plans or retrofitting of urban areas. The platform will allow them to do this work themselves; giving them the opportunity to compare scenarios and to address both the demand and energy supply issues. Similarly, new regulatory frameworks will be evaluated in detail and their possible implementation will be monitored over time.

More information about his project can be found at http://meu.epfl.ch/

Urban Energy Information System (SIEU), http://www.crem.ch/sieu

The role of local authorities in achieving ambitious objectives in terms of energy and GHG emissions cannot be overemphasized. A very clear example is "The Covenant of Mayors" which binds the elected local authorities to the European Commission to achieve the "3x20" objectives mentioned above.

As a result, many local authorities are trying to implement locally adapted climate and energy policies. However, unlike countries, whose custom services allow determining exactly what the annual national energy consumption is (via import and export fiscal data), local authorities currently have access to limited energy data only. However, this information is crucial to decision makers to both evaluate the impact of their actions and to refine their action plans in order to ensure that the objectives are achieved.

The main goal of this project is thus to assess the feasibility to measure and collect on a single platform all relevant energy data across a local authority, in order to obtain energy and climate indicators which can characterize the urban energy flows, as precisely as possible. The necessary experience needed for data collection and

data structuration with a very fine granularity has been acquired through various previous projects, most notably the Territorial energy planning project (PlanETer, http://www.crem.ch/planeter) which served as the basis of all calculations.

Objectives are multifold: the first step consists in finding useful energy indicators which have to be taken into account, as well as to identify possible legal barriers (private data…). Such indicators should allow to completely monitor the actual results of local climate and energy policies. Therefore, a comprehensive assessment of the main methods existing for data collection should list all available data versus data which have to be estimated. Information used in the system can be found in energy utility companies' databases, smart meters, questionnaires, measurements of traffic flow and so on. All those data are merged and centralized to obtain global useful indicators. Finally, an important feature is the identification of market niches to develop new products and/or services for monitoring (including in particular oil, wood, biomass, mobility and transport, electricity consumption according to its uses, etc…).

More information about this project can be found at http://www.crem.ch/sieu

Rêve d'Avenir : http://www.revedavenir.org/

The European Commission has recently acknowledged that local authorities and their citizens are central to the success of climate objectives. Thus, the strategic aim of the project REVE d'Avenir revolves around the mobilization of stakeholders of these local territories to address the energy and climate challenges. As a consequence, several thousands of European local authorities have engaged in the Covenant of Mayors. This initiative, launched by the European Commission in 2008, brings together local communities which aim at achieving the "3x20" targets mentioned above by developing and implementing a concerted action plan for sustainable energy. The achievement of these objectives will thus be the fuel for a real social and economic dynamics, and therefore potentially increase the territory's overall competitiveness.

REVE d'Avenir uses the experience acquired through projects such as MEU and PlanETer, and brings to local communities across European borders the needed innovation, methodology, and exchange of know-how to support them in the challenge they have set themselves by signing the Covenant of Mayors, in a bottom-up experience.

1) Opening-up towards innovation: Each community involved in the project engages itself in the development of an experimental "negawatts power plant", designed by REVE d'Avenir to model and spatially distribute the energy savings and avoided CO_2 emissions across a territory. This experimental plant aims at mobilizing all different stakeholders (administration, businesses, citizens, etc...) to act on climate and environmental issues. This global mobilization is of utmost importance for the success of the project. Through the implementation of innovative communication initiatives, thanks to original and motivating advertisement towards the citizens, climate and energy goals can be achieved, and the concept of "negawatts" validated. These actions will be designed according to the individual needs of the different communities.

2) Support: In order to have a full experience and various point of views from different stakeholders a certain number of workgroups are implemented with the goal of sharing knowledge and developing exchanges in mind. The communities volunteering to implement a specific project in their territory may choose to participate in one or two groups. One of those is specifically devoted to energy planning in urban areas and is led by EPFL.

3) Skills development: Exchange of experiences and inter-cluster to strengthen European ties at European level.

This cross-border project – financed by EU under the Interreg program – will take place over a period of 36 months (2010-2012). It includes a mixed team made up of people from academia, associations, communication sector, as well as local authorities and local citizens.

More information about this project can be found at http://www.revedavenir.org/ and http://www.3x20.org/.

Energy flows in a territorial approach

Another approach is to broaden the scale and area of interest to an entire canton, in order to create a tool for decision support and monitoring, which centralizes all the useful information on energy carriers. This allows a global overview, understanding and monitoring of the energy situation in the entire canton.

The final goal is to implement a platform enabling the direct visualization of all useful flows, thus translating the national statistics on the energy chain to the cantonal level. Therefore, this innovative tool will allow to visualize primary and final energy, to model conversion nodes in the energy chain, as well as to assess the overall energy balance per use sector or even per sub-entity of the considered territory: either a municipality, a district, or the entire canton.

The data inserted into the gigantic database are updated automatically, and can be accessed through a web platform to make the system permanently accessible to the users. Finally, it allows a very precise visualization of complex entities such as water-treatment plants or cogeneration units.

Conclusion

All those projects are still in their prime youth, and still need to be completed before the extent of their application potentials can be fully assessed. However, those new tools will be of utmost importance to decision-makers in order to orient their energy strategies and future choices for urban planning. Such powerful instruments will thus enable the making of well-balanced decisions and the overall involvement of the stakeholders in these decisions, in particular citizens. ★