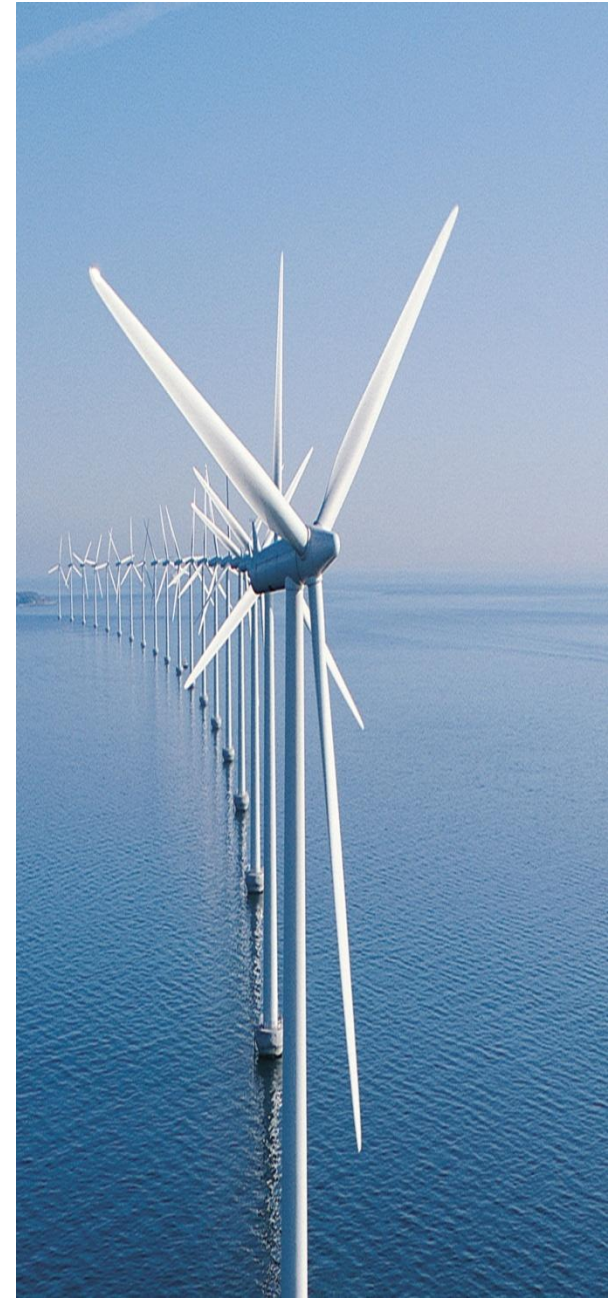


# Using semantics to facilitate data integration of offshore wind farms

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# Outline

- ❑ Introduction
- ❑ Motivation
- ❑ Data integration challenges & solution
- ❑ The semantic model
- ❑ Use of the model
- ❑ Conclusions

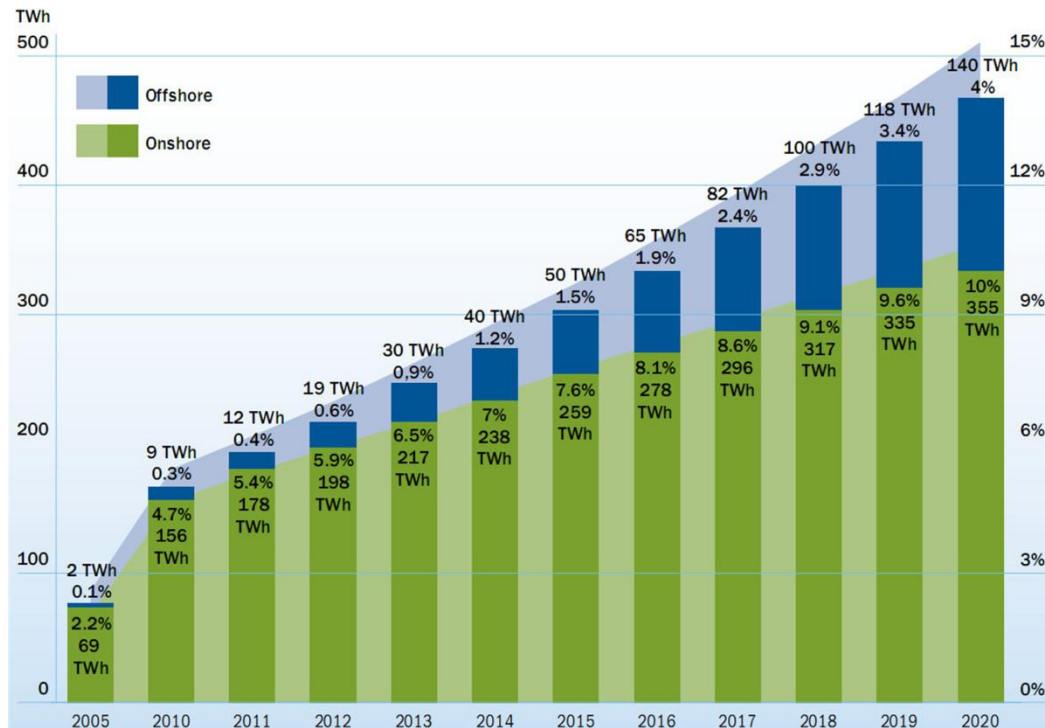
# Introduction

The rising of sea levels, acidifying of oceans and melting of ice caps are happening quicker, EU and other industrialized regions must reduce domestic greenhouse gas emissions by 80-95% until 2050:

→ banning carbon emissions from new power plants installed after 2015

→ expecting 34% renewable electricity in 2020 and 100% by 2050.

Wind energy alone could provide **50%** of Europe's electricity by then.



## Motivation

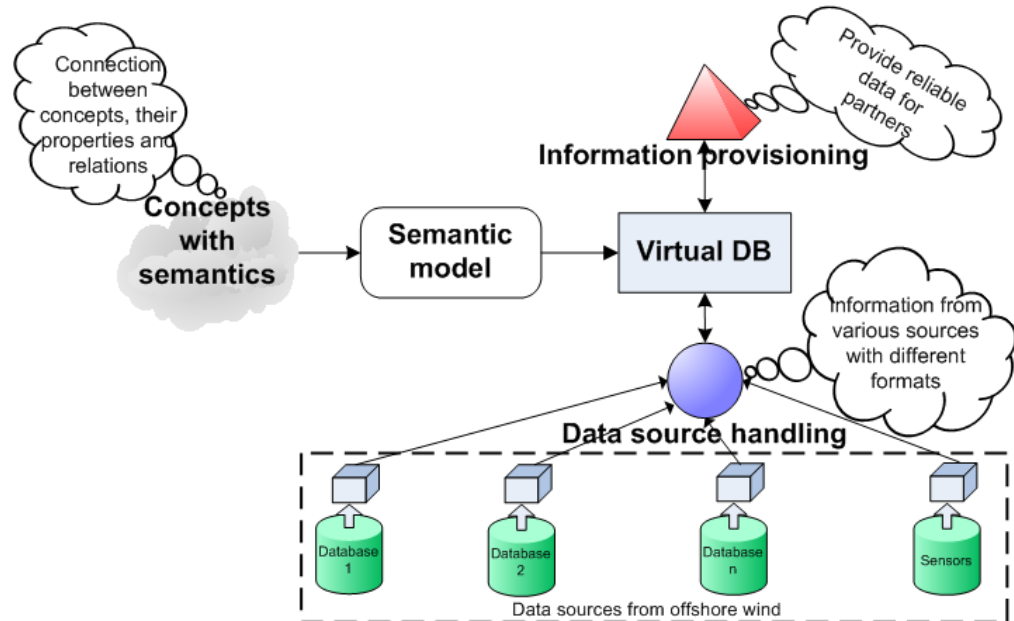
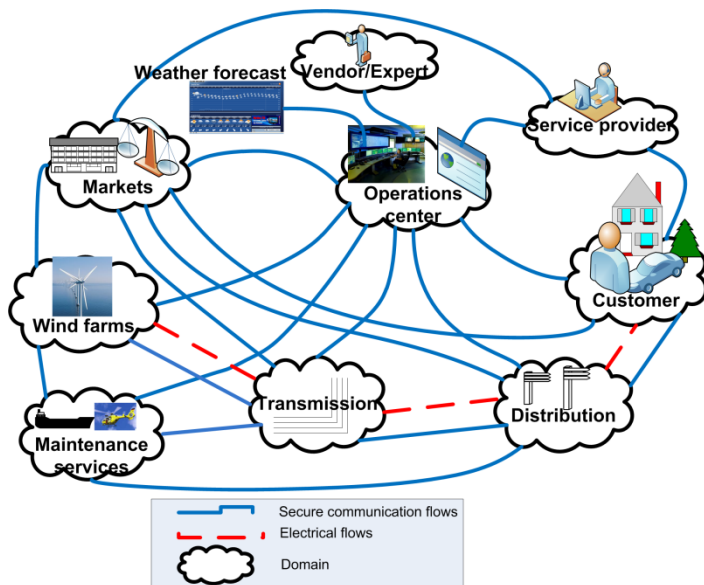
To reduce the operation and maintenance expenses of offshore wind farms, accessibility of information and interoperability are significant:

- Design of new components can get benefits from available data of used components;
- better decisions can be made based on available data;
- failures can be detected at an early stage;
- damages can be reduced and repairs can be better planned.

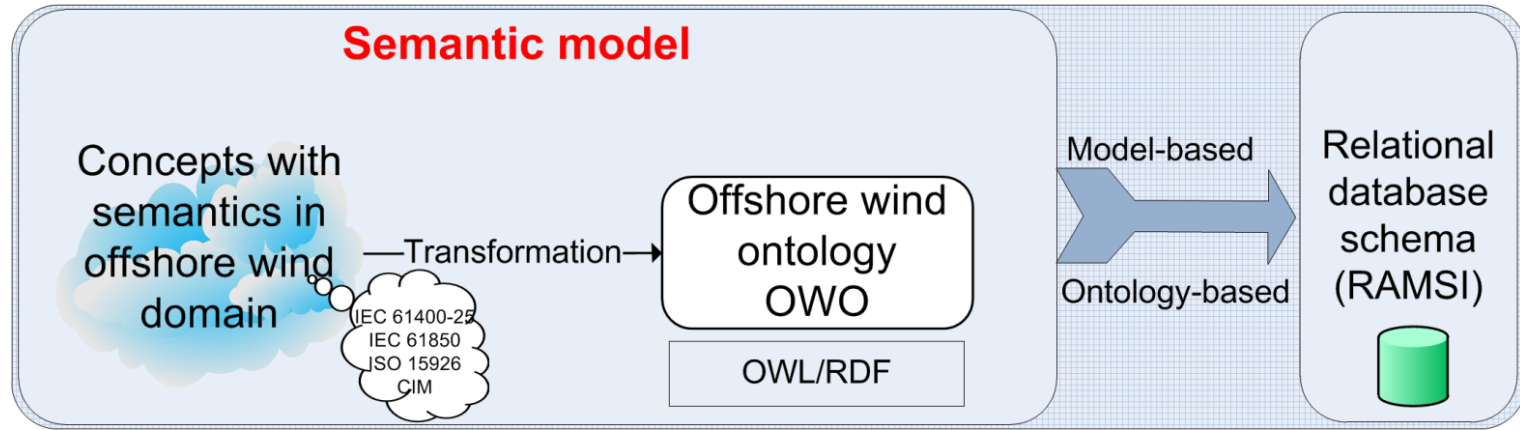
In order to do so, it is necessary to understand the semantics of wind farm data. The idea of creating an Offshore Wind Ontology (OWO) for data integration is thus important.

# Data integration challenges & solution

1. Multiple applications having incompatible interfaces and data formats and not being able to communicate with each other.
2. Many actors are reluctant to share data about their equipments, or to let third parties collect such data.
3. Agreement on data exchange and data format to exchange only happens at the end of the development when the partners encounter integration problems.



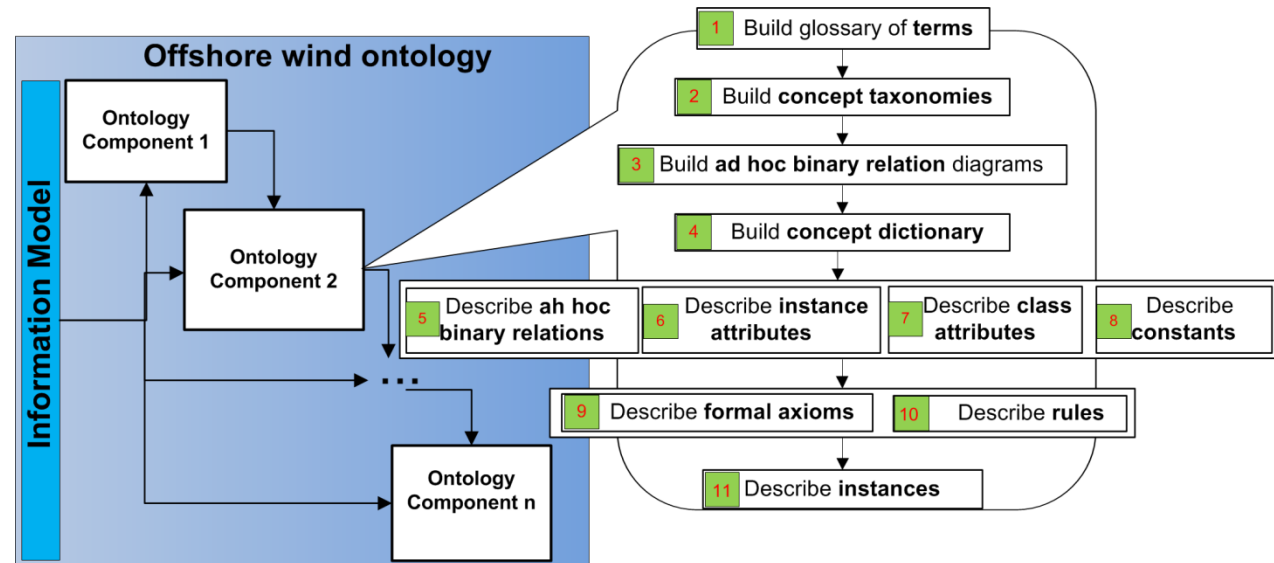
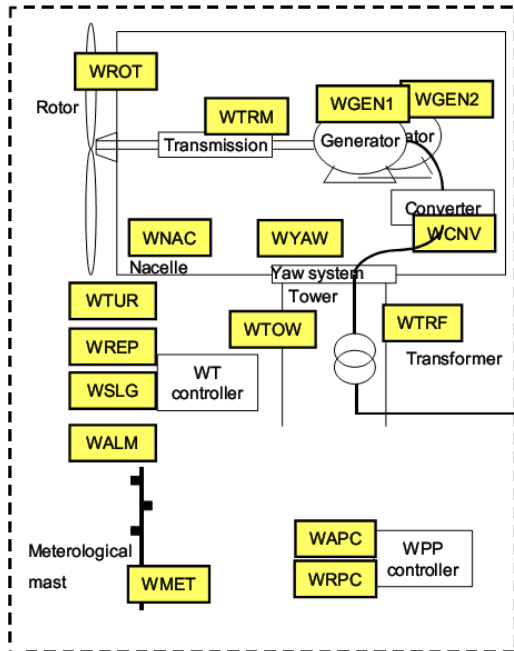
# The semantic model



## Approach:

- Building an information model based on the IEC 61400-25, IEC 61850-7, IEC 61400-3, and taking the oil and gas ontology, provided by the ISO 15926, into consideration.
- Transform the information model to offshore wind ontology (OWO).
- Ontology?

# The semantic model: Ontology development



The OWO is built by defining an ontology for each wind turbine component (WPP generator, WPP rotor, WPP tower, etc.)

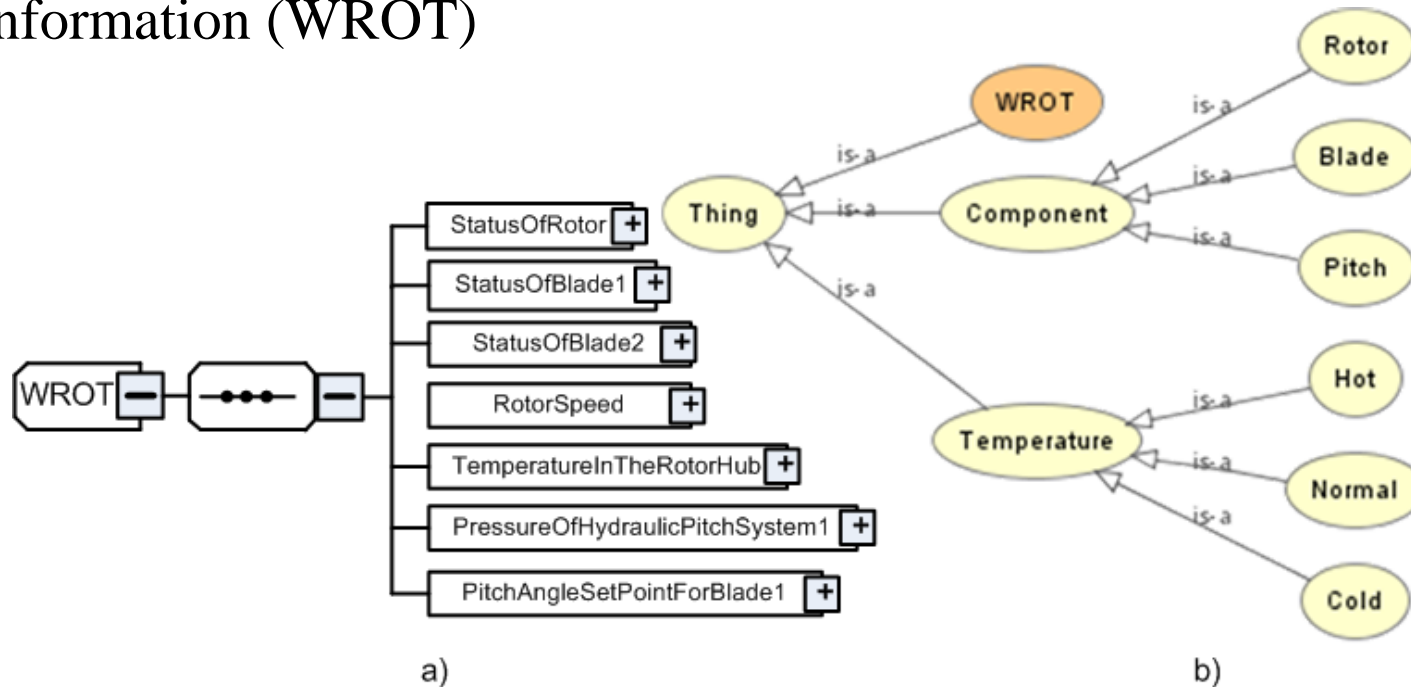
The ontology developing starts with the core of basic terms, and then specifying and generalizing them as required.

Methodology: METHODOLOGY; Tool: Protégé 4.1<sup>1</sup>

<sup>1</sup><http://protege.stanford.edu/>

# The semantic model: An ontology component

A data structure and an ontology of Wind turbine ROTor information (WROT)

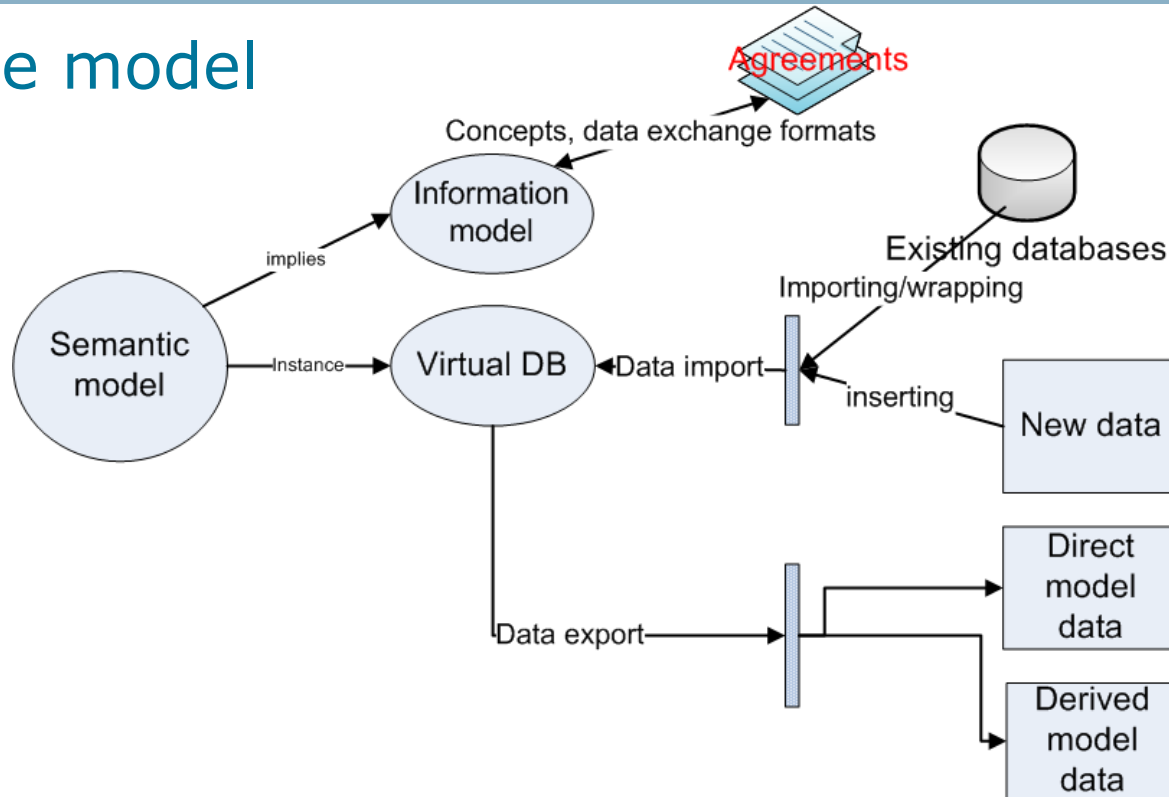


a) An information structure of WROT based on the IEC 61400-25 standard

b) A graph visualization of the WROT using Protégé 4.1



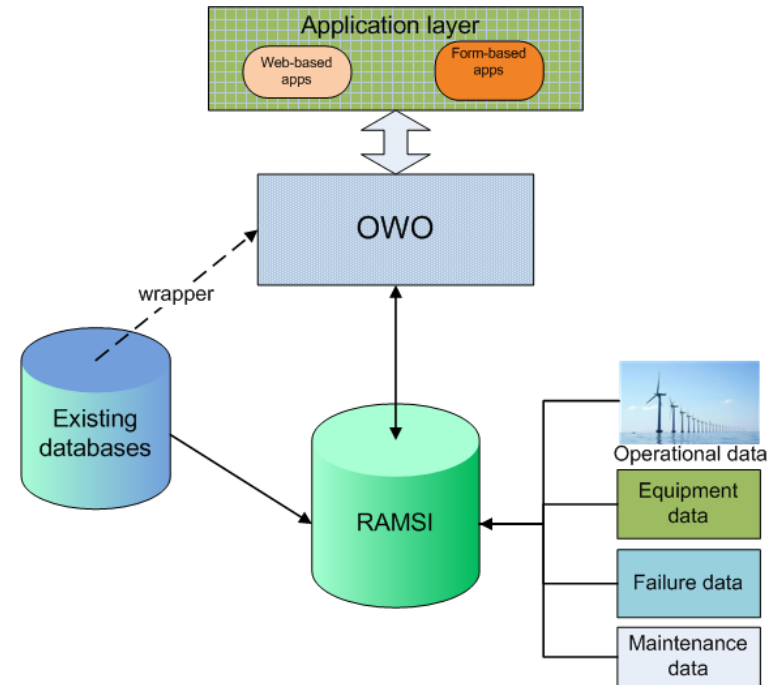
# Use of the model



1. Deriving information model from the semantic model for agreeing on data exchange formats, and sharing concepts.
2. An instance of the semantic model (e.g., a virtual DB) could be acting as an “umbrella” over which existing databases or new database with a schema matching the model will go through.
3. Direct data and derived data can be exported from the model’s instance.

## Use of the model: Examples

We introduce a RAMSI (reliability, availability, maintainability, safety, and inspect ability) database based on the semantic model in order to break the semantic gap between ontology and relational database, and preserve the goodness of both semantic technology and RAMSI database.



Another use is code generating for Web services development. For example, using JAXB (Java XML binding) tools such as JAXB-XJC to generate Java classes, which are considered as Data Transfer Object (DTO), in order to express which information has to be secured.

## Future work

- - Get the OWO complete following the IEC 61400-25
- - Design set of SWRL
- - Map the OWO with real data
- - Using OWL API & Pellet to reason over the wind farms' knowledge

# Conclusions

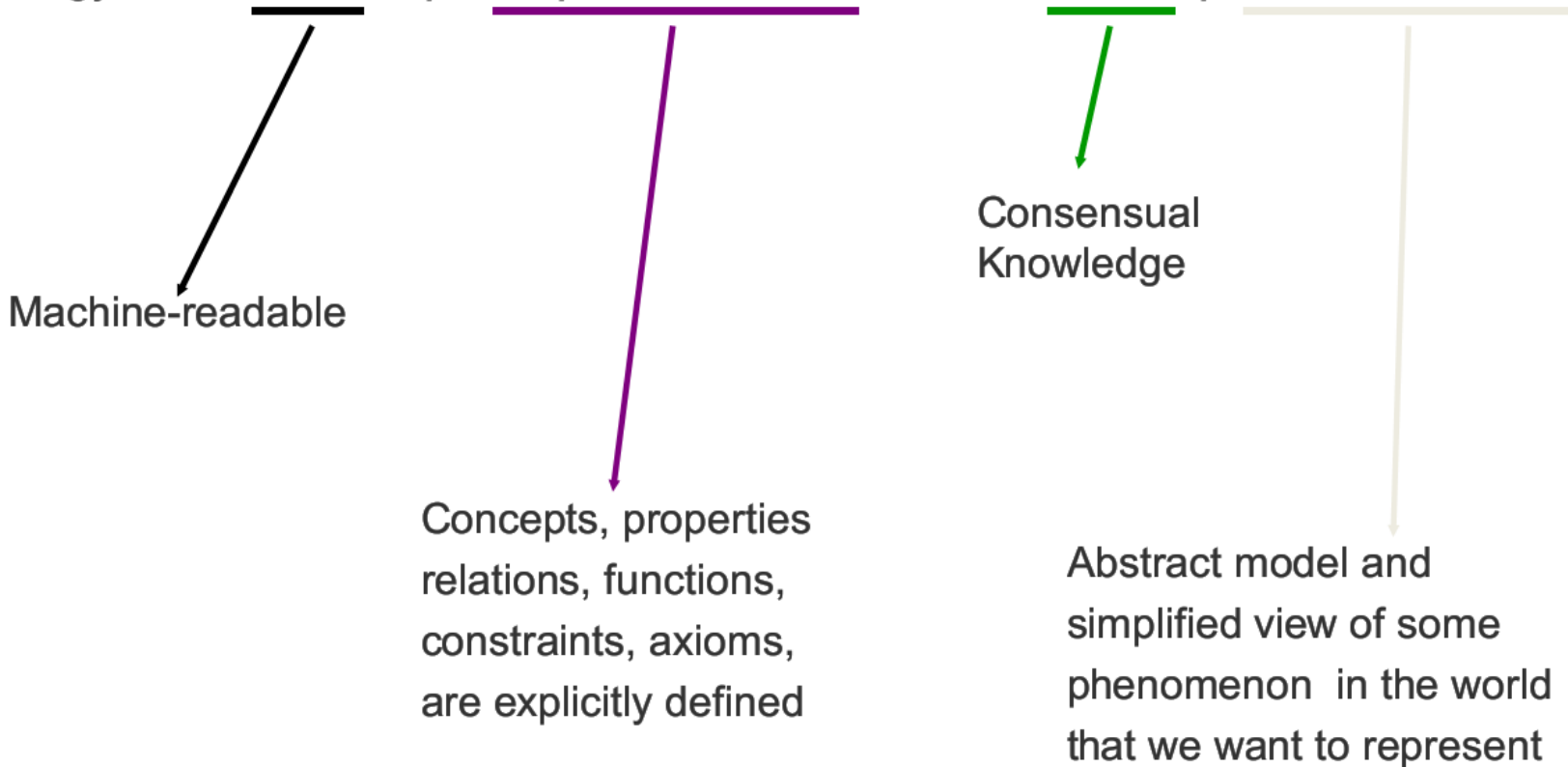
- A semantic model with high potential of practical value in the offshore wind domain was proposed.
- The offshore wind ontology plays a key role in the proposed model and it can be developed based on approved standards and existing semantic technologies.
- Early trying of using semantic technologies to facilitate data integration in the offshore wind industry.



**Thank you for your attention!**

# Ontology?

*“An ontology is a formal, explicit specification of a shared conceptualization”*



Studer, Benjamins, Fensel. Knowledge Engineering: Principles and Methods. *Data and Knowledge Engineering*. 25 (1998) 161-197