Requirements for an energy efficiency software for small and medium sized enterprises

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Abstract
Implementing tasks for energy efficiency is not easy to do especially for small and medium sized enterprises (SME) and has still not arrived the corporate routine. Beyond the daily business life SME rarely have personnel and also financial capital available to realize tasks for energy efficiency strutted and constructively. With an percentage of more than 99,6% (Ifm 2012) of all enterprises in Germany they are most important responsible in the business world. What they need are tools to manage this task beside the actual day trade. Standard software can be the solution, however the focus has to have high affinity for relevant corporate requirements while the developing process. Branch-oriented software references particular environments and is suited for this problem since intersections are optimal within a branch. Through detecting those requirements and by closely collaboration with the target group a product with high relevancy to practice can be developed. Within the project ReMo Green branch-oriented energy efficiency networks support the process of gathering energy efficiency software requirements which will be assigned to a software product that will be provided to all enterprises of a branch in the network.

1. Motivation
SME struggle with increasing energy costs these days. With an amount of partly 30% of all intern costs energy efficiency becomes an existence threatening condition for SME (Prognos 2010, p. 17). The fact that SME mostly do not see their core competences in applying energy efficiency methods hedges about a positive progress. Other obstacles are the lack of investment and workforce for implementing tasks and site optimization e.g. First approaches to counter energy efficiency in enterprises overall are so called energy efficiency networks.

In Germany there is a wide range of networks that primarily congregates enterprises and support them with energy efficiency and energy management consulting and the effort and motivation of learning from each other by initiating meet-ups and workshops. The most popular network initiator is „30 Pilot Netzwerke (30 pilot networks)“, who works by the LEEN method for learning energy efficiency networks. LEEN allows the network partners, usually consisting of a leading agency and their partners, moderators, energy management consultants and participating enterprises, to set a energy and CO2 saving target agreement (between 10% and 20%\(^2\) of energy and around 10% of CO2) for a fix project duration that is normally three years. Beside the fact that those networks are not necessarily oriented about SME, that build more than 99% of Germanys economy, nor oriented about single branches, which provide common interfaces, the efforts and stimulations made in those networks can only hardly be put on a permanent basis in the daily business routine due to a lack of a systematic approach toward energy efficiency. The chance of introducing and applying software solutions to support the network enterprises in applying, monitoring and rating energy efficiency tasks is usually not part of common LEEN networks.

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\(^2\) http://www.30pilot-netzwerke.de/nw-de/content/Netzwerke.php (accessed on 02.07.2013)
2. **ReMo Green - Energy Efficiency for branch-oriented SME networks**

Small and medium sized enterprises in Germany mostly employ less than 20 employees (Prognos et al. 2010, p. 13). That’s why there’s a lack of personnel resources and also financial funds to support a clearly neglected field. Energy efficiency is so far not one of the core competences in SME, where day-to-day business dominates and all entrepreneurial resources collect. Experience with SME shows that detailed knowledge about energy consumption seldom exist. That’s on one hand based on the subordinated value of energy efficiency and also on the other hand the lack of competence and (software) tools to collect and analyze necessary data. Furthermore, these enterprises lack of a well-founded data base, that enables and introduces them to derive tasks for energy efficiency from it, although depending of the initial situation in enterprises, the condition of facilities and production conditions, 25% of all energy consumption costs can be saved through energy efficiency tasks (Prognos 2006, p. 94).

The project ReMo Green picks up these defects according to energy efficiency tasks in SME. In energy efficiency networks enterprises work together in improving their energy situation, to create an awareness for energy efficiency and collect and implement requirements of an energy efficiency software. The establishment of those networks is going to be branch-oriented. This is based on the fact that within one branch based on the same fabrication structures comprehensive intersections for detecting possible savings exist because products, facilities and processes are comparable.

Figure 1 shows progress and cohesion within the project. Starting with the network initiator who establishes and moderates the network a information and experience exchange within the network consisting of enterprises and experts is going to be aspired. Periodical network meetings about current topics motivate the cooperation partners and inform about important subjects.

![Figure 1](image-url)

**Figure 1**
ReMo Green project structure
Source: authors own
The tasks that are shown in figure 1 and that are fixed for the network, support the process of developing the energy efficiency software directly. Additionally a technology platform for management tools for energy efficiency software builds a base for detecting and exploiting energy efficiency potentials in the network enterprises and also that way define core functionalities for the software.

The execution of energy efficiency benchmarking within the networks leads on one hand to a comparison of the energy situation (energy consumption, energy production, energy costs) of the network enterprises with „best of class“ enterprises. That way the possibility is made to adapt relevant tasks for increasing energy efficiency. On the other hand basic information according the energy efficiency software can be gathered.

Many software development projects have shown, that beside the knowledge of particular tools for energy efficiency also technical and production related initial situations matter, to increase the relevance of application of a energy efficiency software. Therefor all technical data, such as machinery and technical facility has to be determined. Furthermore incoming invoices for energy and the depiction of synthetic load profiles are important in this process.

For the application of new software within a scope that has been neglected before particular requirements need to be gathered and defined together with the target group and potential users. Thats why a semi-structured interview outline has been developed to support the enterprises in shaping all the desired requirements for a energy efficiency software. Investigations show that this method has a high level of contentment for all participants, because its structured, traceable and practical in its application (Weßel 2010).

3. Requirements analysis

3.1 Core data base

To analyze the current situation and to gather information about the requirements of an energy efficiency software for SME the network members took part in an interview. Preparing the interview, five main tasks of operational energy efficiency have been defined, which were brought into the context of a software product and finally defined the structure of the questionnaire. Those core functions are energy monitoring, energy controlling, report of the internal situation and the energy situation which result from the defaults that result from the energy management tasks according to ISO 50001. Furthermore the software supports the energy efficiency benchmarking process and keeps all basic data of the enterprises that are the base of different energy evaluations applied. All core functionalities are based on a comprehensive core data collection. It builds the data base and the computation base for all necessary energy related calculations and indicators. In detail the core data base consists of:

1. Enterprises Core Data (e.g. annual sales, income, number of employees, location)
2. Machinery Core Data (e.g. type, energy consumption, production level, year of manufacturing)
3. Periphery Data (e.g. type, production level, energy consumption)
4. Cross-sectional Technology Data (e.g. lighting, process warmth, compressed air, electrical drives)
5. Energy Delivery Data (e.g. power, warmth, fuel and gas delivery, contracts and conditions)
3.1 Core software functionalities

In detail the software core functionalities in figure 2 can be described as followed:

3.3.1 Energy monitoring

First core functionality that is build upon the priorly described data base is energy monitoring. It is a wide known fact that the transparency of (energy) data causes a better awareness of energy consumption and leads to better efficiency that saves costs in the end. Energy monitoring for the planned software consists of three mayor data sources. One source is the energy meter that should either read automatically if its an electrical type of meter or should be read manually in intervals depending on the enterprises initial situation. Another source are regular measurements on machines and peripheries as well as cross-sectional technologies to track differences that might be caused from behaviour modification or the modification of machine setup. A third important source is monitoring all energy consumption bills. This is needed to track and display the actual costs of energy consumption considering the increase of energy costs.

3.3.2 Energy controlling

Bottom-up energy controlling references the collected data from the monitoring process. In this step its important to support the interpretation of the monitoring data and constructively suggest suitable energy efficiency tasks to decrease energy costs. That process must lead to a priorly defined target. The suggested tasks are ideally fitted to the enterprises needs. That means that enterprises that do not run e.g. a central
compressed air system will not get suggestions about energy efficiency tasks referencing the system. That way the software system is kept reduced to the enterprises needs and no unnecessary functionality that might confuse the user will be displayed. The catalogue of tasks for energy efficiency will be structured after a maturity level construct. This way, the application of tasks leads enterprises level-wise upward a state of ready for e.g. energy management certification and prepares enterprises successively for this step.

3.3.3 Energy reporting

The reporting functionality provides comprehensive information about the whole energy situation in the enterprises referencing the transparency target put into graphs. The energy reports display the overall energy consumption in different freely selectable intervals. That is important to compare intervals from previous years. In the printing business the degree of capacity is not consistent - rather low in the summer months and highly increasing with the Christmas trade e.g. Choosing customized and flexible intervals helps to compare energy consumptions for equal periods. Another advantage of regular reporting is keeping track of applied tasks and their effects. Assuming those tasks will be immediately documented the report shows the progress in the enterprises energy efficiency efforts. Additionally it is not seldom that enterprises have to report energy related data to third parties e.g. industrial or occupational units. The needed data will be prepared through the report functionality and the effort of reports addressing third parties will be reduced.

3.3.4 Energy efficiency benchmarking

Another part of the project ReMo Green is to establish and implement suitable benchmarking methods for energy efficiency in enterprises. That means that network internal comparisons of the energy situation and energy tasks and suitable indicators motivate a process that can be described as „Learning from the Best“. The benchmarking process will be supported by the software by previously finding the right indicators in agreement with the enterprises. Those keys will be branch-oriented e.g. for the printing business energy consumption per employee or energy consumption per product type.

3.3.5 Energy simulation

Highly depending on a comprehensive data base is the fifth core function simulation. Enterprises will be able to simulate their facilities and energy consumption in a simplified simulation environment. Therefor it is necessary to collect all energy relevant information about the machinery and periphery. For a whole simulation of energy consumption it is recommended to add facility of IT infrastructure and electricity consumers at all. This functionality enables enterprises to simulate different constellations of machines and periphery. In case of machinery substitution and any other process related and process manipulating tasks the software gives insight in expected energy consumptions prior the actual acquirement.

To further prepare the questionnaire the five core functionalities build the base for appropriate scenarios of energy efficiency tasks in enterprises. Those scenarios help to communicate a better practical relevance and focus on operational issues in the interview. The interview itself was developed as semi-structured questionnaire, that provides wider answering frame. This way even more issues and insights could be won than with common questionnaires and forms. The interview span over 15 enterprises from the first network of the printing business and has been documented comprehensively. First result of these interviews was the confirmation, definition and design of the five energy efficiency tasks or core functions within SME.
All this way determined software requirements have been processed with the Volere requirements specification template and thereby provided methods. The advantage of this method is the specific structure provided by the Volere Template that takes care of individual business events, that have been collected with the interviews and derives specific software requirements from it. Also Volere provides a more detailed structure of non-functional requirements which are comparably important for a user-optimized software product. First of all Volere demands beside the projects basic facts like description of project partners and naming conventions a clear approach on finding and gathering the needed software requirements by deeply considering the enterprises current situation. That process starts with describing the scope of the work first which includes the current situation and the context of the work. In case of ReMo Green according to the interview statements, several visits and ensuing energy analyses the current situation displays as not applied energy efficiency methods at all in the attending network enterprises and the context is to improve all efforts of energy efficiency and the energy situation at all. That’s why particular activities for energy efficiency in SME has to be defined. These activities are structured within the five core functionality construct and displayed in figure 3 as an activity diagram.

![Activity diagram of energy efficiency tasks within ReMo Green network enterprises](source: authors own)

After that the particular business events of the enterprises relating energy efficiency could be listed. Additional information like input and triggering data as well as outputs and a summary of the business use case have to be provided alongside. E.g. the event „limit exceeded“ requires input data from the monitoring component and puts out a warning message. Summarized in a Business Use Case (BUC) that event records all necessary data and reports on the person in charge (figure 4).

Based on the event table the BUCs have been comprehensively described in an extra step. Attributes like triggers, requirements and participants of the use case are more detailed here. After that a raw business data model has been developed that shows all in the use case participating models and attributes and
their relations. A comprehensive data dictionary that describes the attributes and defines them in several types supports the business data model. Afterwards the scope of the project could be determined by defining single product use cases (PUCs) such as recording metering data, delivering energy bills and documentation of energy efficiency tasks. The PUCs lead to the final step of requirements analysis.

Starting with the so called snow cards, the Volere method to collect and define all software requirements, all atomic requirements based on the former defined PUC and the results of the interviews have been gathered and specified with different attributes provided such as descriptions, rationals, fit criterions and customer satisfaction and dissatisfaction factors. Also provided are describing attributes like priorities and conflicts as well as supporting materials, originators and meta attributes. This way the most frequently mentioned requirements of the software will be picked and off candidates e.g. preparing reports for the German Census Bureau will be dismissed based on the commonness of mention in the interviews.

The Volere method also takes care of the non-functional requirements of a software product. More specified than common analysis methods, Volere differs between various kinds of non-functional software requirements. The following and their more specific units have been applied in the analysis:

1. Look & Feel Requirements (Appearance Requirements, Style Requirements)Usability and Humanity Requirements (Easy of Use Requirements, Personalization and Internationalization Requirements, Learning Requirements, Understandability and Politeness Requirements, Accessibility Requirements)
2. Performance Requirements (Speed and Latency Requirements, Safety-Critical Requirements, Precision or Accuracy Requirements, Reliability and Availability Requirements, Robustness or Fault Tolerance Requirements, Capacity Requirements, Scalability or Extensibility Requirements, Longevity Requirements)

3. Operational and Environmental Requirements (Expected Physical Environment, Requirements for Interfacing with Adjacent Systems, Productization Requirements, Release Requirements)

4. Maintainability and Support Requirements (Maintenance Requirements, Supportability Requirements, Adaptability Requirements)

5. Security Requirements (Access Requirements, Integrity Requirements, Privacy Requirements, Audit Requirements, Immunity Requirements)

6. Cultural Requirements

7. Legal Requirements (Compliance Requirements, Standards Requirements)

All these non-functional requirements have been considered in the analysis process depending on their relevance to the case of the software scope. They were also part of the interview and have been defined by the results of the questionnaire. E.g.

The implementation of the energy efficiency software occurs as a web based solution to take care of data comparison for the benchmarking process and to provide platform independency as much as possible. The monitoring data of energy consumption will be gathered and sent with the help of mobile meters assuming the needed environment consisting of access to the meter location and a network connection. Energy efficiency tasks will be provided through a catalogue that is productively structured and leading to a defined energy efficiency target that possibly a particular amount of energy saving or an aspired energy management certification. This will be realized by a maturity model that will be developed along side and prevents the enterprise from punctual single activities that do not lead to a particular target in the end.

4. Conclusion

The advantages of developing branch-oriented energy efficiency software and the realization within the project ReMo Green - Energy efficiency in Berlin-based small and medium sized enterprises have been described in this paper. Energy efficiency beside the efficiency of employment and material is the third big cost item in SME, which are the supporting pillar of German economy. However their temporal, financial and personnel capacities, particularly comparing with large concerns, are considerably limited. Thats why these enterprises need support in realizing adequate energy efficiency tasks. Beyond information and consulting they need a powerful but also simply applicable tool to assist the optimization of their energy conversion. Empiric investigations resulted in 5 core functionalities for energy efficiency in SME: monitoring, controlling, reporting, benchmarking and simulation. These core functionalities become part in a standard software system for energy efficiency, which meets the concerns of relevant and individual requirements of SME.

EnviroInfo 2012 closed with important statements fitting the ideas of the project ReMo Green. First of all it is demanded to work with SME more intensively since they are the base of German economy. Secondly mentioned was a better cooperation and collaboration with enterprises when its about developing environmental (software) solutions. ReMo Green hooks right at these two statements and provides a network of branch-based SME that helps to find common starting points and defines requirements for a relevant and highly applicable software solution together with SME to overcome the lack of personnel and financial capacities of applying energy efficiency tasks.
5. Bibliography


