IEC Standards: Toward Digital Standards with JSON Schema

An introduction to the schema for the upcoming IEC 61400-16 “Standard file format for sharing power curve information” and our experiences developing it.

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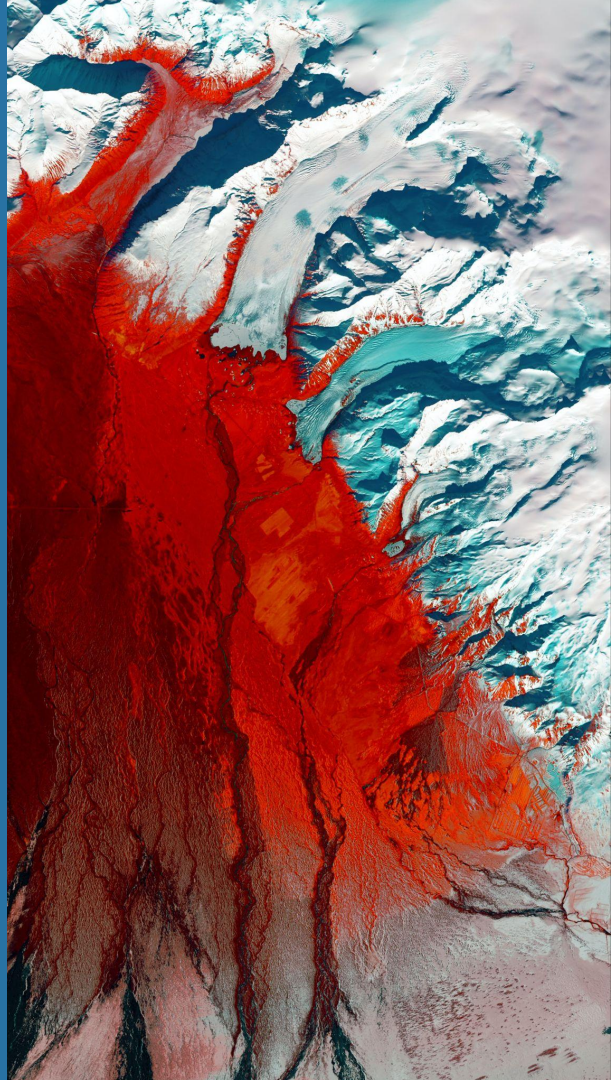
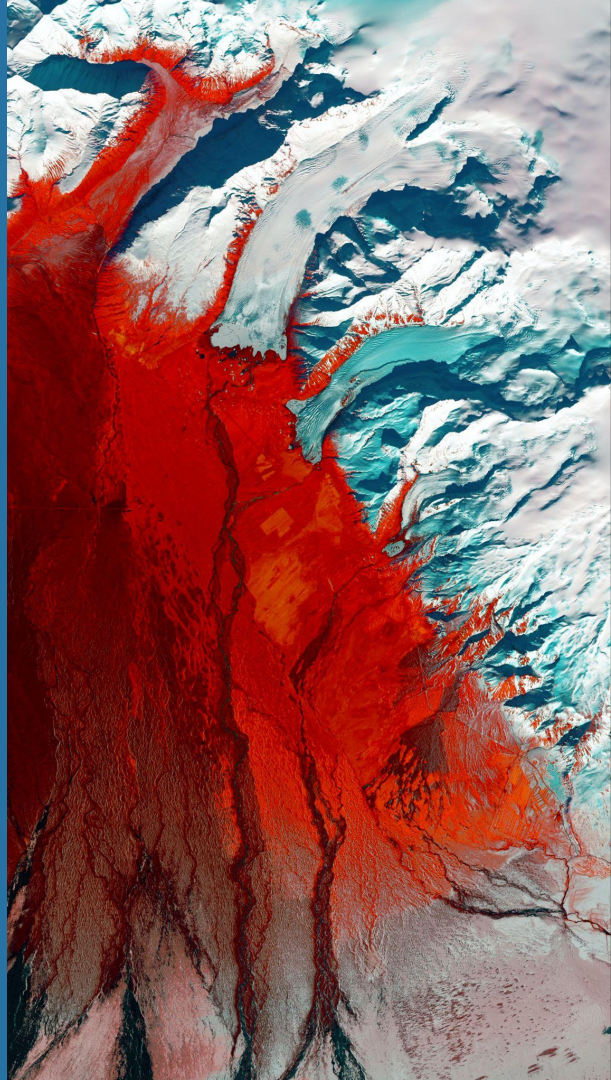
5th of December 2024



Octue

Our mission: Help scientists and engineers work more effectively with data

- we develop open-source tools for scientists and engineers
- we provide consultancy on data engineering and application development
- we specialise in renewables and climate, with most of our work in wind.



FOREWORD

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Kill me now...

TERM ENTRY 3.1.14.3 You can not edit this document

TERM

JSON key

PREFERRED - FULL FORM

DEFINITION

string enclosed in quotation marks which is the name of the variable to which a value will then be assigned within the JSON data-interchange format

SOURCE

ISO/IEC 21778:2017

A strategy to save the world

- To meet the **1.5C target by 2030**, Wind Turbine installation **rate** needs to grow by **5x** very quickly (GWEC 2023).
- People in data-heavy roles **lose 45% of their time** in low-value data management tasks (Anaconda Foundation 2022).
- Only 20% of technological/R&D effort has significant organisational outcomes (Gartner 2019) — the so-called **“technology chasm”**.
- It takes **10+ years** to train specialist technical staff.
- Installation rate is constrained by (among other things) **staff capacity.**

A strategy to save the world

Your staff are wildly talented, but are only **55% x 20% = 11% efficient in their core role**, because of reasons that could be solved* with effective digitalisation.

Not to mention that all those wasted staff wages will cost **£3.9b/year by 2025** (based on 132,000 professionals, a 55% efficiency, and a £44k wage +50% overhead). But that kind of seems insignificant.

It takes ~10 years to train more. You need 5x more staff capacity in the next 3 years.

A strategy to save the world

"Make everyone in the Wind industry 10x better and quicker at what they do. FAST."

Today

Introduction to the schema and its status

Why and What. We'll look at motivations, key features and the process of becoming a standard.

Tools and Ecosystem

A look at some of the possibilities

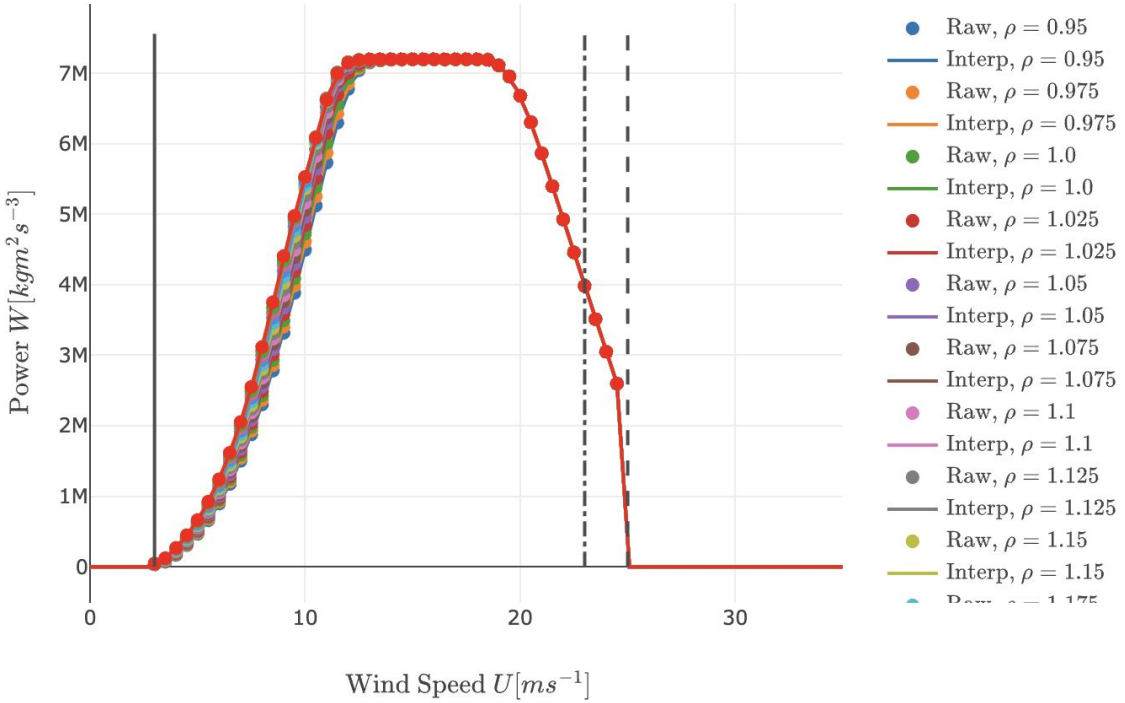
> "Doing wind farm design 10x faster, 10x better"
>
> - CEO of multi-national Wind Energy Consultancy

Scaling difficulties and technical considerations

Let's cover some of the difficulties we had in building the

What is a “Power Curve”?

TLDR: It’s the spec sheet that you get if you want to buy a Wind Turbine.



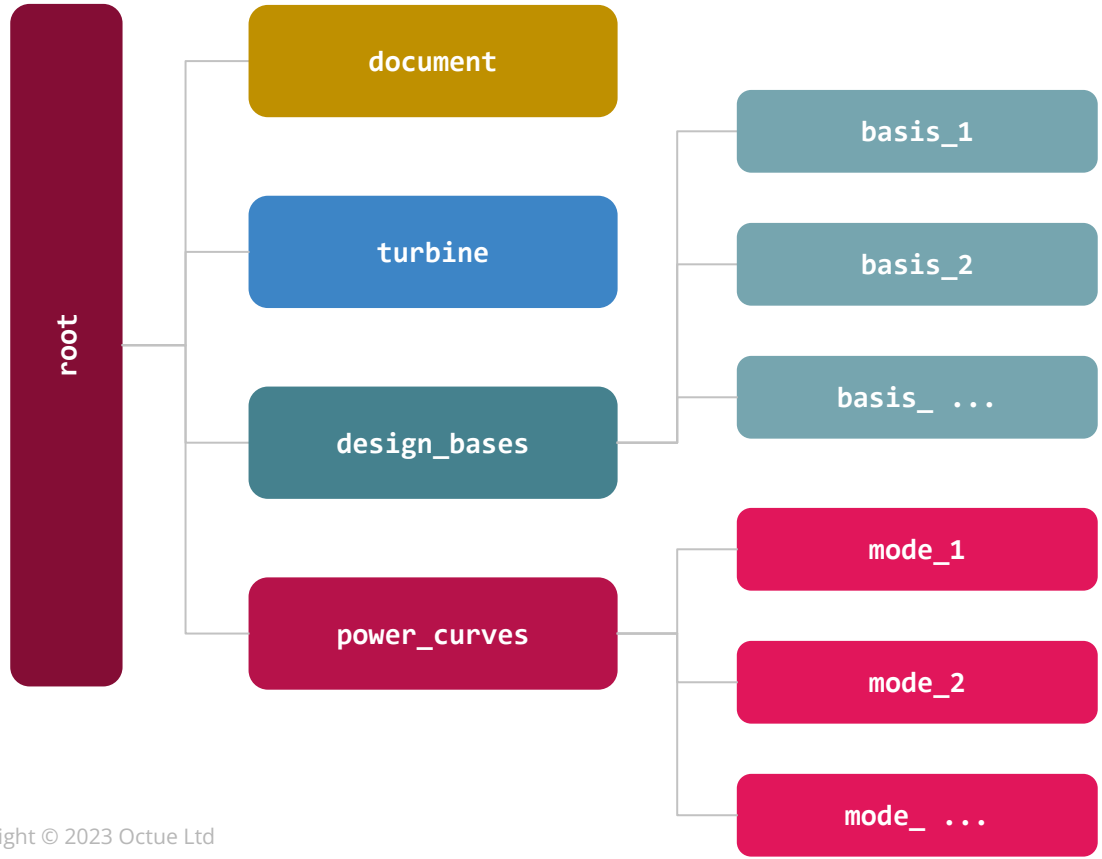
Aims and Motivation

To create a common format to be used by all OEMs for the sharing of power curves and associated key information that serves multiple stakeholders using an agreed machine-readable format and common terminology to minimize errors and to reduce the turnaround time for Energy and Turbine Suitability Analysis.

Digitalization of power curves, especially seamless data exchange, will enable reduction in:

- **time-to-market** for new wind turbine sales (eg by accelerating turnaround for OEMs' local sales teams)
- **time-to-financial-close** for new wind farms
- **workflow friction** between internal and external teams
- **technical, commercial and reputational risk** (eg from human error in EYA and other processes)
- **exposure of sensitive information** beyond the intended audience and duration

Root level structure



Data is split into four key areas

- `document` contains information about the document itself such as author, identifiers, provenance etc.
- `turbine` contains information about the turbine for which the power curve data is produced.
- `design_bases` is a specification of the conditions under which the power curve(s) are valid.
- `power_curves` comprises a list of the different operating modes available, each containing a power curve. Each mode contains informational metadata (eg the name and purpose of the mode) and power/thrust curves.

Killer Features

In no particular order…

- **`DCMI Compatible metadata`**
- **`Fields added to facilitate web app development`**
  - Such as `manufacturer_short_name` vs `manufacturer_name`
- **`Custom or predefined environmental classes`**
  - Allows simple specification eg “IEC Class 2” all the way to full environmental conditions under which a power curve is valid
- **`Power, thrust and acoustic emissions`**
  - Parameterisable by stability, turbulence, shear, veer, wind direction, wind speed, air density
- **`Mode-specific overrides`**
  - To allow for edge cases in certain modes - fewer available hub heights, rated power, etc
- **`Thermal derating`**

Status and Resources

- Underlying schema has now had 3+ years in production, covering (to-date) 112 curves over 15 different manufacturers
- We (WindPioneers and Octue) open-sourced the schema in 2023 as a basis for the IEC 61400-16.
- Panel of experts and occasional input from members in other groups (IEA Wind Task 43, TIMWind)
- Currently in 12-week review period before an 18 month long adoption period.

github.com/octue/power-curve-schema

Tools and ecosystem

A JSONSchema allows quick development of a rich set of tools and integrations around the schema. Here are a few of the tools that have been built on top.

Q. Why is there a Wind Turbine on the JSONSchema Stand?

JSON Schema

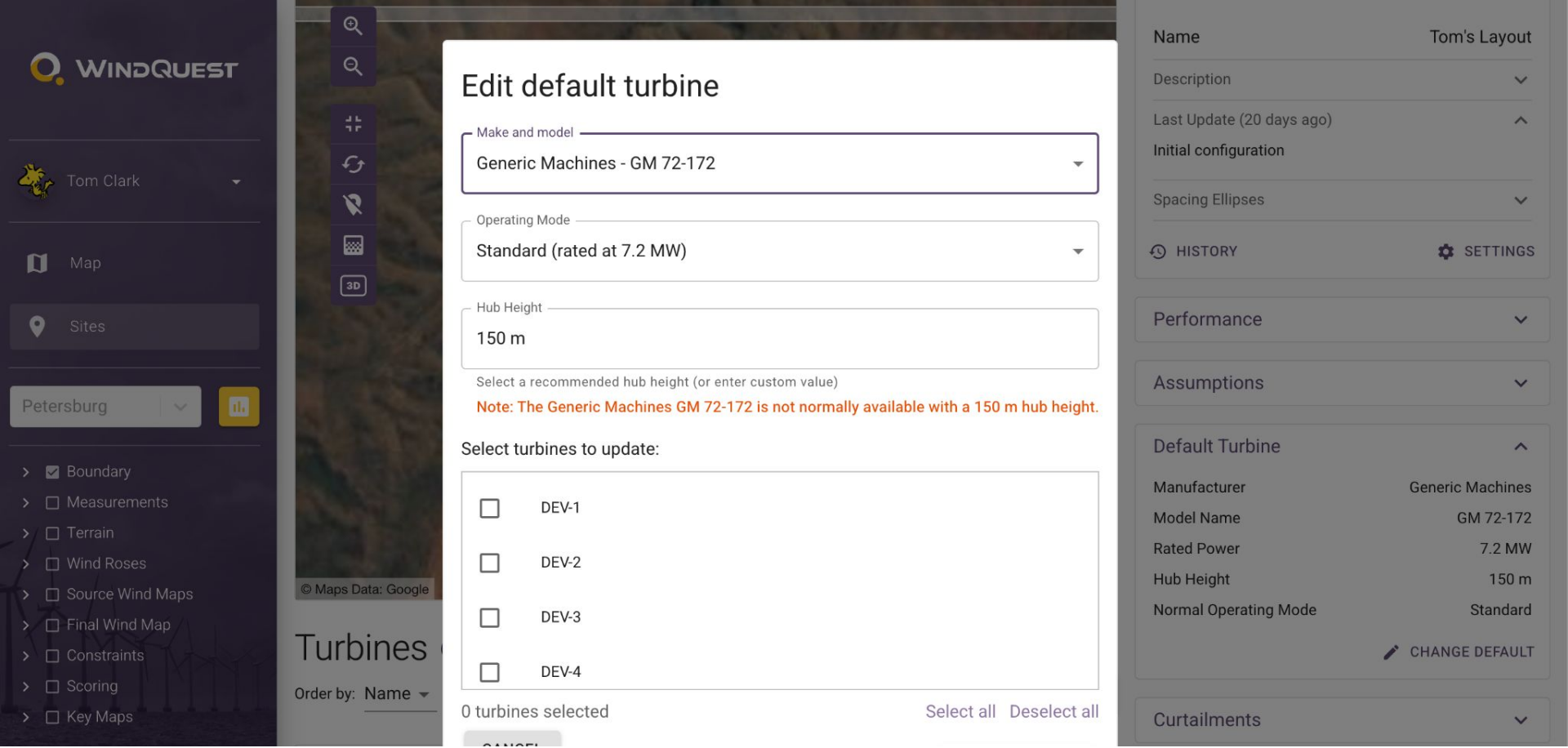
A. Adopting JSONSchema has reduced the lead time (from conception to generating power) of new wind farms by *months*.

Find out more in the JSONSchema track on Thursday morning!

strands

a JSONSchema repository

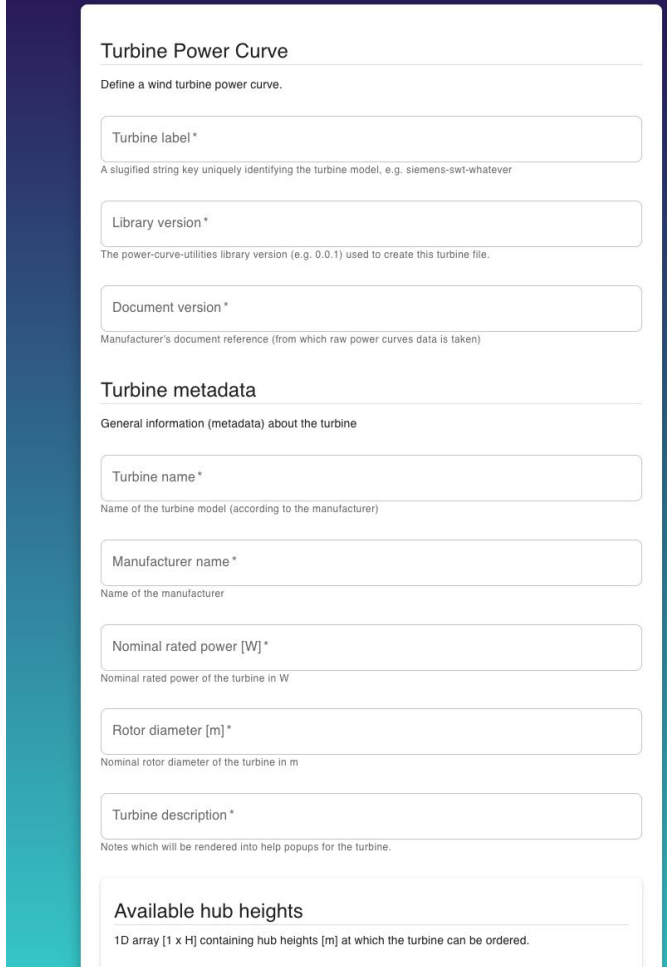
sponsored by Octue



"Orders of magnitude improvement in capability of the team" (quote from WindPioneers' CEO) from rapid iterative design of wind farms. Consistent schema allows to switch and compare turbines in the context of true economic value, as well as raising warnings around performance and configuration.

Input Forms

JSONSchema can be used to quickly generate web forms for data entry. The default table fields are not really suitable for multidimensional data but could be made fit for purpose.



Scaling difficulties and technical problems

Scaling difficulties

Domain specialists: 40

JSONSchema Specialists: 1

It can’t be just me writing data standards for the whole wind industry… can it?

How can we democratise it so Domain Specialists build their own Schema?

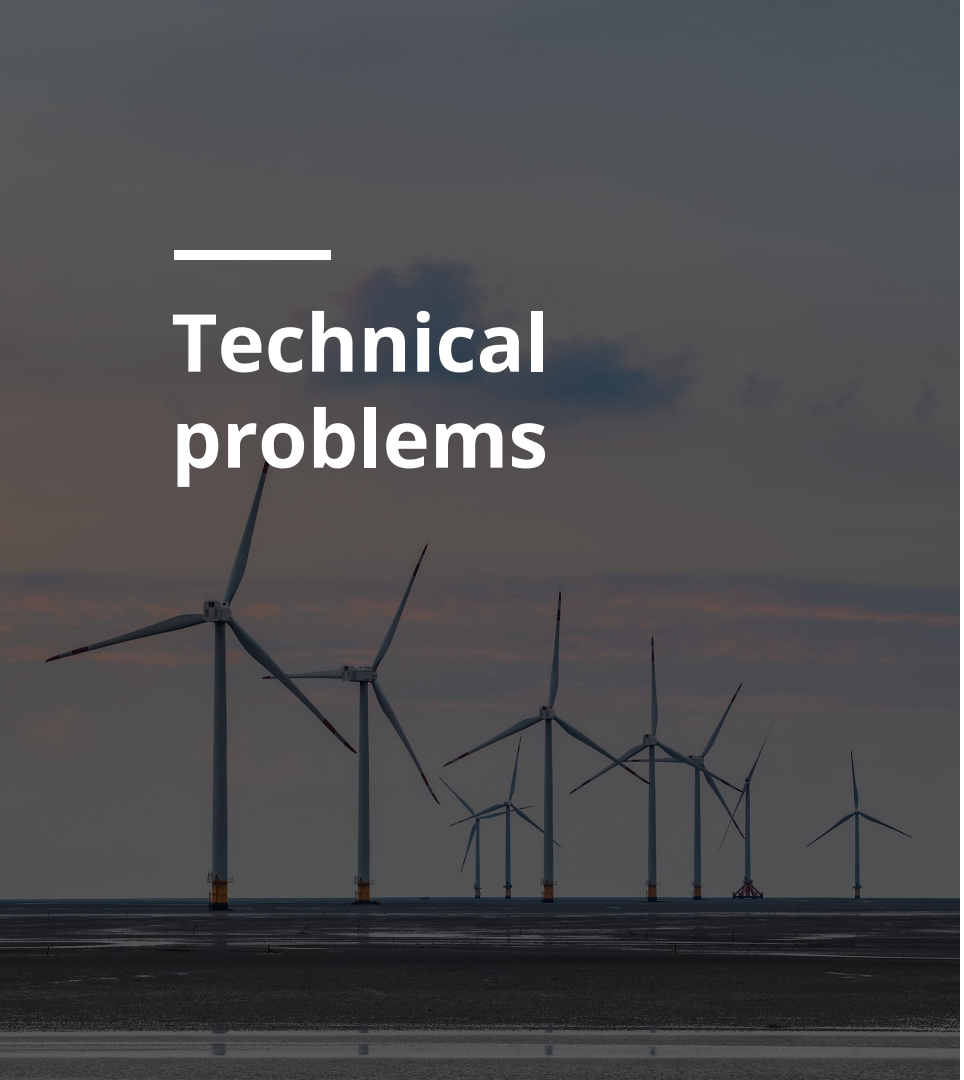
Just quickly: What is a schema?

A schema is a way of describing data and its structure.

It's possible to include conditional logic, cross references, and deeply nested data items... but here's a simple excerpt of schema and matching data.

```
"manufacturer_name": {
    "type": "string",
    "title": "Manufacturer name",
    "description": "Full name of the manufacturer",
    "minLength": 1,
    "examples": [
          "Generic Turbines (US) Inc.",
          “Megacorp GMBH”
    ]
}
```

```
"manufacturer_name": “Tom’s Turbines Ltd”
```



Technical problems

Version control

Standards are SLOW moving. Data is FAST moving. How can we evolve whilst in-between Editions

Is Semantic Versioning the answer?

What about `additional_properties`*?*

Array dimensionality, units and notation

Are vocabularies and custom extensions or drafts the answer? Or do we accept limitations and make a few sensible extra validations before hitting business logic?

Octue

Thank you to WindPioneers for willingly open-sourcing the schema in the first place!

Please follow Octue on LinkedIn!

There will be many more resources coming in the following months...