Final event

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Politecnico di Milano

Via Lambruschini, 4 – 20156, Milan

Building BL28, Aula Magna Carassa e Dadda

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Atena

University of Naples Parthenope

FuelSHIME

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General project presentation

MULTIFUEL SOFC SYSTEM WITH MARITIME ENERGY VECTORS

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Brief gist of the project

FuelSOME = Multi**fuel** **SO**FC system with **m**aritime **e**nergy vectors

4 year project, Sept 2022 to Aug 2026

Total project budget €2.5 Million

The broad call from the EU is '**Emerging technologies for a climate neutral Europe**' CL5-2021-D2-01-08.

Within this call the consortium prepared a proposal for 'Multifuel to power'

The end application is ocean going vessels

The different fuels that we are considering within the project are: Ammonia, Methanol and Hydrogen.

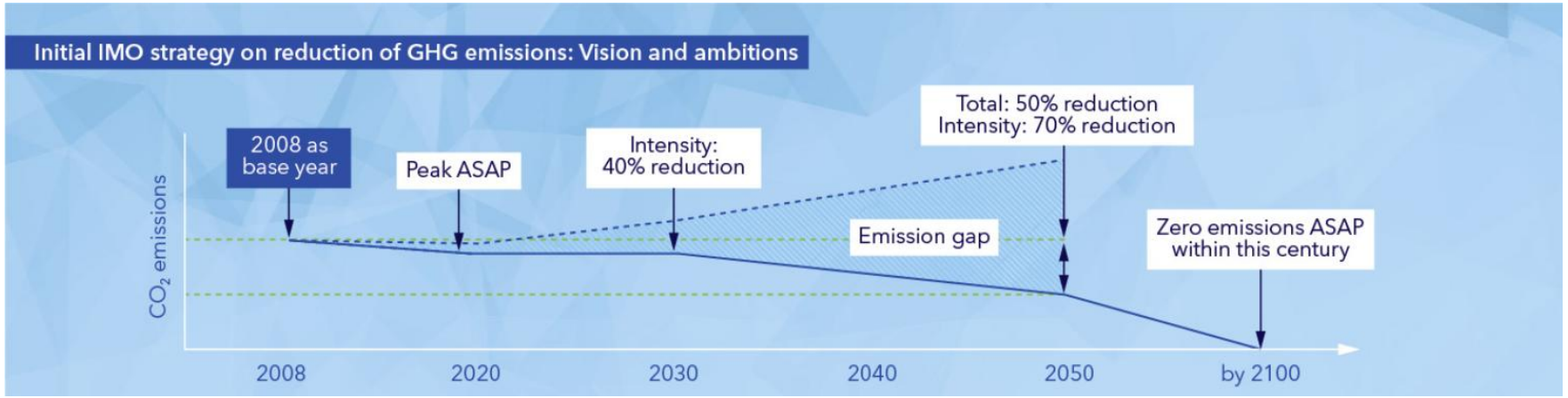
- Fuels processed from waste streams
- Green fuel production supply chain

The power conversion aspect is via Solid Oxide Fuel Cells

Shipping and Green House Gas

1. Shipping is responsible for around 1 billion tons of carbon dioxide emissions, making up about **2.5% of total global greenhouse gas emissions**.
2. Within the transportation sector, shipping claims the third position in terms of carbon dioxide emissions, **comprising 11% of the total**.
3. Shipping is reported to produce **16.14 grams of CO2 per kilometer** for each metric ton of cargo they carry.

International Maritime Organization (IMO) vision and ambitions



- The urgent need to significantly decrease GHG emissions from shipping - **a crucial objective within the EU Green Deal** framework.
- Internationally, in 2018, the International Maritime Organization (IMO) strongly emphasized the need to reduce CO2 emissions from shipping by at least 50% by 2050 compared to 2008 levels.
- The maritime industry - **challenging sector for decarbonization**, is actively pursuing alternative technologies that improve environmental sustainability while maintaining current performance standards.
- Uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources – **at least 5% in international shipping by 2030**

Current state-of-the-art technologies for both fuels and propulsion systems

- Existing state-of-the-art technologies for both fuels and propulsion systems do not meet the necessary emission standards established by global and EU regulations.

- Consequently, there is an urgent requirement to investigate transformative technologies**, thoroughly assessing their environmental, social, and economic implications**. This investigation is crucial for aligning with the EU's and the sector's goal of achieving climate neutrality.

Project Vision

The **vision of the project** is to find a scalable and flexible path for supply of multi-fuels, viz. **ammonia and methanol** besides hydrogen, to act as key contenders in replacing marine diesel as fuel on ocean going vessels, coupled with their use in a **multi-fuel energy generation system** using **Solid Oxide Fuel Cell** technology

FuelSOME project and the transformational technology

FuelSOME project is driving the advancement of ground-breaking technologies with a focus on two main areas

1

Prioritizing sustainable alternative fuels such as Ammonia, Methanol, and Hydrogen tailored for maritime use,

Ammonia and methanol, known for their liquid form and exceptional energy density, are prime candidates for decarbonizing deep-sea shipping. While hydrogen has shown satisfactory performance as a fuel.

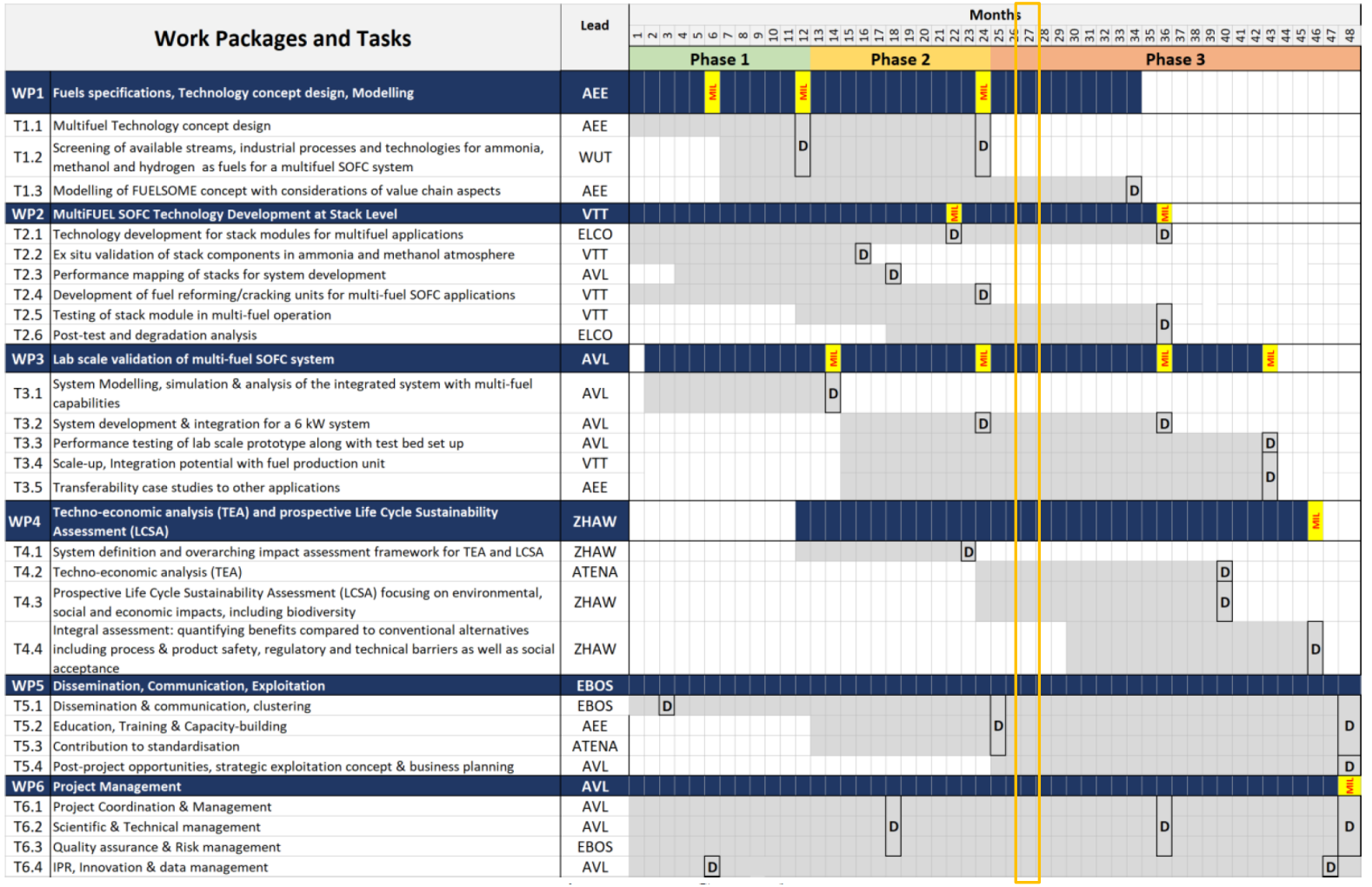
2

Developing highly efficient multifuel energy conversion systems.

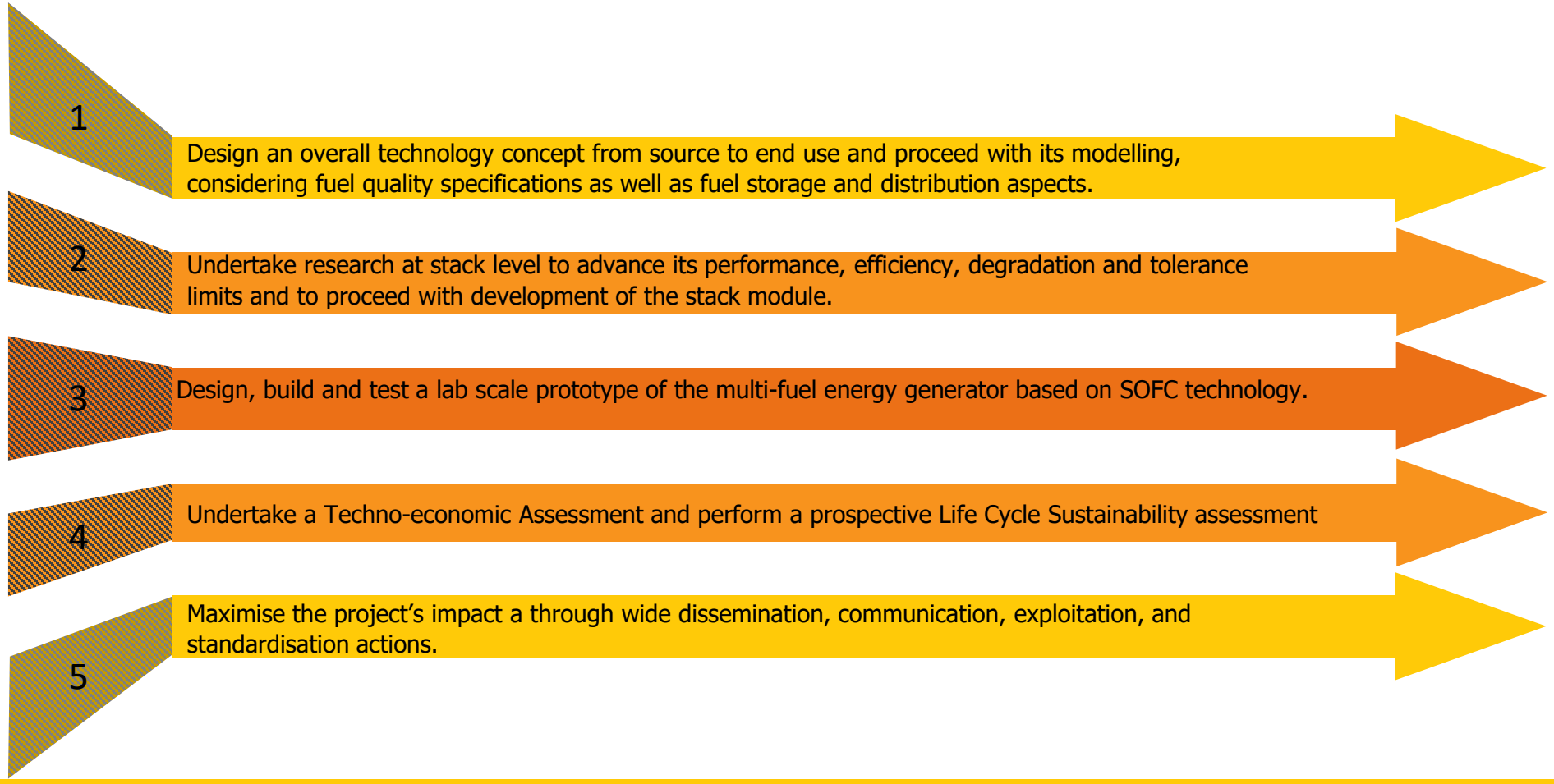
Fuel Cells, particularly Solid Oxide Fuel Cell (SOFC) systems, offer significantly high energy efficiencies compared to internal combustion engines. Among fuel cell options, SOFC systems are particularly promising for maritime applications, especially for long-distance voyages. Therefore, improving SOFC performance with above diverse fuels is essential for developing a reliable high-performance system.

Time schedule

	Work Packages and Tasks	Lead
WP1	**Fuels specifications, Technology concept design, Modelling**	**AEE**
T1.1	Multifuel Technology concept design	AEE
T1.2	Screening of available streams, industrial processes and technologies for ammonia, methanol and hydrogen as fuels for a multifuel SOFC system	WUT
T1.3	Modelling of FUELSOME concept with considerations of value chain aspects	AEE
WP2	**MultiFUEL SOFC Technology Development at Stack Level**	**VTT**
T2.1	Technology development for stack modules for multifuel applications	ELCO
T2.2	Ex situ validation of stack components in ammonia and methanol atmosphere	VTT
T2.3	Performance mapping of stacks for system development	AVL
T2.4	Development of fuel reforming/cracking units for multi-fuel SOFC applications	VTT
T2.5	Testing of stack module in multi-fuel operation	VTT
T2.6	Post-test and degradation analysis	ELCO
WP3	**Lab scale validation of multi-fuel SOFC system**	**AVL**
T3.1	System Modelling, simulation & analysis of the integrated system with multi-fuel capabilities	AVL
T3.2	System development & integration for a 6 kW system	AVL
T3.3	Performance testing of lab scale prototype along with test bed set up	AVL
T3.4	Scale-up, Integration potential with fuel production unit	VTT
T3.5	Transferability case studies to other applications	AEE
WP4	**Techno-economic analysis (TEA) and prospective Life Cycle Sustainability Assessment (LCSA)**	**ZHAW**
T4.1	System definition and overarching impact assessment framework for TEA and LCSA	ZHAW
T4.2	Techno-economic analysis (TEA)	ATENA
T4.3	Prospective Life Cycle Sustainability Assessment (LCSA) focusing on environmental, social and economic impacts, including biodiversity	ZHAW
T4.4	Integral assessment: quantifying benefits compared to conventional alternatives including process & product safety, regulatory and technical barriers as well as social acceptance	ZHAW
WP5	**Dissemination, Communication, Exploitation**	**EBOS**
T5.1	Dissemination & communication, clustering	EBOS
T5.2	Education, Training & Capacity-building	AEE
T5.3	Contribution to standardisation	ATENA
T5.4	Post-project opportunities, strategic exploitation concept & business planning	AVL
WP6	**Project Management**	**AVL**
T6.1	Project Coordination & Management	AVL
T6.2	Scientific & Technical management	AVL
T6.3	Quality assurance & Risk management	EBOS
T6.4	IPR, Innovation & data management	AVL



Broad project objectives



Specific project Objective=s

"FuelSOME" will develop and validate, **up to TRL 4, a novel multifuel energy generation system based on Solid Oxide Fuel Cell Technology** – called the FuelSOME system which will be capable of operating on various fuels and fuel mixtures.

Sub- Objectives

Overall technology concept – Source to end use

- Fuel quality specification
- Fuel storage & distribution aspects
- Fuel supply value chain
- Sustainable & circular production approaches

Stack level advancements

- Multi-fuel compatible stack
- Identify operating windows
- Understand fundamental aspects related to fuel oxidation
- Investigate stack degradation mechanisms when used on multi-fuels

Lab scale prototype

- System simulation
- System design freeze
- System build up
- Testing & performance characterisation

TEA & LCA studies

- TEA & LCA for FuelSOME system
- Quantify environmental, social & economic sustainability performance
- Compare with conventional ship propulsion systems

Maximise project impact

- Dissemination
- Communication
- Exploitation
- Standardisation

FuelSOME project consortium

4 Academic and research technology organizations

Leading European institute of applied research in renewable energy and resource efficiency.

Institution of higher education. One of Poland's top centers for chemical engineering education and research.

One of Europe's leading research institutions and a visionary research and innovation partner for companies and society.

One of the leading universities of applied sciences in Switzerland, focusing on important societal challenges.

3 Small to medium enterprises

World's most advanced manufacturer of ceramic anode-supported solid oxide cells and stacks.

Research and Technology Hub comprising Italian universities, research institutes, and private companies collaborating on projects.

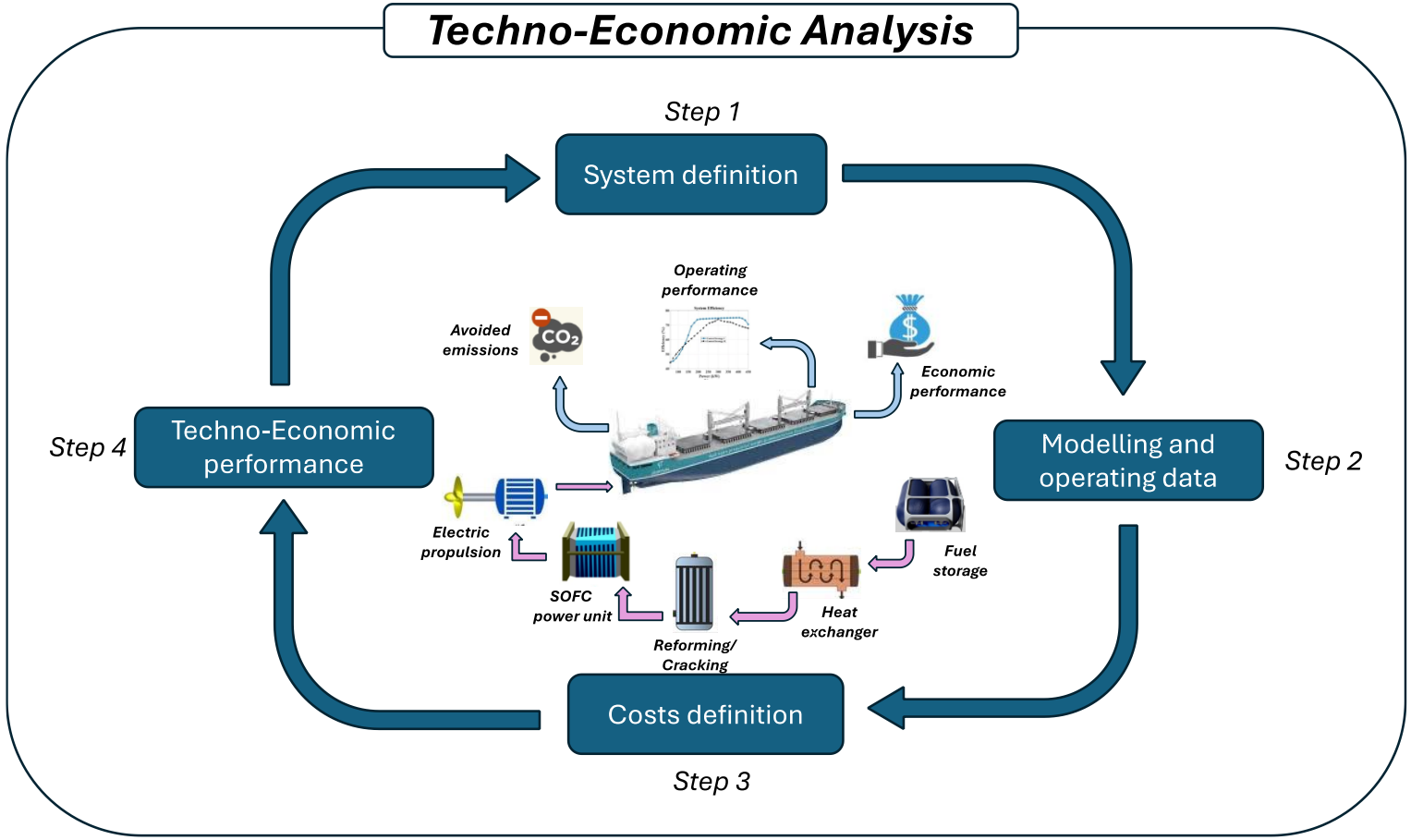
A leading research and development institution, is an innovative and client-focused SME providing technologically-advanced e-business software solutions.

1 Large industry

An experienced Project Coordinator with a proven track record of excellence, has led numerous successful collaborative projects throughout Europe. They bring their extensive expertise to the development, integration, and testing of Solid Oxide Fuel Cell systems.

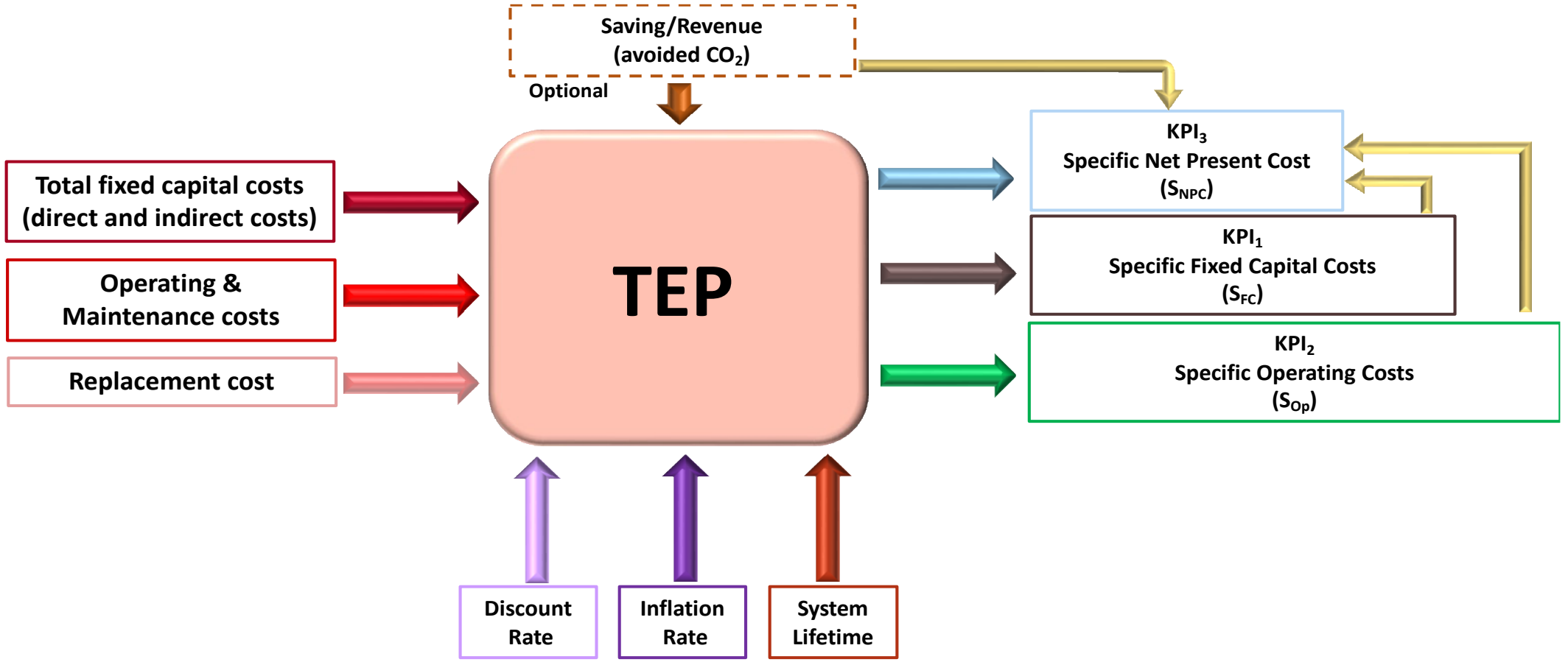
WP4
Techno-economic analysis (TEA) and prospective Life Cycle Sustainability Assessment (LCSA)

Techno-Economic Assessment Framework



WP4
Techno-economic analysis (TEA) and prospective Life Cycle Sustainability Assessment (LCSA)

Techno-Economic Performance (TEP)



FuelSOME

Multifuel SOFC system with Maritime Energy vectors

Thank you!

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FUELSOME

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