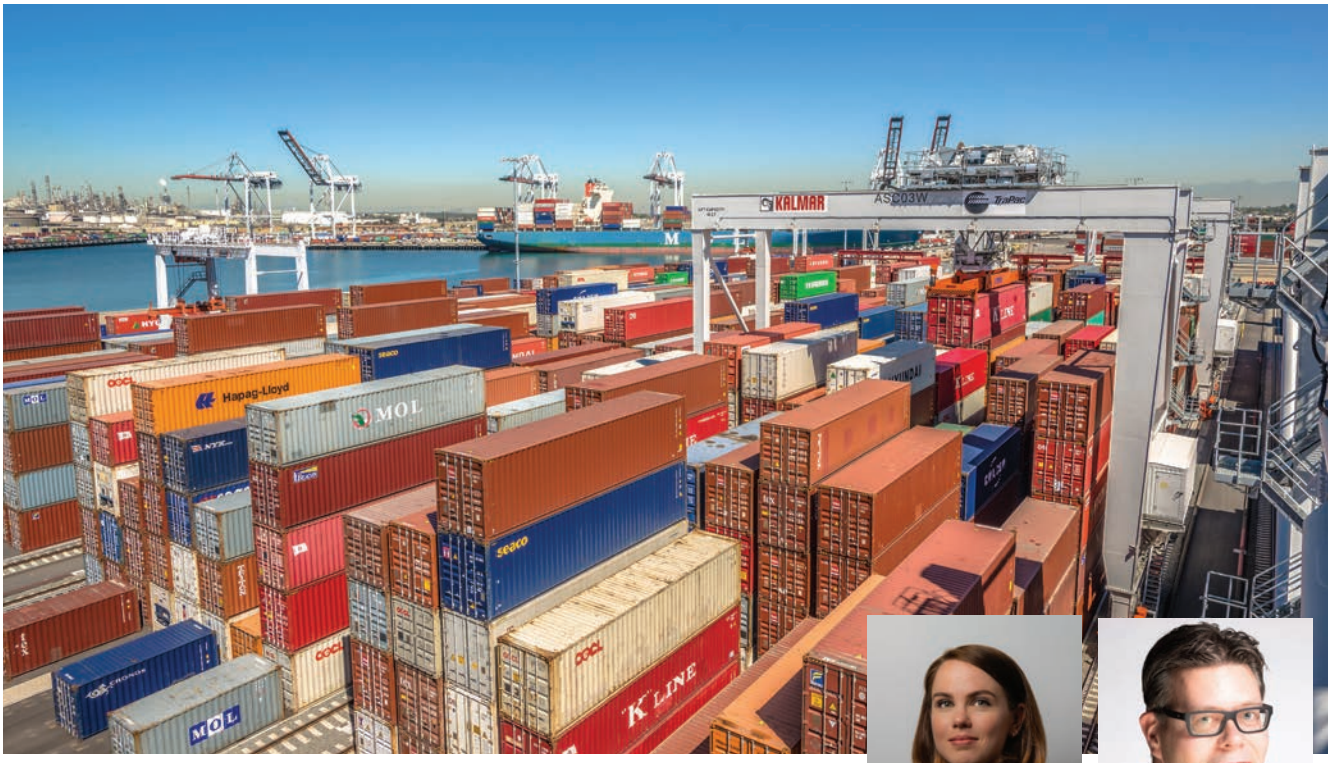

DATA AND AI DRIVE ELECTRIFICATION AT CONTAINER TERMINALS

By Dr Hanna Grönqvist, Data Scientist, Data Driven Services;
Pekka Mikkola, Director, Data Driven Services, Cargotec

Societal and mediatic discussion about technology has in recent years been heavily focused on artificial intelligence (AI). This expression and the hype surrounding it gives rise to strong emotions: it is either extremely exciting or terrifying depending on whom you ask. Perhaps the only somewhat universal sentiment is that of confusion or ambiguity as to what all of this means. There being no shortage of articles written on the subject of AI in general, in the following we will simply shed some light on how this technology can be used in terminal operations for improved eco-efficiency and productivity.

WHAT IS AI AND WHAT MAKES IT USEFUL?

In the Middle Ages philosophers looked at the night sky and wrote down the position of stars; using mathematics it became possible for the philosophers to foresee future positions based on previous ones. Today this kind of intelligence normally associated with humans is increasingly done by computers and this reasoning is called "artificial intelligence". With computers available to do most of the hard lifting it has become possible to study more complex problems than mapping the positions of stars. Contemporary examples include targeted internet ads based on browsing history, suggestions of people to connect with on social media based on current contacts and fingerprint or facial recognition for unlocking a smartphone.

In the global logistics industry and for container terminals in particular the relevance of AI lies in deciphering patterns in the thousands of factors that affect operations. These can be related to the machines and their work cycles, to the containers being moved, the incoming and outgoing vessels, the gate, the yard and even external factors such as the weather or tidal waters. In the above example of movements of stars, it is possible for humans to draw the coordinates on a piece of paper, connect the dots and predict future behaviour.

The power of AI comes because this same fundamentally simple reasoning can be applied to systems with seemingly so many parameters that the human mind struggles to keep track of all of them. Fortunately, computers have no trouble with simultaneous processing of a multitude of parameters and can furthermore be programmed to find relevant dimensions through a process called feature engineering, potentially simplifying things but without any guarantee of success. In terminal operations one typically encounters problems that do not necessarily have exact solutions or else are not solvable in a reasonable amount of time. While waiting for quantum computers to become a commodity, this implies that trade-offs always need to be made -- the best one can do is to find a good-enough approximation.

UNLOCKING BUSINESS BENEFITS USING AI - THE PATH TOWARD FULL ELECTRIFICATION

There is constant pressure on terminal operators to improve both efficiency and productivity at the same time as the global logistics industry grows. The overall volume of containers moved across the globe increases and this development is accompanied by new and ever more stringent regulations on sustainability entering into force. The apparently conflicting nature of these two outlooks is fruitful ground for innovation: through the smart use of data efficiency improvements and emissions reductions can be attained and global trade can continue all the while supporting the battle against climate change. Furthermore, allowing the continuation of global trade means that billions of people in developing countries can be given opportunities for livelihood, be lifted out of poverty and improve their standard of living in a sustainable way.

Kalmar started its electrification journey almost fifty years ago, concretely taking action to develop new technology. The company's rail-mounted yard crane offering has been electrically powered for decades, and the world's first mains powered RTG was introduced already in 2002. Today, over 50% of Kalmar cargo handling equipment is available with electric power sources.

The first steps of becoming the leader in introducing diesel-hybrid solutions have recently been continued with offering electrically powered solutions such as Kalmar FastCharge to the market, and as a company, Kalmar is committed to providing the entire range of container-handling equipment with fully electrical drivelines in 2021. In the existing equipment offering there are also machine types that apply active energy recovery in the course of normal operations. For straddle carriers with hybrid and electric drivelines, the maintenance-free regenerative energy system converts braking and spreader lowering energy into electrical power and stores it in a state-of-the-art on-board lithium ion battery system.

The key takeaway in transitioning to electrically powered machines is that machines cannot be considered as separate entities but the overall operation needs to be understood and this is where data analytics comes in. In comparison with diesel drivelines, electrification brings many more and new types of constraints that need to be simultaneously balanced: drivelines, battery chemistries, depths of charge thresholds, chargers, charging opportunities and grid requirements just to name a few. Compared to the diesel driveline, electric machines need to be charged more often and at the right time, maintaining the state of charge at a safe level and maximally supporting the operations. This means that the location and timing of charging needs to be planned.

AI-POWERED TOOLS AS A BASIS FOR ELECTRIFICATION

A data-driven approach to understanding the needs of a given terminal is studying the current operations and computing the energy needed for accomplishing them. In this way the dynamic energy requirements can be mapped and only then can infrastructure installations (greenfield) or upgrades (brownfield) be planned. Understanding the key elements in operations such as container masses, work cycles and driving patterns have enabled Kalmar's energy modelling capabilities and the creation of AI-driven energy models for different equipment types. Without the globally collected telemetry data from Kalmar equipment such analyses would be impossible to do, showing just how data drives innovation and brings about unexpected and potentially life-changing insight and solutions.

In practice the use of AI-powered modelling means that a customer can describe their operations with a set of key parameters that serve as input and giving as output an accurate plan including equipment deployment, charging events and their timing together with the positioning of charging stations. It is important to note that the quality of the output depends on the quality of the input as the saying "garbage in, garbage out" goes. Quite concretely, the better the relevant processes and operations are understood, the better the predictive power of this AI-enhanced optimization tool.

SUSTAINABLE END TO END CONTAINER OPERATIONS

Modelling the energy consumption of machines is not the end of the story: when planning for electrification multiple external factors also come into play. One of the main questions is that of securing and optimizing the electricity supply, in particular for brownfield terminals where the current infrastructure may be inadequate or economically prohibitive for the heavy consumption of a fleet of electrically powered machines. Electricity providers therefore have an important role to play in setting up the best possible infrastructure. Once the energy modelling has been done with the help of AI, terminal operators may choose their preferred origins of energy considering their respective environmental impacts together with costs, resulting in emission-free end to end container operations.

Summarizing the main opportunities and challenges presented above, we emphasize that first of all, the globally observed mega trend of electrification exposes a vast opportunity for cargo handling operations, allowing full end-to-end processes to rely on sustainable energy. Secondly, the mega trend of AI has already proven helpful in understanding the extremely complex system that a container terminal is. Thirdly, Kalmar believes that data-driven methods such as AI are crucial for making the transition to electrically powered fleets possible in a judicious and factual manner instead of having to resort to speculation and uncertainty.

ABOUT THE AUTHORS

Dr Hanna Grönqvist works as a Data Scientist in the Data Driven Services team at Cargotec. Hanna has been working at Cargotec since 2018 after finishing a PhD in theoretical physics and working in a startup at the intersection of nanotechnology and software. She is passionate about applying analytics from a top-down perspective to enhance the level of intelligence in operations across the Cargotec business areas.

Pekka Mikkola works as Director, Data Driven Services at Cargotec. Pekka has been working at Cargotec since 2009 in various positions. Prior to that he has been working with Services development and Business consulting for more than 20 years. Pekka has founded Cargotec IoT Cloud, which is a platform for creating intelligent services using data and analytics. Pekka's team contributes to Cargotec's offering and services development bringing data insights and AI/ML capabilities.

ABOUT THE ORGANIZATION

Kalmar, part of Cargotec, offers the widest range of cargo handling solutions and services to ports, terminals, distribution centres and to heavy industry. Kalmar is the industry forerunner in terminal automation and in energy efficient container handling, with one in four container movements around the globe being handled by a Kalmar solution. Through its extensive product portfolio, global service network and ability to enable a seamless integration of different terminal processes, Kalmar improves the efficiency of every move.

ENQUIRIES

www.kalmarglobal.com
kalmar@kalmarglobal.com