Cut a tech-dash

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The three-year ongoing IHATEC[1]-funded project Port Energy Management Dashboard – dashPORT strives to enable port companies and terminal operators to achieve cost savings through a holistic energy-management of both the entire port and all parties that operate within. By developing a working prototype in the German Port of Brake, dashPORT aims to realize efficiency gains by using Artificial Intelligence (AI) and Internet of Things-applications (IoT) to help optimally sequence the energy needs of ports, hence improve their ecological and economic bottom line.

Multipurpose ports are highly complex and dynamic ecosystems where numerous operations intersect. This complexity is reflected in their energy consumption: electricity is needed to power cranes, lighting, pumping stations, locks, ventilation systems, charging of electric vehicles, post-processing systems, gates, winches and office buildings.

Each of these electric consumers is involved in its own processes, which are typically scheduled independently. Such processes may be required at any time, and therefore they often overlap. This translates into highly irregular load profiles, i.e., the amount of energy being consumed at any given time. There may be times where energy consumption is very low, followed by an extreme peak when, e.g., locks need to be opened while cranes start unloading a vessel.

At the same time, energy providers need to plan energy production and the grid composition based on the maximum load required. If demand is difficult to forecast, and riddled with peaks, the network has to be operated in a way that such peaks can be levelled out. Unsteady demand patterns can also make the incorporation of renewable energy sources, with their inherently irregular input, even more difficult. To give industrial customers an incentive to avoid load peaks, grid operators measure the load in 15 minute-intervals and record the highest peak in a billing period. This peak is then used as the base for the network utilization fee (e.g. €50 per kW at the peak) for that billing period.

Therefore, the motivation to keep peaks as rare as possible in ports is twofold. First, there is the direct cost implication, which can greatly affect the overall electricity costs. Second, optimized load profiles make forecasting energy demands easier, allowing energy providers to operate on a more stable basis.

Granular outfitting

The dashPORT project started in 2019 and aims to tackle this particular issue prototypically in the Port of Brake. The team is made up of four parties: the port owner Niedersachsen Ports GmbH & Co. KG, the terminal operator J.Müller AG, the IT house OFFIS – Institute for Informatics, and our research foundation Fraunhofer Center for Maritime Logistics CML.

Brake is a multi-purpose port located between Bremerhaven and the Hanseatic City of Bremen at the river Weser. It comprises two quays, northern and southern, and an inner harbour accessible via a sea lock. The southern port area serves as a cargo handling spot for feedstock and grains, while the northern section, with its heavy load capable quay, is utilized for taking care of forestry products, iron, steel, and project cargo like industrial machinery. In the inner harbour coasters and barges can be cleared and handled.

Historically, the involved parties used to handle their energy management individually, relying on analogue meters which were checked manually, once per billing period. Naturally, this fragmentation causes an unoptimized load profile, with abundant peaks and unpredictable cost. With digitalization in ports still just ramping up, it can be assumed that this situation is the rule rather than the exception among the ports of the world.

Within dashPORT, IoT devices are to be used to closely observe the granular energy demand per consuming machine of both parties in the Port of Brake. The live data is fed into a dashboard and simultaneously analysed by an AI decision support system. Using deep learning methods, it can incorporate the processes behind energy demands and thanks to its algorithms, also forecast the load profile of the port as well as offer advice to operators on how to improve it in the short-term.

To realize this, Fraunhofer CML together with OFFIS first analysed the processes of Niedersachsen Ports and J.Müller in the Port of Brake. Mapping the processes from the first message of a vessel which plans to arrive at the quay to a loaded truck or train leaving the port's premises, and vice versa, is the necessary groundwork to identify causal

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relationships between them, as well as to gauge the optimization potential. Based on the process analysis, over 500 individual electric machines and equipment have been chosen and are currently being outfitted with smart meters, which can parse live data into the dashPORT system. The selection of electrical consumers is based on several criteria. First and foremost, their wattage and frequency of use. Secondly, their controllability, i.e., whether the use can be flexibly scheduled, and if it can be operated in different intensities, and their relevance for data-consistency and forecasting.

Once the infrastructure is outfitted accordingly, data collection begins. Over the span of six months, live data from the smart meters will be collected and analysed with the help of deep-learning algorithms. As more and more patterns arise in this analysis, the system will come up with ideal theoretical daily load profiles of the port, based on an everyday energy demand forecast. These optimal load profiles then have to be categorized and adapted regarding their operational feasibility. Finally, the researchers will refine the system in coordination with the industry partners so that it can detect deviations of the optimal load profile and provide recommendations for action to the operators at the port as to how to adapt their current energy use in order to be as close as possible to an optimal load profile, without jeopardizing the day-to-day business.

It is expected that these recommendations would range from shifting an energy-intensive process to a later point in time, to such seemingly mundane things like suggesting turning off a running system that is not currently used for anything purposeful. After the development is finalized, dashPORT will be introduced by both parties, the port authority and the terminal operators – Niedersachsen Ports and J.Müller.

Do your dash

DashPORT will help the Port of Brake to holistically alter their electric load profile, consequently reducing unnecessary costs substantially and facilitating a more efficient grid operation. All while additionally promoting a rise in awareness regarding energy consumption in general by visualizing momentary energy demand – as any classic energy monitoring system would.

The project shows how even low-level IoT devices can simplify time-intensive processes, like in this case the periodic control of hundreds of analogue meters, while also collecting the data that is needed for any kind of further optimization and efficiency gains.

When the project ends in 2021, all findings and procedures will be published to disseminate and to communicate the adoption of such intelligent energy management systems to ports, but also to any kind of other large industrial infrastructure, by showing their obvious economic and ecological benefits. ■

[1] *Within the Innovative Port Technologies (IHATEC) funding programme, the Federal Ministry of Transport and Digital Infrastructure (BMVI) supports research and development projects that contribute to the development or adaptation of innovative technologies in German sea and inland ports and which help to manage cargo handling volumes and improve logistics chains. The BMVI is providing around €64m for this purpose in the period 2016-2021.*

Fraunhofer CML

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