ITEA 3

Project Results

SPEAR

A new approach to energy optimisation

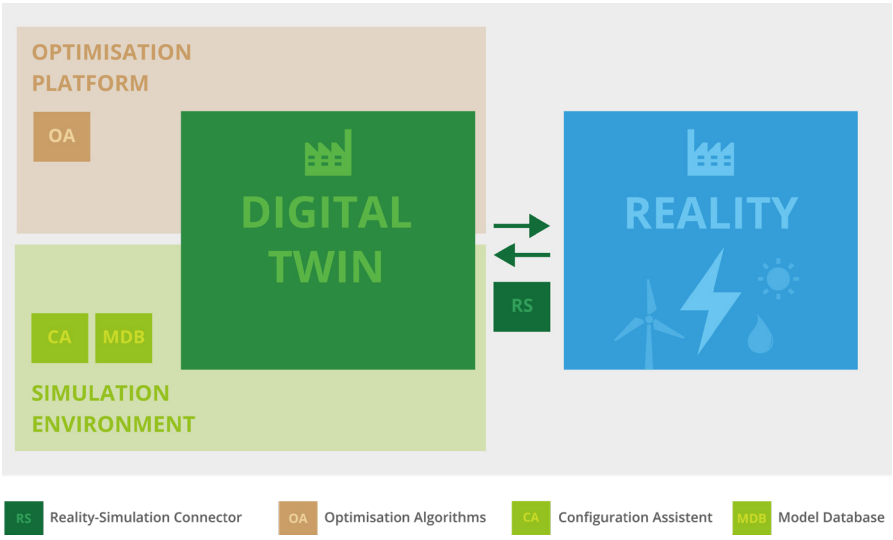
EXECUTIVE SUMMARY

The ITEA project SPEAR, coordinated by EKS InTec, aims to combine real-world production processes with digital twins in a simulation environment in order to accurately measure and optimise energy usage. Through its open approach to its optimisation platforms and algorithms, the project aims for uptake by companies of all sizes and a corresponding rise in the use of renewable energy in production plants.

PROJECT ORIGINS

In industrial plants, energy optimisation is impossible if there is no knowledge on how much energy is needed to perform a production process. The current norm, however, is optimisation upon a specific product purchase without further impact analysis, largely due to a lack of energy measurement units integrated into real production systems. Additionally, energy modelling requires huge investments in both time and money and there are no established simulation environments for the running phase. The market must change for energy optimisation to become truly accessible.

SPEAR (Smart Prognosis of Energy with Allocation of Resources) drives this change through its flexible optimisation platform, which aims to improve the energy profile of industrial production processes. Digital models (called energy models) have been created to represent the energy behaviour of each component in the production system, inputting real signals from the system's programmable logic controller (PLC) into a simulation environment in order to calculate its needs. The resulting energy profiles are linked to a model of the production system process to enable the relevant optimisation, such as peak-shaving or Single Machine Scheduling.



Accurately measure and optimise energy usage by combining real-world production processes with digital twins in a simulation environment.

TECHNOLOGY APPLIED

SPEAR's main technological component is the optimisation platform, which uses algorithms to create an accurate prognosis of the expected energy consumption and is available as either a local application or cloud-based service. As the algorithms are separate from the cloud platform, users are able to extend them via an open interface. This is supported by a simulation environment containing a configuration assistant and model database. By simulating behaviour models on low-cost hardware, SPEAR extends digital twins of the production processes with energy models that represent holistic descriptions of characteristics, such as dynamic information.

Four diverse use-cases have been developed. For body-in-white car manufacturing, a virtual commissioning demonstrator of a station uses the same robot and PLC code of the real station whereas a real demonstrator evaluates the optimisation algorithms and data acquisition while defining the requirements needed to implement research results. The second use-case (manufacturing of various car parts from rubber and metal) focuses on the validation of functionalities, performance and usability in the simulation and

real environment as well as energy consumption prediction and optimisation for an Automated Guided Vehicle (AGV).

In the third use-case, a simulator has been created for a bakery's predicted data consumption, taking into account the optimisation of a real-time energy provider and costs per kilowatt per hour. The final use-case aimed to improve energy efficiency in textiles, including energy diagnosis, prognosis and production scheduling optimisation. SPEAR also features a standard description to enable generic process descriptions which are distinct from these use-cases.

MAKING THE DIFFERENCE

Energy optimisation is one of the grand challenges of today, so SPEAR's results must be placed within a bigger context of both business and society. By helping companies to optimise their energy usage, SPEAR enables them to manage resources more effectively and increase their productivity in a sustainable manner. SME Reeb-Engineering, for instance, has realised a service for simulation-based AGV path planning while taking energy consumption into account, allowing them to hire a new employee. KANCA, meanwhile, has seen an 8% decrease in kwh/kg and Atkas has improved its energy optimisation by 5%.

Technological improvements lead directly into commercial gains: through the smart selection of energy sources, the smart adaptation of process-relevant parameters and the reduction of power peaks, SPEAR has been able to reduce energy costs by roughly 10%. The project has also opened up business cases for the consortium. ÅF, for example, offers a new service called Real Virtual Commissioning, while Algoryx's AGX Dynamics simulation tool has been updated with a new module that can compute energy losses. Across the consortium, two new employees and nine PhD students have been taken on as a direct result of the project.

SPEAR will allow companies of all sizes to reap such benefits by making its results available as free software prototypes. Further dissemination is taking place through the formation of two standards: (1) an interface description for optimisation algorithms based on the Json data format and (2) an optimisation algorithm realised as a REST service. In turn, this should allow for a greater uptake of renewable energies (such as solar and wind) which were previously difficult to optimise on a large scale due to their weather-dependency. This gives SPEAR a vital role in reducing CO2 emissions and slowing the speed of climate change throughout society as a whole.

MAJOR PROJECT OUTCOMES

Dissemination

- More than 20 papers (e.g. CIRP CMS 2019, CIRP IPS², CIRP CMS 2020, etc.).
- Several presentations/demos at conferences/fair (e.g. SCEWC, SICP Symposium, etc.).

Exploitation (so far)

- SPEAR Optimisation Platform to perform energy optimisation (www.cloud.spear-project.eu).
- RF::PEAK tool for description of production process via AutomationML (AML) standard.
- Distributed Co-Simulator based on AML, Functional Mock-up Interfaces (FMI) and ROS.
- Web-based configurator for production systems based on AutomationML and FMI (https://as3850.lps.ruhr-uni-bochum.de/spear).
- Standard interface description for optimisation algorithm based on the Json data format (https://hub.docker.com/r/dailab/spear-rest-interface).
- Optimisation algorithm realized as REST service based on the SPEAR standard interface description (https://spear.aot.tu-berlin.de:8082/).
- Extension of the FMI based co-simulator RF::CSPy on normal hardware from ENTOC.

Standardisation

- Concrete suggestion for description of production processes via AutomationML standard.
- Suggestion for description of Optimisation Algorithms (standardisation group being sought).
- Provide SPEAR results for energy modelling via FMI to Cadenas (ENTOC FMI Store).

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September 2017

Project end
September 2020

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