



— 70 years —  
1950-2020

# DEVELOPING NEXT-GENERATION LI-ION BATTERIES FOR ELECTRIC VESSELS

Dr. Simon Clark – SINTEF Industry

NCE Maritime CleanTech Webinar, 23.06.2020

The technology landscape is changing, and batteries are a main driver of innovation today.



# Batteries Power Modern Life

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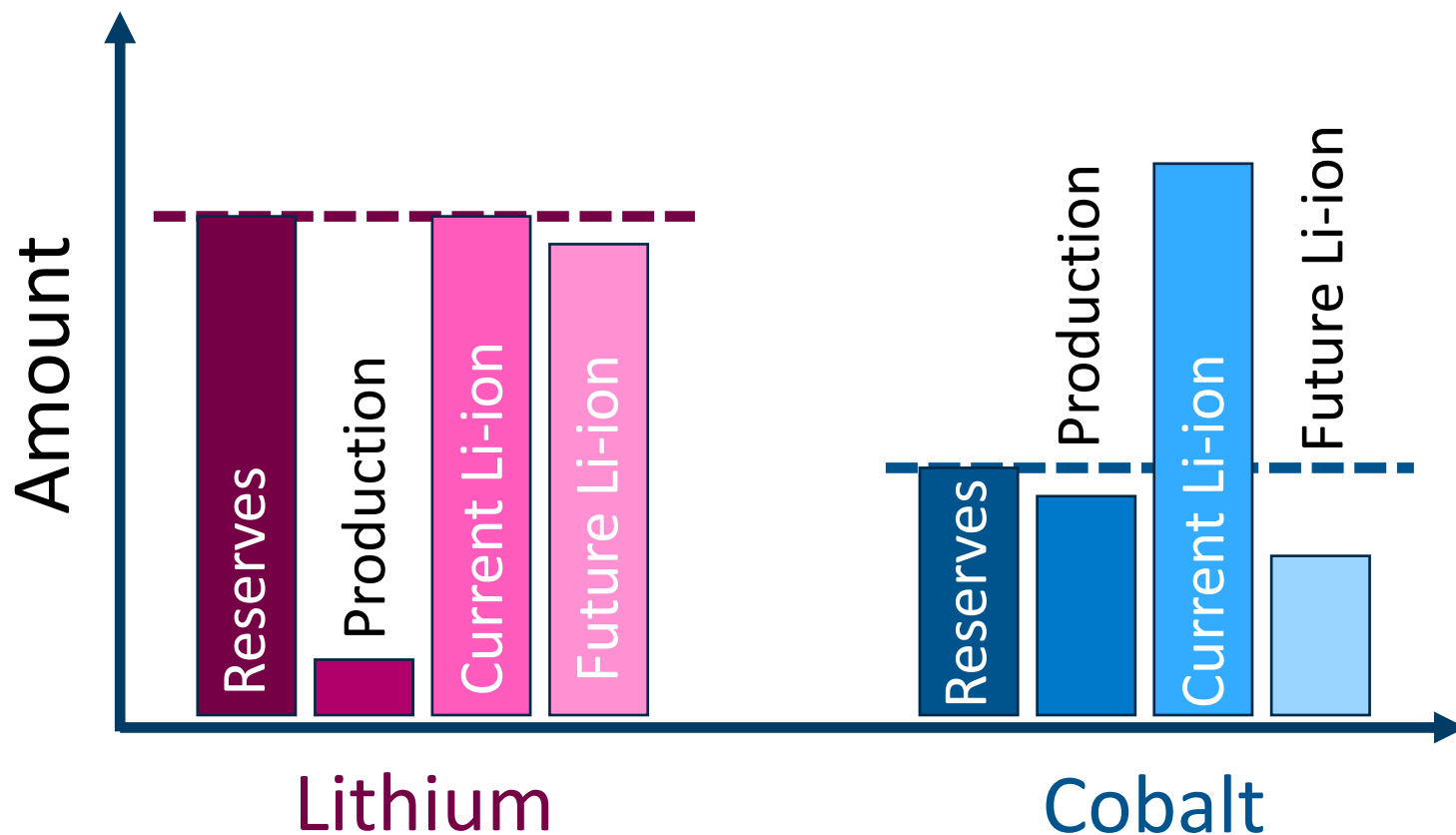
**Batteries are expanding** to new applications outside of traditional fields

**Lower prices** are making widespread EV uptake feasible

**Improved performance** is driving gains in electric shipping and aviation.

**What does this mean for the future of battery development and design?**

# Li-ion Supply Limitations Through 2050

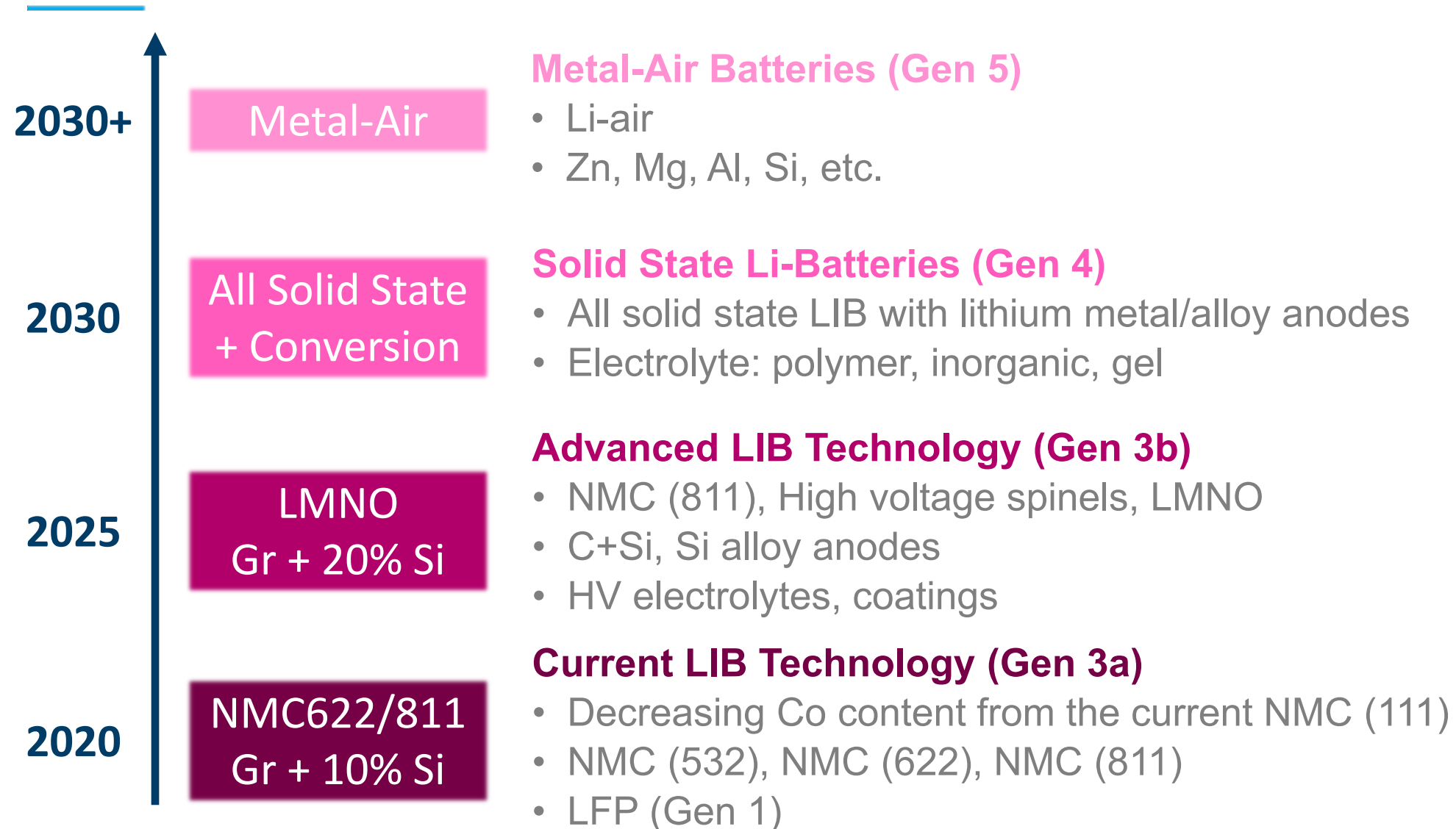


We Need:

- New Materials
- New Chemistries
- Better Cell Designs
- Improved System Engineering

...and we need them as quickly as possible

# Vision for Battery Development



# Li-ion Battery Technologies Today

## Technology

Tesla battery supplier Catl says new design has one million-mile lifespan

### Elon Musk: Tesla Battery Day happening in September

Battery Day is rumored to bring news on Tesla's "million-mile" battery.



Sean Szymkowski

June 22, 2020 11:41 a.m. PT



▶ LISTEN - 01:04



Enlarge Image

Big battery news could be just a few months away.

Tesla

Rumor: BYD Blade Battery Production Capacity To Reach 13 GWh



JUN 05, 2020 at 7:37AM

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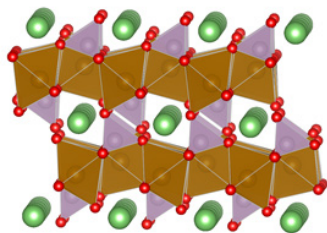
By: Mark Kane

2020 has seen some advances in Co-free battery development:

- CATL "million mile" LFP battery
- BYD LFP Blade



# Li-ion Battery Technologies Today

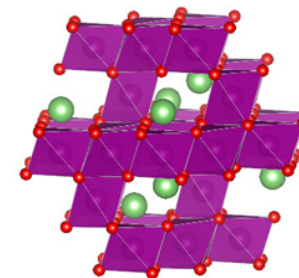


Lithium Iron  
Phosphate (LFP)

Power	★★★★☆
Energy	★★☆☆☆
Cost	★★★★☆
Safety	★★★★★
Cycle Life	★★★★☆



**Hybridized  
Electrodes for**  
High Energy,  
High Power and  
Long Life



Lithium Manganese  
Nickel Oxide (LMNO)

Power	★★★★☆
Energy	★★★★★
Cost	★★★★☆
Safety	★★★★☆
Cycle Life	★★☆☆☆

# The Concept

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**HYDRA**, taking its name from the mythological beast, will use a **multi-headed** integrative approach:

- Generation 3b Li-ion batteries **hybridizing high-power** with **high-energy** materials.
- **Si-C Anodes & Hybrid Cathodes**
- **Stable** electrolytes
- Model-based **novel component development**
- **Competitive EV batteries**
  - 90 € kWh<sup>-1</sup>

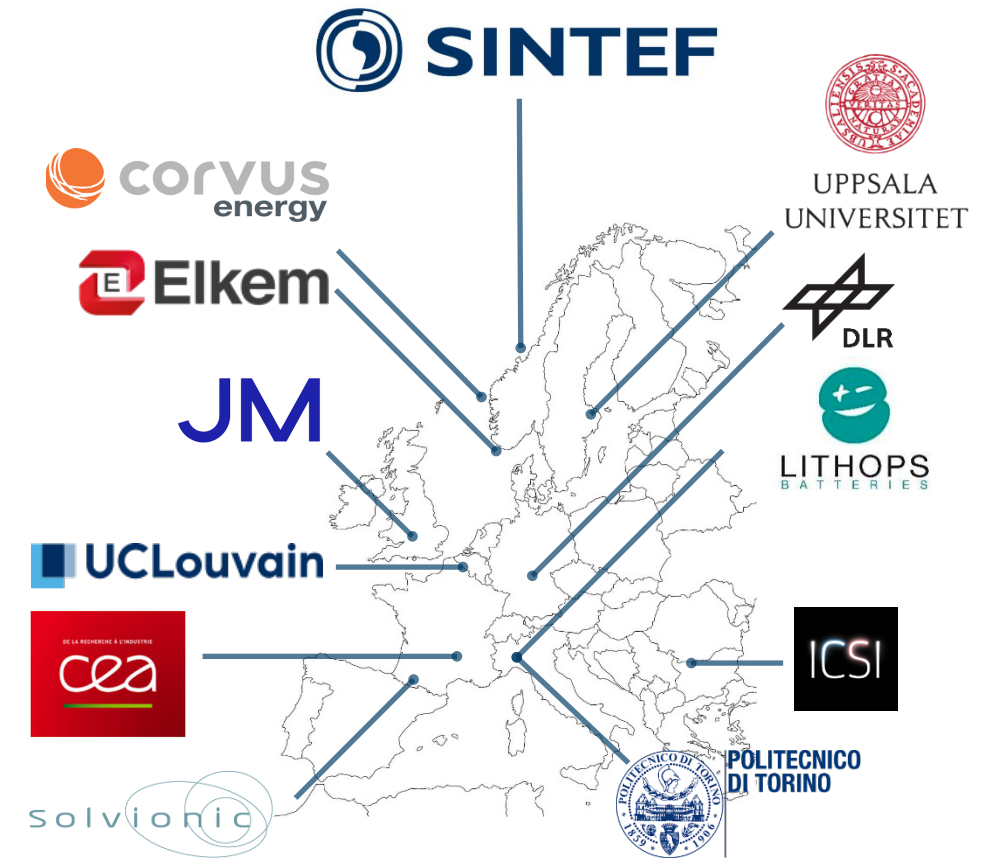




# The Project & Consortium



- **Topic:** Gen 3b Li-ion Batteries
- **Start Date:** 1 September, 2020
  - Delayed from 1 May due to COVID-19
- **Coordinator:** SINTEF
- **Industry Partners:** JM, Elkem, Corvus, Lithops, Solvionic
- **Research Partners:** SINTEF, UCL, CEA, POLITO, ICSI, DLR, UU
- **Funding:** EU H2020 LC-BAT-5, Grant Agreement No. 875527

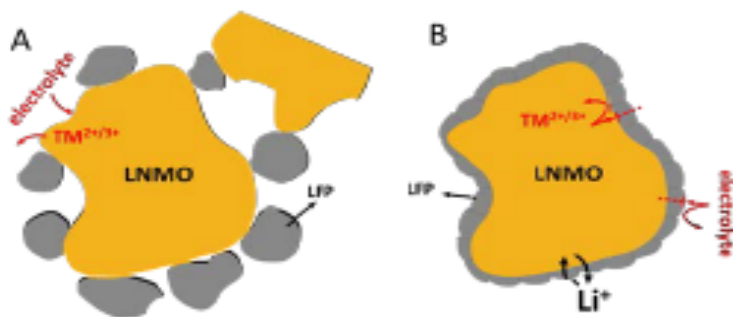


# The Approach

**HYDRA** will have a strong focus on sustainability and theory-based design & development

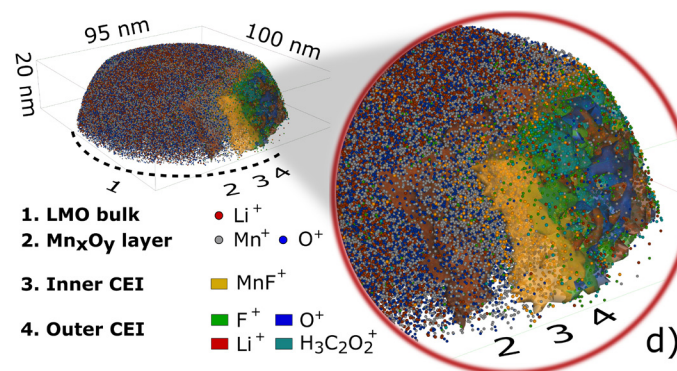
## Cobalt-Free Battery

LMNO-LFP Hybrid Cathodes  
Physical & Chemical Blends



## Advanced Characterization & Models

Materials, Components, Cells  
Linked Model-Experimental Workflow



## Sustainable, Optimized Manufacturing

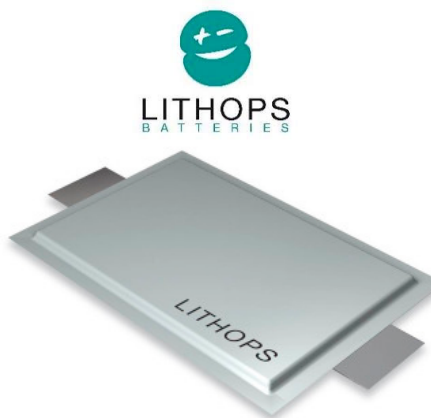
Aqueous Processing  
Pilot-Scale Production



# The Approach



**HYDRA** has **strong industry commitment** across the value chain with a focus on **sustainability**. The project will demonstrate **pilot scale production** and achieve **TRL 6**.



Electrode  
Materials

Electrolyte

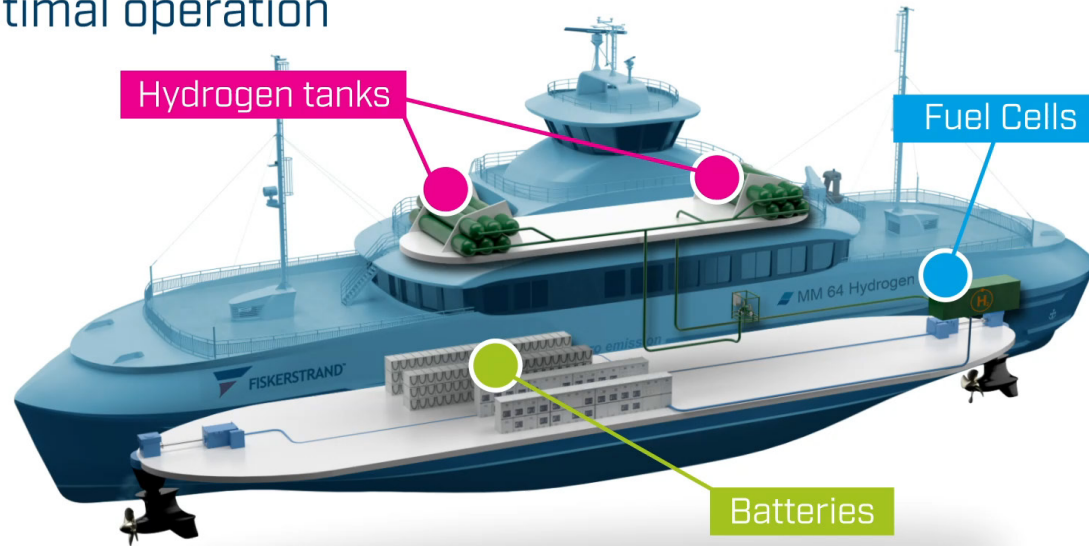
Cells

Packs

# Electric Vessel Integration - ZESES

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Systemdesign and  
optimal operation

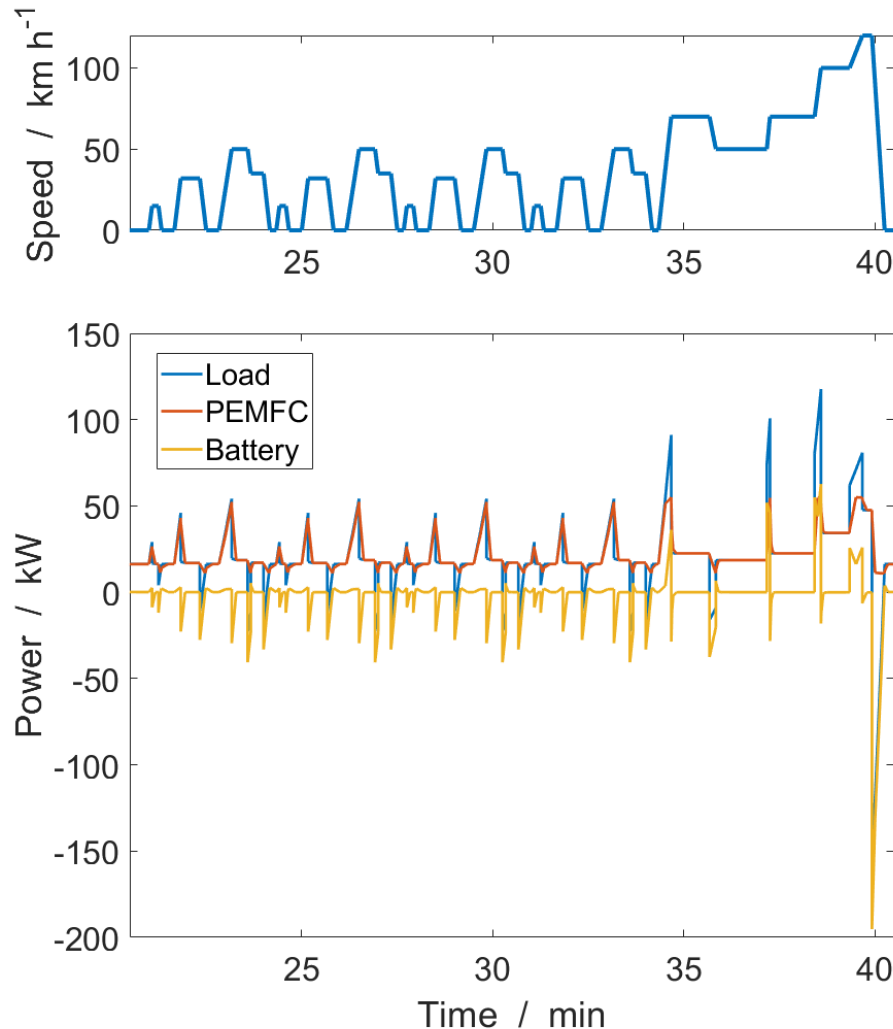


**ZESES is a SINTEF Platform for cost-performance-lifetime optimization of zero-emission hybrid ships.**

- **Calculates** optimized system costs and lifetime
- **Considers** vehicle loading profile, system sizing, etc.



# Electric Vessel Integration – Virtual-FCS



Virtual-FCS is a cyber-physical platform for X-in-the-loop development of hybrid PEMFC-battery systems

- **System level model** of electric vehicles
- Determine the performance of specific components (**model, software, or hardware**) under realistic conditions
- EU FCHJU-funded **open-source platform**.
  - Grant Agreement No. 875087
- Initial release in **Jan 2021**.

<https://www.sintef.no/projectweb/virtual-fcs/>

SINTEF is working to develop the  
**next-generation of light-weight  
batteries** and support their  
**integration in electric vessels.**

# Acknowledgements

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**Hydra – Grant Agreement No. 875527**

**VirtualFCS – Grant Agreement No. 875087**





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1950-2020

Teknologi for et bedre samfunn