

A TRANSPORT SPECIFIC LIFE-CYCLE ASSESSMENT

THE EUROPEAN SUPPORT ACTION TRANSENSUS LCA

Final Event

Transfer to other markets

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on behalf of the TranSensus LCA Consortium

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Outline

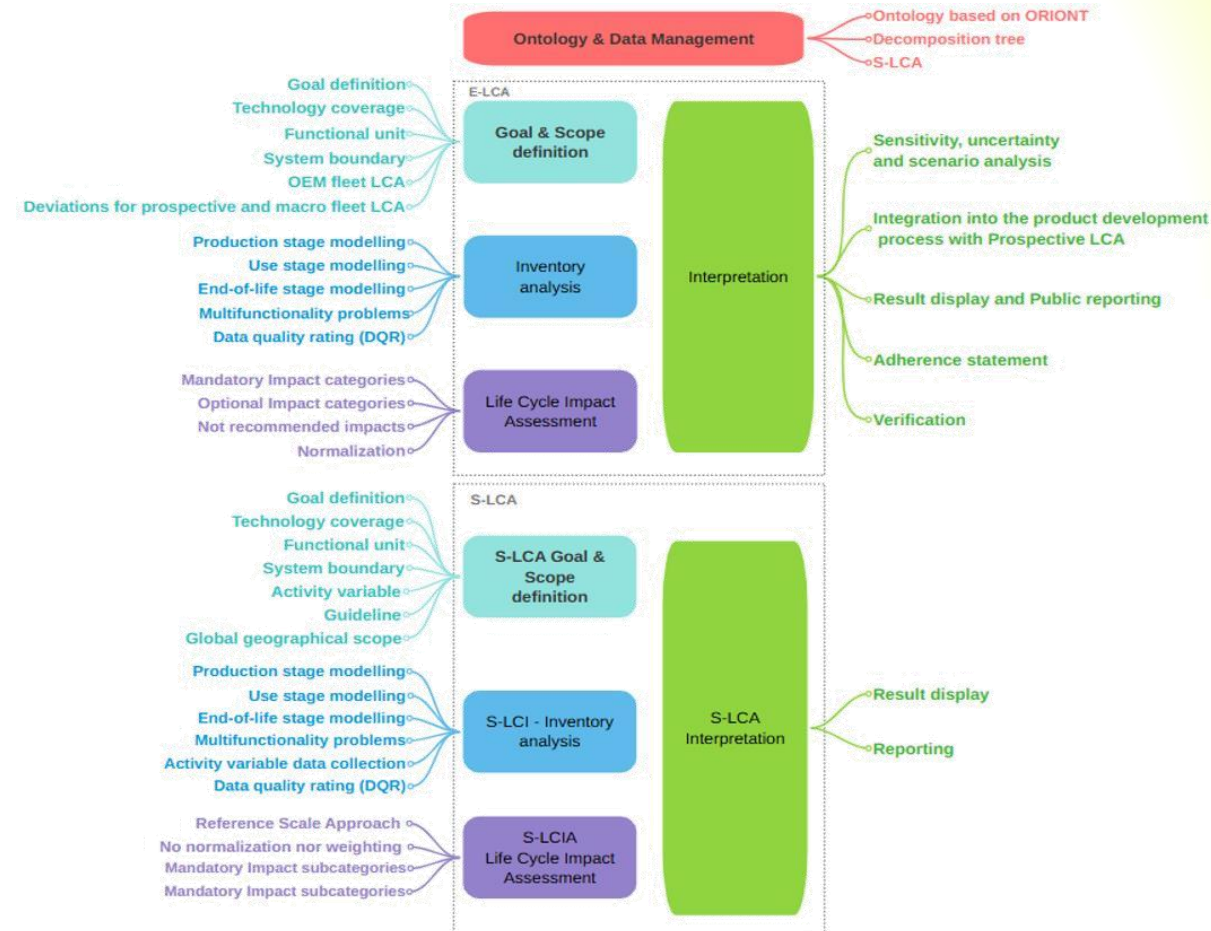


- **Motivation and objectives**
- **Approach**
- **Transferability to other markets**
- **Summary**
- **Outlook**

Transfer to other industrial sectors

Systematic approach

- Study on transferability based on **D2.3 TranSensus LCA final harmonised approach¹**
- **E-LCA/S-LCA**
 - Goal & scope definition
 - Inventory analysis
 - Life Cycle Impact Assessment
 - Interpretation



¹D2.3 TranSensus LCA final harmonised approach

https://lca4transport.eu/wp-content/uploads/2025/03/TranSensus-LCA_D-2-3_Final_2.pdf

Transfer to other industrial sectors

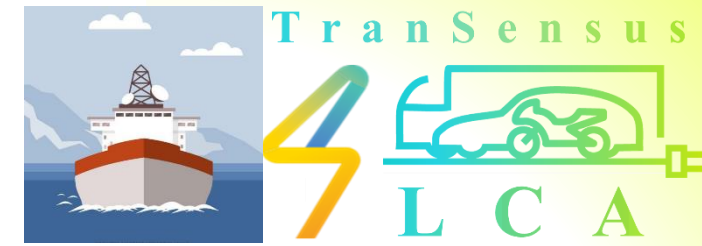
Focus on certain markets / applications

- The following applications were analysed within this TranSensus LCA task:
 - Waterborne transport
 - Charging stations for BEVs / H2 refuelling
 - Airborne mobility
 - Construction equipment
 - Railway vehicles (S-LCA/S-LCI)



Transfer to other industrial sectors

Waterborne transport



- Includes bigger vessels like container ships, ferries, cruise ships, ...
- From raw material extraction, manufacturing, transportation, assembly, operation to end-of-life
- Potential stakeholders: shipping companies, government, international organisations, classification societies, equipment manufacturers, shipbuilding companies
- Standards to perform LCA: ISO 14040 and 14044
 - No dedicated harmonised standard to perform LCA on zero emission vessels / vessels with fuel from renewable sources



<https://www.flickr.com/photos/iip-photo-archive/22307565878>



<https://www.flickr.com/photos/blmiers2/6108076454/>

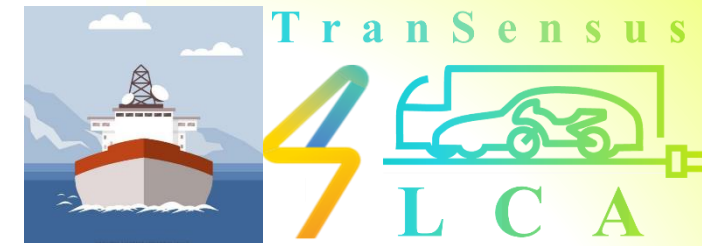


<https://www.flickr.com/photos/tranbc/7652518230>

Transfer to other industrial sectors

Waterborne transport - Goal and scope

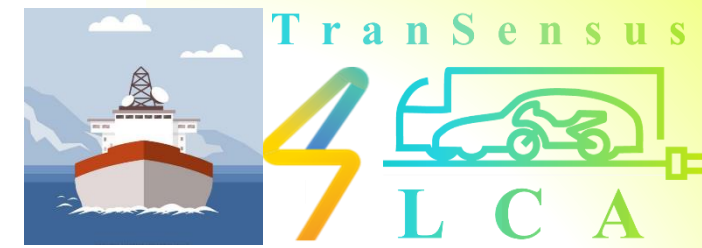
- **Retrospective, prospective, OEM fleet, and macro level fleet LCA can be applied**
- **Technology coverage:**
 - Battery electric propulsion systems
 - Hybrid systems
 - Internal combustion engine systems (with renewable fuels – biofuels, methanol, ammonia, hydrogen...)
 - Bunkering / refuelling facilities need to be considered as well
- **Functional unit:**
 - Transported goods or passengers per km (tonne-km / passenger /km)



<https://www.power-sonic.com/blog/a-guide-to-marine-battery-charging/>

Transfer to other industrial sectors

Waterborne transport – Inventory analysis

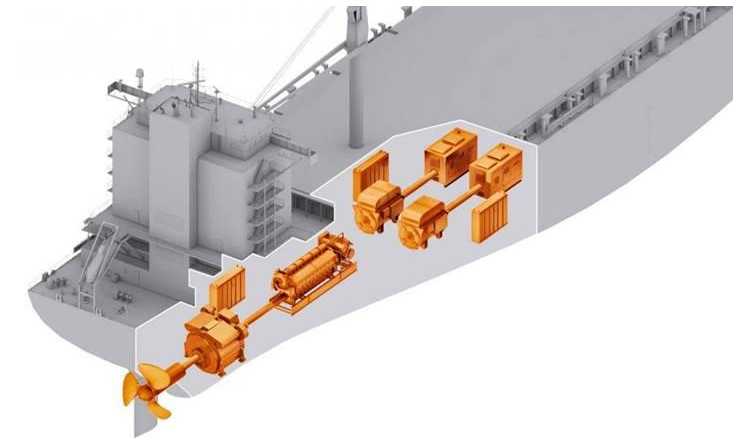


■ Production stage modelling

- Level 3 LCA for a ship life cycle assessment, the following minimum cradle-to-gate **data requirements** can be applied
 - Choose components necessary to reach Level 3 threshold
 - Components covering x % 20-% of supply chain GWP without the energy storage system

■ Electric energy supply in manufacturing stage

- Default modelling choice is location-based
- For industries opting to utilize Energy Attribute Certificates (EACs), a 100% market-based approach can be adopted
- Mixed-method approach (when there is not enough adequate data)

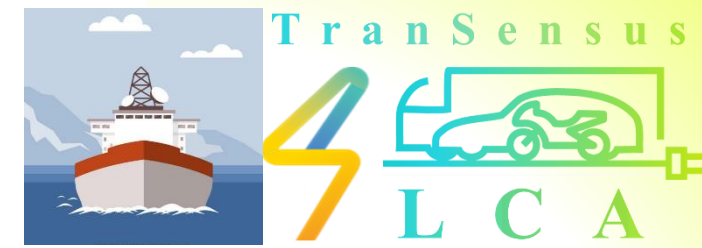


Electrical drive train of a vessel

<https://theswitch.com/wp-content/uploads/2012/04/The-Switch-electrical-drive-trains-for-marine.pdf>

Transfer to other industrial sectors

Waterborne transport – Inventory analysis



- **Use stage modelling**
 - **Operational emissions**
 - Longer lifetime compared to most road vehicles
 - Fuel combustion emissions from internal combustion (if applicable)
 - Auxiliary engines or generators
 - Activities at port (loading and unloading)
 - Ballast water management
 - Waste water treatment
 - ...

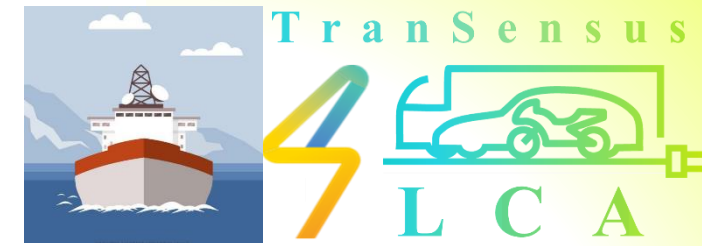


Onboard Ballast Water Treatment System

<https://medialibrary.damen.com/transform/4de92cb2-bce2-4d4f-a9f9-17d28b4eb272/bwts-small-compact-systems?io=transform:fill,width:1080,height:774&quality=75>

Transfer to other industrial sectors

Waterborne transport – Inventory analysis



■ Use stage modelling

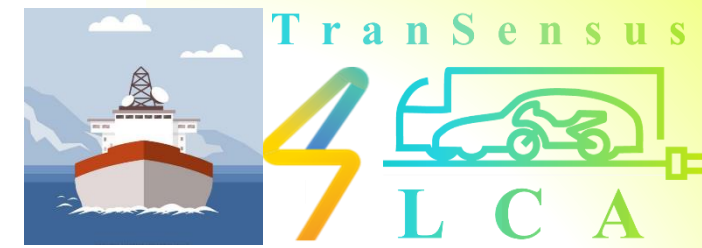
■ Maintenance

- Distinct to road vehicles
- Maintenance involves large-scale systems such as hull integrity, deck equipment maintenance, environmental systems maintenance, ...
- Maintenance of recreational facilities (for cruise ships)
- Vessels usually undergo refits during lifetime
 - Can mean significant modifications to the vessel's structure, layout, or systems, aimed at enhancing performance, compliance with new regulations, or adapting to changing operational needs

→ Energy consumption, emissions, or maximum permissible payload might change

Transfer to other industrial sectors

Waterborne transport – Life Cycle Impact Assessment



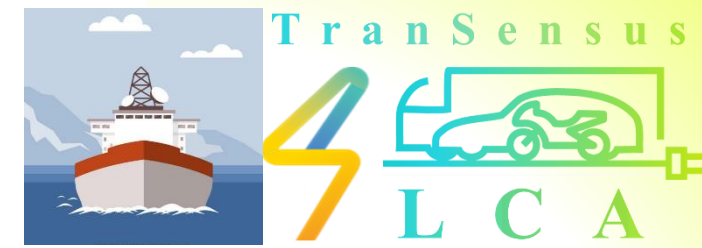
- Division of impact categories in mandatory and optional can be adopted
- Assessment of maritime-specific factors should be undertaken
- Movement of ships through water and their direct interaction with the marine environment increases the likelihood of marine pollution, including issues like acidification and eutrophication



Figure III-1 (D2.3): Life cycle impact assessment requirements of TranSensus-LCA in a form of a mind map

Transfer to other industrial sectors

Waterborne transport – Life Cycle Interpretation



- Proposal of **recommendations for conducting sensitivity analysis, scenario analysis, and/or uncertainty analysis** can be adapted
 - Parameters and suggested kind of analysis must be established for maritime applications (e.g., usage: maintenance & wearing as a mandatory parameter instead of a recommend analysis)
- **Integration into product development process – frontloading approach from TranSensus LCA can be adopted**
- **Approach on result display and public reporting, adherence statement and verification can be adopted**

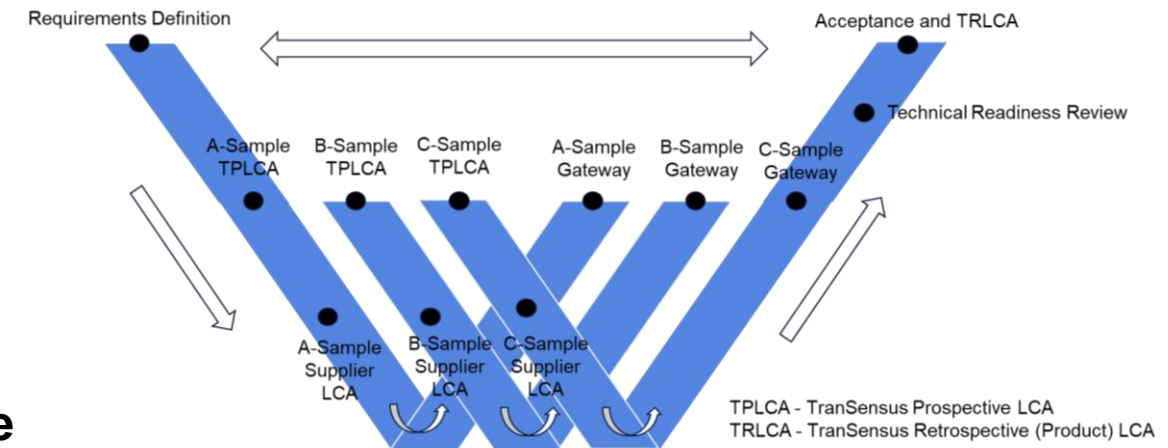


Figure IV 4 (D2.3): TranSensus-LCA Calculations within Product Development Process

Transfer to other industrial sectors

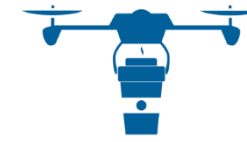
Charging stations for BEVs / H2 refuelling



- Applications: Charging stations and refuelling stations for hydrogen
- Life Cycle Impact Assessment, Life Cycle Interpretation and Social Life cycle Inventory / Social Life Cycle Assessment can be adopted from TranSensus LCA with minor adaptations
- Biggest differences in “Goal and Scope” and “LCA Inventory”
 - Goal and Scope: Technology coverage differs - Greater emphasis on charging speeds, stationary/mobile charging, battery swapping, wireless charging, Vehicle-to-Everything (V2X e.g., Vehicle-to-grid, Vehicle-to-building, Vehicle-to-vehicle, ...) and smart charging
- LCA Inventory Use Phase:
 - Operational emissions from operating the charger / refuelling station

Transfer to other industrial sectors

Airborne mobility



- Applications: Electric vertical take-off and landing (eVTOL) aircraft for short trips, unmanned aerial vehicles (UAVs) e.g., for delivery and surveillance, air taxis, ...
- Life Cycle Impact Assessment, Life Cycle Interpretation and Social Life cycle Inventory / Social Life Cycle Assessment can be adopted from TranSensus LCA with minor adaptations
- Goal and scope
 - Not only transporting cargo or people – e.g. surveillance, agriculture tasks like spraying → different functional units
 - Drones for longer range operations will include ICE motors for a transition period
 - Rapidly changing sector – technology coverage will vary
- Different environmental conditions: Weather and environmental conditions such as wind, temperature and altitude change consumption

Transfer to other industrial sectors

Construction equipment



- Applications: Cranes, excavators, bulldozers, loaders, concrete mixers, etc.
- Life Cycle Impact Assessment, Life Cycle Interpretation and Social Life cycle Inventory / Social Life Cycle Assessment can be adopted from TranSensus LCA with minor adaptations
- Goal and scope
 - Construction equipment specific operational profiles
 - Functional unit varies based on specific task (e.g., cubic meters excavated)
- Life Cycle Inventory
 - Use phase: May also account for specialized components (e.g., engines, attachments)

Transfer to other industrial sectors

Railway vehicles (S-LCA/S-LCI)

- Application: **Trains**
- Comparison with **Hitachi Rail's Social Product Declaration** (SPD) and SPD-Product Category Rules (SPD-PCR)
- **Goal and Scope:**
 - Stakeholder Categories and Mandatory Impact Subcategories vary slightly
 - System boundary: SPD-PCR rolling stock has use stage and end of life stage as optional



<https://www.flickr.com/photos/eldelinux/22762912720>

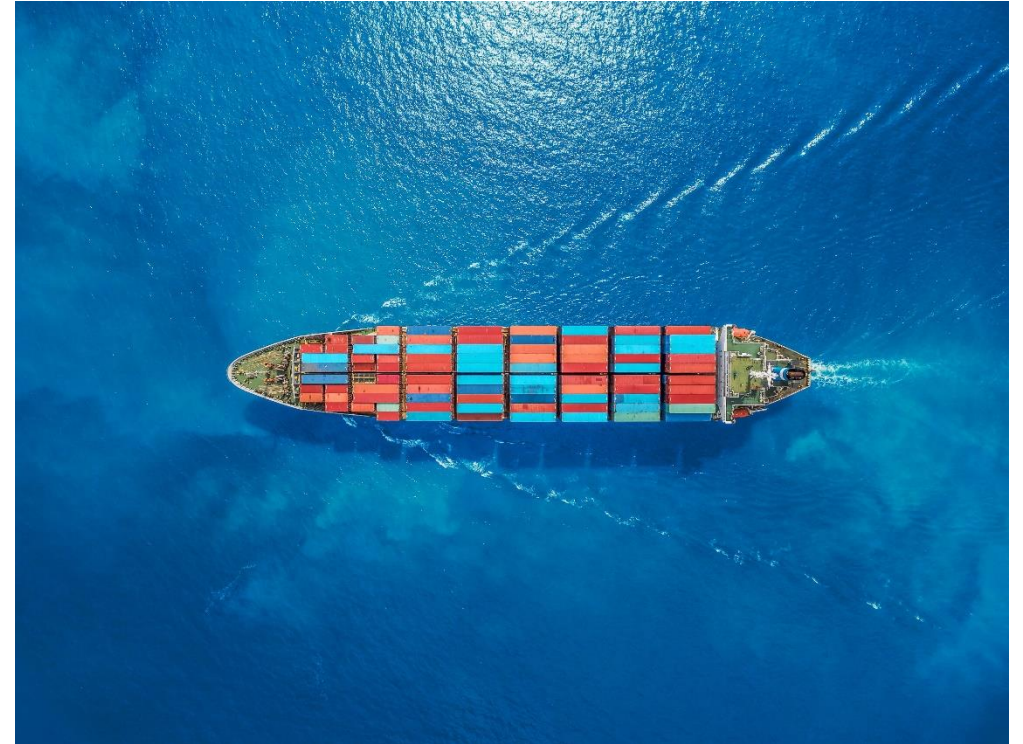
Summary

- A study on **transferability to other industrial sectors** was performed to identify requirement from other markets, synergies and needs for adaptations of the proposed approach.
- The greater the compatibility with the technologies in TranSensus LCA, the easier the transferability
 - Mobility solutions
 - Zero tailpipe emissions
 - Transportation of people or cargo
 - ...
- Stationary applications / applications with internal combustion engines require additional adaptations



Outlook

- This study only scratched the surface
→ Additional work is needed
- Need for harmonisation of LCA in other markets
- Future research projects should address the gaps
- Thorough industry expertise needed
- Results can be prospectively used for standardisation



A pair of hands is shown holding a small, realistic-looking globe of the Earth. The globe is positioned in the center of the frame, showing the Americas. The hands are cupped around the globe, with fingers pointing outwards. The background is a soft, out-of-focus green, suggesting foliage or grass. The lighting is bright and even, highlighting the texture of the hands and the details of the globe.

Thank you very much for your attention!

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