Energy Performance Contracting Plus

Technical Toolbox for Technical Measures for use in SPIN-constellations

Hydraulic adjustment of heating systems

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www.epcplus.org

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Content

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.

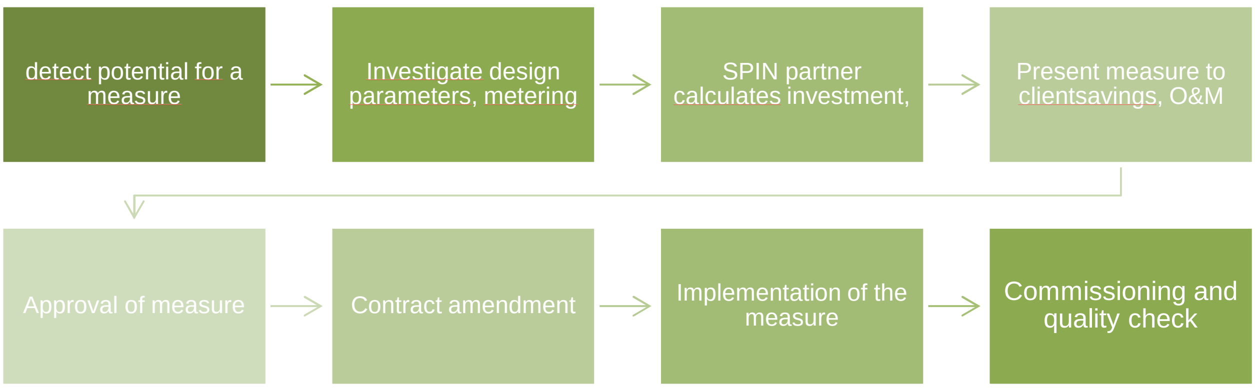
Each measure applicable for EPC+ is described on a general basis. Moreover the design parameters and the possibilities for application are defined, last but not least including a list of situations, where the specific measure is not applicable.

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. Hydraulic adjustment of heating system

2.1.1. Technical description

2.1.1.1. General description (PU)

To detect, if a heating system has been adjusted hydraulically a few parameters have to be observed and taken into account. This delivers a quick indication, whether the hydraulic adjustment is necessary and effective or not:

- Uneven heating distribution: rooms – especially the ones near the distribution pipes – are overheated, while others never reach the required indoor temperature
- Radiators produce flow noises
- High energy costs (consider benchmarks)

The standard procedure to eliminate the problem of not reaching the desired temperatures in distant rooms is to increase the flow temperature and the speed level of the heating pumps. This normally leads to high distribution losses and overheated rooms near the distribution pipes and subsequent losses through opened windows and is thereby not energy-efficient.

At the hydraulic adjustment the volume flow has to be limited for each heating circuit and each radiator that far, that oversupply can be avoided by still delivering the necessary heat quantity. On one hand this leads to increased comfort through even heat distribution, but especially to high savings on heat demand.

Depending on the size of the facility the hydraulic adjustment should be performed through:

- Pre-adjusted thermostatic valves or a similar method to limit the volume flow at the radiator
- Circuit control valves per zone, regulated through demanded volume flow or pressure difference
- Speed controlled pumps (varying volume flow)

Through reduction of the pump’s rotation speed or by replacing them through speed-controlled pumps further electricity consumption can be reduced.

2.1.1.2. Design parameters

At small facilities mostly the data for the existing system is missing, so it is hardly possible to perform a detailed piping calculation similar to new constructions. But still also without a complete data set fair results are possible through a simplified calculation approach through the installed radiator sizes and the detection of the necessary preset or through measurement in-situ. Afterwards the scenario with in-situ-metering will be discussed, because this procedure produces better results and gives more and better possibilities for metering after implementation and the according performance improvement.

For smaller facilities (up to 1.5 meters pumping height) the hydraulic adjustment is performed through volume flow reduction directly at the radiator, e.g. through preset thermostatic valves or through limiting the maximal valve lift. – optimized results can only be achieved through combination with speed-controlled pumps.

For middle-sized facilities each singular heating circuit has to be adjusted within the whole system through circuit control valves or differential pressure regulators – again ideally in combination with speed-controlled pumps.

The adjustment of the individual radiators can be obsolete in the case, that the radiator system is well adjusted. This can be detected with high probability by comparing the temperature differences of radiators at different positions in the heating circuit: if the temperature difference is nearly the same (± 3°C), it can be assumed that a further improvement is not economic.

- Heat distribution system
  - Installed radiator type (length, width, depth, type) for each room – or simplified: installed radiator power = heating load of the room
  - Brand, type and pre-settings of the existing thermostatic valves
    remark: if there are no pre-adjustable thermostatic valves installed, these have to be retrofitted. This produces (in most cases) significant additional effort, because the heating circuit(s) have to be emptied and refilled.
  - Accessibility of each radiator has to be given
- For each heating circuit:
  - Heat demand – assumption through sum of installed heating power is possible, but has to be checked for plausibility
  - Design temperature (flow and return flow temperature)
  - Installed heating pump
    - Brand
    - Type
    - Structural length
    - Fitting dimension
    - Electricity connection (230V/400W)
    - Type of control (constant speeds / speed controlled pumps) and pre-set value
    - Wet runners / dry runners
    - Operation point
      - Flow rate [m³/h]
      - Height [m]
  - Brand, type and pre-settings of the existing circuit control valves
    remark: if there are no circuit control valves installed, these have to be retrofitted.
  - Heating times per flow circuit

- Temporary metering (cf. Chapter M&V (2.1.4))
  - For each heating cycle: flow and return flow temperature, temperature difference, pressure, volume flow, heating load, heat quantity, electrical power and consumption of the pump over a period of a full (regular) cycle of operation (i.e. 1 or 2 weeks) in the

heating season (ideally in transitional season, but safely beyond heating threshold temperature)
- o outside temperature and inside temperature in at least three rooms provided by the cycle metered :
  - room at the beginning of the distribution line (it is often too hot)
  - room in the middle of the distribution line (required temperature can be reached)
  - room at the end of the distribution line (required temperature cannot be reached – it is too cold)
- o First step: flow and return flow temperature of 3 radiators in the heating circuit with differing positions (distance to the heating central)
- o Second step (if adjustment of all radiators has been considered to be economic: For each radiator: flow and return flow temperature of the radiator itself

2.1.1.3. Measure suitable for

Typical surrounding conditions for this measure:

- If there are uneven conditions in the building: overheated rooms versus rooms that hardly reach comfort temperatures
- Only small temperature spread between flow and return flow respectively high flow- and return-flow-temperatures
- Noises of flow at the radiator's valves
- After a thermal refurbishment of a building
- After adding an annex to an existing building
- Buildings with combination of static heating and ventilation system

2.1.1.4. Measure not suitable for

Typical failure condition for this measure (but often seen)

- Already adjusted buildings
- Buildings with high percentage of non-thermostatic valves

2.1.2. Calculation method

2.1.2.1. Expected savings

Savings can be expected in the range of 10-20% of the baseline. The more effort is invested into the hydraulic adjustment, the higher the potential savings are.

- Adjustment of heating circuits without individual radiators: 5-8%

- Adjustment of all heating circuits including all radiators: 10-20%

The savings are composed out of the following components:

- Reduced volume flow and thereby less demand for pump power (savings on electricity). assumption: a doubling of temperature spreading between flow and return flow allows to reduce the volume flow by 50% → the pumping power demand can be reduced by 12%
- Reduced heat distribution losses through lower flow temperature (generally the flow temperature can be significantly reduced after hydraulic adjustment) and higher temperature spreading
- Demand orientated heating: oversupply can be eliminated (reduction of down-cooling through windows or ventilation systems)

What influences the probability that the calculated savings differ from the true savings:

- behaviour during metering phases (before and after; medium influence)
- correction of heat degree days might not be linear to true consumption (low influence)
- other heat sources (solar radiation, internal heat sources)
- domestic hot water demand (low influence)

Mandatory output parameters:

	Dimension	Amount, formula or reference
Cost savings	*[€/year]*	Has to be calculated by respective SPIN-partner. Simple formula is not applicable
Consumption savings	*[kWh/year]*	Has to be calculated by respective SPIN-partner. Simple formula is not applicable

2.1.2.2. Investment costs

Costs to be investigated and agreed on within the SPIN:

1. Material: pre-adjustable thermostatic valves or flow restrictors, circuit control valves, high efficient heating pumps (each, if not already in place)
2. Labour: working hours for adjustment and removal of metering equipment, hydraulic adjustment per radiator (approx. 30-45 minutes each) and per heating circuit (approx. 60 minutes each if circuit control valves in-situ)
3. Travel expenses
4. Coordination, engineering: lump sum, to be determined by each SPIN

5. Metering after implementation and adjustment (for determineration of performance): lump sum per circuit

Mandatory output parameters:

	Dimension	Amount, formula or reference
Costs material	*[€]*	See above
Costs labor	*[€]*	See above
Costs design, engineering, coordination	*[€]*	See above

2.1.2.3. Running costs

The measure generates no running costs.

Mandatory output parameters:

	Dimension	Amount, formula or reference
Running costs	*[€/year]*	no running costs

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

The valves and pumps are considered to work properly for 15 years

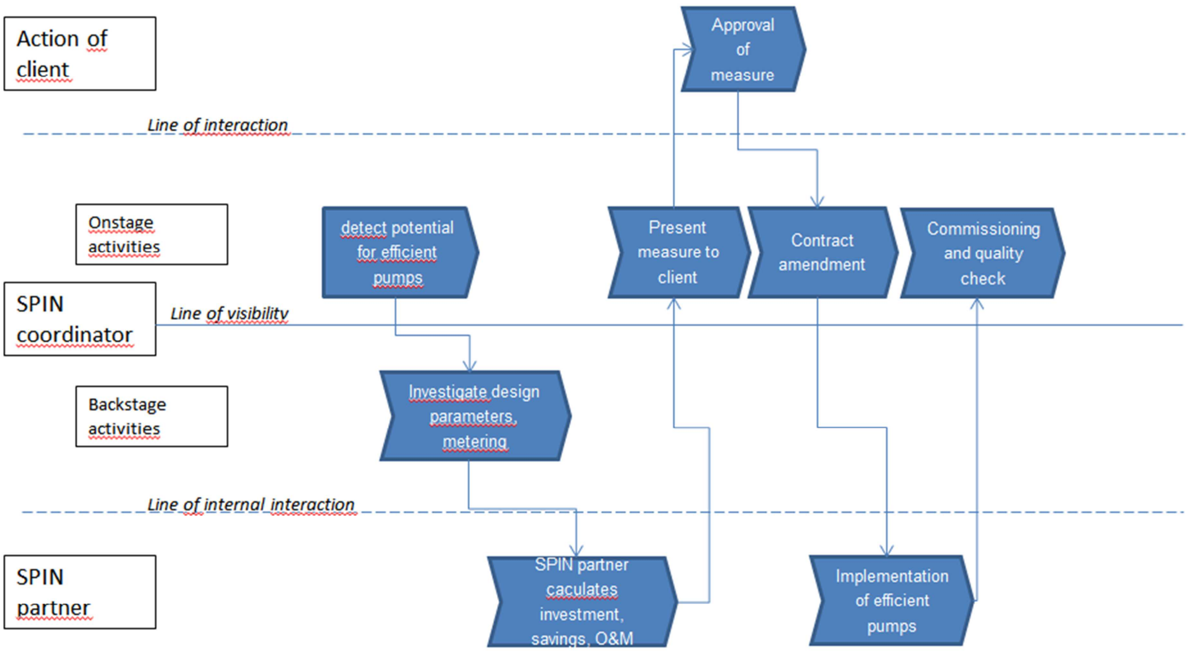
Resulting replacement-costs: irrelevant

Mandatory output parameters:

	Dimension	Amount, formula or reference
Life-span of measure as a whole and specific components	*[years]*	15
Yearly costs	*[€/year or % of investment]*	0

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

Example



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

Metering after implementation and adjustment over a period of a full (regular) cycle of operation (i.e. 1 or 2 weeks) in the heating season (ideally in transitional season, but safely beyond heating threshold temperature) according to metering the status before implementation of the measure:

a. For each heating cycle: flow and return flow temperature, temperature difference, pressure, volume flow, heating load, heat quantity, electrical power and consumption of the pump
b. Outside temperature an temperature in the ident three rooms provided by the metered cycle
    i. room at the beginning of the distribution line (it is often too hot)
    ii. room in the middle of the distribution line (required temperature can be reached)

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

iii. room at the end of the distribution line (required temperature cannot be reached – it is too cold)

Metering of each heating circuit is necessary: once before and once after implementation of the measure and hydraulic adjustment. The results of heat consumption have to be corrected according to the outside temperature. The difference of the corrected heat consumption plus the difference of power consumption represent the achieved savings.

The improvement in comfort through constant and regular indoor temperatures cannot be put into economic figures, but it can be demonstrated by the results of metering the indoor temperatures and guarantee of the quality of the measure.

Inacceptable options for a SPIN:

1. calculation of expected savings
2. calculation of static payback
3. Metering of only one circuit and multiplication with number of circuits with similar profile is not acceptable.
4. Metering of heat load only before and after the implementation, as the surrounding situations are normally not comparable and take into account only a short moment in a dynamic system.