

Climbing the ladder of TRLs

From an ELKARTEK project to a HAZITEK proposal

Vincenzo Nava

IX Marine Energy Conference, Bilbao

June 21, 2023



Outline

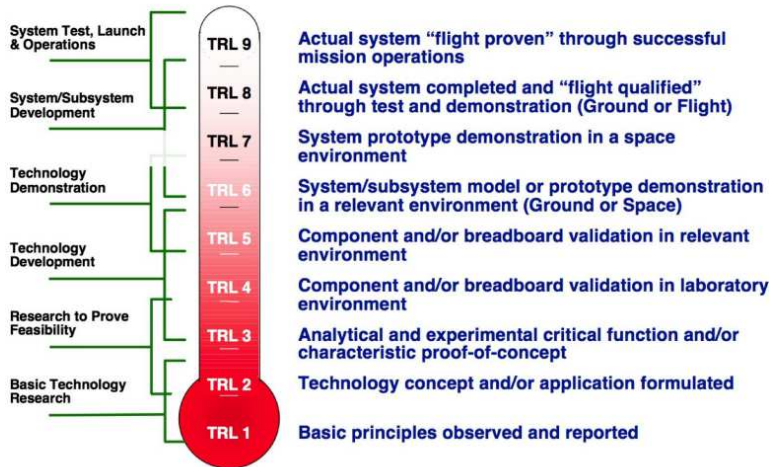
- Climbing the TRL ladder: from ELKARTEK to HAZITEK programs
- A travel through time and TRLs
 - The ELKARTEK project Expert-IA
 - The Knowledge Transfer
 - The HAZITEK proposal Integr-IA
- Tips for a successful knowledge transfer

Outline

- **Climbing the TRL ladder: from ELKARTEK to HAZITEK programs**
- A travel through time and TRLs
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 - The Knowledge Transfer
 - The HAZITEK project Integr-IA
- Lessons learnt for a successful knowledge transfer

What are the TRLs?

NASA/DOD Technology Readiness Level



TECHNOLOGY READINESS LEVEL (TRL)



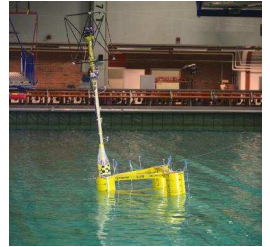
Climbing the TRL ladder



TRL 8-9



TRL 6-7



TRL 4-5

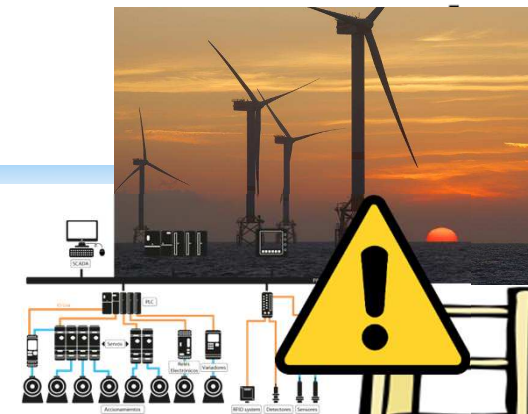


TRL 0



TRL 2-3

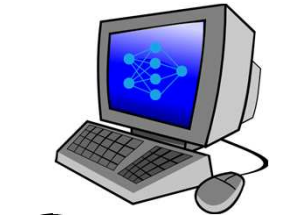
Floating Offshore Wind



TRL 8-9



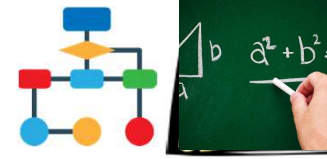
TRL 6-7



TRL 4-5



TRL 2-3



TRL 0

AI for damage classification



TRLs and the Basque Government R&D funding schemes



ELKARTEK

- Type I for Collaborative Fundamental Research Projects
- **1M €** minimum budget
- At least **3** different **typologies of institutions** belonging to RVCTI

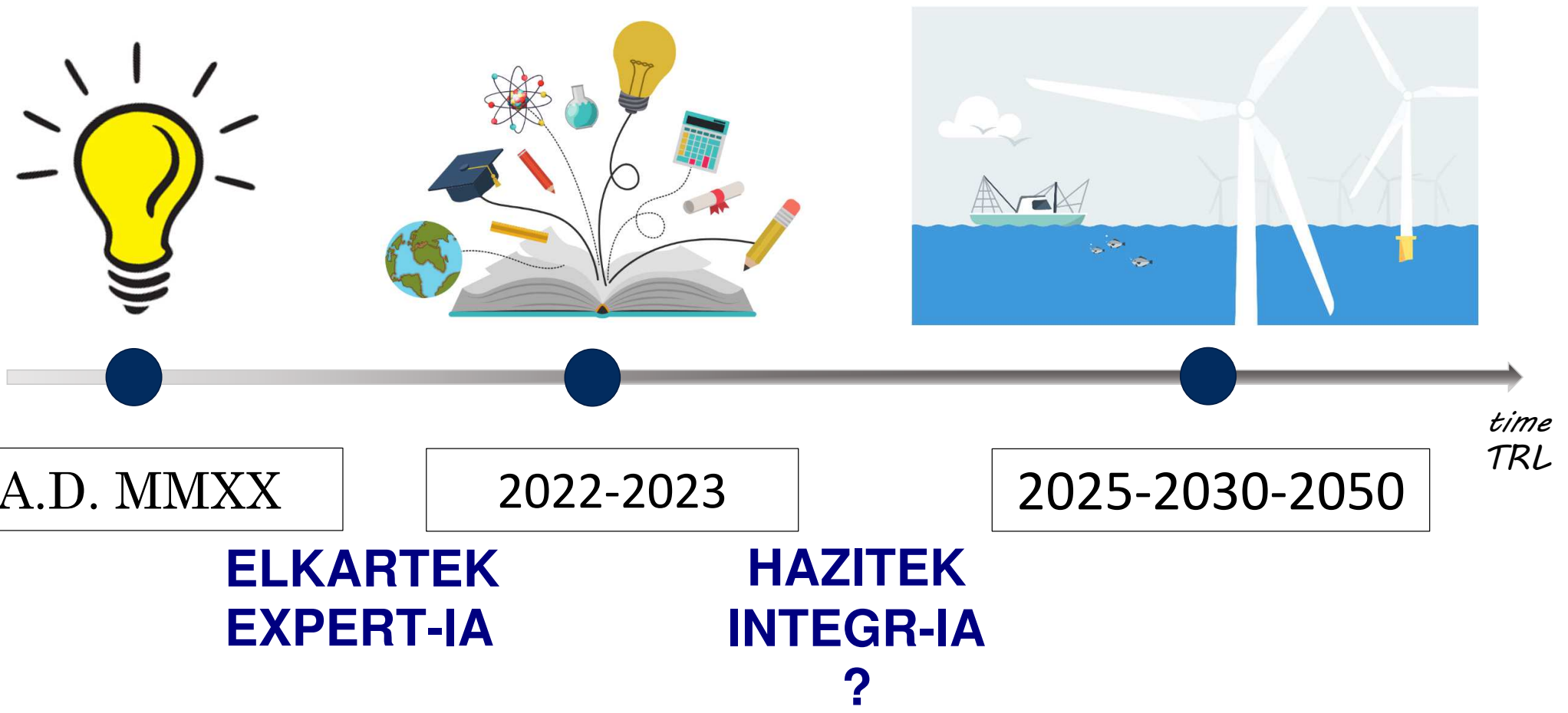
HAZITEK

- Strategic Projects with high potential to boost Basque country economy, supporting the **development of SMEs** and the Access to HE framework.
- **4M €** minimum budget
- Research in cooperation among at least **3 companies and subcontracted institutions of RVCTI**

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A trip through time and TRLs: from an ELKARTEK project to a HAZITEK proposal



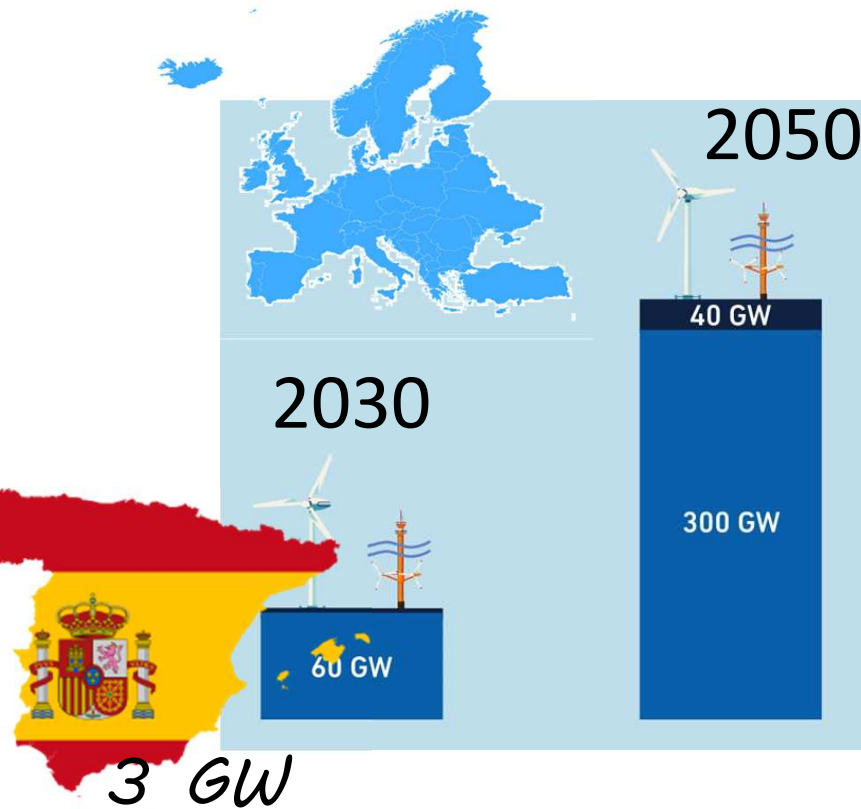
The motivation Accomplish Objectives for Offshore Wind

2030-2050

Achievement of
UN SDG - 7

*by increasing the
production of OW*

*and reducing capital
and operational costs*



$$LCOE = \frac{\text{CAPEX: } \$(\text{Wind} + \text{Tower}) + \text{OPEX: } \$(\text{Maintenance})}{\text{LEP: } \text{Energy}} + \text{Interest}$$

CAPEX



OPEX

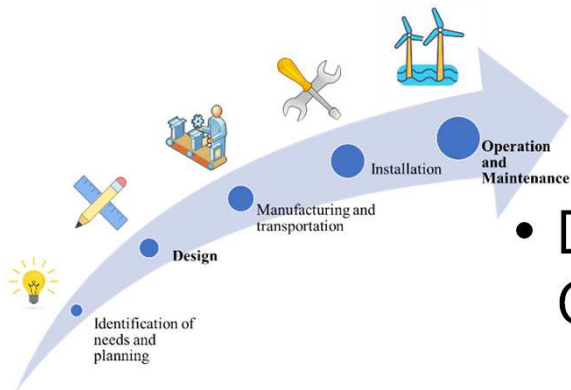


The motivation Digitalisation

2030

- **Digitalisation** is one of the drivers in order to achieve decarbonization goals of society and energy.

- **Areas of improvements** (Ciuriuc et al., 2022)
 - optimisation of sensing
 - development of digital twins
 - Building Information Models (BIMs)



- Data based approaches can support **different phases** of an ORE project (Clifton et al., 2022)

The ELKARTEK project Expert-IA



A.D. MMXXI

ELKARTEK2021
EXPERT-IA



THE CONSORTIUM

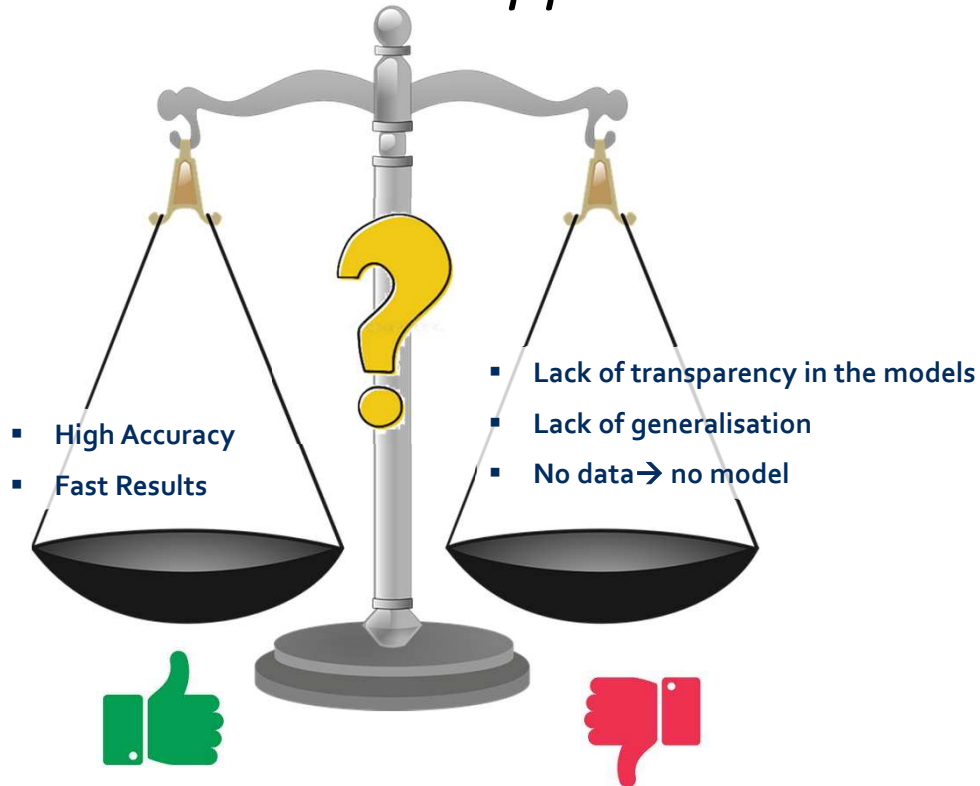


THE CONCEPT

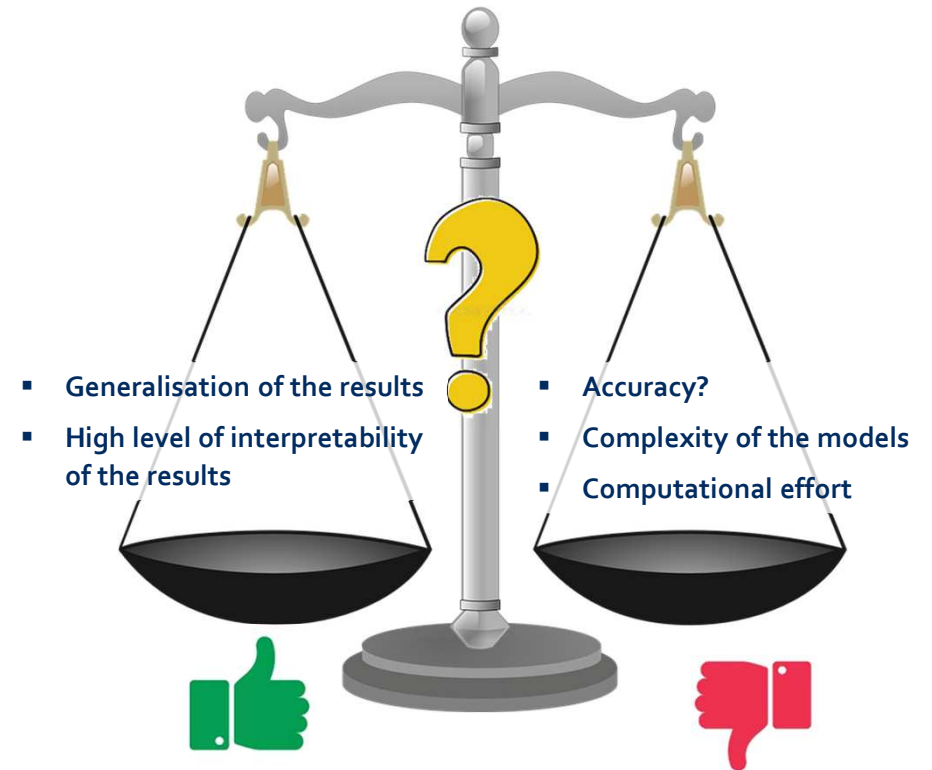
Evolution of modelling and control of the industrial processes:
advanced models combining
expert domain knowledge and **physics-based models**
with
AI techniques
during design and deployment.

The state of art

Data-driven approach



Physics-based models

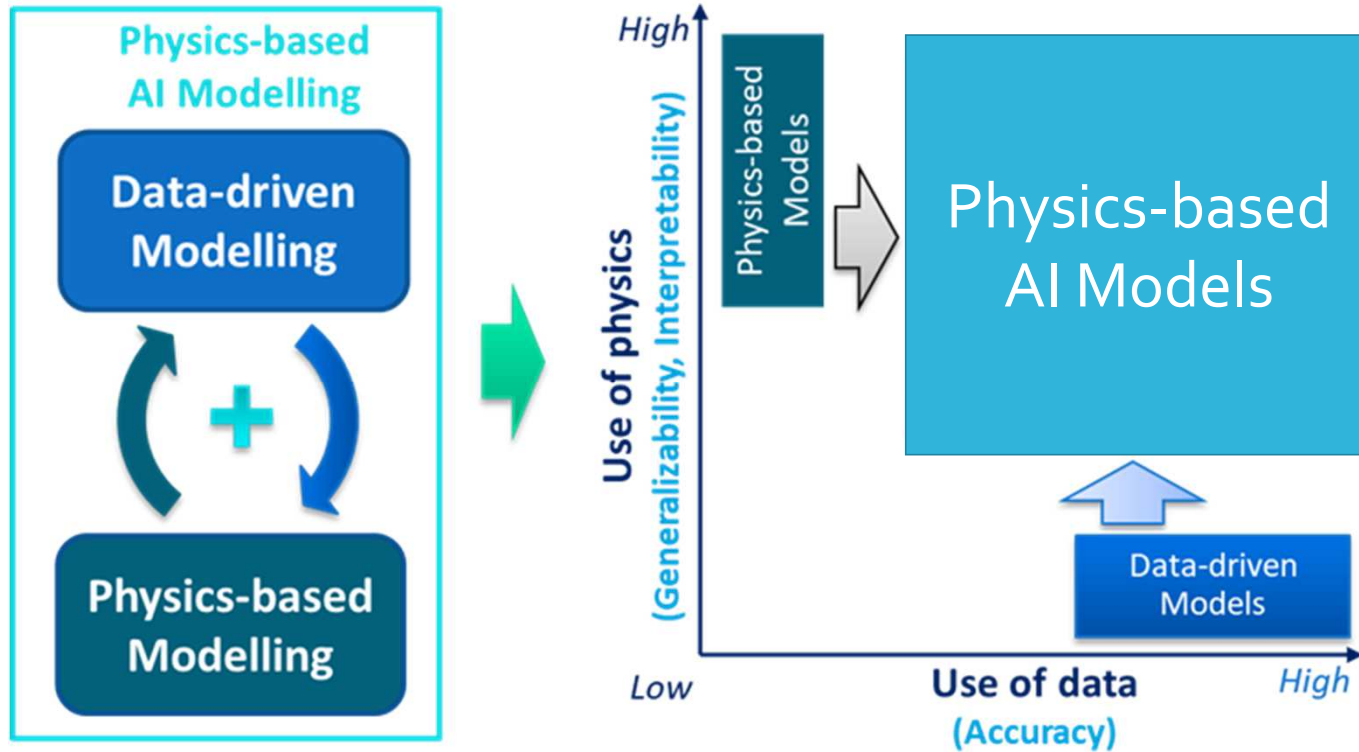


The selection of the most appropriate approach depends on the availability of data, specific requirements of the case, etc...

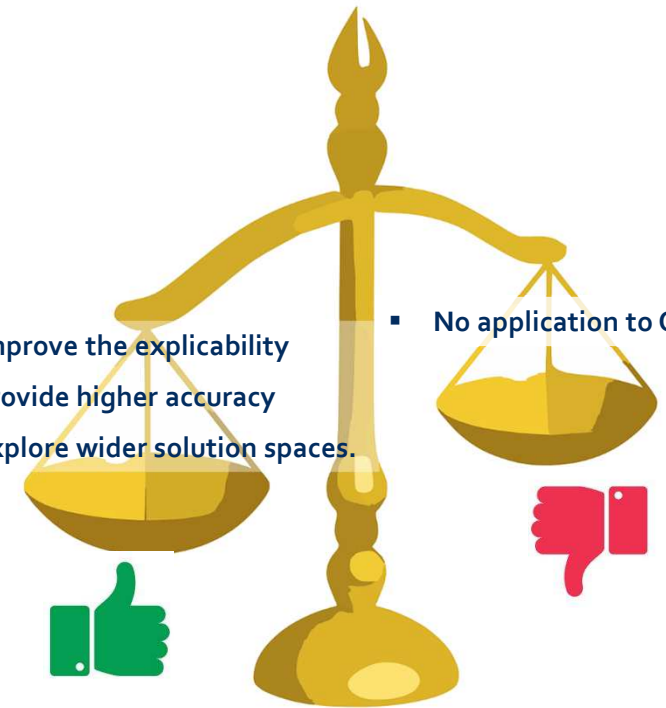
How Expert-IA goes beyond the state of the art

IMBRICATION

Physics-based AI models

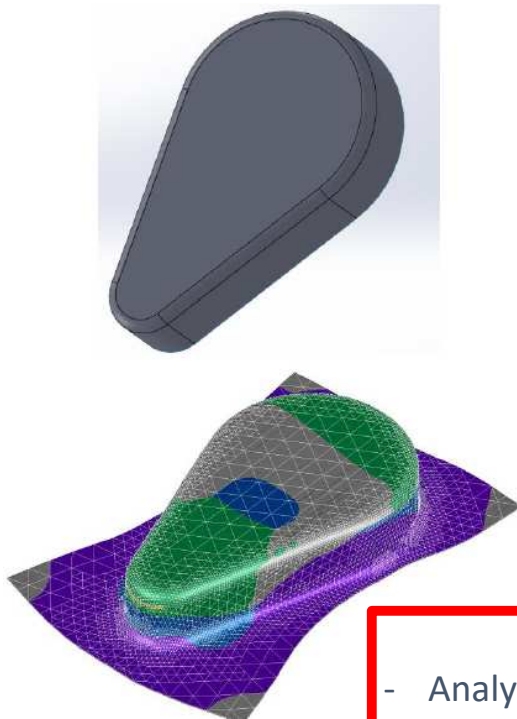


- improve the explicability
- provide higher accuracy
- explore wider solution spaces.
- No application to ORE



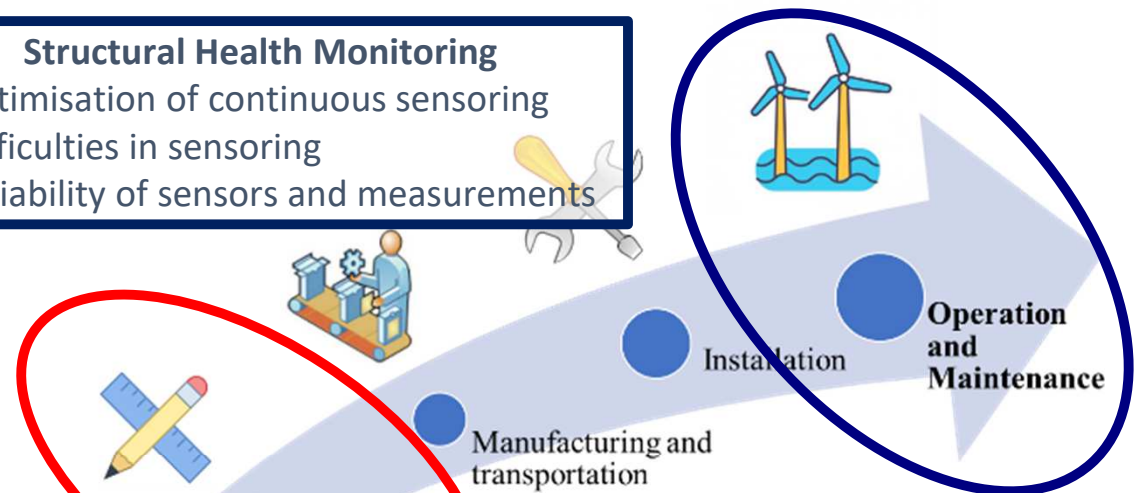
The Use Cases in Expert-IA

Metal stamping



The OFFSHORE Use Cases

- Structural Health Monitoring**
- Optimisation of continuous sensing
 - Difficulties in sensing
 - Reliability of sensors and measurements

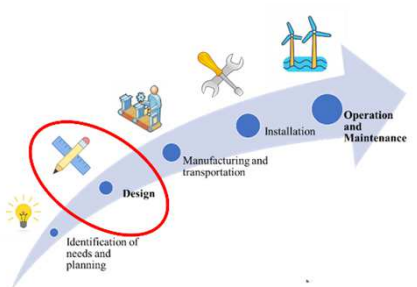


- Design phase**
- Analysis of several design options
 - Analysis under a predefined number of DLCs
 - Amount of simulations

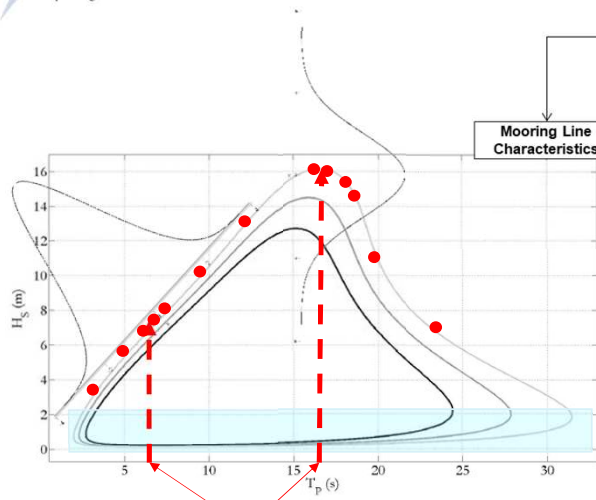
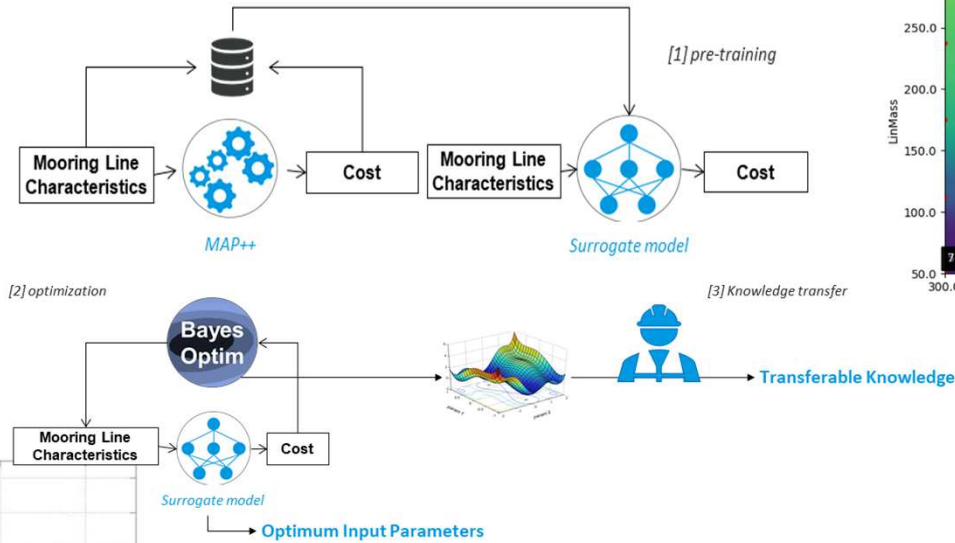


The main results (I)

2022-2023

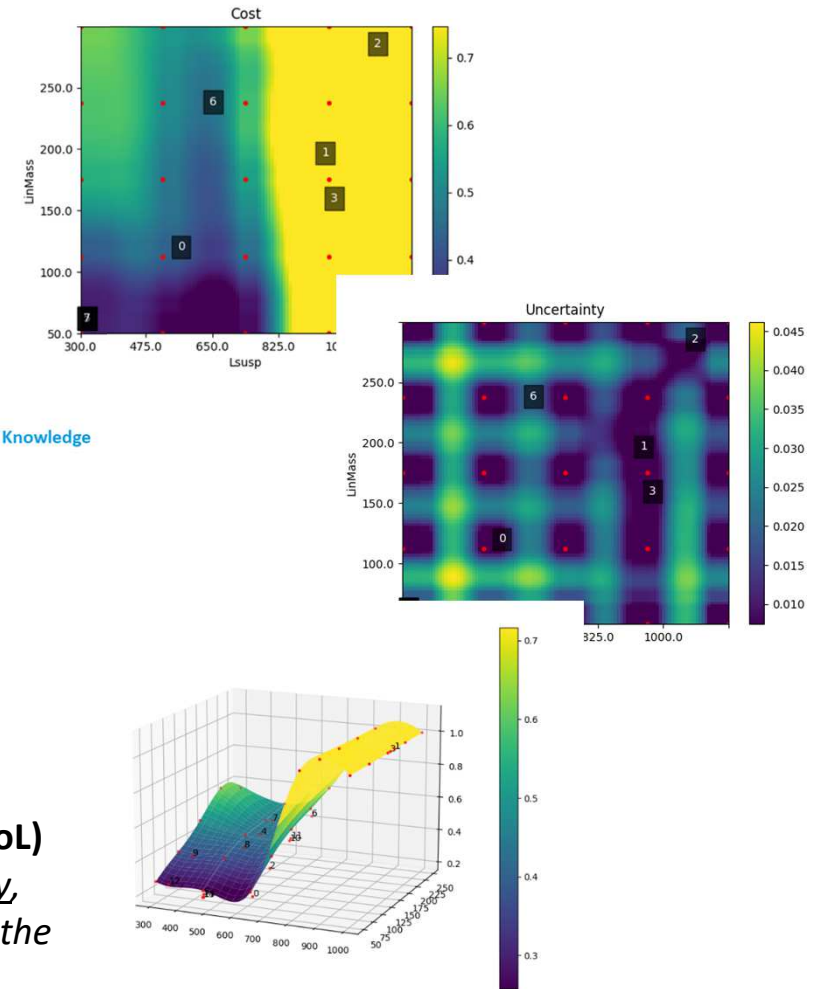


Validation & Implementation



- Cost functions based on structural cost
- Hard constraints for unfeasible designs
- Soft constraints treated as penalisation

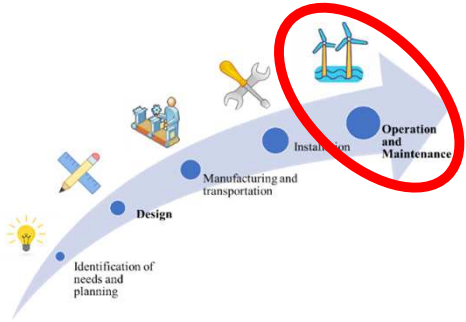
Human-in-the-(optimization)-loop (HIToL)
*Trade-off between cost and uncertainty,
 between exploitation and exploration of the
 model*



**Expert Domain Knowledge transformed
 into probabilistic distribution for
 reduction of DLCs**

The main results (II)

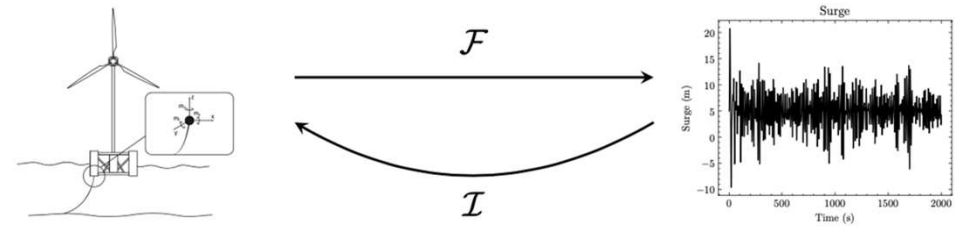
2022-2023



Degradation in mooring systems

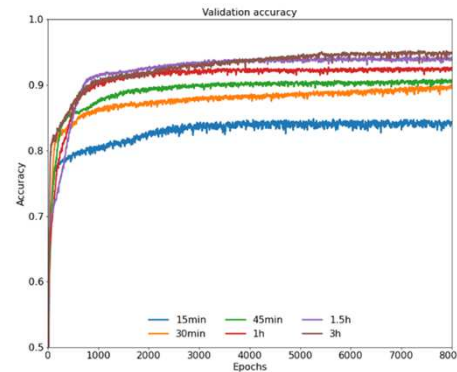
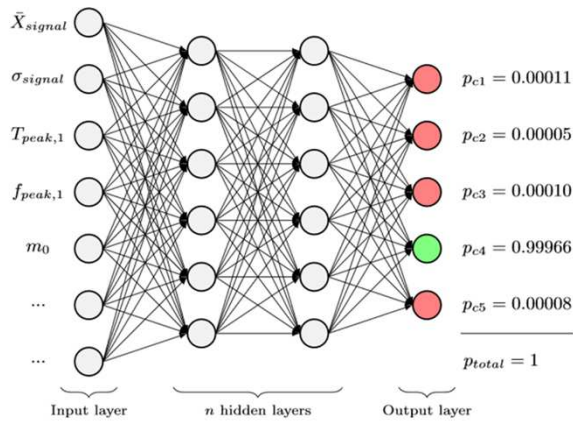


Can we solve an inverse problem, from statistical descriptors of the response?

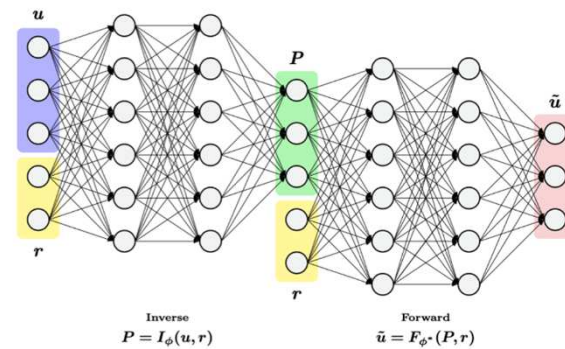


Different Architectures

MLPs - 1 DOF



Autoencoders - 6DOFs



Very mild	7257	128	0	0	0
Mild	511	2409	127	0	0
Interm.	1	287	1644	44	0
Severe	0	1	221	1254	24
Very severe	0	0	0	182	1242
	Very mild	Mild	Interm.	Severe	Very severe

The knowledge transfer

The role of the Advisory Committee

A.D. MMXXI

Advantages to take part to the **Advisory Committee** in an ELKARTEK project

- **Easy access to consortia** for the development of tasks in fundamental research
- Alignment of **RVCTI research with the needs of the industry**, merging domain knowledge with the deployment of highly innovative solutions
- Provide **data for the application** to real case studies
- **Knowledge transfer for the comercial development of the research**, counting on technology partners

Advisory Comitee in EXPERTIA (offshore wind)

Nautilus 
Floating Solutions

IDOM

 SENER


CoreMarine



The knowledge transfer Participation to TRANSFIERE

2023

The lessons learnt in ExpertIA were presented by



in the session

“Technology transfer in Euskadi to push towards a new sustainable and digital model”



From an ELKARTEK project to a HAZITEK proposal

2023

HAZITEK2023
INTEGR-IA

13 partners, 7 research centres
belonging to RVCTI

7.9 M€ budget

Digital twin architecture for acquisition and management of big data

Quick connector for offshore wind

Tool for electrical asset management at farm level

Advances Monitoring Systems

Coatings for boatlanding to reduce maintenance during useful life

High performance station-keeping systems and monitoring systems

Sensing of T_p for SHM

Bearings and hydraulic actuators sensorised for control of offshore wind turbines

Research on the structural integrity of offshore wind structures using AI based models



Structural integrity in floating offshore wind turbines

(NAUTILUS, NAVACEL, COREMARINE, ERREKA, DITREL, PINE, ALERION)

Degradation models for floating offshore wind

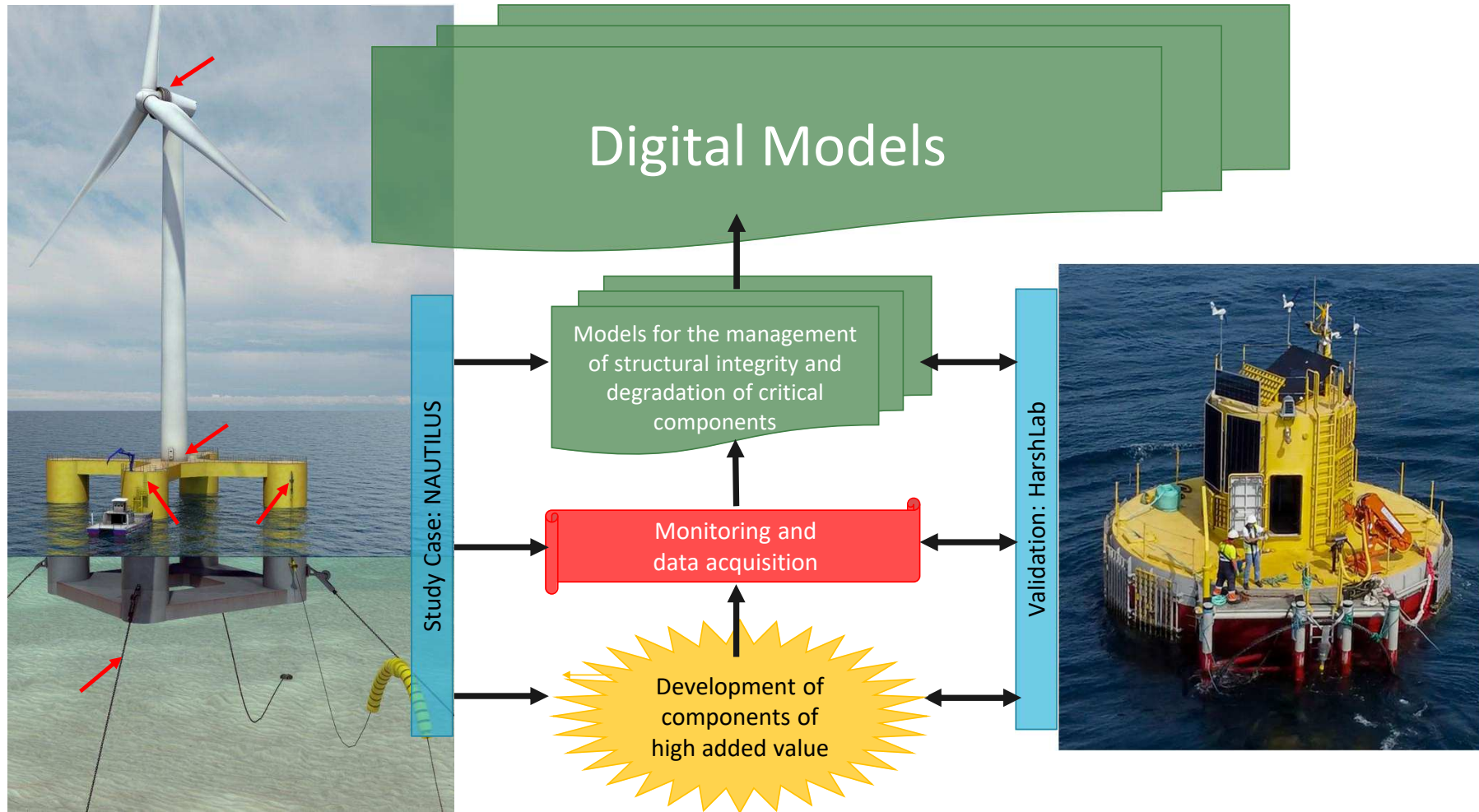
(LAULAGUN, ALERION, HINE, INNOMAT, KERACOAT, ERREKA, NAUTILUS, GLUAL)

Monitoring, data acquisition and AI for floating offshore wind – Integral digital twin

(IBERMATICA + Rest of the consortium)

Expected Outcome of Integr-IA

2025



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Tips for a successful knowledge transfer

The case of **Expert-IA // Integr-IA** showed that

- A ***staged development approach*** (based on measuring progress on a ***TRL scale***) can ensure a successful evolution ***from research to industrialisation*** of innovations.
- **ELKARTEKs** can represent a useful funding framework for ***fundamental research*** oriented towards the ***needs of the sector, strategic for the industrial supply chain in Euskadi***
- Establishing a ***continuous dialogue with the Advisory Committee*** throughout the project is a good practice to keep the project aligned with industrial needs
- The **HAZITEK** program allows to ***transfer*** the main achievements, techniques and methodologies from the RVTCl centres that developed them to the industrial sector.

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