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Actions towards zero-emission Danube fleet

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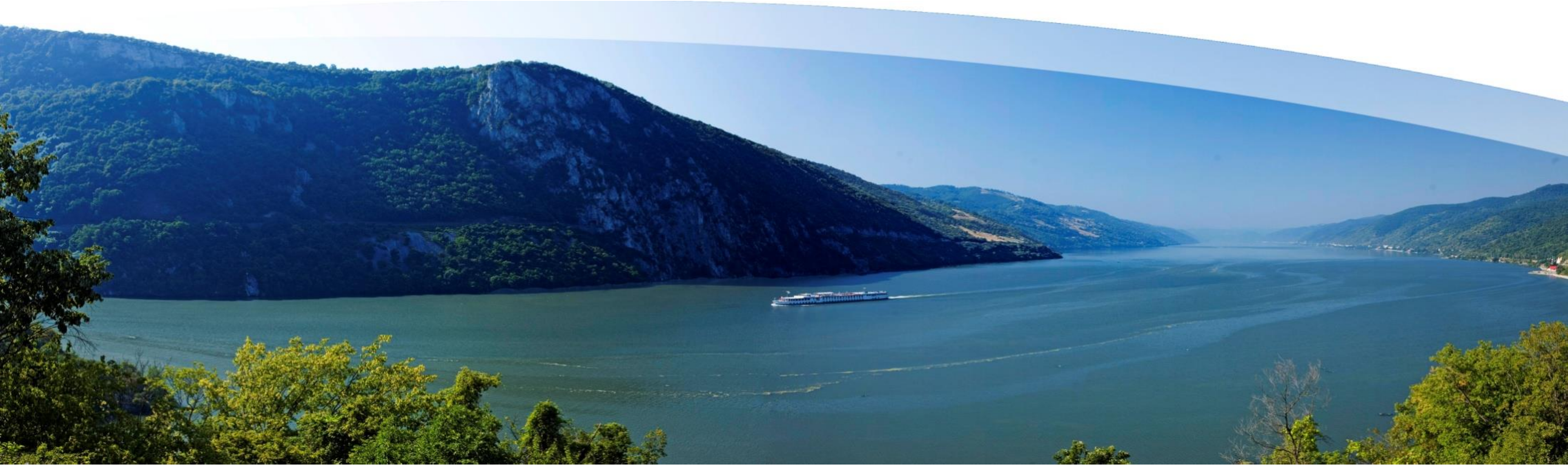

Federal Ministry Innovation, Mobility and Infrastructure Republic of Austria

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MINISTRY OF TRANSPORT, INFRASTRUCTURE AND COMMUNICATIONS

Purpose of PA1a/DC process towards zero-emission Danube fleet

- Analysis and identification of current challenges and opportunities within the sector
- Evaluation of the potential of near zero-emission technologies by stakeholders
- Definition of short-term and mid-term goals for the Danube waterway transport
- Outlining key areas for action and propose strategies to overcome existing obstacles and achieve policy targets
- For the time being the roadmap focuses on cargo transport only, as this segment seems to be faced by the most persistent challenges
- Passenger transport and its pathway to zero-emission sailing will be included at a later stage

Vision and long-term policy goals

European Green Deal

- Broader EU strategy: achieve climate neutrality by 2050
- Objective for the transport sector: reduce greenhouse gas (GHG) emissions by 90% by 2050/proposed new milestone in 2024: cut GHG emissions by 90% by 2040 (baseline 1990)

Renewable Energy Directive (RED III)

- Part of the EU's "Fit for 55" programme
- Binding targets for the transport sector: 14,5% GHG intensity reduction in transport fuels by 2030 (compared to 2020), at least 29% renewable energy share

Current status

Current Danube Fleet (estimation)

Vessel type (motorized units)	Estimated number (active fleet)
Passenger vessels	200
Push boats <500 kW (incl. tugs)	300
Push boats 500 - 2000 kW (incl. tugs)	350
Push boats >= 2000 kW (incl. tugs)	25
MCV Dry >=110 m	100
MCV liquid >= 110 m	5
MCV Dry 80 - 109 m	250
MCV liquid 80 - 109 m	40
Motor vessels <80 m	120
Total	**1,390**

Table 1: Danube fleet: Estimated number of motorized units
[Source: own calculations based on statistics of Danube Commission and PROMINENT project]

Estimation of GHG emissions of the Danube cargo fleet

- Estimation of the total CO_2 emissions from Danube cargo vessels: **1.6 million tons of CO_2/year**
- Diesel consumption of 513 mln litres/year or 430,000 tons/year
- Basis for the estimation: definition of vessel types and operational profiles, values and modelling tools to assess fuel consumption and emission outputs provided by projects such as PROMINENT

Near zero-emission technologies in IWT

Potential solutions for the transition toward (near)zero emissions

- Stage V internal combustion engines (ICE) powered by renewable diesel (HVO-Hydrotreated Vegetable Oil)
- Stage V internal combustion engines operating on Liquid Bio Methane (LBM)
- Battery-electric propulsion systems
- Hydrogen-based technologies, used either in fuel cells (FC, electric propulsion) or in modified internal combustion engines
- Methanol-powered systems, applicable in both fuel cell configurations and traditional combustion engines

Comparison of emissions generated by potential solutions

Technology	GHG / CO2e	NOx	PM
CCNR 2 and below	0%	0%	0%
CCNR 2+SCR	0%	82%	54%
Stage V, Diesel	0%	82%	92%
Stage V, HVO	100%	82%	92%
Stage V, LNG	10%	81%	97%
Stage V, LBM	100%	81%	97%
Battery	100%	100%	100%
H_2 FC	100%	100%	100%
H_2 ICE	100%	82%	92%
MeOH FC	100%	100%	100%
MeOH ICE	100%	82%	92%

Table 2: Emission reduction potential per technique/fuel compared to CCNR Stage 2 engines using fossil fuel [Source: CCNR, 2021]

Considerations on the potential of biofuels (e.g. HVO)

- Cost-efficient pathway for achieving measurable short-term emission reduction
- Compatibility with existing engines and refuelling systems minimizes the need for major capital investments
- Long-term decarbonization will require a shift toward more sustainable technologies, such as battery-electric, hydrogen and methanol

Additional measures to effectively save energy and reduce emissions

- The use of digital tools for route planning and execution
- Training personnel in energy-efficient navigation and operation of the ship (which in the maritime sector is a standard already)
- Diesel-hybrid propulsion architectures, as the new generation of power management systems, combined with diesel-electric propulsion and batteries, in many cases offer improved overall efficiency compared to direct diesel propulsion (the so-called "future-ready" architectures).
- Hydrodynamic improvements
- Use of photovoltaics (e.g. installed on the cargo hatches)

Transition pathways for Danube navigation by 2030 and 2050

Transition pathways developed by CCNR (2021)

- Comprehensive study commissioned by the Central Commission for the Navigation of the Rhine (CCNR)
- Examination of transitional pathways for achieving (near) zero emissions
- Presentation of two pathways
  - Conservative pathway
  - Innovative pathway

Pathways for Danube navigation

- Stakeholder consultations within Danube workshops: in total 55 respondents
- By 2050, the 55 respondents expect that 64% of engines and fuel types used on the Danube waterway will be either CCNR Stage 2 or Stage V, powered by diesel or drop-in biofuels.
- As market circumstances and subsidies in Western Europe accelerate the adoption of zero-emission ships, the fleet composition is expected to shift by 2030. **The older ships being replaced in Western-Europe will likely find their way into the Danube fleet, as in the last decades since the opening of the Main-Danube corridor in 1992.**
- This relative “modernization” could be supplemented by drop-in HVO fuels, as new owners are unlikely to invest in costly retrofits that far exceed the value of the vessel.

Pathways for Danube navigation

A clear majority of the sector representatives participating (21 out of 29 respondents) in the DC/PA1a workshop in Budapest on October 8, 2024 identified **HVO as the most promising & cost-effective alternative fuel**

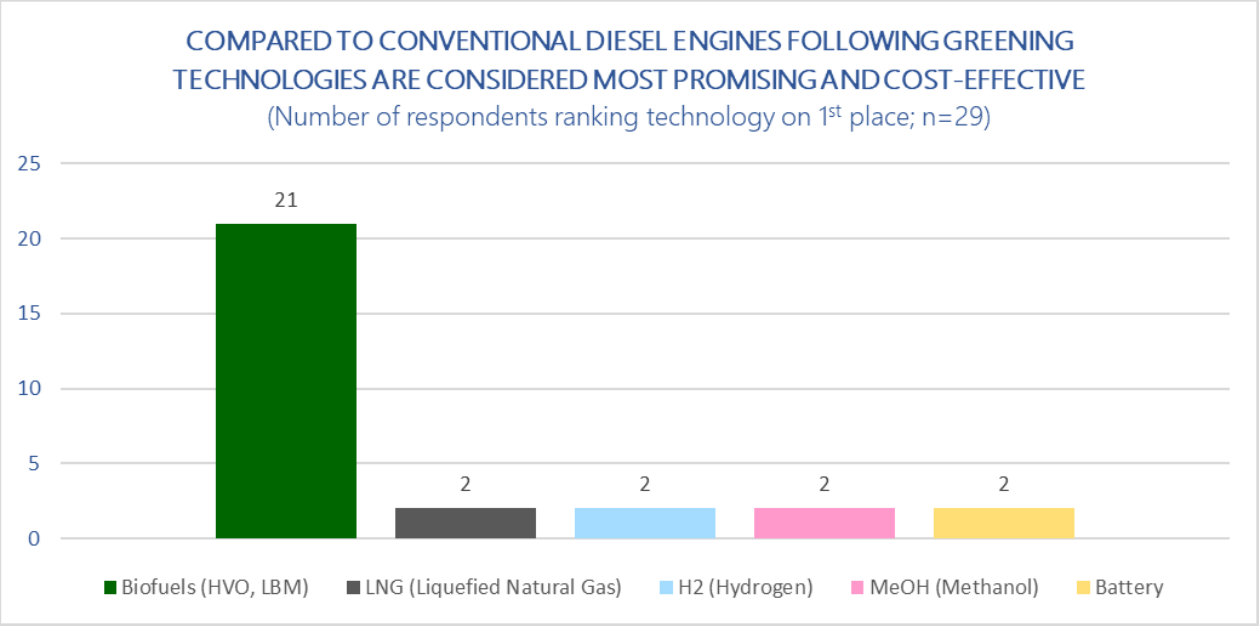

Figure 4: Ranking of most promising and cost-effective alternative fuels [Source: PA1a EUSDR, 2024]

Pathways for Danube navigation

- HVO:
  - Immediate GHG reduction option for inland shipping
  - Compatible with diesel engines but needs NO_x/PM after-treatment
  - Faces challenges with lubricity, higher price, limited sustainable supply, and competition from other transport modes e.g. aviation
- Other fuels:
  - Hydrogen, methanol, ammonia require major infrastructure and vessel investments
  - Swappable battery containers are a flexible option but limited by sparse container terminal networks in the Danube Region

Implementation barriers

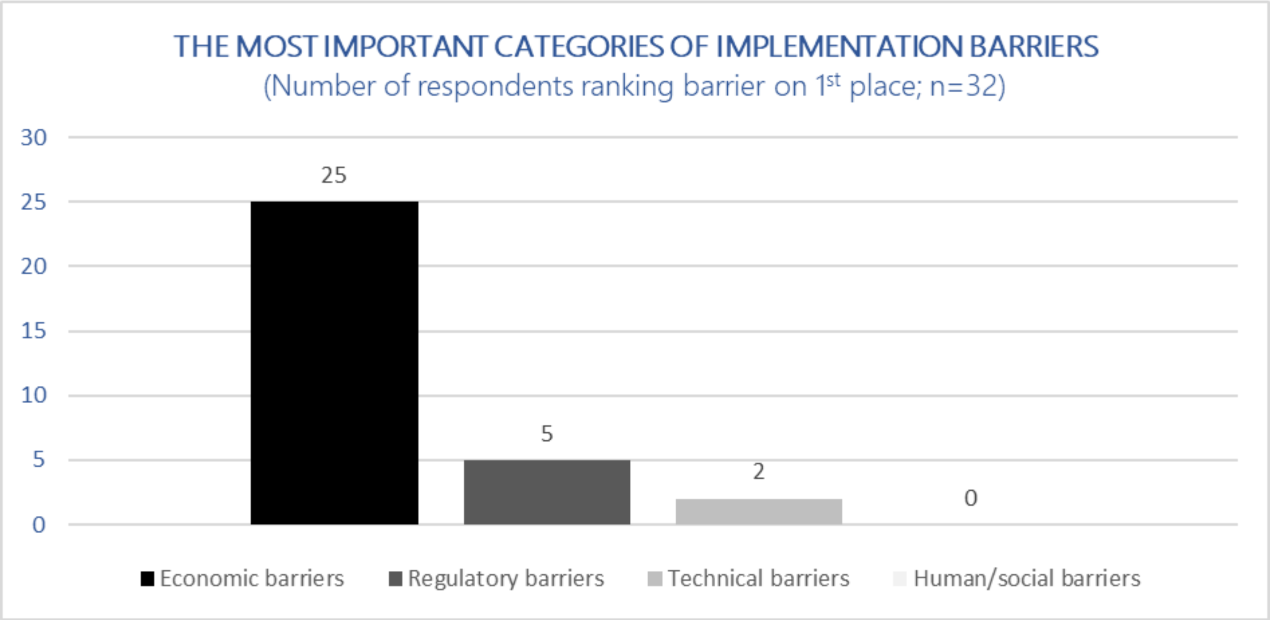

Figure 4: Ranking of most important barriers to modernisation [Source: EUSDR PA1a, 2024]

During the PA1a/DC workshop held on October 8, 2024, participants were asked to identify the main categories of barriers hindering innovation and modernisation.

Out of 32 respondents, 25 identified economic barriers as the most significant constraint to increasing the fleet's modernisation rate.

Economic barriers

Lack of business cases for alternative fuels

Lacking a system of internalisation of external costs, operators of greener and cleaner vessels are generally not rewarded for greening investment in economic terms

Example HVO:

- Currently, the market price of HVO is about 30% higher than that of conventional diesel, but prices largely differ between Member States due to differing national fuel policies
- Operational costs would remain unchanged if it is made available at competitive pricing against conventional diesel
- In a scenario where HVO reaches price parity with fossil diesel, the Total Cost of Ownership gap for achieving 100% GHG emission reduction would be eliminated

Technology	Expected additional operating costs compared to CCNR2 engines and fossil diesel (2030)
CCNR 2 and below	0% (=baseline)
CCNR 2+SCR	[not assessed]
Stage V, Diesel	10%
Stage V, HVO	40% to 60%
Stage V, LNG	[not assessed]
Stage V, LBM	80% to 110%
Battery	50% to 370%
H_2 FC	350% to 520%
H_2 ICE	210% to 370%
MeOH FC	300% to 450%
MeOH ICE	60% to 90%

Table 3: Cost impacts per technique/fuel compared to CCNR Stage 2 engines using fossil fuel
[Source: Provincie Zuid-Holland, 2021]

Regulatory barriers

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Emission regulations are not affecting legacy fleet

- Standards are only applicable to new engines
- Number of new engines entering the market is too small to have a significant effect on the emissions of the total fleet
- > 80% of the inland fleet is not affected by any limits with respect to emission characteristics
- Zero emission navigation will not be achieved in a business-as-usual scenario

Regulatory barriers

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Failing earmarking of available alternative fuels

- Biofuels such as Hydrotreated Vegetable Oil (HVO) are not specifically earmarked or reserved for sectors that are difficult to decarbonize
- Allocation of these renewable fuels is left to market dynamics, which prioritize sectors with higher purchasing power
- Danube navigation faces the risk of limited access to sustainable fuels
- Targeted measures introduced within REDIII could ensure the availability of renewable fuels for inland navigation

Technical barriers

Availability of alternative fuels and incomplete alternative fuelling infrastructure (1/2)

- Limited infrastructure available to support alternative fuels such as hydrogen, electricity, or even biodiesel
  - **HVO is compatible with the current refuelling infrastructure**
  - For other alternative fuels, technical and legal constraints – such as restrictions on carrying hydrogen stacks – pose challenges and require significant investments

Technical barriers

Availability of alternative fuels and incomplete alternative fuelling infrastructure (2/2)

- To enable widespread adoption, significant investments are still necessary to scale up dedicated biofuel bunkering infrastructure
  - Storage tanks and pipelines: adapted to handle the chemical properties of biofuels
  - Fuel blending and distribution hubs
  - Retrofitting existing bunkering stations: upgrades in storage compatibility and safety systems.
  - Production and supply chain development: Expanding capacity along the Danube corridor

Technical barriers

Availability of alternative fuels (1/2)

- Approximately 430,000 tonnes of HVO would be required to fully replace the current volume of fossil diesel used by the Danube cargo fleet by 2030.
- Primary barriers are:
  - Higher price
  - Limited availability
- EU reliance on external HVO suppliers risks supply disruptions and price volatility.
- Aviation demand for HVO may drive shortages and higher costs for inland shipping (crowding out).

Technical barriers

Availability of alternative fuels (2/2)

- If European fuel suppliers (e.g. OMV) continue to scale up sustainable fuel solutions in the Danube region, inland waterway transport operators will gain greater access to low-emission alternative fuels.
- Sufficient competition on the part of fuel suppliers must be ensured from the outset (e.g. by bundling demand).
- Short term, a gradual transition to HVO30 (a 30% HVO blend) is considered more feasible than an immediate switch to HVO100 allowing:
  - operators to adapt progressively to new fuel standards and supply conditions,
  - HVO producers to ramp up the capacity and
  - fuel distributers to provide sufficient fuel.

Policy strategies towards a greener Danube fleet

Short-term policy strategy for drop-in fuels as a ready solution

- HVO (Hydrotreated Vegetable Oil) ready to use short-term solution
- Roll-out of HVO
  - reliable annual supply of ca. 430,000 tons of certified HVO needed for competitive pricing
- Regulation as key driver for the roll-out of HVO

  → Stable regulatory framework and coordinated approach
  - Financial support for ramping up the HVO production in the Danube states
  - Coordinated implementation of REDIII in the area of IWT
  - Harmonized taxation of HVO and HVO blends, as further crucial elements

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

- Other green fuelling solutions shall be developed further in parallel to mitigate risks regarding availability and price and to achieve higher resilience.
- Regulation has historically been main driver of transformation in IWT
- To successfully implement alternatives beyond drop-in fuels, the current market failures must be urgently addressed through:
  - A predictable and pro-innovation regulatory framework that provides legal certainty and equals conditions for all
  - A goal-based and technology-neutral approach
  - Funding and support for technological advancements beyond drop-in solutions, making other renewable energy solutions more efficient and cost-effective over time.

Proposed policy actions

Shaping the Next Steps

Short-term policy strategy for roll-out of drop-in fuels

Safeguard coordinated implementation between Member States of REDIII in the area of inland waterway transport

- Multiple transport sectors, including aviation, increasingly adopt biofuels to meet EU targets, inland shipping may face heightened competition and rising fuel costs.
- The implementation of RED III needs to be coordinated at both the EU and Danube Region levels to ensure the reliable and cost-competitive annual supply of HVO for Danube navigation.

Responsible actors: EC, EU member states, IWT sector representative organisations

Timeline: ongoing in line with the timing of RED III implementation.

Questions

- Why could this policy work?
- Why would this policy fail?

Short-term policy strategy for roll-out of drop-in fuels

Use the potential of AFIF for roll out of alternative refuelling infrastructure

- EU funding mechanism: Alternative Fuels Infrastructure Facility (AFIF) (within CEF Programme)
- Targets the development of alternative fuel supply infrastructure along the Trans-European Transport Network (TEN-T)
- In IWT the potential of AFIF funding remains largely underutilized
  - funding rates and the application conditions are not favourable enough for Danube region actors.
  - Involvement of non-EU Danube states is limited and complicated

Responsible actors: EC, EU member states

Timeline: ongoing (call dependent)

Questions

- Why could this policy work?
- Why would this policy fail?

Short term policy strategy for roll-out of drop-in fuels

Ensure active state aid implementation by Member States

- Such as the General Block Exemption Regulation (GBER) and the Climate, Energy and Environmental Aid Guidelines (CEEAG) by EU Member States
- Providing targeted public support – such as investment aid, operating subsidies, or tax incentives – within a clear legal framework
- Help reduce financial uncertainty for operators and stimulate private investment in clean technologies.

Responsible actors: EU member states

Time line: continuously

Questions

- Why could this policy work?
- Why would this policy fail?

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Assess ETS-2 opt-in for inland navigation (1/2)

- ETS-2 will extend the EU's carbon pricing mechanism to the road transport and buildings sectors
  - planned to begin in 2027
  - IWT not included, but impacted
- Long-term impact of ETS-2 will be to provide a strong incentive for the sector to adopt cleaner solutions
- Whilst RED III imposes direct regulatory pressure to adopt renewable fuels by 2030, ETS-2 will create an indirect push by increasing the cost of fossil fuel use across the broader transport ecosystem

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Assess ETS-2 opt-in for inland navigation (2/2)

- An EU-wide opt-in for inland waterway transport could further de-risk greening investments by providing a stable and predictable revenue stream for operators
- If generated revenues are earmarked for green IWT technologies, it would establish a dedicated funding mechanism to support the transition to cleaner vessels and infrastructure

Responsible actors: EU member states

Time line: in line with ET-2 implementation plan

Questions

- Why could this policy work?
- Why would this policy fail?

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Harmonise and improve taxation regime ensuring competitive pricing for renewable fuels

- Through the Energy Taxation Directive (ETD)
- Aligning national tax policies to ensure consistent and competitive pricing across EU Member States
- By providing tax incentives for cleaner fuels, ETD can help reduce cost disparities between renewable and conventional fuels

Responsible actors: EU member states

Timeline: in line with ETD implementation timeline, countinously

Questions

- Why could this policy work?
- Why would this policy fail?

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Amend NRMM Regulation to include hydrogen and methanol as reference fuels for certification of combustion engines

- By officially recognizing these alternative fuels for engine certification, it would create clearer regulatory pathways for their adoption
- Enhance investor confidence, reduce technological uncertainty, and drive the development of hydrogen- and methanol-powered engines

Responsible actors: EC, EU member states, IWT sector

Timeline: in line with the timeline for revision of NRMM Regulation

Questions

- Why could this policy work?
- Why would this policy fail?

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Create RTD and innovation funding opportunities that ensure SME-friendly access

- Research, Technology Development (RTD)
- Should be designed to ensure SME-friendly access and promote the development of cost-effective, efficient renewable energy technologies and refuelling systems
- Lowering entry barriers by simplified application processes, smaller funding tranches, and tailored support for SMEs

Responsible actors: EC, Zero-emission Waterborne Transport (ZEWT) partnership, EU member states, IWT businesses

Timeline: in line with Horizon Europe Call timeline

Questions

- Why could this policy work?
- Why would this policy fail?

Mid-term policy strategy for zero-emission technologies beyond drop-in fuels

Create dedicated IWT investment Fund

- Pooling national and EU funding schemes
- Enable large-scale deployment projects involving all value chain partners

Responsible actors: EC, EU member states, IWT sector

Timeline: next EU multiannual financial framework (MFF) / modified EU Innovation Fund

Questions

- Why could this policy work?
- Why would this policy fail?