ENERGY RELATED CONSIDERATIONS OF ULTRA-EFFICIENT URBAN INDUSTRIAL PARKS

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Introduction

The recent global trends of urbanisation and demographic growth are involuntarily building the prerequisites for paradigm shifts towards the decoupling of growth rates from resource consumption rates, especially in the manufacturing sector. Following this most probable arising scenario, a sustainable proportionality between production volume and resource input should be a key goal [1]. Assuming different policy scenarios defined by the International Energy Agency, their "World Energy Outlook" statistic 2018 shows an ongoing trend in energy demand until 2040 [2]. Therefore, an imperative for action regarding energy efficiency of companies must be followed. Moreover, 75 % of the global resource consumption are used in urban environments [3]. This leads to a need for a fundamental shift towards enabling the setup of production sites in urban environments worth living in.
Against this background, Fraunhofer developed the holistic visionary approach of the *Ultra-efficient Factory*. The concept defines a loss-free production site, which has a symbiotic-positive contribution, operating in perfect symbiosis to its environment [4]. Following this holistic approach, one of the fields of action defined is *energy*, aiming to pursue energy efficiency as the target function of improvement.

Methodology

The solution approach of the ultra-efficient factory in urban surroundings was extended, aiming the development of a method to define, identify and assess both existing and potential symbiotic effects within urban industrial parks, at the interface to their surrounding urban environment. The approach following the criteria of the ultra-efficient factory, usually applied to individual factories, was applied to the selected industrial park. However, the factory level was selected as the highest resolution for the data collection. The adjacent municipality was included, since it interacts directly or indirectly with the industrial park. The overarching goal was the development of a holistic concept for ultra-efficient urban industrial parks, applied upon a suitable pilot location in Baden-Württemberg, Germany.
Accordingly, the present paper describes the energy related investigated considerations, following the goal mentioned. In order to achieve it, first a data driven graphical method was chosen to identify and derive symbiotic effects on location. Second, a procedure based on an "if-then" statement for the design of sustainable energy systems was developed and is depicted in Figure 1. Facing an open but firmly determined system with regard to its physical boundaries, a neutral to negative resulting balance of all energy exchange relations on location, in addition to the terms concerning the energy generation, conversion, transportation, utilisation and storage, aims to declare the whole system sustainable.

Results

Using the mentioned data driven graphical method, a diagram was built showing both the existing and potential energy exchange flows between the companies on site, but also with their (urban) environment, for different useful energy forms (Figure 2). Specifically, where excess energy occurs, it can be distributed to other facilities or the municipality having an energy demand, increasing the overall energy efficiency of the industrial park. On the other hand, during two experts workshops at Fraunhofer new technologies and specific research results were assessed, which could contribute to the achievement of an ultra-efficient urban industrial park. This way, more than ten energy efficiency increasing measures were derived for the selected industrial park, including energy generation, sharing, storage and recovery. Specifically, the expansion of the waste heat usage between more companies was identified. Also, the electricity surplus can provide hydrogen as a raw material, for a flexible electricity usage or to be used in local emission-free mobility concepts. A smart network of decentralised compressed air systems can increase the overall energy efficiency on site. A local DC power grid can improve the integration of renewable energy sources. All these findings were bundled as an individual, holistic concept for a sustainable, ultra-efficient energy system for the selected industrial park.

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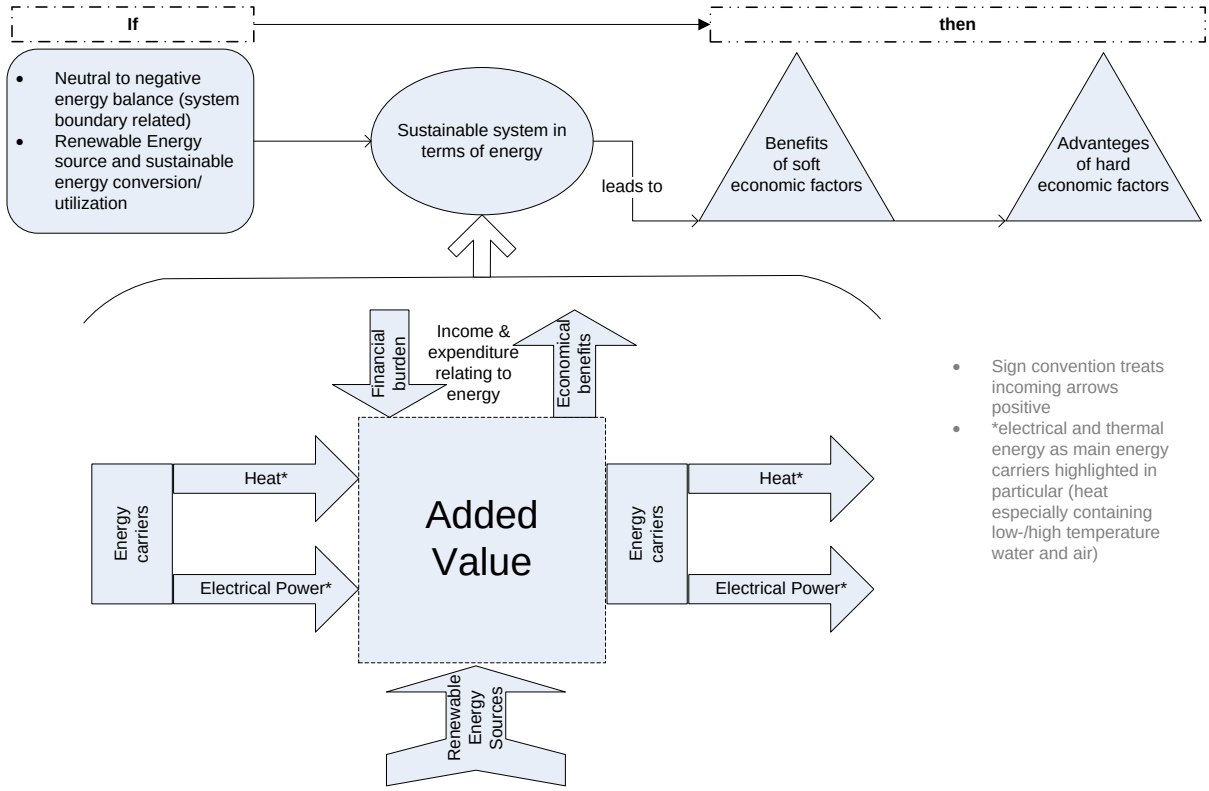

Figure 1: The "if-then" statement as core part of the developed method

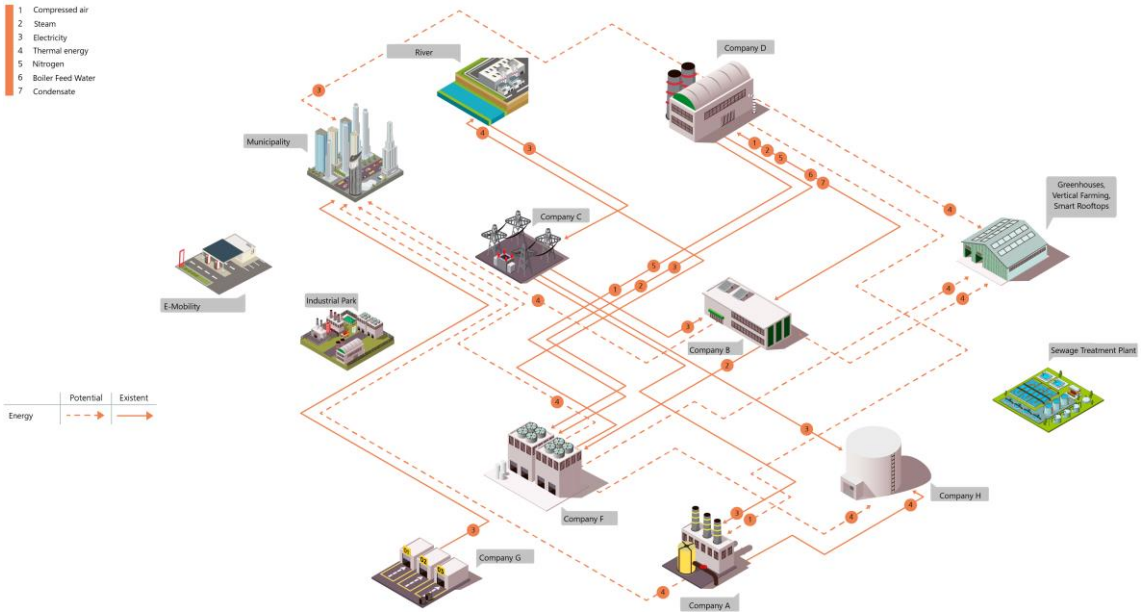

Figure 2: Existing and potential symbiotic effects within the selected industrial park in Baden-Württemberg, Germany

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