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Abstract

The purpose of this document is to describe some general considerations and rules that shall apply in all technology evaluations and case studies involving surplus heat-to-power technologies. The intention of defining such a common framework is to enable relatively fair comparisons of technologies in HighEFF scenarios, from evaluations performed by different parties and over the centre duration. This is very much in line with the overall vision of HighEFF.

The framework parameters and KPI's defined below should always be included in HighEFF-evaluations, but the work does naturally not have to be limited to these constraints. The description below may evolve over the centre duration.

1 Framework for evaluating heat-to-power technologies

The purpose of this document is to describe some general considerations and rules that shall apply in all technology evaluations and case studies involving surplus heat-to-power technologies. The intention of defining such a common framework is to enable relatively fair comparisons of technologies in HighEFF scenarios, from evaluations performed by different parties and over the centre duration. This is very much in line with the overall vision of HighEFF.

The framework parameters and KPI's defined below should always be included in HighEFF-evaluations when the purpose is to explore or demonstrate potential or feasibility, but the work does naturally not have to be limited to these constraints. The description below may evolve over the centre duration.

1. Technology evaluations shall be performed for real or hypothetical *industrial scale implementations* with significant potential impact. This implies a main focus on:
    a. Considering significant heat sources from the investigated industry or industrial process
    b. Concepts with significant utilization of the available energy in the heat source
2. Energy and mass balances shall be shown to be fulfilled across and within the investigated system
3. *Sensible engineering practice* should be applied to all aspects that are not sufficiently modelled in both performance and cost. (Example: defining a reasonable temperature difference or pinch in a heat exchanger, reasonable expander efficiency)
4. The inclusion of the following KPI's in all evaluations is encouraged:
    a. Net power produced
    b. *Exergy efficiency* (fraction of net power produced to the available exergy in the heat source). For limited, sensible, and constrained heat sources, the available exergy can be estimated as:

$$Exergy_{Sensible,Constr} = Q_{heatsource,available} \cdot \left[1 - \frac{T_{Ambient}}{(T_{Heatsource} - T_{Constraint})} \cdot \ln\left(\frac{T_{Constraint}}{T_{Heatsource}}\right)\right]$$

    Where $T_{Heatsource}$ is the initial temperature of the heat source, and $T_{Constraint}$ is the minimum allowable temperature for the heat source (e.g. to maintain downstream process)
5. Fan/pump work (or penalties to) shall be considered when applicable:
    a. Pressure drop in heat exchangers is rarely negligible – when not modelled in detail or otherwise considered, the excepted impact of heat exchanger pressure drop on the KPI's should at the very least be thoroughly discussed
    b. Cooling water pump (and similar) work: setting 1 bar nominal friction pressure loss if not modelled in detail. Use pump isentropic efficiency of 70% if not known.

$$W_{pump} = \eta_{pump} * \Delta P_{water} * V_{water}$$

$$W_{pump} = 0.7 * 1E5\ Pa * V_{water}$$

    b. Fan work (or penalties to):

$$W_{fan} = \eta_{fan} * \Delta P_{fan} * V_{actual}$$