WISE Wide & Intelligent Sustainable Energy

WISE Midpoint Event – Project Updates

22 September 2026



WISE Wide & Intelligent Sustainable Energy



INTEGRATED HYDROGEN-ARGON POWER CYCLE

Maciej Mikulski – Efficient Powertrain Solutions, University of Vaasa
Jari Hyvönen – Advanced Concepts, Wärtsilä

WISE Wide & Intelligent Sustainable Energy

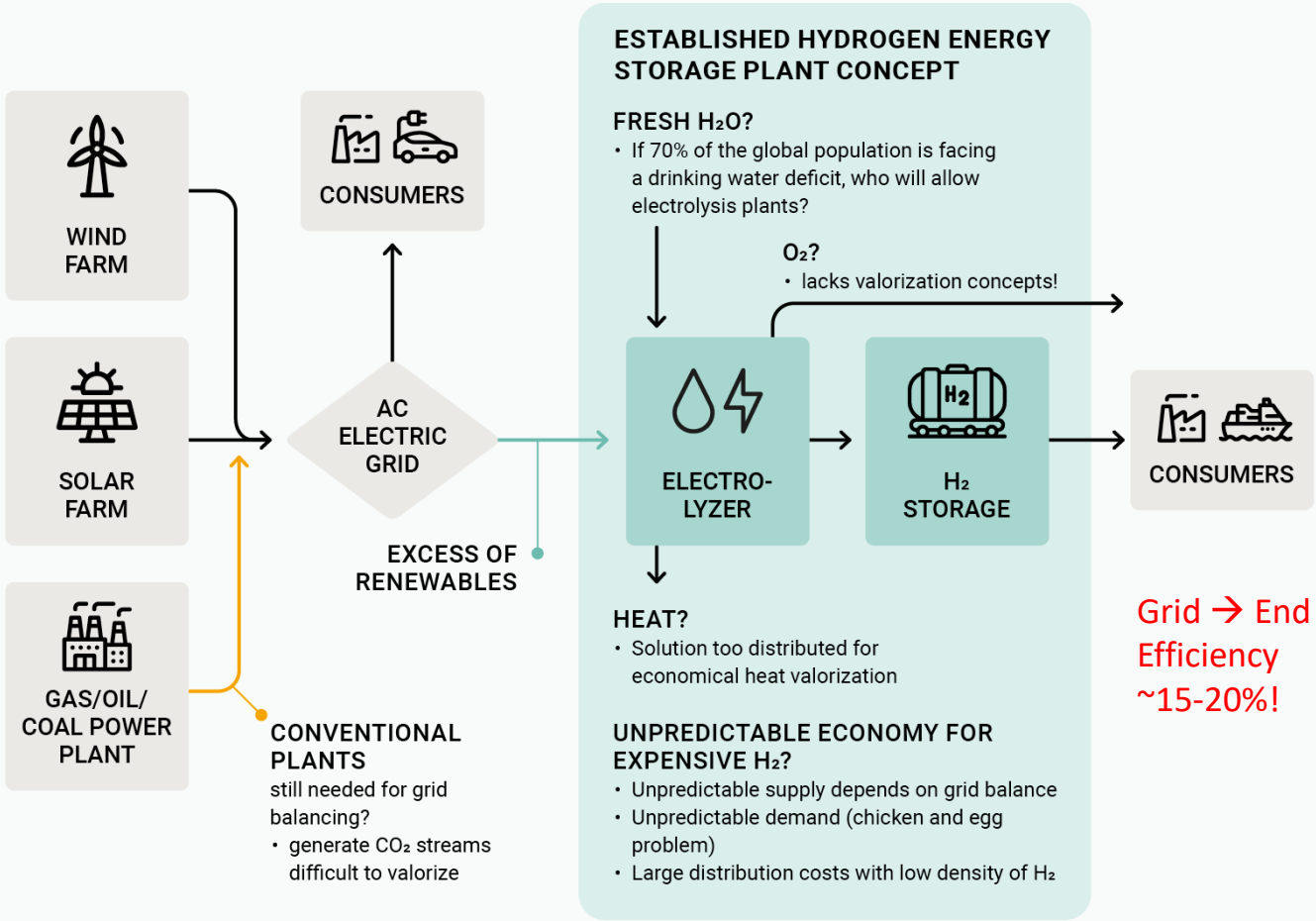
We reinvent energy storage!

Creating a fully circular power-to-H2-to-X systems that store renewable energy and returns it on demand to useful product with zero emissions and unprecedented efficiency

... without consuming natural resources.

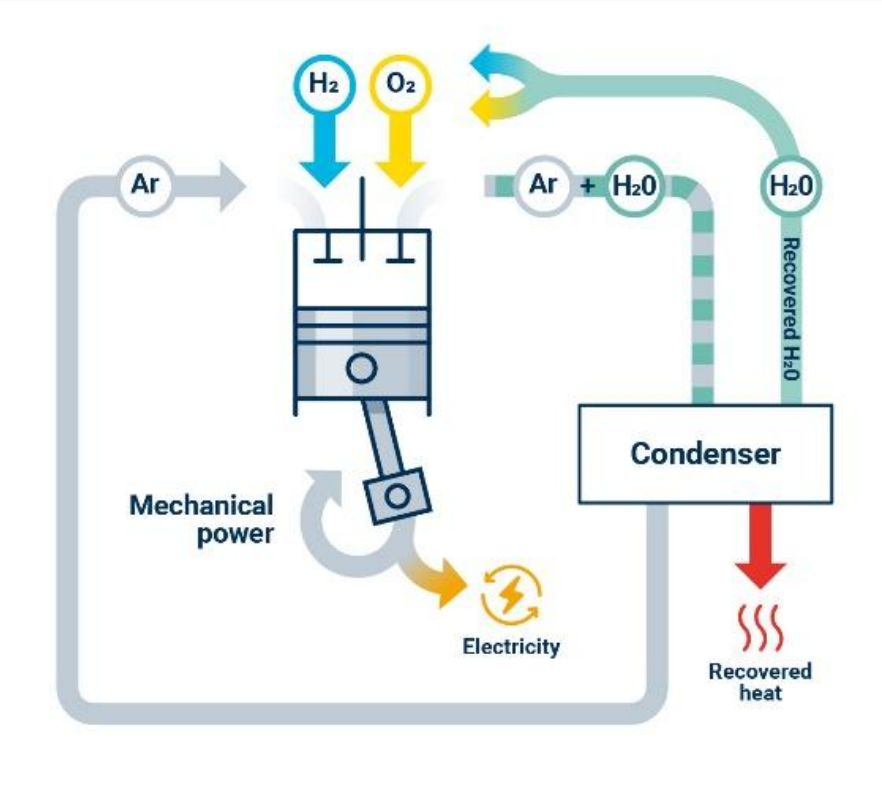
Critical problem for distributed energy storage

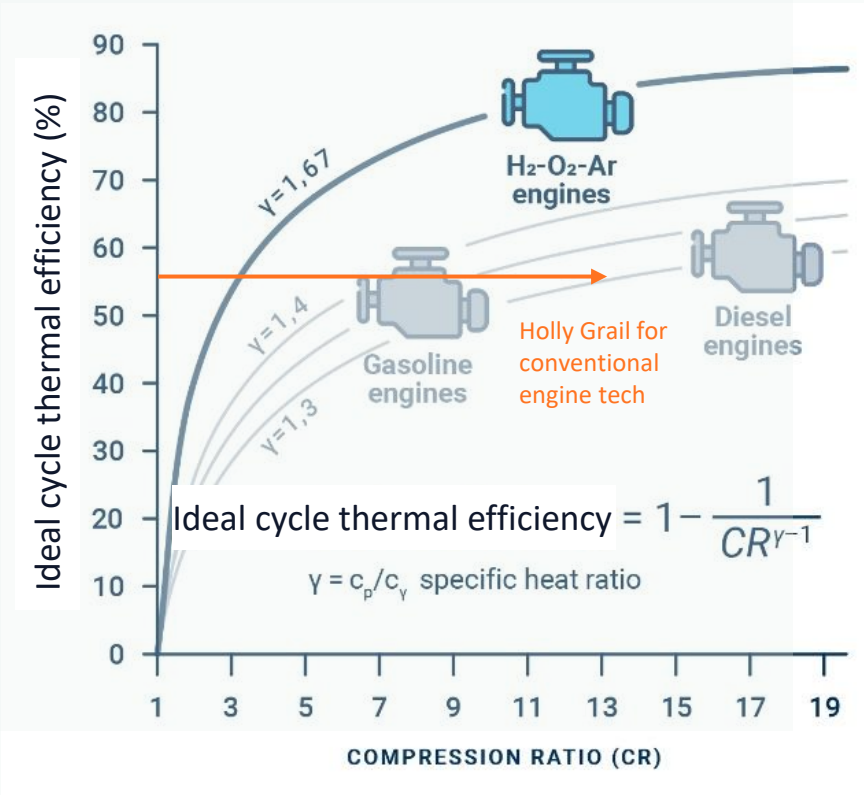
- Batteries, Flywheel only good for storing <1h
- H2 energy storage for long-to mid-term storage
- The established vision for the H2-economy has more holes than Swiss cheese…
- We need to redesign the system, not patch it!



Co-Innovation solution (in iHAPC project)

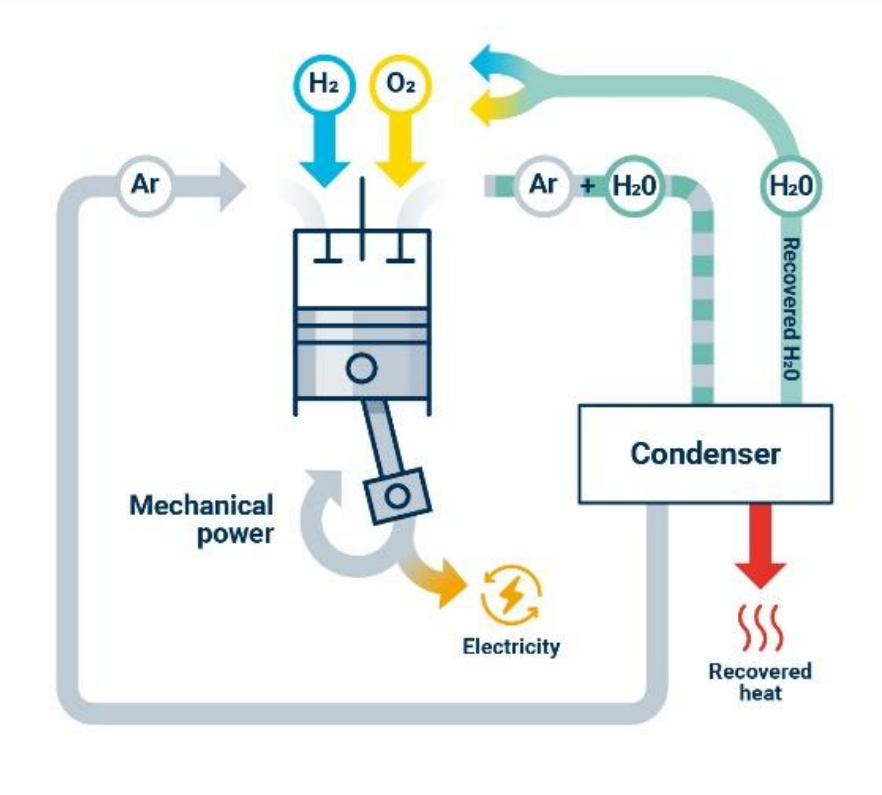
- **Demonstrate Hydrogen–Argon Power Cycle at TRL 6 / 60% efficiency / 150kW**
- **Establish scalability in simulation with min 20% operational cost saving compared to conventional peaking plant**

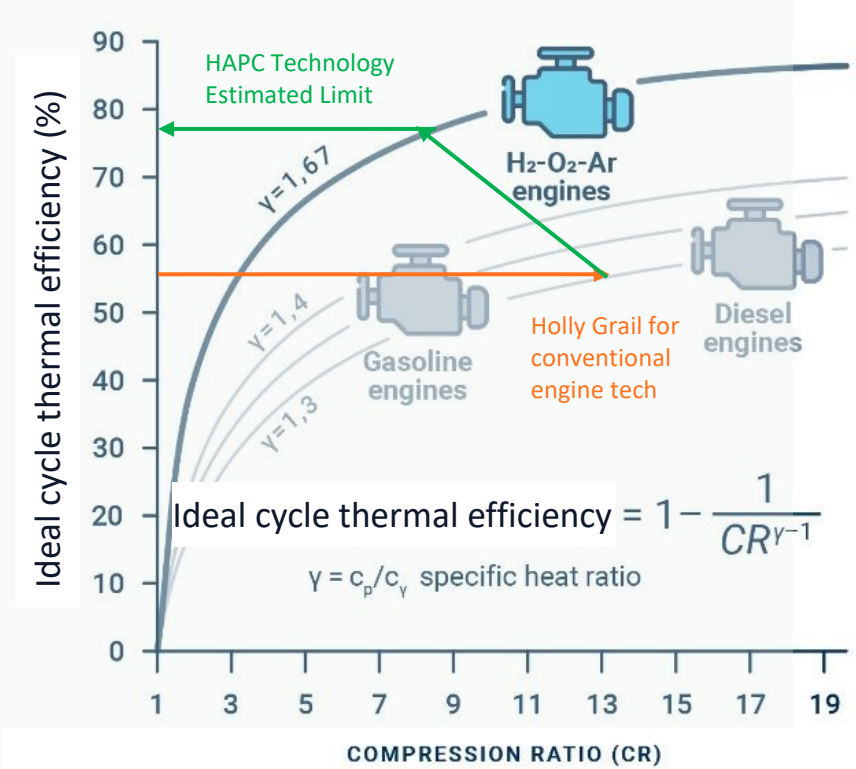




Co-Innovation solution (in iHAPC project)

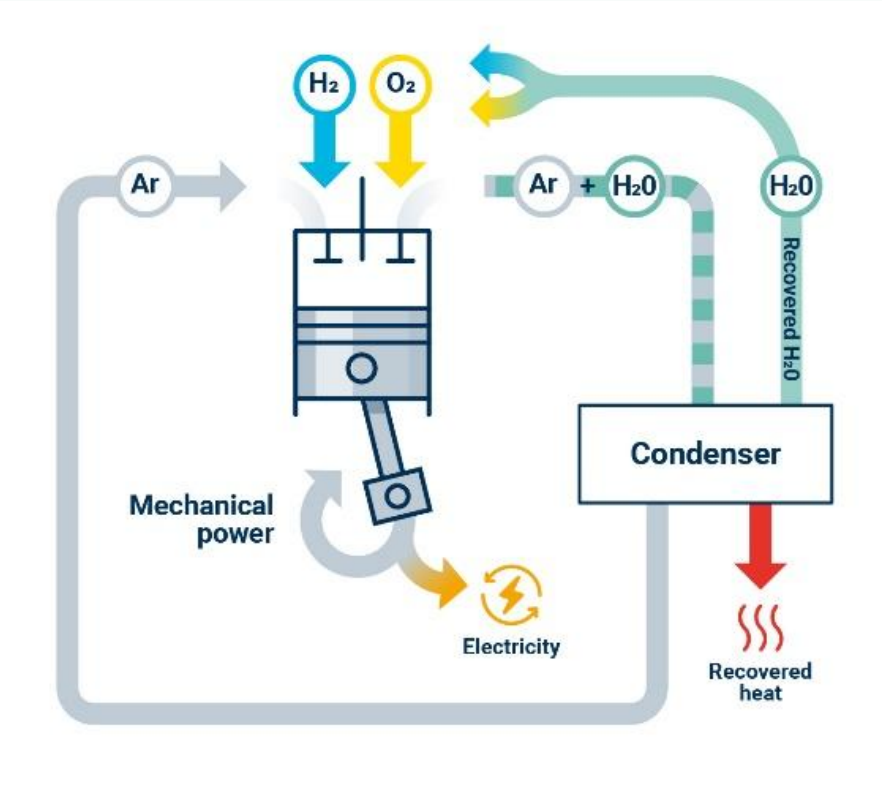
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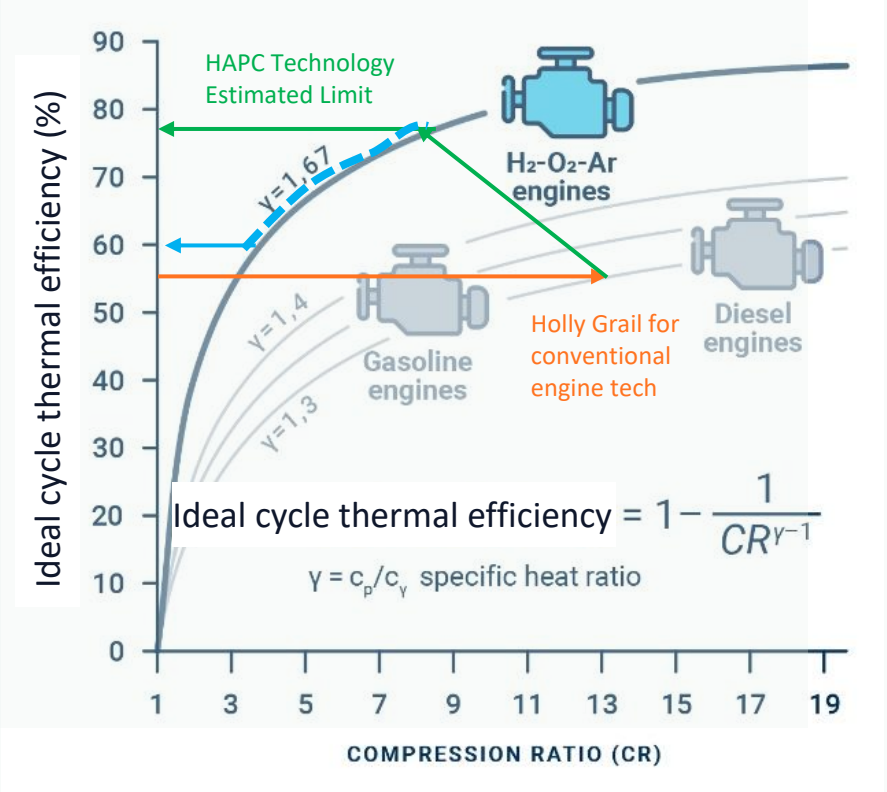




Co-Innovation solution (in iHAPC project)

- **Demonstrate Hydrogen–Argon Power Cycle at TRL 6 / 60% efficiency / 150kW**
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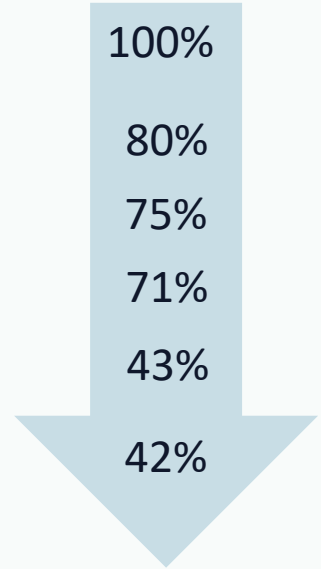




Estimation of potential cycle efficiency from electrical to electrical using H2 storage with technology improvements

Energy conversion	Efficiency today	Efficiency outlook 2030+	Efficiency outlook 2035+ with iHAPC
Electrolysis to H2 and O2[1)]	~61% (PEM)	~75% (SOEC)	~80% (SOEC)
Compression & Storage H2[2)]	~91% (cH2, 35MPa)	~92% (cH2, 35MPa)	~94% (cH2, 35MPa)
Compression & Storage O2[3)]	-	-	~95% (cO2, 20MPa)
ICE thermal efficiency	45-50%	50-55%	55-65% (iHAPC)
Generator[4)]	~96%	~97%	~98%
Total	~25%	~35%	~42%

EtE-efficiency *)

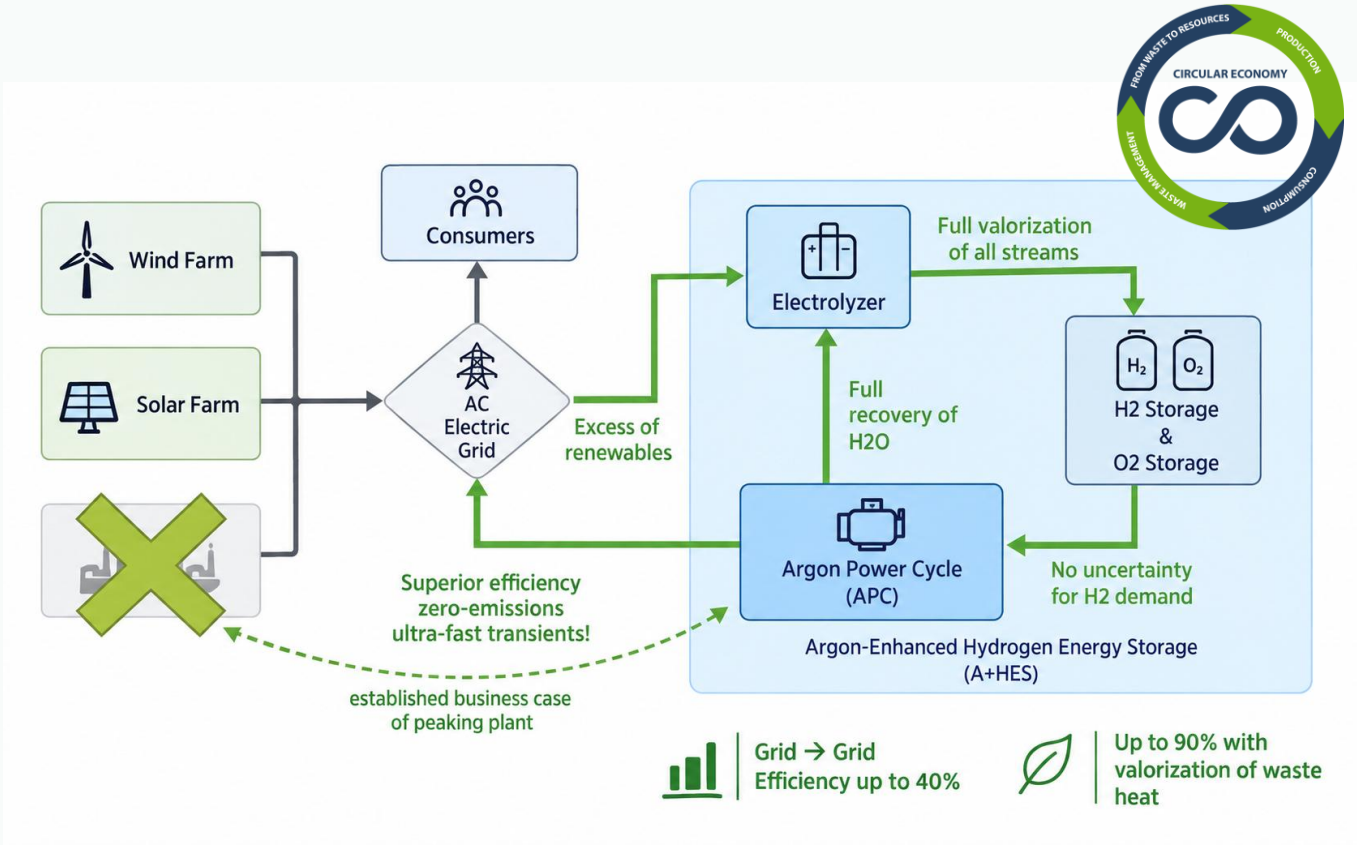


EtE = Electrical-to-Electrical

1) US DOE; Hydrogen Shot, Water Electrolysis Technology Assessment, June 2025
2) Clean energy Vol7, 2023; A review of hydrogen storage and transport technologies
2, 3) US DOE, Hydrogen and Fuel Cells Program Record, 2009
2) Linde, Hydrogen FuelTech Tomorrow's Fuel Today, 2021
4) Typical 10-25 MW synchronous generator electrical efficiency

Co-Innovation solution (visionary goal)

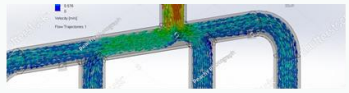
- Goal: to reinvent energy storage, and make hydrogen-based economy feasible by deep, targeted system integration
- IHAPC: is the first concept on the new extrapolated energy system roadmap



Co-Innovation solution (how?)

- 10 interconnected work packages, 8 dedicated partners
- Over 13 M€ budget (8.55 in Business Finland founded project)



1  100%

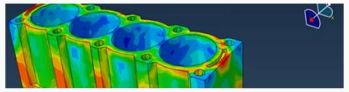
Defining argon-based mixture composition

2  69%

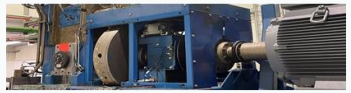
Hydrogen combustion in argon-based environment

3  58%

Safety aspects

4  34%

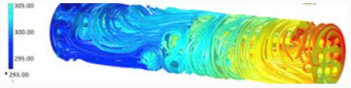
Advanced knock/thermal stress mitigation measures

5  70%

APC system buildup and project coordination

6  75%

Gas-path control / system layout vs. full-cycle efficiency

7  53%

Condenser efficiency improvement

8  100%

Fuel flexibility considerations

9  65%

System level applications and P2X2P

10 

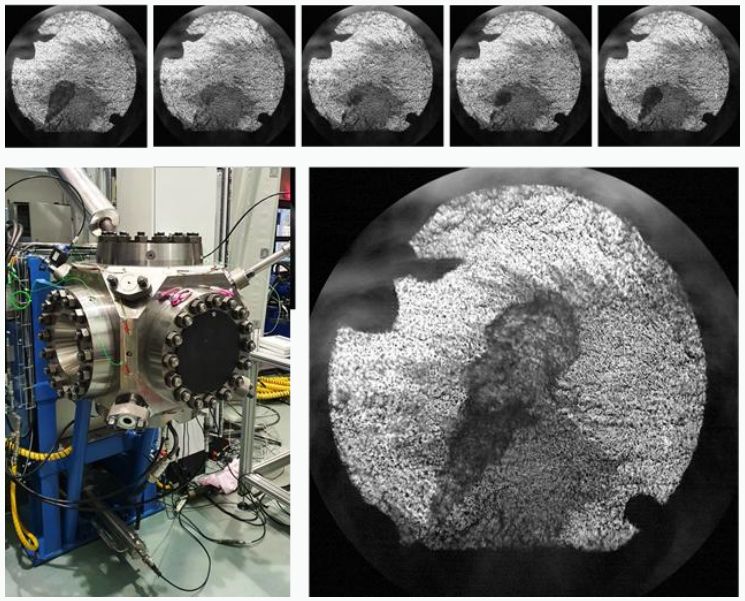
29%

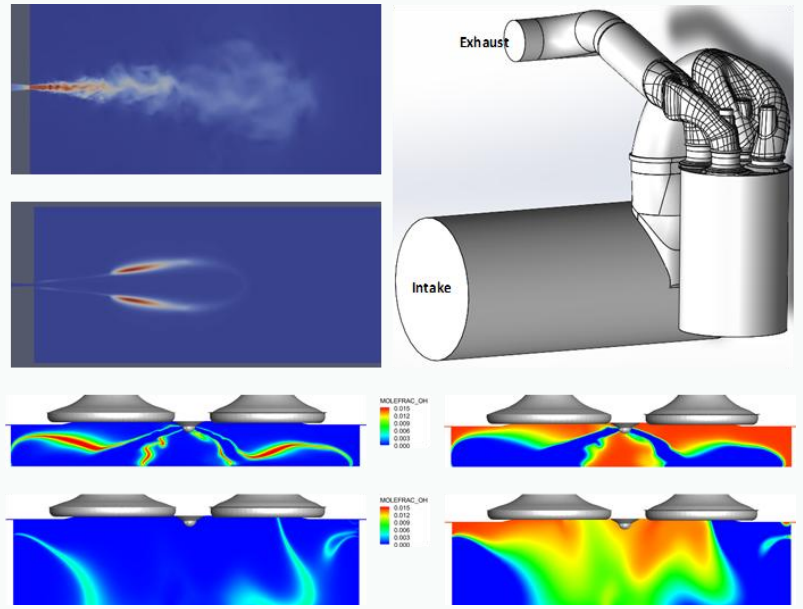
Business case and feasibility

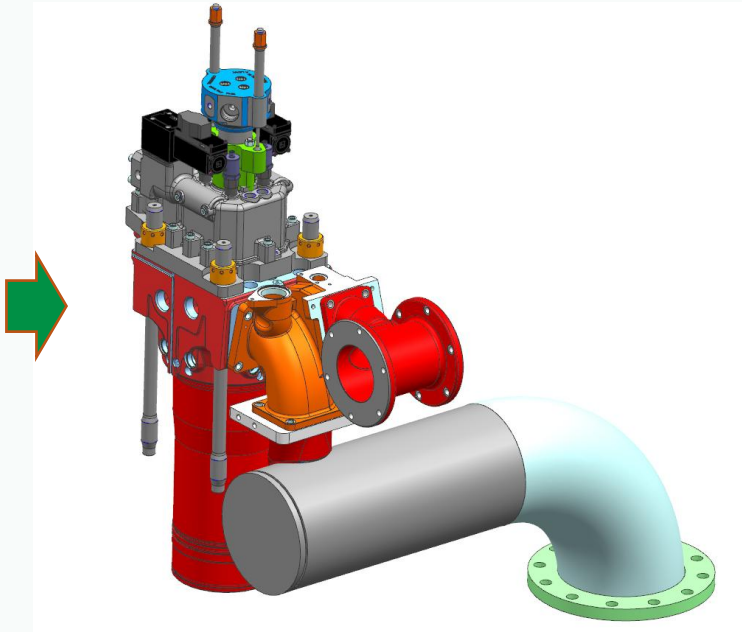
Work Package Structure and Execution Status

Progress update (combustor)

Similar workflow for other critical system components (condenser, separator)







100%

Hydrogen jet combustion in Argon experiments in OSCC

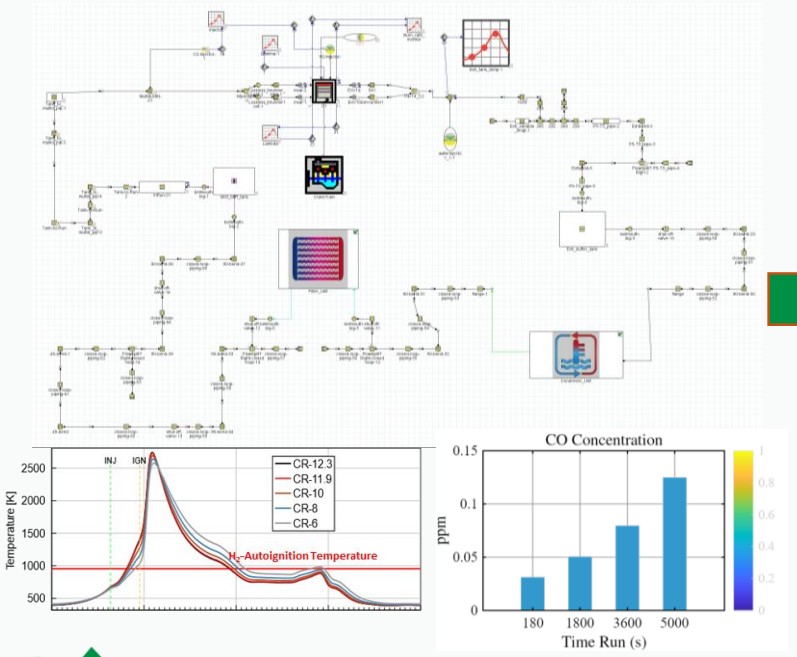
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Hi-fidelity model validation and model-based performance optimization

Detail design, component durability, manufacturing and assembly

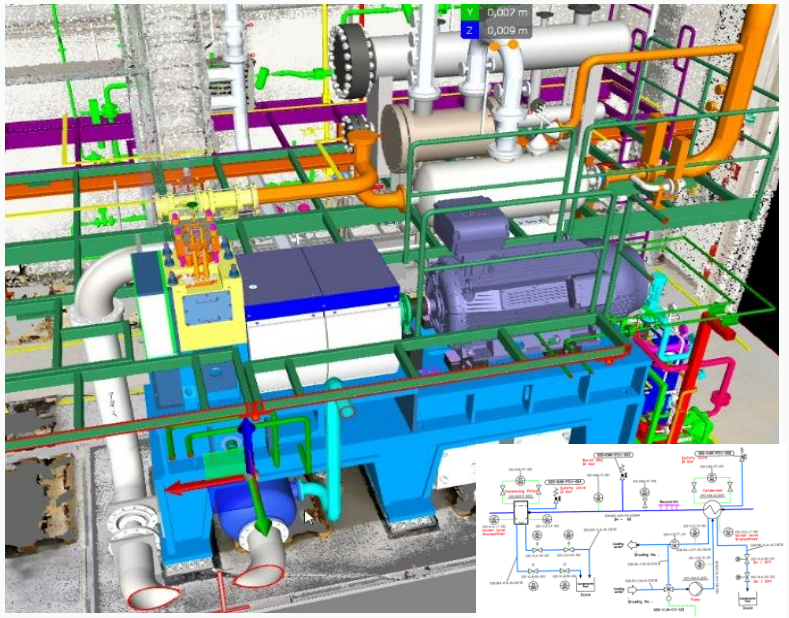
Progress update (APC – system integration)

The demonstrator is taking shape!



100%

Model-based HAPC System Optimization



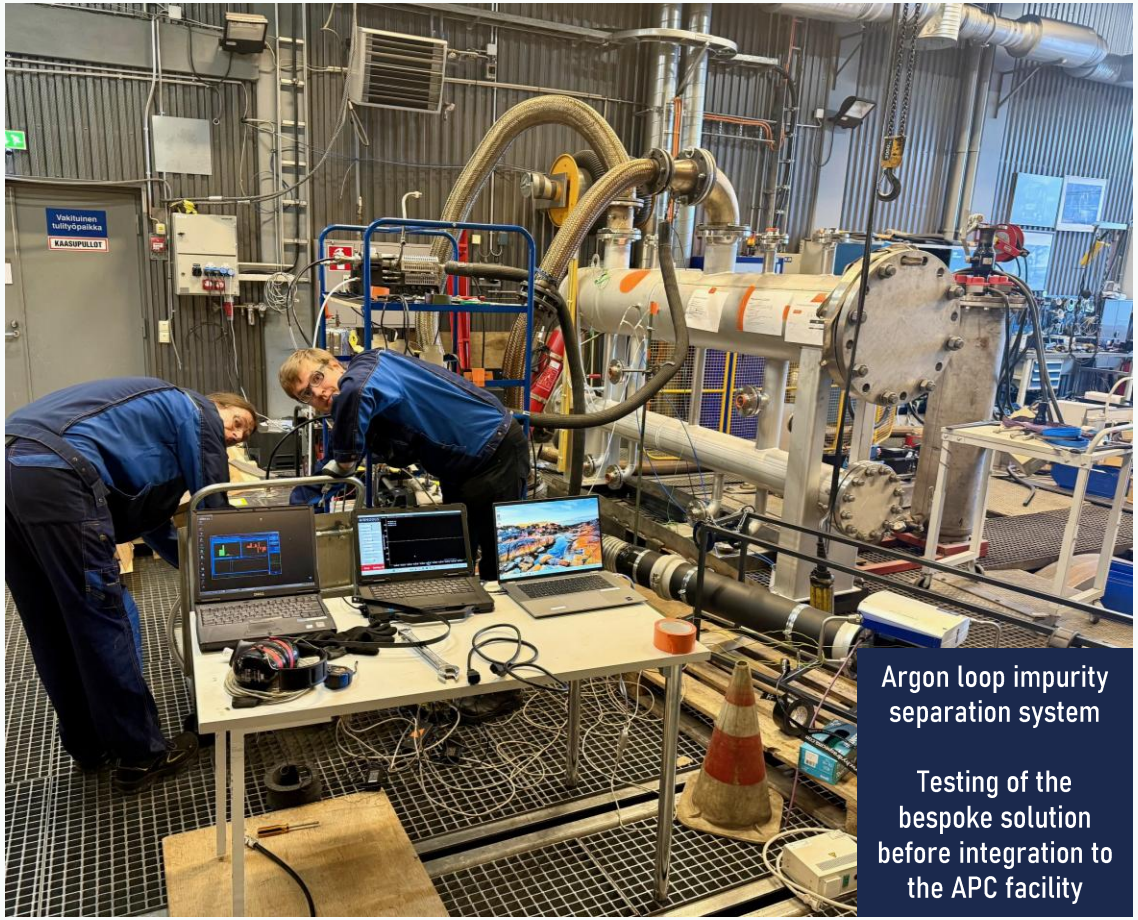
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Process/mechanical design and procurement



System assembly and control implementation

Progress update (towards 2027)

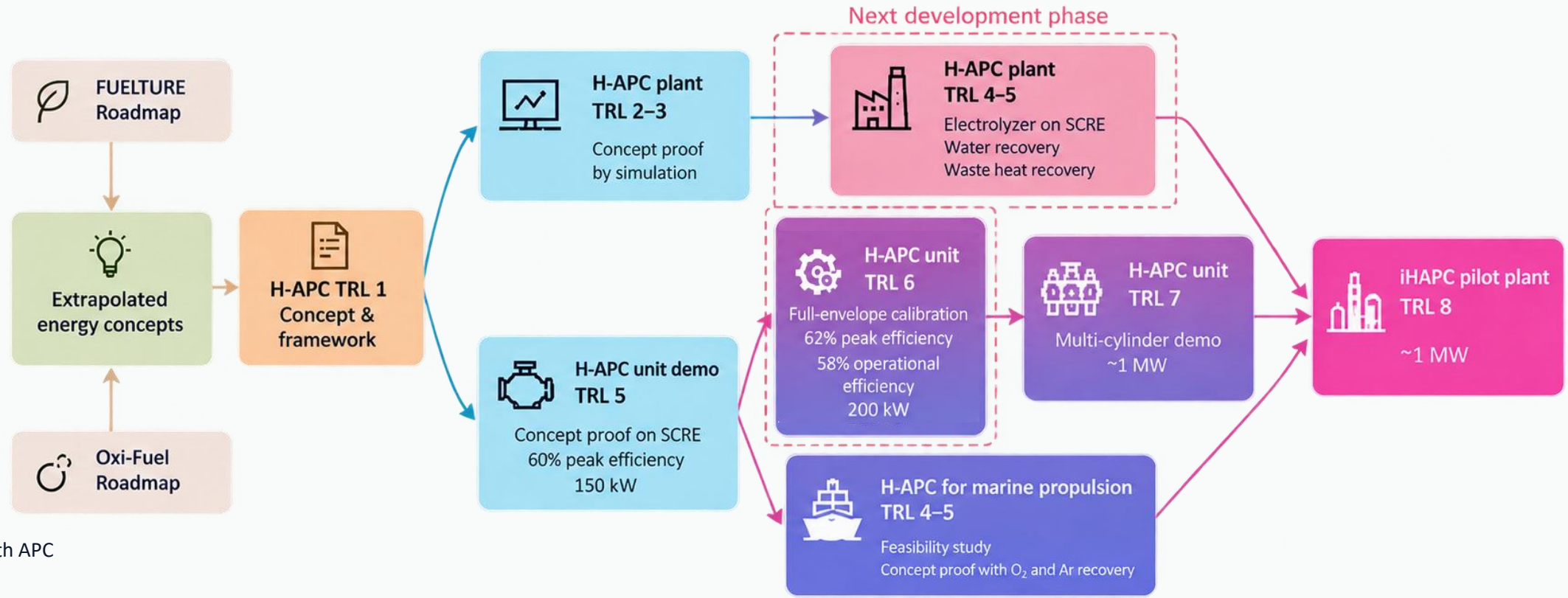


Argon loop impurity separation system

Testing of the bespoke solution before integration to the APC facility

- Condenser and Filtration unit commissioning finalized by September 2026
- First smoke tests (Engine-level commissioning) by June 2027
- H2/O2 infra commissioning including HP Injection system by May 2027
- First sustainable run with Argon in the loop by September 2027
- 60% Indicated Efficiency demonstrated with Argon and Water recovery by end of 2027
- So far so good! – fingers crossed ☺

Ecosystem roadmap



First patent with APC
1948 in US

Pollution-Free Closed Cycles (1960s-1970s)

The Key Breakthrough, APC patent by NASA 1976

Modern APC Research (2010-Present)



Call to Action

Let's build the first complete H-APC energy storage plant together!

We are forming a new consortium to scale iHAPC from a 200 kW demonstrator to a complete Power-to-H_2-to-Power solution.

- Store renewable energy
- Strengthen grid flexibility
- Zero emissions greater energy independence



From innovation to impact.

Join the consortium and help shape the next stage with us!

iHAPC
INTEGRATED HYDROGEN-ARGON POWER CYCLE

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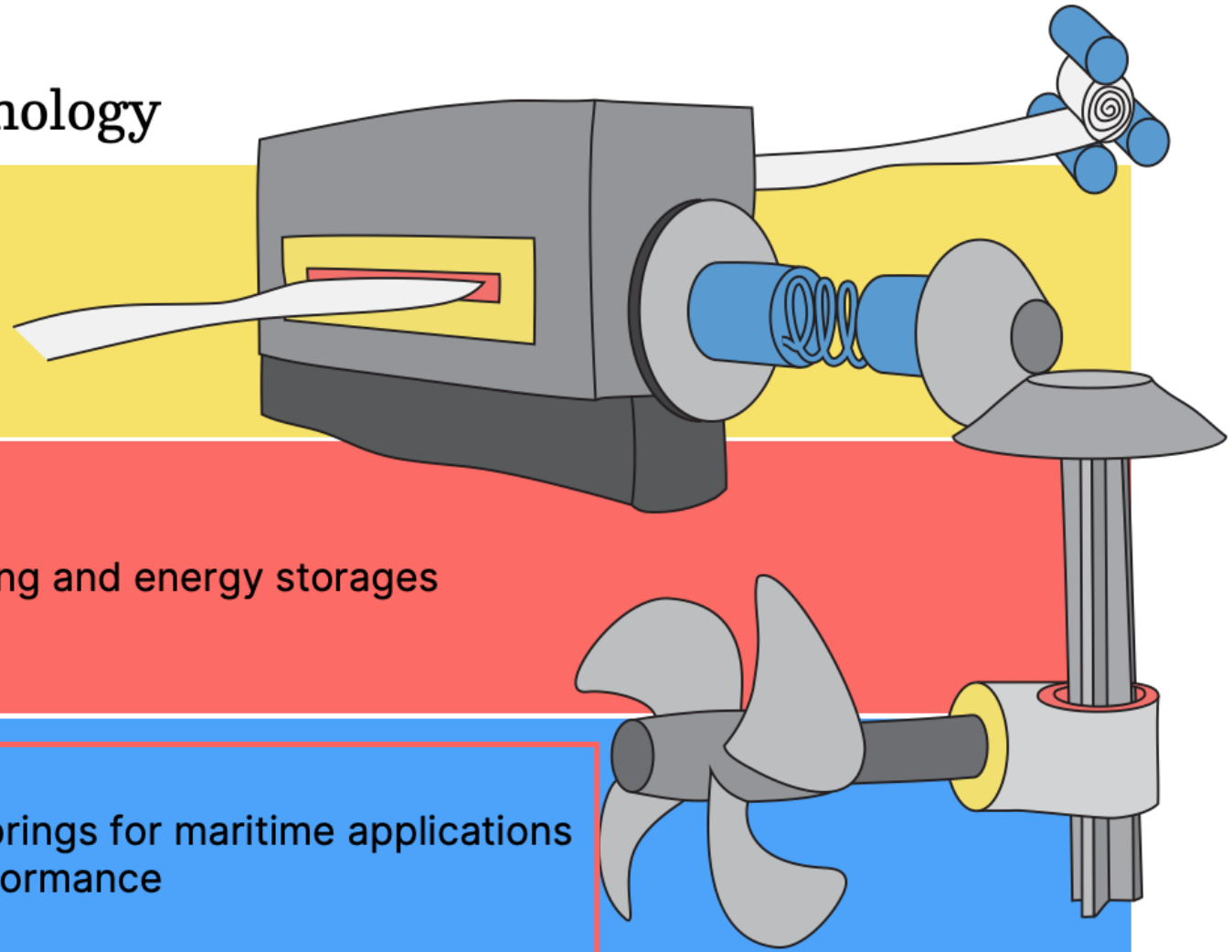
BEST

Better bearing, seal and vibration technology

Tero Lokasaari, Raine Viitala and Oliver Häggman

BEST

Better bearing, seal and vibration technology



WP1: Seal-ability

- Seal condition monitoring
- Marine thruster wear prediction and mitigation
- Novel seal concepts
- Sealing of superheated steam dryer

WP2: Low friction

- Low friction and inertial in roll-to-roll manufacturing and energy storages
- 3D printed gas bearings and seals

WP3: Less vibration

- Torsional vibration damper based on wire rope springs for maritime applications
- Fatigue effects on wire rope damper/isolator performance

AROTOR Aalto University Rotor Laboratory

WÄRTSILÄ

ROSENDAHL NEXTROM

TIIVISTETEKNIIKKA

TIIVISTEKESKUS

TERA LOOP

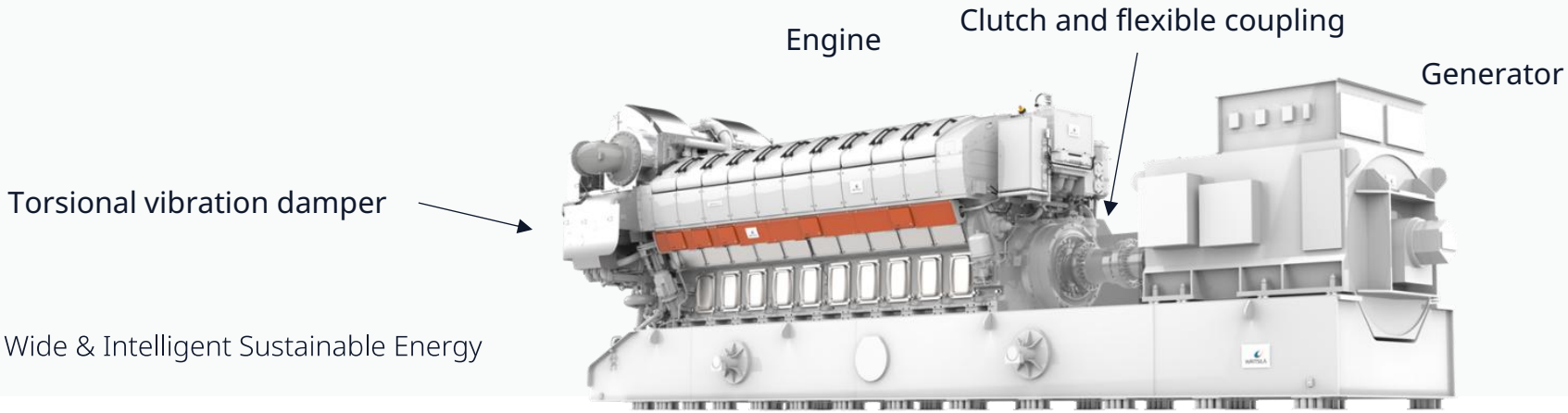
VIBROL VIBRATION IN CONTROL

Valmet

KONGSBERG

Critical problem

- Internal combustion engines create torsional excitation due to their operating principle
- This needs to be reduced to
  - Increase component lifetime and to take more output from the engines
  - Support rapidly varying loads, driven by grid balancing and data center demand



Critical problem

- Flexible couplings are mostly elastomer-based today
  - Elastomer-based couplings are sensitive to temperature and certain chemicals. They can also overheat due to poor heat dissipation.

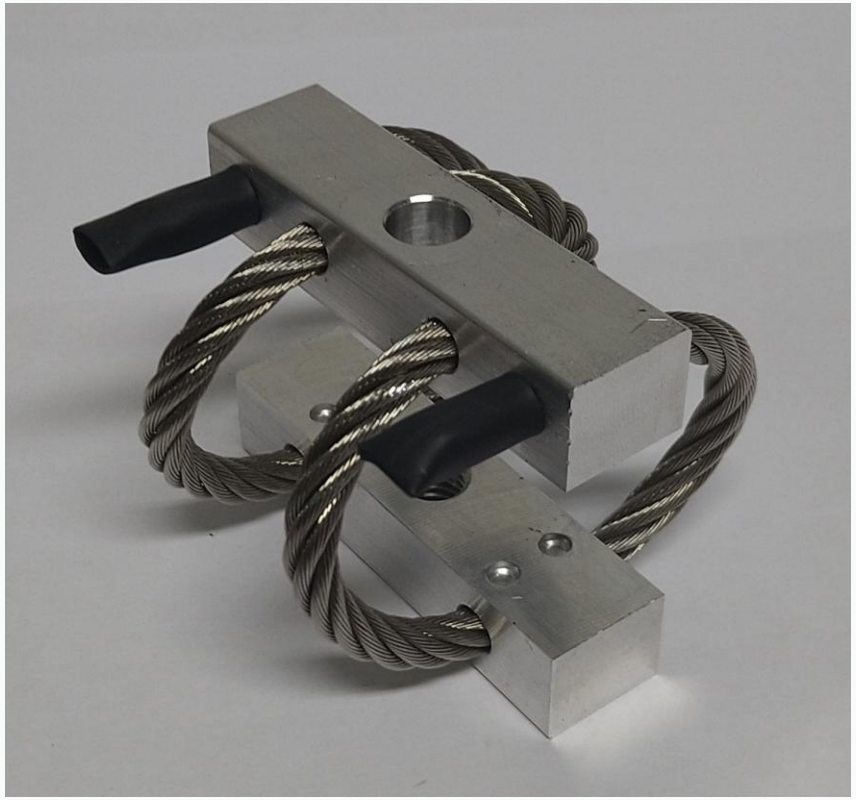


- Torsional vibration dampers are made out of steel and utilize oil for damping
  - Torsional vibration dampers are expensive and do not allow field servicing



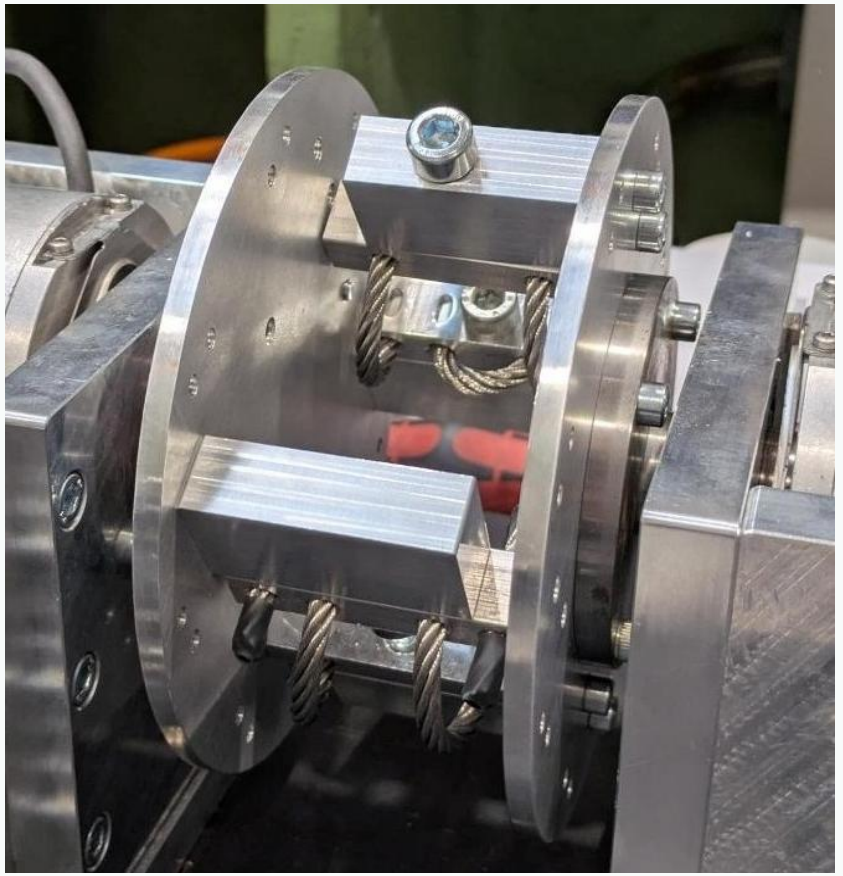
Co-Innovation solution

- Wire-rope isolator/damper
  - Well-known solution in lateral vibration and shock protection
    - Highly flexible
    - High damping
    - However able to transmit large loads
- Can flexible couplings and torsional vibration dampers be made using wire-rope?

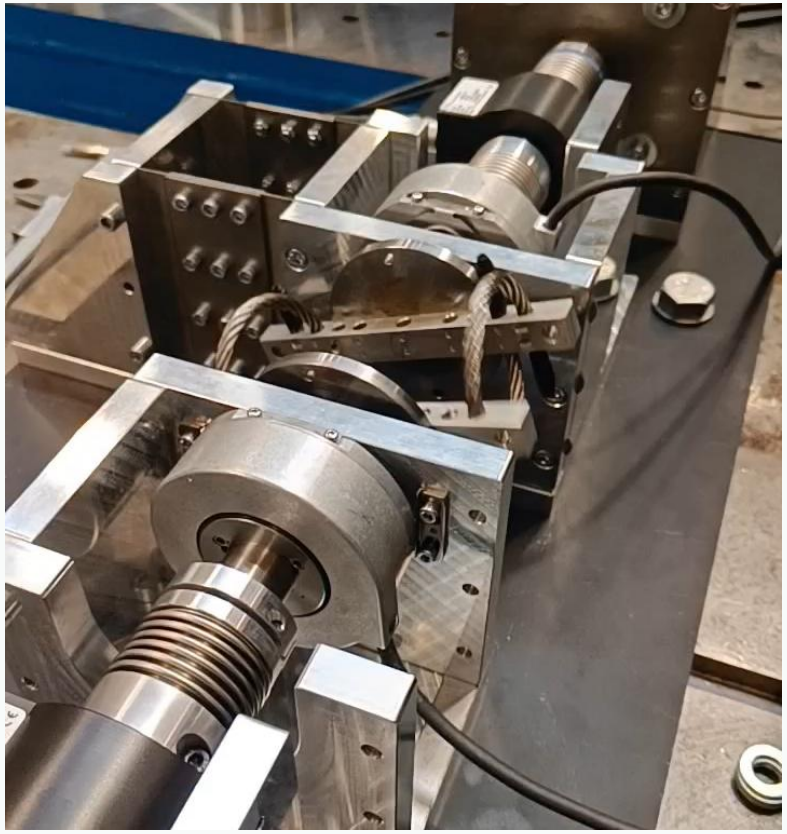


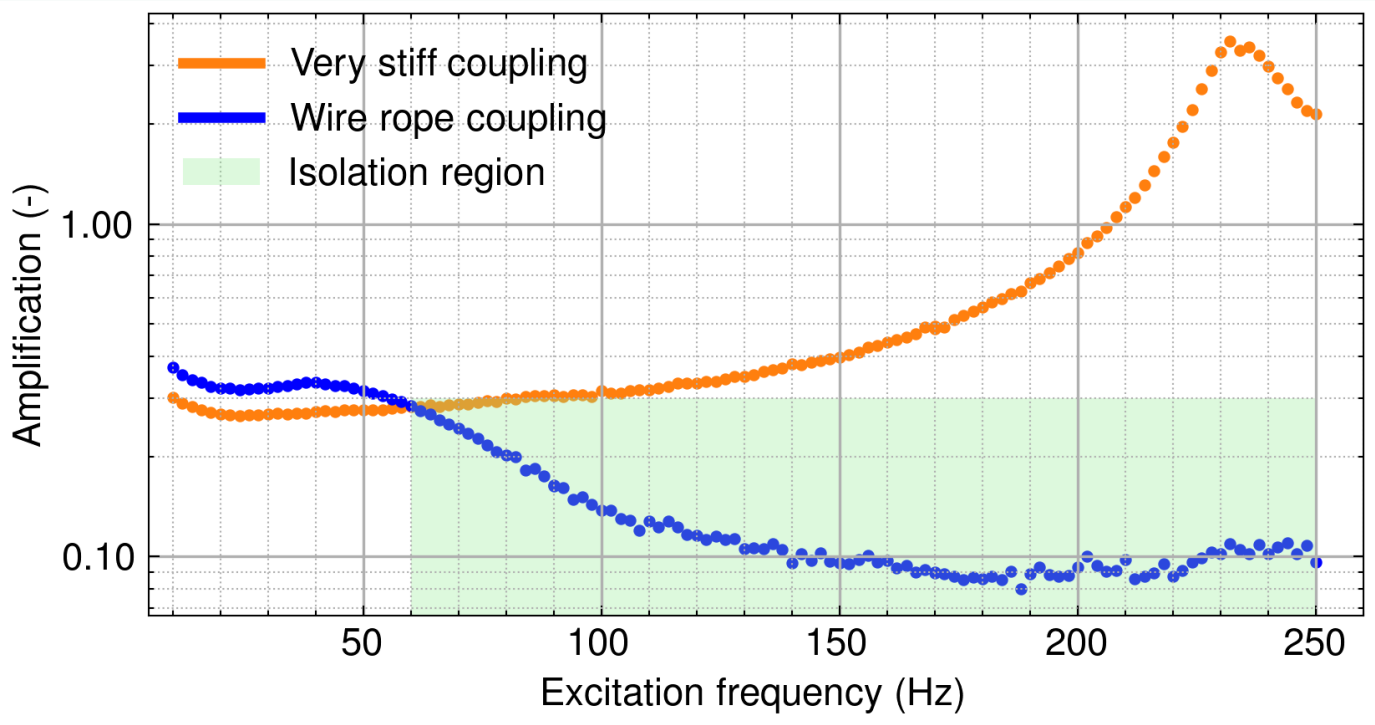
Co-Innovation solution

- The use of wire rope isolators for torsional vibration attenuation is investigated
- Wire rope isolators have a simple mechanical design and are robust in various environments
- Putting a new solution on the market would increase competition, bringing prices down and production to Finland

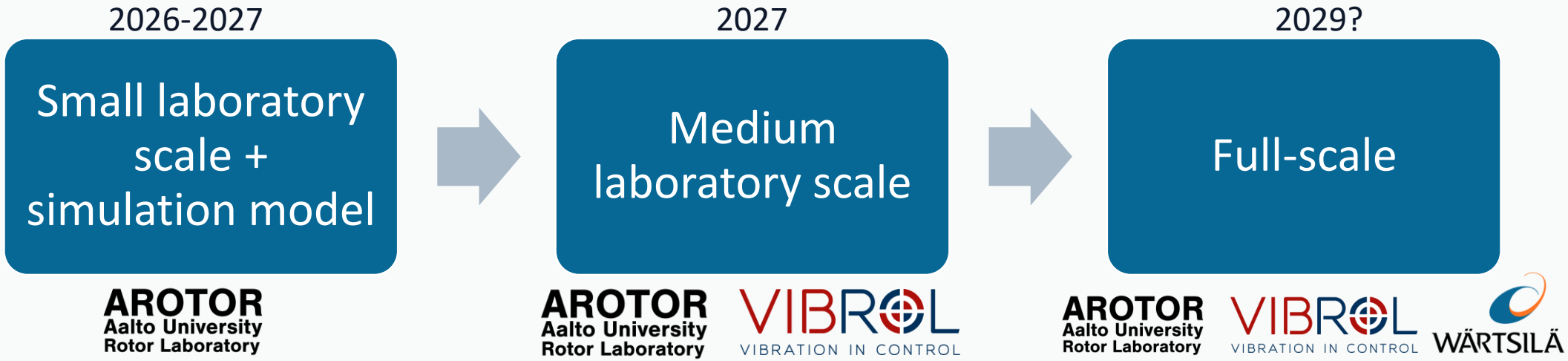


Progress update





Ecosystem roadmap



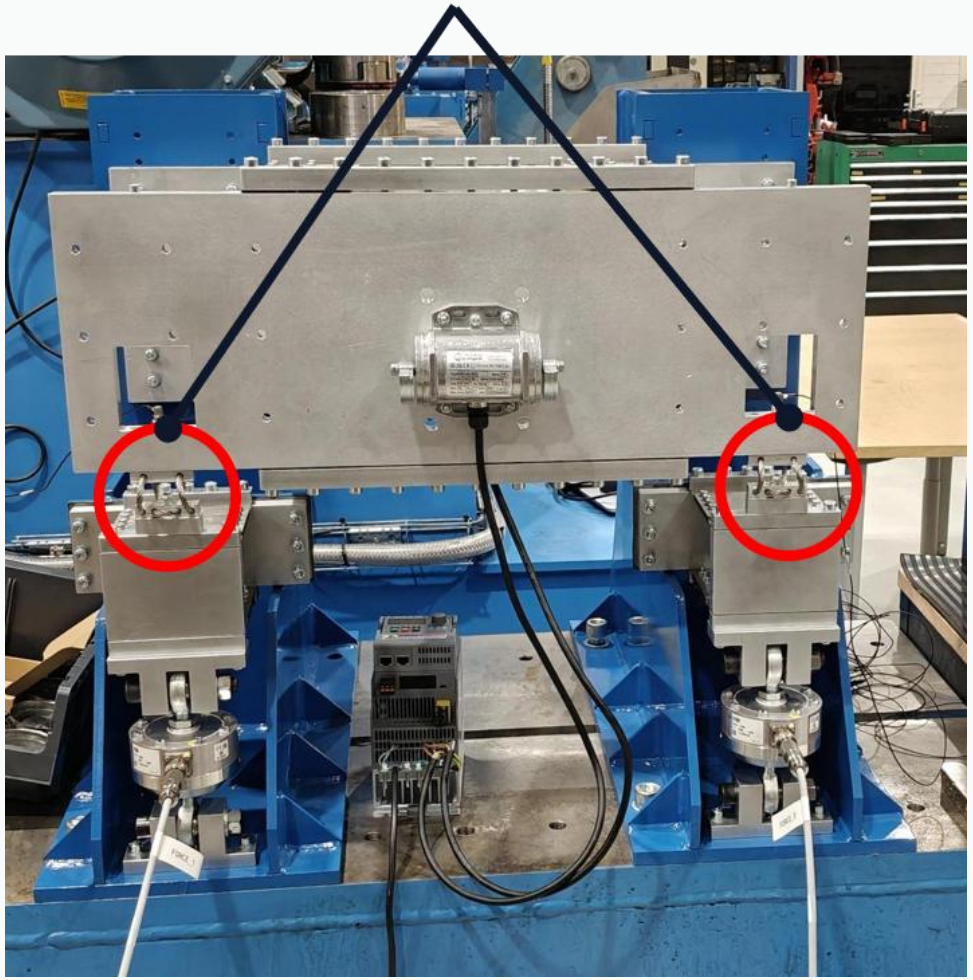
- Rapid prototyping at small and medium laboratory scale
- Simulation models, validated at small scale, can give estimates of full-scale behavior

Call to action

- There is still much to be done
  - Effect of wear
  - Effect of lubricants, oil, water…
  - The results look very promising but does it scale up?

- Other applications?

Wire rope isolators



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MatH2

Materials for Hydrogen Handling: storage, transfer and utilization

Anu Solla, Wärtsilä Finland Oy

Elina Huttunen-Saarivirta, VTT Technical Research Centre of Finland Ltd

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MatH2 will tackle one of the key barriers to scaling the hydrogen economy: **materials**.

MatH2 consortium in a nutshell



Volume

Total volume:
6.4 M€



Partners

10 partners:
8 companies
2 research organizations
(VTT, University of Oulu)



Key outcomes

Knowledge enabling materials, components and technologies
that withstand hydrogen and other chemical species essential for hydrogen economy

MatH2 partners

Companies with own R&D projects

EOS
Neste
Nordic Tank
SSAB
Teknos
Wärtsilä

Companies with SG membership

Bumax
SP Stainless

Research organizations

VTT
University of Oulu

Critical problem: Hydrogen deployment cannot scale without reliable material solutions

H_2

Rapid deployment

Climate goals, energy security, sector coupling

The missing building blocks

- **Performance and lifetime**
- **Structural integrity**
- **Material compatibility**

Materials readiness gap

Storage, transfer and utilization

Need for reliable material solutions for infrastructure and technologies

Three research pillars to close the materials readiness gap

Performance and lifetime

- Material manufacturing-microstructure-hydrogen resistance causalities
- Design of hydrogen resistant AM

Structural integrity

- Development of test methods
- Fatigue behaviour of materials
- The role of welds in structural integrity

Material compatibility

- Role of gas impurities in material-hydrogen interactions
- Corrosion behaviour of materials
- Gas flow effects and their management

Call to action : From Collaboration to Impact

MatH2 is here to demonstrate what is possible when industry and research work together. Transforming hydrogen from opportunity to reality requires collective action. Let's continue the journey together through collaboration, knowledge sharing, and bold innovation.

What’s next?

- **Strengthen** collaboration across the hydrogen value chain
- **Share** knowledge, expertise, and testing capabilities
- **Identify** new joint development opportunities
- **Accelerate** the industrial deployment of hydrogen technologies



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EDE3

Early Detection of Extreme Engine Events

Mika Laurén, Mohamed Sayed, and Tero Lokasaari

Autonomous power plants need autonomous failure prevention

Engine events can rapidly develop into severe failures.

Impact:

- Downtime
- Maintenance costs
- Reduced availability
- Business losses









Engine mechanical failures cause safety risk and high costs

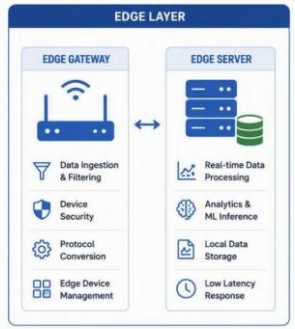
- Engine failures can cause long downtimes, high costs and safety risks.
- The intended results are improved engine reliability and reduced operational risks

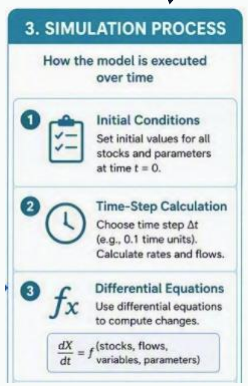


Picture: TUAS EngineLab / M. Laivola

Co-Research solution

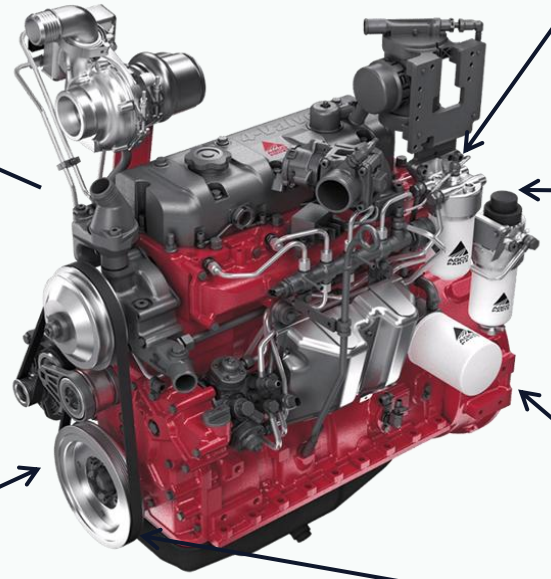
Edge- computing unit by Unikie





Simulation models

Vibration and acoustic sensors by Nome Oy

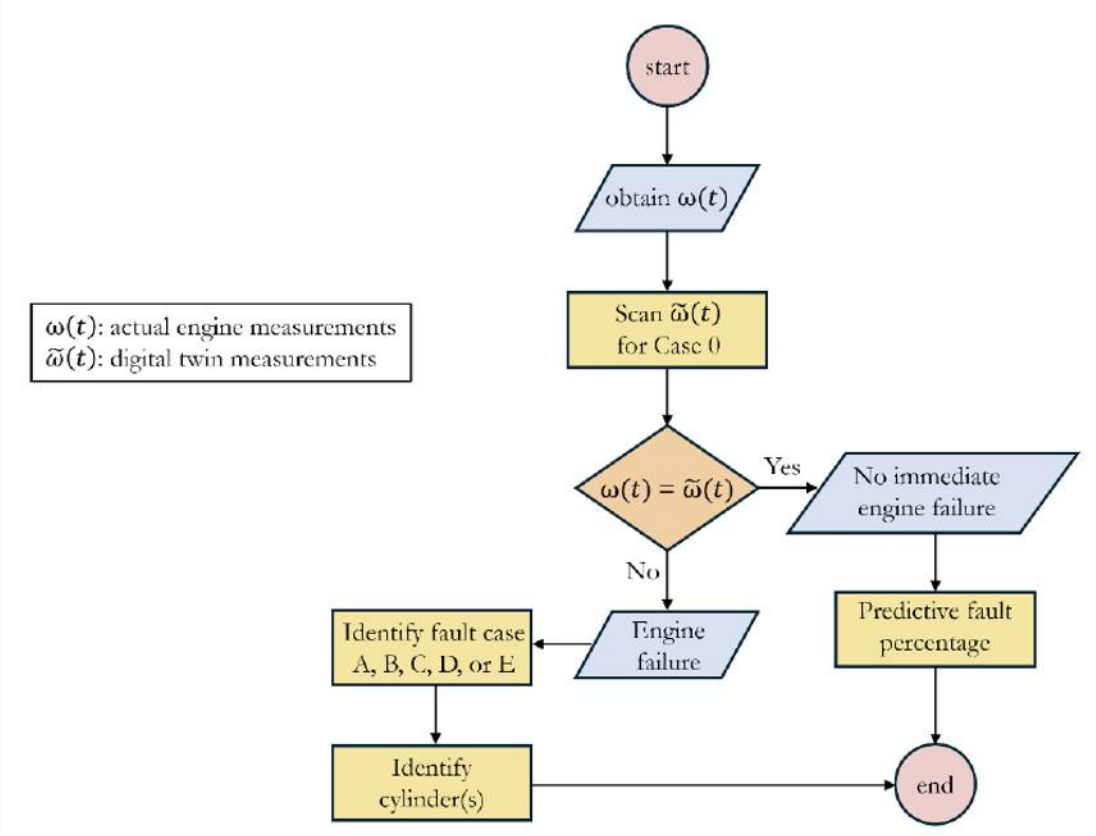


Picture: AGCO Power, AGCO 49 -engine

Cylinder pressure and exhaust manifold pressure measurements by AVL Indiset

High-speed crank angle measurement at both ends of the crank train by AVL Indiset

Co-Research solution



An illustration of the proposed early fault detection framework (E. Immonen)

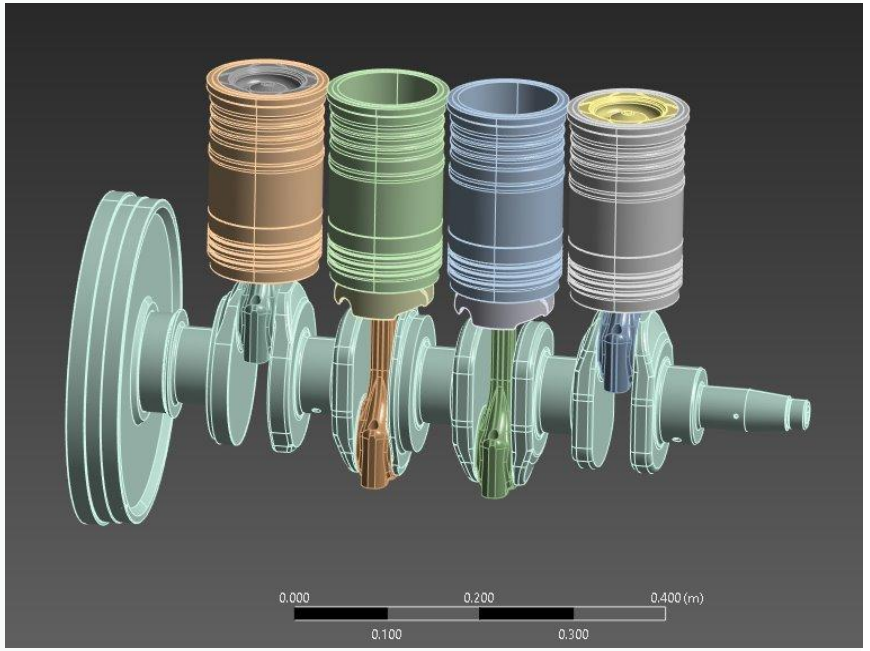
- The EDE3 project aims to address these challenges by developing a real-time system to identify and predict severe engine problems before they occur.
- The research will develop a general framework for real-time identification, characterization, and prevention of such catastrophic faults.

Ecosystem roadmap

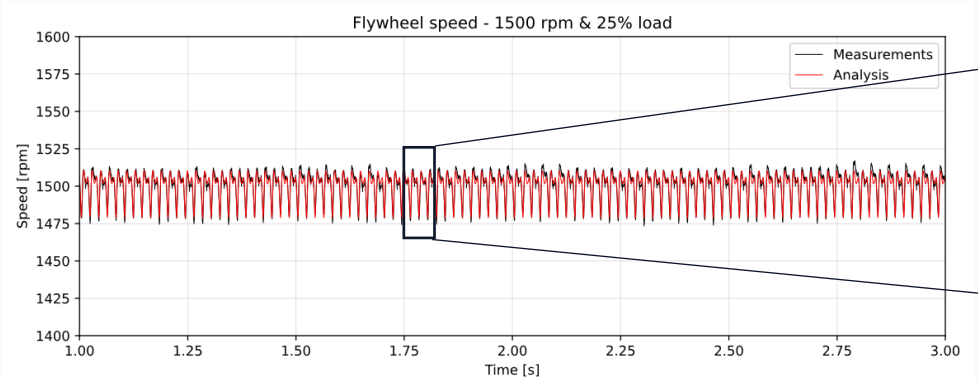


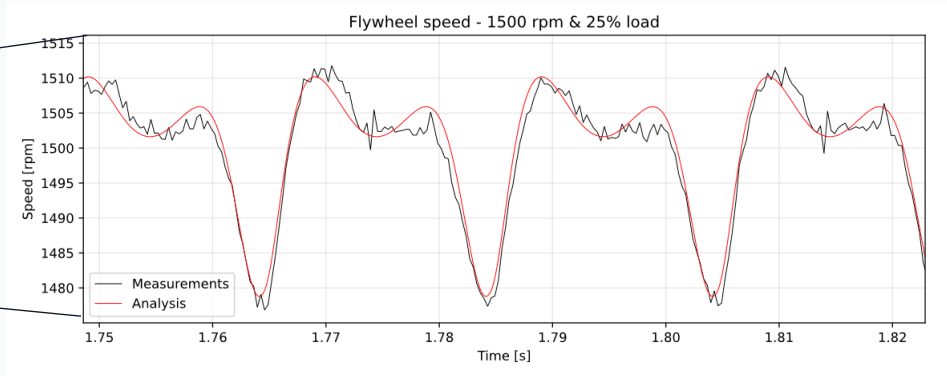
Progress update

- The EDE3 project is halfway through.
- Developed and validated a physics-based model in ANSYS and a simplified rigid model of the "healthy engine."



Physics-based model by Mohamed Sayed





Next steps



The engine in the test bed in the TUAS engine laboratory

- Developing reduced real-time engine models for edge computing purposes.
- Prototype of the Expert Advisor that integrates data acquisition, modeling, state estimation, and decision-making procedures for predicting severe failures during engine operation.

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METECH

Measurement technologies and quantification of exhaust emissions from clean transportation solutions.

Päivi Aakko-Saksa, VTT

Kenneth Widell, Wärtsilä

WISE Wide & Intelligent Sustainable Energy

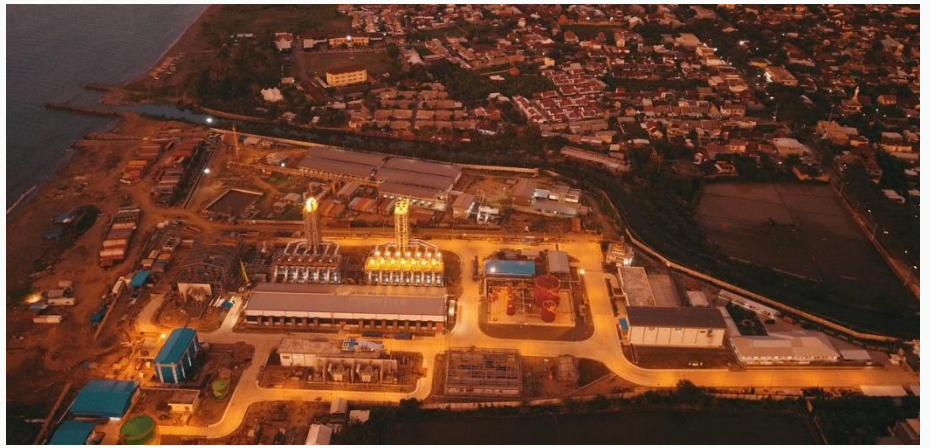
Polluter Pays

Grams become kilos, tons and kilotons

Euro becomes kilo euros and millions

Critical needs

- Energy, transport and non-road sectors remain major emission sources.
- Future regulations target to CH_4 and N_2O greenhouse gases besides CO_2.
- Net-zero targets along with EU MRV and ETS require accurate emissions monitoring.
- Even low emissions can have significant climate and economic impacts.
- Reliable measurements at low concentrations are essential.





METECH co-research solution

- Development of accurate methods for measuring CH4, N2O, CO2, NH3, SO2 and particles.
- Validation of FTIR-based methods for international regulatory approval.
- Validation of reliable methods for emerging fuels and low-emission technologies, particularly hydrogen and ammonia.
- Measurement campaigns in real-world environments using validated methods.

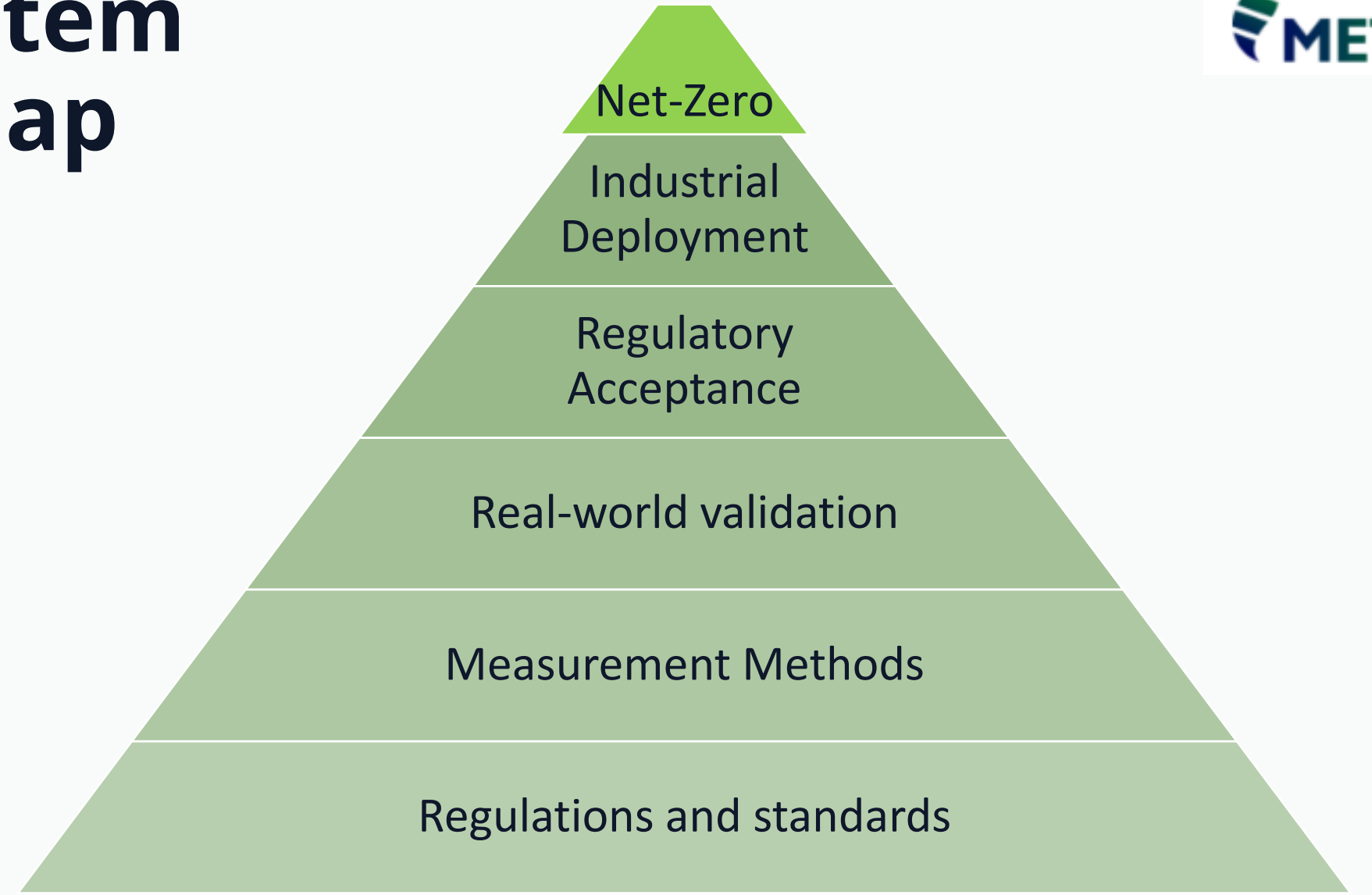


Outcome

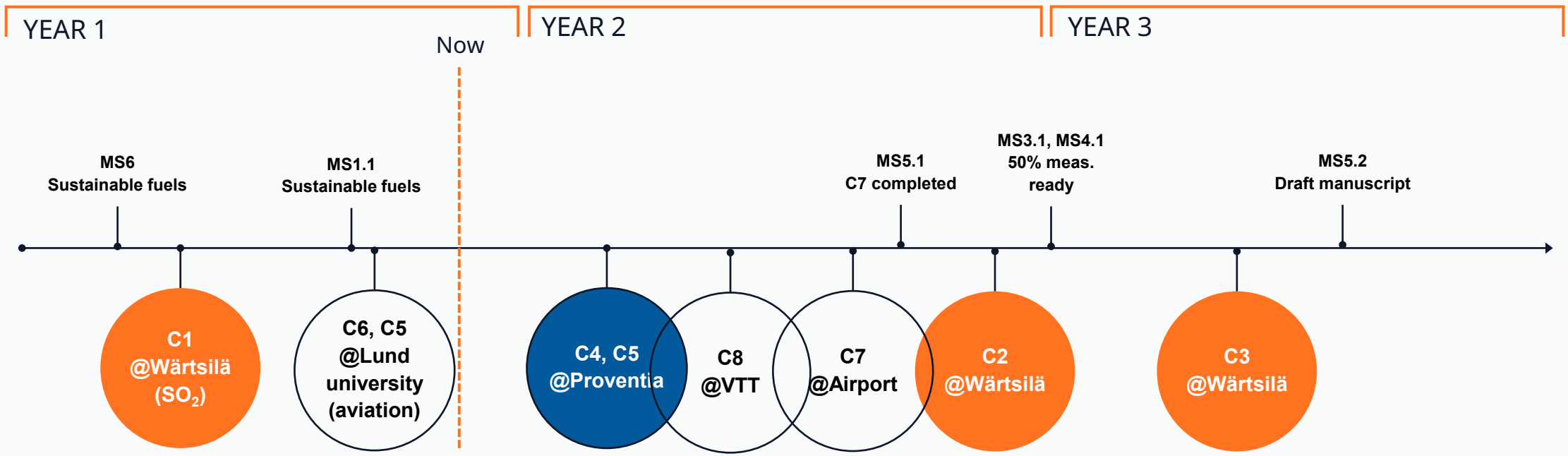
- Verification of low-emission technologies
- Support compliance with climate and air-quality targets
- Improved competitiveness and new business opportunities
- Market growth through regulatory acceptance
- Consistent results between field and laboratory measurements



Ecosystem roadmap



Progress update: month 10/36



Call to action

- Research tries to answer question, guaranteed is that there will be more questions
- We need to harvest these new questions
- New measurement technologies and concepts are needed
- Accuracy is a start, for industrial application robustness is a must

https://metech.fi

- Research partners: VTT Technical Research Centre of Finland, Tampere University, Finnish Meteorological Institute
- Industrial partners: Wärtsilä Finland Oy, Proventia Oy, Gasmet Technologies Oy, Dekati Oy, Pegasor Oy, Airmodus Oy, HSY, AGCO Power Oy, Maurus Oy
- Funded by Business Finland