Evaluation methodology to assess the theoretical energy impact and the actual energy performance for the 27 communities of the European CONCERTO initiative

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Abstract
The European CONCERTO initiative aims at supporting communities for the implementation of combined actions towards energy efficiency and use of renewable energy sources. In a first phase, 27 European communities are involved in the programme. An evaluation methodology is elaborated to assess the impact of the CONCERTO initiative and the energy performance of the CONCERTO communities. Given the specificity of the initiative, a combination of ex-ante and ex-post evaluation is foreseen.

The ex-ante evaluation consists of assessing the theoretical impact of the CONCERTO initiative with a set of indicators prepared by DG-TREN. This requires the definition of baseline scenarios and system boundaries for the representation of energy flows. The baseline scenarios are defined at national or regional level, so that common values for energy consumption of buildings may be determined in accordance with national or regional standards. The system boundaries are set considering the projects' characteristics.

The ex-post evaluation consists of assessing the actual energy performance of the individual communities. After buildings and plants have been built or refurbished, available metering will be used to assess the actual energy consumption and production from renewable energy sources and to compare it with the figures proposed initially by the communities. Given the limited budget available for metering, the ex-post evaluation will only partially cover the energy flows of the communities. Therefore recommendations regarding monitoring of future CONCERTO communities are formulated.

Introduction

THE CONCERTO INITIATIVE: AN INTEGRATED APPROACH
The European CONCERTO initiative aims at supporting communities for the implementation of combined actions towards energy efficiency (EE) and use of renewable energy sources (RES). In a first phase, 27 European communities are involved in the programme and a large panel of actions is planned for each community. One of the main objectives of the project involves the integration of demonstration activities. In the field of energy efficiency, thermal retrofitting of existing buildings, construction of new low energy buildings, increasing the efficiency of every kind of energy system and introducing polygeneration technologies are the most important actions to be undertaken. In the field of renewable energy sources, large or small scale energy systems based on RES are to be built to provide single buildings or whole districts with electricity, heating and cooling energy. Another objective of the project entails operations such as awareness campaigns and training for encouraging the communities to take advantage of the high concentration of demonstration activities to locally increase the consciousness of citizens on energy relevant issues. The most important feature of the CONCERTO initiative is that all these activities are combined within an integrated approach. More than a mix of independent actions, the combination between the components of the whole energy system are optimized thus considering energy supply and storage units as well as end-customers. To allow for this holistic as well as technical integra-

tion, a high number of stakeholders are involved in a public initiative. Therefore technical aspects are just one part of the CONCERTO initiative, which also covers socio-economic and energy policy issues.

NECESSITY OF EVALUATION: THE PROJECT CONCERTO PLUS

Given the level of complexity of each project, the evaluation methodology needs to cover the different aspects of the initiative in the framework of the project CONCERTO PLUS. This project has been initiated by the European Commission (DG-TREN) to deal with coordinated analysis, monitoring and dissemination of the results from all CONCERTO projects including the strengthening of networking between the CONCERTO projects and facilitating the transfer of best practices to new communities across the European Union [CONCERTO]. A team lead by arsenal research has the task to implement the work of evaluation, dissemination and recommendation. As presented in [IAEA, 2005], both social and energy evaluation is needed. This paper only deals with energy evaluation and focuses on the corresponding theoretical impact assessment and the actual energy performance assessment. Energy evaluation is necessary for the following reasons:

- One of the targets of the CONCERTO initiative is to support actions in the field of EE and RES in a well balanced way, to avoid, for instance, non efficient areas to be supplied by large energy systems based on RES. The evaluation methodology is defined to cover both aspects and to assess the balance between EE actions and energy supply by RES.
- A comparison between the different communities and their strategies should lead to benchmarking and therefore evaluation is needed. Because of their high number and variety, communities will be put together in groups characterized by common parameters, and benchmarking will be implemented across these groups. The common parameters are as follows:
    - Geographic position
    - Typology of settlement (rural area, new urban district, old urban district)
    - Main activity in the area (residential, administration, industry, agriculture)
    - Energy supply technologies
- The evaluation results will be presented such that the strengths and weaknesses of similar strategies implemented in different framework conditions or of different strategies implemented in similar framework conditions can be worked out. The high amount of data and the variety of projects will allow for benchmarking and for recommendations on the best strategies.
- The success of the CONCERTO initiative will rely on the results of the evaluation, so that the ability of the CONCERTO initiative to support sustainable communities in the implementation of combined actions in the field of EE and RES can be demonstrated. On the basis of the results of the evaluation project CONCERTO PLUS, recommendations for energy policy and funding initiatives will be formulated. Both the re-definition of the requirements for communities and the definition of additional selection criteria concerning energy and monitoring aspects will be important parts of these recommendations.

SPECIFICITY OF EVALUATION AND CHOSEN METHODOLOGY

Number and variety of projects

The 27 communities of the first phase are located in 12 European countries and grouped in 9 projects. This implies a large panel of processes, methodologies and technologies which all have to be evaluated through a unique evaluation methodology. Energy evaluation should allow for benchmarking, even though climatic conditions, initial energy situation, building codes and energy performance regulation can vary considerably from one region to another.

Conflict with single projects evaluations

The difficulty in defining a common methodology consists also in the fact that the definitive indicator set and the common methodology itself has been defined after approval of the projects and that each community or project of the first CONCERTO generation also has specific indicators to serve political targets. Therefore the chosen methodology for the single projects may differ from the one followed in this work.

Data availability

The quantity and quality of data available differs from one community to another, making a too detailed methodology inadequate. There are existing modelling tools like [SUNTool, 2006] which might be used for energy evaluation, but their use requires a high amount of input data exceeding what is available in the single projects. Evaluation is always a compromise between evaluation objectives which determine the accuracy of the results and evaluation costs. Within the CONCERTO initiative, high priority is set on demonstration activities and the budget available for monitoring is limited compared to the diversity of demonstration activities supported in the single projects.

Short metering period

In many cases, metering will not be implemented for more than 2 years because the whole project duration is limited to 5 five years (starting in 2005) and many buildings will be completed at the end of this period. The amount of metered data to evaluate the projects will be limited because two years will not be representative for the buildings' operation: during the first year the control strategy of the HVAC systems will be optimized and so the metered data will not represent the optimized building energy performance. Therefore ex-post evaluation within the frame of the project will be limited.

Chosen methodology

The specificity of the CONCERTO initiative makes it necessary to combine a theoretical impact assessment with an actual energy performance assessment, like illustrated in Figure 1:

- The actual energy performance of the communities after the implementation of demonstration activities has to be assessed. Metering data will be considered to present as well as possible the actual energy performance (ex-post evalu-

ation) of the individual community, i.e. its energy flows where metering data is available. It will be crucial not to dissociate the assessment from the framework conditions in which metering is implemented (climate conditions, control strategy and users' behaviour).

- Since the variety of metering strategies implemented among the actual projects and the variable and short time periods foreseen for these metering activities do not allow for a consistent evaluation referring to baseline scenarios, a theoretical impact assessment (ex-ante evaluation) is needed in order to evaluate the impact of the CONCERTO initiative compared to a reference scenario called baseline.

The indicators' definitions and the presentation structure for actual energy performance assessment are explained first, followed by the data availability among the CONCERTO projects. Thereafter the link between rough data and indicators, namely the methodologies chosen for the theoretical impact assessment (ex-ante evaluation) and the actual energy performance assessment (ex-post evaluation) are presented.

Indicators for theoretical impact assessment (ex-ante evaluation)

A set of indicators is defined to realize the theoretical impact assessment.

SET OF TECHNICAL INDICATORS

The set of indicators to be used for the CONCERTO initiative has been defined by DG-TREN [CALL] and principally covers indicators ECO1 and ECO13 of [IAEA, 2005]:

- ECO1: Energy use (total primary energy supply, total final consumption and electricity use)
- ECO13: Renewable energy share in energy and electricity

The set of indicators is made with the following indicators:

1) Increase in % of renewable energy in electricity consumption of CONCERTO area
2) Increase in % of renewable energy in heating / cooling consumption of CONCERTO area
3-a) Reduction in electricity consumption per m² of each building type (efficiency measures)
3-b) Reduction in heating / cooling energy consumption per m² of each building type (efficiency measures)
4) Overall reduction in conventional energy consumption in the CONCERTO area (sum of efficiency gains and renewable supply)
5) m² of new high performing eco-buildings constructed
6) m² of refurbished high performing eco-buildings constructed
7) MW of new renewable electricity generators commissioned
8) MW of new renewable heating / cooling commissioned

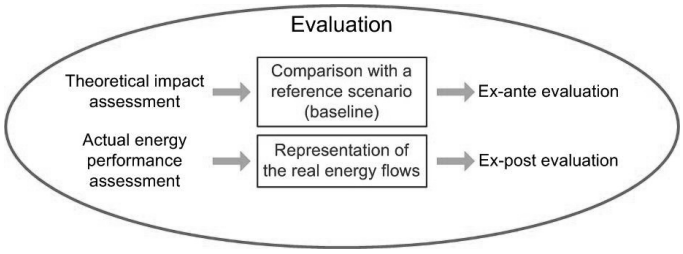

Figure 1: general evaluation methodology

TYPE OF INDICATORS

Indicators 1) and 2) refer to the increase of the share of RES in overall energy consumption and correspond that way to the indicator ECO13 of [IAEA, 2005]. As they refer to energy consumption, they implicitly take into consideration the reduction of energy consumption due to the implementation of EE actions and so allow for representing the integrated approach of the CONCERTO initiative.

Indicators 3-a), 3-b) and 4) refer to the reduction of the overall energy consumption both at the building energy use level and at the primary energy supply level and correspond that way to the indicator ECO1 of [IAEA, 2005].

The indicators 1) and 3-a) refer to data point DP2 of Figure 2, meaning the final energy consumed at the building interface level (energy use). In order to consider the heating or cooling energy generated by RES systems located at the building, indicator 2) refers to data point DP1 defined at the output of the generation systems located in the buildings (see Figure 2). For the same reason, indicator 3-b) also refers to DP1. Indicator 4) refers to DP2 at the building level, but the conversion into primary energy is done.

Indicators 5), 6), 7) and 8) are defined as absolute values to show the real dimensions of the individual projects and allow for comparison between the project size, because the projects' dimensions are quite different from one community to another.

DETAILED DEFINITION

Indicators 1) and 3-a) refer to electricity consumption of the CONCERTO area. Considering the energy balance of the CONCERTO area, it is assumed that all electricity produced from RES is "consumed" in the CONCERTO area. If the demand in the CONCERTO area is larger than the local production, the remaining part will be assumed as having the average mix of electricity of the whole community. Indicator 1) could also be defined in a socio-economic way asking all consumers for the type of electricity bought, but this is not the target of the energy evaluation.

Indicators 2) and 3-b) refer to RES-heating (RES-h) and RES-cooling (RES-c) "consumption" of the CONCERTO area. Energy "consumption" is considered at DP1 and is defined as following (see Figure 2):

- amount of thermal energy sold to consumers in the case of district heating (low and high temperature) and cooling;
- amount of thermal energy produced by the RES-systems in the buildings (before storage and distribution of energy). This means:

- for solar thermal collectors, the amount of thermal energy delivered directly by the collectors to the primary circuit;
- for biomass boilers or micro-RES-CHP, the amount of thermal energy delivered directly by the boilers at the heat exchanger level;
- for heat pumps, the amount of thermal energy delivered in the condenser (heating mode) or abstracted in the evaporator (cooling mode);
- for absorption or adsorption chillers, the amount of thermal energy abstracted in the evaporator. In the case of a back-up system using a non-RES as driving energy, just the RES-fraction (e. g. solar fraction) will be considered.

Considering the energy balance of the CONCERTO area, it is assumed that all heating and cooling energy produced from large RES plants and distributed to customers is "consumed" in the CONCERTO area (district heating and cooling). If the plants are integrated in larger networks which also provide buildings which are not part of the CONCERTO area it is assumed that the CONCERTO area is fully supplied by this plant. If the demand in the CONCERTO area is larger than the local production, the remaining part will be assumed as having the average mix of heating or cooling energy of the whole community (district heating and cooling).

Because in indicators 2) and 3-b) generation losses are not considered, indicator 4) is introduced to take into account the improvement of plant efficiencies and the overall primary energy consumption.

The contribution of CHP towards the reduction of electricity imports is also taken into consideration through indicator 4). In the same way, although if the use of absorption chillers with COP<1 will result in an increase of gas or district heating consumption, the positive effect on the reduction of primary energy consumption will be taken into consideration through indicator 4).

REQUIREMENTS

The set of indicators allows for a good assessment of the impact of the CONCERTO initiative, because they consider in a set of indicators both EE and RES actions and so they are able to evaluate this integrated approach. Some indicators are just related to EE (3-a and 3-b), others to RES (1 and 2), whereas indicator 4 is defined to show the interaction between EE and RES measures. Moreover, both relative and absolute indicators are available and this is beneficial to compare the different communities at different levels.

To have a consistent theoretical impact assessment, the most important requirements are to define the systems' boundaries (CONCERTO area) and the corresponding reference scenarios to which the CONCERTO activities are to be compared to (baselines).

Actual energy performance assessment (ex-post evaluation)

The actual energy performance assessment is based on the representation of the actual energy flows of the CONCERTO communities. It consists mainly of the following steps:

- Design of a community energy flow diagram (Sankey diagram) reporting the actual flows during one metering year;
- Calculation of the actual share of RES in the overall electricity consumption, heating and cooling energy input (DP1 of Figure 2);
- Correction of values of heating and cooling energy input using heating and cooling degree days. This correction is planned in order to compare values of heating and cooling energy inputs during different years. One common definition will be used for communities of the same climate region. Reference heating and cooling degree days are calculated with the software [METEONORM].

Data availability

MONITORING TYPES

Assessing the technical annexes of CONCERTO projects and leading discussions with local team members during visits and workshops resulted in the following conclusion: technical monitoring can be divided into 4 different processes, depending on the type of data monitored and their source:

Metering

Metering is the measurement of physical data during a defined time period at a defined time step. This is the most reliable data source, because metering is an explicit action of CONCERTO projects. Nevertheless, not all components of the whole energy system are metered in detail. The level of aggregation for the data varies from one project to another and from one building to another, depending on the individual project targets.

Some communities implement a large metering strategy to follow the energy consumption of a high number of buildings in the CONCERTO area. In a few cases the communities keep their metering system already used in the past for energy management targets, mainly for public buildings. Similar strategies for private households and tertiary private sector are also to be implemented in different communities, so that energy production and storage can be adapted in function of the demand (real-time energy management system). The large RES-plants will be metered in all cases, mainly in order to control the operation and assess the efficiency of the single plant and to meter the amount of energy produced and sold.

Not all projects plan to meter the energy used for hot water preparation separately. Mainly in cases where the same system (e. g. biomass boiler) provides heating energy both for space heating and hot water preparation, communities will not be able to deliver the value corresponding to hot water without making assumptions based for instance on the domestic hot water consumption.

Overall electricity consumption of buildings or dwellings will be metered in many cases for demonstration buildings.

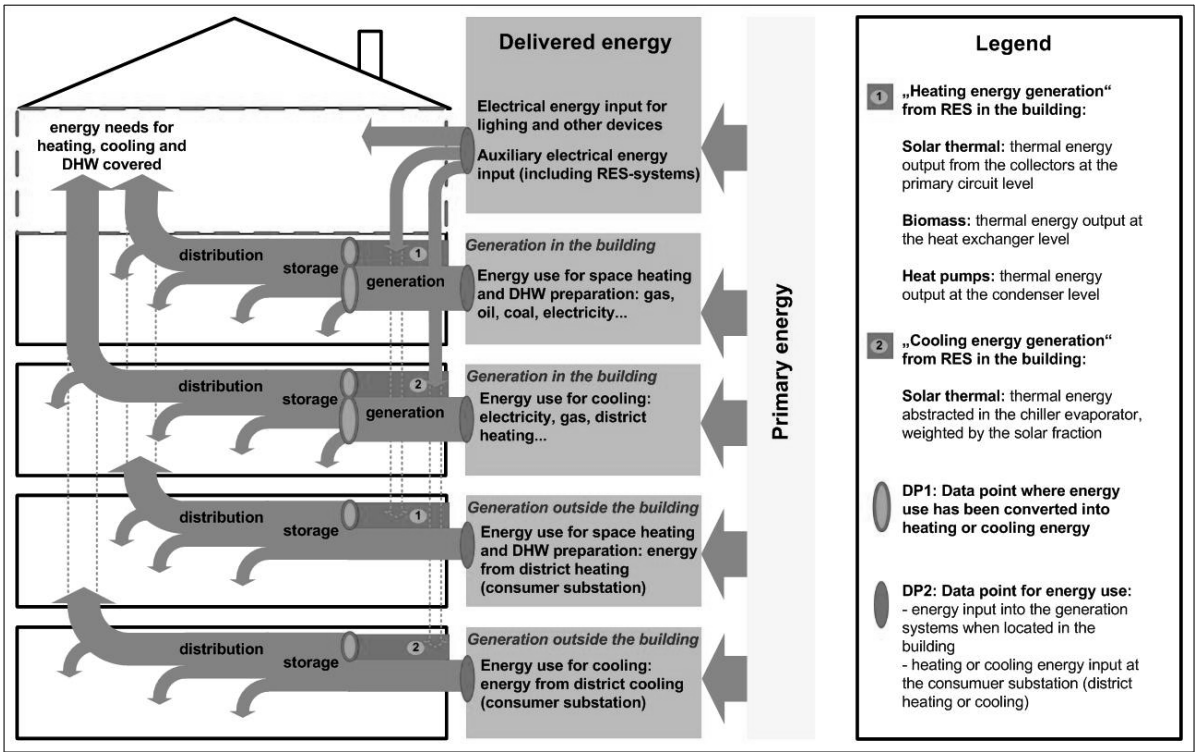

Figure 2: definition of building energy flows and data points

Just in a few cases there will be a separate metering of electricity consumption of devices. This means that it will not be possible to know the actual auxiliary energy consumption for HVAC systems (electricity consumption of pumps and fans) and to accurately assess the energy performance of the building services.

In some cases, the transmission of data will happen automatically on a real-time basis by using different kind of technologies (optical cable network, electrical network…). In other cases, mainly because metering will not serve any real-time energy management system, metering will be combined with data collection: users will be invited to fill in questionnaires with the value read on the meters or an operator will implement this task.

Many projects will also meter internal comfort data (room air temperature and relative humidity) in order to assess the comfort of eco-buildings or to adapt their billing structure in function of the demand. This will be a way to assess and limit the risk of rebound effect which can be observed for instance when higher comfort levels are required by occupants after buildings have been refurbished.

Collection

Collection is the enquiry of data from energy consumers or providers. The origin of data is metering, but metering is not undertaken explicitly in the framework of CONCERTO activities. This is why this source is not as reliable as an explicit metering. It concerns mainly the enquiry of electricity consumption and depends on the willingness of consumers to collaborate.

Calculation

Data can be calculated following a defined methodology (e. g. space heating energy demand). The origin of data is collection, but is not undertaken in the framework of CONCERTO activities. Following the definition of [PASTILLE, 2002], the calculated space heating energy demand for instance is already an indicator related to a single building.

Estimation

Estimation is based on statistical analysis. The origin of data might be metering, collection or calculation. Because of the impossibility to know a parameter's value for one building in particular, the value might be interpolated using a statistical database and a benchmarking process.

Some projects address a lot of different energy consumers and also the CONCERTO funded activities are not all determined yet, because they depend on the local process for the allocation of the funding (organisation of calls). In these cases, the energy savings achieved can only be estimated because there is no budget allocated by the communities to meter the improvements. It is the typical situation of small decentralized RES-systems, mainly solar thermal collectors, whose heating energy production will not be metered in all cases.

DATA POINTS

Independently from the monitoring type considered but in order to be compatible with the set of indicators required by DG-TREN, two data points are defined at the interface between building and energy supply system. This definition is required in order to take into consideration both the energy generation systems located in the community and providing the buildings across a network and the small scale energy systems based on RES located at the buildings and providing only the considered buildings with heating and cooling energy.

As illustrated in Figure 2, data point 1 (DP1) corresponds to the point where energy has been converted into heating or cooling energy. This is the only point where the contribution of generating systems producing energy from RES and located at

Table 1: Definition of categories and most represented monitoring type across communities

Building category	Building type		Category of actions implemented		Support from CONCERTO	Most represented monitoring type
	New	Refurbished	EE	RES		
1) Demonstration buildings RES	X	X		X	X	Collection or estimation
2) Demonstration buildings RES+EE	X	X	X	X	X	Metering
3) Demonstration buildings EE	X	X	X		X	Collection or estimation
4) Other: large refurbishment		X	X			Estimation
5) Other: new buildings	X		X			Estimation
6) Other: existing and new buildings concerned by RES	X	X		X		Estimation
7) Other: existing and new buildings concerned by awareness	X	X	X	X		Estimation
8) Other categories	X	X				Estimation

the building can be added with the thermal energy delivered by a conventional system (boiler located in the building or district heating). DP1 is the point where the share of RES in heating or cooling energy consumption can be calculated.

Data point 2 (DP2) is defined at the point where energy is delivered into the building. This interface corresponds to the energy use and energy input as defined in [prEN 15603, 2006]. This way, the overall energy input can be referred to and presented in a separate way according to every energy source.

DP1 and DP2 can be expressed using the following definitions:

- DP1 = total thermal energy consumption = DP2 + thermal energy output from generation systems located at the building
- DP2 = thermal energy input from generation systems located outside the building

CALCULATION OF THE BUILDING ENERGY PERFORMANCE FOR THE THEORETICAL IMPACT ASSESSMENT

The theoretical impact assessment is made on the basis of the calculation of the building energy performance and the corresponding values of energy consumption.

In every community the energy performance of the buildings is calculated according to the national or regional calculation method. The energy performance of the reference buildings according to current national building codes is also calculated in order to highlight the increased performance of the buildings supported in the framework of the CONCERTO initiative. The problem is that in many countries only the heating energy needs are limited, and the calculation method for energy use (DP2) according to [prEN 13790, 2006] have not yet been implemented everywhere. For the 27 CONCERTO communities of the first phase, available data on building energy performance is quite often limited to energy needs and energy use is not given yet. That is why regional specific solutions will be elaborated for the areas where the CEN norms are not implemented [CEN, 2005].

In Germany for instance, the different losses and the auxiliary energy comprising of generation, transport, control, distribution, storage and emissions can now be calculated using the tool [DIN V 18599, 2006] developed to implement the corresponding German norm. In Spain, the software tool which allows for the calculation of energy use according to the new building code [CTE, 2006] is still under development. To respond to the needs of the theoretical impact assessment, the actual solution consists of calculating the system heat losses via the overall system efficiency.

MONITORING STRATEGY FOR THE ACTUAL ENERGY PERFORMANCE ASSESSMENT

The assessment of the actual energy performance of the communities can only be done by collecting or metering data.

The communities implement different monitoring types depending on the projects' targets and the accessibility to the required data. Mostly a mixed approach is followed: buildings and systems are divided into categories in function of the type of action within CONCERTO, which determines very often the corresponding monitoring type. An overview of the most represented monitoring types across the communities is given in Table 1.

As shown in Table 1, metering is implemented mainly for demonstration buildings of category 2), where both actions concerning EE and use of RES are to be implemented (eco-buildings). An ex-post evaluation will only be possible for buildings of categories 1-3, since data from metering or collection will be available. For all other categories where estimation is the only source of data, only an ex-ante evaluation will be possible. This means that the actual performance assessment will be limited to the energy flows involving the building categories 1-3.

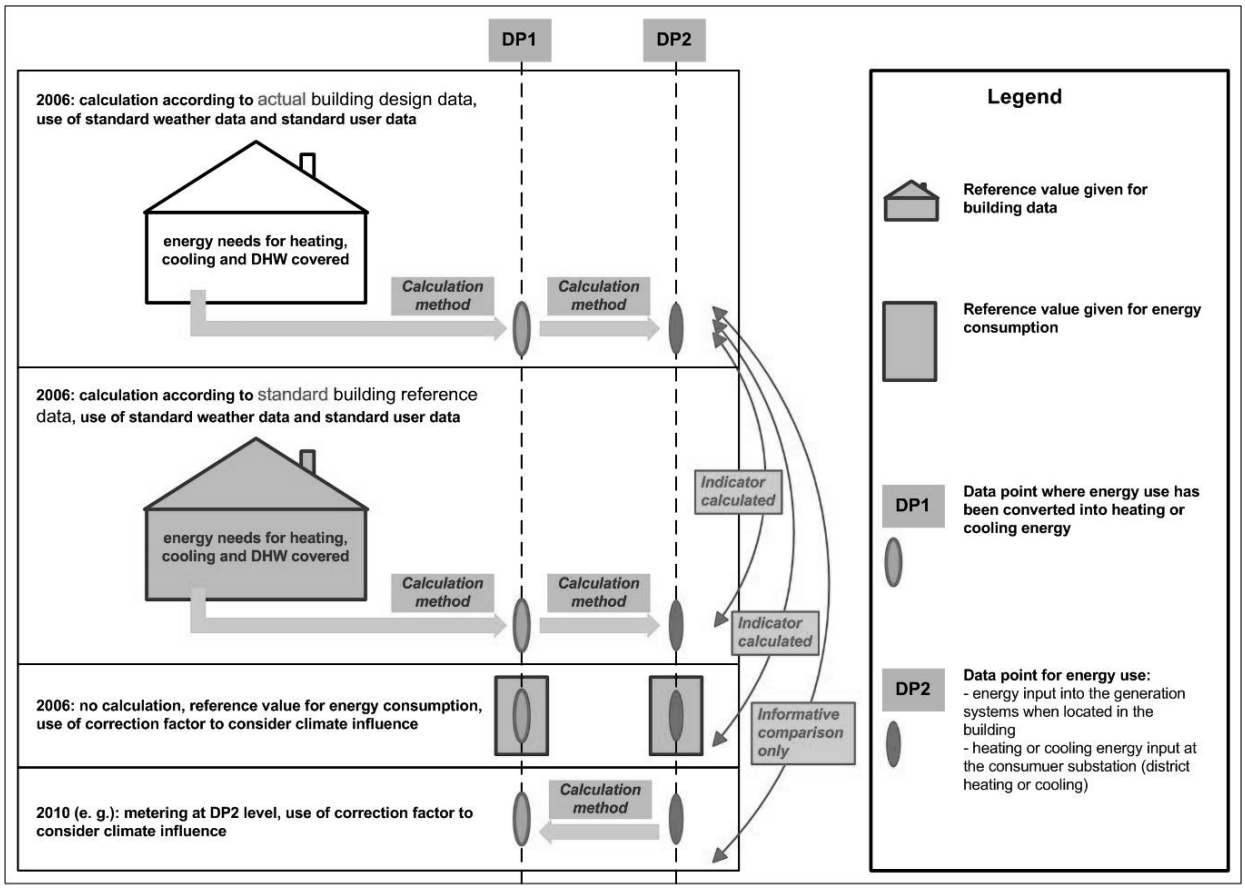

Figure 3: definition of reference values and calculation methods

Methodology

DEFINITION OF SYSTEM BOUNDARIES

The system boundaries are the materialisation of the so called "CONCERTO area". Depending on the community considered, the CONCERTO area might be:

- the whole community (city or metropolitan area)
- a restricted area including all the CONCERTO demonstration projects and buildings concerned by awareness campaigns
- an area made up only of CONCERTO demonstration projects

The CONCERTO area defined considers all the buildings supported in the framework of the CONCERTO initiative, meaning the demonstration buildings, and eventually the other buildings concerned indirectly by CONCERTO measures (building categories 4-8 of Table 1). In any case, at least the area made up of demonstration projects will be considered. In a second step and depending on the limitations of the projects, the area might be enlarged to consider also awareness measures implemented in the surrounding area. In a third step and mainly for the small communities where the impact of the CONCERTO initiative is relevant at city level, the energy balance of the whole city might be considered. As a result, in some case there might be different levels of energy evaluation, depending on the system boundaries chosen.

DEFINITION OF BASELINE

Accurate baselines are necessary to calculate the required indicators which are the result of a comparison with a reference scenario (not absolute but relative values). There are two options to define baselines.

As presented in [SRCI, 2001], the first option could also be adapted to ex-post evaluation and consists of identifying a control area similar to the CONCERTO area at its initial status in terms of building fabric characteristics, dimensions and main activity exercised. This could, for instance, be a new building area to be developed in a conventional way, without particular high energy efficiency standards or integrated energy supply concept. The same monitoring concept could be applied to this control area and the monitoring results would define the baseline for the CONCERTO area. There are two major barriers to apply this option in the CONCERTO initiative:

- The barrier lies in the difficulty to identify a separate control area which is similar to the CONCERTO area. This could only be done if, for instance, only one part of an existing residential district would be refurbished in the framework of the CONCERTO initiative.
- The second barrier is related to the small budget available for monitoring activities, which does not allow the communities to implement additional monitoring facilities on buildings which are not part of the demonstration activities.

The second option consists of defining reference values for "conventional buildings" in order to compare the energy per-

formance of demonstration buildings with this value. This approach can be implemented without major costs within the CONCERTO initiative. In the case of retrofitting, the reference values will be associated to the buildings themselves before retrofitting and not to a "conventional retrofitting". Baselines will be unified amongst communities from the same country, so that comparability might be obtained at least for co-national communities.

The baseline is defined at the energy consumption level (energy use) considering both DP1 and DP2, as illustrated in Figure 3. The two following approaches are considered and are proposed to the CONCERTO communities:

- use of reference values for the building fabric and calculation of energy needs and energy use for this reference building, considering reference HVAC systems. This approach is very time consuming, because it requires re-calculating the energy needs of the building with reference values.
- use of reference values of energy consumption given for the different building types. This approach is much more feasible, because it doesn't require the recalculation of the building's energy performance. The condition is to have a national database with reference values of energy use for the different building types.

COMPARISON WITH BASELINE: THEORETICAL IMPACT ASSESSMENT (EX-ANTE EVALUATION)

Reference and estimated values should not be compared directly with metered values, since metering also takes other factors into consideration (weather conditions and user behaviour). However the actual data needs to be combined with the defined baseline to calculate the indicators required. This is why the indicators can only be calculated in the ex-ante evaluation, where the theoretical impact of the CONCERTO initiative will be evaluated.

USE OF METERING DATA: ACTUAL ENERGY PERFORMANCE ASSESSMENT (EX-POST EVALUATION)

The ex-post evaluation will not be based on the comparison with a baseline to calculate the indicators 1)-4), because no control area has been defined. Figure 3 illustrates both approaches underlining the fact that in the framework of the calculation of indicators, metering can be used at an informative level only. The baselines are defined using calculation methods depending on many assumptions related to the user's behaviour for instance. Therefore the reference values they provide can not be combined with the metered values in a mathematical formula to obtain the value of an improvement rate for instance. Nevertheless metering data will provide an important overview of the actual energy performance of the communities, which will be the most important output of the evaluation work. The methodology to assess the actual energy performance on the basis of metering consists of the following steps:

- For the CONCERTO projects of the first and second generation, the budget for metering activities has been fixed before the evaluation methodology has been defined by CONCERTO PLUS. Therefore the only option was to define the qualitative requirements for metering activities. This has been done with an "agreement on collaboration between CONCERTO communities and CONCERTO PLUS regarding monitoring and impact assessment" presenting the main information also explained in this paper. The data available will be presented in the form of a yearly energy balance for every CONCERTO community. This actual energy balance will not be compared to the theoretical energy balance to calculate for instance the increase of energy efficiency, but the actual share of RES in the overall communities' energy consumption could be compared to the initial expectations. All communities will be encouraged to continue the monitoring after the finalisation of the projects. Additional funds and cooperation with other projects will be sought to continue the evaluation of this unique and invaluable data. The development of the "Technical Monitoring Database" will further assist in the collection and evaluation of this data.
- For the CONCERTO projects of the next generations, the following recommendations are made to ensure a unified approach to benchmarking:
    - The evaluation objectives and methodology should be clearly detailed in advance for each community interested to join the CONCERTO initiative. The results from the projects of the first and second generation may be used to illustrate the evaluation objectives.
    - The funding of future CONCERTO projects should be linked with the monitoring requirements listed in Table 2.

Table 3 provides a current overview on relevant monitoring features of the CONCERTO communities. Across the 27 communities, at least 5 communities plan to implement a communal energy management system. For these communities, energy consumption will be metered to fulfil energy management targets, and the data will be presented in the form of overall energy balances. These communities will act as pilots for representing the actual impact of the CONCERTO initiative. In particular this will give important information about how far the actual implementation deviates from the initial targets and the theoretical impact. On the basis of the data available, the energy balance as well as the energy flows will be represented for each community and year.

In particular the following questions will be answered:

- How far does the energy balance deviate from the expected energy balance (comparison between ex-ante and ex-post evaluation)?
- What is the variability of the absolute values of the energy flows? It is expected that the climate influence might be roughly quantified by comparing the data before it has been corrected using heating and cooling degree days. After the use of the correction factors, the range of data will be caused by the variability of users' behaviour and change of operation or control strategies. Unexpected failure in the systems' operation may still be responsible for anomalies in the energy flow diagrams.
- Is it possible to quantify the influence of non technical measures (awareness) on the energy flow diagram? This can

Table 2: Suggestion for monitoring requirements

Type of requirement	Justification of requirement	Requirement (general)
1) Qualitative requirement	To define a harmonise metering strategy among the CONCERTO initiative	Metering is done to provide energy use data at levels DP1 and DP2 (see also page 7) Electrical energy input is divided between energy use for heating (incl. auxiliary), cooling (incl. auxiliary) and all other applications.
2) Quantitative requirement	To ensure that metering covers the totality of CONCERTO activities	An energy management system based on measurement of energy consumption data according to 1) is implemented.
3) Baseline definition	To define the scenario to which the CONCERTO initiative will be compared to	A control area (requirements for the definition of this area are still to be defined) is proposed by the CONCERTO communities and monitored.

Table 3: current monitoring features of CONCERTO communities (status March 2007)

Community	Energy management assisted by measurement of energy consumption data and real-time data transmission (supply / demand control system)	Collection of energy consumption data using forms distributed among consumers	Price signals depending on energy consumption or indoor temperature	Presentation of metering results using a Geographical Information System
act2 / Hannover				
act2 / Nantes				■
cRRescendo / Ajaccio				
cRRescendo / Almere		■		
cRRescendo / Milton Keynes		■		
cRRescendo / Viladecans		■		
ECO-City / Helsingborg				
ECO-City / Helsingør				
ECO-City / Trondheim	■			
ECO-City / Tudela	■	■		
ECOSTILER / Amsterdam				
ECOSTILER / London				
ECOSTILER / Måbjerg				
energy in minds! / Falkenberg			■	
energy in minds! / Neckarsulm		■		
energy in minds! / Weiz Gleisdorf		■		
energy in minds! / Zlin		■		
POLYCITY / Cerdanyola del Vallès	■			
POLYCITY / Ostfildern	■			■
POLYCITY / Torino	■			
RENAISSANCE / Lyon				
RENAISSANCE / Zaragoza				
sesac / Grenoble				
sesac / Delft				
sesac / Växjö				
TetraEner / Geneva		■		
TetraEner / San Sebastian	■			

only be done if the operation and control strategy does not vary from one year to the other and if all other parameters are under control.

- Does the monitoring strategy need to be adapted and eventually amended if some important data or parameter has not been metered?

TECHNICAL MONITORING DATABASE

A Technical Monitoring Database is currently under development to facilitate data collection, analysis and reporting. At present the structure and definitions for data collection are available only in the form of Excel files. These templates will be transformed into an internet based Technical Monitoring Database with a section for each CONCERTO project. The database will be accessible via the internet and will allow for the input and analysis of base data (weather data, baselines etc.), generation data (electricity, heating and cooling) and consumption data (demonstration EE, demonstration RES etc.). The defined methodology will then be implemented to provide the calculation of performance indicators for each CONCERTO project and for all CONCERTO projects together, resulting in the performance indicators of the whole CONCERTO initiative. Both the design values necessary for the ex-ante evaluation and the metering values to be used for the ex-post evaluation and the determination of the actual yearly energy balance will be included in this monitoring database. With this Technical Monitoring Database the projects are provided with a tool to calculate their own project specific performance indicators. The results will be made available online for the communities, the European Commission and CONCERTO PLUS for further analysis.

Conclusion

The methodology has been developed based on the requirements of the project and data availability in the field of baselines and energy performance data. The main aim to develop a transparent and efficient energy evaluation has been achieved by creating a methodology which can be used with a limited amount of data and throughout a variety of projects. It is recognised that the proposed ex-ante evaluation methodology has its limitations and that actual available metering data must be assessed individually for the different projects. Therefore actual energy performance assessment will be done in parallel on the basis of metering data, which unfortunately will only be available at the end of projects' implementation period and for a maximum of 2 years. However, this will allow for a basic assessment and comparison of the communities' actual energy performance data across Europe. In particular the deviation from the expected and the actual energy performance will be presented.

The main consequences of this methodology are as follows:

- The quality of the methodology will be the success of CONCERTO, because its target is to elaborate consistent data which can correctly present the impact of the initiative, also if this will be done at a theoretical level at first. Data available now is characterized by a lack of consistency between projects from the same regions, and cannot be elaborated in the form of indicators.
- The methodology will allow for comparability, which is a crucial point in the CONCERTO initiative. The target is not to single out the most ambitious projects, but to evaluate what is the real potential of these combined actions, and to determine the best strategies for the different European regions.
- The high amount of data collected will allow for establishing a European database where baselines and standards will be presented for the different regions and building categories. This will constitute a very useful guideline for energy policy recommendations, which also form one part of the project CONCERTO PLUS.
- In many projects, energy performance data will be monitored and assessed over a long period of time also after the finalisation of the projects (after 2010). This benchmarking will be a very useful source of information for other communities following the example of CONCERTO.

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