Cross-company site-wide optimisation without sharing of sensitive data

The problem

• Large chemical sites consist of several independently managed production plants.
• There is a high degree of integration and coupling via streams of energy and material.
• Site-wide optimisation is difficult due to the problem size and confidentiality reasons.
• There is a large unexploited economic and ecologic potential.

The solution

• Coordination by a neutral coordinator to improve the efficiency of the site.
• Consumption and production of shared resources is charged at certain prices.
• The coordinator adapts the transfer prices according to the current situation.
• The coordinated plants only transmit their consumption and production amounts for certain prices to the coordinator.

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The problem

Site-wide optimisation

In the process industry, the larger sites consist of several production plants that are interconnected by networks of raw and intermediate materials and of carriers of energy, such as natural gas and steam at different pressure levels. In addition to optimising the operation of each production plant, coordinating the production and consumption of the shared resources provides an impactful lever towards a more resource efficient production, since it ensures that not only the individual plants but also the overall site operates optimally. However, site-wide optimisation poses two crucial challenges: the size of the problem and the fact that the different stakeholders (independent companies or business units within one company) do not want to share business-related information.

The solution

Price-based coordination

Distributed solution methods can compute optimal production levels and the optimal distribution of shared resources while maintaining a large degree of confidentiality. Internal cost structures, plant models, constraints, and demand patterns are not revealed.

The producers or consumers (prosumers) pay a variable price or receive a reward per unit of produced or consumed material. A neutral coordinator iteratively adapts the transfer prices based on the announced supplies and demands of the different plants for a given set of transfer prices. The prosumers react with new production or consumption rates. When the network is balanced (Fig. 1) and the prices are stable, the site-wide optimum is found and the corresponding production and consumption rates are fixed. When a new situation arises, the process is repeated.

Within CoPro, the legal framework conditions were examined and more efficient coordination algorithms were developed. With such coordination, the site becomes an internal micro-market, and better and faster reactions to changes compared to the usual static long-term contracts are realised.

The summary

Enabling cross-company optimisation

The proposed price-based coordination methods make it possible to optimise whole production sites, including the coordination of streams across company boundaries. On-site and external supply and demand of shared resource streams are iteratively matched and the optimal transfer prices are determined. In this manner, the most efficient production of the overall site can be realised. As for the different plants smaller optimisation problems arise, the approach is also promising for large sites under a single ownership as, e.g., in steel or metals production.