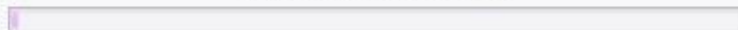


Modeling the Installation of Offshore Wind Farms



ECN Install 2.0



Starting...



Outline

Contents of slide

- Cost modelling
- The software ECN Install
- What can it do?
- Who is it for?

Offshore Wind Energy

Cost modelling

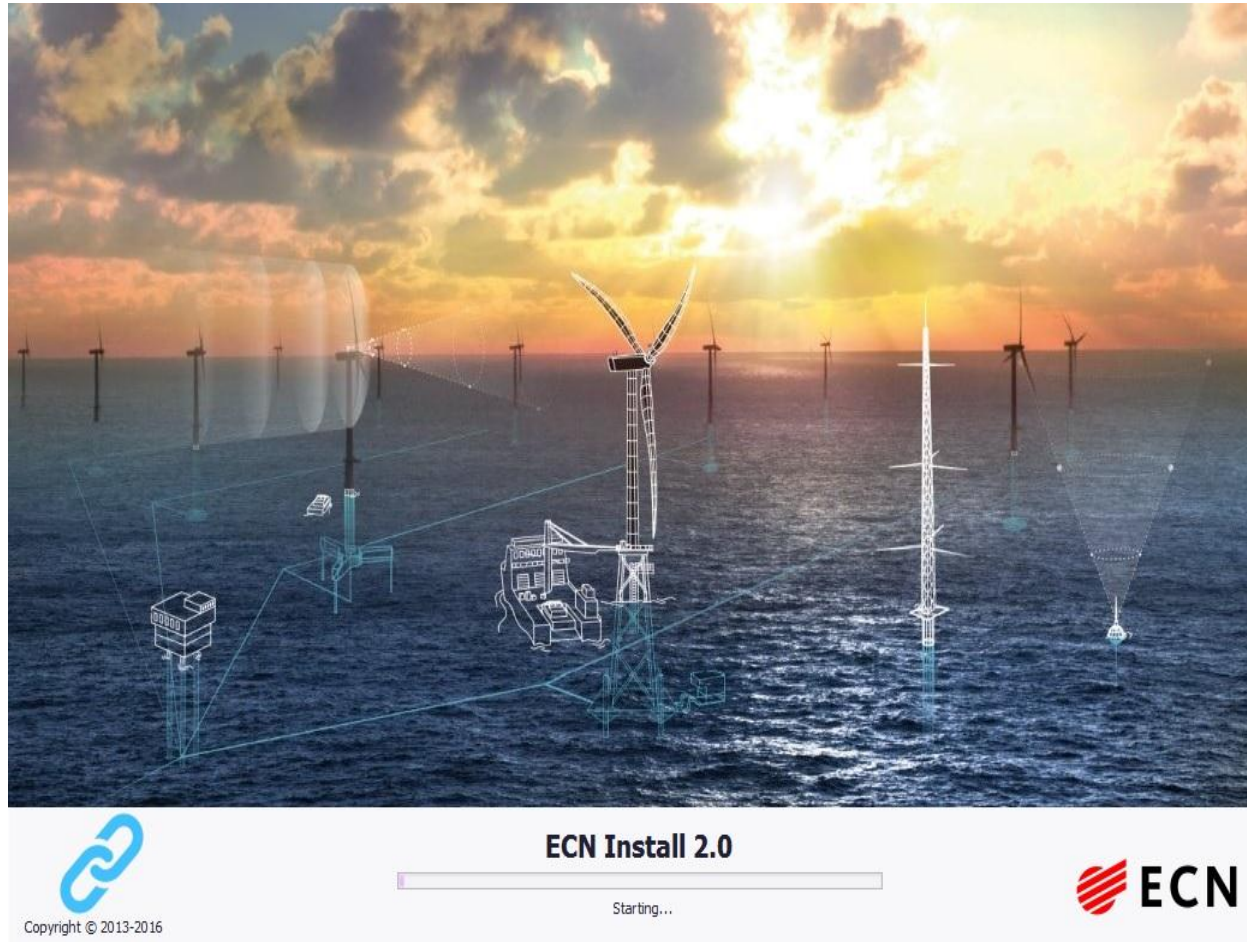
- ECN's O&M Tool is the industry standard
- Methodology is now used for installation
- ECN Install developed in cooperation with major industry players (Van Oord, Royal IHC)



Example Users of ECN O&M Tool

ECN Install

The Tool – dissemination of the installation process



Inputs - Outputs

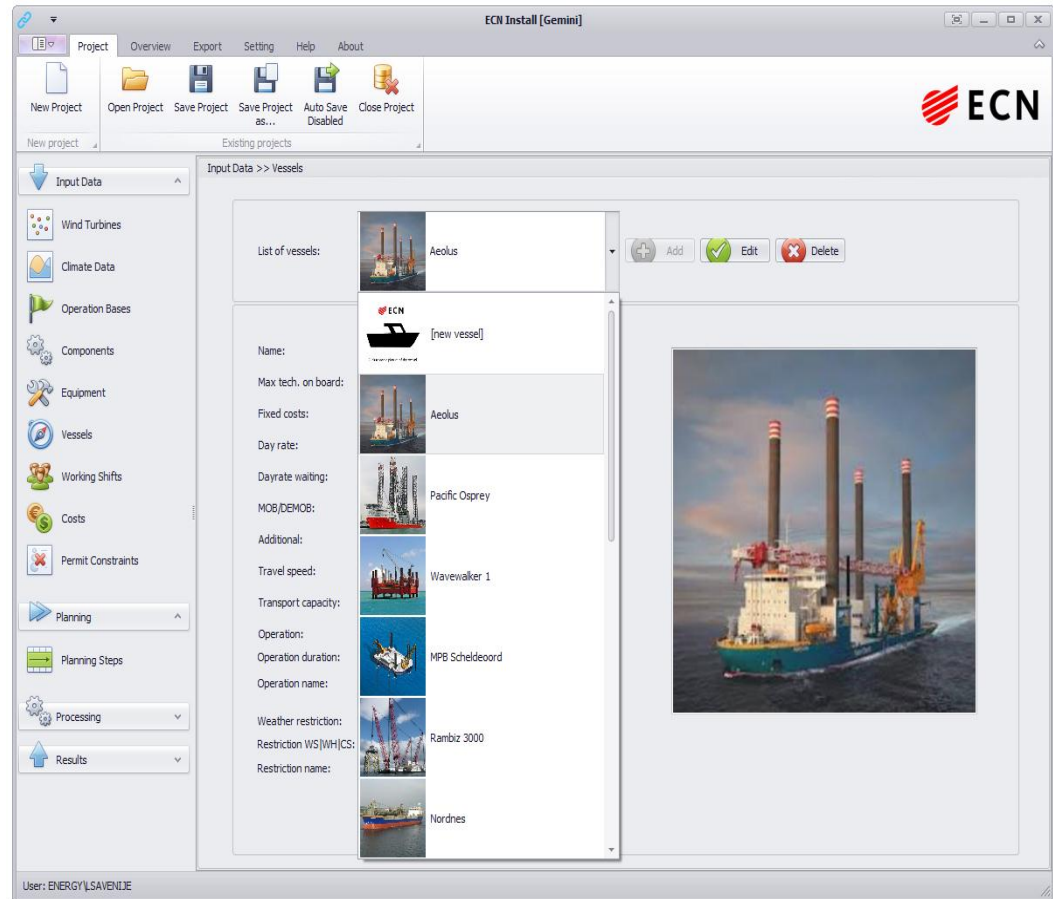
Framework

- Input
 - Wind turbine
 - Components
 - Operational bases
 - Vessels
 - Equipment
 - Climate data
 - Permit restrictions
 - Crew working shifts
 - Fixed costs
- Planning
 - Steps
 - (de)Mobilization
 - Loading
 - Travelling
 - Installation
 - Select from input
 - Planning
 - Grouping
 - Ordering
 - Iterating
- Pre-processor
 - Weather
 - Workability
- Outputs
 - Time
 - Resources
 - Cost

ECN Install

The Tool

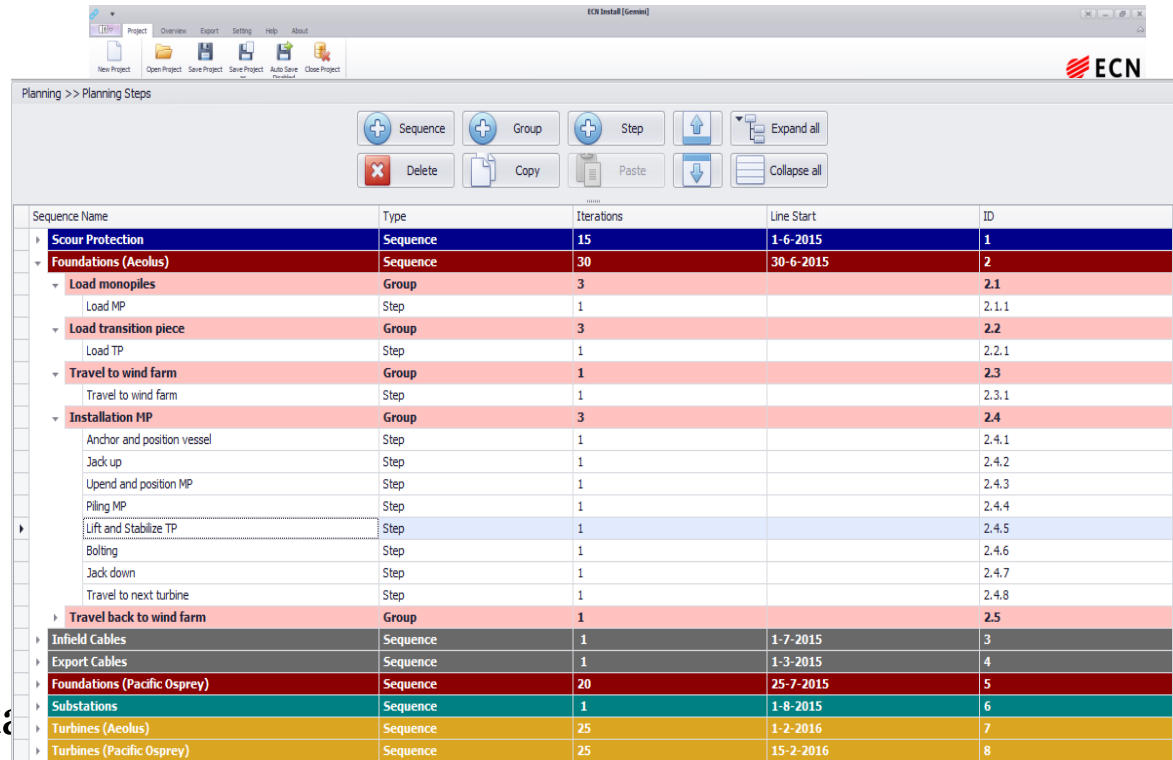
- Input
 - Wind turbine
 - Components
 - Operational bases
 - Vessels
 - Equipment
 - Climate data
 - Permit restrictions
 - Crew working shifts
 - Fixed costs



ECN Install

The Tool

- Planning
 - Steps
 - (de)Mobilization
 - Loading
 - Travelling
 - Installation
 - Select from input
 - Planning
 - Grouping
 - Ordering
 - Iterating



Sequence Name	Type	Iterations	Line Start	ID
Scour Protection	Sequence	15	1-6-2015	1
Foundations (Aeolus)	Sequence	30	30-6-2015	2
Load monopiles	Group	3		2.1
Load MP	Step	1		2.1.1
Load transition piece	Group	3		2.2
Load TP	Step	1		2.2.1
Travel to wind farm	Group	1		2.3
Travel to wind farm	Step	1		2.3.1
Installation MP	Group	3		2.4
Anchor and position vessel	Step	1		2.4.1
Jack up	Step	1		2.4.2
Upend and position MP	Step	1		2.4.3
Piling MP	Step	1		2.4.4
Lift and Stabilize TP	Step	1		2.4.5
Bolting	Step	1		2.4.6
Jack down	Step	1		2.4.7
Travel to next turbine	Step	1		2.4.8
Travel back to wind farm	Group	1		2.5
Infield Cables	Sequence	1	1-7-2015	3
Export Cables	Sequence	1	1-3-2015	4
Foundations (Pacific Osprey)	Sequence	20	25-7-2015	5
Substations	Sequence	1	1-8-2015	6
Turbines (Aeolus)	Sequence	25	1-2-2016	7
Turbines (Pacific Osprey)	Sequence	25	15-2-2016	8

The user of ECN Install can ensure the accuracy of the results.

Installation modelling

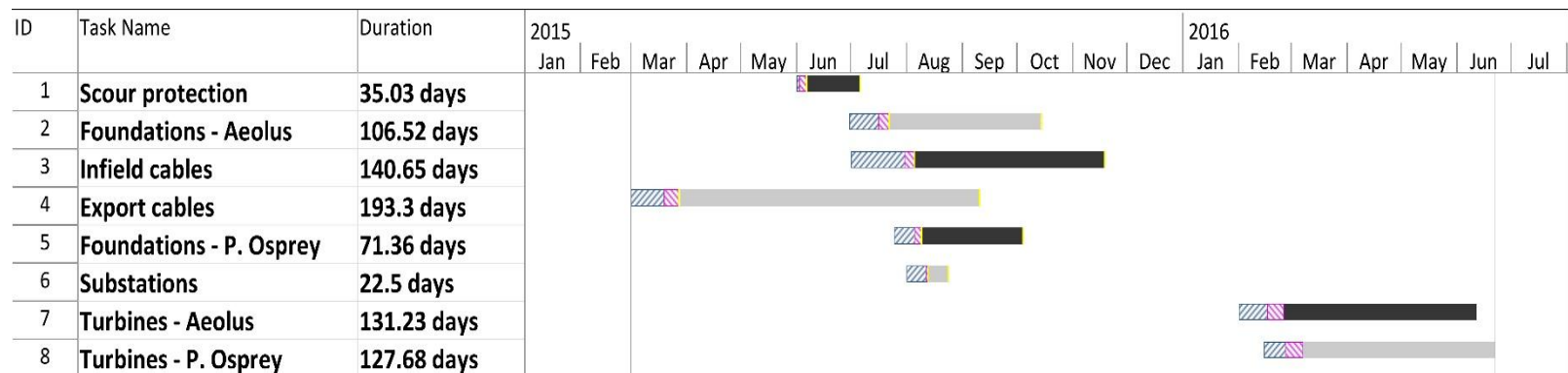
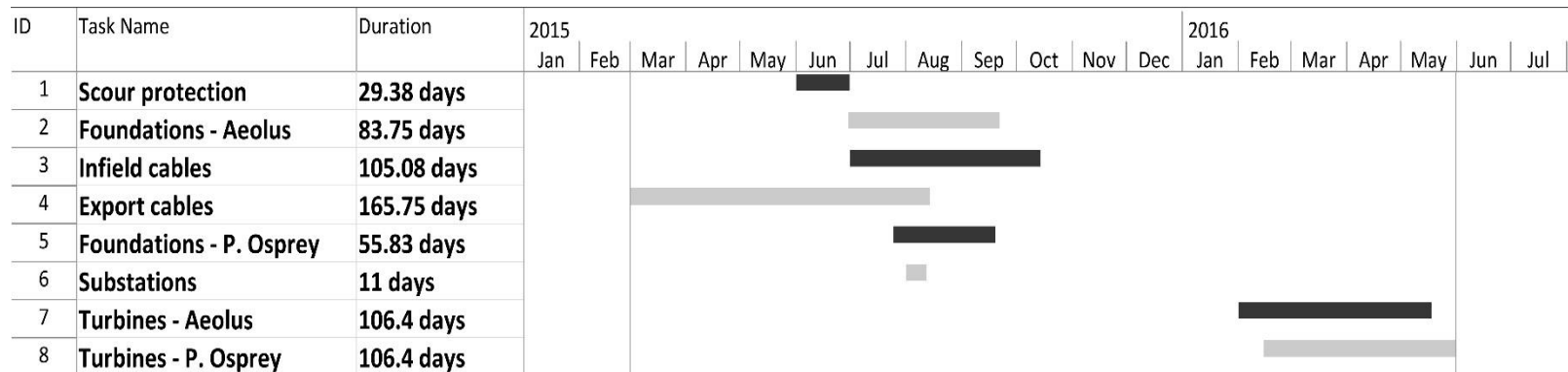
Calculating impact of delays - scenarios

The model calculates project delays caused by:

- Permit or contractual restrictions
 - Lack of resources
 - Working shifts
 - Bad weather
 - Harbour locks
-
- **Outputs**
 - Planning with delays
 - Breakdown of resources and costs
 - Export results to Graphs, MS Excel and MS Office Gantt chart

Possible Outputs

Results – planning with delays (export Gantt chart)



Project: Gemini
Date: October 26, 2015 9:49 AM

Weather Delay  Harbour Delay 
Shift Delay 

Possible Outputs

Results - graphs

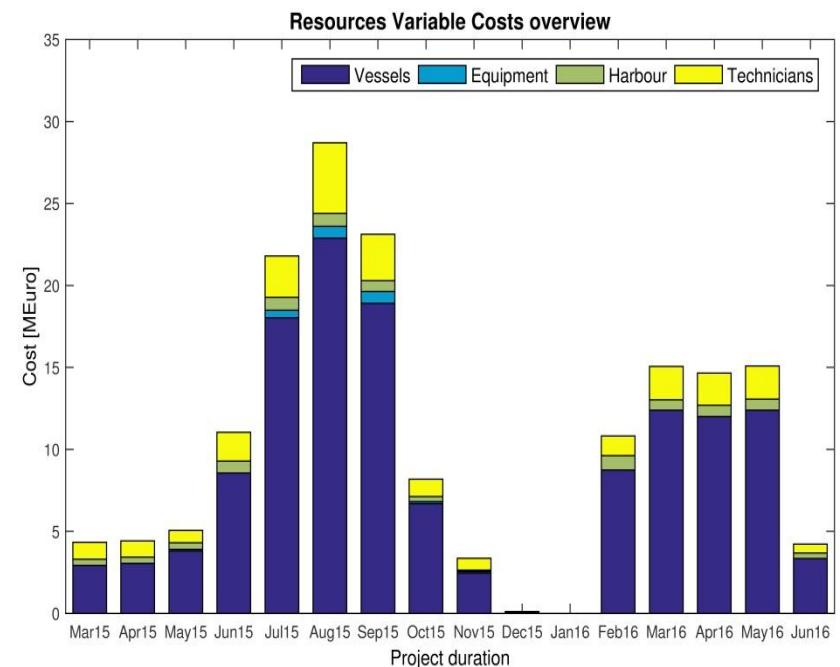
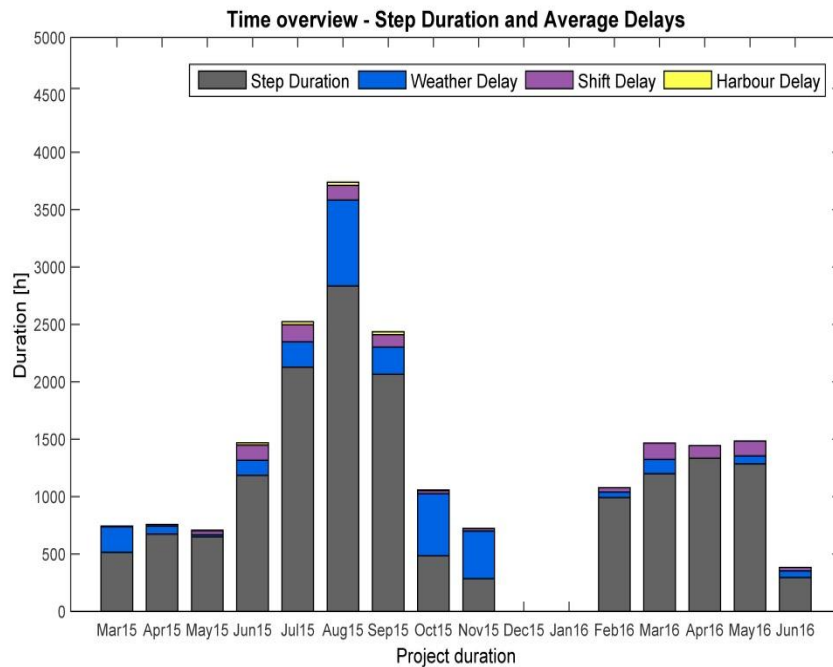
Select Graphs to produce

Time Graphs:	All	None	Cost Graphs:	All	None	Resource Graphs:	All	None
☐ Average Delays Breakdown per Delay Type			☐ Average Cost Breakdown for each Vessel (n)			☐ Number of Trips per Vessel		
☐ Average Delays Breakdown per Step Type			☐ Average Cost Breakdown per Vessel			☐ Number of Outgoing Trips per Harbour		
☐ Total Delays per Simulation year			☐ Average Cost Breakdown for each Equipment (n)			☐ Average Utilization Breakdown per Resource		
☐ Delays overview - Worst, Average Best scenarios			☐ Average Cost Breakdown per Equipment			☐ Vessel Utilization Overview		
☐ Average Delays overview per Sequence of steps			☐ Cost Breakdown per Component			☐ Equipment Utilization Overview		
☐ Time overview: Step Duration and Average Delays			☐ Average Cost Breakdown per Harbour			☐ Average Man-hours Overview		
			☐ Average Cost Breakdown per Resource					
			☐ Resources Cost per Simulation year					
			☐ Variable costs overview - Worst, Average Best scenarios					
			☐ Average Total Cost comparison: PreProcessed and Post-Processed					

The user can create 22 standard graphs using ECN Install

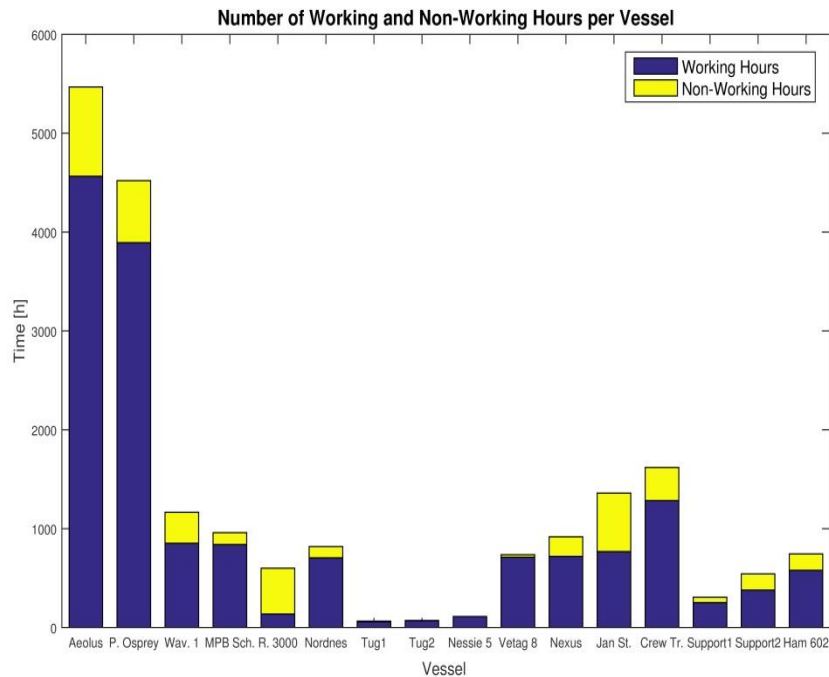
Example Outputs

Results - graphs

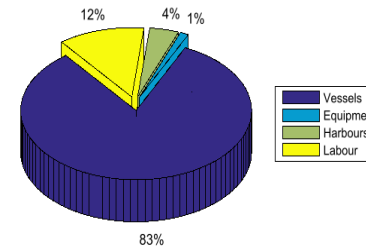


Example Outputs

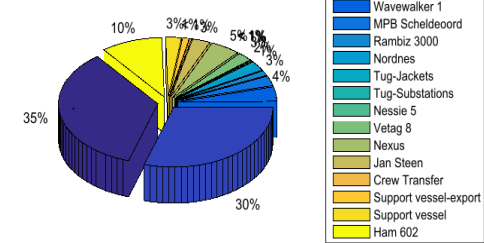
Results - graphs



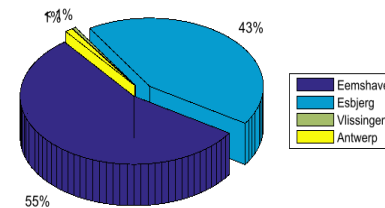
Average Cost Breakdown per Resource



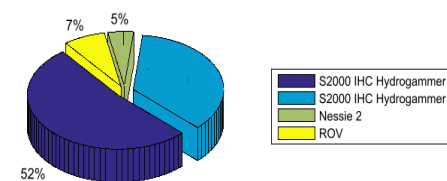
Average Cost Breakdown per Vessel



Average Cost Breakdown per Harbour



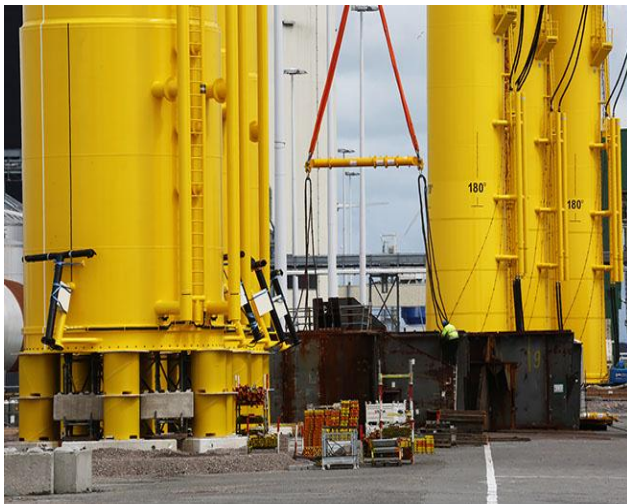
Average Cost Breakdown per Equipment



Installation modelling

What can it do?

- Design and optimize installation strategy for offshore wind farm
- Determine project planning, delays, costs and risks
- Monitor progress during installation



Installation modelling

What can it do?

- Commercial proof of new and innovative installation concepts
 - Installation methods
 - Support structures & wind turbines
 - Vessels and equipment



Source: Royal IHC



Source: Bugsier and Wärtsilä

Installation modelling

Where are biggest LCOE gains to be achieved?

Potential user	Added value
Developers	Procurement strategy, marshalling harbour strategy, procurement evaluation
Contractors BOP / WTG	Execution strategy, logistical strategy, workability analysis
Investors	Risk scenarios, contingency levels
Vessel & Equipment designers	Added value of a new design at site specific circumstances
Port authorities	Added value of the port location for project logistics

Innovative solutions
to lower the cost of energy

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