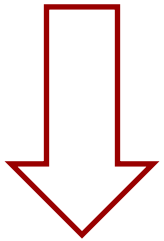
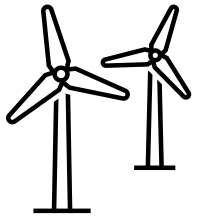
Simon Ivar Andersen, DTU Offshore

Minimizing the Discharge of Harmful Chemicals Offshore (from industrial activities)

Discharge of “energy by-product” to the Ocean





- Our Produced water management program aimed at zero harmful discharge from O&G –

?

- We also adapted to the new offshore related technological activities….

The activities we look at presently:
Old and New Energy Production and use Offshore

Produced water quality and environmental impact increasingly important and still an effort

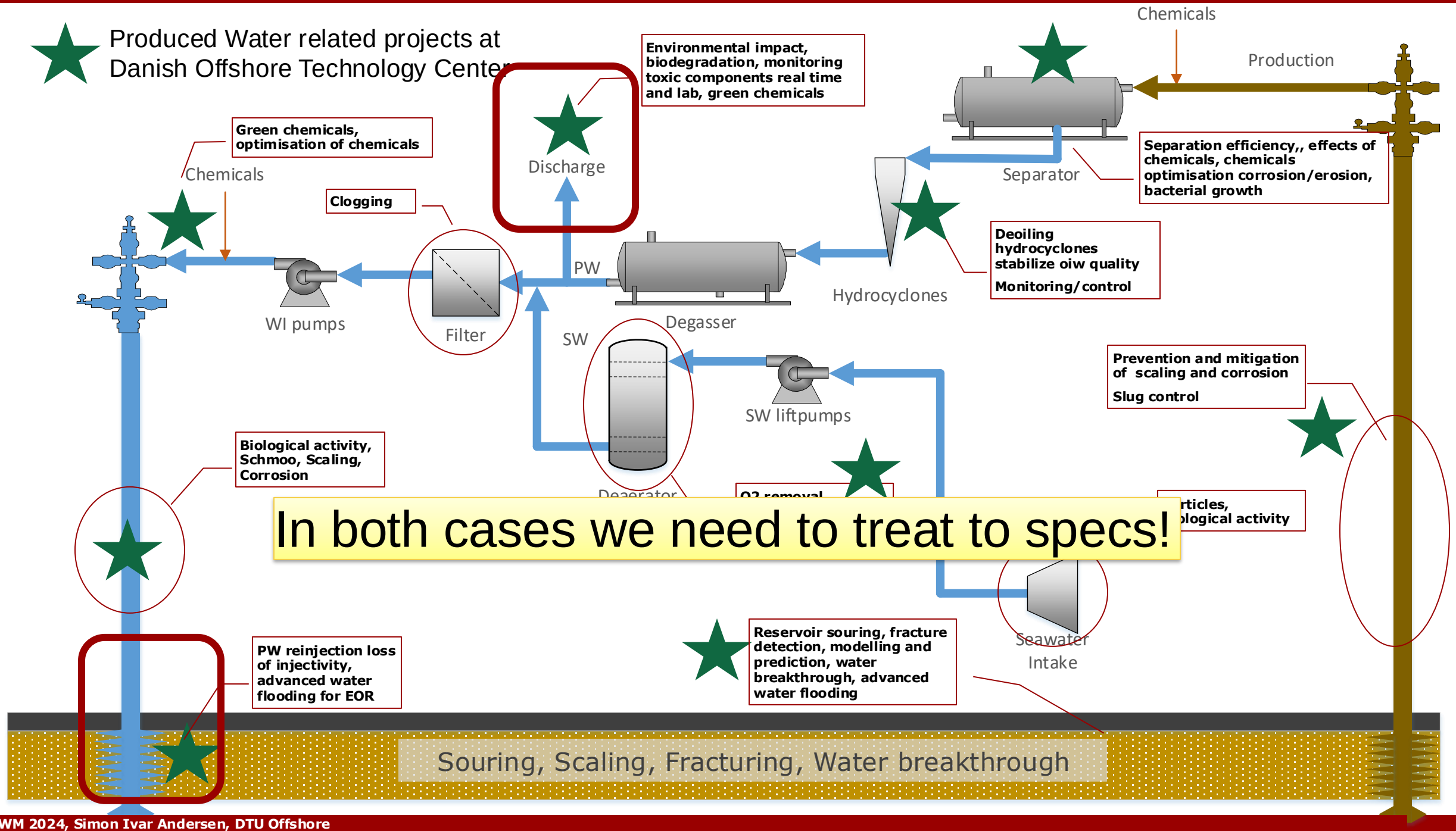
New at sea – new chemistries

No control of chemistries

Replacement of fossil with bio....

Illustrations of technology and offshore energy sources

Produced Water related projects at Danish Offshore Technology Center



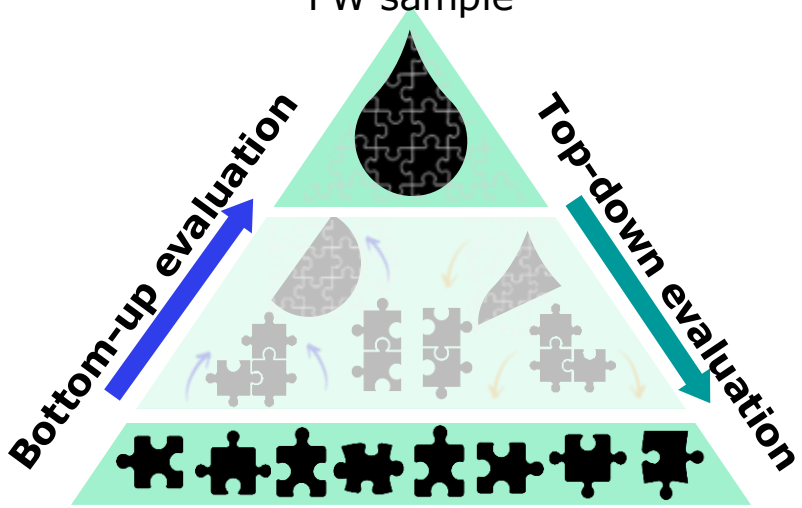
Environmental impact, legislation and ecotoxicity

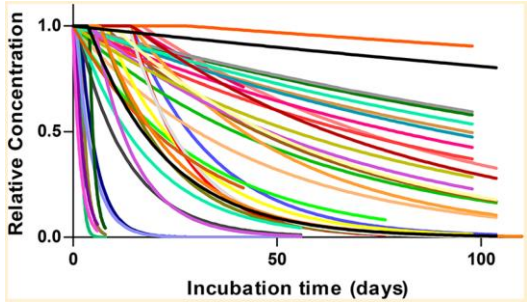
Assessing Environmental Impact

Legislation

§ Compliance §
???

Proposing solutions



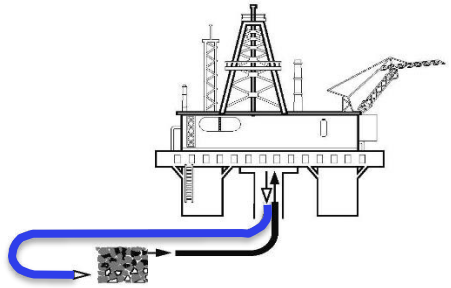


Total EIF = ∑ Individual EIF$_i$

Natural compounds	ppb
Dispersed oil	4
BTEX mono-arom	17
Naphthalenes	2.1
PAH 2-3 ri thalenes)	0.15
PAH 4	0.05
Ph 3	10
4 - C5	0.36
s C6 +	0.04
nic (Zn)	0.46
Copper (Cu)	0.02
Nickel (Ni)	1.22
Cadmium (Cd)	0.028
Lead (Pb)	0.182
Mercury (Hg)	0.008

Action

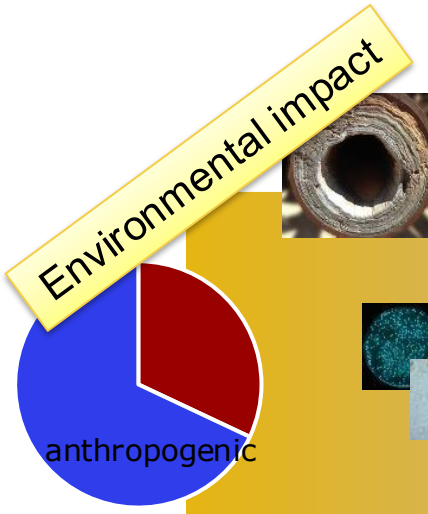
Improve processing?

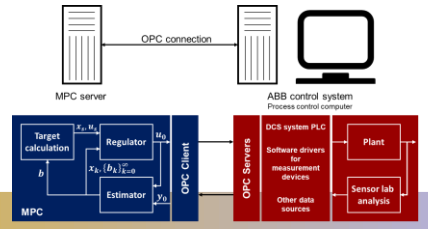


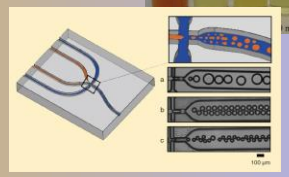
Produced Water Management Reduction of Environmental Impact and Foot Print of O&G

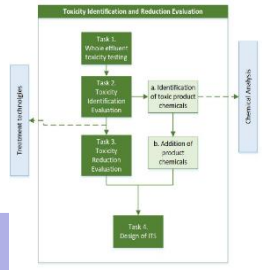
Management of PW discharge is an increasingly important aspect of O&G operations.

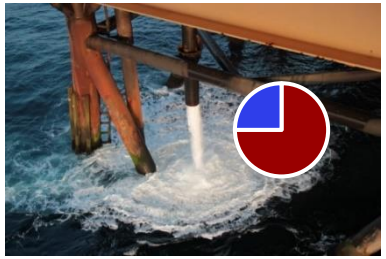
DTU Offshore PWM program ***35 projects*** targeting all aspects of the water cycle

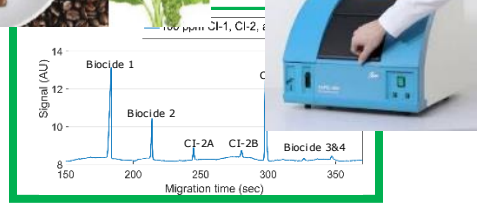


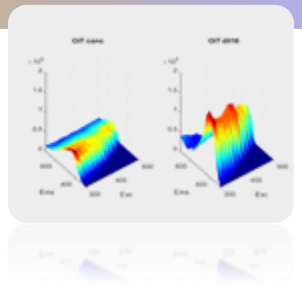












Zero Harmful Discharge

Efficient control

Reuse

PWRI

CO2 storage

Rare earth minerals

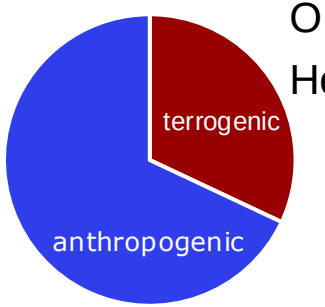
Reduced CO2 foot print

Chemicals in Produced Water Management

From oil

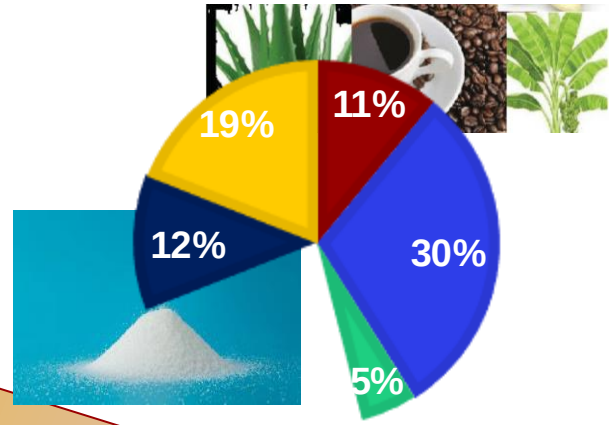
Organics

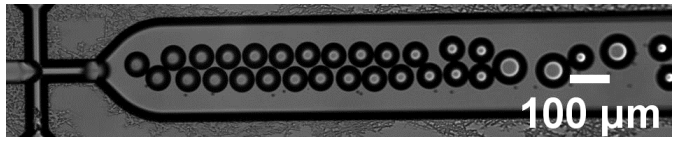
Heavy metals



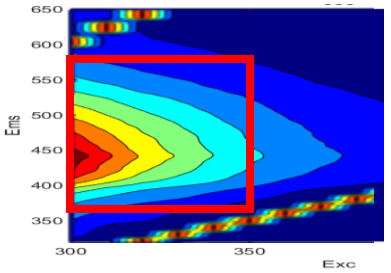
From additives

?





Impact of chemicals on separation



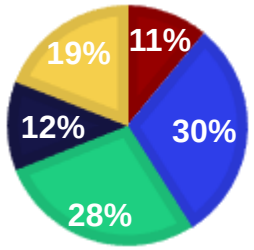
More processing?

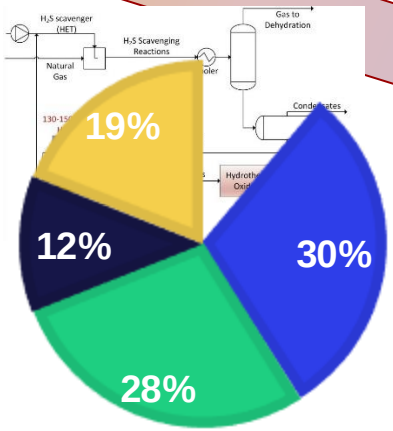
OiW mg/L

Natural compounds	PNEC ppb
Dispersed oil	40.4
BTEX mono-aromatics	17
Naphthalenes	2.1
PAH 2-3 ring (excl. naphthaleneS)	0.15
PAH 4 - 6 ring	0.05
Phenols C0 - C3	10
Phenols C4 - C5	0.36
Phenols C6 +	0.04
Zinc (Zn)	0.46
Copper (Cu)	0.02
Nickel (Ni)	1.22
Cadmium (Cd)	0.028
Lead (Pb)	0.182
Mercury (Hg)	0.008

Risk model

- H2S scavenger
- Biocides
- Corrosion Inhibitors
- Other Chemical
- Naturally Occuring





PNEC= Predicted No Effect Concentration

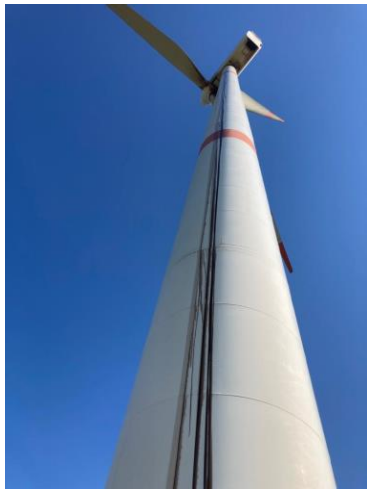
Understand the impact

- Offshore energy production—whether from oil and gas, wind farms, or ship propulsion (which inherently involves converting fuel to energy) —has significant environmental impacts, many of which involve the discharge of harmful chemicals into the marine environment by streams or accidents

$1m^3$ oil = $1 km^2$ oil slick

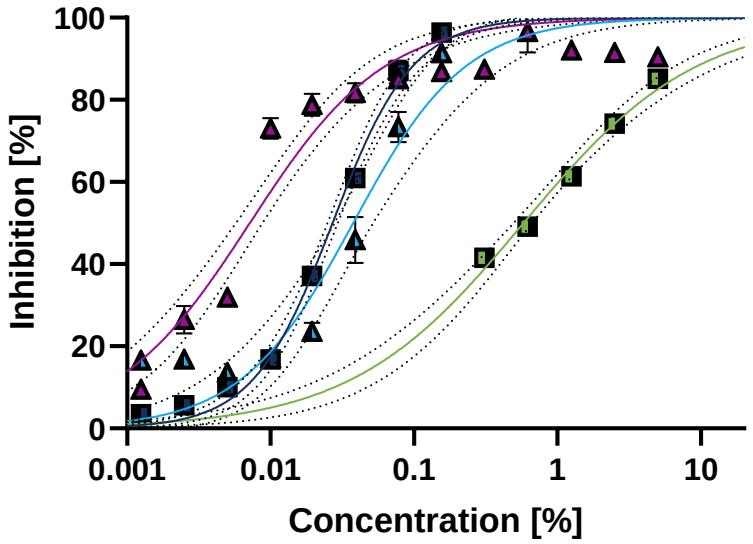
1000+ tons released

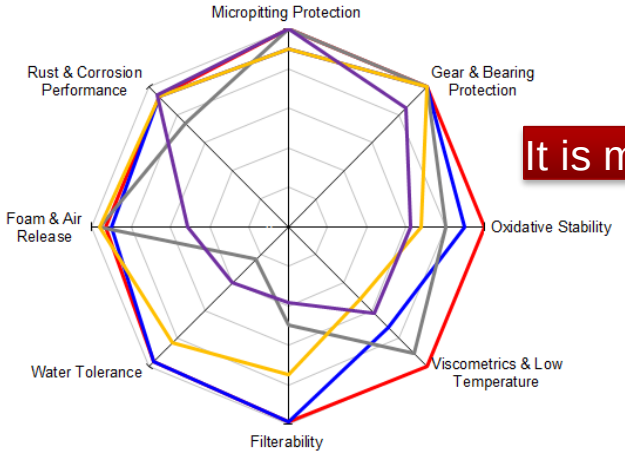
Accidental leaks from wind turbines have chemical impact on the environment



Statement in literature:
5-15 % suffer from leakage in hydraulic system?*

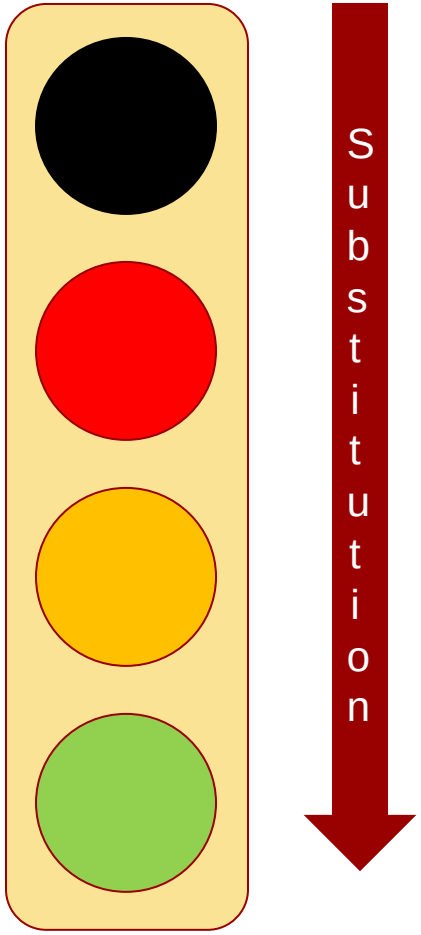
*Depending on maintenance quality



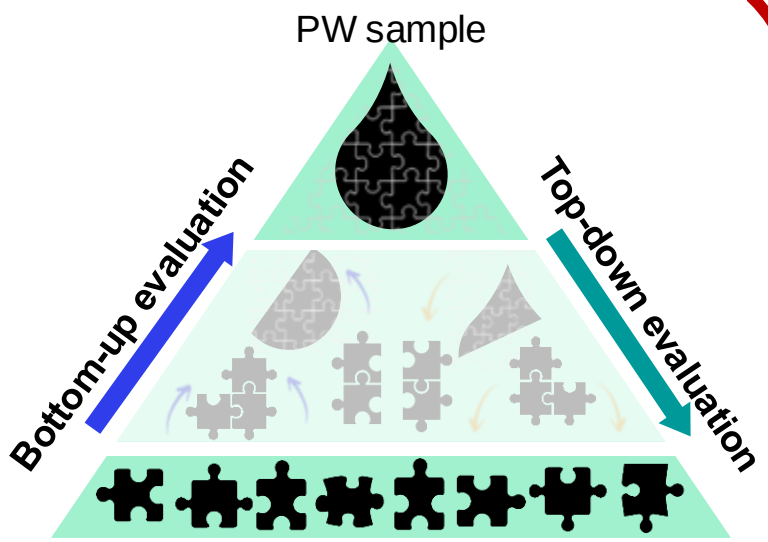


Gearoil
Gearoil
Cooling Liquid
Hydraulic oil

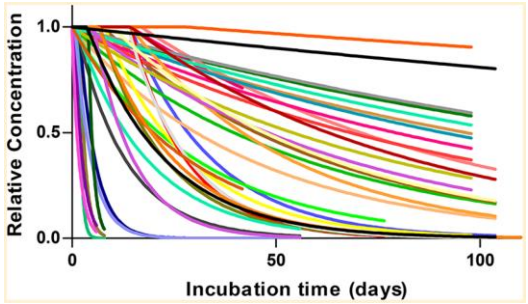
It is mainly the additives



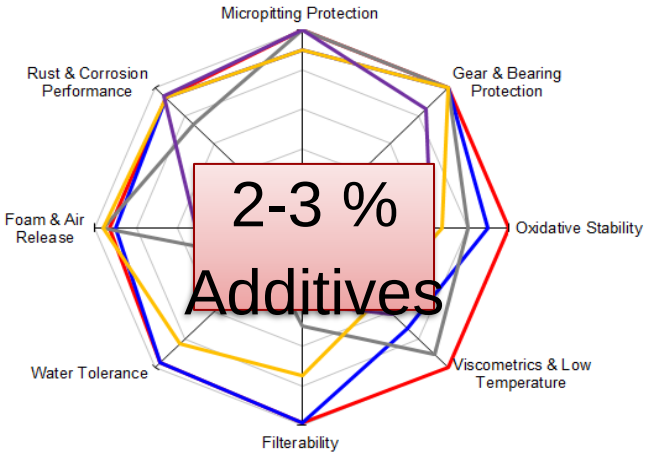
Composition impacts the environment – regulatory practice?

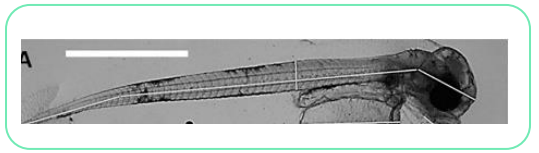


Individual PW constituents

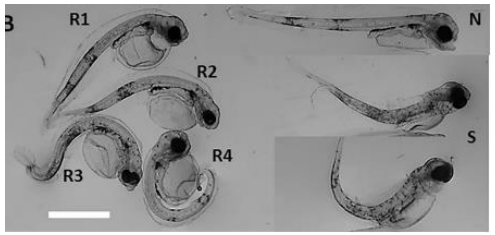


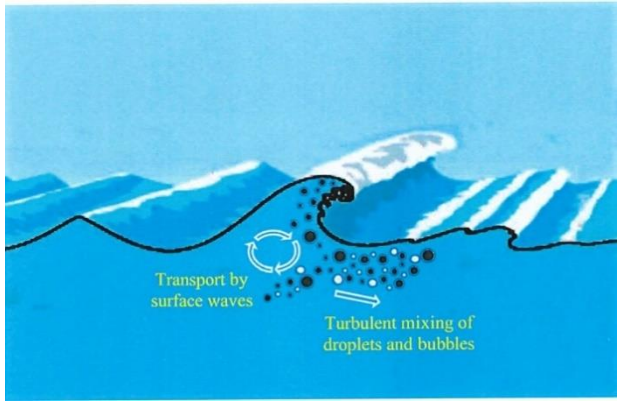
Additives in windturbines





Effect of contact with oil droplets:





Think mitigation before if grows into a real issue

- ”This is just another road block!”
- Achieving true sustainability requires early identification, analysis, and mitigation of potential risks, including chemical exposure, to protect the marine environment.
- Failing to do this has implications later on.
- This can be done faster than you think….as it is often not rocket science.
- But there is still needs of understanding and identifying some of the unkowns

1 m3 windturbine oil = 100.000 m3 PW

Time in service

Fig. 2: Degraded hydraulic oil [right] compared to new oil [left] (Source: C.C.JENSEN)

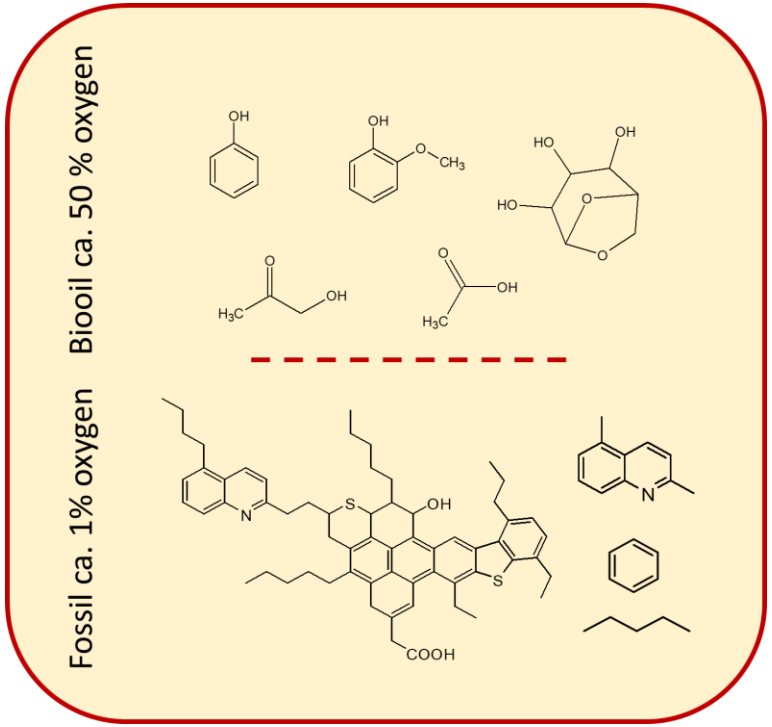
Increased failure risk

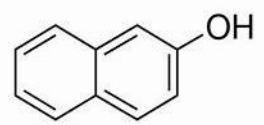
New Fuels in Shipping – New spill approach?

New chemistry

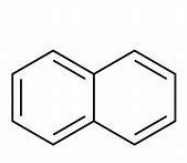
New impact on marine life

Secure blend stability





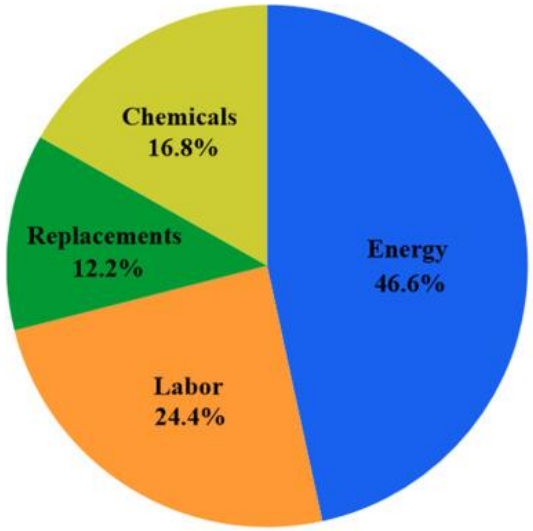
755 mg/L water

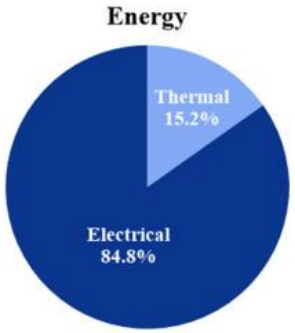


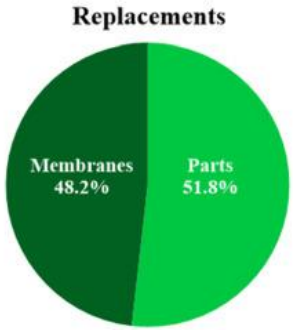
31 mg/L water

Desalination of water for P-t-X e.g. hydrogen

- Cost same as for drinking water and Produce salty high density brine
- 50 % efficiency in terms of water produced.
- Concentrated brine released – sinks to bottom....
- Large number of chemicals used in process.
- High demand of energy.







Have we considered the chemical environmental impact?

To include sustainability by design

- We need to solve ”all this” before issues appear
- We will still need some fundamental insights
- But many things are known....
- Don´t see this as a show stopper.
- We need collaboration to get to good pragmatic solutions
- And we need you not to be ”afraid” as it is not difficult