CoPro – Coordinated Production for Better Resource Efficiency

Project Overview

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Individual units often are already automated and operated efficiently.

Inefficiencies result from lack of coordination.

Better coordination of production means improved energy and resource efficiency.
CoPro: Short fact sheet

- Full title: Improvement of Energy and Resource Efficiency by Better Coordination of Production in the Process Industries
- Contributing to circular economy and industrial symbiosis
- Builds on the results of FP7 projects
  - MORE: Real-Time Monitoring and Optimization of Resource Efficiency in Integrated Processing Plants
  - DYMASOS: Dynamic Management of Systems of Systems
- 17 partners from 8 countries
- Duration: 42 months
- EC contribution: 6 M€
Consortium

Industry with 5 applications covering the complete value chain

Technology providing SMEs

Universities

Dissemination and exploitation support

Research institutes
Improved coordination is key to better energy and resource efficiency of the existing assets

CoPro addresses coordination in three dimensions:

- **Cross-layer process integration**, from basic process controls to the coordination of the complete supply chain
- **Cross-unit and cross-plant coordination**: Integrated management and control of heterogeneous units coupled by flows of energy and materials
- **Cross-functional coordination**: Coordination between different functions related to production, e.g. between maintenance and operations and between operations and the procurement of electricity
Goals

Provide and demonstrate tools for process monitoring, dynamic planning, and scheduling and control of plants, sites and industrial clusters under dynamic market conditions

- Improved energy and resource efficiency by coordinated optimization of production units
- Buffering the effects of fluctuating renewable energy production and distribution by integrating demand-side response with plant-wide scheduling and control
- Efficient plant and resource utilisation by integrated plant-wide scheduling and control
- Optimization of maintenance
Plant and site operation efficiency largely determined by discrete events and decisions. CoPro includes discrete decisions in plant-wide control and optimisation schemes.

Plant managers and operators have a crucial role in the operation of processing plants. CoPro develops intuitive forms of human-machine interaction and optimisation-based advanced decision support.

Suitable mathematical models in most cases are only available for some important plant or units. CoPro develops techniques for coordination of production units that can employ models of different types.

Operation of plants of different companies in industrial parks that are connected by energy & material streams are not coordinated. CoPro develops technology for balancing and optimising networks, and for distributing the joint benefit in industrial parks.
Optimal site and cracker planning and scheduling including optimisation of plants operations and DSR

“We operate a petrochemical complex with interacting plants and produce a large number of base chemicals. We need to plan this production for at least the year ahead. With optimal planning of the site and optimisation of some of our units we can react quickly to changes in the market and save resources and energy.”

Alexander Gammersbach
Team Leader of Site Optimisation
INEOS Köln GmbH
Generation of an optimal schedule for the operation of the plants in the ammonia network
- Time horizon one month or more
- Includes logistics
- Optimization of plant loads and cold storage
- Improved resource usage
- Demand side response

Improving the coordination of strongly coupled production plants

Improving the coordination of strongly coupled production plants


Large saving potential identified if the network operations are performed in an optimal fashion compared to recorded data.
“We strive to optimize the production and distribution of basic chemical gases required in the synthesis of our polymers. By means of advanced modelling, monitoring and optimization methods, we want to improve the energetic efficiency in the production of gases while respecting environmental and safety regulations.”

Christine Maul
Team Lead of Advanced Process Control Covestro Deutschland AG
Covestro use case – CO and H₂ network optimisation

Balancing the networks by coordinating

- Internal production
  - Considering fluctuating electricity prices
- Internal consumption
- External consumers
- Purchases from external producers
  - Minimum purchasing quantities
  - Coupled contracts with different tariffs
  - Cashback for yearly targets
- Transfer of gases between sites

Improving economics and resource efficiency by reducing waste streams and demand side response

Optimal process coordination for the recovery section of EU’s largest viscose fiber production plant

“The recovery of the spinbath is the key process step in the viscose fiber production with the highest energy demand. Especially the spinbath reconcentration by evaporation requires a huge amount of heat. In CoPro our goal is to improve our multi-unit evaporation process by focusing on load allocation, cleaning cycles, cooling water distribution and the heat recovery.”

Christian Jasch
Process Engineer
Recovery & Spinbath
Lenzing AG
Lenzing use case: Spinbath recovery system

Cross-unit and cross-functional coordination of the recovery cycle in Europe’s biggest cellulose fiber plant

Objectives:
- Efficient load allocation in the multi-unit evaporator network
- Cleaning sequence coordination for the evaporator and heat recovery section
- Optimized cooling water distribution in the recovery cycle

The recovery cycle of Lenzing’s viscose fibre plant in Upper Austria
Optimisation of production and packing of consumer goods products

“We produce a large number of similar products in the same plant and with the same equipment. The process of fitting all products in the daily schedule and the change from one product to the other makes it all quite complex and often not optimal. The main objective in this project is to increase the plant productivity by means of optimal planning and optimal and efficient utilization of assets, resources and energy.”

Francesc Corominas
Principal Engineer
Procter & Gamble
P&G use case

- **Challenges**
  - Demand-driven production
  - Great variety of products, sequence-dependent changeovers
  - Plant-wide manual scheduling not possible for longer time horizons

- **Benefits**
  - Reduction of waste due to changeovers
  - Optimised schedule translates into increased energy and resource efficiency
  - Improved production capacity and flexibility
  - Less work on weekends
“At FRINSA, we produce over 400 different products on shared production equipment. Our main challenge is to optimally plan, schedule and operate the equipment to minimize queues, idle times and consumption of energy. CoPro technology will replace manual scheduling methods and will improve the energy efficiency and reduce total costs.”

Jose Manuel García Lampón
FRINSA Production Manager
Fransa del Noroeste, S.A.
FRINSA use case

- **General characteristics**
  - Large order-driven production with high production flexibility
  - **Sterilization**: Most critical element
    - Ensures food safety & product quality
    - Energy intensive process
    - Production bottleneck

- **Main challenges**
  - Optimisation-based reactive scheduling
  - Optimization of the sterilization process ➔ significant energy savings by better control and coordination with scheduling
  - Trade-off between
    - Productivity (higher temperatures, faster sterilization)
    - Energy consumption (lower temperatures, longer processing times)
Expected impacts

- 10% improvement of energy and resource efficiency if implemented fully and along the value chains across all applications and sectors
- High impact on the competitiveness of all individual partners by being first using the technologies; fast followers expected after dissemination and interaction with stakeholders
- Strategic partnership between the CoPro SMEs and large industrial companies
- Long term growth in employment at the technology providing partner SMEs
- **Contribution to circular economy and industrial symbiosis**
Outlook: Dynamic management for industrial symbiosis

- **Industrial symbiosis**: *Tight coupling of production units by streams of material and carriers of energy*
- Similar to Verbund sites, but between different companies
- Available/ requested amounts of material or energy carriers depend on the operating conditions of the plants involved which are operated by different companies
- Each company has to react to customer demands, availability of green power, etc. → *Propagation of variability between the plants*
- **Integrated management** is needed to realize the potential of industrial symbiosis!
- Must include *sharing of benefits* in a fair manner
  - Without violating anti-trust regulations!
Distributed coordination

Hurdles for solving integrated optimisation problems
- Missing information
- Complexity of the problem
- Scalability and adaptation to changes
- Heterogeneous modelling approaches
- Agility
- Confidentiality of information

Finding the system-wide optimum by centralized optimization is often not practically implementable
Distributed coordination

Solution approach:
Market-like distributed optimisation

- Intuitive concept in accordance with current accounting systems
- Scheme mimics an auction mechanism
- Online adaptation of the prices by the coordinator (central function)
- Only limited data exchange between the subsystems required (resource production/consumption)

Wenzel et al. (2018). “Virtual Splitting of Shared Resource Networks for Price-Based Coordination with Portfolio Tariffs.” ESCAPE28, Graz, Austria
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- ResearchGate:
  https://www.researchgate.net/project/CoPro-Coordinated-Production-for-Better-Resource-Efficiency
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