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Replacing Fossil Fuels by Wind Power in Energy Supply to Offshore O&G Exploration and Production Activities – Possibilities for Brazil

Silvia Schaffel, Fernanda Westin, Mauricio Hernandez, Emilio Lèbre La Rovere
CentroClima/PPE/COPPE/UFRJ

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Introduction

- GHG emissions will create **constraints for O&G sector**.
- Regulations to limit GHG emissions in **many geographies**.
- Pressure from stakeholders for **Climate Disclosure**.
- Cut in **subsidies/financing** for fossil fuels production.
- Meeting the growing **world energy needs** with **lower GHG emissions**.
- Paris Agreement (2016).

Recognize the Climate Issue and that the global energy system is in a transition for a LOW CARBON ECONOMY.

Introduction

Power Demand Offshore Depends on Key Elements (MYHRE, 2001):

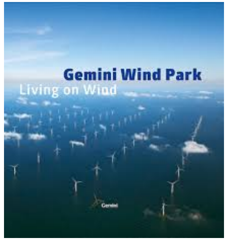
- Oil field that will be explored (temperature, pressure and oil/gas ratio);
- Characteristics of the O&G processing and stages required;
- Need for water or gas injection to develop the field;
- Transport system type (pipelines/shuttle).

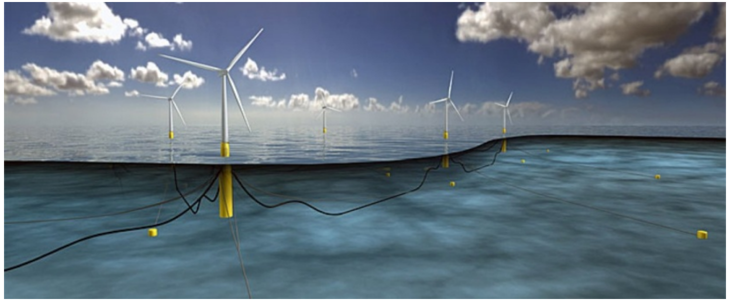
Power Supply Offshore: by gas turbines or diesel generators.

- Small platforms: 10 – 100 MW
- Big platforms: > 100 MW

Typical restrictions of offshore platforms: space onboard, weight, reliability/maintenance.

Replacing Fossil Fuels by OWP in the World





Hywind Scotland - the world's first operational floating wind farm
https://www.equinor.com/en/what-we-do/hywind-where-the-wind-takes-us.html

Gemini Wind Farm - produce renewable electricity for 1.5 million people, while reducing CO_2 emissions by 1.25 million tonnes per year
https://www.geminiwindpark.nl/about-gemini-wind-park.html

Johan Sverdrup Field - Equinor:
Average emissions from production of O&G:
•Johan Sverdrup Field ~0.67kg CO_2/bbl (powered from shore).
•Average emissions Norwegian Continental Shelf ~9kg CO_2 /bbl
•Average emissions globally ~18kg CO_2 /bbl
https://www.equinor.com/en/what-we-do/johan-sverdrup.html

Replacing Fossil Fuels Offshore: Norwegian Case

- 1996: **Norwegian Parliament** resolved that all new offshore development should consider onshore power supply.
- Shore power supply was classified as "***relatively expensive climate measure***".
- 2010: Climate Cure 2020 has studied measures for the Norwegian petroleum industry which could reduce GHG emissions, among which: **electrification**.

Norwegian Case: Strong Carbon Regulations for the Upstream Sector

Conceived to be one of the most carbon-efficient offshore fields in the world (0.67 kg CO_2 emissions per barrel)

Table 2 – Examples of Oil and gas platforms electrification and their respective reduction of GHG emissions

Offshore Platforms	GHG emissions reduction potential (ton CO_2/year)	Country	Operator	Year(s) of platform's operation	Distance from shore (km)	Capacity (MW)	Source of electric power
John Sverdrup	460,000	Norway	Equinor	Nov. 2019 (1^{st} Phase) and 2022 (2^{n} Phase)	160	300	From shore
Troll C	365,000	Norway	Equinor	1996-2065	65	200	From shore
Valhall	300,000	Norway	BP	2011	292	78	From shore
Sleipner area platforms	250,000	Norway	Equinor	1996	250	-	From shore
Troll A	230,000	Norway	Equinor	1996-2066	70	200	From shore
Gulfaks (A, B and C) and Snorr (A and B)	200,000	Norway	Equinor	1970s-2040	125	88	Offshore Wind Power (projected)
Martin Linge	200,000	Norway	Equinor	2018	161	55	From shore
Beatrice Alpha	14,500	Scotland	Talisman Energy UK	1980-2017	24	10	From Offshore Wind
Neptune Q13-AA	14,000	Netherlands	Neptune Energy	-	13	-	From shore / Hydrogen pilot project by 2020[e]

Sources: EQUINOR 2019 and 2018; OT, 2018; NEPTUNE ENERGY, 2019.

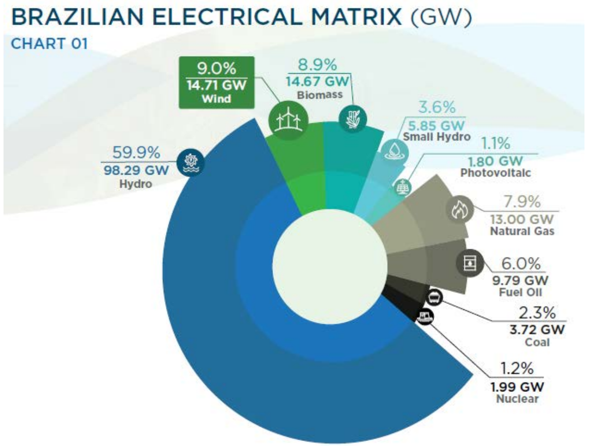
Strong carbon regulations for the upstream sector.

Projected floating turbines can meet 35% of the annual power demand of the offshore platforms.

Brazilian Onshore Wind Power Sector

- 608 Onshore Wind Plants.
- 12 Brazilian States.
- 15.1 GW Installed Capacity.
- 20.58 million tons of avoided CO_2 emissions in 2018.

Source: ABEEOLICA, 2018.



Source: ABEEOLICA, 2019.

Brazilian Offshore Sector

- 9th top oil producer in the world and the largest in Latin America (ANP, 2019).
- Internationally recognized for technological development in deep waters.
- 3 E&P environments: onshore, offshore and pre-salt.

Table 4 – Number of Producer Wells and O&G Production in Brazil

Environment	Number of Producer Wells	Production (Thousand boe/d)	Average Oil Production per well (bpd)
Pre-Salt	91	1,936 (59.4%)	21,279
Conventional Offshore	593	1,095 (33,6%)	1,846
Onshore	6,570	230 (7.1%)	35
Total	7,254	3,261	23,160

Source: CASTILHO, 2019 based on monthly production report from March 2019.

Brazilian Offshore Wind Power Sector

Offshore potential 12 times > onshore potential (ORTIZ and KAMPEL, 2011).

Challenges:

- Better understanding environmental impacts of the activity.
- Mapping onshore potential.

Offshore Wind Power Plants in Initial Permitting Stage in Brazil

Name	Operator	Power	Distance/shore	State
CEO Asa Branca I	Eólica Brasil	400 MW	3 – 8 km	CE
Pilot Wind Power Plant in Ubarana Field	Petrobras	7 MW	20 km	RN
Caucaia Parazinho	EOL Bienergia	310 MW	10 km	CE

Brazilian OWP Sector: Synergies with Offshore E&P

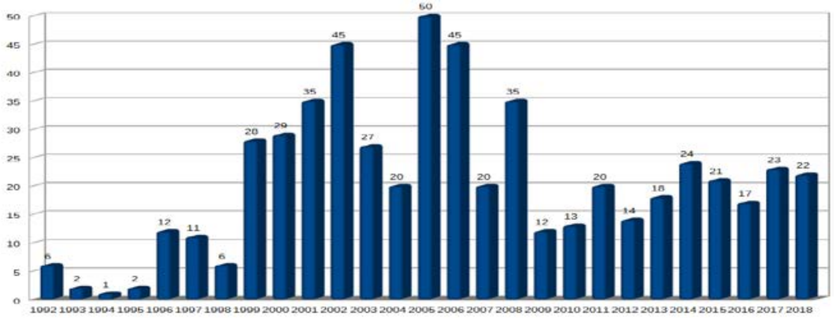
Experience with Offshore Environment:

- Metocean information sharing.
- Design foundations for installation of fixed structures.
- Logistics optimization (supply vessels, shore bases, helicopters).

Experience with Environmental Permitting:

- Lessons learned from past 20 years.
- Environmental programs, primary data collected

Number of O&G Processes Since 1992



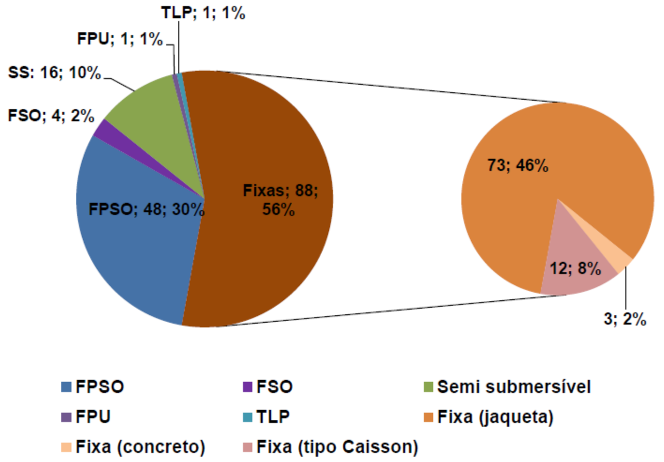
Source: IBAMA, 2019.

Brazilian OWP Sector: Synergies with Offshore E&P

Decommissioning:

- Considerable decommissioning scenario for the next years (50% production platforms > 25 years).
- ANP Resolution 27/2006 under revision: Devolution of Areas and Deactivation of Installations in the Production Phase.
- ANP incentives different uses for decommissioned structures (Ex: reuse of fixed structures).

Offshore Production Units Operating in Brazil/type



Source: ANP, 2018.

Brazilian OWP Sector: Synergies with Offshore E&P

Complementarity: Mature Oil Fields, Life Extension and Offshore Wind Resources

Brazilian Mature Fields in shallow waters: Campos, Sergipe-Alagoas, Potiguar and Ceará Basins.

Brazilian Recovery Factor is low (ANP, 2018).

→ Overlap with areas of offshore wind potential. Ex: water injection for maximizing oil recovery powered by OWP.

↓ Wind-powered water injection system could become cost competitive in reducing cost and emissions (DNV GL, 2019).

Source: ANP, 2018.

Brazilian OWP Sector: Synergies with Offshore E&P

Complementarity: Mature Oil Fields, Life Extension and Offshore Wind Resources

CARVALHO (2019) analyzed 30 Brazilian offshore mature oil fields:

- Water depths - up to 33m,
- Distance from shore - up to 40 km,
- Average wind speed - 8 m/s at 100m.

7 Brazilian Mature Oil Fields would have enough wind resources to operate a wind farm: 1 Ceará and 6 Rio Grande do Norte (CARVALHO, 2019).

Brazilian OWP Sector: Synergies with Offshore E&P

Pre-Salt Development

Brazilian FPSOs:

- High distance from shore (200 – 300 km).
- High water depths (1,000 – 2,500 m).

Process plants are energy intensive:

- Brazilian FPSOs provide 1.8 GW of power (PEREIRA and CARVALHO, 2015).
- Half FPSOs fired by gas turbines (PEREIRA and CARVALHO, 2015).
- NO_x emission limits for atmospheric pollutants from gas turbines > 100 M are double than for those < 100 MW.

Offshore Wind Power could be used as auxiliary power for FPSOs

Conclusion

- **Carbon emissions** are a constraint on future O&G development.
- An offshore field operated using **electrical power generated onshore**, could reduce offshore emissions by 80% compared to a standard development using gas turbines (EQUINOR, 2019).
- **Like the O&G industry**, offshore wind industry has begun near the coast and has been advancing towards deeper waters, in the quest for floating offshore wind power.

In Brazil:

- **Onshore wind power** was once viewed as an expensive and unpredictable energy source, but now holds the 2nd place in the Brazilian power generation mix.

Conclusion

Brazil has 2 offshore E&P environments:

Conventional Offshore:

- Complementarity between development of **mature fields and OWP** is an opportunity to be assessed, such as the **reuse of fixed platforms** as structures for offshore wind development.
- ANP fosters the Brazilian industry to propose **different uses** for decommissioned structures, in ways that might help the energy transition.

Pre-Salt:

- Is being developed based on the **FPSOs concept**, whose processes are energy-intensive.
- Half of Brazilian FPSOs are powered by **gas turbines** and sometimes there is no space onboard to install additional turbines. The use of floating wind turbines connected to the FPSO could be an alternative to be assessed.

References

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Thank you!!

CENTROCLIMA - Centro de Tecnologia - Bloco I - Sala 208
CEP 21945-970 - Ilha do Fundão - Rio de Janeiro/RJ
+ 55 (21) 3938-8759

silvia.schaffel@lima.coppe.ufrj.br
fernanda@lima.coppe.ufrj.br
mauriciohernandez@lima.coppe.ufrj.br
emilio@ppe.ufrj.br