

# Risk-based Design of an Offshore Wind Turbine Support Structure using Vol



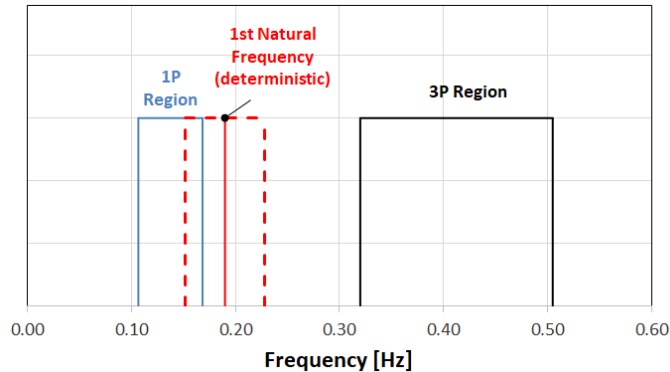
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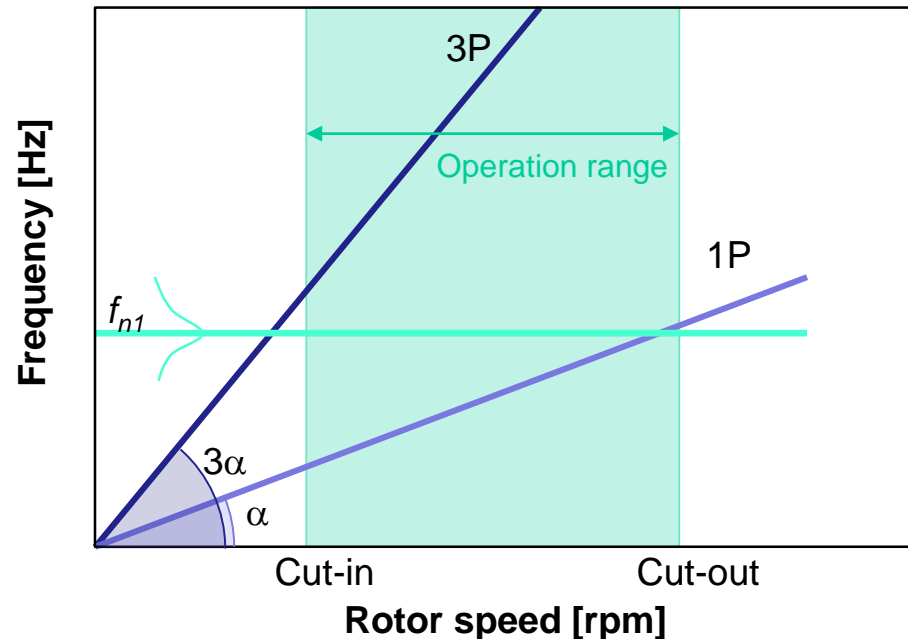


**Figure 2A.** Example of monopile as a solution in an OWF.

- The **monopile** to support an OWT is **to be designed**.
- A modal analysis is performed to assess the **resonance hazard** with the **1P** and **3P** regions.
- Large uncertainty in the soil-structure interaction exists.

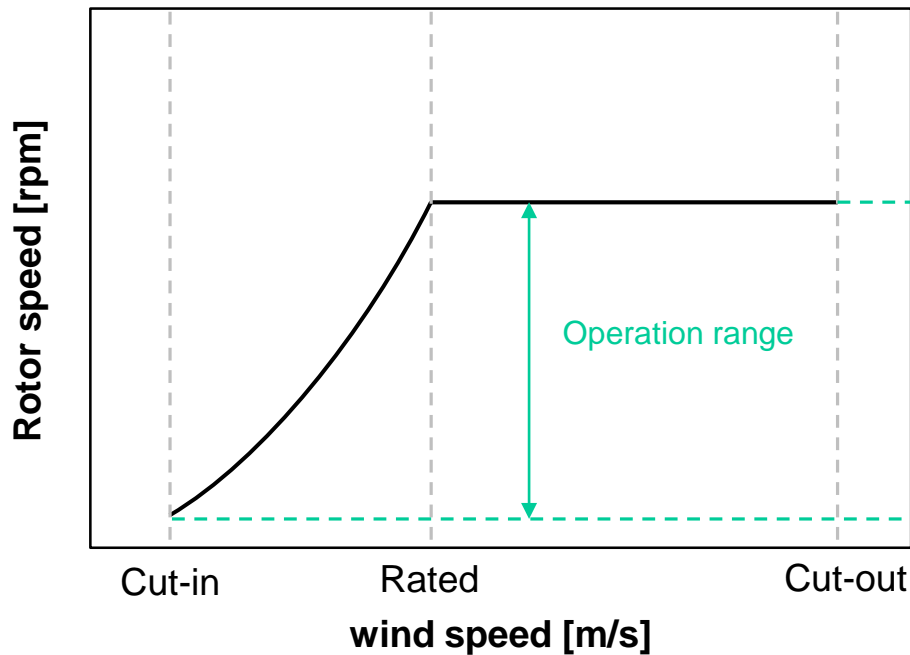


**Figure 2B.** Frequency content.

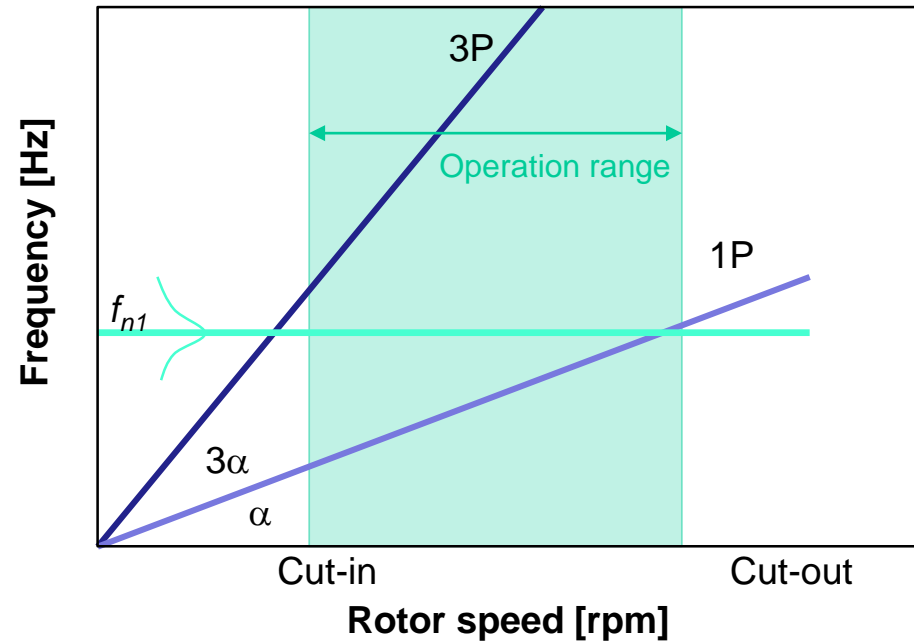


**Figure 2C.** Campbell diagram.

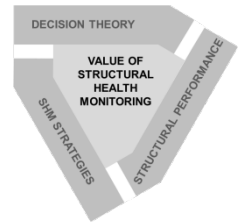
# Resonance hazard



**Figure 3A.** Typical relation between rotor speed and wind speed for a pitch-controlled wind turbine



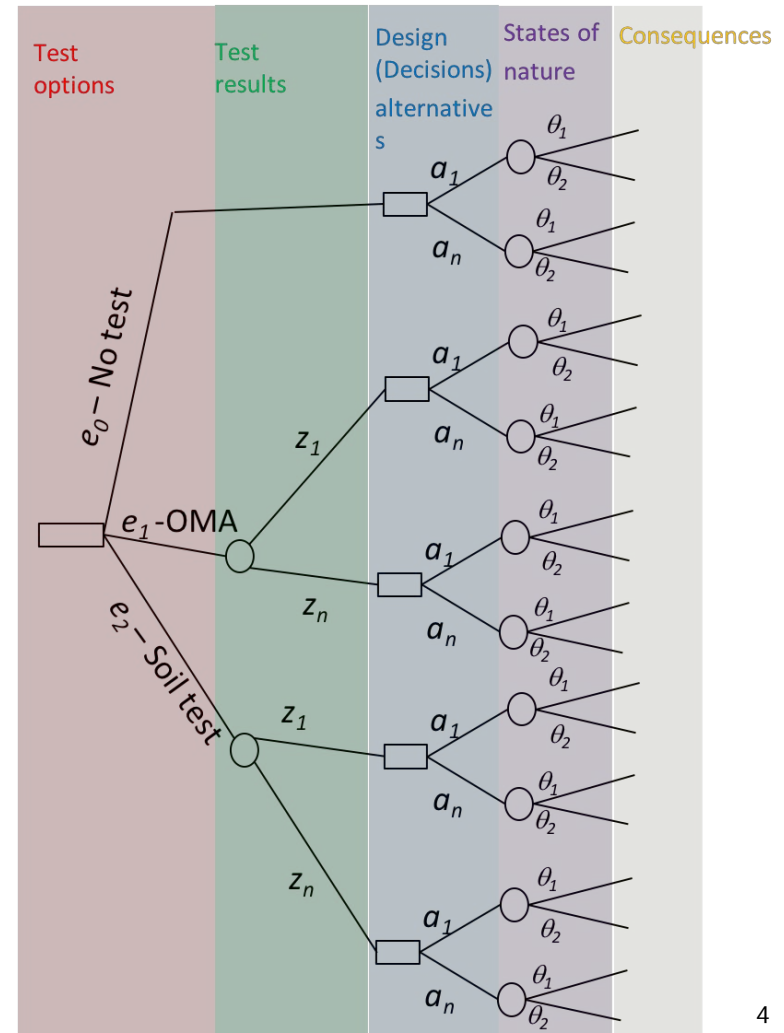
**Figure 3B.** Campbell diagram.

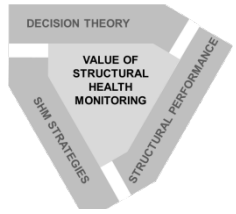


# Reducing epistemic uncertainty

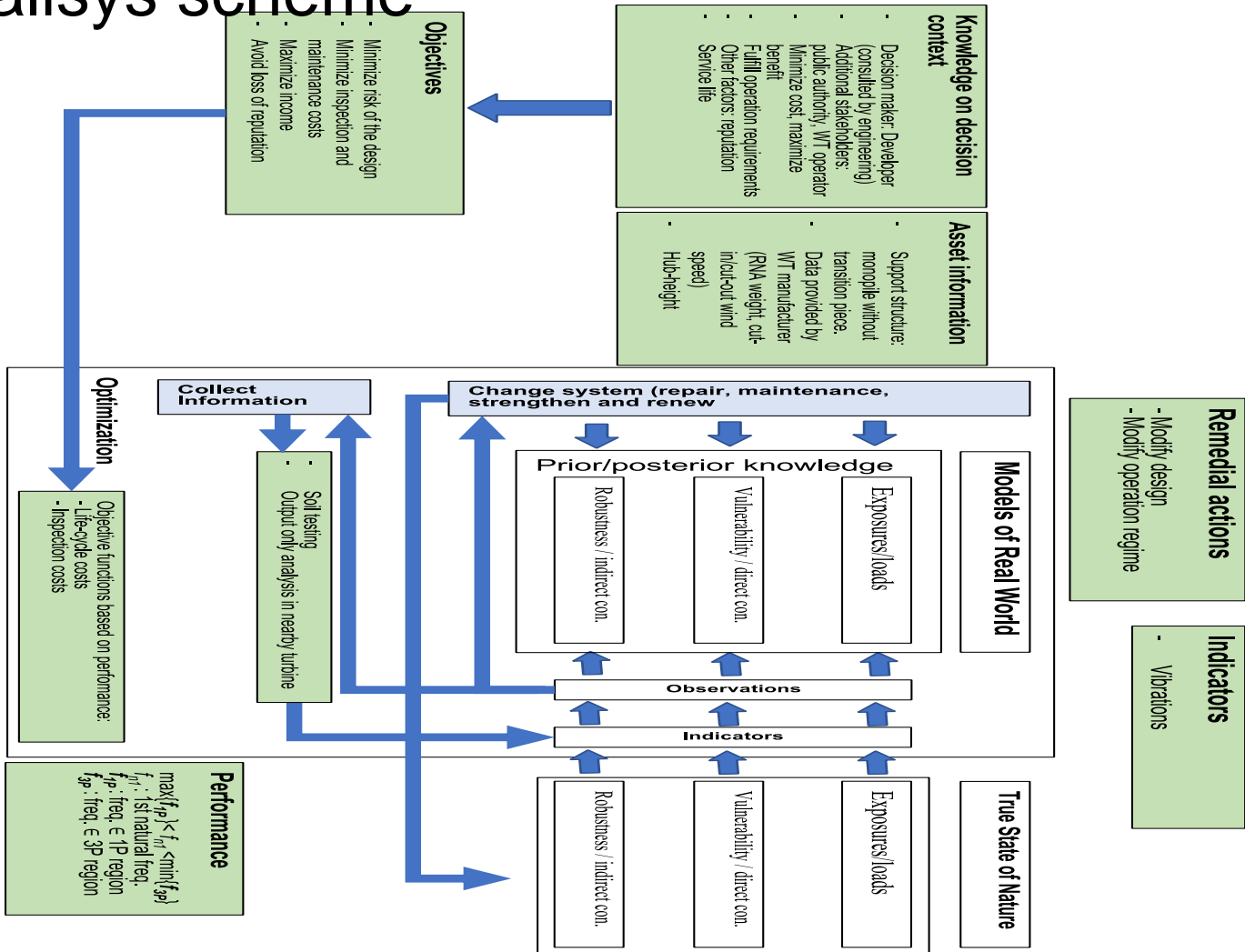
Two test options are considered:

- Further testing the soil
- Output-only analysis (OMA) in a nearby already installed monopile

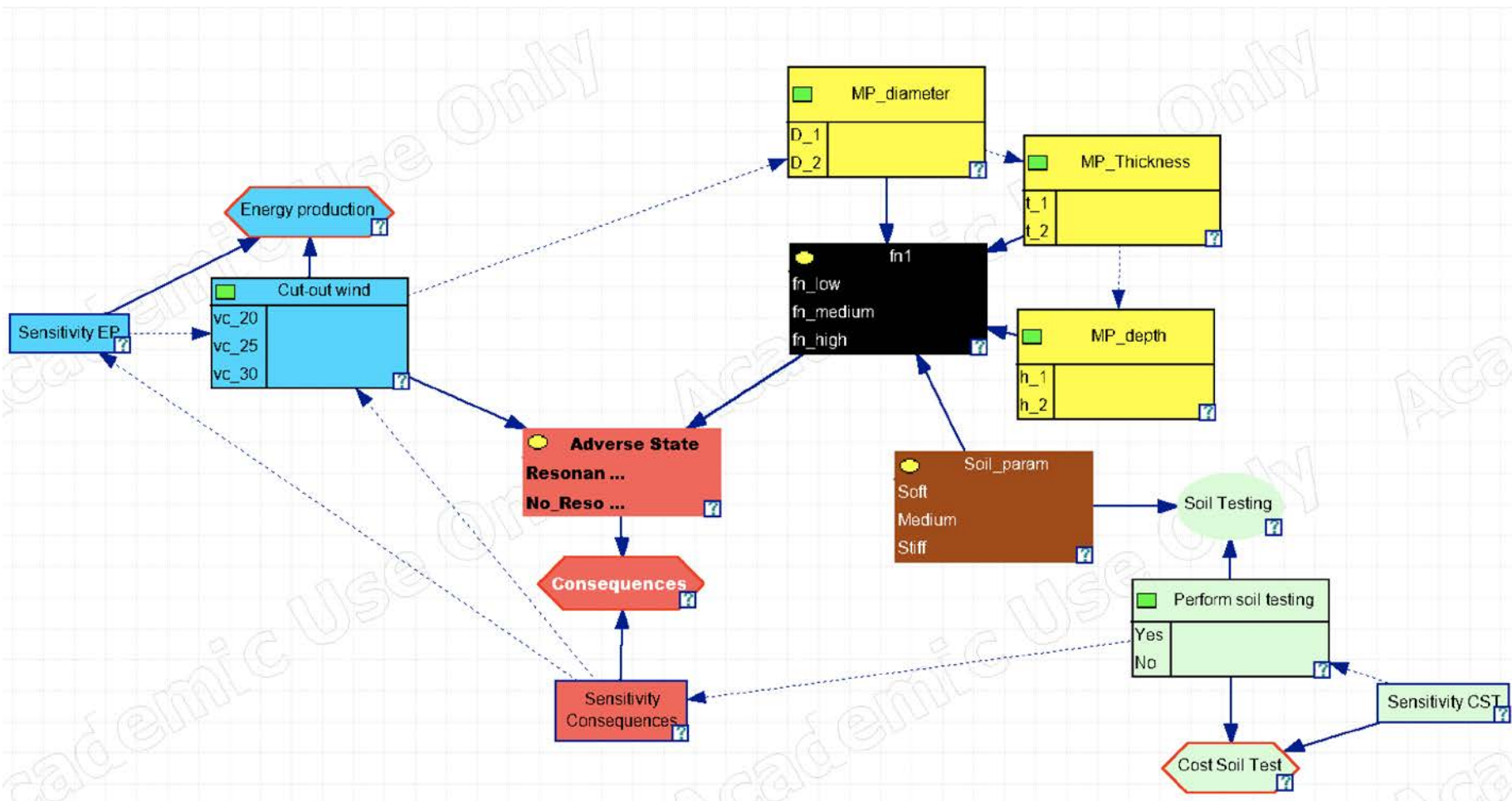


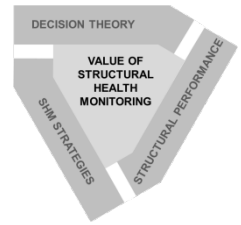


## Vol Analysis scheme



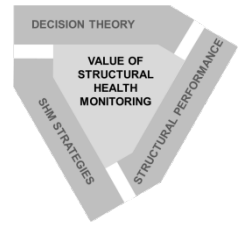
# Bayesian Network in GeNIe





## Obstacles and further development

- Continuous tests outcomes and link with variables of interest.
  - Likelihood of test outcome conditional on the variable of interest.
- Limitations in the amount of possible considered designs.
- Assessing the consequences of the adverse state
  - Resonance is not associated to imminent catastrophic consequences
  - Resonance is related to a higher fatigue damage (lower fatigue life)
  - The structure will be subject to amplified dynamic vibrations for wind speeds above rated



## Assumptions and standardisation

- Soil testing; if possible similar to existing standards for the test procedure itself. Additional standards for sampling and data analysis (for determining the likelihood).
- Choice of simplified system representation should be standardized.
  - Several ways of representing the system should/can be standardized.
  - Simplified system representation must include all decision variables.