ETIP Ocean & DTOceanPlus Webinar: Digital Representation of Standard Data Formats for Ocean Energy Systems

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DTOcean+

Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment

Webinar

Digital Representation of Standard Data Formats for Ocean Energy Systems

Vincenzo Nava, Pablo Ruiz-Minguela

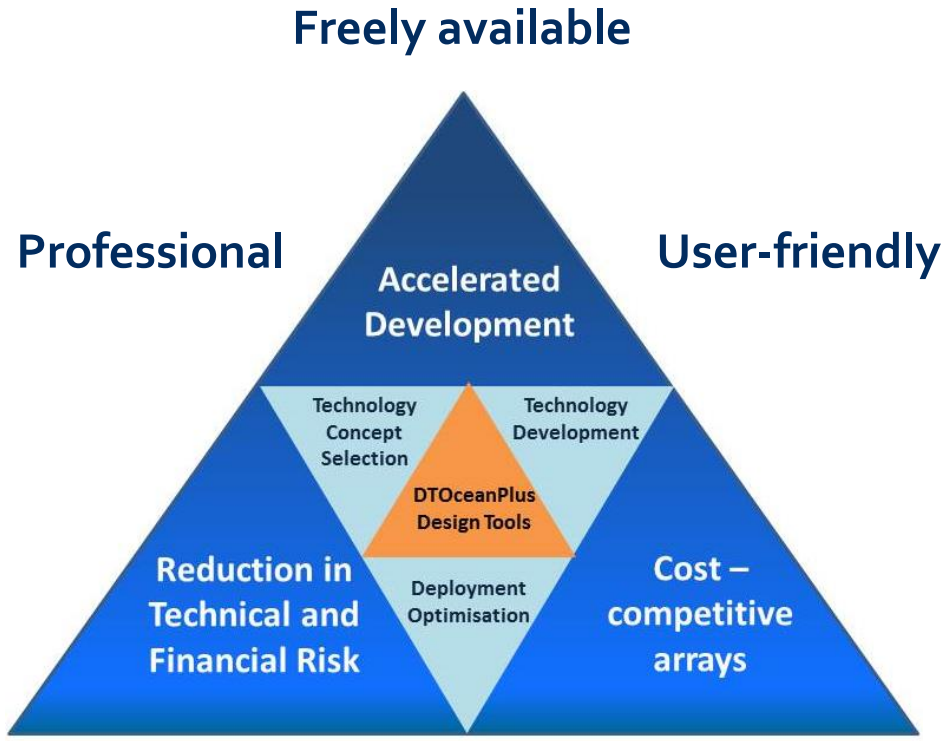
Tecnalia, 2020

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 785921

Contents

1. Introduction to DTOceanPlus (I)

- An **integrated open-source suite of design tools** to support the entire innovation and development process for ocean energy sub-systems, devices and arrays.
- Continuing **the development of DTOcean**, which produced a 1st generation of freely available, **open-source design tools for wave and tidal energy** arrays.
- Its operational capabilities and value will be **demonstrated (TRL6) with data from real case technology projects**.



Used at different levels of complexity and aggregation

1. Introduction to DTOceanPlus (II)

- **Structured Innovation Tool**

  For concept creation, selection and design.

- **Stage Gate Tool**

  Assisting decision-making through the use of metrics to measure, assess and guide technology development.

- **Deployment Tools**: Site characterisation, Energy capture, Energy transformation, Energy delivery, Station-keeping, Logistics and Marine Operations

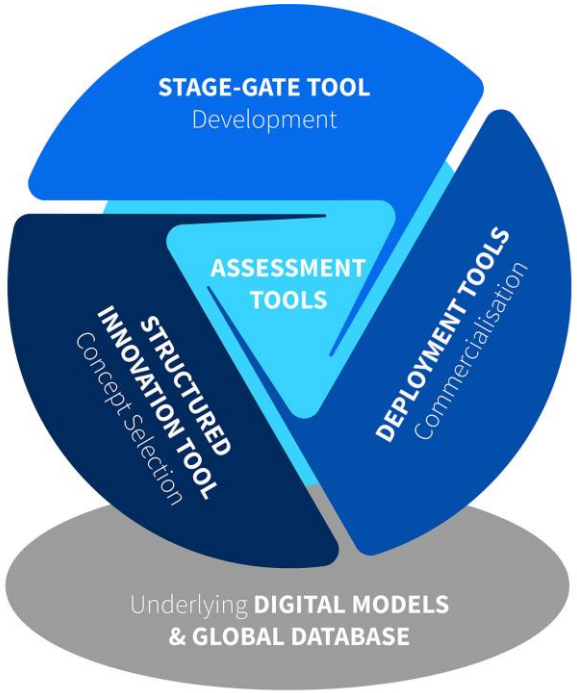
  Supporting optimal device and array deployment.

- **Assessment Tools:** Performance & Energy Yield, RAMS, Lifetime Costs, Environmental and Social Acceptance

  Providing objective information to the developer or investor on the suitability of a technology and project.

- **Common digital models – Digital Representation**

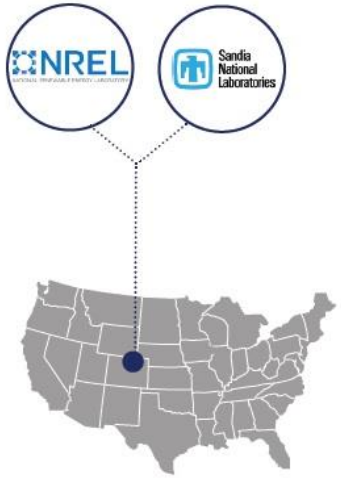
  Standard framework for the description of sub-systems, devices and arrays to allow sharing of design information.



1. Introduction to DTOceanPlus (III)

- A 3-year EU project (May 2018 - April 2021) with a total budget of **8 M€**.

- **Multidisciplinary team** of 16 partners from 7 EU countries, with the collaboration of 2 leading research laboratories from the USA.

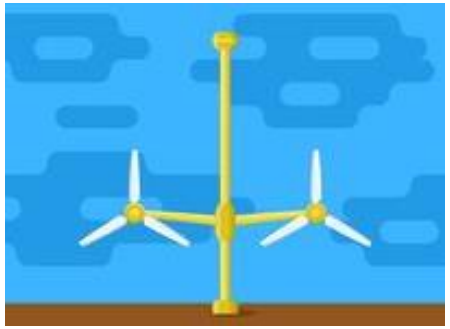


2. Standard data formats for OES (I)

Motivation and objectives

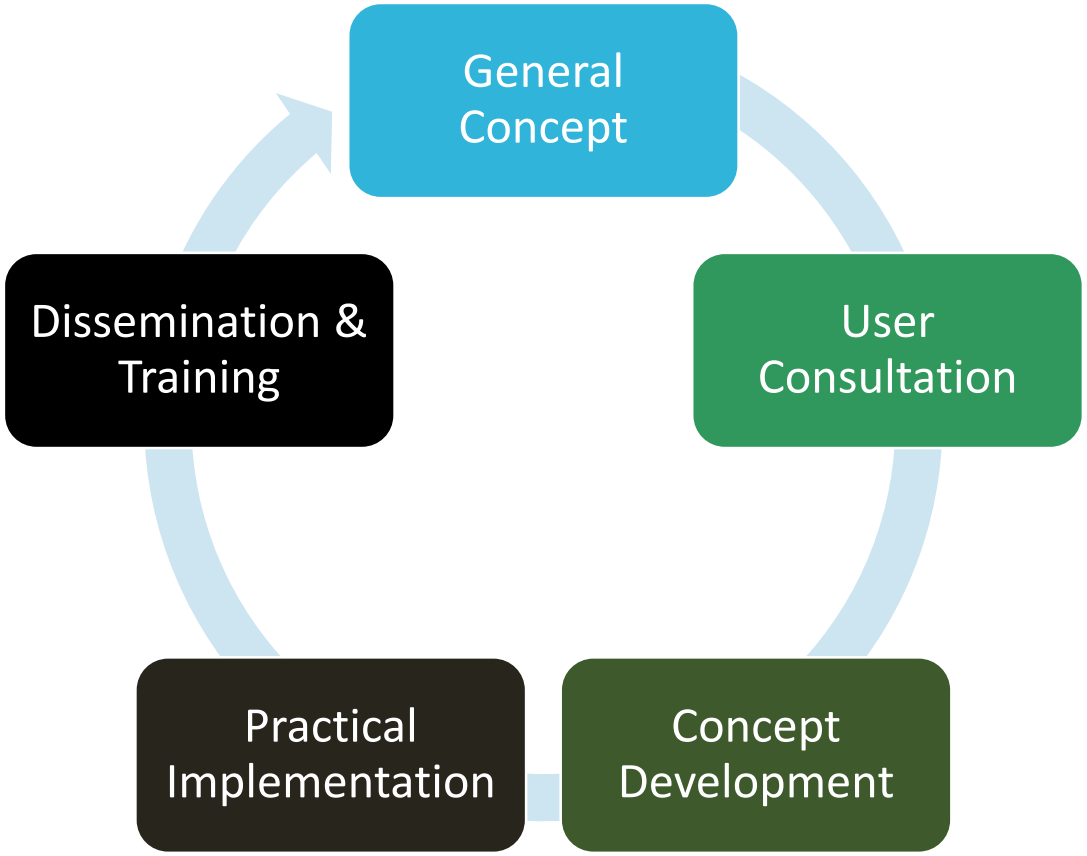
- Lack of a **standard method** for describing the key characteristics and attributes of Ocean Energy technologies:
  - Makes it difficult to impartially analyse innovative designs.
  - Renders impossible to objectively compare competing technologies.
  - Hinders knowledge sharing activities.
  - Can lead to misuse of limited funding and resources.

- The **Digital Representation** aims to:
  - Provide a common language and architecture for storing project information.
  - Facilitate data and information exchange.
  - Enable objective comparisons between various technologies.
  - Enhance the ability of sector stakeholders to work collaboratively.



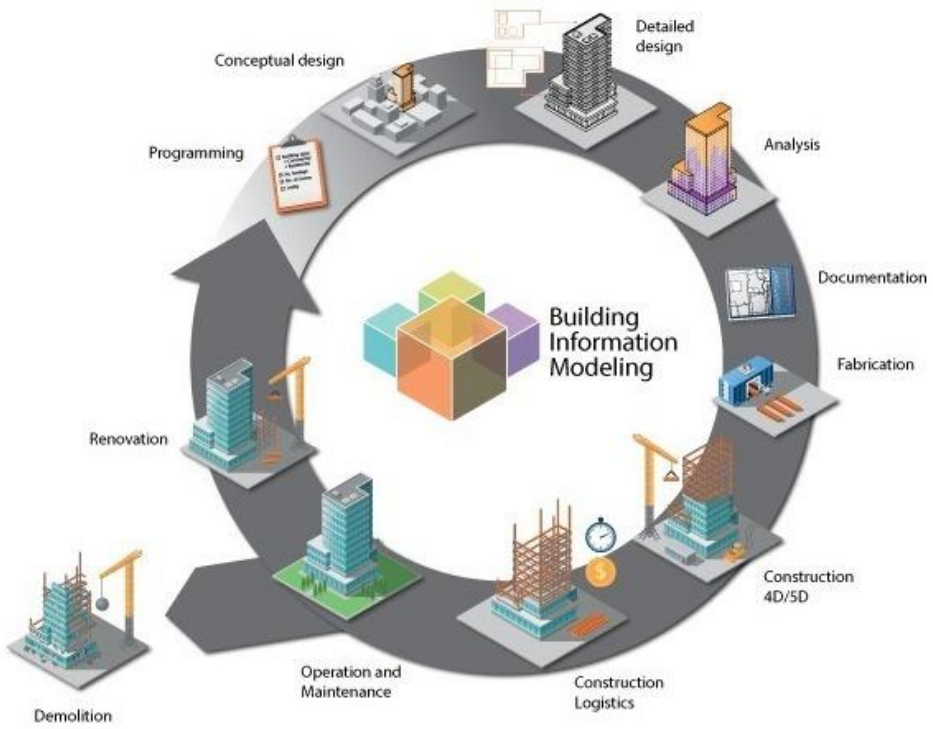
2. Standard data formats for OES (II)

Methodology

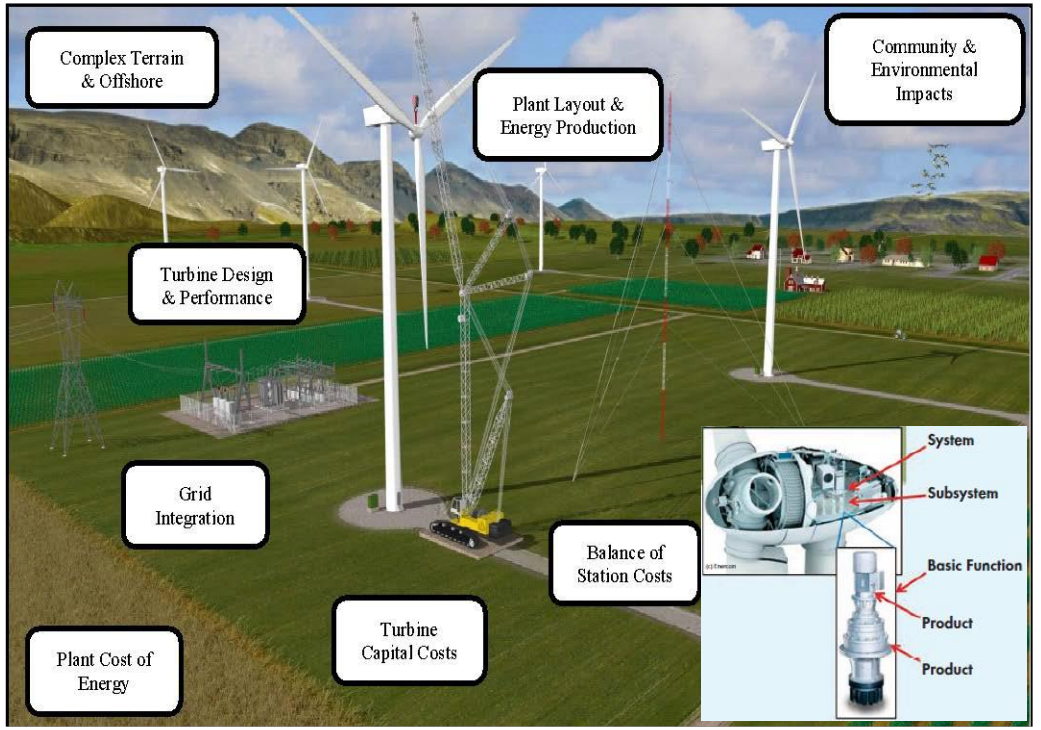


2. Standard data formats for OES (III)

Digitalisation in other sectors



Construction sector: Digital objects/twins over the project lifetime

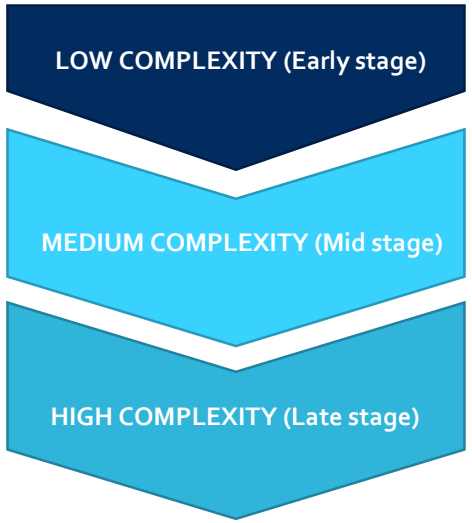


Wind sector: Guidelines for a common conceptual architecture for wind turbines and plants

2. Standard data formats for OES (IV)

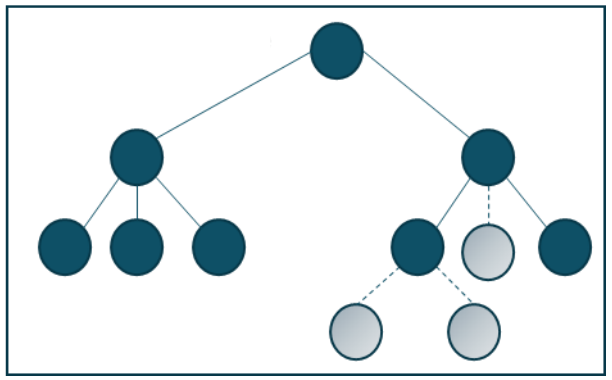
Four guiding principles

Flexibility



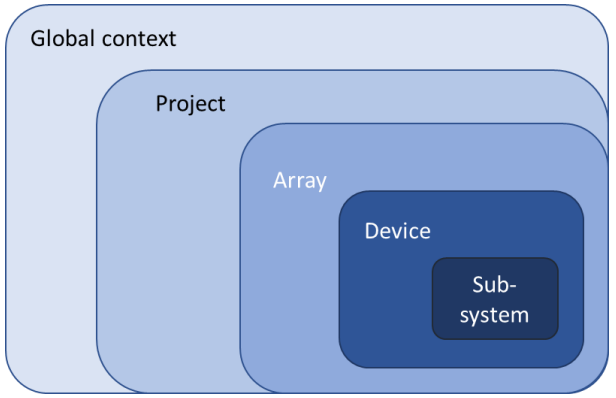
Different levels of data granularity to match technology maturity (TRL)

Expandability



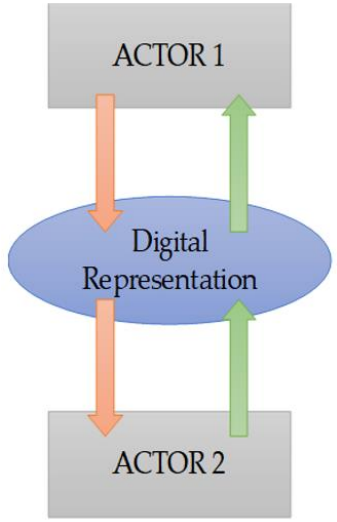
Avoid early obsolescence as the sector evolves and brings in new objects and lower levels of detail

Aggregation



Facilitate objective comparisons of individual sub-systems, devices and arrays

Communication

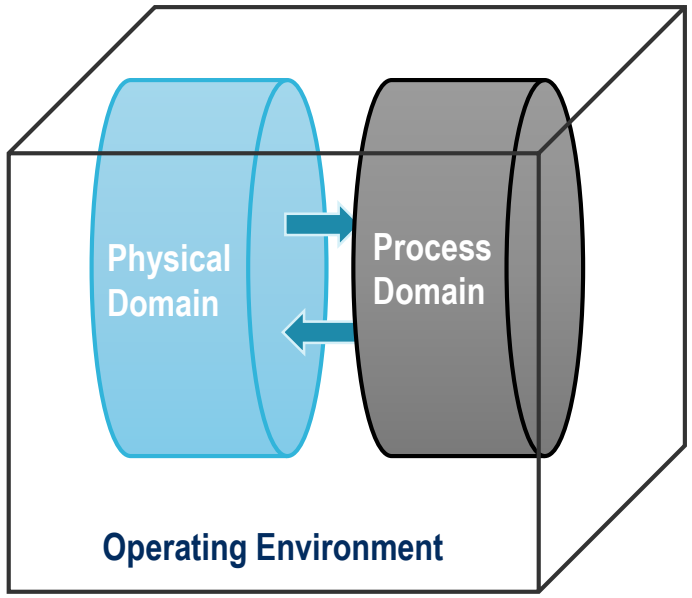


Seamless exchange of information among software tools and stakeholders

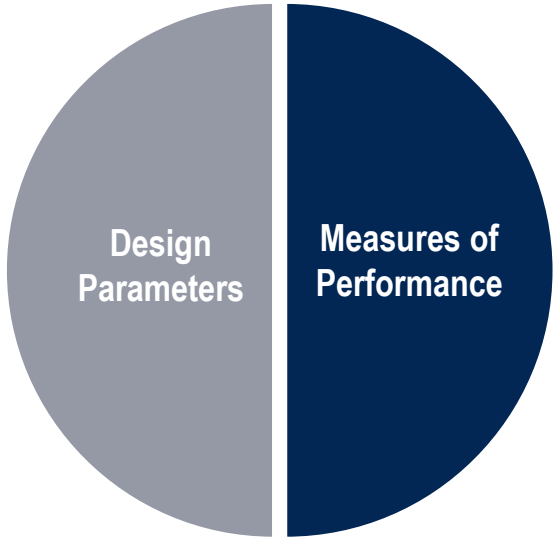
2. Standard data formats for OES (V)

Digital Objects

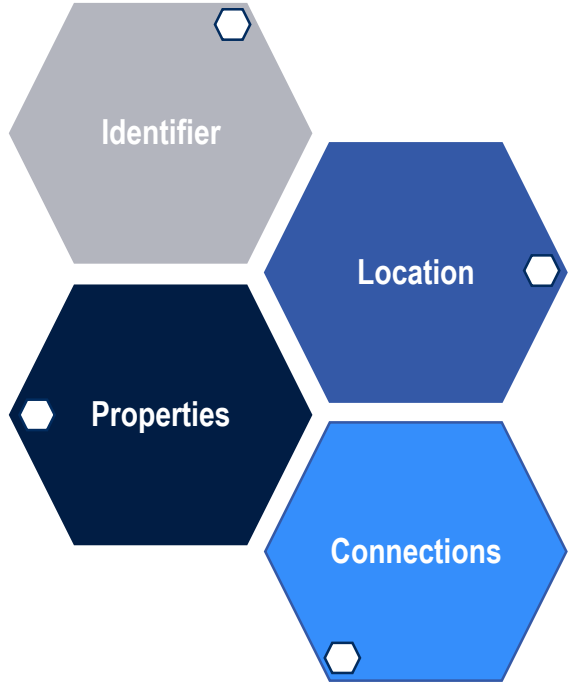
Three Design Components



Two Model Perspectives



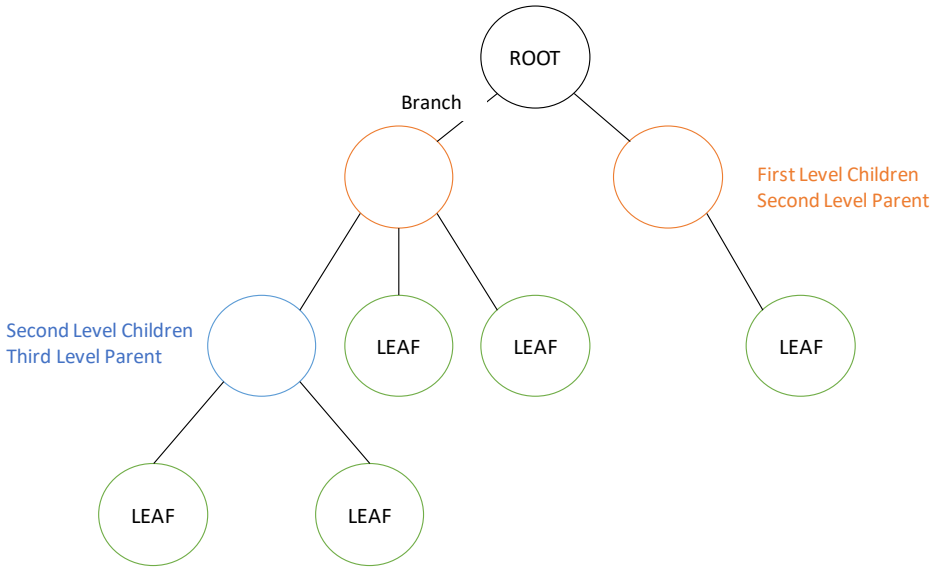
Single Object Structure



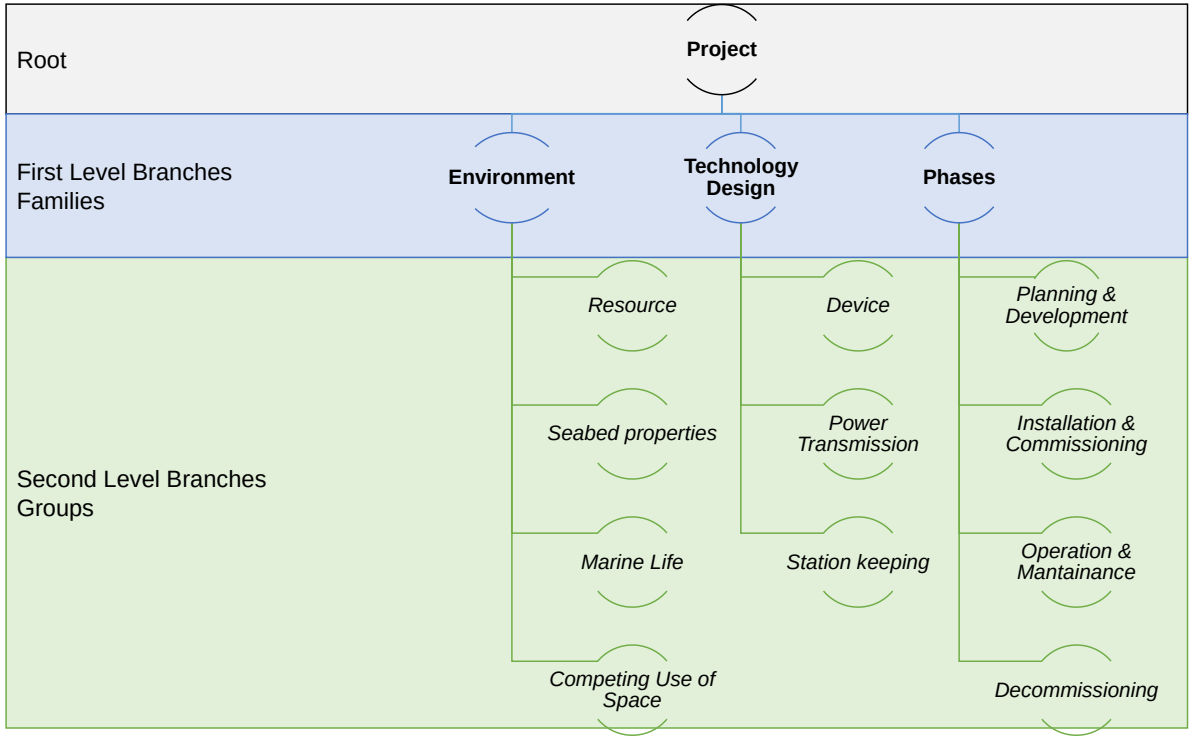
2. Standard data formats for OES (VI)

Hierarchical Structure

Rooted tree

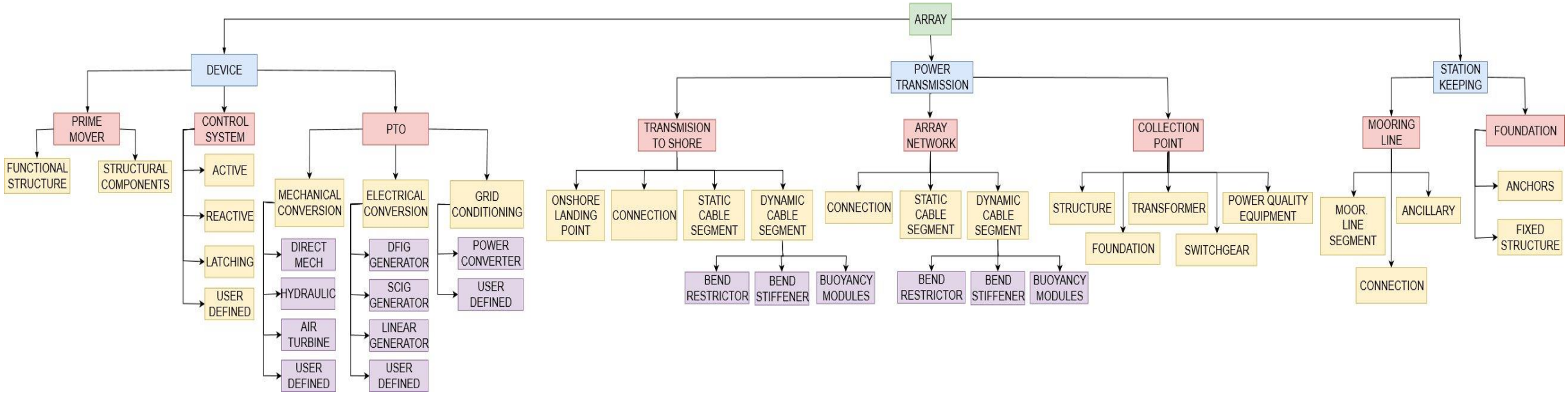


Ocean Energy Families and Groups



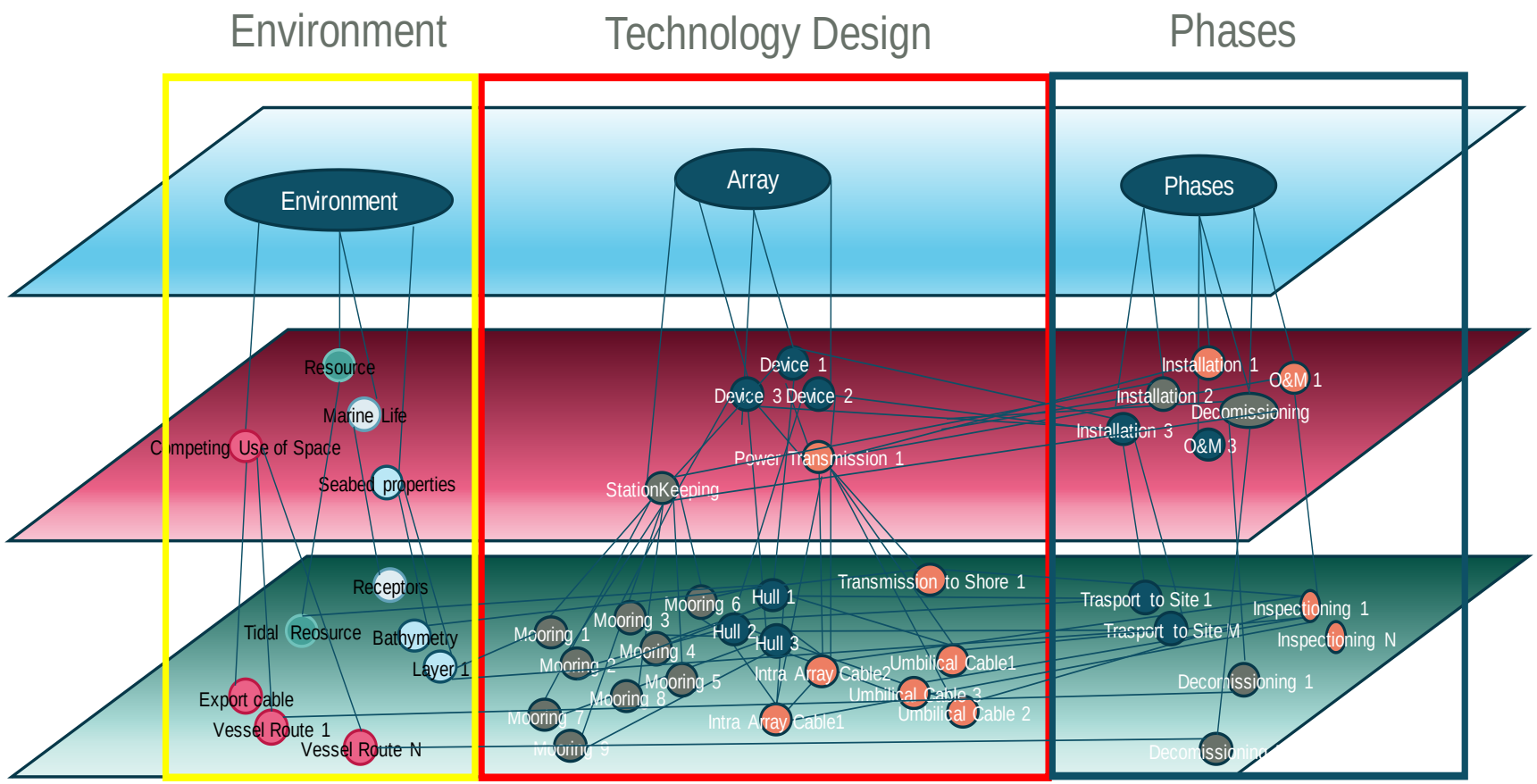
2. Standard data formats for OES (VII)

Example of the Technology Design Family



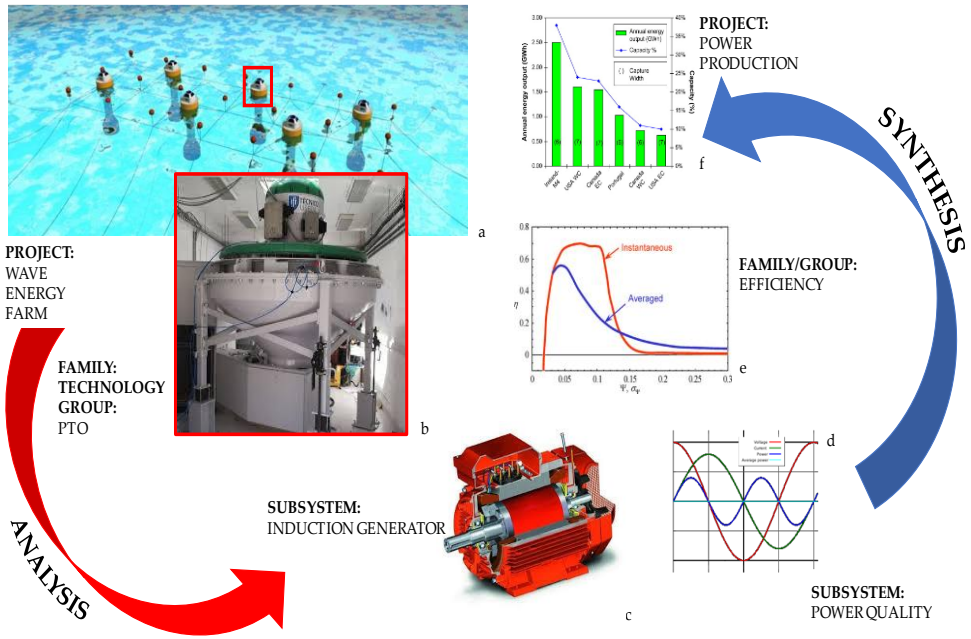
2. Standard data formats for OES (VIII)

Intra- and Inter-relationships



2. Standard data formats for OES (IX)

Example of DR for an Induction Generator for the PTO of a WEC

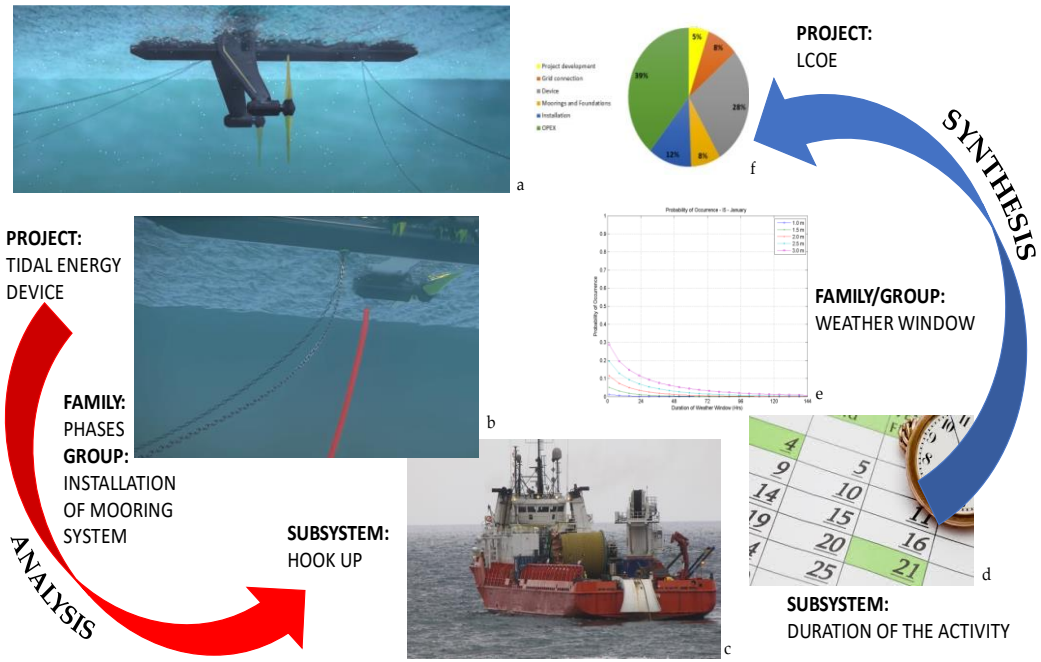


PTO	ID		PTO-1	String
	LOCATION	[x, y, z]	[0,0,0]; [0,0,2]	1D Array
	PHYSICAL AND FUNCTIONAL PROPERTIES			
		Type of mechanical conversion	Air Turbine	String
		Number of PTO	2	Scalar
		Type of electrical conversion	SCIG	String
		Type of grid conditioning	Power Converter	String
		Pnom	500 kW	Scalar
		Name Material & weight	Steel & 500 kg	Array
	ASSESSMENTS			
		CAPEX	5e4 €	Scalar
		OPEX	1e5€	Scalar
		Failure rate	1e-4 hr-1	Scalar
		Risk priority number	-	Scalar
	HIERACHICAL CONNECTION			
		Part of {Device ID}	Device01	List of Strings
		Mechanical conversion {IDs}	Mech01	List of Strings
		Electrical Conversion {IDs}	Elec02	List of Strings
		Grid conditioning {IDs}	Grid04	List of Strings
	CONNECTION		-	
		Installation of PTO {Operation IDs}	[Inst01, Inst02, Inst03]	List of Strings
		O&M of PTO {Operation IDs}	[Op1, Op2, Op3]	List of Strings
		Decommissioning of PTO {Operation IDs}	[Dec1, Dec2]	List of Strings

SCIG GENERATOR	ID		SCG1	String
	LOCATION	[x, y, z]	m	1D Array
	PHYSICAL AND FUNCTIONAL PROPERTIES			
		Pnom	250 kW	Scalar
		Name Material & weight	Steel & 10 kg	Array
	ASSESSMENTS			
		Efficiency	75%	Scalar
		Cost	1e3€	Scalar
		Failure rate	0.001	Scalar
	HIERACHICAL CONNECTION			
		Part of: {Elect. Conversion ID}	Elec02	Scalar
	CONNECTION			
		Installation of Mech. Conv {Operation ID}	Inst1	String
		O&M of Mech. Conv {Operation ID}	Op1	String
		Decommissioning of Mech. Conv {Operation ID}	Dec2	String

2. Standard data formats for OES (X)

Example of DR for the Installation of a Mooring Line for a TEC



INSTALLATION

ID		INST-01	String
NAME		Installation of Mooring System	String
TYPE	Installation		String
START/END			
	Start date	20/02/2020	Date
	End Date	28/02/2020	Date
DURATION			
	Total Duration	168 h	Scalar
	Duration at Sea	100 h	Scalar
	Duration at Port	15 h	Scalar
	Waiting time	20 h	Scalar
	Mobilisation Time	33 h	Scalar
VESSELS, PORTS, EQUIPMENT			
	Type of Vessel		String
	Number of Vessels	1	Scalar
	Port	Santander	String
	Other Equipment	-	String
	Operating Limiting Conditions [Hs, Tp, Vc, Vw]	[1.5,7, -, -]	List of scalars
ASSESSMENTS			
	Downtime Hours [h]	-	Scalar
	Vessel/equipment consumption	25	Scalar
	Vessel Route [list of coordinates]	[0,0], [0,1], ..., [125,345]	List of coord.
	Operation cost	1e5 €	Scalar
	Production of CO2 and other pollutants	1e4	Scalar
	Number of crew/workers	10	Scalar
	Risk of Collision (in case of Vessel operation)	25/100	Scalar
	Underwater nois	24/100	Scalar
CONNECTION WITH PHASE			
	Is Part of {Operation ID}	-	List of strings
CONNECTION WITH TECHNOLOGY DESIGN			
	Technology (ies) involved	Moorign1-	List of strings
CONNECTION WITH SITE			
	Id of the Time Series	TimeSeries1	List of strings

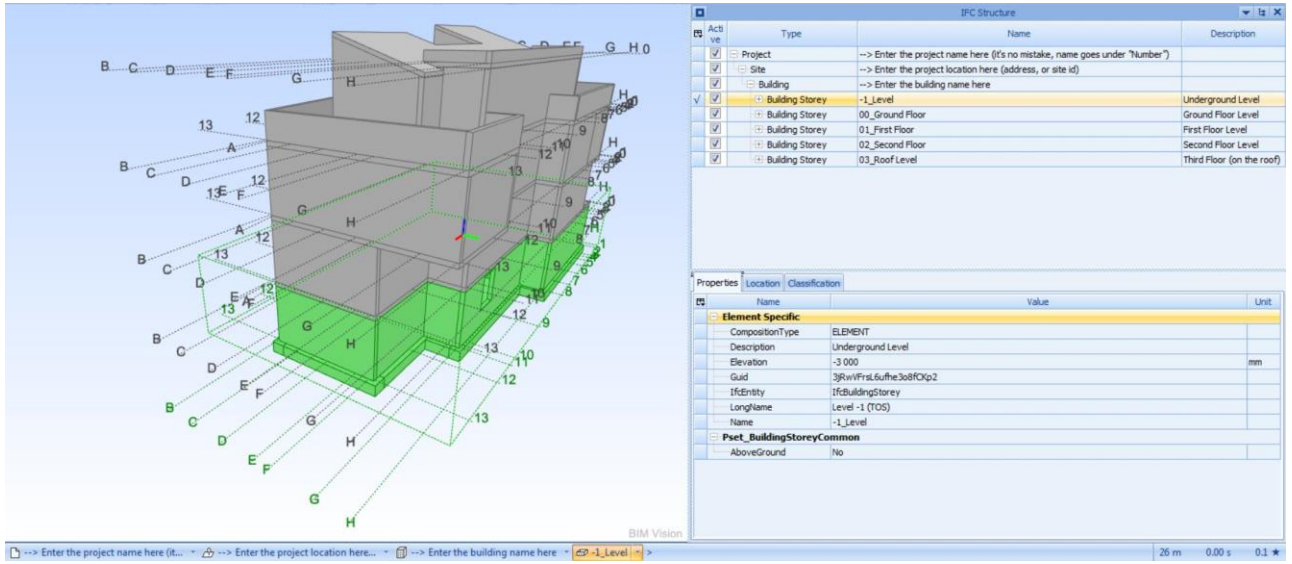
CONNECTION

ID	HOOK-01	-	String
NAME	Hook up of Mooring System	-	String
TYPE	Hook up		String
START/END			
	Start date	22/02/2020	Date
	End Date	22/02/2020	Date
DURATION			
	Total Duration	8 h	Scalar
	Duration at Sea	8 h	Scalar
	Duration at Port	- h	Scalar
	Waiting time	- h	Scalar
	Mobilisation Time	- h	Scalar
VESSELS, PORTS, EQUIPMENT			
	Type of Vessel		String
	Number of Vessels	1	Scalar
	Port	Santander	String
	Other Equipment	-	String
	Operating Limiting Conditions [Hs, Tp, Vc, Vw]	[1.5,7, -, -]	List of scalars
ASSESSMENTS			
	Downtime Hours [h]		Scalar
	Vessel/equipment consumption		Scalar
	Vessel Route [list of coord.]		List of coord.
	Operation cost	1e5 €	Scalar
	Production of CO2 and other pollutants	-	Scalar
	Number of crew/workers	10	Scalar
	Risk of Collision (in case of Vessel operation)	25/100	Scalar
	Underwater noise	24/100	Scalar
CONNECTION WITH PHASE			
	Is Part of {Operation ID}	INST-01	List of strings
CONNECTION WITH TECHNOLOGY DESIGN			
	Technology (ies) involved	Moorign1-	List of strings
CONNECTION WITH SITE			
	Id of the Time Series	TimeSeries1	List of strings

2. Standard data formats for OES (XI)

Practical implementation in DTOceanPlus

- XML and JSON file formats are being considered
  - Widely used (e.g. BIM)
  - Human readable
  - Provide a schema that can be tailored (= future expandability)
  - Ensure document consistency and validity



- One main file with reference to external files (in their native format, e.g. cvs, pdf, …)
  - Stored in the same directory, or
  - Packed together in self-extractable archive

Images courtesy of
https://www.engipedia.com/revit-organizing-template-ifc-export/

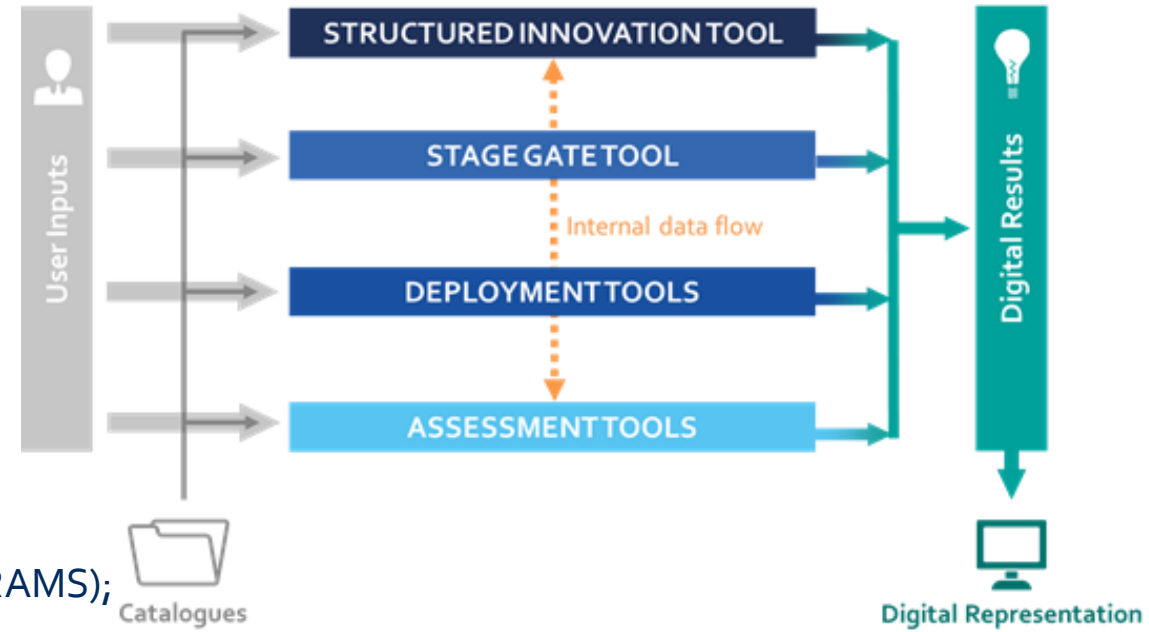
3. Summary and future work (I)

- Standard representation of data formats for OE Systems to:
  - Provide a common language and architecture for storing project information.
  - Facilitate data and information exchange.
  - Enable objective comparisons between various technologies.
  - Enhance the ability of sector stakeholders to work collaboratively.

- Digital objects:
  - Integrate in a single structure two model perspectives (physical design and assessment) for three different design elements (environment, physical entities and processes)
  - Hierarchical structure to allow future expandability and different levels of aggregation and complexity.
  - Connectivity to represent the inter- and intra-relationships between instantiated objects.

3. Summary and future work (II)

- The Digital Representation will be built in practical terms during the implementation of the different tools and modules of DTOceanPlus:
  - Structured Innovation Tool (SI).
  - Stage Gate Tool (SG).
  - Deployment Tools:
    - Site Characterisation (SC);
    - Energy Capture (EC);
    - Energy Transformation (ET);
    - Energy Delivery (ED);
    - Station Keeping (SK);
    - Logistics and Marine Operations (LMO).
  - Assessment Tools:
    - System Performance and Energy Yield (SPEY);
    - System Lifetime Costs (SLC);
    - System Reliability, Availability, Maintainability, Survivability (RAMS);
    - Environmental and Social Acceptance (ESA).

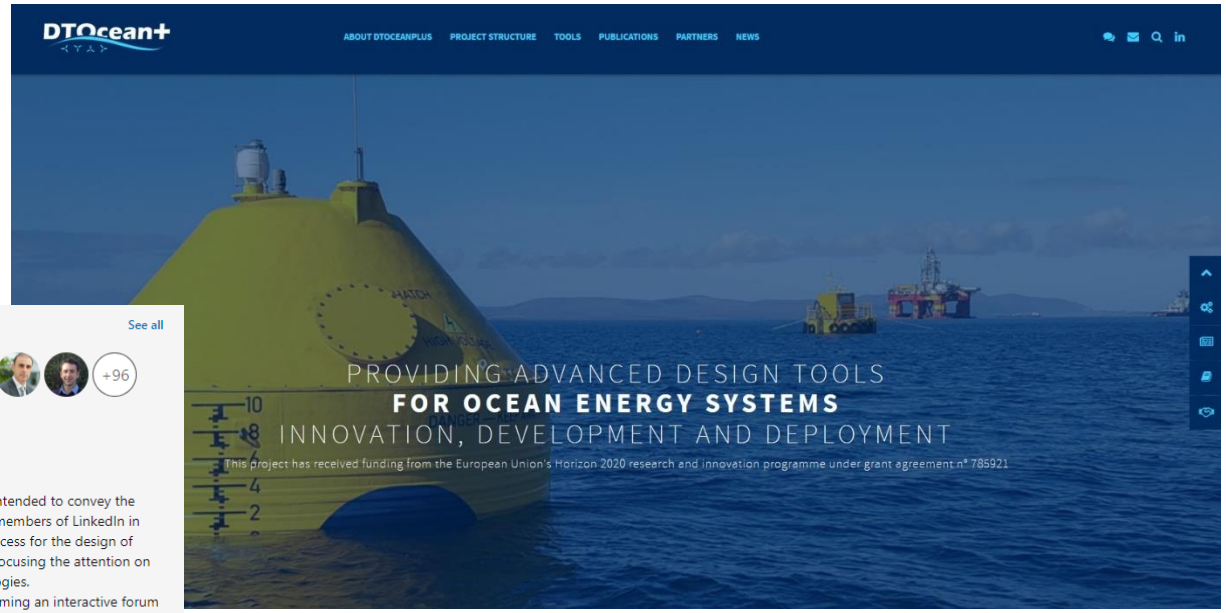


- … and tested with data from real case technology projects

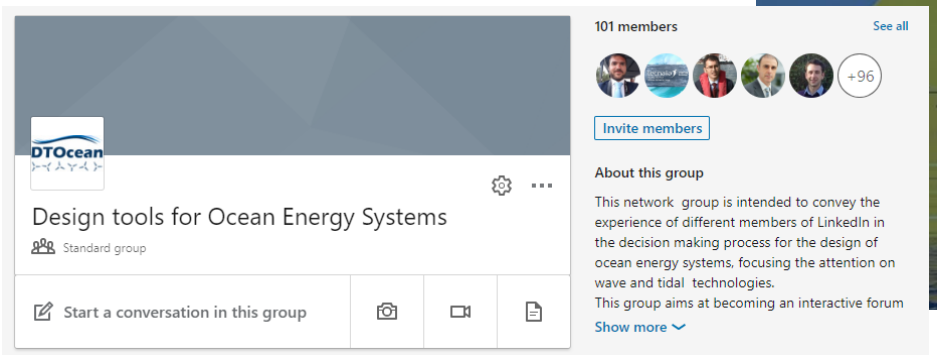
3. Summary and future work (III)

- The concept of the Digital Representation will be presented to stakeholders during a set of dissemination and training actions:
  - Conferences such as EWTEC 2019 or ICOE2020
  - Scientific publications
  - Webinars and tutorials

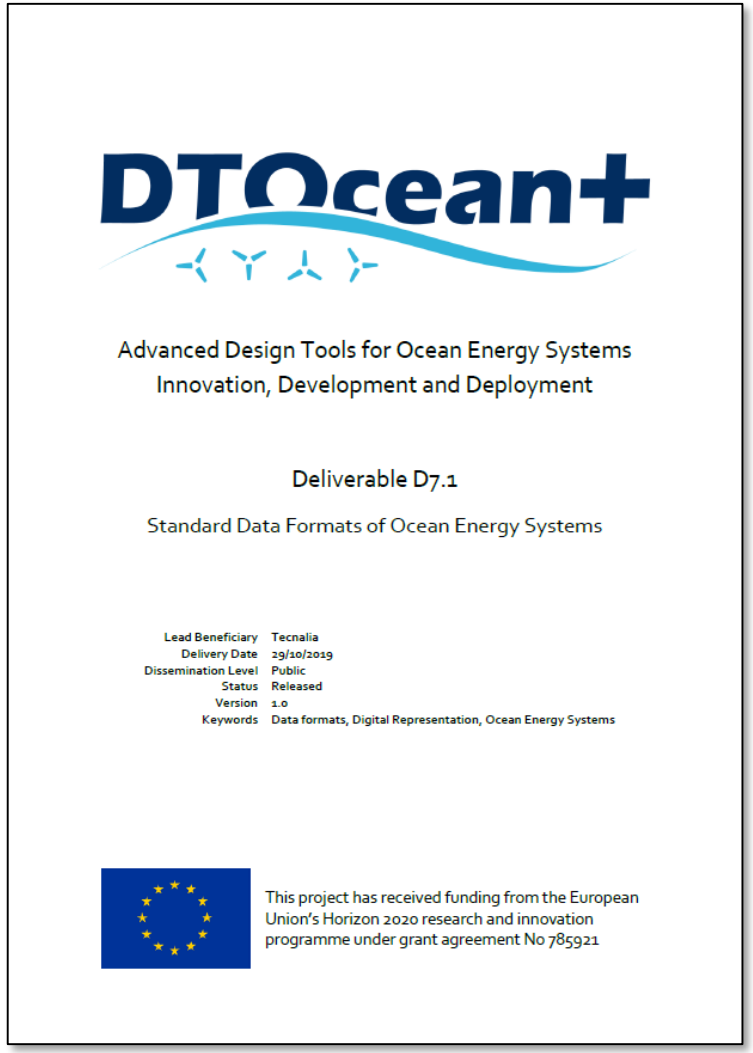
dtoceanplus.eu



Online forum
LinkedIn Group



4. Reference Material



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Advanced Design Tools for Ocean Energy Systems
Innovation, Development and Deployment

Deliverable D7.1

Standard Data Formats of Ocean Energy Systems

Lead Beneficiary	Tecnalia
Delivery Date	29/10/2019
Dissemination Level	Public
Status	Released
Version	1.0
Keywords	Data formats, Digital Representation, Ocean Energy Systems

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Deliverable D7.1 "Standard Data Formats of Ocean Energy Systems" of the DTOceanPlus project is a report, collecting the outcome of the work carried out during task T7.1 of the project, aiming at fully describing the data used for a generic ocean energy system design in a structured manner.

Section 6 (Annex) contains the full list of data structures for the Digital Representation of Ocean Energy Systems

Document Information

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Advanced Design Tools for Ocean Energy Systems Innovation, Development and Deployment

Thank you – Questions?

Vincenzo Nava, Pablo Ruiz-Minguela

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