
DTU

Industrial IoT for Digitization of Electronic Assets

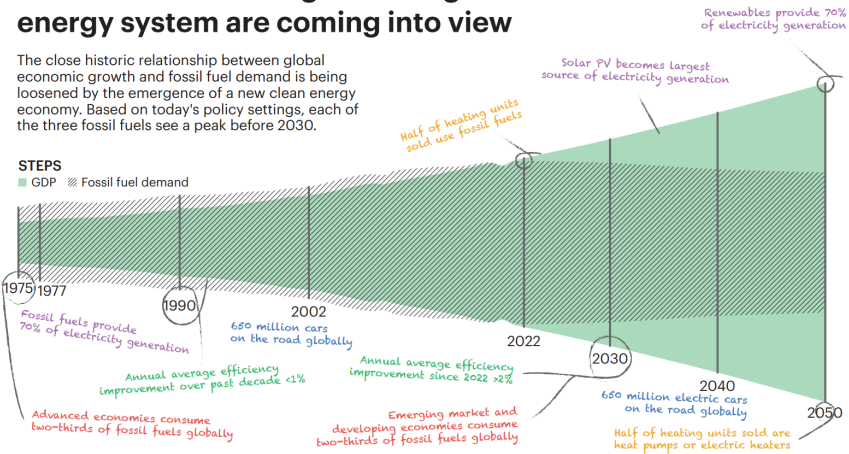
Digital Twins & Green Transition: An Introduction

Agenda

- The goals of the green transition.
- The European Targets.
- Future Projections in Denmark.
- Future Challenges.
- Digital Twins (DT): Some Definitions.
- Boosting the Digitalization with **DT**.

Transformative changes of the global energy system are coming into view

The close historic relationship between global economic growth and fossil fuel demand is being loosened by the emergence of a new clean energy economy. Based on today's policy settings, each of the three fossil fuels see a peak before 2030.



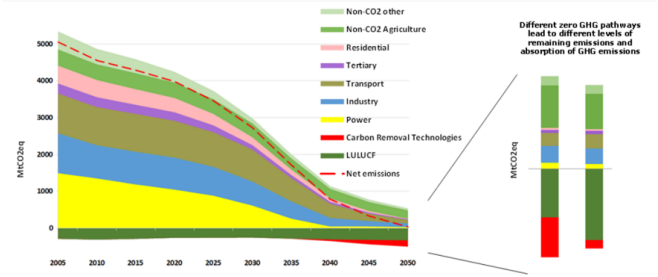
World Energy Outlook 2023, iea

The Green Transition and European Targets

Europe has set the goal of reducing 40% of Greenhouse Gas emissions by 2030 and 80-95% by 2050, to reach the target of maintaining global atmospheric warming below 2° C. To accomplish this target, massive investment in renewable is on the way:

Key Goals:

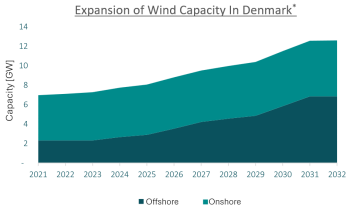
- 45% of Renewable resources by 2030
- **600 GW** of Solar Capacity
- **450 GW** of Wind Capacity

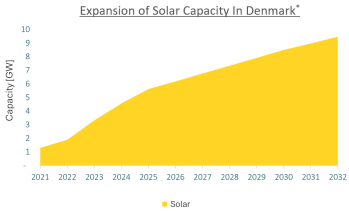


European policies on climate and energy towards 2020, 2030 and 2050

Future Projections In Denmark

Word leading country in wind energy with more than 44% of the energy production from renewable sources. Carbon Neutral by 2030, with Offshore and Onshore Wind up to 13 GW and Solar up to then 10 GW.





Energinet. (2022). SCENARIERAPPORT 2022 – 2032: Forventninger til fremtidens Systemydelser. Energinet

What Are the Main Challenges of an Energy System Based on Renewables?

Past and Future Challenges

- Higher chance of frequency disturbances.
- Higher capacity of Ancillary Services.
- Tailored control strategies.
- Optimize Storage and Production.

Past and Future Challenges

- Higher chance of frequency disturbances.
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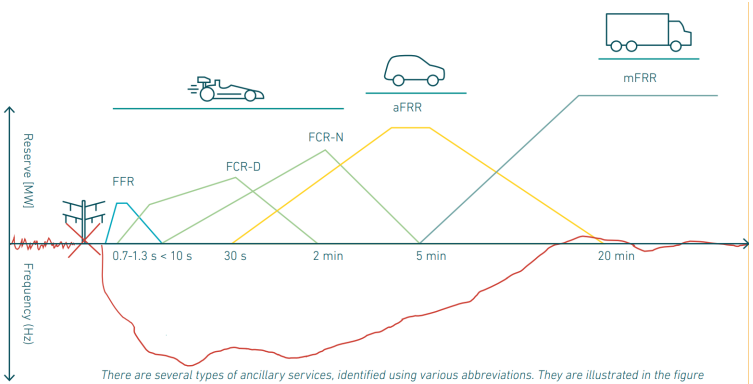
- Exploit flexibility of variable loads (*fans, drives, compressors*).
- Aggregate multiple presumers.
- Data-driven modeling solutions.
- Boosting digitalization in old energy assets.

Ancillary Services



There are several types of ancillary services, identified using various abbreviations. They are illustrated in the figure above using vehicles. The racing car represents small, responsive reserves, while the truck is a bit slower, but carries more load when it starts to move. The figure shows how a frequency drop (red curve) occurs in the event of sudden imbalances or outages. Various ancillary services are then activated to restore the frequency to the 'healthy' level (50 Hz). Frequency products must quickly add power to the system to mitigate the frequency drop and prevent it from falling to a critical level. The more energy-intensive services (aFRR and mFRR) have to relieve the frequency services, so these are available again to mitigate new frequency drops and restore balance.

Energinet - ANNUAL MAGAZINE 2023

Digital Twins: Some Definitions

"A digital twin is a digital replica of a living or non-living physical entity, such as a manufacturing process, medical device, piece of medical equipment, and even a person... to gain insight into present and future operational states of each physical twin." NIH -Interagency Modeling Analysis WG (2019)

"A Digital Twin is an integrated multiphysics, multiscale, probabilistic simulation of an as-built vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the life of its corresponding flying twin"
TA 11 (2010)

"Digital Twin -the application of interdisciplinary modeling and simulation across the product lifecycle."
John Vickers (2021)

"A digital twin is a virtual representation of an object or a system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making." –IBM (2021)

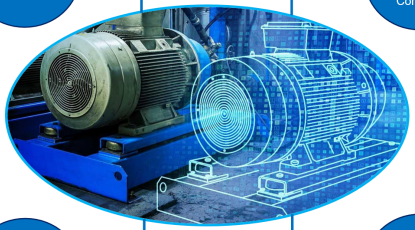
"A digital twin is a virtual replica of an object, being, or system that can be continuously updated with data from its physical counterpart."
Purdy, MIT Sloan

Digital Twins:

A core technology to boost the Digitalization

IoT sensors enable the real-time data transmission, which is used to create a digital duplicate of the real asset.

IoT



Modelling & Control

Data-driven modelling and tailored control strategies to enhance energy efficiency operation and provide grid support.

Cloud architecture allows access to the stored data from any location and enables to external computational capabilities

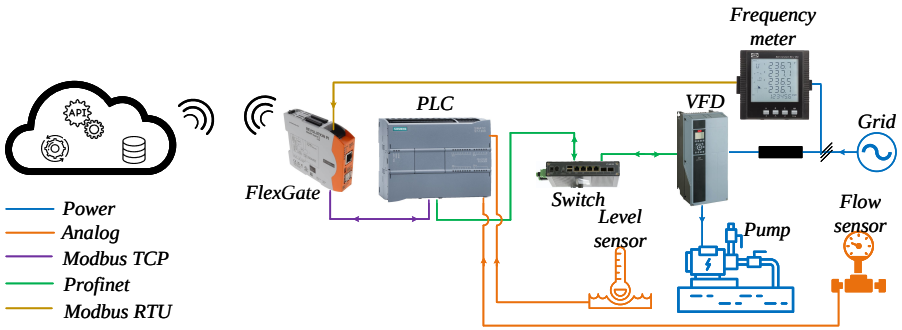
Cloud

AI

As Advanced analytical tool, AI analyze the data, offering real-time inference and condition monitoring.

Digital Twins:

An application example to the Wastewater in Bornholm.



Quattrociocchi, A., Subroto, R. K., Oppedijk, W. M., & Dragičević, T. (2023, October). Energy Efficiency Optimization of a Wastewater Pumping Station Through IoT and AI: A Real-World Application of Digital Twins.