


# Life Cycle Assessment

## Assessing local impacts

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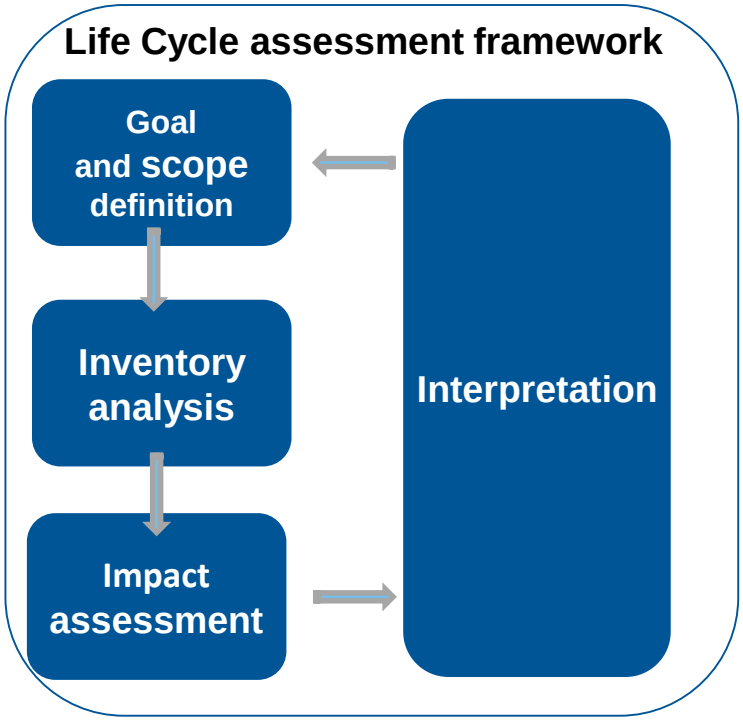
The research leading to these results has received funding from the European Union Seventh Framework Programme under the agreement SCP2-GA-2013-614020.

# 1. INTRODUCTION

## 1.1 LCA METHODOLOGY

- **LCA is a standardized technique to assess the environmental aspects and potential impacts associated with a product, process, or service.**
- **The LCA process is a systematic, phased approach and consists of four components**



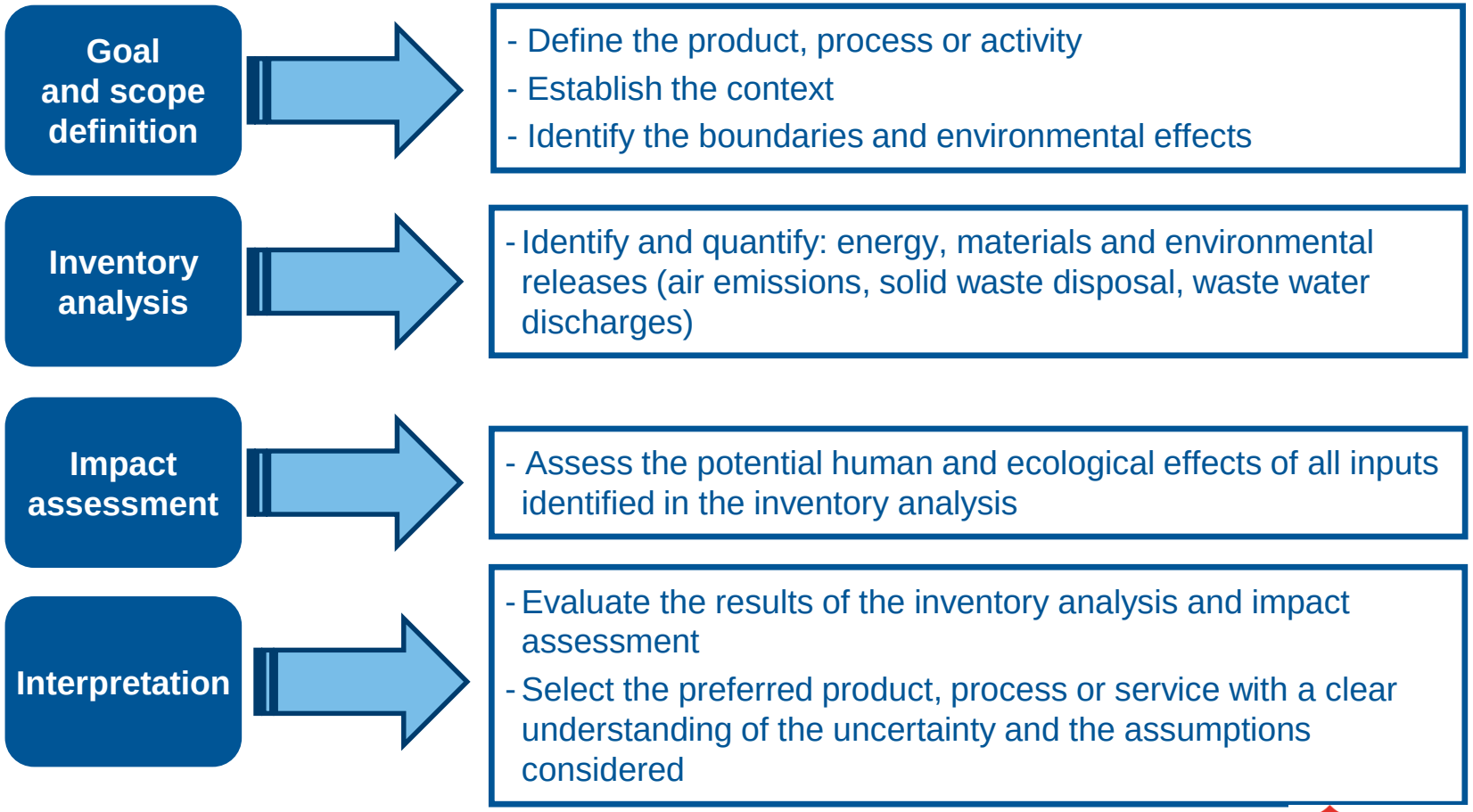

ISO 14040
ISO 14041
ISO 14042
ISO 14043

**Direct applications:**

- ❑ Product development and improvement
- ❑ Strategic planning
- ❑ Public policy making
- ❑ Marketing
- ❑ Other

# 1. INTRODUCTION

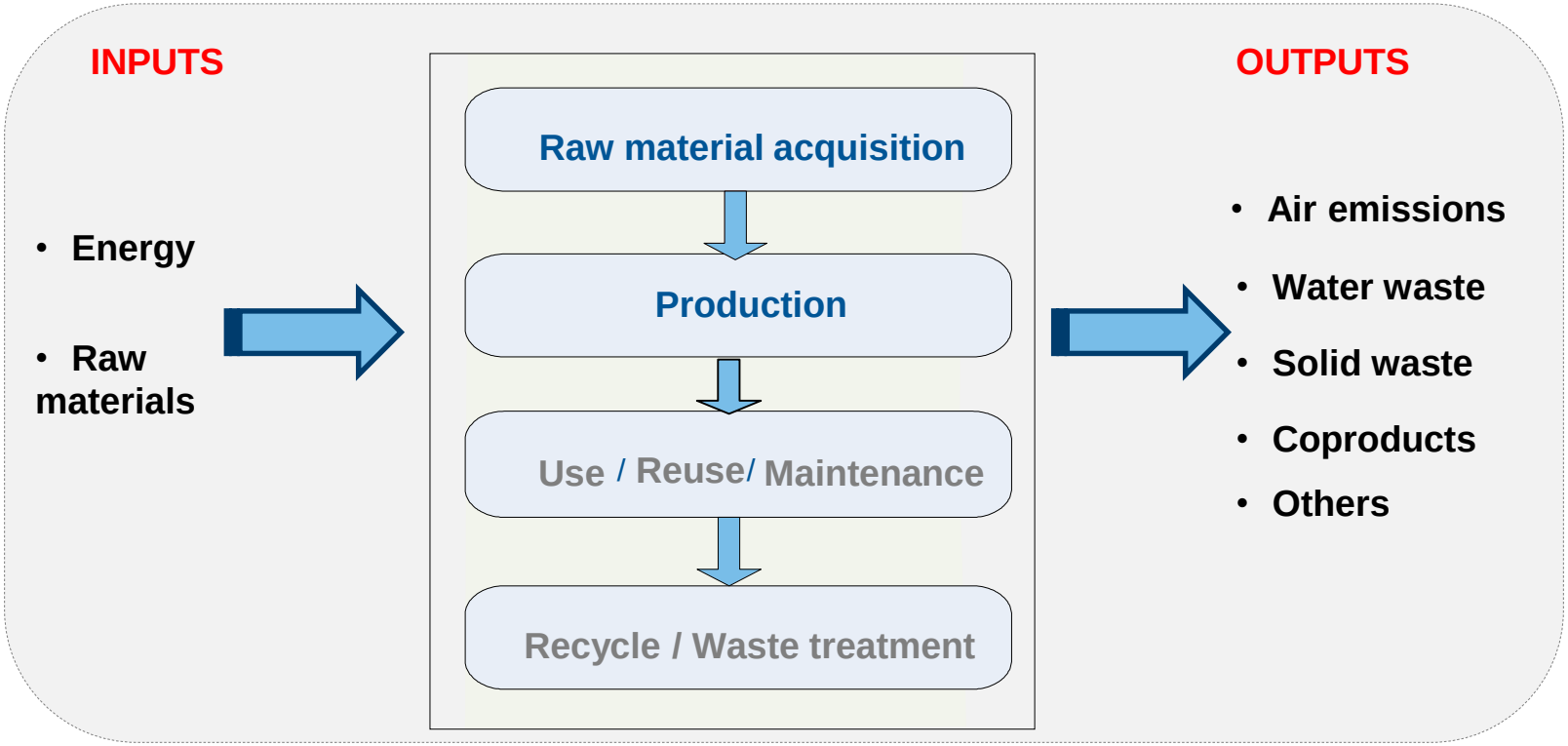
## 1.1 LCA METHODOLOGY



# 1. INTRODUCTION

## 1.2 LIFE CYCLE STAGES

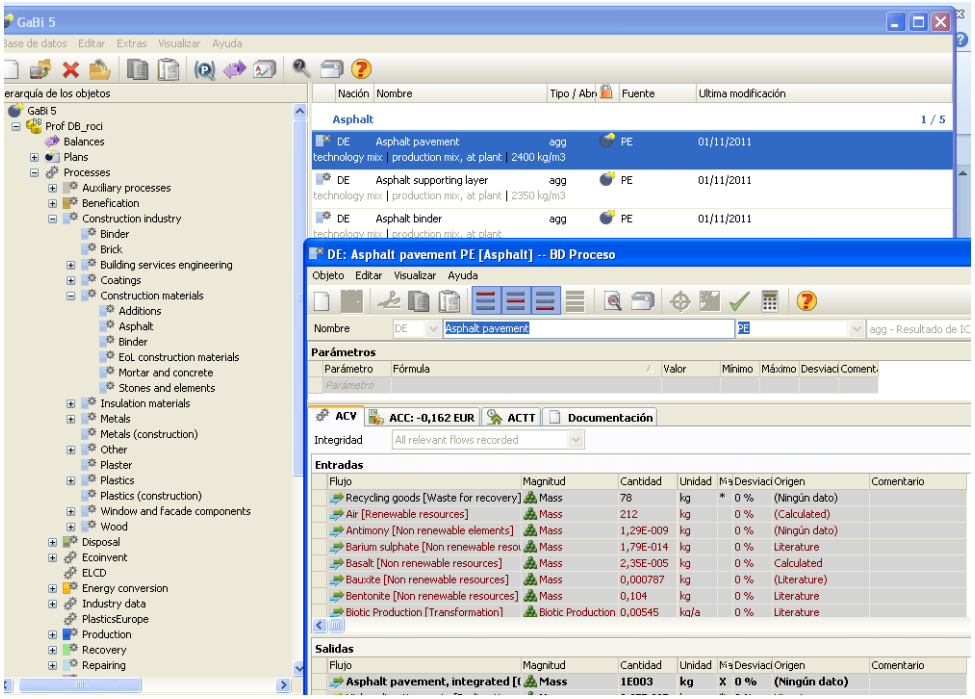
**LCA is a “cradle-to-grave” approach for assessing innovative processes or products**



# 2. LCA TOOL. GABI 6 SOFTWARE

- **Provided by PE International, in collaboration with IKP University of Stuttgart**
- **The program incorporates its own database with information of many processes**
- **It includes Ecoinvent, GaBi and ELCD databases (update 2016)**

Latest upgrade: Gabi 6




GaBi Software

# 3. CASE STUDY

## 3.1 SCENARIOS

| DESIGN SCENARIOS | | | | |
|---|---|---|---|---|
| | Site conditions | | Ground conditions | |
| Design case | Water depth (m) | Distance to Port (km) | Shallow bedrock | Medium dense sand |
| **0** | 20 | 30 | ✘ | ✘ |
| **1** | 40 | 30 | Gravity bases | XL Monopiles<br>Gravity Bases |
| **2** | 60 | 100 | Lattice Structures<br>Gravity Bases | Lattice Structures<br>Gravity Bases |
| **3** | 100 | 30 | ✘ | Floating foundations |

| | Location | Ground conditions | Foundation type | Foundation installation | Foundation Installation Vessel | Turbine Installation | Turbine Installation Vessel | Turbine Installation Method |
|---|---|---|---|---|---|---|---|---|
| **Site 1** | West Gabbard | Shallow bedrock | Gravity base | Float-out | 3 tugs + 1 AHT + 1 support vessel | Installed separately | Jack-up | Bunny ears with 2 part tower |

# 3. CASE STUDY

## 3.2 FUNCTIONAL UNIT

**Data gathering from results of WP2**

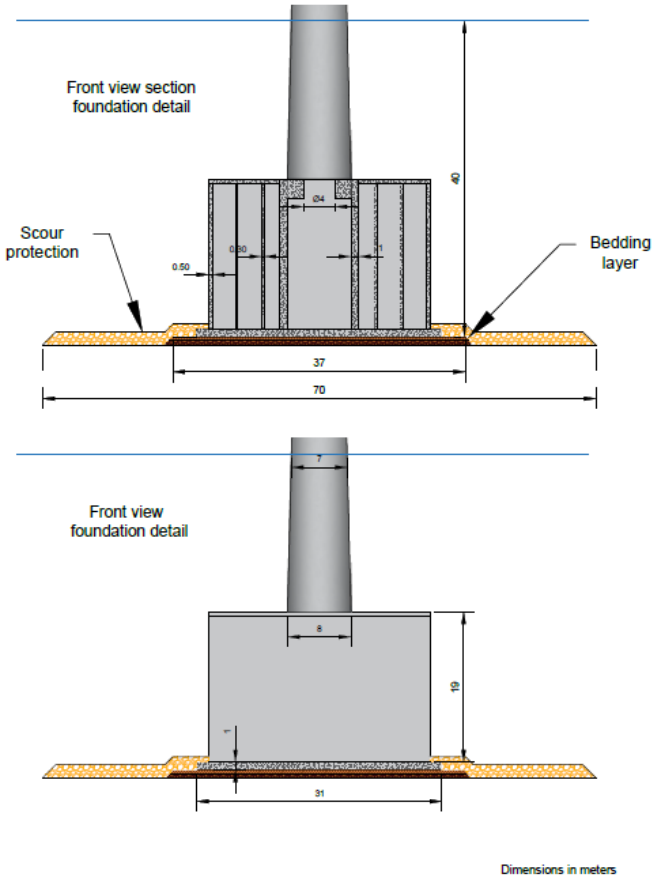
- **Reference product: Gravity Base Foundation**
- **Function: Support of 8 MW Wind Turbine**

**Geometry**

| | |
|---|---|
| **Bottom slab** | 28 m diameter |
| **Shaft** | 20 m height |
| **Footing** | 31 m diameter, 1 m thickness |
| **Transition piece** | 24 m height; 8 m diameter; 75 mm thickness |
| **Outer perimetral wall** | 50 cm thickness |
| **Inner perimetral wall** | 30 cm thickness |
| **Radial wall** | 25 cm thickness |
| **Inner cylinder** | 1 m thickness; 8 m diameter |

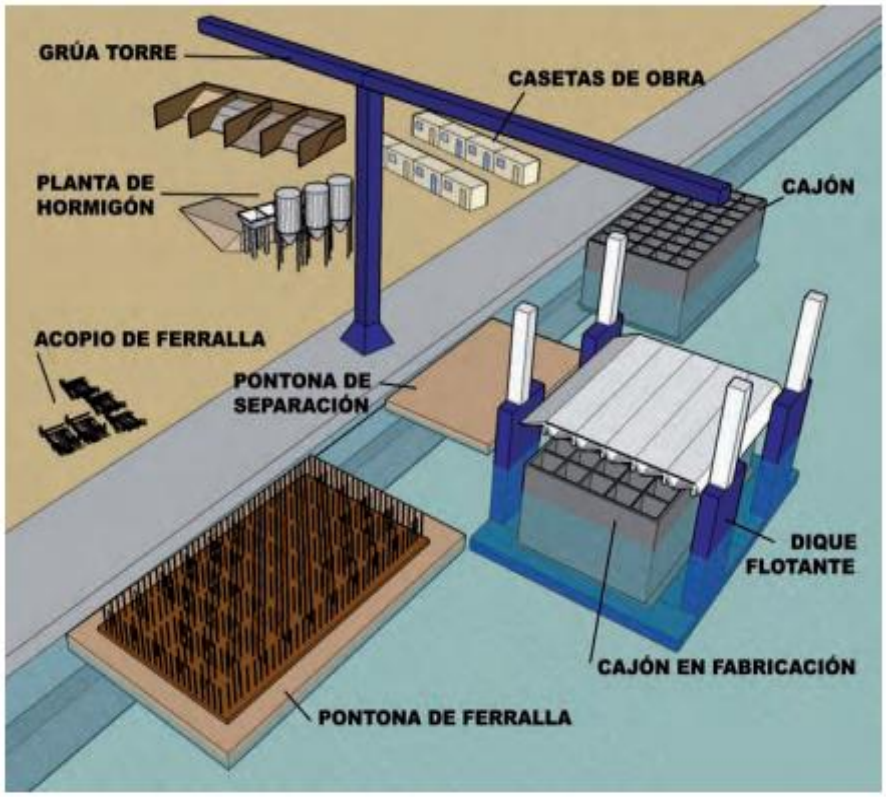
**Composition**

| | |
|---|---|
| **Concrete volume HA-35** | 3,498.33 $m^3$ |
| **Steel quantity B500S** | 524,749.5 kg |



# 3. CASE STUDY

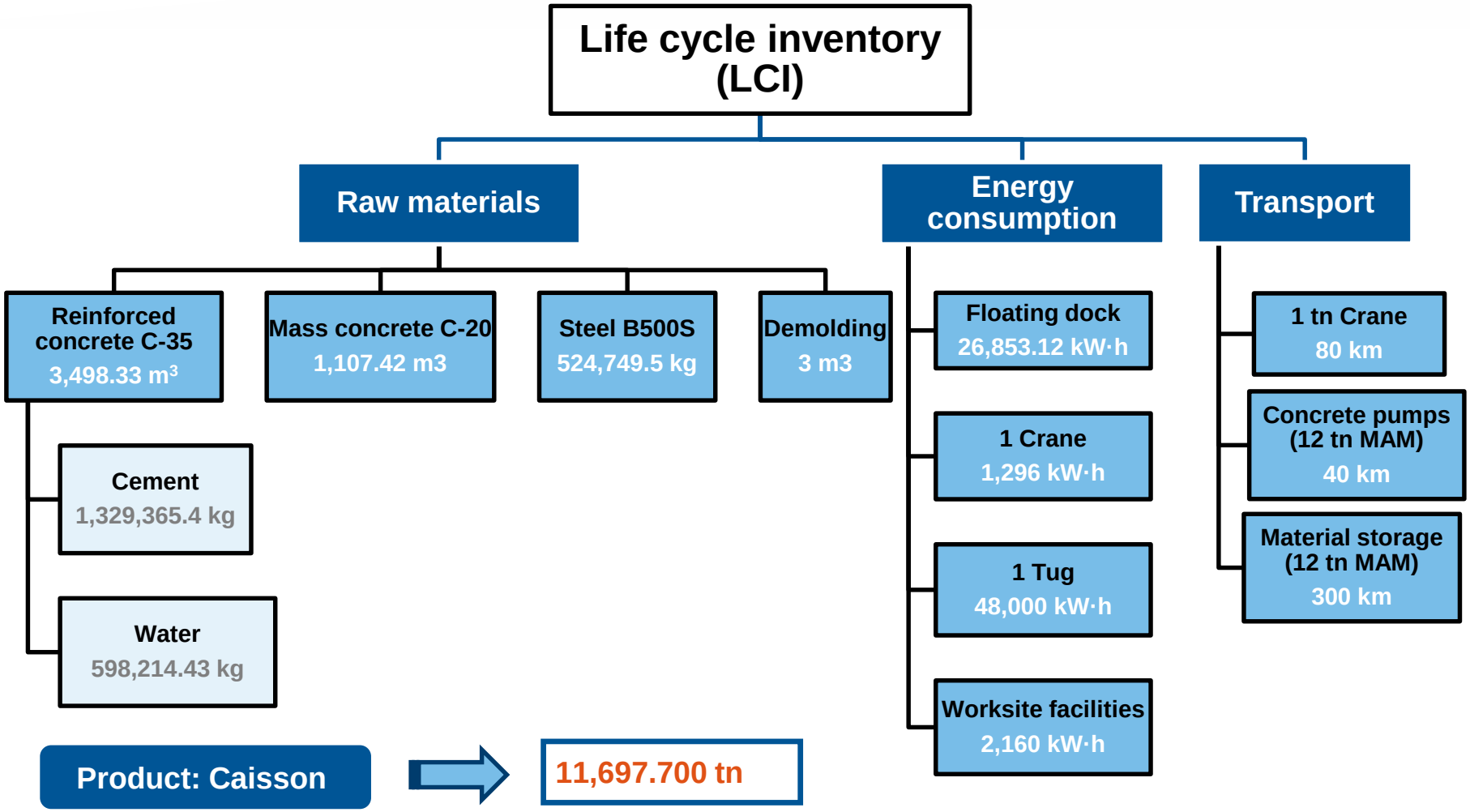
## 3.3 PRODUCTION PROCESS




1. Assembly of the bottom slab reinforcement
2. Concreting of the bottom slab
3. Placing of the first section of shaft reinforcement
4. Concreting of the shaft
5. Preparation of the launching
6. Launching and refloating of the floating dock
7. Concreting of top slab

9 days

# 4. INPUTS TO BE GATHERED. LCI



# 5. SIMULATIONS AND LCA RESULTS

- **LCA in 2 stages:**
  - **Stage I: Installation and mobilization of equipment**
  - **Stage II: Caisson construction**
- **Software tool: GaBi 6**
  - **Legislation: EN15804 (Sustainability of Building Materials)**
  - **Methodology: CML2001**

| Environmental impacts | Stage I | Stage II | Units |
|---|---|---|---|
| | Value | Value | |
| **Global Warming Potential (GWP 100 years)** | **485** | **1250000** | **[kg CO2-Equiv.]** |
| **Acidification Potential (AP)** | 2,03 | 2360 | [kg SO2-Equiv.] |
| **Photochem. Ozone Creation Potential (POCP)** | -0,68 | 326 | [kg Ethene-Equiv.] |
| **Eutrophication Potential (EP)** | 0,51 | 275 | [kg Phosphate-Equiv.] |
| **Primary Energy Demand (PED)** | 6680 | 8270000 | [MJ] |

- **Conclusions**
- **Comparison with XL Monopile**

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Thank you very much
for your attention