Smart eco-industrial park: modelling, optimisation and system integration

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Abstract

An industrial park (IP) is a cluster of businesses that collaborate with each other and the local community to efficiently share resources and reduce waste and pollution. The advantage of forming an IP is that the combinative benefit (social, economical and environmental) achieved through the symbiosis relationships is much greater than the simple summation of the stand-alone individuals. Novel strategies of applying modelling, optimization and system integration to industrial park are shown as follows:

Multi-level modelling: a global/regional industrial system is structured as several hierarchies corresponding to the scales addressed: devices, process lines, plants, companies and sectors, countries, and global. Advanced mathematical modelling approaches will be used to describe the material and energy consumption problems at each level. The global/regional scale is at the top level, a number of companies and sectors are located at the second level, and a large number of plants, processes and devices are presented at the last three levels, respectively.

Multi-level optimization strategy: the variables determined from the upper level problems are set to be the input parameters to the lower level problems, which are solved accordingly. For example, firstly, the top level problem (global/regional material and energy optimization) are solved to optimize the network structures in the global/regional scale determining all optimal inflows and outflows of companies and sectors (namely the design stage); secondly, each company is optimized (such as optimal production) under the restrictions of its inflows and outflows obtained from the optimization of the top level problem; and then these company production data are passed to each plant or process to find the best operation; finally, the obtained plant and process data are utilized into device models to achieve better device performances (namely the control stage).

Applications: The application make use of the latest advances in high performance computing (HPC), advanced mathematical modelling, and semantic web technologies. In
order to achieve this, it is proposed to associate each industrial component with its own semantic representation which will also include an executable mathematical model. These models are fed data from industries using the techniques developed from machine learning and statistics, and can be represented by surrogate models after employing model reduction techniques. An overall system forms a network of such component models which can, in turn, be described and optimized using efficient mathematical programming approaches. System integration and software integration are proposed for the final applications, including storing all models with ontologies, using semantic technologies to query model information and select suitable solvers for problem optimization.