DTOcean User Experience

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• Introduction

• Alpha Walkthrough

• Future Work
Structure Overview

User Inputs & Selections → Global Decision Tool → RESULTS

Global Decision Tool:
- ARRAY HYDRODYNAMICS
- ELECTRICAL SUB-SYSTEMS
- MOORINGS & FOUNDATIONS
- INSTALLATION
- LOGISTICS FUNCTIONS
- OPERATIONS & MAINTENANCE

Optimisation Routines

GLOBAL DATABASE
Thematic Modules

GLOBAL TOOL

MINIMISE LCOE

RESULTS

LCOE

€ / kWh

ALL MODULES

ECONOMIC

POWER

CAPEX

OPEX

THEME

RELIABILITY

FAILURE RATE

SCHEDULE

THEME

ENVIRONMENT

RESOURCE

DISRUPTION

CONSTRUCTION

THEME

ENVIRONMENT

INDICATOR

INDICATOR

RELIABILITY

ECONOMIC

POWER

CAPEX

OPEX

THEME
Tool Requirements

• A standalone application

• Easy to understand

• Suited to continuous modification

• The whole architecture has to be modular

• The core of the global tool will be written in Python
Tool Requirements

• [The tool] will integrate a Graphical User Interface (GUI)

• The connection with the tools developed in other WPs will be provided by the introduction of external functions

• Specifications for coupling with other software of common use for more sophisticated analysis
Development Stages

• Alpha (0.1): month 18
  – Forward flow of data through modules

• Beta (0.2): month 24
  – Delivery of finalised modules
  – Sensitivity analysis

• Release Candidate (0.9): month 30
  – Optimisation
  – GUI

• Final (1.0): completion of project
  – Manuals
  – Installer
Key Facts

• Deployment:
  – Open Source
  – Windows 64bit, 8GB RAM
  – Graphical Installer

• Technologies:
  – Python 2
  – PostgreSQL database service
  – Qt4 user interface
Contents

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Entering Data

Pipeline: Provide inputs...
- Hydrodynamics
  - Electrical Sub Systems
    - Position of Each Device
    - Offshore Cable Cost Functions
    - Device Characteristics
    - Cable Electrical Data
    - Rated Array Power
    - Network Characteristics
    - Number of Devices
- Assessment
  - Economics
    - Annual Power Production
    - Discount Rate
    - Project Lifetime
    - Electrical Component Costs
- Optimisation

Inputs  Advanced Inputs

Project Lifetime

Please enter a number: 20 (Years)

OK
Data Validation

Checking data requirements... FAILED

The following data is required and must be provided:

<table>
<thead>
<tr>
<th>Section</th>
<th>Branch</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modules</td>
<td>Hydrodynamics</td>
<td>Rated Array Power</td>
</tr>
</tbody>
</table>
Contents

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Beta Functionality

1. Solution modification:
   – Going back to an intermediate solution stage, modifying variables and rerunning.

2. Solution comparisons:
   – Comparing solutions between original and modified simulations.

3. Single parameter optimisations:
   – Best LCOE over a set range of values.
• **Economics:**

![LCOE (c€/kWh) chart](chart1)

- **CAPEX:***
  - Total WEC Manufacturing: 31%
  - Total Moorings Components: 31%
  - Total Electrical Connection Equipment: 18%
  - Total Assembly, Installation & Commissioning: 20%

- **OPEX:***
  - Total Annual Monitoring & Maintenance: 14%
  - Total Onsite replacement & works: 9%
  - Total Major replacement & works onshore: 16%
  - Total Contingencies: 61%
Thematic Indicators

• Economics:

LCOE components
- CAPEX WEC Manufacturing
- CAPEX Electrical Connection Equipment
- CAPEX Assembly, Installation & Commissioning
- CAPEX Monitoring & Miscellaneous equipment
- OPEX Management & Administrative Costs
- OPEX Annual Monitoring & Maintenance
- OPEX Onsite replacement & works
- OPEX Major replacement & works onshore
- OPEX Contingencies
- Decommissioning Costs

Impact within the defined range

Distance from site to shore
Distance from shore to substation/grid
Water depth at central farm location

Min. Variation  Max. Variation

Project Expenses
Thematic Indicators

• Reliability:

<table>
<thead>
<tr>
<th>Array</th>
<th>device001</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>deviceN</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MTTF (10^6 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pessimistic</td>
</tr>
<tr>
<td>1.0</td>
</tr>
</tbody>
</table>

[Graphs showing reliability data]
• Reliability:

<table>
<thead>
<tr>
<th>Reliability</th>
<th>TTF (10^6 hours)</th>
<th>RPN</th>
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</thead>
<tbody>
<tr>
<td>Pessimistic</td>
<td>Mean</td>
<td>Optimistic</td>
</tr>
<tr>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Thematic Indicators

• Environmental:

![ENVIRONMENTAL IMPACT ASSESSMENT Diagram]

- Positive: +32
- Adverse: -75

**SCORING SYSTEM SCALE**

- Positive: +50 to 0
- Adverse: -100

- Levels: Low, Moderate, Significant, High

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### Thematic Indicators

#### Environmental:

**ENVIRONMENTAL IMPACT ASSESSMENT**

<table>
<thead>
<tr>
<th>Positive</th>
<th>Adverse</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Assessment Icon" /></td>
<td><img src="image2" alt="Assessment Icon" /></td>
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<tr>
<td><img src="image3" alt="Assessment Icon" /></td>
<td><img src="image4" alt="Assessment Icon" /></td>
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<tr>
<td><img src="image5" alt="Assessment Icon" /></td>
<td><img src="image6" alt="Assessment Icon" /></td>
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</tr>
<tr>
<td><img src="image9" alt="Assessment Icon" /></td>
<td><img src="image10" alt="Assessment Icon" /></td>
</tr>
</tbody>
</table>

**FUNCTIONS RESULTS**

<table>
<thead>
<tr>
<th>Footprint</th>
<th>Collision Risk</th>
<th>Chemical Pollution</th>
<th>Turbidity</th>
<th>Aerial Noise</th>
<th>Underwater Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>-52</td>
<td>-10</td>
<td>+0</td>
<td>-12</td>
<td>-5</td>
<td>-80</td>
</tr>
</tbody>
</table>

**SCORING SYSTEM SCALE**

- Positive: Low, Moderate, Significant, High
- Adverse: Low, Moderate, Significant, High

![Scale Icon](image11)
Data Collection

Bathymetry/Geotechnical Data

```
public.bathymetry
- id: bigint
- utm_points: point
- depth: double precision
- utm_cords: integer
- utm_lat_bnds: char
- crd_point_key

public.bathymetry_layer
- id: bigint
- fc_point_id: bigint
- layer_order: smallint
- sediment_types: varchar(50)
- thickness: double precision
- crd_point_layer_key

public.constraint
- id: serial
- boundary: polygon
- fc_constraint_type: integer
- constraint_key

public.time_series_wave
- fk_point_id: bigint
- measure_date: date
- measure_time: time(6)
- period: double precision
- peak_period: double precision
- wind_direction: double precision
- crd_point: bigint

public.time_series_tidal
- fk_point_id: bigint
- measure_date: date
- measure_time: time(6)
- u_coeffs: double precision
- v_coeffs: double precision
- measure_depth: double precision

public.time_series_tidal_turbulence_intensity
- fk_point_id: bigint
- measure_date: date
- measure_time: time(6)
- turbulence_intensity: double precision

public.time_series_wind
- measure_date: date
- measure_time: time(6)
- wind_speed: double precision
- std_dev: double precision
- crd_point: bigint

public.bathymetry_geotechnic
- id: bigint
- fl_layer_id: bigint
- soil_type_id: integer
- effective_drained_cohesion: double precision
- undrained_soil_friction_angle: double precision
- drained_soil_friction_angle: double precision
- buoyant_weight_of_soil: double precision
- undrained_soil_shear_strengths: double precision
- undrained_soil_shear_strengths: double precision
- friction_coefficients: double precision
- shape_factor: double precision
- elastic_shear_modulus: double precision
- soil_density: double precision
- soil_specific_gravity: double precision
- soil_liquid_limit: double precision
- soil_plastic_limit: double precision
- soil_water_contents: double precision
- compression_index: double precision
- overconsolidation_ratio: double precision
- bearing_capacity_factor_of_buried_mooring_line: double precision
- cohesion: double precision
- bearing_capacity_factor: double precision
- maximum_skin_frictional_resistance_for_piles: double precision
- maximum_uu_soil_bearing_capacity_at_tide: double precision
- bearing_capacity_factor_limiting_value: double precision
- rock_compressive_strength: double precision
- pile_deflection_coefficients: double precision
- pile_moment_coefficients: double precision
- grout_strength: double precision
- short_term_holding_capacity_factor: double precision
- long_term_holding_capacity_factor: double precision
- holding_capacity_factor_drained_soil_conditions: double precision
- soil_parameters_large_anchors: double precision
- bearing_capacity_factors: double precision
- adhesion_factor: double precision
- soil_density: double precision
- relative_soil_density: double precision

layer_geotechnic_1_key
```
Thanks for your attention

Any questions?