The CONCERTO monitoring database as a tool for benchmarking among sustainable communities and their energy performance assessment

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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. Currently 45 European communities are involved in the programme and the 26 communities which were the first ones to start implementing these actions in 2005 are being analysed in detail. To support the impact assessment of the CONCERTO initiative and the implemented local energy strategies, a monitoring database has been developed and is being used by all involved communities.

The CONCERTO monitoring database has been designed to be as flexible as possible and suitable for different types of communities: it is used for new urban development areas, urban regeneration projects and rural areas. To allow for an assessment of the overall community energy performance, the database consists of two main parts: the "consumption" part gathers all data related to energy use (mainly buildings) and the "generation" part focuses on the description of the energy supply infrastructure (district energy systems and distributed energy plants).

Both expected and metered energy performance data is stored into the database, allowing for a comparison between expected and actual community energy performance (ex-ante and ex-post evaluation). At the time being only the ex-ante evaluation is possible, since the demonstration projects are currently being implemented and the first monitoring data available still need to be analysed and verified before being officially published. However, the paper presents the first findings on energy efficiency aspects in buildings. The focus is put on the evaluation of the energy savings in the building renovation activities and the energy performance of new eco-buildings. A first benchmarking among the different climate zones and building types is presented.

Introduction

THE CONCERTO INITIATIVE AND THE UMBRELLA PROJECT CONCERTO PLUS

The CONCERTO initiative has been launched by the European Commission as part of FP6 and FP7 in order to enhance the role of cities and local authorities as driving forces towards a sustainable community development. This constitutes a paradigm shift with the traditional funding schemes for activities usually focussing on single actions, thus supporting only specific technologies and their related industries and markets. By directly supporting local authorities and integrating energy related actions in a holistic approach of sustainable development, the initiative promotes innovative planning and implementation mechanisms which are the main success factors of such demonstration projects.

Five million people live in the 45 CONCERTO cities located in 18 member states and ca. 500.000 people are directly or indirectly affected by CONCERTO activities in the local communities consisting of chosen neighbourhoods. The eligible costs for projects in these communities amount to ca. 222.000.000 €. ca. 1.500.000 m² of buildings are currently being built as new eco-buildings or renovated to achieve ambitious energy performance standards. On average, the energy use of these buildings in the initiative is covered at 100% by renewable energy sources (RES). Some communities are implementing large scale energy systems based on RES and providing more energy than required by the CONCERTO demonstration buildings in the concerned community. They compensate other projects which do not have a high share of RES in their energy mix. Out of the 45 communities, the 26 communities which were the first ones to start implementing these actions in 2005 are being analysed in detail in the umbrella project CONCERTO PLUS. The single contracts between each of these 26 communities and the European Commission will last until 2010.

The demonstration actions are implemented as milestones in the development of sustainable communities in new urban development areas, existing urban neighbourhoods and rural areas. They are carried out 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) and renewable energy systems. Large or small scale energy systems based on RES are being built to provide single buildings or whole districts with electricity, heating and cooling. Most of these activities are accompanied by research projects.

Awareness campaigns and trainings are implemented in parallel to encourage the communities to take advantage of the high concentration of demonstration activities by locally increasing the consciousness of citizens on energy relevant issues and their involvement in this development. These activities are included in the more general process of increasing the life quality in the concerned neighbourhoods by maintaining a certain social mix and varying the services offered locally, thus contributing to cover also the social aspects of sustainability. All these activities are combined within an integrated approach, the preferred focus on one or the other aspect depending on the project type and the local conditions. Existing neighbourhoods might be characterised by socio-economical problems (fuel poverty, lack of services, low social mix leading to ghettoization) and synergies are being found between energy related actions and urban regeneration from a social point of view. Similarly, while developing new urban areas, the target is not to create "gated sustainable communities" but to reach a high mix of end uses. Therefore a high number of stakeholders are involved in these projects which all are coordinated by local authorities (municipal, metropolitan or regional divisions for urban planning, urban regeneration, climate protection, energy issues); the technical demonstration activities are one part of the CONCERTO initiative which also covers socio-economic issues, so that a holistic approach towards sustainable development can be initiated.

The details on the monitoring strategies and the assessment methodology designed in the framework of the CONCERTO PLUS project are presented in [Pol & Österreicher, 2007]. 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, facilitating the transfer of best practices to other communities across the European Union and providing policy recommendations [CONCERTO website]: in the framework of these activities, a position paper on the recasting of the EPBD[1] has been already compiled on the basis of the initial experience of the CONCERTO communities. In the last years, many conferences have been organised in the framework of the CONCERTO projects on the main topics covered by the initiative, such as municipal energy management, urban regeneration, polygeneration or success conditions of sustainable energy projects in urban areas.

NECESSITY OF A DATABASE

As announced in [Pol & Österreicher, 2007], an internet based Technical Monitoring Database[2] has been developed to facilitate data collection, analysis and reporting. The main reasons for introducing this tool instead of following a traditional reporting format were the followings:

- All users having access to the database are provided with the same status of information. This issue is important because all energy relevant figures from the CONCERTO communities might be frequently updated.
- Because of the high capacity of the database, original and non-treated data can be stored on it. In particular, absolute figures of energy use are given in order to avoid misunderstandings due to the floor area definition in specific energy performance ratings. In a similar way, degree day corrections or primary energy use calculations are made in a second step on the basis of the non treated data. On one hand this guarantees a high data quality since all users involved in one project can access and review the original data. On the other hand this gives many possibilities for benchmarking and assessment because of the high quantity of data available.
- The three procedures of data collecting, analysing and reporting are integrated in one tool, which highly simplifies the assessment work.
- As soon as the database is set up for each community (i.e. the general and design data for all buildings and plants is stored), the monitoring data transfer can be done easily. The database will be used also after the completion of the CONCERTO projects thus providing a platform for long term monitoring and maximising the impact of the assessment work done in the framework of CONCERTO PLUS.

In order to be suitable for the assessment work done on the CONCERTO initiative, the database provides the opportunity of combining information from different fields of activity, including both the demand side and the energy supply side in one data structure. This consists of linking building related data to the associated data describing the energy systems the buildings are connected to. In particular, energy performance assessment can be done for each community on the basis of the final or the primary energy use.

The aim was to develop an easy-to-use tool in close collaboration with the technical monitoring experts from the different communities who are the main users of the database. On the

1. Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings

2. Referred to as "database" in the rest of this paper

Table 1. Overview on database structure

Base data	Consumption data	Generation data
- General information (total population of community, project type: new urban development project, urban regeneration project or rural project…) - Specific energy targets (expected balance for electricity, heating and cooling) - Weather data for climate correction - Conventions (definition of floor area for the calculation of energy performance ratings) - Metering periods (starting and ending dates) - Primary energy factors for energy flows coming into the system boundaries	- Design parameters (general information, design data about building fabric, energy performance certificate, description of monitoring strategy) - Calculated and actual energy performance data - Costs of the implemented activities (total investment costs, elegible costs and investment grants from CONCERTO)	- Location and assignment to a single building or a district energy system - Design data - Calculated and actual energy performance data - Costs of the implemented activities (total investment costs, eligible costs and investment grants from CONCERTO)

one hand, the data input for communities is facilitated and the user is provided with immediate calculation of impact assessment indicators related to every community (see [Pol & Österreicher, 2007]). On the other hand, CONCERTO PLUS has access to the whole data set which is the basis for benchmarking throughout all CONCERTO communities (i.e. comparison of data from the same countries, within one project or of communities featuring similar systems) to serve as basis the policy recommendations.

The database contains design and monitored data for each individual building or plant, thereby allowing an ex-ante and an ex-post evaluation. In this paper, the database structure and its functionalities are introduced in order to demonstrate that it is suitable for community energy performance assessment. In a second part, the results of first benchmarking analyses are presented.

Database structure and functionalities

STRUCTURE

The database follows a simple structure which includes, beside general information about the community (part "Base data"), all steps of the energy transformation chain supplying the buildings of a specific community, thus allowing for a complete description of every community energy system. One part ("Consumption") is dedicated to the buildings as end users and includes data related to the different energy applications inside the building. If the delivered energy is heating or cooling energy (in case of buildings connected to district heating or cooling networks), the calculation of the corresponding primary energy factor in the sense of the European standard [EN 15603] is made following the weighting system proposed in the European standard [EN 15316-4-5:2007]. All energy systems are defined in the "Generation" part of the database, specifying whether the system is directly located at a building or connected to a district energy network. This functionality allows for a parallel assessment of building energy performance and community energy performance.

To consider the parts located outside the community energy system boundaries and the energy import contribution, the primary energy factors are defined for the different energy carriers as an interface to the energy system the community is connected to (for electricity, gas, biomass, district heating).

As a result, the database covers all components of a community energy system, including all generation technologies and making it possible to assess the community energy performance on the basis of its primary energy use. In particular, it is possible to compare the effects of onsite renewable energy systems located at the buildings and district energy systems as the distribution losses are included in the calculation.

An overview of the data stored in each part of the database for every community is given in Table 1.

The generation of results (i.e. calculation of indicators) is possible through the database output functionalities. Some figures are calculated directly within the database whereas the more detailed analyses are made after having exported entire datasets from the database.

DATA RELATED TO ENERGY EFFICIENCY AND RATIONAL USE OF ENERGY

To analyse the impact of different measures aiming at reducing energy use, the dataset describing the building energy characteristics ("Consumption data" part) includes a list of the measures implemented in the building. This list has been established on the basis of the most common measures used in the CONCERTO demonstration buildings.

Reduction of heating needs

For buildings undergoing thermal renovation, the measures are those which are commonly used in the course of renovation activities[3]. Initially most of the communities working on thermal building renovation planned to implement comprehensive operations including all these measures. Actually, in many cases communities had to reduce their ambitions and the experience shows that the complete renovation package is rarely available. The main reasons for that are the low funding rates, the high

3. Thermal insulation of outside walls, thermal insulation of roof or upper slab, thermal insulation of basement, replacement of windows, special treatment of thermal bridges, improvement of air tightness, ventilation system with heat recovery, reduction of distribution losses

renovation costs which are not always compatible with a limitation of the rent increase allowing residents to keep in living in their flats after renovation (social stability) and the highest priority of specific measures (replacement of windows, roof renovation, etc.) due to non-energetic aspects (security, comfort, appearance, etc.). There are currently only few examples of comprehensive renovation operations which include all of the single measures. This list will help to identify the measures with the highest impact in practice and those which still need technical and financial support to become more efficient to be more widely applied.

For new buildings, it is supposed that all of these measures are implemented, since they are the basic construction principles of low-energy buildings and they are already implemented at a less ambitious level in the common building practice; therefore the database includes the key figures which quantify the efforts made to reduce energy needs (e.g. U-values, results of blower door tests).

Reduction of electricity needs

The measures targeting a reduction of electricity needs are:

- substitution of direct electrical heating
- use of energy efficient appliances

The use of energy efficient appliances is not always under the direct sphere of influence of the CONCERTO initiative, unless all relevant stakeholders are involved or addressed in the framework of the CONCERTO activities. When the property developers and the building users are the same institution (e.g. for municipal or company office buildings), these requirements can usually be observed and this is confirmed by all CONCERTO communities. However, in the current real estate practice and because of the investor/user paradigm[4], the use of energy efficient appliances can only be supported when all actors in a building's lifetime are involved: specific campaigns can provide an incentive for end-users, caretakers and facility managers. Many CONCERTO communities work on this issue.

Reduction of cooling needs

The analysis of measures aiming at reducing cooling needs is limited to the gathering of g-values[5] for glazing and the calculation of shading factors[6]. The number of buildings where passive cooling strategies are explicitly applied is not significant to allow for consistent statistic analysis or benchmarking. In this regard, two main strategies are followed in the CONCERTO initiative:

- In some communities, there are specific design requirements to realise residential buildings without active cooling systems (mainly in the Southern European countries). However, it is difficult to prevent the tenants or flat owners from using individual room air conditioners if they are not satisfied by the natural indoor climate conditions. An ex-post assessment to this issue would be necessary; however, the socio-economic analysis does not cover this aspect in all CONCERTO projects.
- At the moment only one community in the Netherlands decided to solve the problem by offering radiant floor cooling possibilities in residential buildings. "Cooling system available" is above all a sales argument, but the idea is also to control the cooling energy use by allowing cooling in the residential sector more efficiently. A comprehensive ex-post analysis is necessary to evaluate the consequences of this strategy.

Reduction of energy use in operation phase

For all demonstration buildings[7] and both for the heating and electricity part, a set of other measures is related to the operation of the buildings and to the rational use of energy:

- use of a building automation system aiming at reducing heating energy and electricity use
- use of user feedback systems (in Växjö and in Falkenberg (S) displays are already installed in the flats in order to inform the tenants on their daily energy use and compare it with the average value of the last days and the tenants from the same building)
- use of soft awareness measures (in Grenoble (F) where the first stage of a new urban development operation has been recently completed, special information days and workshops are organised with the future tenants and owners to inform them on the particularities of their new neighbourhood and educate them on domestic energy issues)

ACCESSIBILITY

At the moment the database is available in "read only" access for everyone involved in the CONCERTO initiative. Only the monitoring experts from each community have write access rights. In future and as soon as consistent results are available, it is planned to extend the public visibility of the database.

DATA EXPORT PROCEDURE

A set of predefined reports can be generated for each community or many communities complying with specific criteria. These reports contain the main indicators defined in [Pol & Österreicher, 2007], as the share of RES in electrical or heating energy use, the area of new eco-buildings and buildings undergoing renovation activities, the installed capacity of energy systems using RES, the reduction of primary energy use (compared to the defined baselines), etc. To allow for the benchmarking analysis presented in the following part of this paper, a data export procedure has been defined to gather complete datasets and implement the cross analyses required.

4. The investor is not the direct beneficiary of the implemented measures, unless he can take another advantage from this particular investment (sales argument being a guarantee for a better position in the real estate market, higher price...)

5. Solar heat gain coefficient

6. The shading factor is defined as the ratio between the total solar heat gain coefficient of the system "window + shading device" and the solar heat gain coefficient of a reference double pane window (g = 0,8).

7. At least all demonstration buildings have to be included into the database. If data are available, other buildings which are indirectly affected by CONCERTO can be included as well (e.g. when they benefit from a large scale biomass CHP supported by CONCERTO through a connection to the district heating network).

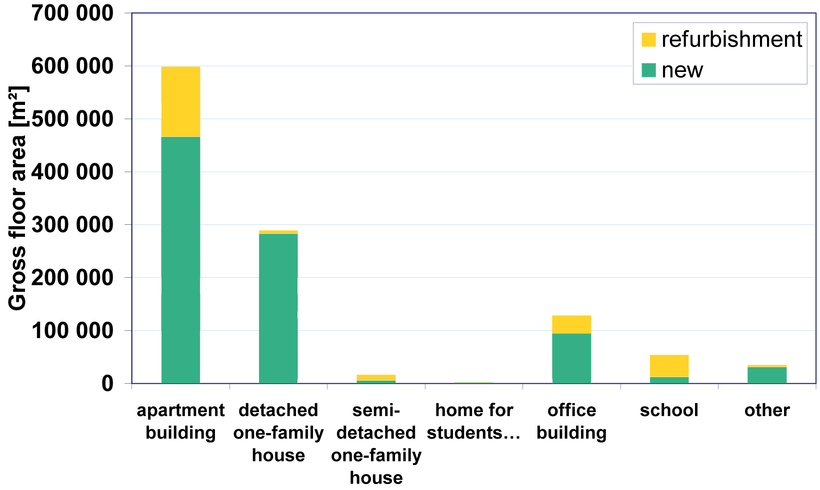

Figure 1A. eco-buildings planned (and partially built) in the 26 CONCERTO communities (building type distribution)

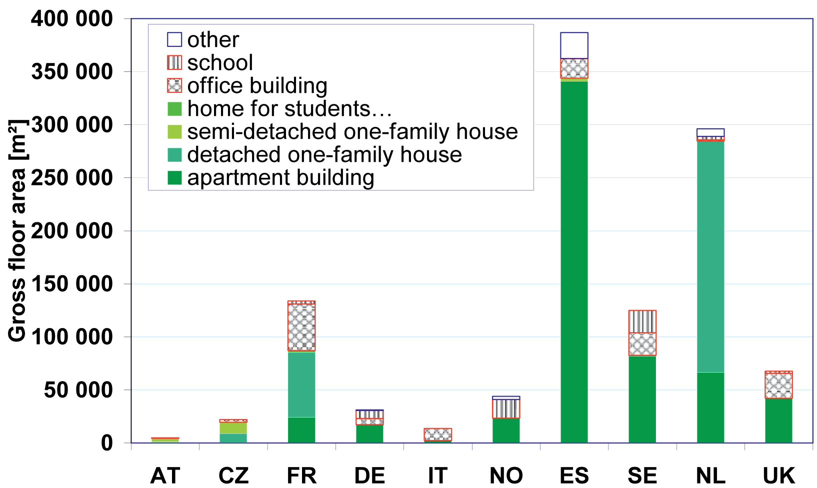

Figure 1B. eco-buildings planned (and partially built) in the 26 CONCERTO communities (country distribution)

First benchmarking results

STATISTICS ON BUILDINGS INCLUDED IN THE CONCERTO INITIATIVE

The table in the annex shows the list of the 26 CONCERTO communities assessed and the building types which are included as demonstration activities in every project. The distribution of the gross floor area in terms of building type and country is shown on Figures 1A and 1B. Apart from residential buildings which are available in nearly all projects (25 communities of 26, with ca. 900.000 m^2_{GFA} [8]), office buildings are included in 14 communities of 26, with ca. 120.000 m^2_{GFA}. Furthermore, schools are well represented (10 communities of 26, with ca. 50.000 m^2_{GFA}), whereas all other tertiary buildings only account for a smaller fraction of all buildings, which does not allow for significant benchmarking. In terms of constructed floor area, it is planned to build ca. 890.000 m^2_{GFA} of new eco-buildings and to renovate ca. 230.000 m^2_{GFA} of existing buildings. This definitely confirms the main focus on new buildings in the first 26 CONCERTO communities. Spain, the Netherlands, France and Sweden are the countries where the CONCERTO construction activities in terms of gross floor area are planned. However, at the time being, the Spanish projects are facing many delays due to the financial problems in the real estate sector.

Although there are more examples of new buildings than of renovation projects, the renovation activities are linked to different types of urban regeneration projects or to rural and suburban areas. In particular, in Amsterdam (NL), Ajaccio (FR), Delft (NL), Grenoble (FR), Hannover (DE), London (UK), Nantes (FR), Turin (IT), Viladecans (ES) and Zaragoza (ES) the building renovation activities are integrated in overall urban regeneration projects focussing more generally on the increasing quality of life in the concerned neighbourhoods. A first overview of these projects is given in [Di Nucci & Pol, 2008]. The renovation of one-family houses is included in Falkenberg (S), Neckarsulm (D), Weiz-Gleisdorf (A) and Zlin (CZ) which demonstrate various activities in rural and suburban communities.

8. GFA: gross floor area

FIRST EXAMPLES OF BENCHMARKING RESULTS

Supported by the technical monitoring database, the CONCERTO initiative provides the unique opportunity for benchmarking, both at single action level and at community level. Single actions are categorised in activities focussing on energy efficiency and on the use of RES, but CONCERTO aims at being much more than an addition to single demonstration activities: in many cases both activities are combined in one approach, like the integration of photovoltaic panels in renovated buildings, the connection of renovated buildings to district heating based on biomass or the design and implementation of a comprehensive district energy system (combined district heating and cooling based on RES) in a new urban development area. The target will be to obtain statistical evaluation which takes advantage of the high number of buildings of the same type, similar technologies and project types (new urban development areas, urban regeneration projects, distributed projects in rural areas).

Because of the long data gathering, transmission and validation procedure, this paper focuses on the energy efficiency aspects in buildings, considering CONCERTO as it would be only a pool of demonstration new eco-buildings and renovated existing buildings. The first buildings were completed in 2007, so the first annual energy use monitoring data were communicated at the end of 2008 and only limited results on some of these buildings can be included in this paper. The analysis is structured according to the climate zone definition which has already been used in reports done on the building and energy sector in Europe ([Nemry et al., 2008] and [Boermans et. al., 2007]), namely using the heating degree days (HDD) to characterise the climate zones. The findings presented here can be so far compared to the information given in these reports.

Benchmarking for thermal insulation standards

The U-values of the building envelope components can be taken as key characteristic figures illustrating the insulation standards of the CONCERTO buildings. In Figures 2, 3 and 4 the statistic distributions of the U-values for outside walls in the different climate zones are represented. The diagrams show the percentage (calculated on the basis of the total floor area of new eco-buildings and existing buildings taken separately) of constructed floor area for buildings having U-values between intervals of 0,05 W/m².K. These figures were planned by the communities (design data) and actually implemented in nearly all buildings already completed. There are very slight differences between the figures planned (target values) and those actually implemented. In some cases, the insulation standards have even been improved, following the tendency of the national buildings codes which have been revised in some countries during the last five years. Similar analyses can be done also for roofs, ground floors or window panes.

Both the effort of the CONCERTO communities done to go beyond the local building code requirements and the differentiation following the climate zones can be quantified with the help of Figures 2, 3 and 4. In particular, the Northern European communities are slightly more ambitious than the Central European communities in terms of requirements for new buildings. On the other side, the existing CONCERTO buildings to be renovated used to have much lower thermal insulation standards in the Central European communities than in the Northern European communities. However, they plan to reach similar thermal insulation levels. The effort done by the Central European communities therefore seems to be higher in this field. There is no additional finding on a possible link with national requirements for existing buildings at the moment. There are still few countries having set specific minimal requirements for renovation standards which might have influenced this. Also the Southern communities (see Figure 3) are expected to make significant efforts in this field. However, at the time being only two renovation projects (in Turin (IT) and in Zaragoza (ES)) have been completed in the Southern European communities and this does not give the possibility for further detailed cross analysis.

In [Boermans et al., 2007], the recommended U-values for walls for Southern European cities are calculated between 0,30 W/m².K (Ajaccio) and 0,35 W/m².K (Barcelona (ES)). Figure 3 shows there are some CONCERTO buildings still far from these values. The recommended U-values in the Central European communities are between 0,20 W/m².K and 0,30 W/m².K which actually corresponds to the figures implemented in CONCERTO, both for the new and existing buildings (see Figure 2). In the Northern European countries, the recommended values of maximum 0,20 W/m².K is reached in nearly all new buildings.

On the basis of a life cycle assessment and an economic optimum calculation, [Boermans et al., 2007] provides recommendations for U-values (i.e. target values which would be optimal from a costs/benefits point of view) for the main European cities according to their climatic location; this provides an interesting benchmark opportunity for CONCERTO. [Boermans et al., 2007] does not differentiate between new and existing buildings in terms of optimum U-value and recommends that existing and new buildings should have the same energy performance level if there were no technical limitation for implementing ambitious renovation measures in the existing building stock. The practical CONCERTO experience shows that this is true for the Central European communities, mainly due to the high funding rate for renovation activities (Germany, example of Hanover) which makes such ambitious objectives feasible. This is not valid for the Southern countries which miss such national funding schemes.

Benchmarking for energy performance of buildings

Similarly to the U-value analysis, the distribution of some calculated energy performance ratings for all buildings is represented for the different climate zones in the Figures 5, 6 and 7. Such an analysis can be done with energy needs (space heating, domestic hot water and cooling) or final or primary energy use. The calculated final energy use for space heating is presented on the Figures 5, 6 and 7. The figures are given independently of the energy carrier and they are differentiated according to a categorisation between residential (including apartment buildings, detached and semi-detached one-family houses, home for students, young workers or elderly people) and non-residential buildings (including only office buildings and schools). The diagrams show the percentage (calculated on the basis of the total floor area of new eco-buildings and existing buildings taken separately) of constructed floor area for buildings having a final energy use for space heating between intervals of 20 kWh/m^2_{GFA}.a There is no clear distribution of energy performance

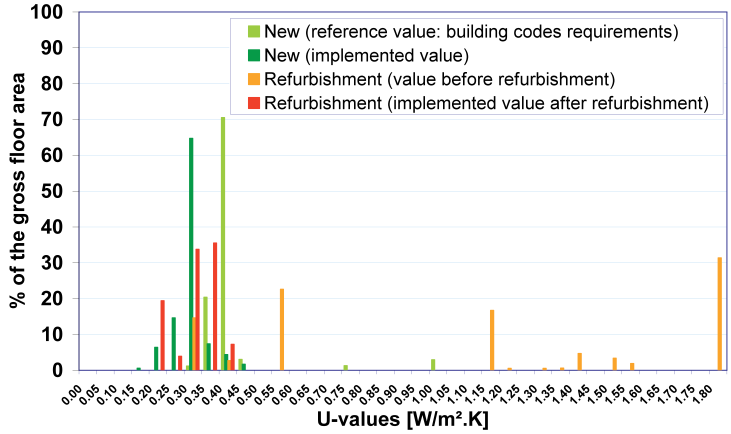

Figure 2. Statistical distribution of U-values of walls in Central European communities

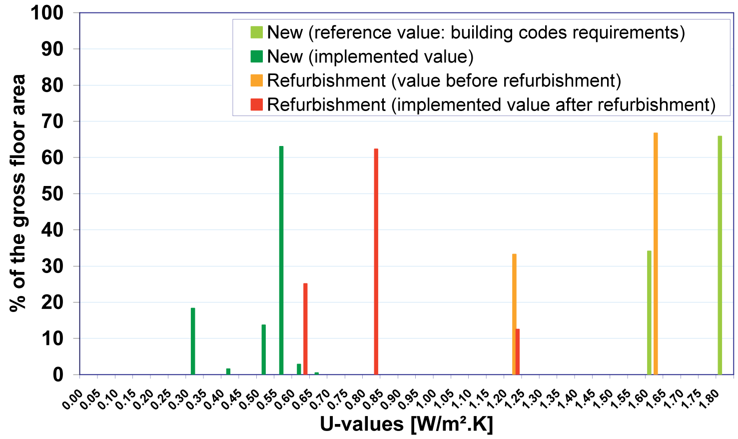

Figure 3. Statistical distribution of U-values of walls in Southern European communities

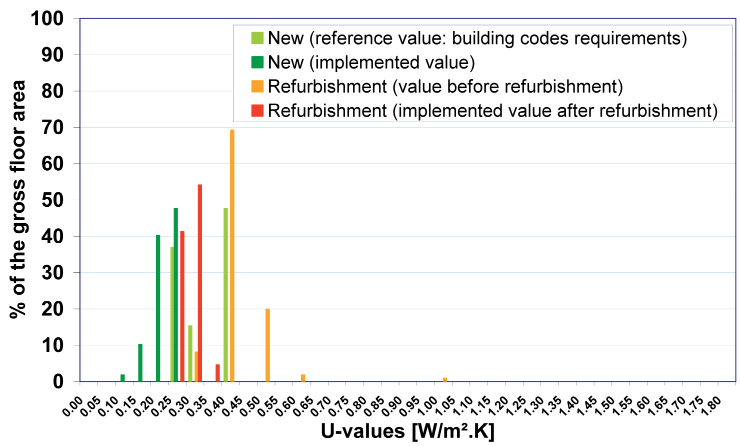

Figure 4. Statistical distribution of U-values of walls in Northern European communities

figures for each building type and climate zones, but first tendencies can be observed.

For the existing residential buildings before renovation, the higher energy use values for the Central European communities than for the Northern European communities are coherent with the conclusions made out of the U-value analysis. The fact that the energy performance after renovation is higher in the Central European communities than in the Northern European communities is also confirmed in the diagrams 5A and 6A.

The majority of buildings in the CONCERTO initiative (Northern and Central European communities) have been designed to reach a final energy use for space heating about 50 - 60 kWh/m^2_{GFA}.a. There are only some rare examples of buildings with passive house quality in the demonstration activities. As the CONCERTO initiative supports both demand-side and supply-side activities, the significant primary energy savings are obtained through a combination of both sets of measures.

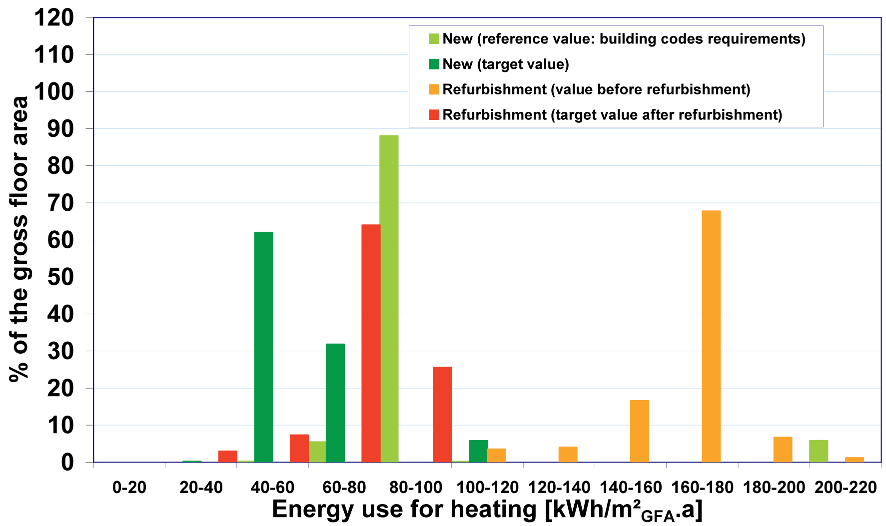

Figure 5A. Statistical distribution of calculated final energy use for space heating in Central European communities, residential buildings

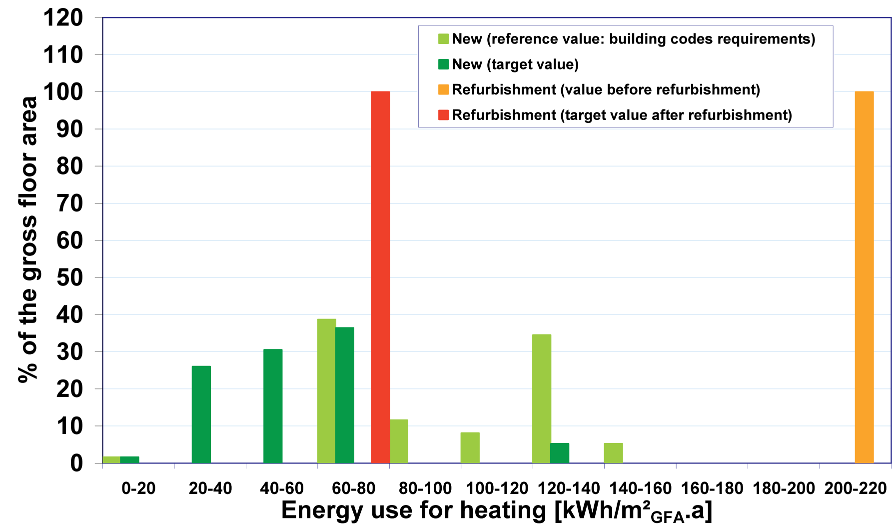

Figure 5B. Statistical distribution of calculated final energy use for space heating in Central European communities, non residential buildings

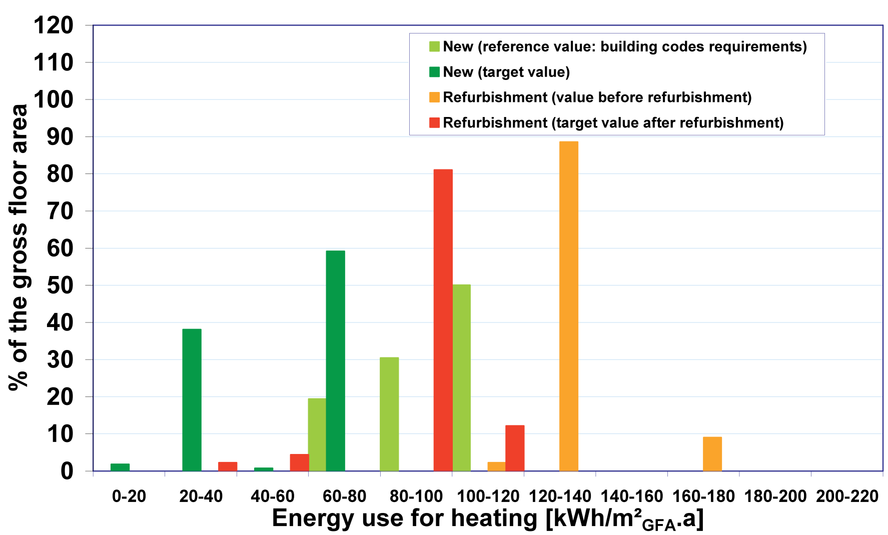

Figure 6A. Statistical distribution of calculated final energy use for space heating in Northern European communities, residential buildings

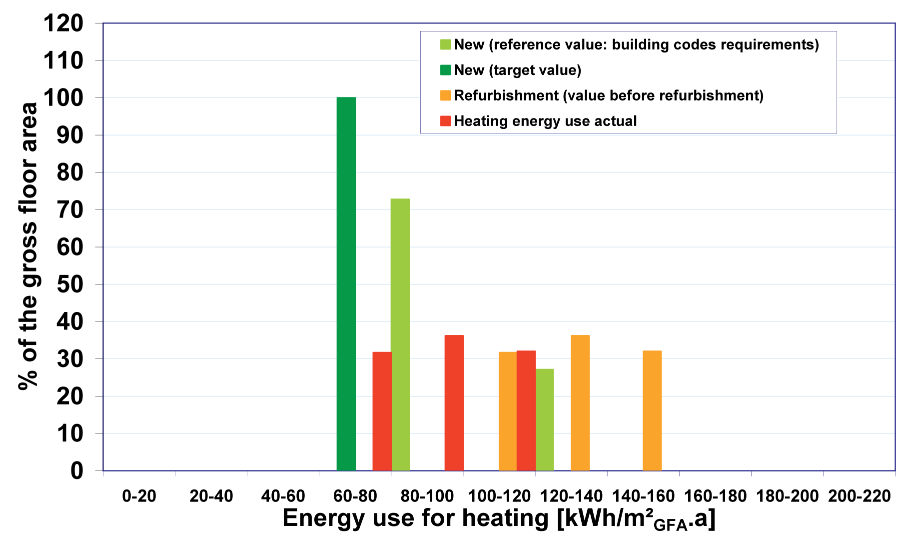

Figure 6B. Statistical distribution of calculated final energy use for space heating in Northern European communities, non residential buildings

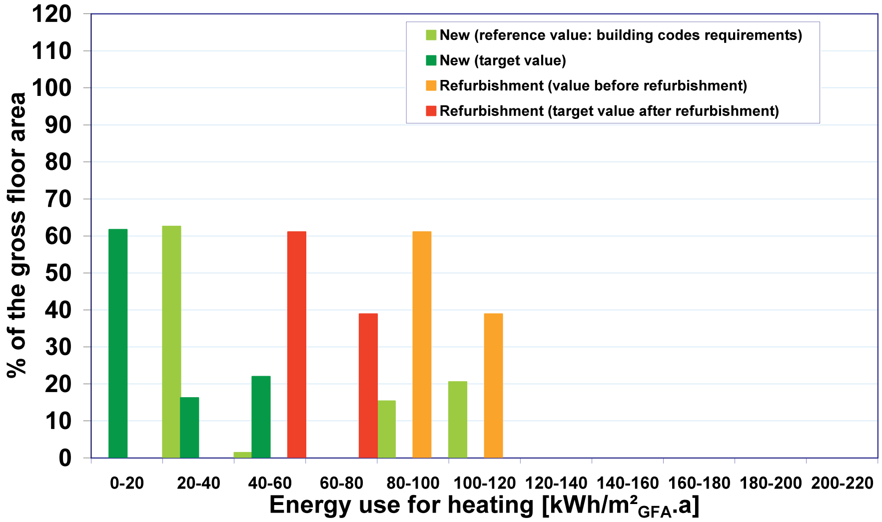

Figure 7. Statistical distribution of calculated final energy use for space heating in Southern European communities, residential buildings

First lessons learned from demonstration activities

First ex-post assessment: Preliminary analysis from new eco-buildings

Given the relatively modest energy performance targets in new buildings among the CONCERTO initiative, there was no particular difficulty in designing and implementing building concepts leading to these target values. The first experience from already completed new eco-buildings shows that the planned targets are reached in nearly all projects. One of the major contributions of the CONCERTO initiative in this sector was to provide mechanisms ensuring the quality of the implementation process. In many communities new training programs were set for the different actors of the construction process (e.g. builders, installers…) in order to ensure the implementation of all design specifications. In France for instance, these trainings have been included in the catalogue of the recognised training institutions in the building sector.

First ex-post assessment: Preliminary analysis from two renovation projects in Germany (Hanover) and Italy (Turin)

At the time being, the number of buildings completed and monitored is still too small to allow for a detailed ex-post analysis and statistical interpretations for all projects. However, the experience from two renovation projects which were completed in 2008 already illustrates some of the key success factors for large scale renovation projects in specific neighbourhoods. The following analysis is not directly linked with the database structure. It shows that additional information is always needed to understand the success factors of some of the measures.

In many German communities the CONCERTO funding is combined to the national funding for renovation activities [KFW website] and a municipal funding ([PROKLIMA website] in Hanover). All funding put together amount to ca. 22 % of the total costs in Hanover (including design and quality insurance costs), which made it possible to implement a nearly comprehensive renovation programme. All renovation measures with exception of mechanical ventilation systems were implemented. By covering only 4 % of the total costs, the CONCERTO funding alone would have not been sufficient for supporting ambitious renovation activities. In some of the French communities the planned renovation activities could not be implemented because of this low funding rate. In Turin (IT) the renovation could only be implemented partially because of the same reasons. The windows could not be replaced in all apartments but only in the flats belonging to the local housing agency (social housing). In the private owned apartments the funding was not high enough so the households were reluctant to invest in these renovation measures. However, other measures were implemented at a neighbourhood scale to offer a better life quality in the concerned area. The quality of the public spaces was improved and the public lighting systems was replaced through induction lamps.

In Hanover, the final energy savings for heating (space heating and domestic hot water) achieved through the renovation measures are significantly higher than in conventional renovation operations, both in percentage terms (50 - 70%) and in absolute terms (ca. 70 - 110 kWh/m².a). First comparisons between the metered energy use and the theoretical calculations show that the predicted heating energy savings as percentage have nearly been achieved in practice. As an effect of the reduction of the overall heating energy use, the share of energy use for domestic hot water preparation and distribution losses has increased because no specific measures were implemented in these fields. In future renovation projects, additional measures should be included to reduce the domestic hot water consumption for instance.

The situation in the project in Turin is very different. The budget available for renovation only allowed for a partial replacement of the windows (ca. 500 out of ca. 2000 windows) and a thermal insulation of the roofs. It is clear that in these buildings the heating energy savings would not reach the expected savings. Additionally, in the course of the renovation activities all flats were connected to the district heating network. As many of the flats did not have any heating system before the renovation works, the connection to district heating might have lead to an increase of the absolute values for heating energy use. There is no data available at the moment to allow for a quantification of the rebound effect.

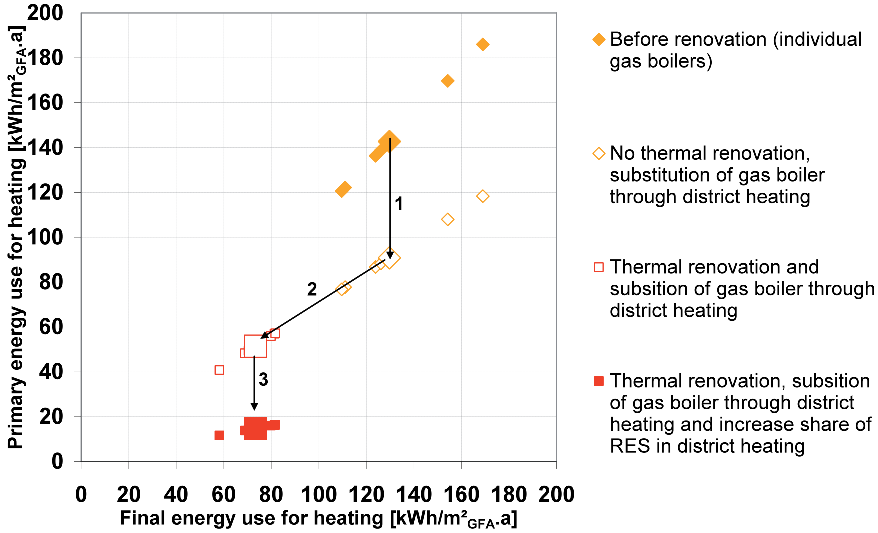

Figure 8. Diagram for the assessment of the degree of integration between demand-side and supply-side activities, example of Hanover (actual energy use figures, assumptions for primary energy factors)

Table 2. Assumed primary energy factors (renewable and non-renewable part)

Energy carrier (final energy level)	Primary energy factor
Natural gas	1,1 [DIN V 4701, 2006]
District heating including a 70 % share of CHP (without any RES)	0,7 [DIN V 4701, 2006]
District heating including a 70 % share of CHP (with a determined share of RES)	0,2 (assumption)

Overall community energy performance

The analysis of final energy use figures (e.g. final energy use for space heating) just allows for a partial assessment of the CONCERTO initiative, namely the building energy efficiency aspects. The final energy is the energy which is delivered to the building in the sense of the European standard [EN 15603], including all conversion, storage and distribution losses. The contribution of renewable energy systems located at the buildings or used through district energy systems is considered by calculating the primary energy factors in the sense of the [EN 15603]. Figure 8 shows the correlation between the primary energy use of a building or a community and its final energy use. By that, the degree of integration between demand-side and supply-side measures can be assessed, giving thus a benchmark indicator for overall community energy performance (see the Figure 8).

Figure 8 illustrates how the community energy performance assessment is being done in the case of the renovation activities in Hanover. The metered final energy use figure for heating before renovation is multiplied by the primary energy factor (see Table 2) corresponding to the heating system before renovation (gas boiler). If only supply side measures would have been implemented (substitution of individual gas boilers through district heating), the primary energy use would have been reduced while keeping a constant value of the final energy use (1), assuming that the distribution losses in the building can be neglected. The CONCERTO activities actually consisted in a thermal renovation of the building envelope and a substitution of the individual gas boilers through district heating (2) and also in increasing the share of RES into the energy carrier mix for district heating (3) (co-firing of biomass in existing CHP). In this case assumptions for the primary energy factors have been taken on the basis of a German standard [DIN V 4701, 2006]. The contribution of RES into the district heating will be considered by calculating the corresponding primary energy factor on the basis of the local characteristics of the district heating network.

Practical aspects related to the implementation of the database

The database was welcomed by the initiator and coordinator of the CONCERTO initiative (European Commission) and by the communities working with it, mainly because it offers a high potential for benchmarking among sustainable community strategies and assessment of the effectiveness of different local policies. The main gain of the database is seen in combination of a long term monitoring strategy. However, the development and use of the database faces many difficulties, mainly because of programme related and administrative factors:

- As the assessment project was initiated after the communities were selected, the database structure was set after communities had structured their own reporting format. The database could not be used as a reporting tool for the communities and was thus seen as a redundant information system. Therefore, it is recommended for future assessment programmes to establish such databases as early as possible to cover the whole time span of the funding programme. Moreover, the database should be used right from the beginning during the proposal submission phase: interested communities would communicate directly their technical data to the database, which would facilitate also the evaluation of the different proposals. In case of acceptance of the proposals, all technical data would be already available for the programme assessment.

- Even if the general assessment methodology and the requirements for monitoring activities have been defined in [Pol & Österreicher, 2007], the complexity of the projects and the high number of stakeholders involved makes it difficult to access the primary data source and there is a risk of losing information between the different actors. Quite often, the monitoring experts from the communities are not the people who implement the monitoring activities in the single building or plant. They depend on other stakeholders (facility management companies, energy supply companies, building developers, etc.) who, if they are not included in the local projects as project partners (third parties), might be reluctant to communicate energy use data. Data might be incomplete or might require additional explanation to be understood correctly. A review and feedback process is necessary to ensure high quality data, which requires additional time.
- As the reporting format is different in each community (frequency, type of documents used, level of detail of data delivered, etc.), there is no electronic interface allowing for an automatic data transfer between the database and other reporting formats at the moment. The single reporting documents need to be analysed case by case and data have to be entered manually, which might be time consuming.
- At the time being there is no concrete framework to implement long-term monitoring. Many communities have already shown their interest to continue monitoring after the end of the projects. This makes sense in particular because the effort to extend monitoring activities is negligible compared to the initial investment to set up the monitoring framework.

Conclusions

After a presentation of the database structure, this paper illustrates its potential applications by showing examples of benchmark analyses on the basis of first validated datasets. First conclusions can be drawn on the building energy performance targets fixed by the communities. The results which will be generated through the database would help other communities to fix their own targets on the basis of the experience of the CONCERTO communities.

The database strength will lie on the quality and quantity of the data stored. By including the 19 CONCERTO communities which joined the CONCERTO initiative in a second step, a representative amount of communities from different countries and types will be available, which is sufficient for statistical analyses. The data quality can only be ensured through a long validation and reviewing procedure which will last over the whole assessment period (until 2010 following the current contracts).

The database has to be seen as investment in the future. As long as monitoring data will be communicated there will be possibilities for analysing and assessing the community energy performances and the efficiency of the local energy strategies.

However, the database remains a purely technical tool which does not contain any detailed social data at the moment. Cost data are included to some extent, allowing at least for an assessment of the ecological and economical aspects of sustainability. As presented with first examples of renovation projects in this paper, in many cases the results from the socio-economic assessment are necessary to understand the technical choices made or to explain why some technical measures (e.g. comprehensive renovation) could not be implemented as initially planned. The complexity of these mechanisms is a characteristic of the whole CONCERTO initiative and is a reason for the long time necessary to implement the ex-post assessment.

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Annex: Overview on demonstration building types included in the CONCERTO initiative (status 10/2008)

		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	POLYCITY / Ostfildern	POLYCITY / Torino	RENAISSANCE / Lyon	RENAISSANCE / Zaragoza	sesac / Grenoble	sesac / Delft	sesac / Växjö	TetraEner / Geneva
New residential	One-family houses				■												■	■		■					■		
	Apartment buildings		■	■	■	■	■	■	■	■	■				■		■		■	■		■	■	■	■	■	■
Renovated residential	One-family houses	■													■	■	■	■									
	Apartment buildings	■	■	■				■		■	■	■	■		■	■	■	■			■				■		
Office buildings	New		■	■	■	■	■												■	■		■				■	■
	Renovation		■						■							■	■				■						■
New other tertiary buildings	Conference centres																										■
	Cultural centres			■			■													■			■				■
	Day care centres				■		■																				
	Fire station														■												
	Health centres				■																						
	Homes for old people						■																				
	Hospitals									■																	
	Retail buildings					■																					
	Shopping centres				■		■																	■			
	Sport centres				■		■																	■			
	Swimming pool				■																						
	Technology centres	■					■												■								
Renovated other tertiary buildings	Community centres	■															■										
	Homes for old people																■										
	Institutions / schools																■										
	Swimming pool	■															■										
Schools	New				■	■				■						■							■	■			■
	Renovation	■							■						■	■	■						■				
Farms	Renovation													■													