SUSTAINABILITY ASSESSMENT APPLIED TO THE CONTAINER TERMINAL OPERATIONS: THE CASE STUDY OF THE PORT OF VIGO, SPAIN (PORTFORWARD PROJECT)

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This project receives funding in the European Commission's Horizon 2020 Research Program under Grant Agreement Number 769267

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Introduction
Framework of the study

PORTFORWARD PROJECT → see the video!

Towards a Green and Sustainable ecosystem for the EU Port of the Future

1. **Smart Port Solutions**
   Employing ICT solutions to improve information flows between ports and port communities.
2. **Green Port Solutions**
   Adopting green technologies to reduce the environmental impacts of port operations and save resources.
3. **Interconnected Port Solutions**
   Combining different modes of transport and integrating different technologies to better monitor and control freight flows.

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Introduction
Objectives of the sustainability assessment

1. To evaluate the **environmental, economic and social impacts** of the **Container Terminal operations** (baseline scenario – current practices)

2. To evaluate the **environmental, economic and social benefits** of the implementation of the **innovative PortForward DSS – Green Yard Scheduler (GYS)** in the Container Terminal operations

3. To feed the virtual platform and the GYS with **environmental and socio-economic indicators**.

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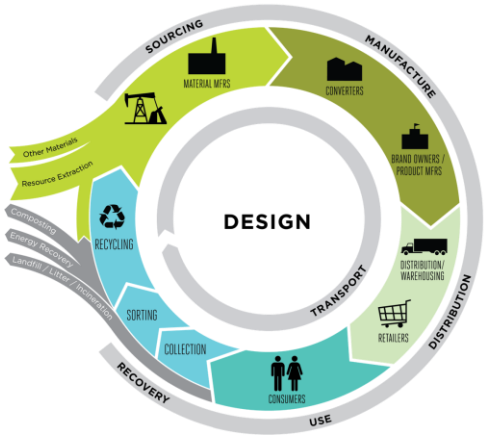
Methodology
Life Cycle Assessment (LCA) methodology

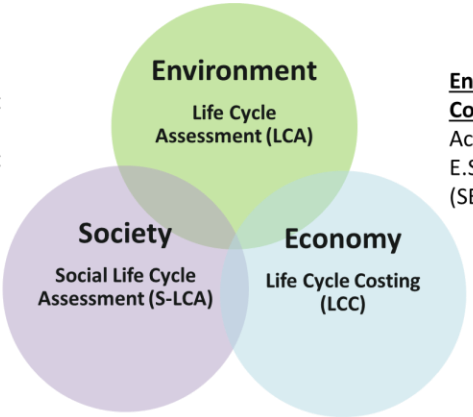
Definition:

"A process to evaluate the environmental burdens associated with a product, process, or activity by identifying and quantifying energy and materials used and wastes released to the environment; to assess the impact of those energy and materials used and releases to the environment; and to identify and evaluate opportunities to affect environmental improvements. The assessment includes the entire life cycle of the product, process or activity, encompassing, extracting and processing raw materials; manufacturing, transportation and distribution; use, re-use, maintenance; recycling, and final disposal"

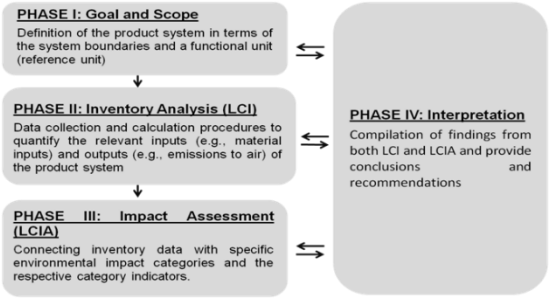
Source: *Society of Environmental Toxicology and Chemistry (SETAC)*



Environmental LCA:
Standardized methodology by:
ISO 14040:2006: Environmental management – LCA – Principles and framework
ISO 14044:2006: Environmental management –LCA – Requirements and guidelines



Environmental Life Cycle Costing (LCC)
According to Thomas E.Swarr et al. (SETAC)



Social Life Cycle Assessment (S-LCA):
According to the Methodological Sheets for Sub-categories in social LCA (UNEP/SETAC) and to other methodologies of interest for the project

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Data analysis
Life Cycle Inventory analysis

Case study: Port of Vigo (Spain)

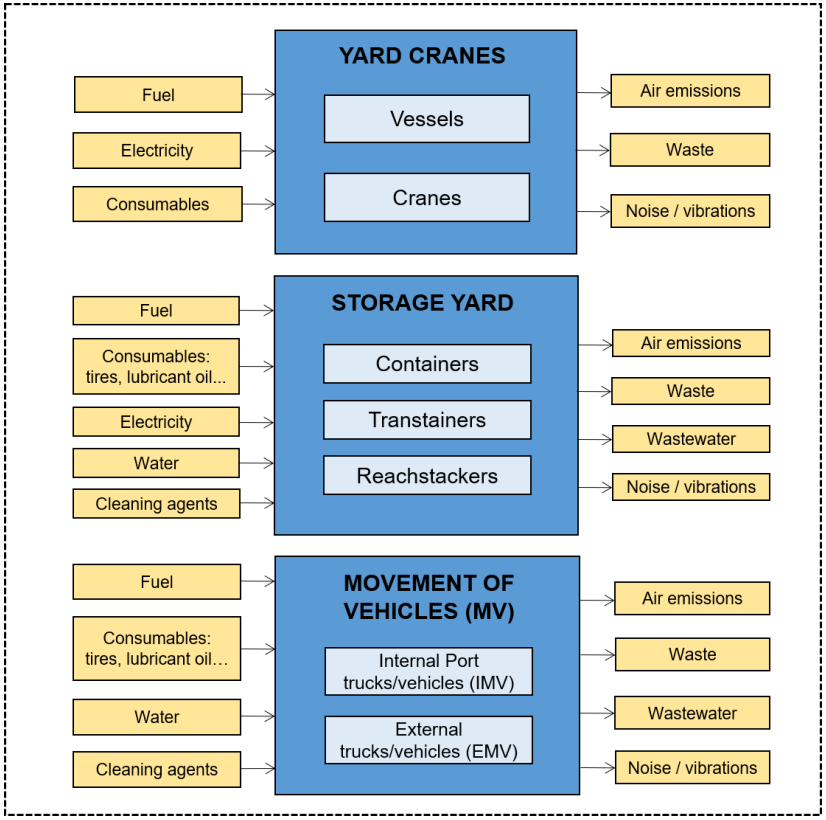
Functional unit: 1 TEU handled in a Container Terminal.

Goals – Baseline Scenario:

1. To calculate the average fuel/energy consumption and the potential CO_2 emissions generated by the different Container Terminal operations considered.

2. To evaluate the environmental impacts of the Container Terminal operations and the main environmental impact contributors.

System boundaries



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Data analysis
Life Cycle Inventory analysis

Case study: Port of Vigo (Spain)

- 2 visit to Vigo Port on: 25th-26th September 2018 and 17th June 2019

- Familiarization with Container Terminal operations end equipment.
- New considerations for the environmental assessment.
- Collection of inventory data: dataset from 2010 to 2021.
- The inventory data used in this study is from 2018.

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Data analysis
Life Cycle Inventory analysis

GENERAL INFORMATION ABOUT THE CONTAINER TERMINAL:

Area of the Container Terminal: 180,000 m^2

Berthing line: 750 m

Draught: 17 m

Reefer connections: 1,270

Operability: 365 days – 24h

Connections: road (motorway) + rail

Near to the city of Vigo

(nearly 300,000 inhabitants)

EQUIPMENT:

9 Reachstackers + 7 Transtainers

6 cranes

20 Mafis

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Life Cycle Inventory analysis

GENERAL INFORMATION ABOUT THE EQUIPMENT OF THE CONTAINER TERMINAL:

Equipment	Inventory data collected
VESSELS	Tonnage (GT) Total berth time (minutes) Estimation of the total quantity of diesel consumed (m^3)
CRAINS (x 3)	Option 1: Electricity consumption (kWh/crane/month) → DONE Option 2: Number of working hours/crain and electricity consumption per hour → PENDING
TRANSTAINERS (x 4.5)	Average number of working hours/transtainer Average diesel consumption/transtainer
REACHSTACKERS (x 4)	Average number of working hours/reachstacker Average diesel consumption/reachstacker
MAFIS	Hours of use of MAFIS/year Estimated diesel consumption MAFI/hour
EXTERNAL TRUCKS	Km done in the Container Terminal (gate in/gate out) Estimated diesel consumption of EXTERNAL TRUCKS/km

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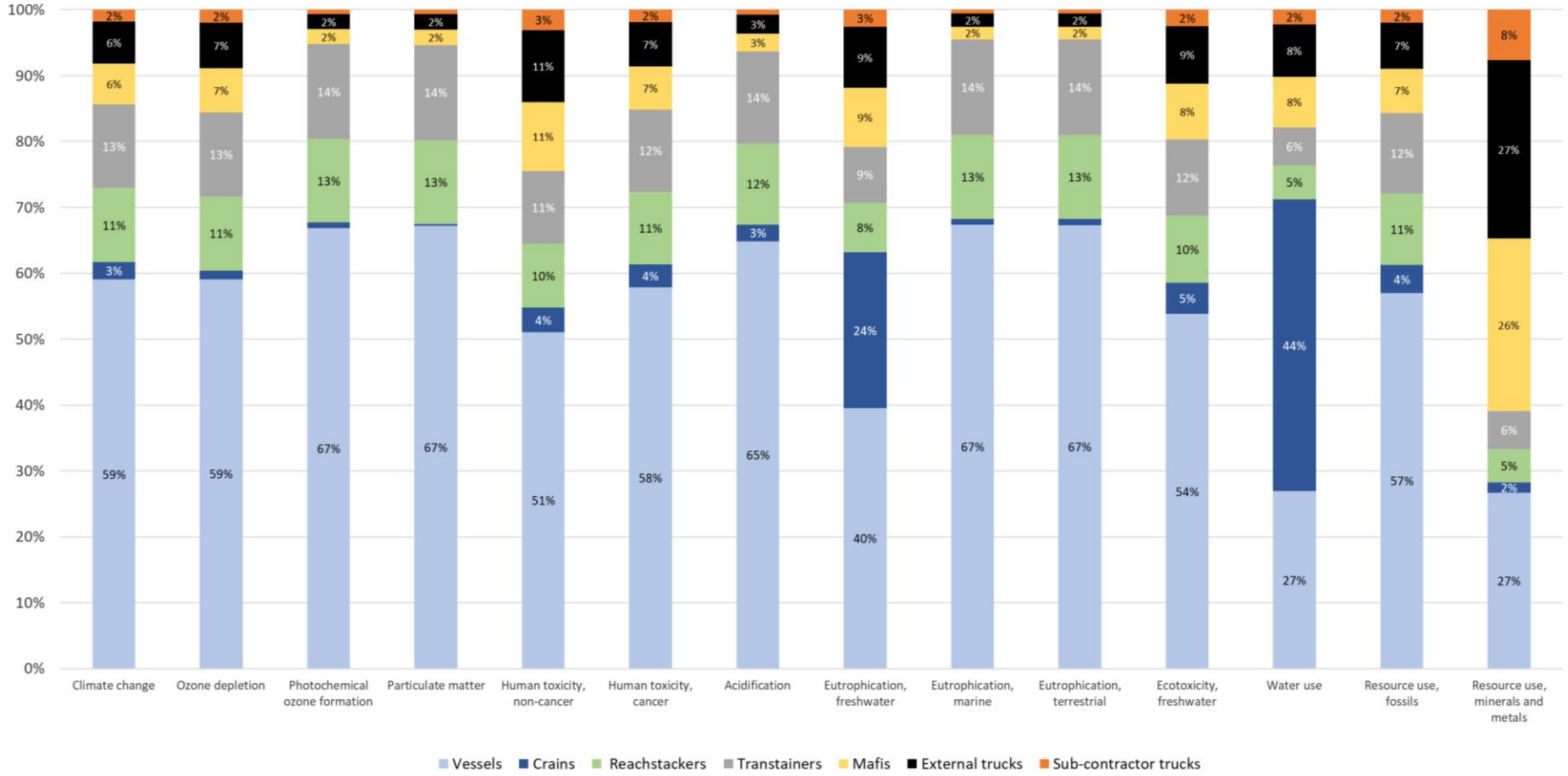
Sustainability Assessment: Environmental analysis

Phase 3: Preliminary Results (environmental impact)

By using the inventory data collected from the Container Terminal, it has been calculated the potential environmental impacts of the most important Container Terminal operations.



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Sustainability Assessment: Environmental analysis

Phase 3: Preliminary Results (environmental impact)

34.373 kg CO_2 eq. / TEU

470.046 MJ / TEU

7.394 kg CO_2 eq. / TEU

101.113 MJ / TEU

6.530 kg CO_2 eq. / TEU

89.293 MJ / TEU

3.711 kg CO_2 eq. / TEU

57.385 MJ / TEU

3.589 kg CO_2 eq. / TEU

55.489 MJ / TEU

1.546 kg CO_2 eq. / TEU

35.284 MJ / TEU

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Sustainability Assessment: Environmental analysis
Conclusions

1. The **potential environmental impact** associated the **Container Terminal Operations** has been **calculated**, by using **real data** (inventory data) provided by Port Authority and TERMAVI.
2. The **main environmental impact contributors** are the **vessels** berthing operations, followed by **transtainers** and **reachstackers**. To remark the high environmental impacts associated to the internal and external trucks.
3. This has allowed to stablish the **BASELINE SCENARIO**.
4. During the next months, the **Green Yard Scheduler** will be **tested** in the Container Terminal of the Port of Vigo. By using this DSS, the **efficiency of the Container Terminal operations will be increase** and it is **expected** that the **environmental impacts** associated to these operations **will be reduced**.
5. Once **inventory data after the application of the GYS** in the Container Terminal of the Port of Vigo will be obtained, the environmental impact assessment of the improved scenario will be performed, in order to **calculate the benefits of the application of the GYS**.

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Future work to improve the environmental assessment
Inventory analysis – Pending information

1. **VESSELS:**
    1. To acquire data about nominal power of vessels engines and efficiency of vessels engines.
    2. Fuel consumption of vessels during anchorage stage → a non common situation → could be avoided from the analysis.
2. **CRANES:** energy consumption → per hour, or information about power and efficiency of cranes engines.
3. **REEFER CONTAINERS:** energy consumed (average data) by a reefer container or data sets of energy consumption of reefer containers.
4. **CLEANING OPERATIONS:** number of containers cleaned per year.
5. To perform and **update** the corresponding assessments.
6. To perform different **SENSITIVITY ANALYSIS**:
    1. Maritime transport vs. road transport
    2. Vessels consuming diesel vs. vessels consuming electricity during berthing

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Future work economic and social assessment
Inventory analysis

- First indicators regarding economic and social aspects have been prospected:
  - € spent in energy consumption / TEU
  - € spent in water consumption / TEU
  - Noise exposure: noise generated by each port operation / TEU → the longer it takes each operation, more noise will be produced per TEU
  - Employment: new job opportunities thanks to the project development
  - Gender distribution of workers per Container Terminal Operations
  - Community engagement in Container Terminal / Port activities
- Inventory data regarding economic and social aspects will be requested to partners (TERMAVI and Port of Vigo) in the coming months.

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Any question?

Thank you!

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