TWIND Summer School 2021

Development of a Underwater Gravity Energy Storage (UGES) concept for offshore applications.

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CITG-HE-Offshore Engineering

07/07/2021

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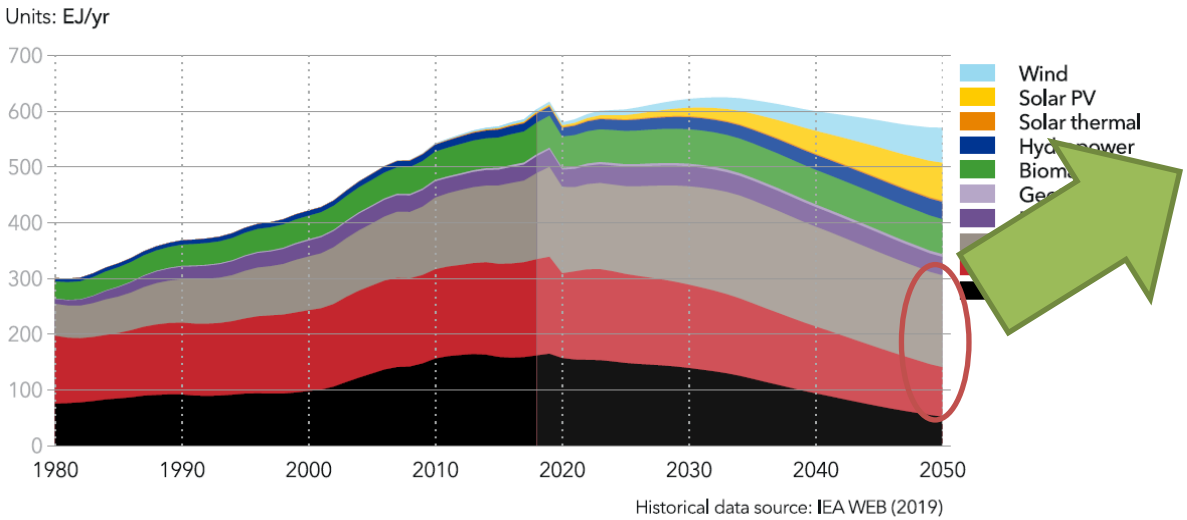
Motivation

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11



Reduce:
- Costs
- Emissions

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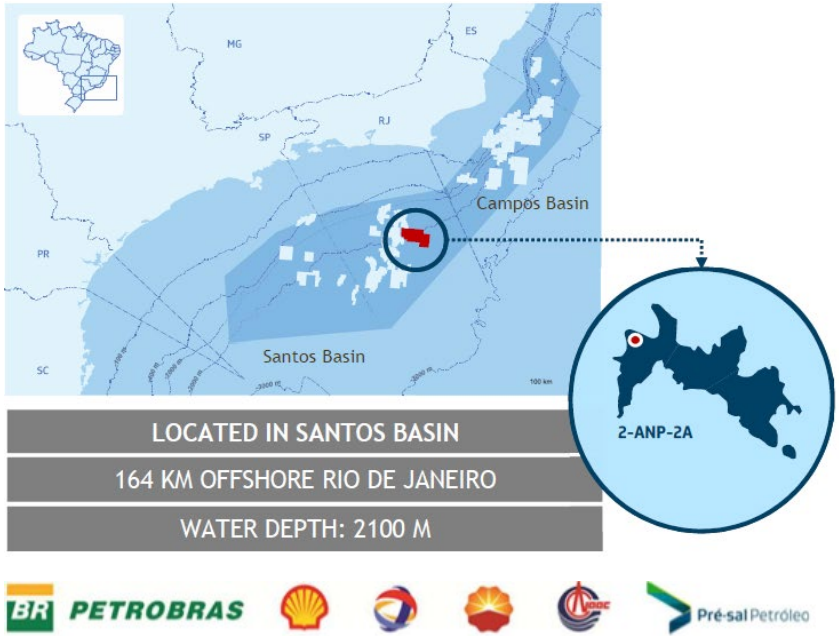
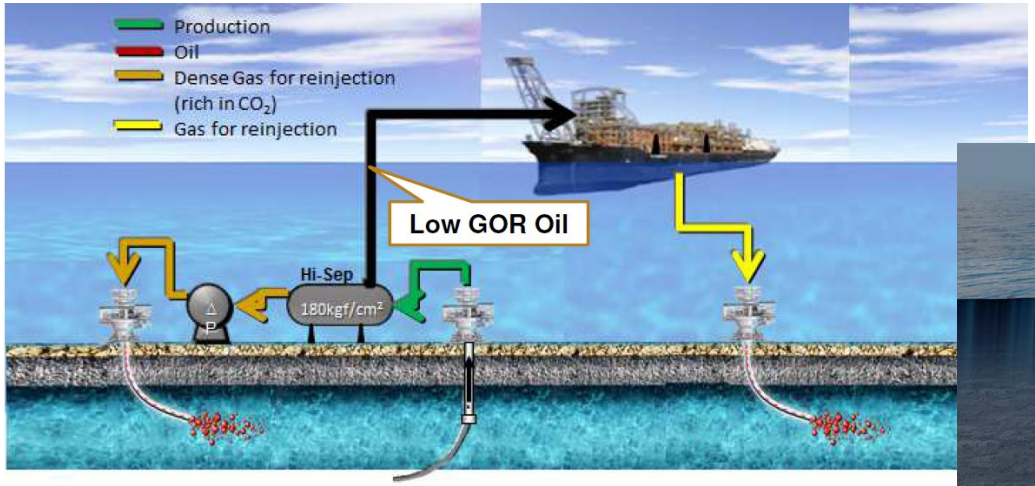
Motivation – High productivity fields



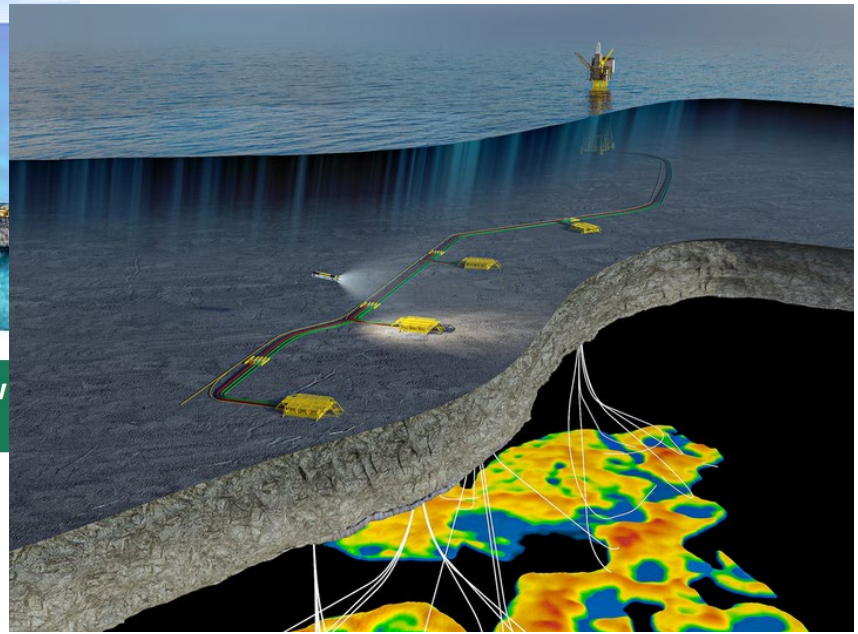
FPSO Capacity limited by:

- Deck space
- Power Generation (100MW)

Motivation – Subsea processing

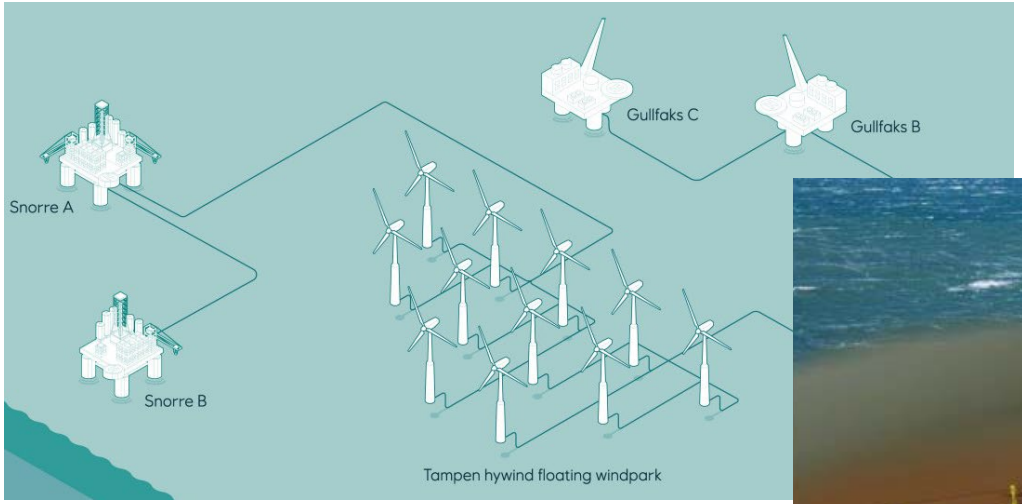


HiSep™ provides Gas Plant Debottlenecking and/or Future New Generation FPSOs with Less Complex Gas Processing Plants

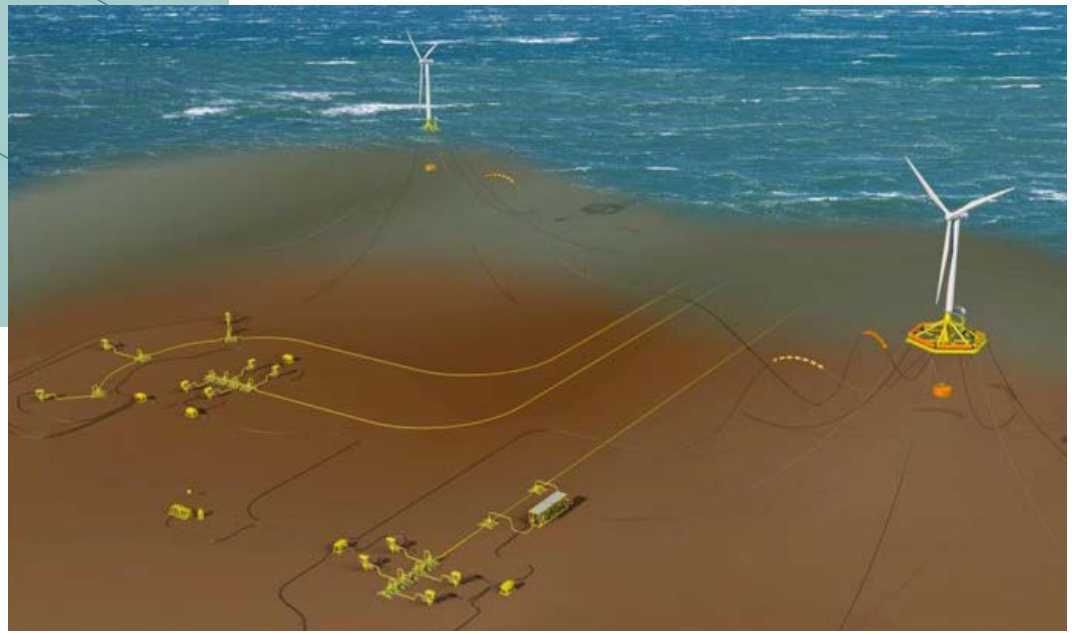


Equinor (2020) - Breidablikk field – North Sea

Motivation – Offshore renewables



Equinor (2019) – Hywind Tampen - Norwegian North Sea



SAIPEM (2020) HEXAFLOAT concept artistic impression

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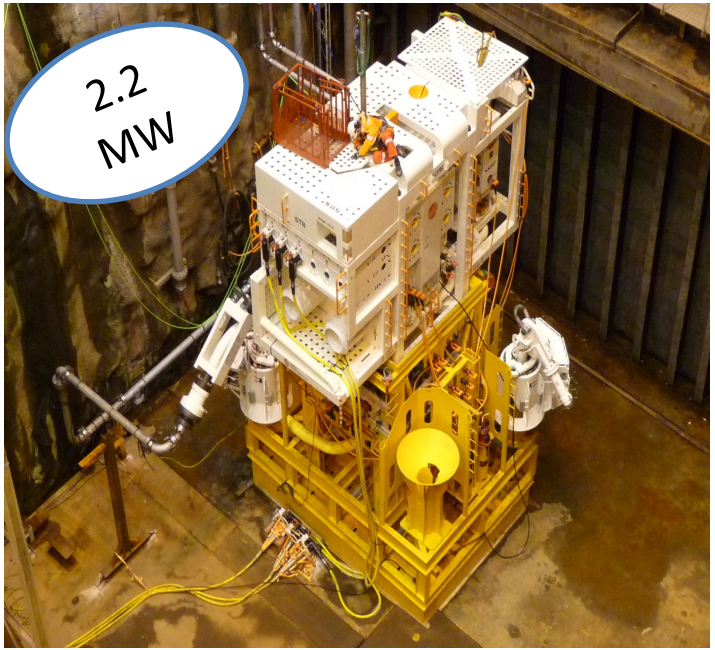
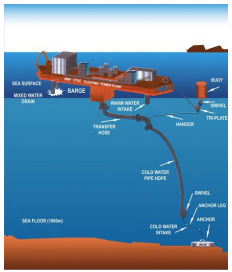
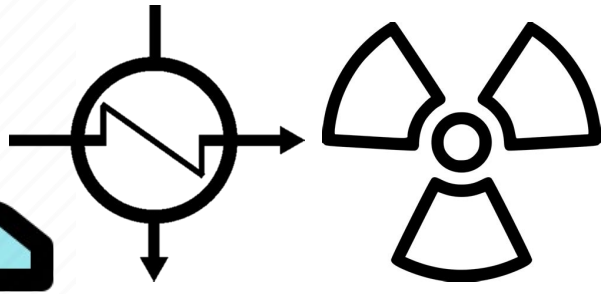
Aims of the project

- Power a subsea system at Mero oil field:
  - Wanter Injection System (SWI)
  - Power Source
  - Energy Sotorage



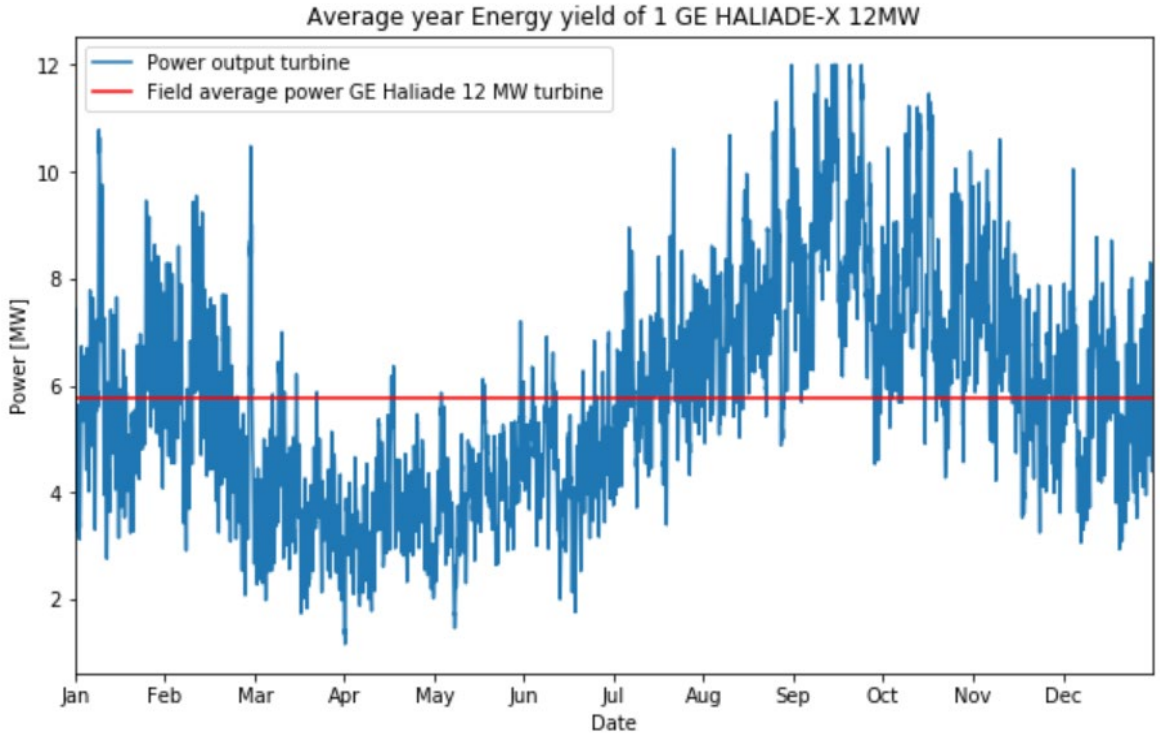
Power source selection (MCDA)





A. R. Novgorodcev Jr. and A. Jarquín-Laguna, “Multi-criteria analysis to rank offshore renewable technologies to support deep-water oil and gas production,” in *4th International Conference on Renewable Energies Offshore - RENEW 2020*, 2020.

Wind power


Average year Energy yield of 1 GE HALIADE-X 12MW
Power output turbine
Field average power GE Haliade 12 MW turbine
Power [MW]
12
10
8
6
4
2
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
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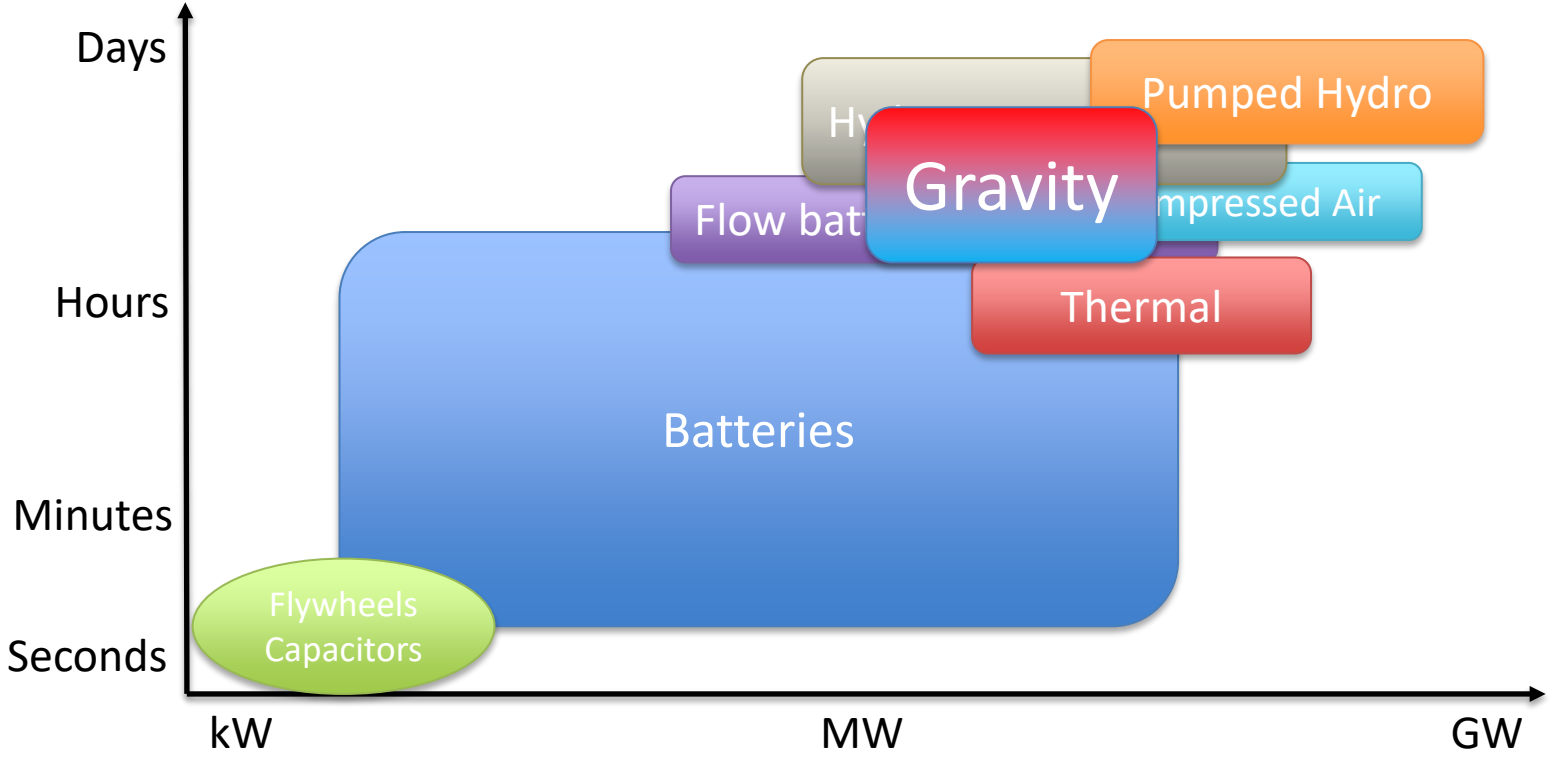
Nov
Dec
Date

Energy storage technology



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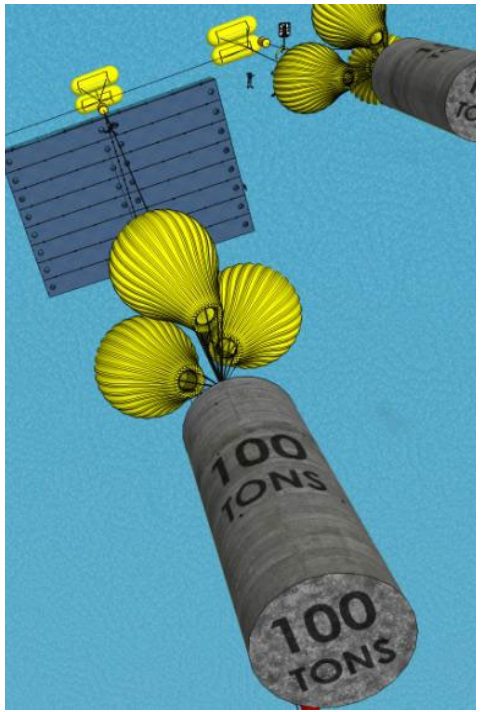
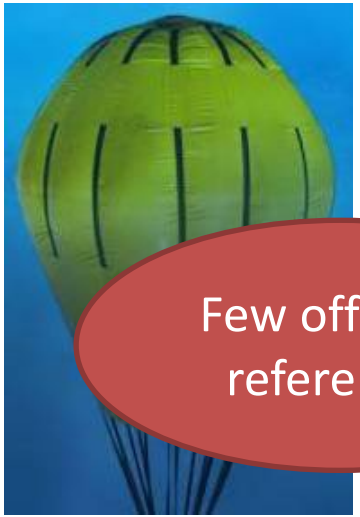
Gravitational Energy Storage

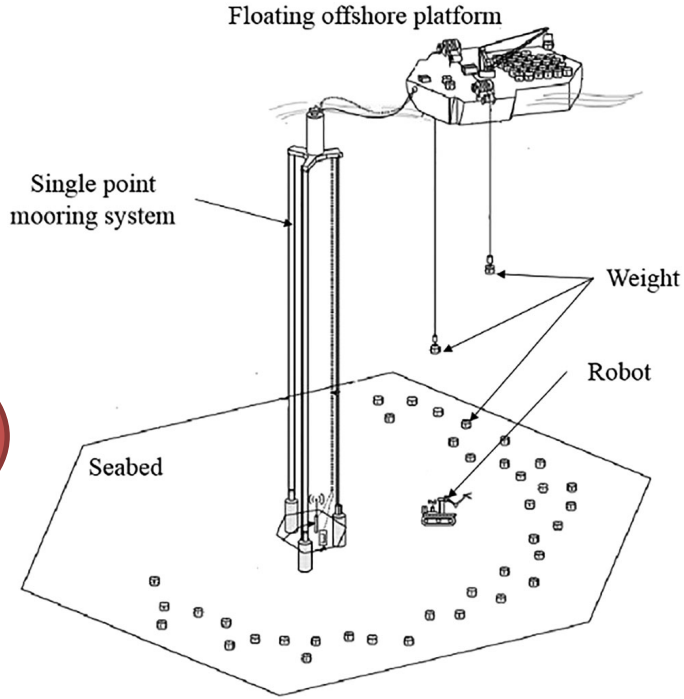


SINK -FLOAT



Few offshore references

Stevens (2016) – Institutional presentation



Zhenjun (2014) – Patent CN103867409B

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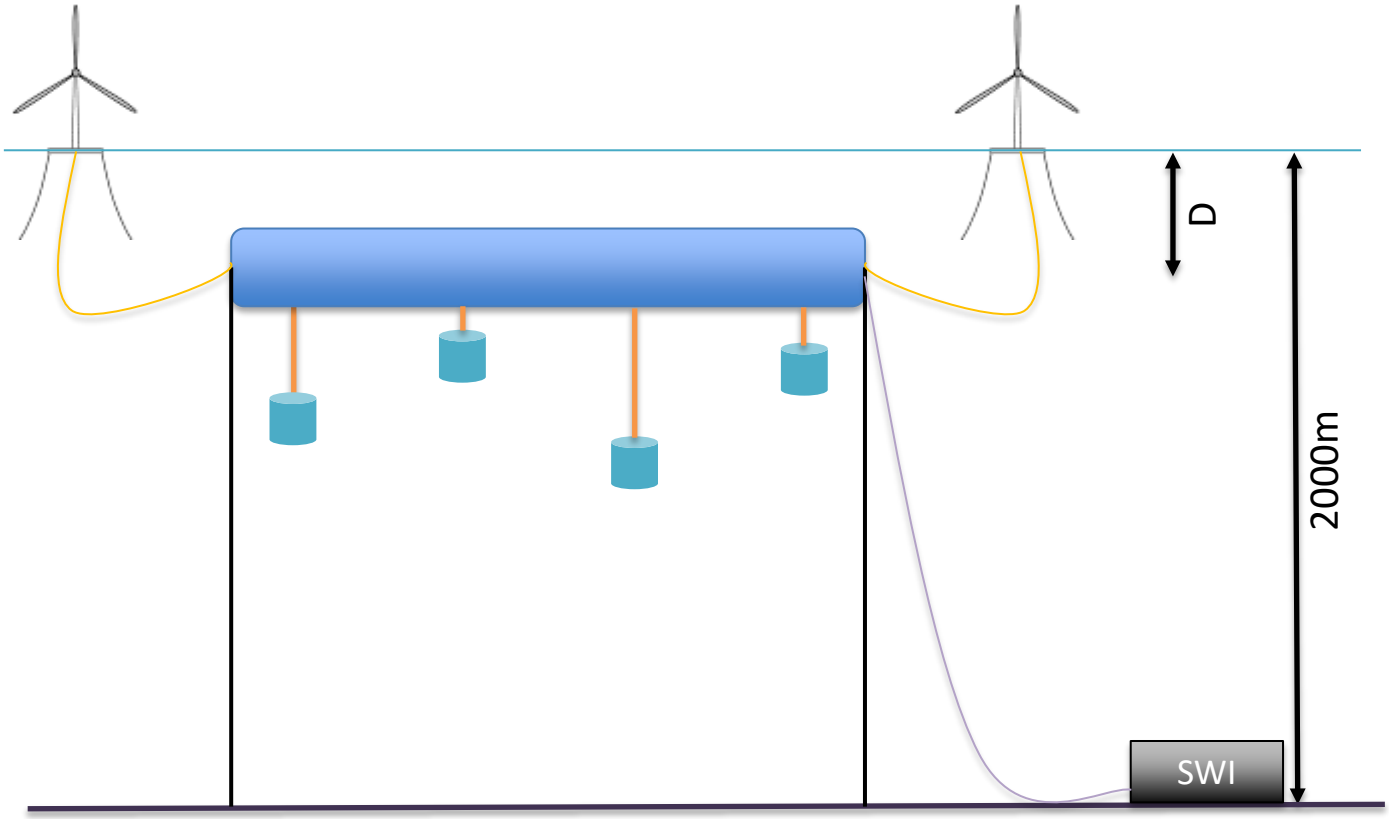
Buoyancy-Supported Rise (BSR)

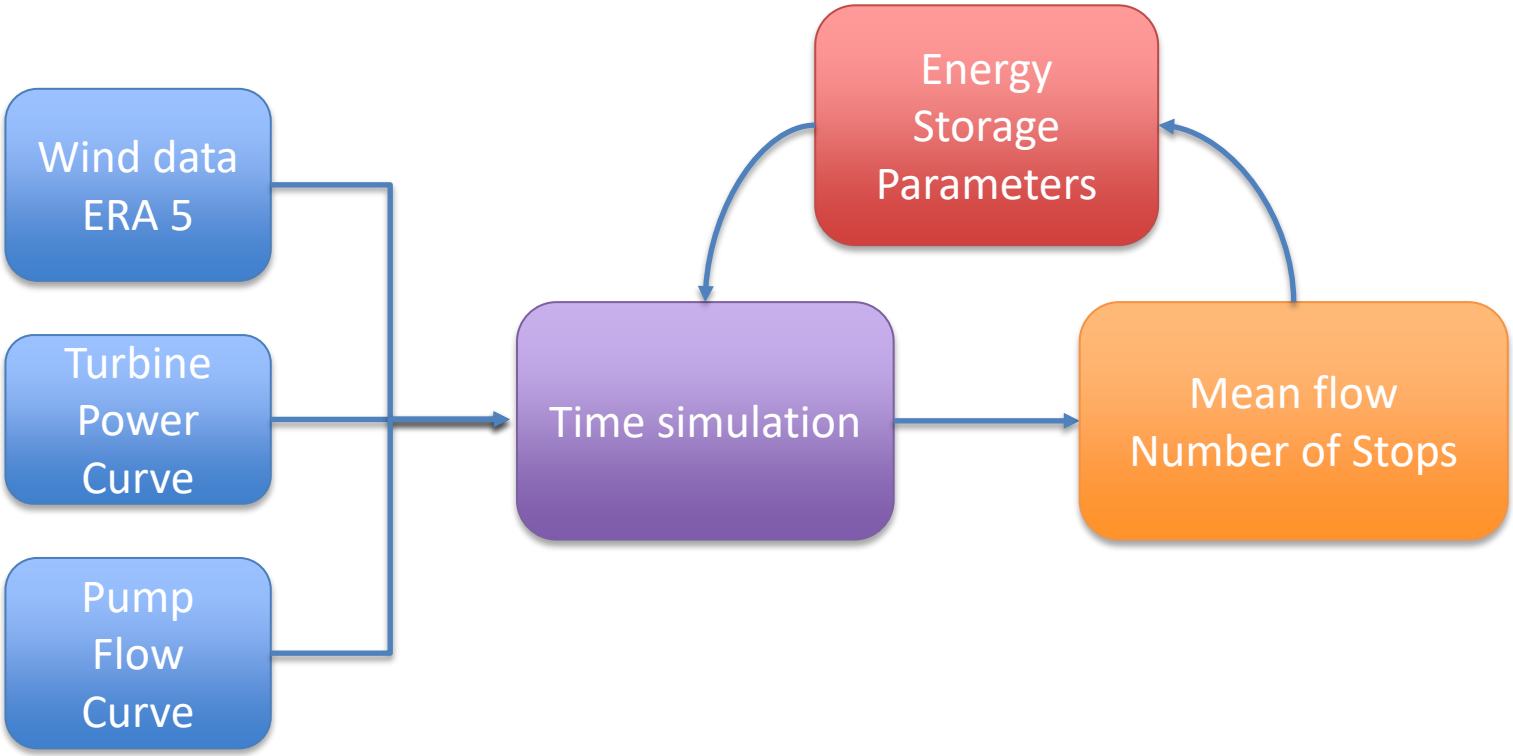
Pascoa (2018) – Offshore engineering magazine

Underwater Gravity Energy Storage (UGES)*



*Out of scale

UGES – Dimensioning



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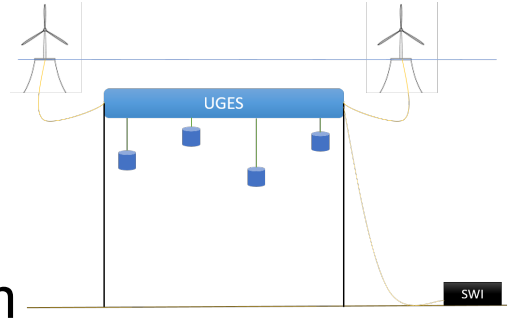
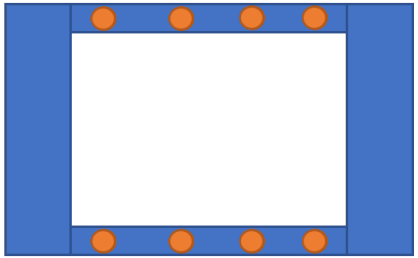
UGES – Preliminary system sizing

- Support structure:
  - 55 X 40 m
- Weights
  - 8 x concrete cylinders r = 2.5 m H = 10 m
  - 474 tones each
- Working Parameters
  - Maximum Speed: 1 m/s
  - Maximum power: 4.64 MW
  - Total energy stored 10.3 MWhr
  - Full power discharge time 4h26min





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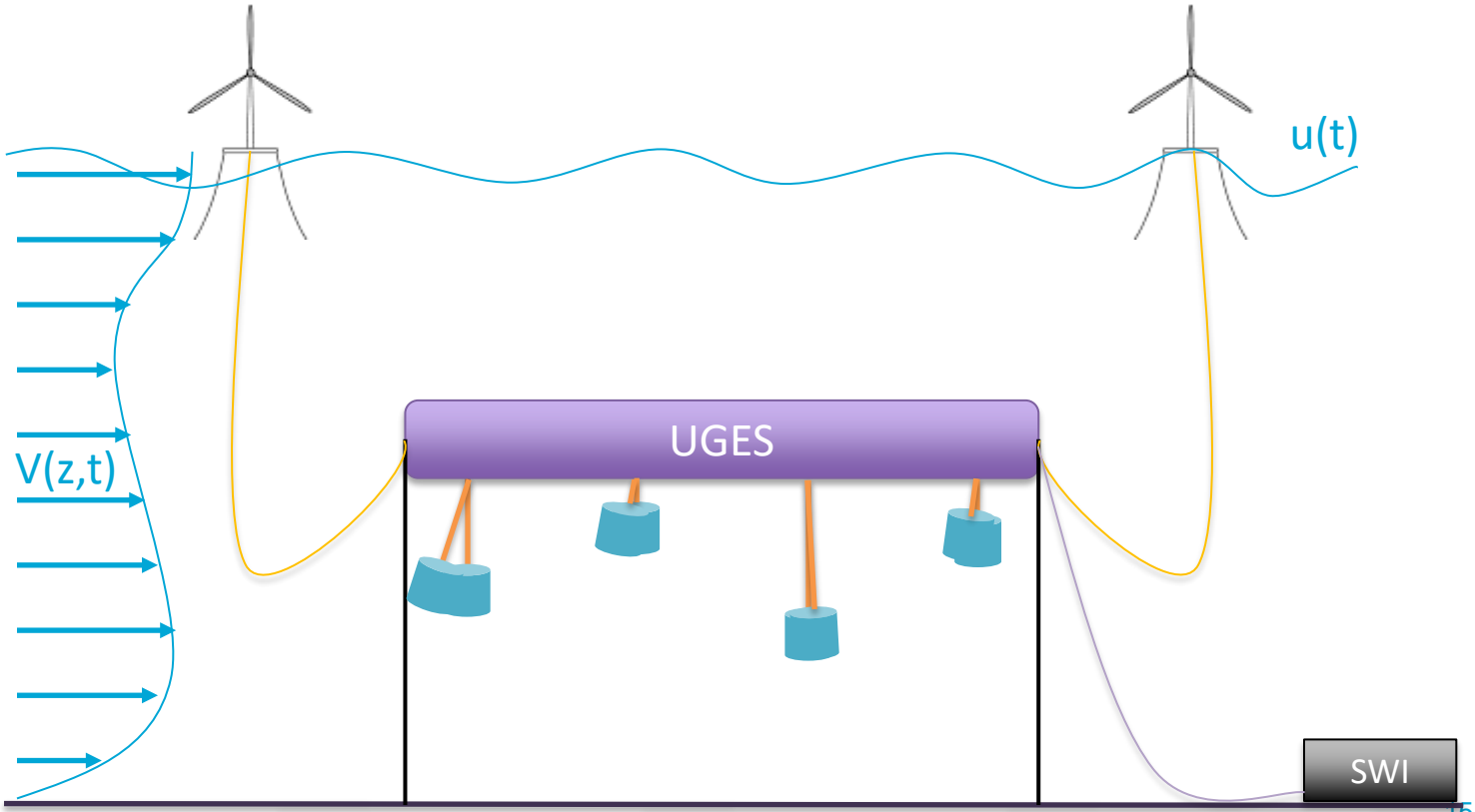
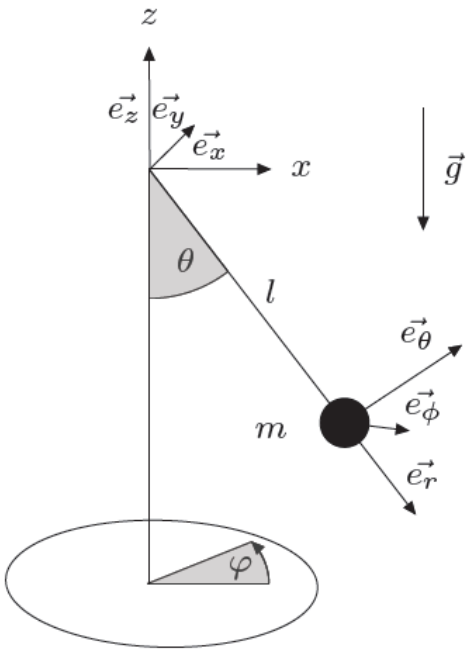
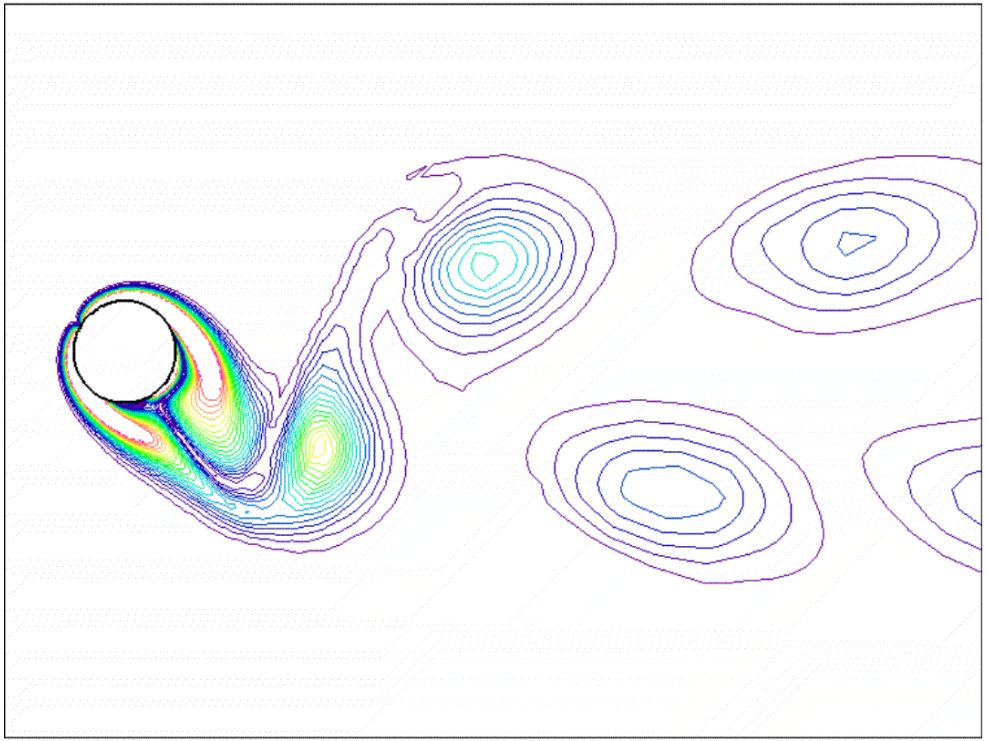
Dynamic Behaviour*



*Out of scale

Dynamic Behaviour

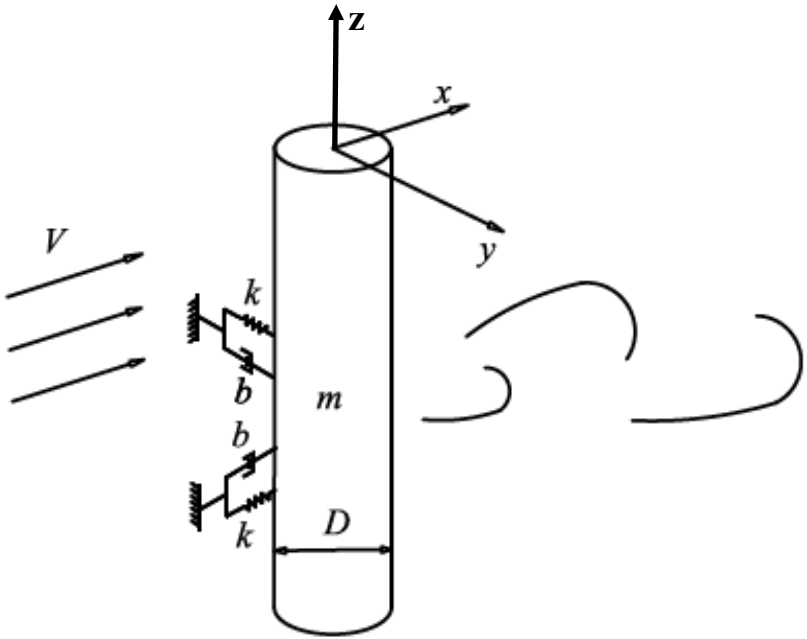




Placzek at al. (2009) – journal paper

Numerical model

- Semi-analytical model based on Yang Qu (2019);
- Couple cross-flow and in-line vortex-induced vibrations (VIV) → **Nonlinear**
- Implemented and solved on commercial software's.



Adapted from Yang Qu (2019) - Thesis

Next steps

- Validate the model
- Evaluate the effect of waves and elasticity of the cable
- Evaluate the sincronization effect

Concluding

Thanks to:

Promoter: Andrey V. Metrikine

Co-Promoter: Antonio Jarquin Laguna

Master student: Frank Mols

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