Sustainable Aviation

Battery Technology for Marine VS
Battery Technology for Electric Aviation

Corvus Energy

07.10.20
Kristian Holmefjord

Corvus Energy

The leading supplier of purpose built energy storage solutions in the form of lithium ion battery systems to the maritime industry.

Kristian Holmefjord

- Production Electrician

- M. Sc. In Electrical and Environmental Engineering

- Research Scientist

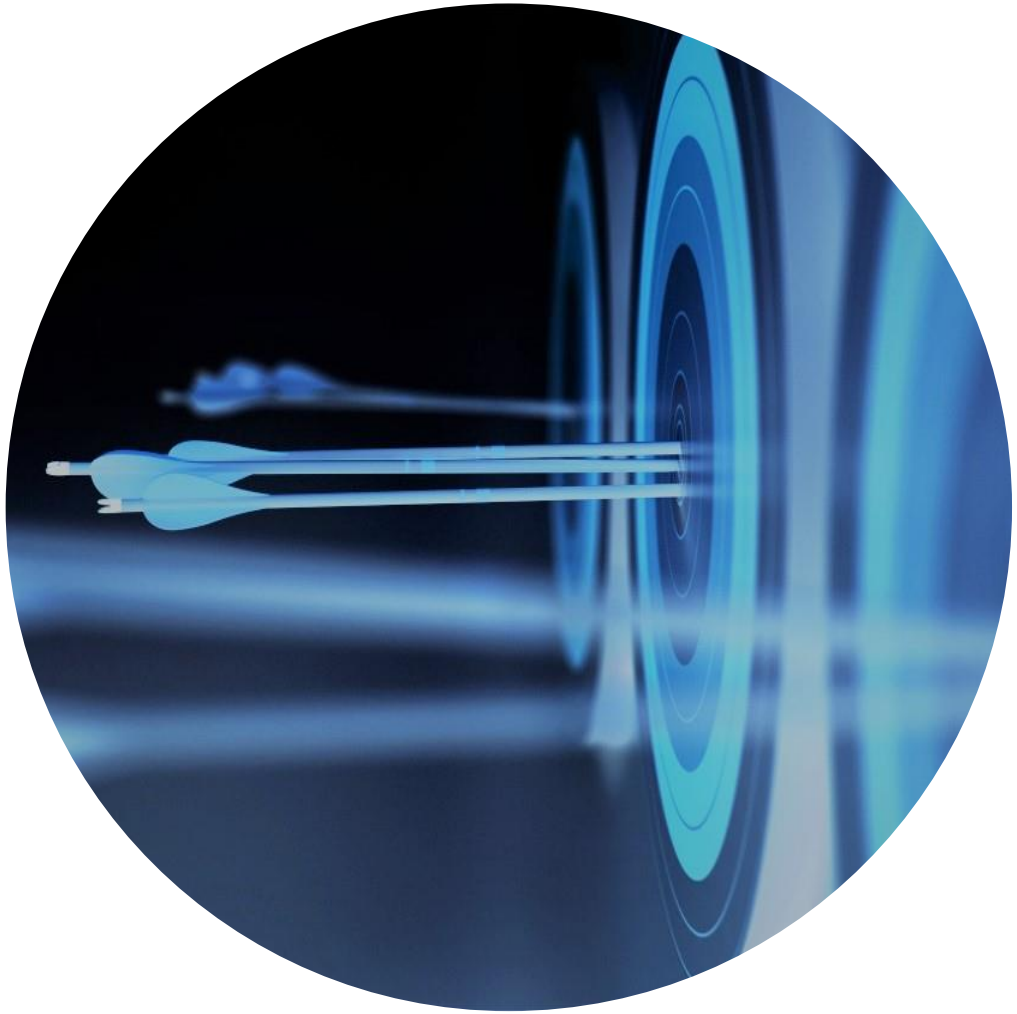
1. R&D Electrical Drives
2. Ship Design and Systems
3. System Design and Integration

- Aerospace Jet Engine Production Improvements

- Executive Vice President

Vision:

To be the leading provider of zero emission solutions for the ocean industries



Company Ownership

Since 2015
Equinor, (Statoil) Norway
Multinational energy company

14,5%

Since 2017
Hydro, Norway
Multinational energy and aluminum producer

21,1%

Since 2014
BW Group, Singapore/Norway
Global shipping company

22,1%

Since 2009
Angel investors, Canada
Canadian angel investors

21,0%

Since 2019
Shell, NL
Multinational energy company

14,7%

Other
Shareholders

6,6 %

Corvus Energy Holding AS

Norway

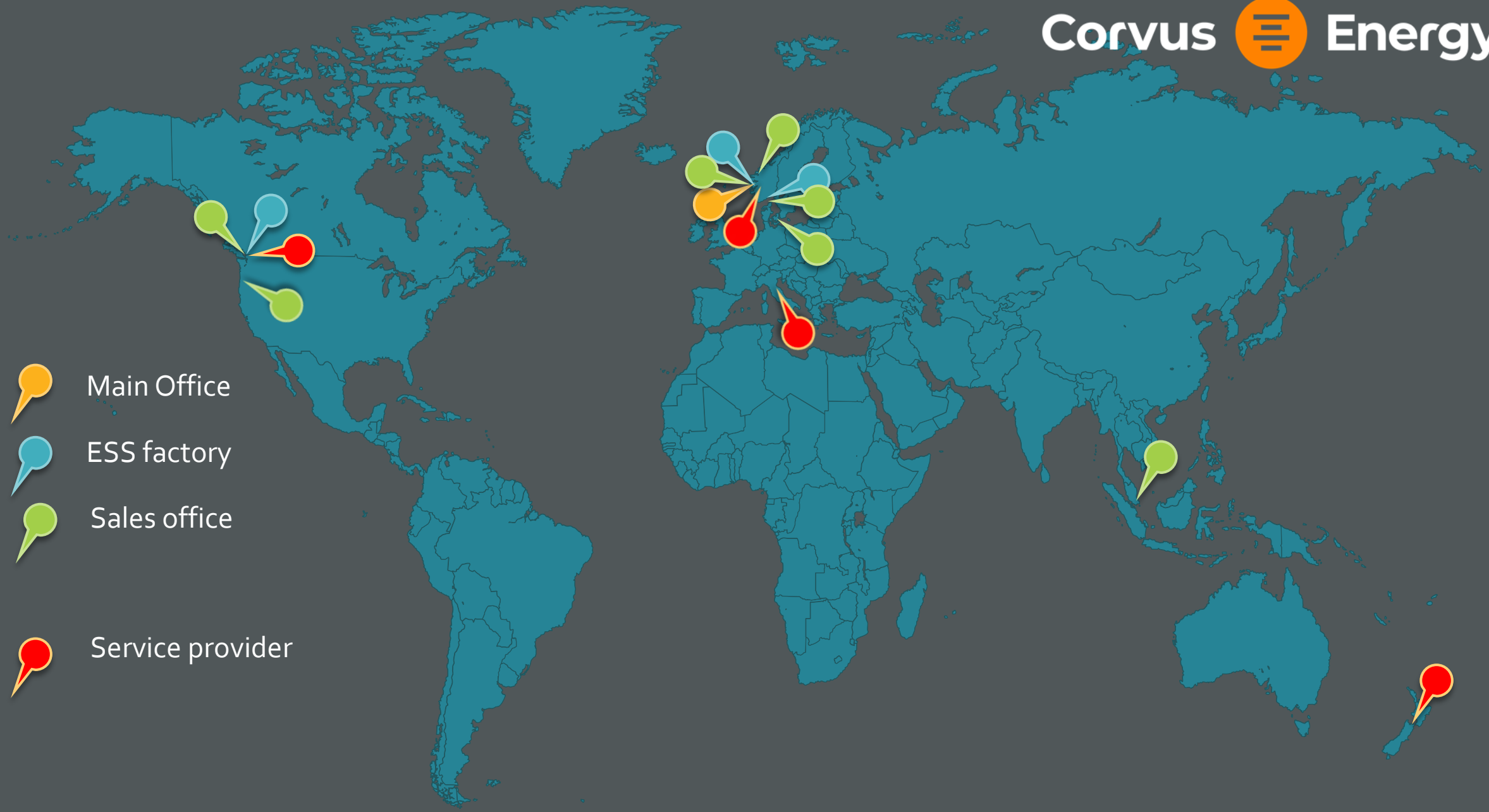
Corvus Energy Inc

Canada
100%

Corvus Energy AS

Norway
100%

Corvus Energy



Project Count

400 Projects

>3 000 000 operating hours

300+ MWh

107

Car and Passenger ferries

23

Cruise and Yachts

58

Offshore and Subsea

51

Tugs/

Workboat/

Fishing/

Research

21

Merchant vessels

138

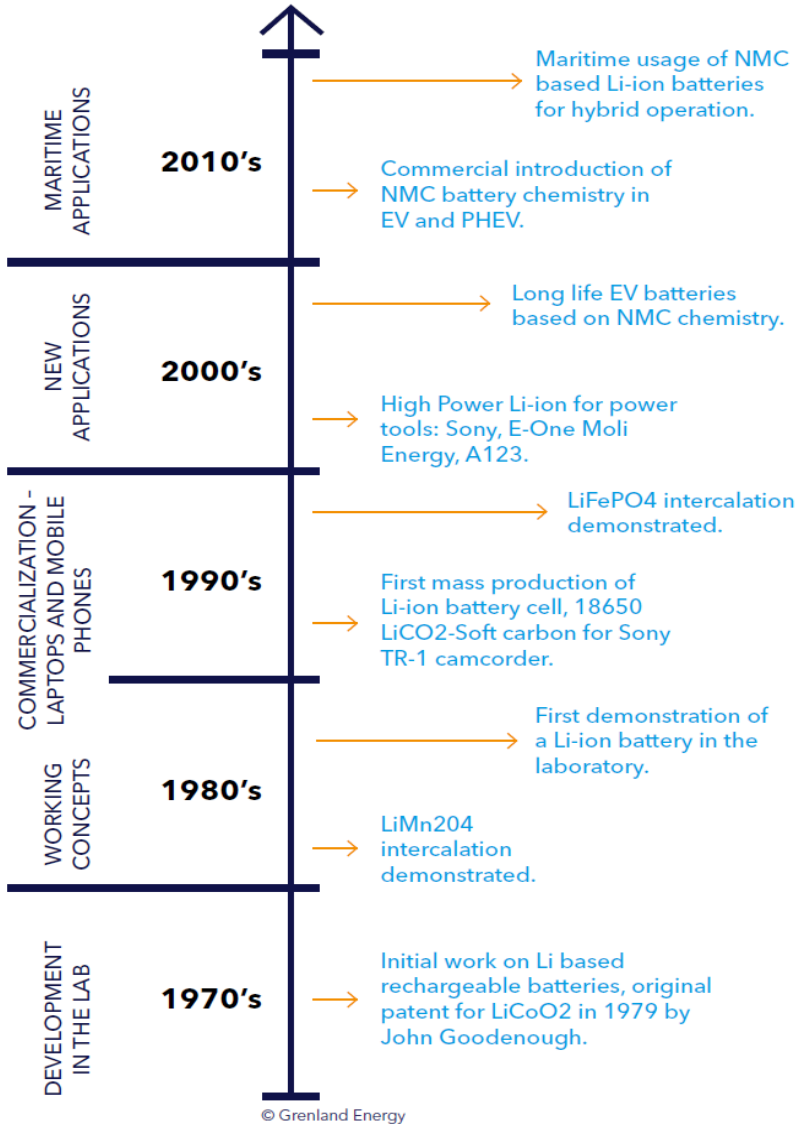
Port equipmentShore stations ++

Nobel Prize 2019

The Royal Swedish Academy of Sciences has decided to award the Nobel Prize in Chemistry 2019 to:

- John B. Goodenough, of The University of Texas, USA,
- M. Stanley Whittingham, of Binghamton University, USA,
- Akira Yoshino of Asahi Kasei Corporation, Japan

"for the development of lithium-ion batteries”



Corvus Energy

Breaking News

New battery tech could help electric cars charge in just 10 minutes

A battery technology worth its salt

A Battery Breakthrough That Could Help Industries Power Up

Post-Lithium Technology: High-Energy-Density Next-Generation Rechargeable Batteries

How we get to the next big battery breakthrough

New battery technology to charge an EV 100 times faster

Battery research: new breakthroughs in research on super-batteries

GM and LG Chem Team In $2.3 Billion Effort to Mass-Produce Battery Cells for Evs.

Tech Breakthrough: Is This The End Of Lithium-Ion Batteries?

…..with new battery technology that can fully charge less than 30 minutes

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Dec. 5th 2019

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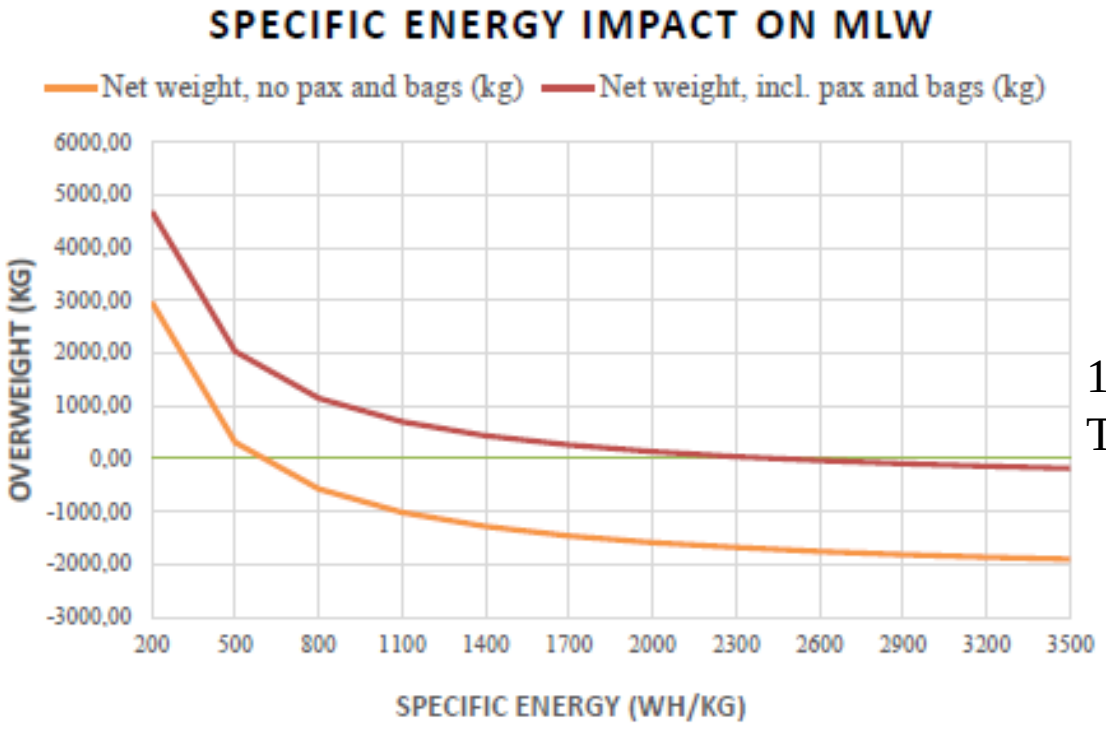
Energy Density – Air vs Marine

Bergen - Stavanger



"A minimum specific energy density of 679 Wh/kg is needed in order to begin to add passenger and luggage, and one will not be able to carry the full load until the battery reaches 2 539 Wh/kg"*

183 Wh/kg	vs	679 Wh/kg	vs	2 529 Wh/kg
Today	vs	Value Beginning	vs	High value

*K. Alvestad, S. Opsal Haug, S. Petersen Jikiun, Thesis

Corvus Product Comparison

HIGH POWER ← PERFORMANCE NEEDS → HIGH ENERGY

Corvus Blue Marlin

- Offshore
- Rig/Topside
- Regeneration of energy

Corvus Orca Energy

- OSVs
- Ferries
- Port Cranes

Corvus Dolphin Power

- Light weight
- High Speed Vessels

Corvus Moray Power

- Regeneration of energy

Subsea Niche Product

Corvus Dolphin Energy

- Light weight
- Long charge/ discharge

Corvus Moray Energy

- Subsea energy bank

Subsea Niche Product

Corvus Blue Whale

- Cruise
- RoRo/RoPax
- Slow Charge/ discharge

Corvus Product Comparison

HIGH POWER ← PERFORMANCE NEEDS → HIGH ENERGY

Corvus Blue Marlin

- 200C
- 550 Peak
- IP44

Corvus Orca Energy

- 3,0C
- 77 Wh/kg
- 13,0 kg/kWh
- IP44

Corvus Dolphin Power

- 2,2C
- 4,4C for 10s
- 130 Wh/kg
- 7,7 kg/kWh
- IP23

Corvus Moray Power

- 0,55C
- 1,1C for 10s

Subsea
Niche Product

Corvus Dolphin Energy

- 0,5C
- 1,1C for 10s
- 183Wh/kg
- 5,5 kg/kWh
- IP23

Corvus Moray Energy

- 0,2C
- 0,77C for 10s

Subsea
Niche Product

Corvus Blue Whale

- 0,7C
- 1,0C for 20min
- 112 Wh/kg
- 8,9 kg/kWh
- IP44

The all-electric evolution

Corvus AT 6500

2016

Corvus Orca Energy

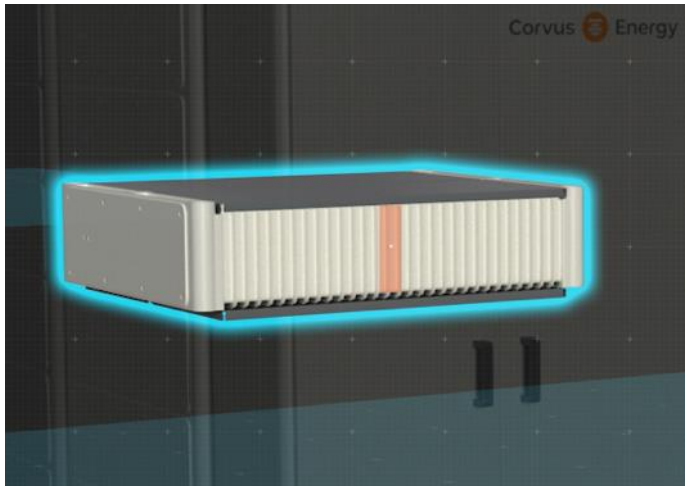
2019

Corvus Blue Whale

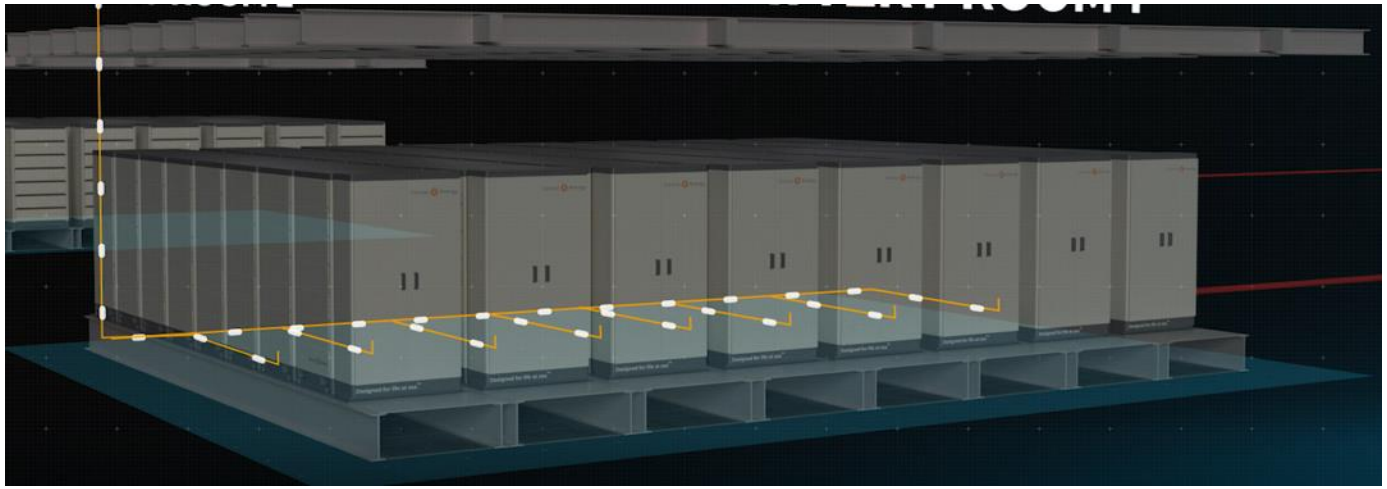
Footprint	50 %
Volume	50 %
Weight	30 %

Footprint	50 %
Volume	50 %
Weight	30 %

Safety – Air and Marine



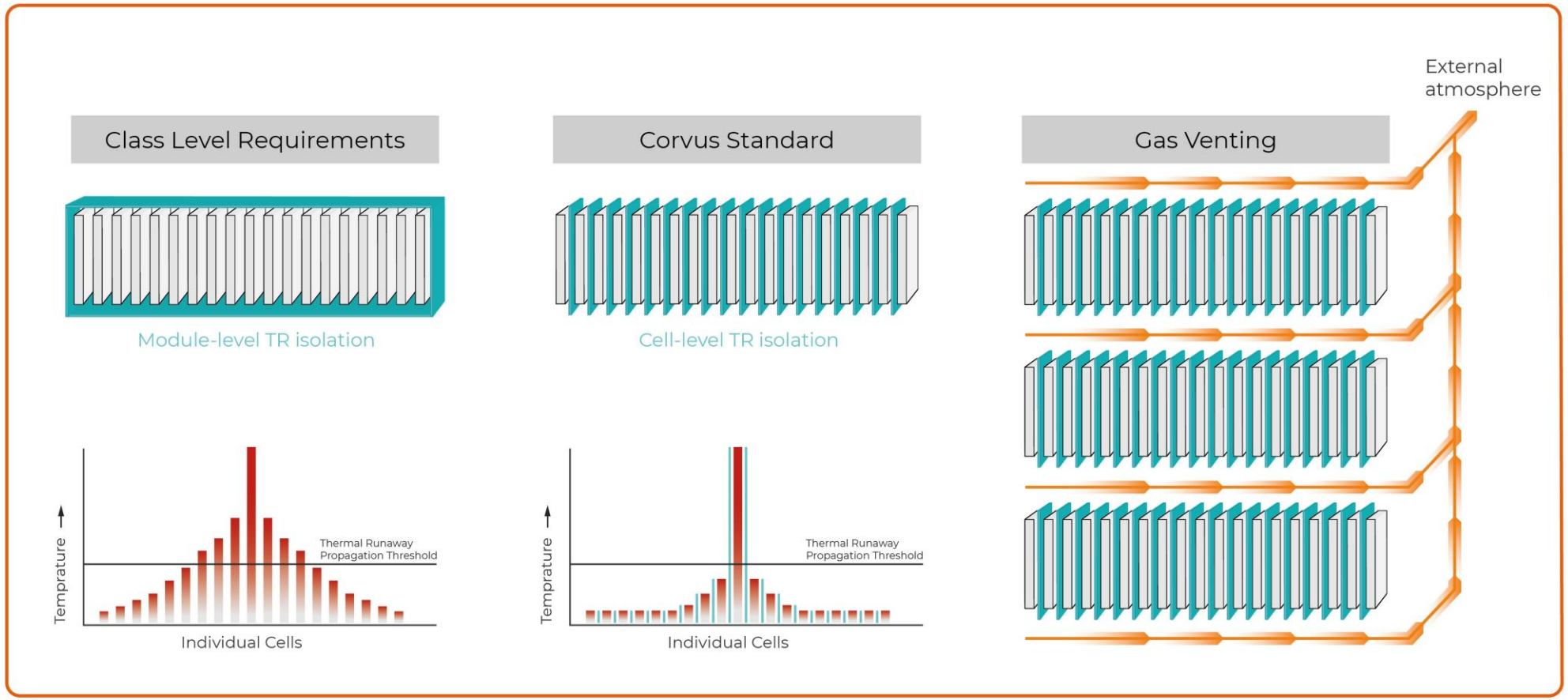
Single Cell Passive Thermal Runaway Insulation



Integrated thermal runaway gas exhaust system. TR gas is easily vented to external atmosphere.

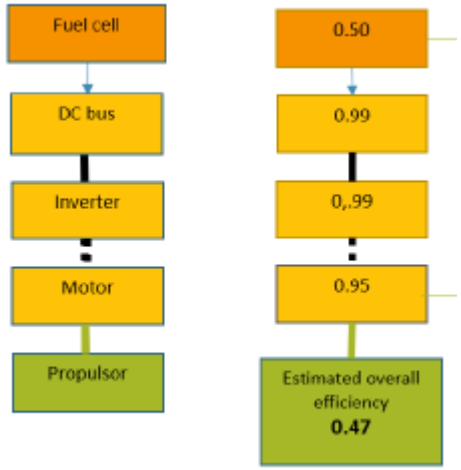
PASSIVE SINGLE-CELL THERMAL RUNAWAY INSULATION

INSULATION HEAT EXHAUST GAS



Hybridisation – Air vs Marine

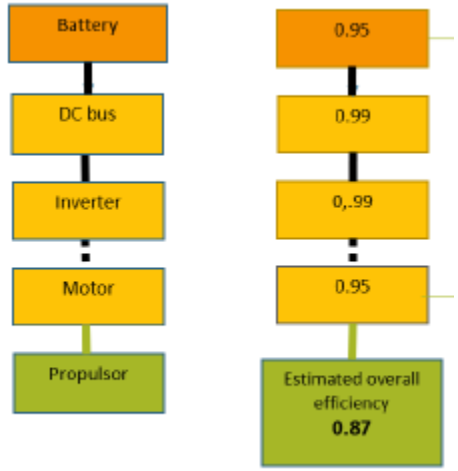
Hydrogen*



Hybrid

Take-off: Battery + bio-fuel or hydrogen
Cruising: Bio-fuel or hydrogen

Battery*



*K. Alvestad, S. Opsal Haug, S. Petersen Jikiun, Thesis

Hybridisation – Air vs Marine

Energy Density – System Viewpoint: Fuel vs Fuel Storage & Battery Cell vs System

Charging/Discharging Requirements: Hybrid vs All-Electric

Time at Ground: Swapping Batteries vs Complexity/Safety vs Amount of Hybridization

Autonomy and Amount of Planes vs Size ?

Efficiency / Cost of Energy

Thank you!

Kristian Eikeland Holmefjord
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