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SUSTAINABLE WATERWAY TRANSPORT, CLEAN AIR

Policy recommendations

Final conference 25 November 2021

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Objectives, added value, partners

Objectives

- D2: Work together to introduce internationally harmonised and aligned policy incentives and funding mechanisms
- D2.1: To provide EU, CCNR, national, regional and local policy makers **with information about real-world performance, costs and local air quality impacts of emission reduction, fuel transition and onshore power supply technologies** for the inland waterway fleet

Added value

- Policymakers can use the results of the CLINSH project (e.g. Policy Support Document) for new legislation and non-regulatory actions by applying (mandatory) emission reductions to existing engines

D2 partners

- Nijmegen (Action leader), UNEW (Task leader D2.2), CE Delft (Task leader D2.4), ANTWERP, FG/MPW, Province of Zuid Holland, New Energy Coalition NEC (Task leader D2.3), LANUV-NRW, EA-NRW, Helmholtz-Zentrum Geesthacht (HZG)

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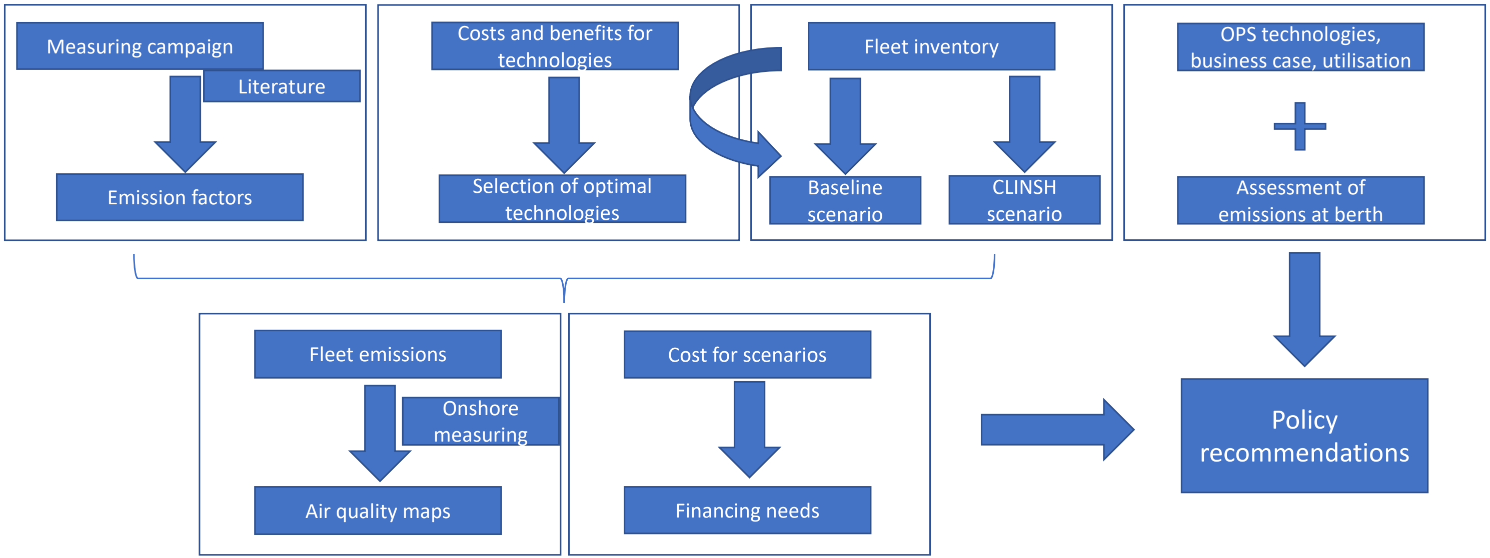
Main activities of the CLINSH project



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CLINSH products

1	**Measurement protocols for measuring ship emissions on-board including engine parameters**
2	Measurement protocols for exhaust plume measurements
3	Dataset of the measurement outputs
4	Emission factors methodology and results from application to real-life measurement data
5	Modelling tool for ship emissions (software)
6	IWT fleet development scenarios
7	IWT fleet emission scenarios
8	Novel application of air quality modelling and concentration mapping
9	Method for deriving NOx emission factors from onshore measurements according to ship type, direction of travel and speed over the Lower Rhine
10	Datasets from intensive investigation of NOx pollution at Rhine and large inland ports
11	Methodology for establishing emissions at berth and investigation of NOx pollution in large inland ports
12	Energy Scan to evaluate energy management on board of barges and assess feasibility of Onshore Power Supply

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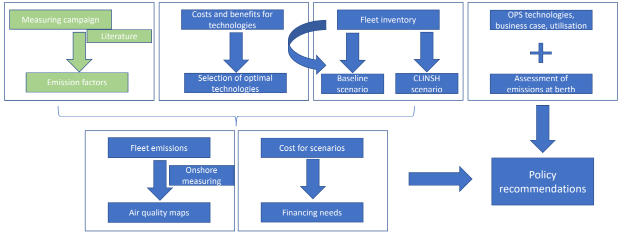
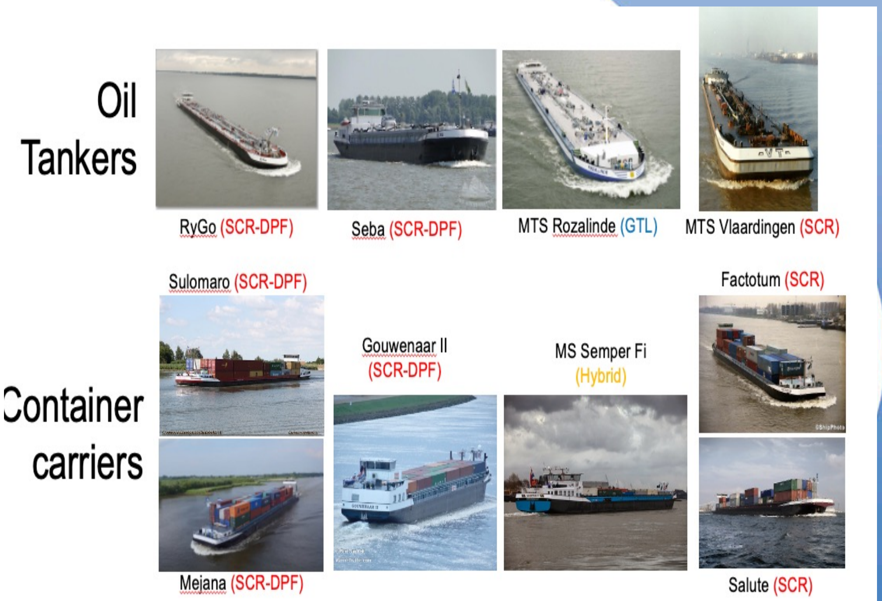


Emissions monitoring

43 vessels monitored in CLINSH fleet



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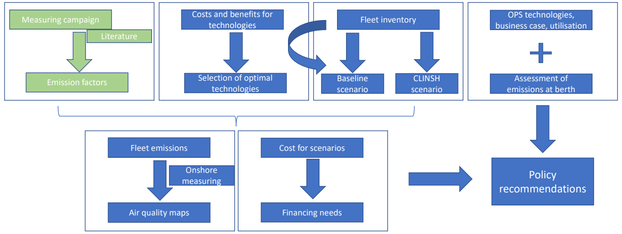
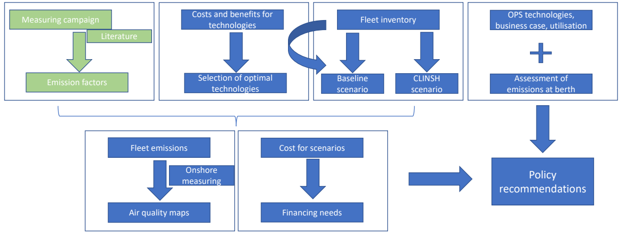


Technologies monitored	Engine class	# Ships monitored
Biodiesel (Hydrotreated Vegetable Oil)	"CCNR0"	1
Diesel	"	1
FWE (Fuel Water Emulsion)	"	2
GTL (Gas To Liquid)	"	4
SCR (Selective Catalytic Reduction)	"	2
SCR-DPF (-Diesel Particulate Filter	"	2
GTL+FWE	"	1
Diesel	CCNR1	3
FWE	"	1
GTL	"	1
SCR-DPF	"	4
Diesel	CCNR2	1
Diesel electric	"	4
Diesel electric + SCR-DPF	"	1
Diesel hydrogen injection	"	1
GTL	"	1
LNG	"	3
SCR	"	2
SCR-DPF	"	4
Diesel electric	Euro VI	1
Euro VI	"	2

Real-life measuring campaign

Overview of ships and technologies monitored in CLINSH. Total: 43 ships.



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Emission factors and reductions relative to CCNR2

Emission factors derived from CLINSH measuring campaign (c) and literature (l)

	NOx emission factor (g/kWh)	NOx emission relative to CCNR2	PM emission factor (g/kWh)	PM emission relative to CCNR2
CCNR0 diesel	10.59 [c]	205%	0.406 [l]	308%
CCNR1 diesel	8.31 [c]	161%	0.132 [l]	100%
CCNR2 diesel	5.16 [c]	100%	0.132 [l]	100%
CCNR2 GTL	4.55 [c]	88%	0.091 [l]	70%
CCNR2 FWE	4.14 [c]	80%	0.066 [l]	50%
CCNR1 SCR-DPF [a)]	2.07 [c]	40%	0.013 [l]	10%
LNG	1.80 [l]	35%	0.013 [l] [b)]	10%
Stage V diesel	1.80 [l]	35%	0.013 [l] [b)]	10%
Euro VI diesel	0.40 [c]	8%	0.010 [l]	8%

a) Compared to CCNR1 the NOx emissions are 25%, or a 75% reduction.

b) The emission limit for stage V is 0.015, the value of 0.013 is based on a 90% reduction as compared to CCNR2.

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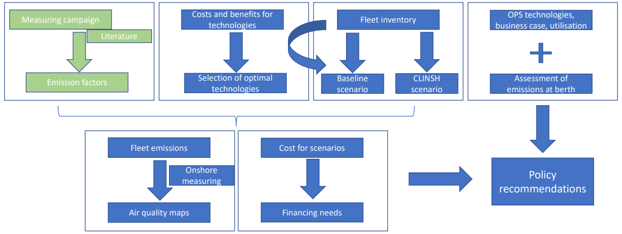

Policy recommendations (1)

- Stimulate, until zero emissions technologies are mature and supported by a regulatory and incentive framework, the **accelerated adoption of readily available NOx and PM emissions reduction options.**
  - A mix of technologies is needed most likely until 2035.
- Conduct **real-life emission measuring of Stage V engines** to confirm the expected low emissions performance in practice.
  - Stage V except Euro VI was not included in the monitored fleet.
- Stimulate widespread adoption of Stage V (equivalent, including marinized Euro VI) engines and optimised after-treatment systems by applying the Stage V (equivalent) emission standard **to the existing fleet in 2035**.
  - Only in combination with a Greening Fund
- **Basing vessel regulations on continuous real-life emission measurements** rather than test-stand based emission standards **needs further investigation.**
  - The CLINSH measuring campaign has revealed practical challenges.

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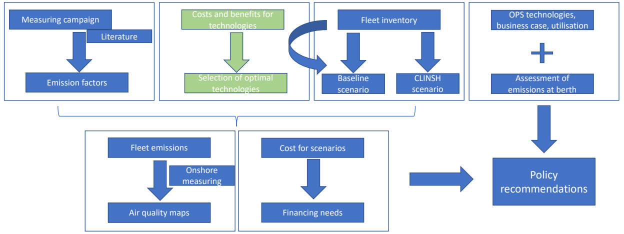
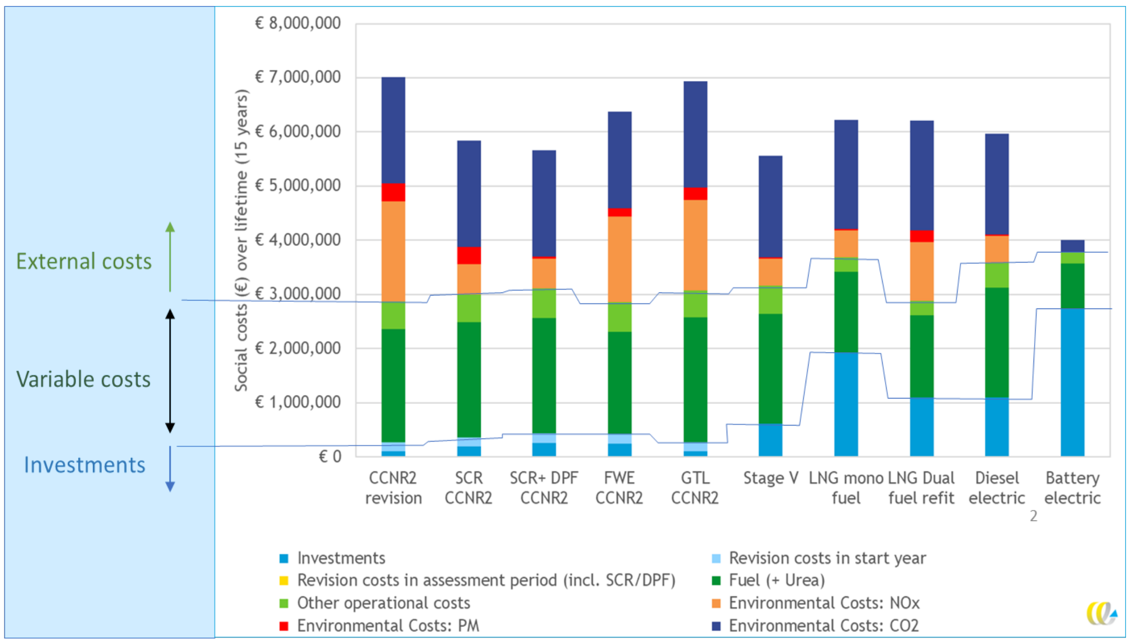


Costs of emissions reductions options



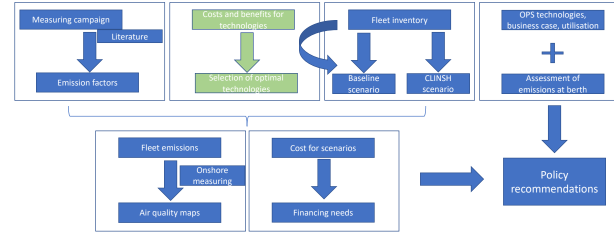
CLINSH performed a cost analysis along two lines:

- the **total costs of ownership** of vessels with the various technologies, and the
- **social costs and benefits** of operating such vessels (emissions translated to money).

This was done for a **range of 18 vessel categories**, and within these categories also for **low, medium and high fuel consumption** vessels.

- Tool for 54 variants

Example *for one vessel category (110 m dry cargo vessel, medium fuel consumption) of Total Costs of Ownership of engine technology (investments plus variable costs) and social cost and benefit (sum of investment, variable costs and external costs), calculated as Net Present Value over 15 years (2020-2035).*



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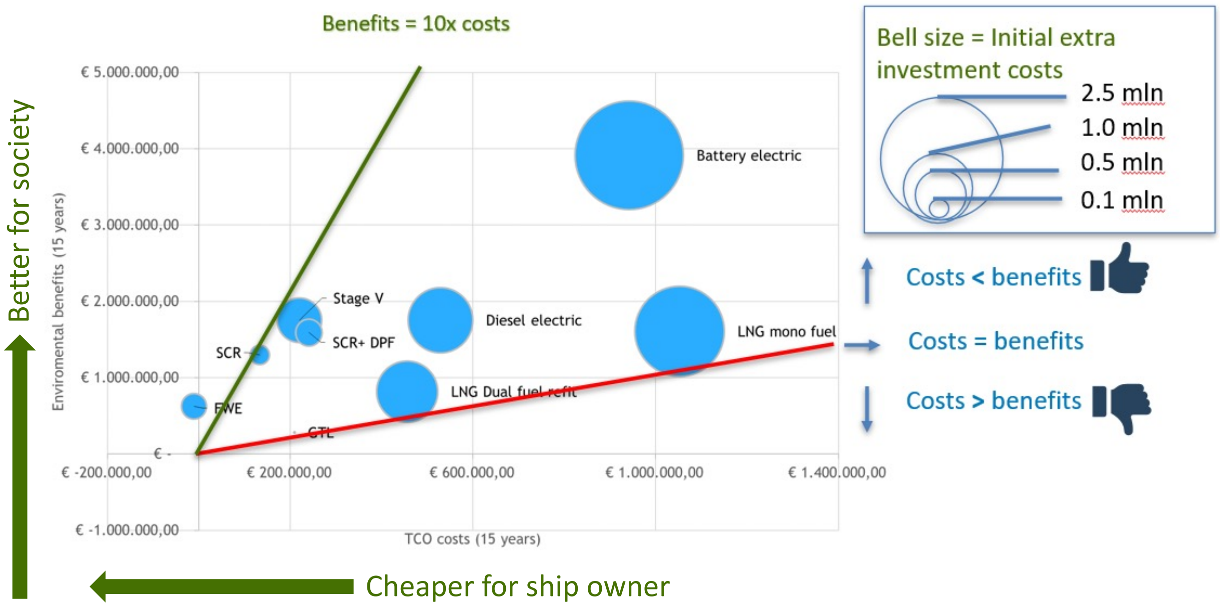
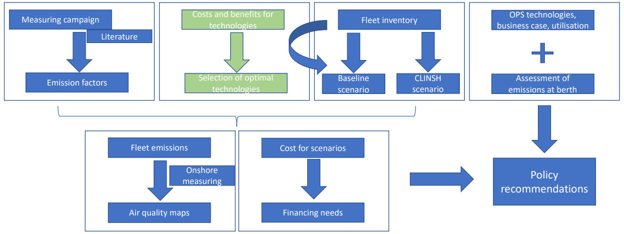
Societal vs ship owner perspective



- Illustration of **social cost perspective** (here: environmental cost) versus **total costs of ownership** for ship owners in the case of a 110 meters dry cargo vessel.
- The costs are relative to revision of a CCNR2 engine.
- Options above the red line are beneficial from a societal point of view because the benefits are higher than the costs for the ship owners.
- The size of the bell indicates initial investment costs for the options.



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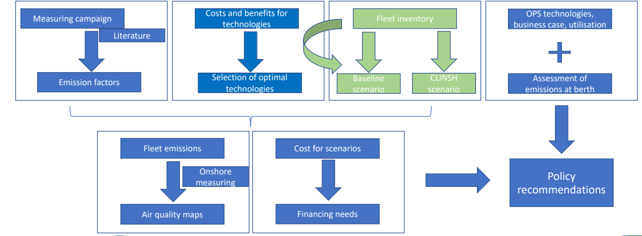
Policy recommendations (2)

- Pursue an **integrated approach** in which the supporting policy is based on **achieving the lowest social costs (including climate)** rather than most cost-efficient technologies.
  - The preferable options from a societal point of view (lowest social cost) **do not correspond** with the preferred options from the cost perspective (lowest TCO) or cost-effectiveness perspective.
- **Stage V and SCR+DPF** and to a lesser extent SCR demonstrate a very good cost/benefit ratio. Based on the modelling the Stage V engine is the best option in many cases, but closely followed by SCR-DPF. Fuel Water Emulsion shows the best cost/benefit ratio but less environmental benefit per vessel.
  - The **specific circumstances of the vessel, combined with policy incentives**, will decide what is the best option.
- The challenge lies in synchronizing the societal and individual interests.
  - Need for **policy intervention** through investment support to ship owners or by differentiated taxation of supporting the better options, in order to reduce the environmental costs from pollutants and to enable ship owners to opt for better solutions.
- Create **incentives that promote the options with the highest emission reductions**, even when they are more expensive.
  - The additional social benefits of extra emission reduction outweigh the higher costs.



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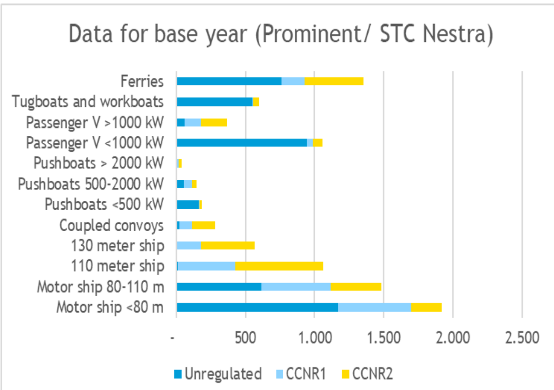
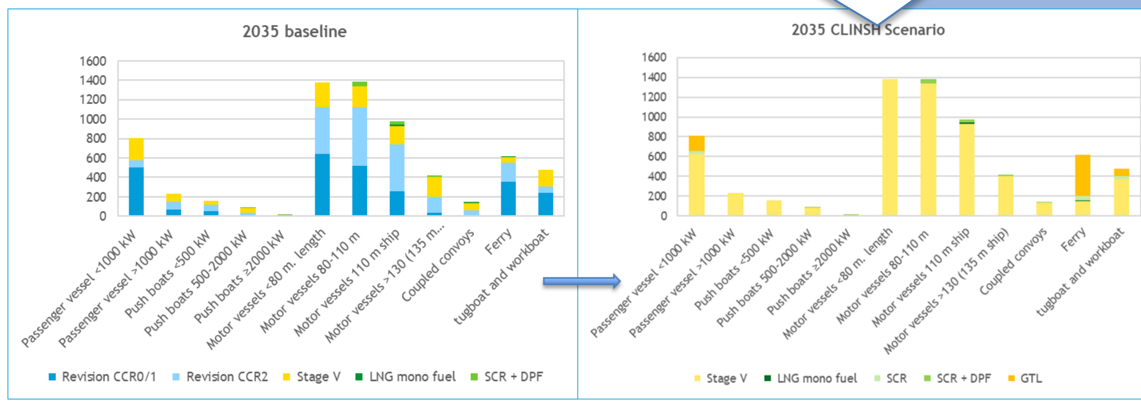
This is a **model outcome**, based on the best scoring technology of average sailing profiles and ship configurations, **assuming that policies are in place to overcome the financial barriers for the optimal options from the societal perspective. It is not a prediction.**

Fleet development scenarios

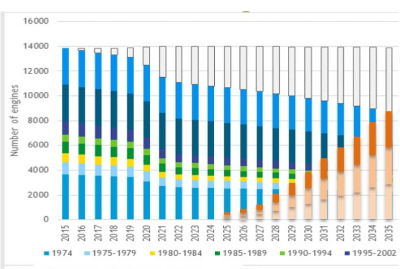


West-European IWT fleet inventory (2020)



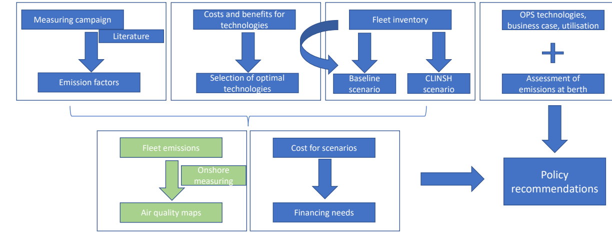
Modelled engine inventory in 2035 in the Baseline and CLINSH scenarios

ZE technologies have on purpose been **omitted** from the scenarios. These technologies will play an important role in the long term, but their role is expected to be limited until 2035 because of range limitations end/or cost. CLINSH focuses on the application of air quality abatement technologies until ZE technologies are mature and widely available.



Baseline scenario: No new policies assumed; scheduled engine renewal only (Stage V).

CLINSH scenario: New policies assumed that lead to accelerated (additional) adoption of reduction options, distribution according to Social Cost Benefit Analysis



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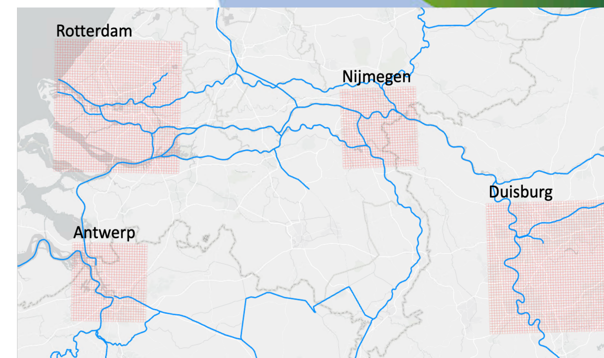
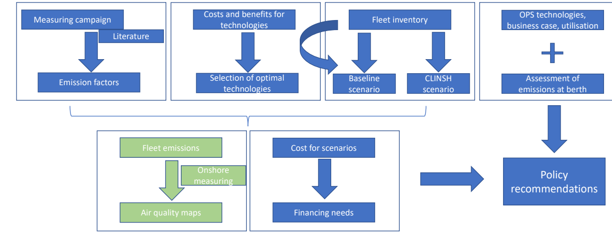
Reductions in CLINSH scenario



Whereas the Baseline scenario leads to NOx and PM emission reductions in the order of 20%, the CLINSH scenario reduces these emissions **in the order of 80%.**

	Rotterdam		Nijmegen		Antwerp		Duisburg	
[kilotons / year]	NOx	PM_{10}	NOx	PM_{10}	NOx	PM_{10}	NOx	PM_{10}
Baseline 2020	2.68	0.098	1.32	0.041	0.97	0.034	2.05	0.063
Baseline 2035	2.06 -23%	0.074 -23%	0.97 -27%	0.028 -32%	0.75 -23%	0.027 -22%	1.59 -22%	0.046 -27%
CLINSH 2035	0.72 -73%	0.032 -65%	0.28 -79%	0.004 -89%	0.27 -72%	0.013 -61%	0.45 -78%	0.010 -84%

Annual emissions from IWT in the model regions for the Baseline 2020/2035 and CLINSH 2035 scenario.



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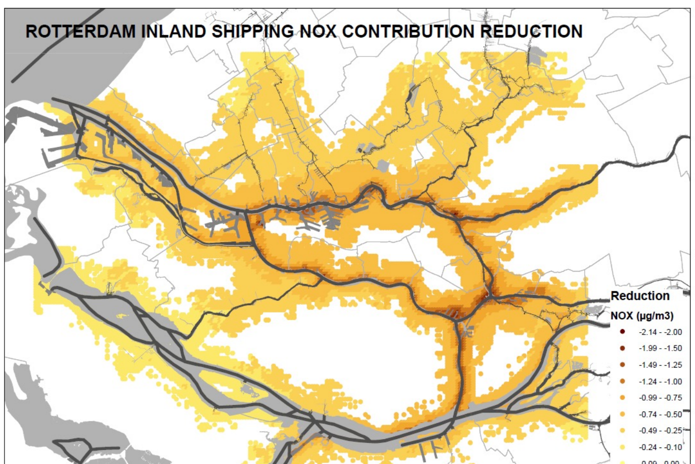
Air quality impact of fleet scenarios

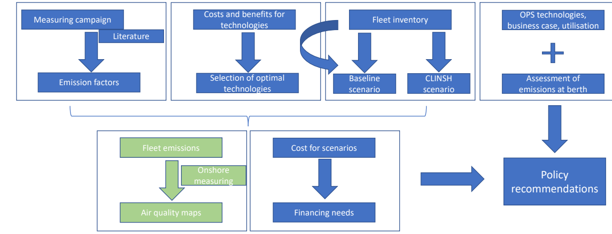


CLINSH developed a method to identify the inland shipping contribution to urban air quality for different emission scenarios in the cities of Antwerp, Rotterdam, Nijmegen and the greater Duisburg area.

Scenario	Max. contribution µg/m³	Average contribution µg/m³	Reduction vs. average Baseline 2020
Baseline 2020	3.0	1.2	-
Baseline 2035	2.6	1.0	16%
CLINSH 2035	1.3	0.4	66%

NOx reduction potential of the CLINSH scenario in Rotterdam region.

Similar results have been calculated for the other port areas and for PM emissions.



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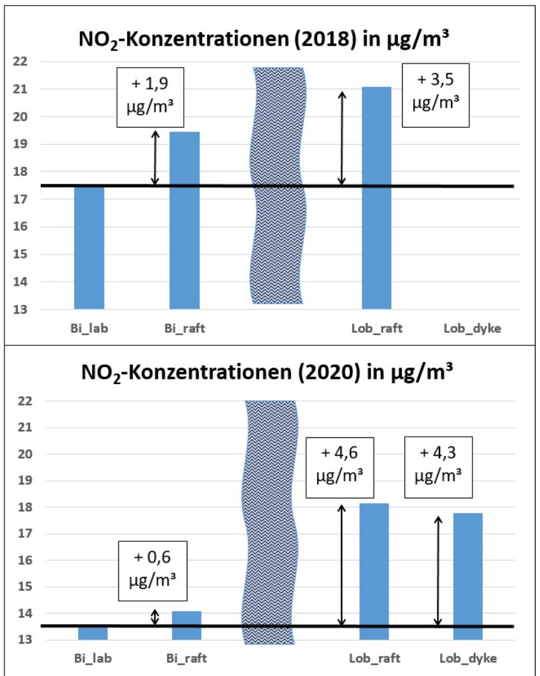
Air quality measurements on shore



- The measuring programmes by LANUV in the ports of Neuss/Düsseldorf and Duisburg as well as the measuring points on the Rhine have shown that the pollution of the ambient air with NOx and PM_{10} caused by the emissions of inland navigation is **not as extensive** as assumed at the beginning of the project.
- The annual average increase in pollution caused by about 110,000 passing inland waterway vessels at the German-Dutch border near Bimmen/Lobith in 2018 +2020 is in the range of **1 (left bank) to 5 µg/m³** (right bank) for NO_2.
- This is in the same range as the modelling results for Rotterdam presented before.
- For perspective: EU Air Quality Directive sets a 40 µg/m³ annual average limit.

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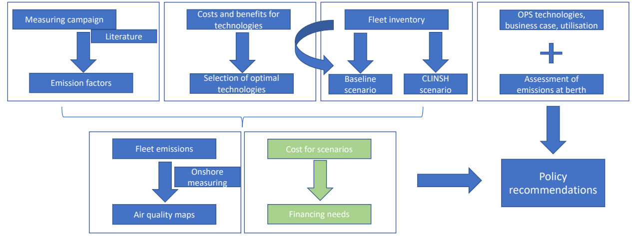

Costs for the scenarios

The number of vessels involved is that of the West-European fleet minus the vessels that need to "autonomously" renew their engine, considering the age of the engines, and also excluding vessels already using LNG, SCR(+DPF), Stage V

	Total social costs Baseline scenario 2020- 2035	Total social costs CLINSH scenario in 2020-2035	Difference
Number of vessels involved, West-Europe*	6,572	6,572	
Social costs with 15 years lifetime (mio €)	**€ 26,139**	**€ 21,280**	**€ -4,859**
TCO (Total costs of ownership) with 15 years lifetime (mio €)	**€ 10,751**	**€ 11,512**	**€ 761**
CO2 costs with 15 years lifetime (mio €)	€ 8,074	€ 7,867	€ -207
NOx costs with 15 years lifetime (mio €)	€ 6,051	€ 1,788	€ -4,263
PM costs with 15 years lifetime (mio €)	€ 1,264	€ 112	€ -1,151
Initial investment costs (mio €)	**€ 1,123**	**€ 2,393**	**€ 1,270**
Diesel consumed over 15 years (mio litres)	14,662	14,286	-376
TCO increase per litre of diesel (€ per litre)	€ 0.733	€ 0.806	€ 0.053

Investment subsidies of usually 40-60% of the price difference between a cleaner product and the established product would close the **€760** million TCO gap between both scenarios. However, even 60% may be too low for many capital-starved vessel owners to make such investments.

The minimum tax on IWT diesel proposed in the Energy Tax Directive is € 0.9/GJ or 3.24 €cts/litre, whereas on average the TCO gap per litre is 5.3 €cts/litre.

if the total IWT fleet, **hypothetically**, switches over to 100% biofuels such as Hydrotreated Vegetable Oil in order to meet Climate goals, the TCO would be raised with about 15 €cents per litre, i.e. € 2.1-2.2 billion more TCO in the scenarios, while adding € 5 billion social benefit from avoided CO_2 (assuming 90% CO_2 reduction).

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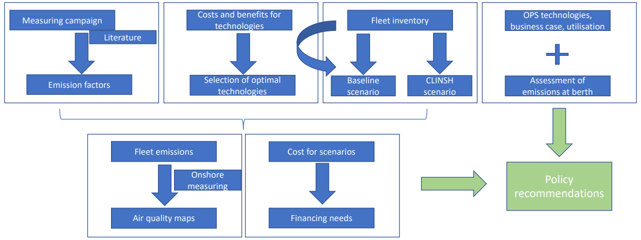

Policy recommendations (3)

- Use the period **until ZE technologies are mature** (2030/2035) for accelerated adoption of available emissions reduction options
  - Stage V (including Euro VI) engine renewal is **optimal from a societal perspective** for many ship types, best at moment of engine revision; other greening techniques like SCR(-DPF) and GTL are good options when engine revision or replacement is more than 10 years away
- EU & Member States should provide incentives for this accelerated adoption through an **IWT Greening Fund or grant schemes**
  - Open to both emission reducing and zero emissions technologies until 2035; thereafter the fund could be for zero emissions technologies only
  - Given the scarce capital availability in the IWT sector it is recommended to seek permission to **provide investment support up to 80%** over the price difference befitting EU State aid laws.
- Budget for the fund or grant schemes could be raised by **allocating revenue from the taxation of IWT fuels** that is proposed in the Energy Tax Directive.
  - A levy on the fuel similar to the CDNI regulated waste disposal charge can also be considered.
- The performance of after-treatment technologies **should be monitored** to ensure functioning well **in practice**.
- The widespread adoption of Stage V (equivalent, including marinized Euro VI) engines and optimised after-treatment systems could be stimulated by applying the **Stage V (equivalent) emission standard to the existing fleet in 2035.**

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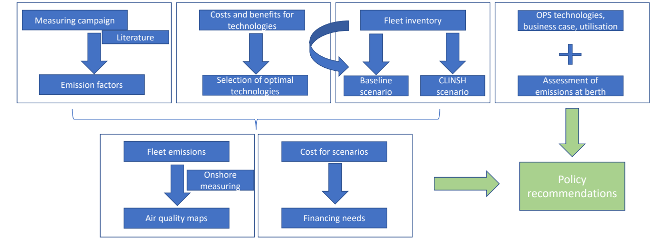
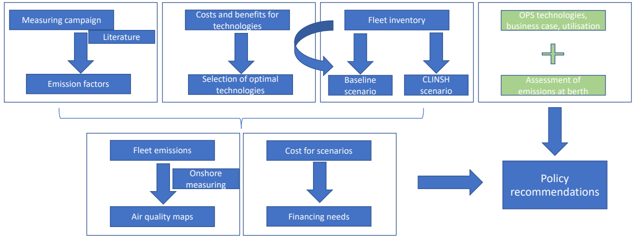


Policy recommendations (4)

- CLINSH endorses the development of **policies for accelerated uptake of biofuels and (sustainable hydrogen based) e-fuels** in IWT fleets.
  - To reduce CO_2 along with NOx and PM emissions already the coming years.
- CLINSH also endorses **policy for promoting Zero Emissions technology to facilitate the ZE goals**:
  - More research on application of ZE technology (battery electric, hydrogen); funding for pilots/demonstrations; investments to make technologies cheaper.
  - Hybrid-electric, i.e. a diesel or gas engine providing power for an electrified driveline, is an interesting option to prepare for Zero Emission.
- CLINSH recommends investigating the feasibility and impact of **low emissions zoning** in ports.
  - More widespread adoption of differentiation of port dues, harmonized across the Rhine states, would provide another incentive for greening the fleet and level the playing field for owners who already invested in greening technologies.
- **Emissions labelling** can be used as the basis for local regulation of IWT vessels
  - E.g. for differentiated port dues and environmental zoning
  - The Netherlands recently launched emissions labelling that rates both air pollutant and climate emissions.



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Policy recommendation on Onshore Power Supply

A Why: relevance of policy supporting OPS

- Based on AIS data and port data, the contribution of emissions at berth to total IWT emissions in ports varies but does not exceed **a few percent**.
- Berth locations – especially for river cruise vessels - are often situated near highly populated areas where local air quality emissions have a **high impact on health**
- Social cost benefit analysis showed that the investment costs of OPS installations more or less equals the societal benefit and support is therefore **justified** from a policy perspective.

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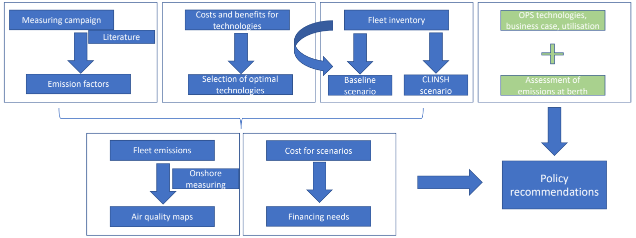
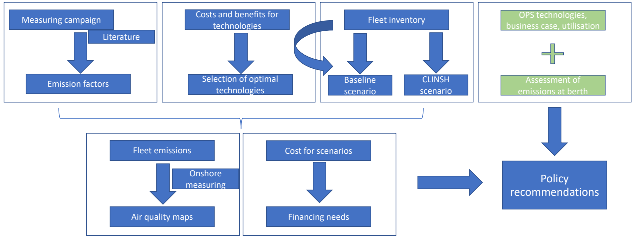


B How: recommendations for a coherent OPS strategy

- **Locations**: invest in OPS where air quality and/or noise concerns are most pressing; and where the cost effectiveness of euros spent to reduce emissions is highest
  - Top-3 type of locations: river cruise berths, waiting docks and overnight mooring, tanker berths
  - Sometimes: container terminals, home ports for nautical services and maintenance and repair yards
- **Implementation**:
  - Price setting: for a ship owner the business case for using OPS should be at last cost-neutral
  - Impose an auxiliary engine requirement to meet specific emission standards in the port wherever OPS is available
  - Promote the use of OPS among ship owners
- **Conditions:**
  - Develop funding mechanisms, in line with Naiades III, Fitfor55 policy package, EP resolution Nachtegaal 2021, to realize OPS in Core and Comprehensive ports and possibly other funding for other ports including recreational ports
  - Energy tax removed (see following)
  - Develop strategy so that current/planned OPS infra in ports could become a **stepping stone for future power infra** needed to achieve the ZE ambition for 2050.



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C Technical / operational recommendations for level playing field in Europe

- The type of connectors used for OPS is generally standard in each country but is not **standardised** internationally
  - Standardisation of connectors, at least on connected waterways, would allow ships that sail across national boundaries to use OPS in any ports where it is available
- Payment systems should be made **convenient** for the skippers
  - This could include linking the booking of a berth and OPS with payment for port dues, freshwater and waste
- Linked in with the booking system could be asking for information such as OPS cable length available on the ship
  - allowing the port to optimise the allocation of berths to maximise the availability of OPS connection points for ships wishing to use them.

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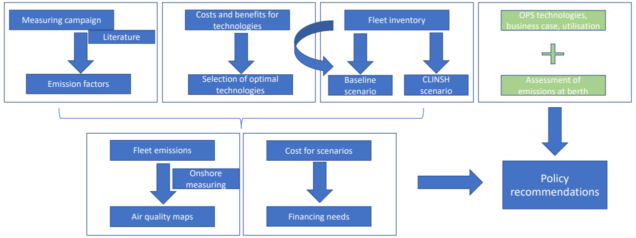

D Regulation will foster uptake of OPS and decreases berth emissions

- **Energy tax** should be removed from OPS electricity (cf. ETD revision)
  - This brings the fuel more in line with diesel supplied for inland vessels which is not taxed. In this light the proposal for amending the Energy Tax Directive by EC is being welcomed.
- Port authorities should reduce **port dues** for ships that use OPS
- Set **age limit** for on-board generators used in ports to remove oldest most polluting ones and mandate use of OPS from certain **vessel size**
  - CLINSH estimated the potential emission reduction at berth if additional regulation in ports would be introduced. Two scenarios were defined based on 1) age limit of 20 years for generators at berth and 2) size limit for (larger) vessels that are required to use OPS at berth
  - Up to >95% for PM and up to > 85% NOx reductions at berth are possible with these measures.
  - To be examined how to enforce age limit for generators

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After-LIFE

- After the formal end of the CLINSH project, **monitoring will continue** for five more years.
  - This will generate a large set of data that can be used by scientists, modelling experts and students.
- The results of the project (database, scenarios, air quality maps) will be **available as open data,** accessible on request.
- CLINSH has produced or enriched several datasets that can be used for future policy support and tooling.
  - For example, EICB will use the CLINSH monitoring outcome to update the **IWT Greening tool** in 2022.
- CLINSH partners will investigate and promote that the **Social Climate Fund** proposed in the Fitfor55 package will include a facility to support skippers.
- CLINSH partners propose that a permanent structural platform or European knowledge centre be set up by the European Barge Union in cooperation with EICB
  - Partners will contribute actively to and lobby for the creation of such a knowledge centre.