Using AI to improve energy and resource efficiency in various industries

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The power of machine learning in enhancing the quality of the manufacturing process is getting increasingly recognized. AI and machine learning have become popular tools for manufacturers to improve throughput and optimize energy consumption. The EU-funded FUDIPO project is making great strides in integrating AI into several critical process industries on a wide scale to achieve radical improvements in energy and resource efficiency.

A news item on the digital publication "Open Access Government' summarizes how various industries like oil refineries and wastewater treatment can use AI systems. It states that "FUDIPO is developing and testing (in five case studies) advanced dynamic physical (complemented with soft sensors) and statistical models, like Bayesian networks and machine learning models, to form advanced diagnostic, decision support, optimization and model predictive control."

Case studies

Erik Dahlquist from project coordinator Mälardalen University explains how the developed system is implemented in five full-scale case studies. These cover an oil refinery, a large heat and power plant, a pulp and paper plant, a wastewater treatment plant, and a micro heat and power turbine. The oil refinery Türkiye Petrol Rafinerileri A.?. (Tüpra?) purchases different qualities of crude oil and converts it into usable end products. FUDIPO seeks to optimize production planning in order to use the available oil in the best possible way. This will help to meet European consumer needs. To estimate product qualities, physical and statistical models are used together with "a diagnostic system to detect faults of temperature sensors and NIR [near infrared] models for feed properties. FUDIPO advancements could save 120-200 TWh/y of energy in EU oil refineries."

Mälarenergi, which operates a large combined heat and power plant in Sweden, focuses on controlling emissions. "This control is improved with FUDIPO, thus decreasing downtime, fluctuations, corrosion, fouling and agglomeration." A physical model is utilized "together with measured data to diagnose possible process and sensor faults using a Bayesian net for probability calculations. This is combined also with MPC [model predictive control] for controlling moisture in the fuel going to the boiler, where on-line measurements of the waste fuel are made to determine content of plastic and moisture."

As for the ABB wastewater treatment plant, "FUDIPO brings development of control algorithms for a better performance, measuring quality of incoming waste, and thus lowering the aeration demand to save energy," according to Dahlquist. "A physical model tested with off-line data has been developed, as well as a python model to detect sensor fault, and a model predictive control."

In the case of the BillerudKorsnäs pulp and paper plant that has three fiber lines with different pulp qualities, the project "leads to a more stable process and fault diagnostics due to better control of Kappa number," as noted in the same news item. Kappa number is a parameter measuring the quantity of lignin left in the pulp after the digester. As this is difficult to control, "a physical model is run as a digital twin and NIR spectra is measured on all incoming wood chips to the digester. This is predicting lignin content and reactivity."

Finally, in the Netherlands, for Micro Turbine Technology's heat and power turbine, "FUDIPO is increasing efficiency supporting clients with scheduled and predictive maintenance support and planning."

The FUDIPO (Future Directions of Production Planning and Optimized Energy- and Process Industries) project will end in September 2020.

More information: FUDIPO project website: fudipo.eu/

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