Energy Performance Contracting Plus

Technical Toolbox for Technical Measures for use in SPIN-constellations

Managing and metering systems for buildings

January 2016

Co-funded by European Union

Contact information

Reinhard Ungerböck
Grazer Energieagentur GmbH
Kaiserfeldgasse 13/1
A-8010 Graz
T: +43 316 811848-17
E-Mail: ungerboeck@grazer-ea.at
Website: www.grazer-ea.at

Content prepared by:

Daniela Bachner
e7 Energie Markt Analyse GmbH
Walcherstraße 11/43
A-1020 Vienna
T: +43 1 907 80 26 - 0

This document has been elaborated within the *Energy Performance Contracting Plus* (EPC+) project and is available on the project website.

www.epcplus.org

Task: 4.2.
Deliverable: 4.2.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 649666.

Content

Content 3

1. General description and explanation how-to-use 4

1.1. Toolbox 5

2. Managing and metering systems for buildings 6

2.1.1. Technical description 6

2.1.2. Calculation method 7

2.1.3. Process flow implementation: including quality assurance measures during and after implementation 8

2.1.4. Options on measurement & verification in order to evaluate the performance in relation to the given performance guarantee 9

1. General description and explanation how-to-use

EPC+ aims at standardizing technical measures in order to make them predictable for other SPIN members (including the SPIN coordinator) and thereby to reduce transaction costs.

The toolbox can serve as a guide for the providers of EPC+-services for the standardization of the measures (design parameters, calculation method, process flow) and defines quality standards for the M&V-method. Text-modules of the descriptions may also be used for the communication with the client in order to create trust into the proposed measures.

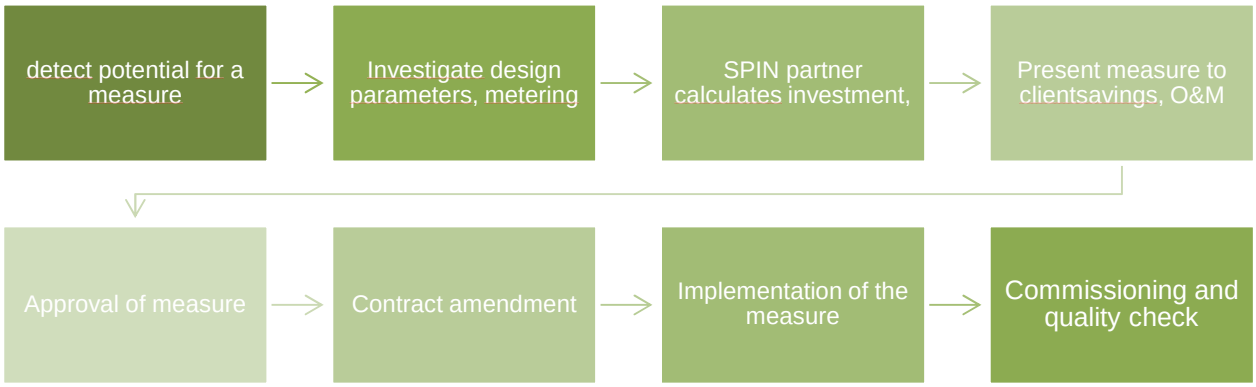
Each measure applicable for EPC+ is described on a general basis. Moreover the design parameters and the possibilities for application are defined, last but not least including a list of situations, where the specific measure is not applicable.

Calculation method

For the facilitation to introduce the measures for a SPIN the generic method of calculating effort for implementation, O&M and savings is described, ideally in form of a product-unspecific, open-source calculation tool.

Process flow

The generic process flow is identical for all measures. Therefore it is also part of the business model of EPC+, variations might be necessary for specific business cases, i.e. if measures interact with each other during their implementation or in their performance phase. See therefore also the interaction matrix of EPC measures, which serves as a quick indicator in which way measures might interact.



As a further development and because of the several players and interfaces in communication the process-flow-diagram is also visualized in the design of the ***service blueprint*** (see chapter 2.1.3)

1.1. Toolbox

Each measure is being described in general and in detail. The measures are categorized in energy-efficiency and renewable energy measures. All measure descriptions can be downloaded at http://epcplus.org/energy-service-packages/. Here is an overview of all measures that have been elaborated:

Energy-efficiency-measures:

1. Indoor lights: LED lights + control system
2. Hydraulic adjustment of heating system
3. Energy efficient pumps
4. Modernization of electrical motors
5. Night cooling
6. Optimising parameters of HVAC systems
7. Managing and metering systems for buildings
8. Renovation/replacement of heating boilers
9. Efficient windows
10. Industrial steam boiler blowdown heat recovery

Renewable energy measures:

1. Solar Thermal Domestic Heating Water
2. Biomass for heating and/or domestic hot water
3. Combined Heat and Power (CHP)
4. PV-panels
5. Wind-power
6. Heat pumps

2. Managing and metering systems for buildings

2.1.1. Technical description

2.1.1.1. General description (PU)

Building management systems can increase a building's energy efficiency as they allow managing the operation of HVAC systems including other applications such as domestic hot water, lighting or shading parameters on the one hand and metering and monitoring the systems' and total building's energy consumption and load profiles on the other hand. As a consequence, possible weaknesses and failures in the operational behaviour of technical building systems can be detected early and prevents a considerable increase of energy costs by correctly adjusting operating parameters. Building management systems are a comfortable way to operate technical building systems, which provide a certain flexibility to set parameters, and offer powerful analysis and assessment tools. Especially in case of a huge number of facilities, it can be very effective to both operate them and monitor the building's total energy consumption on a detailed basis within one software system instead of checking the operational parameters and consumption data individually. Hence it is possible to discover inefficient interaction of different systems, such as running cooling and heating systems at the same time, to name an example. In order to find out, a detailed measurement of energy consumption is required to provide input data for the integrated monitoring. The building management system consists of hardware and software components. It requires control electronics, sensors, data loggers, data transfer and software with user interface.

Several international suppliers offer comprehensive building management systems: Honeywell, Siemens EMC, ENVIDATEC JEVis, IngSoft InterWatt, etc. Furthermore there are products from national suppliers available in most countries.

The implementation of a building management system itself does not increase the energy efficiency. By analysing the energy consumption with the integrated monitoring system and by revealing misadjustments of technical building systems energy saving potentials can be found.

2.1.1.2. Design parameters

- Which parameters are necessary to survey for the design of the measure?
    - Technical parameters of status quo equipment
        - Is a building management system already in use?
        - Are all technical requirements for the use of a BMS complied?
        - Is it possible to equip the current energy meters with a data logger to save consumption data digitally and transfer the data into software?
        - How many energy meters and sensors are currently in use and how are they distributed (one for each floor / one for each HVAC systems, etc.)?
        - Does a collection of past energy consumption metering exist?
        - What technical modifications in the technical building systems are necessary to implement sensors and meters?

- Technical parameters of replacement equipment
  - Is it necessary to inform the energy provider or or apply for permission when changing or adjusting the metering equipment?
  - Are facility engineers available to operate the BMS / monitoring systems?

2.1.1.3. Measure suitable for

Typical surrounding conditions for this measure:

- This measure is suitable for buildings with multiple technical building systems
- It is especially attractive for buildings with a large number of electrical loads

2.1.1.4. Measure not suitable for

This measure is not suitable for

- buildings with few technical building systems

2.1.2. Calculation method

2.1.2.1. Expected savings

The implementation of a managing and monitoring system for a building's equipment and its energy consumption does not lead to energy savings without active setting changes based on the gathered information. Hence it is not possible to calculate the achievable savings with a certain method. It is expected that the implementation of a BMS generates energy savings of 5 to 10 percent of the total energy consumption due to the detection and correction of weaknesses in the system. The span of achievable savings is also dependent on the current energy efficiency standard of the building.

Purchasing a BMS allows implementing most of the energy efficiency measures described in toolbox 6 in an uncomplicated way and is a suitable way to combine several measures within once process. For the calculation of energy savings for heating, ventilation and cooling systems, see technical toolbox 6, for lighting measures see toolbox 1.

2.1.2.2. Investment costs

- Material:
  - BMS software
  - Metering equipment including data loggers and transfer system

- Labour:
  - Installation of BMS and metering equipment

2.1.2.3. Running costs

- Quality check after implementation on a regular basis
- Analysis and quality check of collected consumption data both at the beginning of the monitoring process to detect and implement organisational measures and on a periodic basis to check their impact and the energy consumption characteristics of the building
- Long-term analysis and quality check of metering

2.1.2.4. Expected life-span of the measure and resulting replacement-costs (if any)

The life-span of the measure is foremost dependent on the regular evaluation of monitoring data and plausibility check.

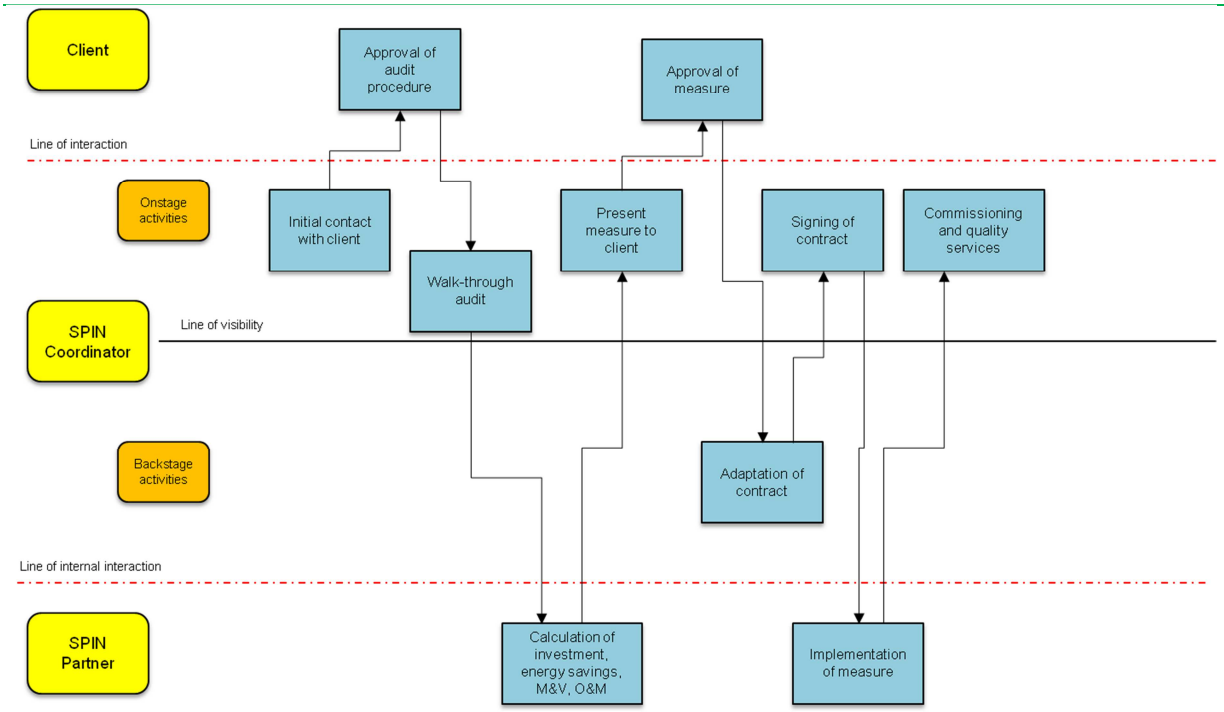
Hardware components such as sensors and meters are subject to periodic replacement. The expected lifetime for servers and the software interface is 5 years, those of other components is 10 to 15 years.

2.1.2.5. Discounted cash flow analysis and Net present value

In order to elaborate a discounted cash flow analysis, amortization rate and net present value of the investment, tools elaborated within the context of the project can be used, please check the European toolbox package at www.epcplus.org/energy-service-packages/. To estimate the amortization rate of a monitoring system, a tool programmed by e7 can be used (available only in German), see https://e-sieben.shinyapps.io/evm-roi.

2.1.3. Process flow implementation: including quality assurance measures during and after implementation

The process of implementing the BMS and metering components starts by evaluating the current metering infrastructure of the building and its number of energy meters as well as any requirement of the current technical building systems to be controlled by the BMS in the future. In communicating with facility engineers a monitoring concept will be designed and a time frame for regular quality check of the gathered data and their interpretation will be set up.



2.1.4. Options on measurement & verification in order to evaluate the performance in relation to the given performance guarantee[1]

Note: It is essential to clarify and confirm the actual need of comfort parameters (indoor air temperature, humidity, air changes, operating times) and the data baseline at the stage of the extensive energy audit **together with client before** setting up the performance contract. Standard wording for the definition of target comfort parameters from contracting agreements can be used.

It is important to collect and log the relevant operating figures of the reference time period. Data have to be accessible during the whole run time of the contract. Therefore, a so called M&V plan will be set up. The plan details information on installation and calibration of the required metering equipment. After implementation of the energy efficiency measure(s) a functionality check is carried out. The plan ends with a report on energy and cost savings.

The following aspects have to be defined together with the client:

- Method and level of detail of verification of energy savings (e.g. system-specific verification based on monitoring data)
- Influencing factors to be included in the monitoring system (automatic normalization for area or occupancy rate, weather, changes of required comfort parameters, etc.)
- Range of negligible changes (e.g. ± 5% changes to the above mentioned factors)

[1] Criteria: minimum effort, but still a proper qualitative proof for solid implementation and a considering performance, not installation only

- It has to be clarified in advance who is in charge of adopting the operational parameters, data analysis and identification of further energy efficiency measures (facility manager, SPIN partner, etc.). All changes of control parameters have to be recorded electronically. An appropriate way of documenting organisational measures may be an entry in the change log within the software or a screenshot of changed operational parameters of technical building systems in the building management system's interface.

As the measure represents the implementation of a long-term metering system on a detailed basis, the performance of the system can be guaranteed by a regular check of the system's reliability in order to avoid data gaps or malfunction of systems (weekly or monthly).

Option B according the International Performance Measurement and Verification Protocol (IPMVP) should be used for calculating the energy savings. Option B says that all required parameters have to be measured on sight. The HVAC system stipulates the system boundary. Therefore efforts for monitoring of independent variables and static factors may be reduced.

In order to verify the savings, the following data should be evaluated at least quarterly:

- Comfort parameters resp. indoor air temperature (e.g. metered every 15 minutes)
- Electrical load and other energy consumption for heating, cooling and ventilation systems (e.g. metered every 15 minutes or once per hour)
- Building's occupancy rate, areal changes for normalization (event triggered)
- Recorded changes of technical building system control settings
- Total building's energy consumption: It is advisable to perform a plausibility check of the achieved savings using the building's total energy consumption.

An alternative M&V approach would be using the load profiles of the whole building.

If all external parameters which determine the energy demand of a building are well-known or remain stable, the M&V concept can be simplified by using that building's load profile. Therefore a certain time period needs to be defined to measure the load profile in an appropriate resolution before a measure was performed (e.g. two months or one year). In some countries, such as Austria, heat and power load profiles are provided by the grid operator for free on a 15 minute basis. All external parameters need to be measured as well within the period, such as temperature or office hours.

After performing the energy efficiency measure, the load profile including all external parameters needs to be measured again for the same time period. In order to evaluate the achieved energy savings of the performed measure, the external parameters are used to normalize the measured load profiles.

However, this method has to be treated cautiously and is only recommended in exceptional cases.