Offshore Technology Conference 2013
6–9 May 2013 ❖ Houston, Texas, USA
www.otcnet.org/2013

OTC-24034-MS

Offshore Energy Efficiency Technologies

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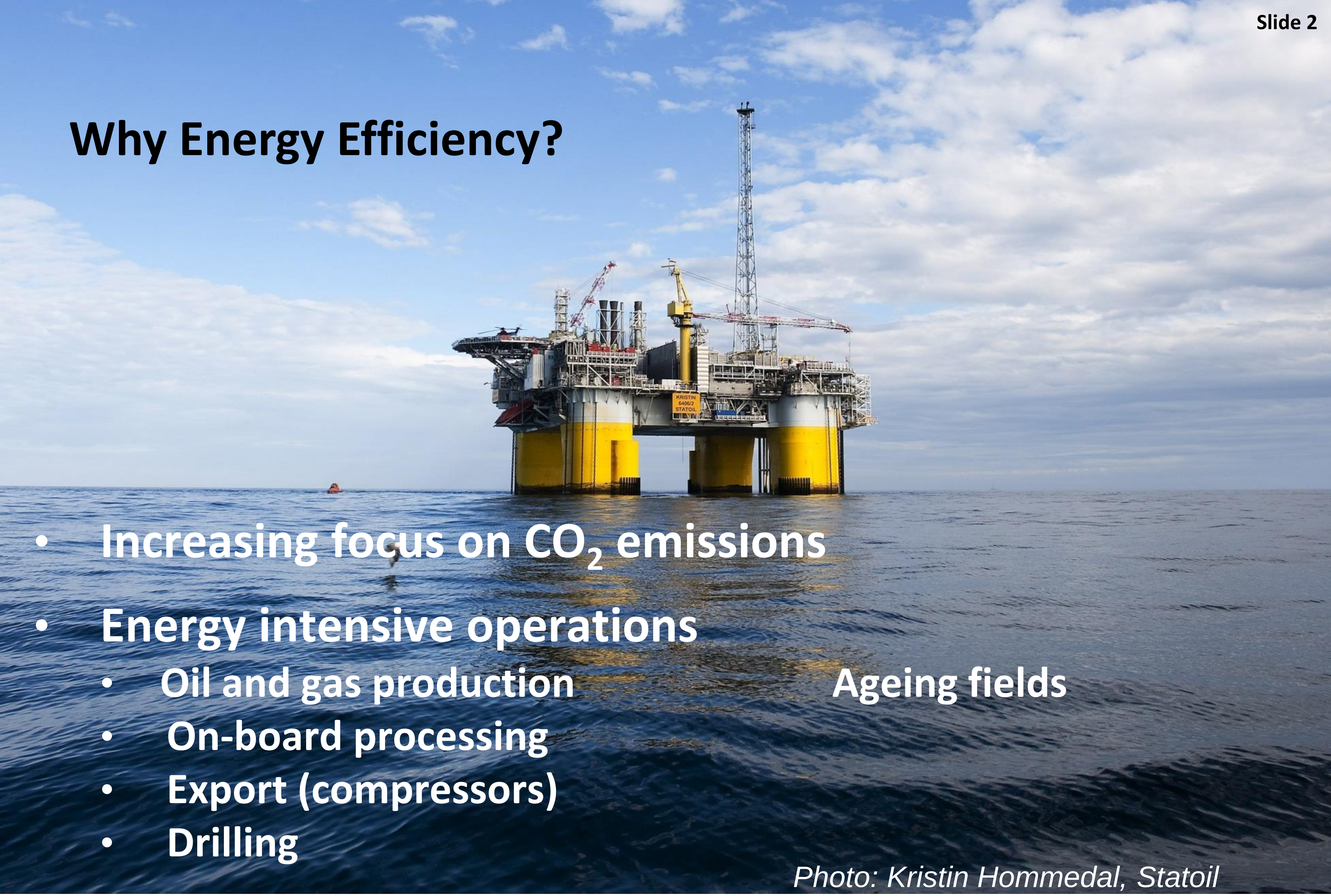
Why Energy Efficiency?



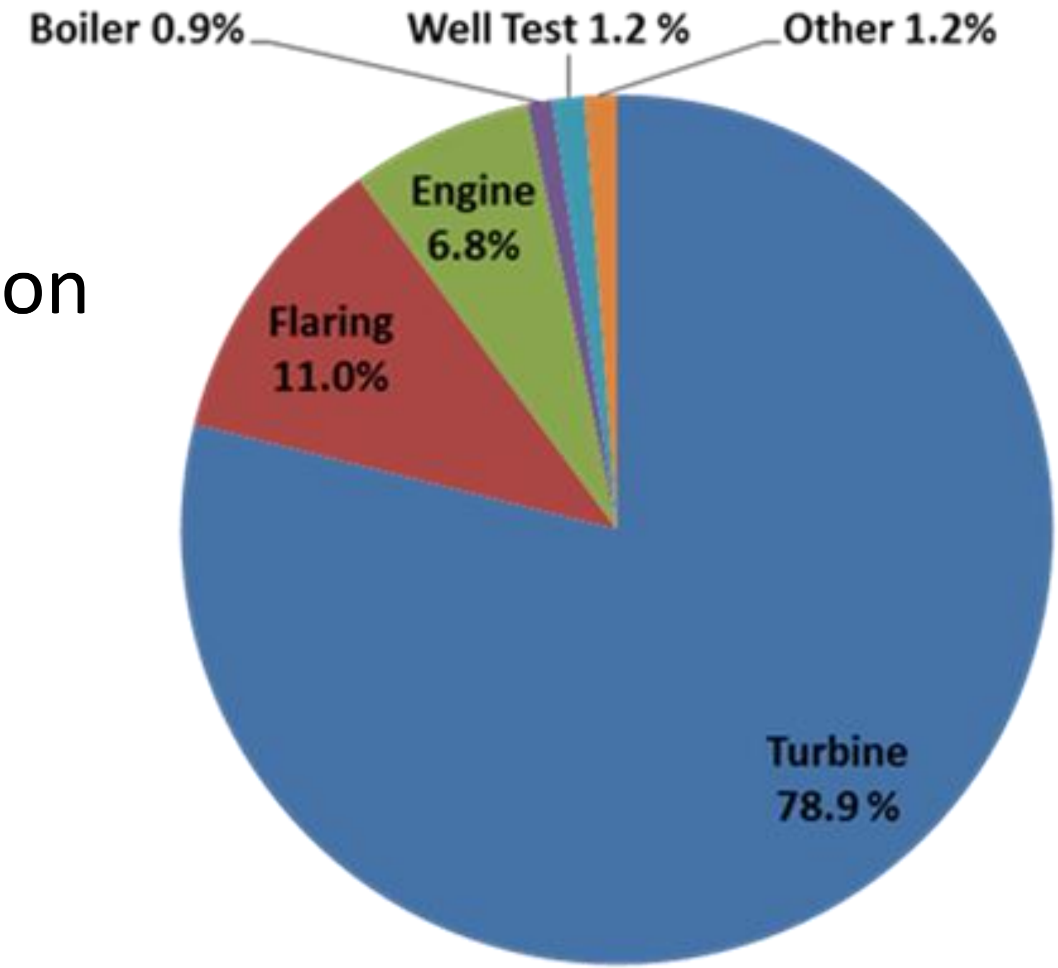
- Increasing focus on CO_2 emissions
- Energy intensive operations
  - Oil and gas production
  - On-board processing
  - Export (compressors)
  - Drilling

Ageing fields

Photo: Kristin Hommedal, Statoil

CO_2 Emissions

Source Distribution



Source:
2010 Data From Norwegian Department of Oil and Energy, Facts, 2011

Goal

- Develop energy efficient technologies
- Promote implementation

Reduced energy use & CO_2 emissions

Means not covered:

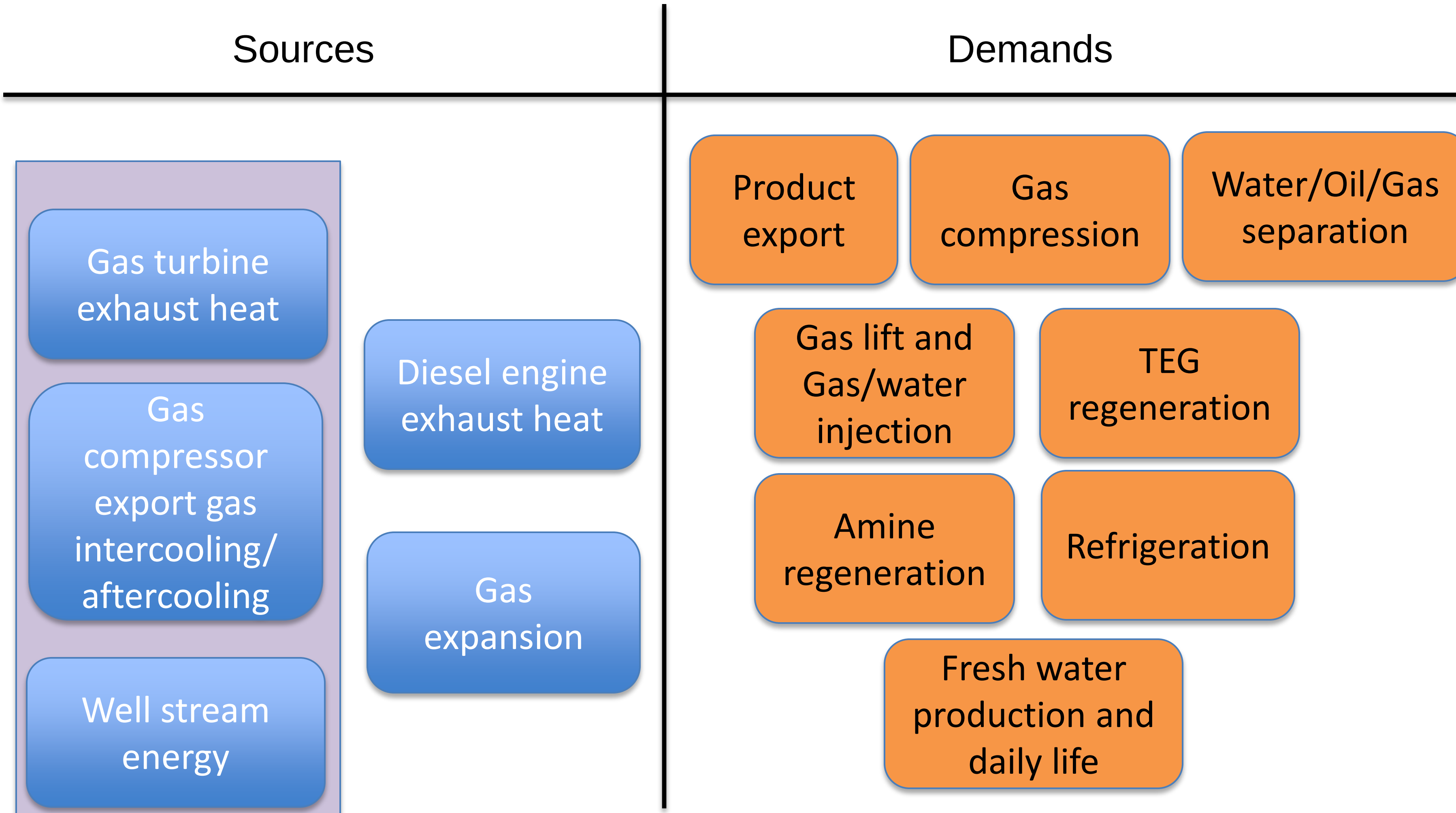
- Reduced flaring
- Electrification
- CCS

EFFORT

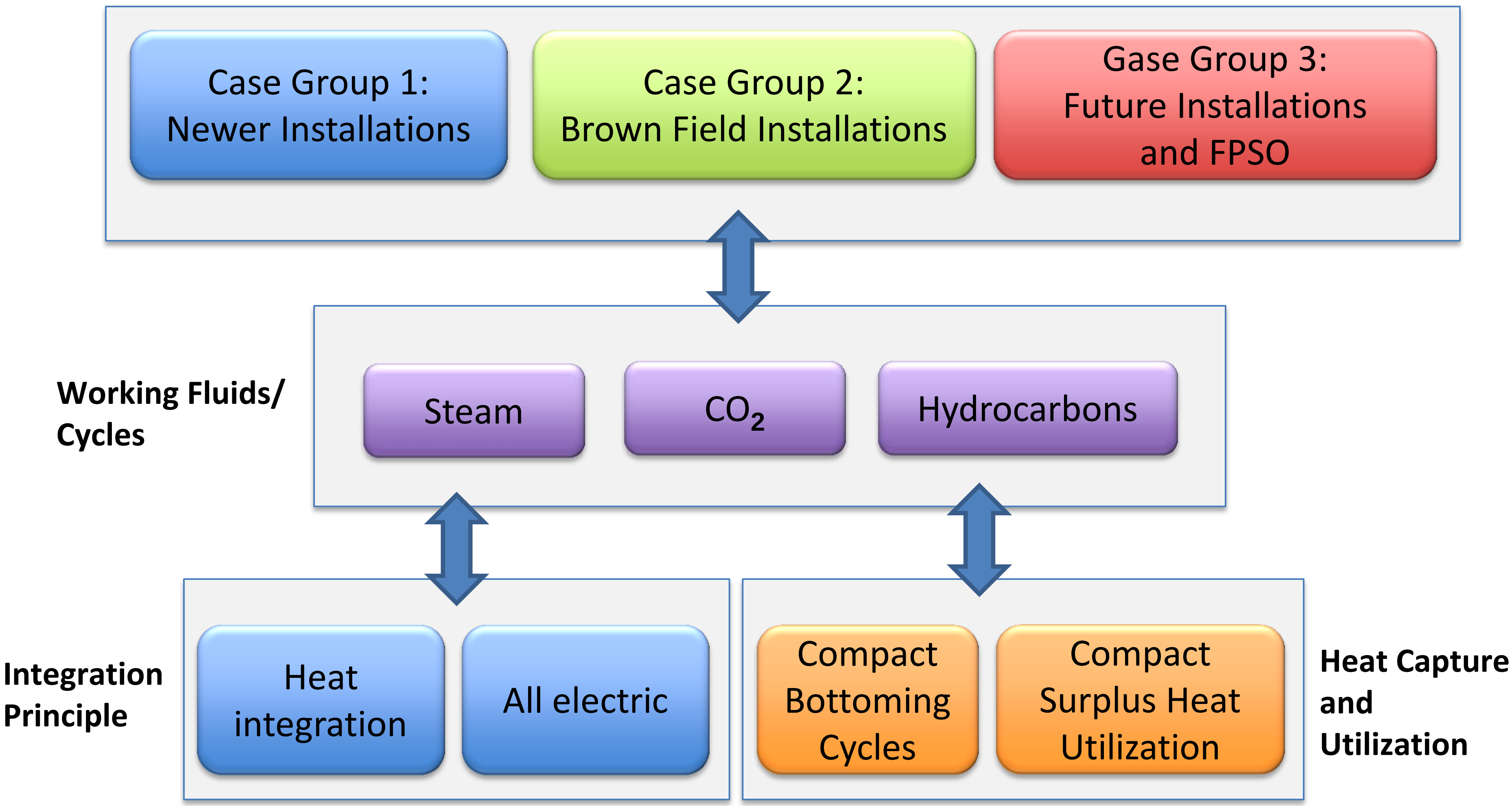
EFFORT Objectives

- Tailor energy efficiency technology to offshore conditions
  - Compact bottoming cycles
  - Power production from surplus heat sources
- Enable **implementation** → focus on offshore-specific requirements
  - Low weight
  - Compact size
- Identify demonstration opportunities

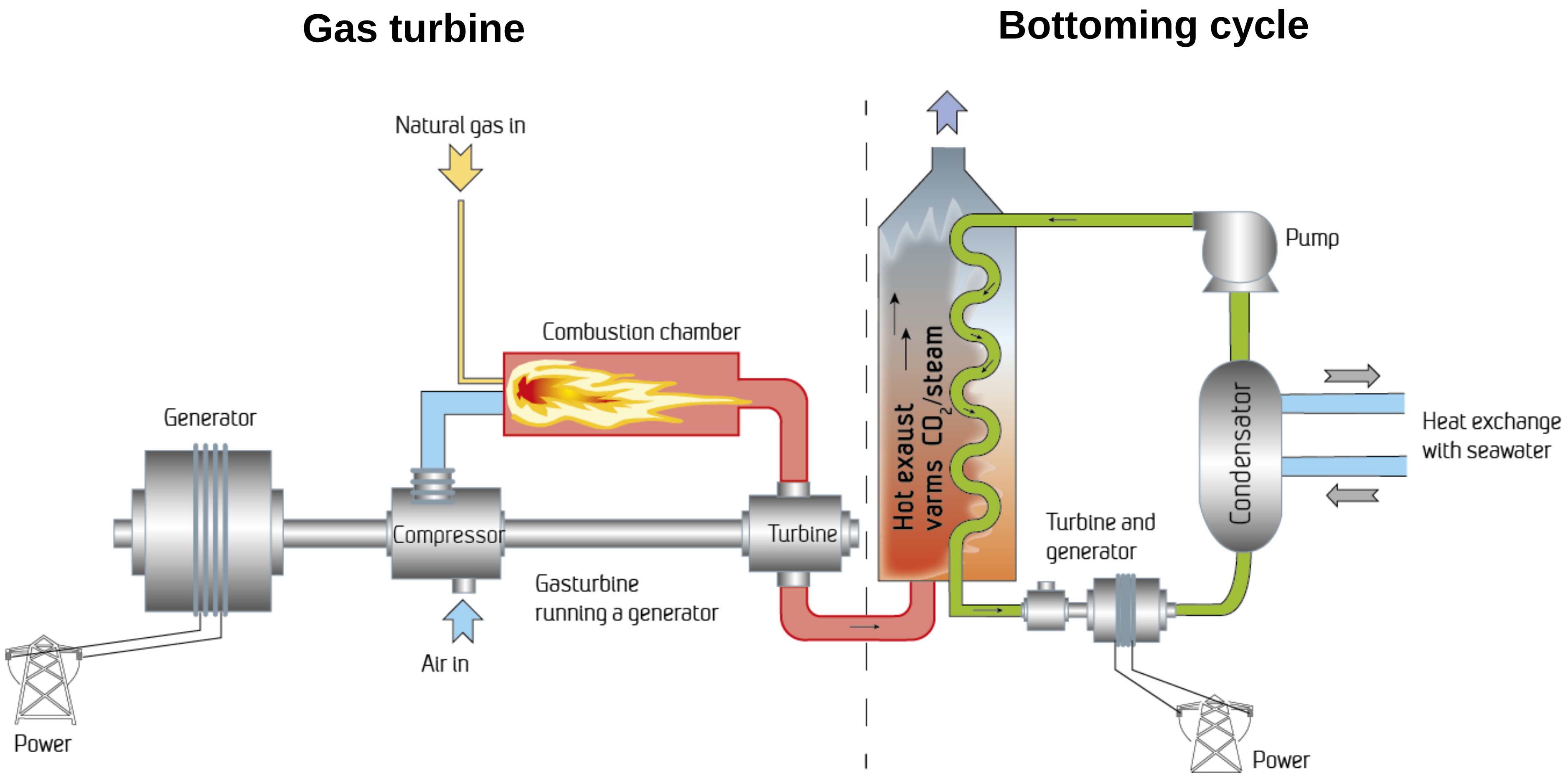
Energy Sources and Demands



EFFORT Case Studies

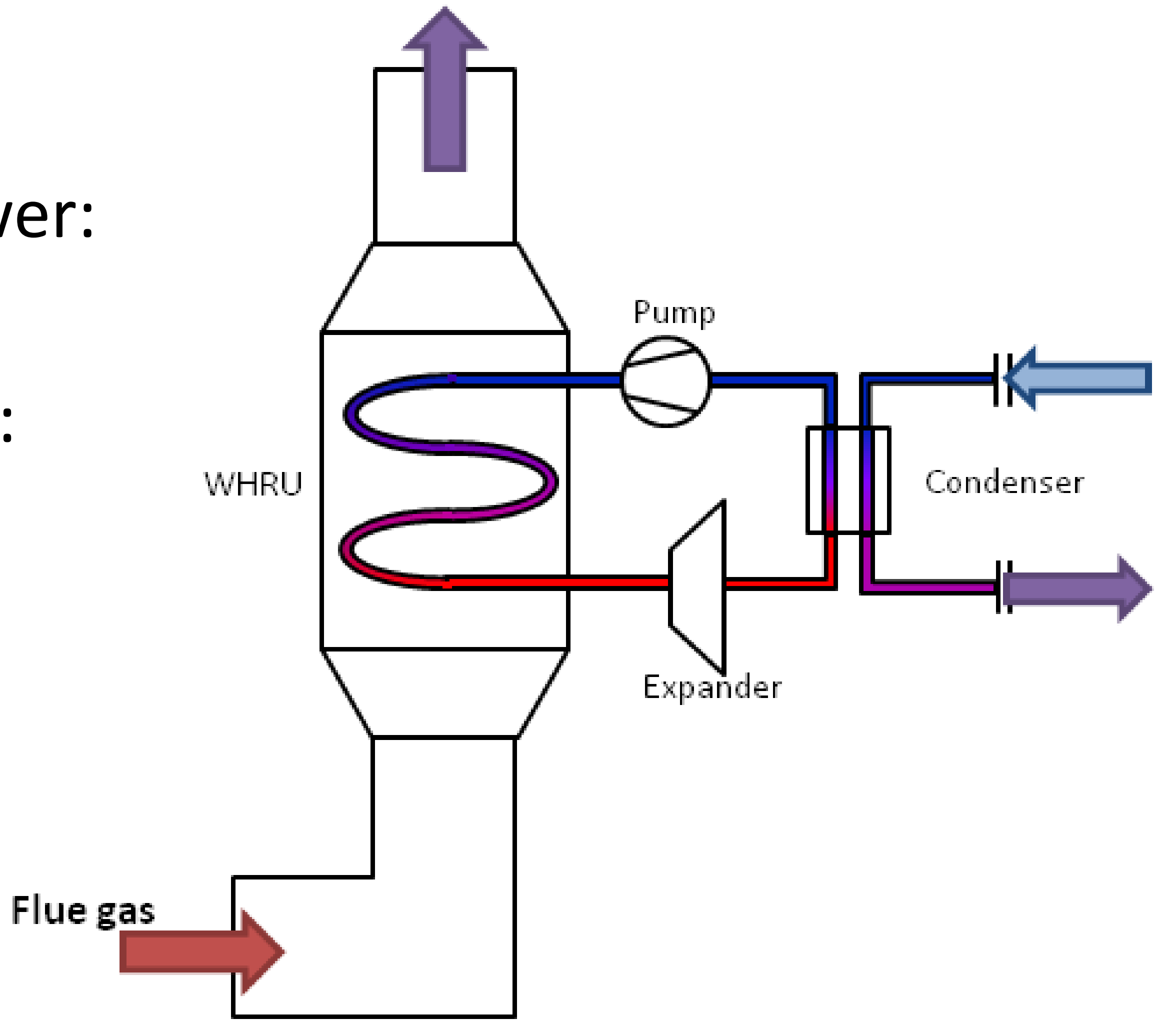


Power Production from Waste Heat



Bottoming Cycle

- GT nominal power: 32MW
- Combined cycle: 42 MW
- Increase in plant efficiency: 38.6 -> 50.0%

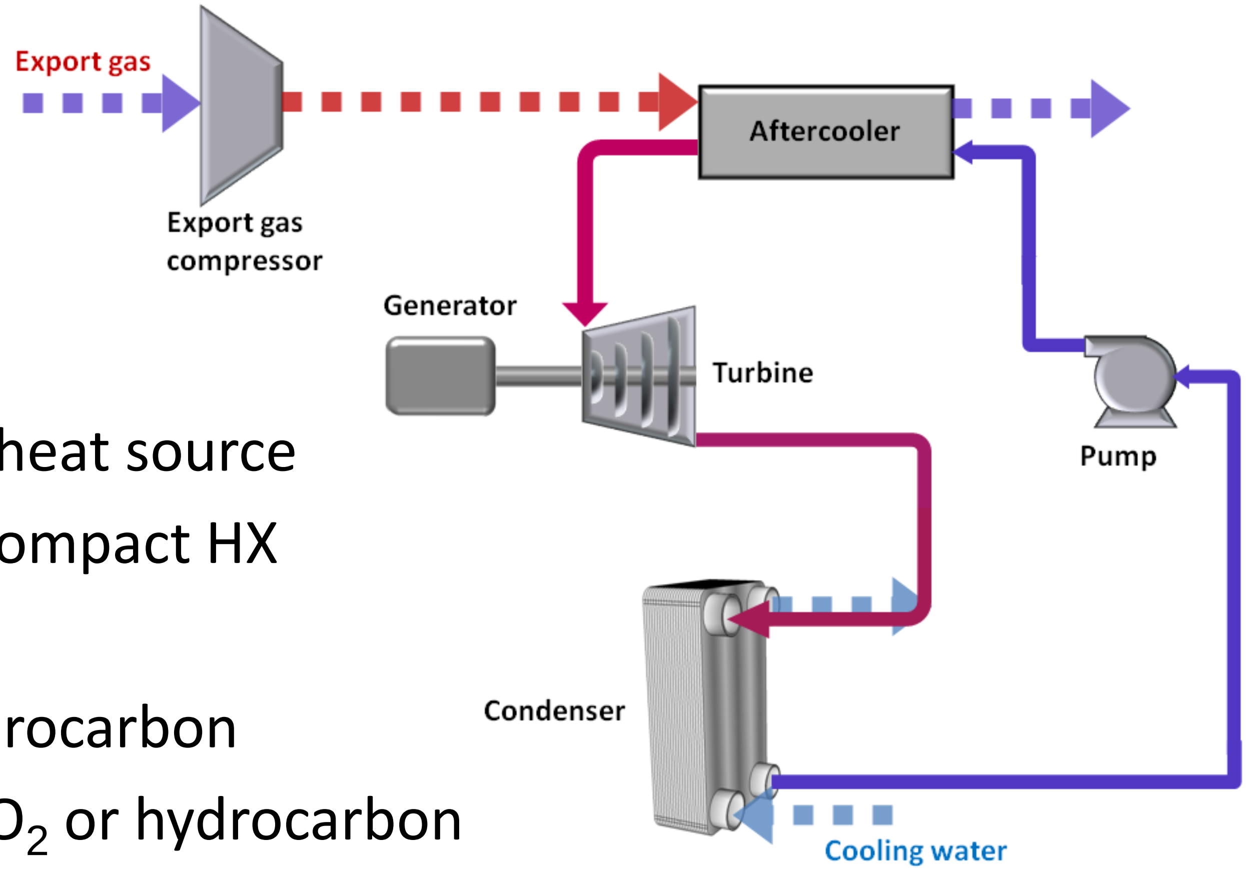


Working Fluids for Bottoming Cycles

Steam
- Conventional technology
- Challenges:
  - Land-based systems too bulky
  - Reliability
- Opportunities
  - Once-through technology
  - Reduce water treatment issues

CO_2
- Under development
- Challenges:
  - Full scale demo necessary
- Opportunities:
  - Potentially more compact
  - Suited for Arctic areas

Power Production from Surplus Heat Sources: Compressed Gas

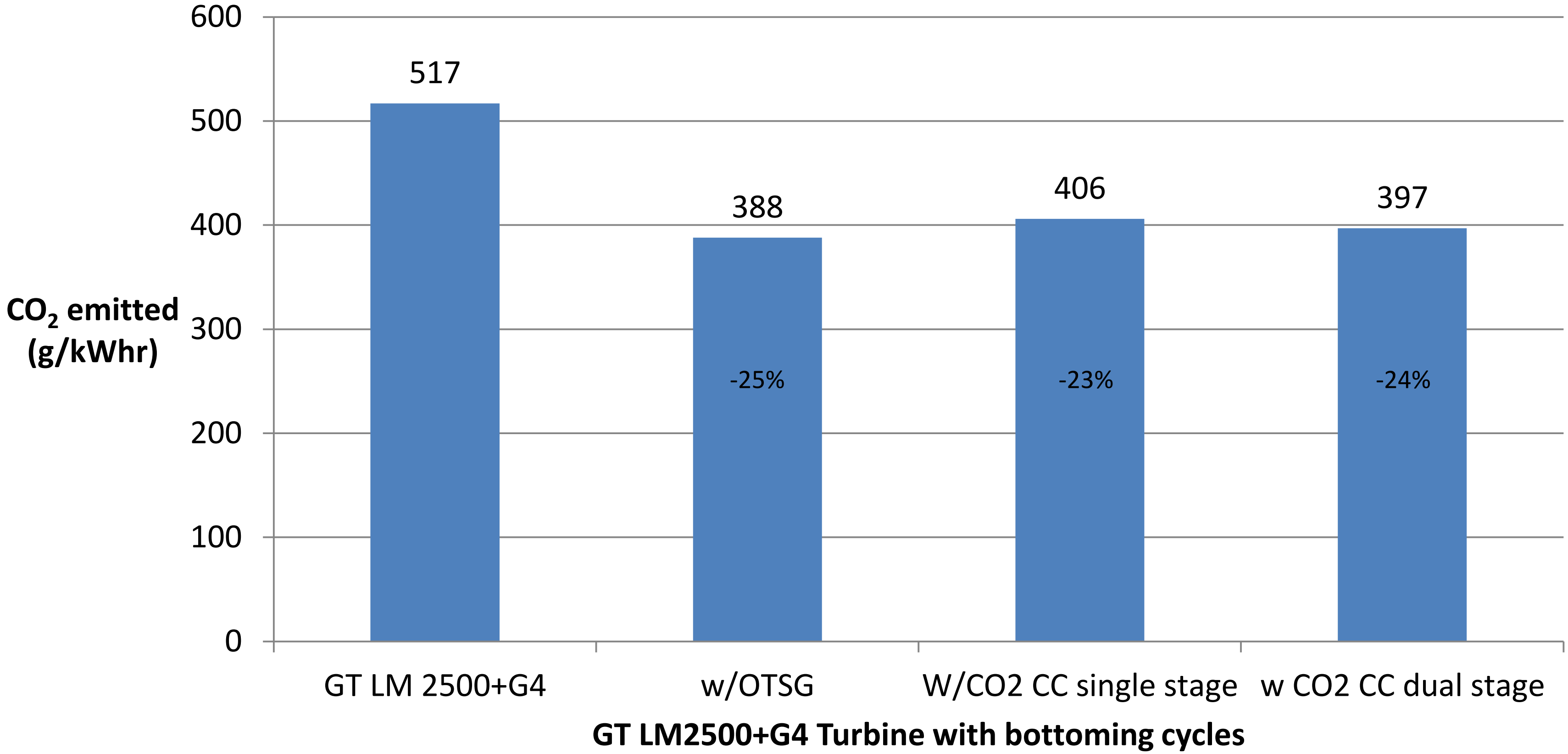


- Low temperature heat source
- High pressure -> compact HX
- Rankine Cycle
  - Subcritical hydrocarbon
  - Transcritical CO_2 or hydrocarbon

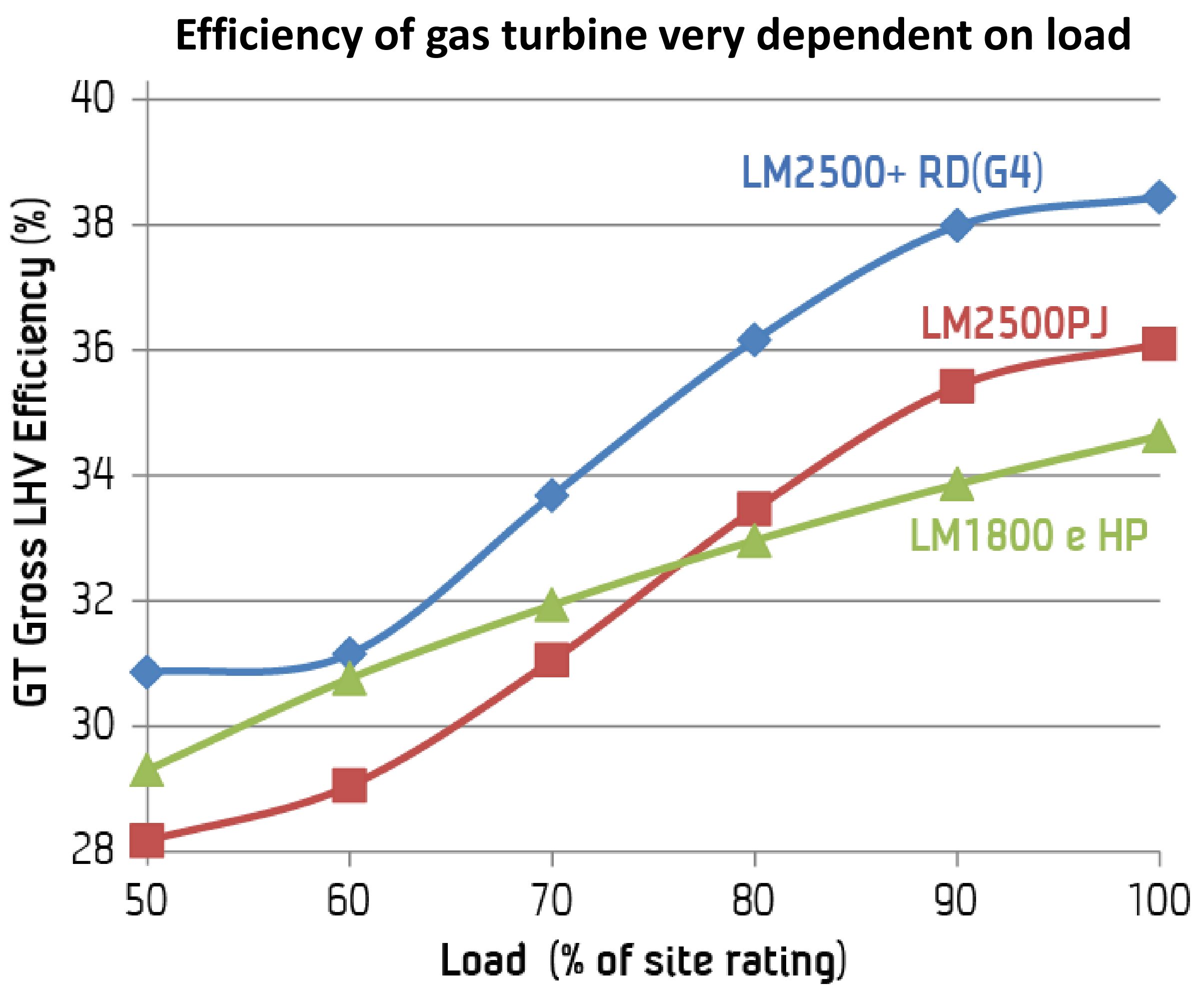
Bottoming Cycle Performance

	Simple Cycle	Combined Cycle Steam OTSG	Combined Cycle CO2 Single Stage	Combined Cycle CO2 dual stage
Gas Turbine	GE LM2500+G4	GE LM2500+G4	GE LM2500+G4	GE LM2500+G4
Net plant power output (MWe)	32.2	42.9	41.1	42.0
GT Gross Power output (MWe)	32.5	32.1	32.1	32.1
Bott Cycle Gross Power output (Mwe)	-	11.3	9.5	10.4
Plant Efficiency(%)	38.6	51.0	48.9	50.0

CO_2 Emissions from Gas Turbine with Steam and CO_2 Bottoming Cycles



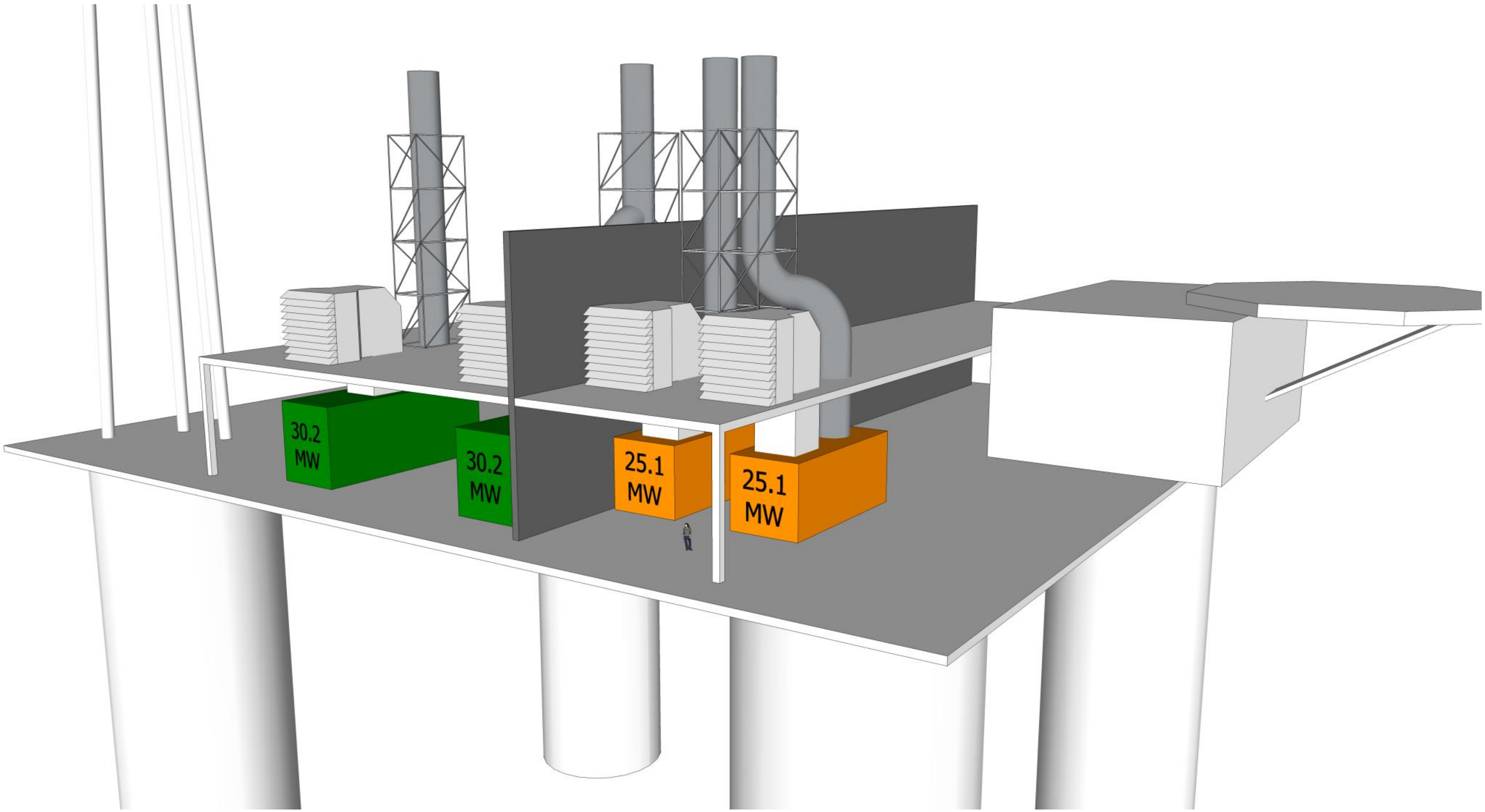
Scenarios for Improving Offshore Energy Efficiency



Scenario 1: Reduce Size of Turbines to Operate at Higher Effective Load

- **More than half of offshore gas turbines on the NCS run at 50-60% load, a few at 70-80%**
- **Beneficial to replace with smaller turbines where possible**
  - Run at higher load and higher efficiency
  - Up to 5 % reduction in CO_2 release
- **Even greater effect towards the end of the life of the platform**
  - power demand is reduced.
  - at low loads a less efficient turbine may become relatively more efficient than the larger turbine
- **Reducing CO_2 emissions without taking up precious space and weight**
- **Important factor in design of future- and during remodeling/maintenance of current platforms.**

Scenario 1: Reduce Turbine Size

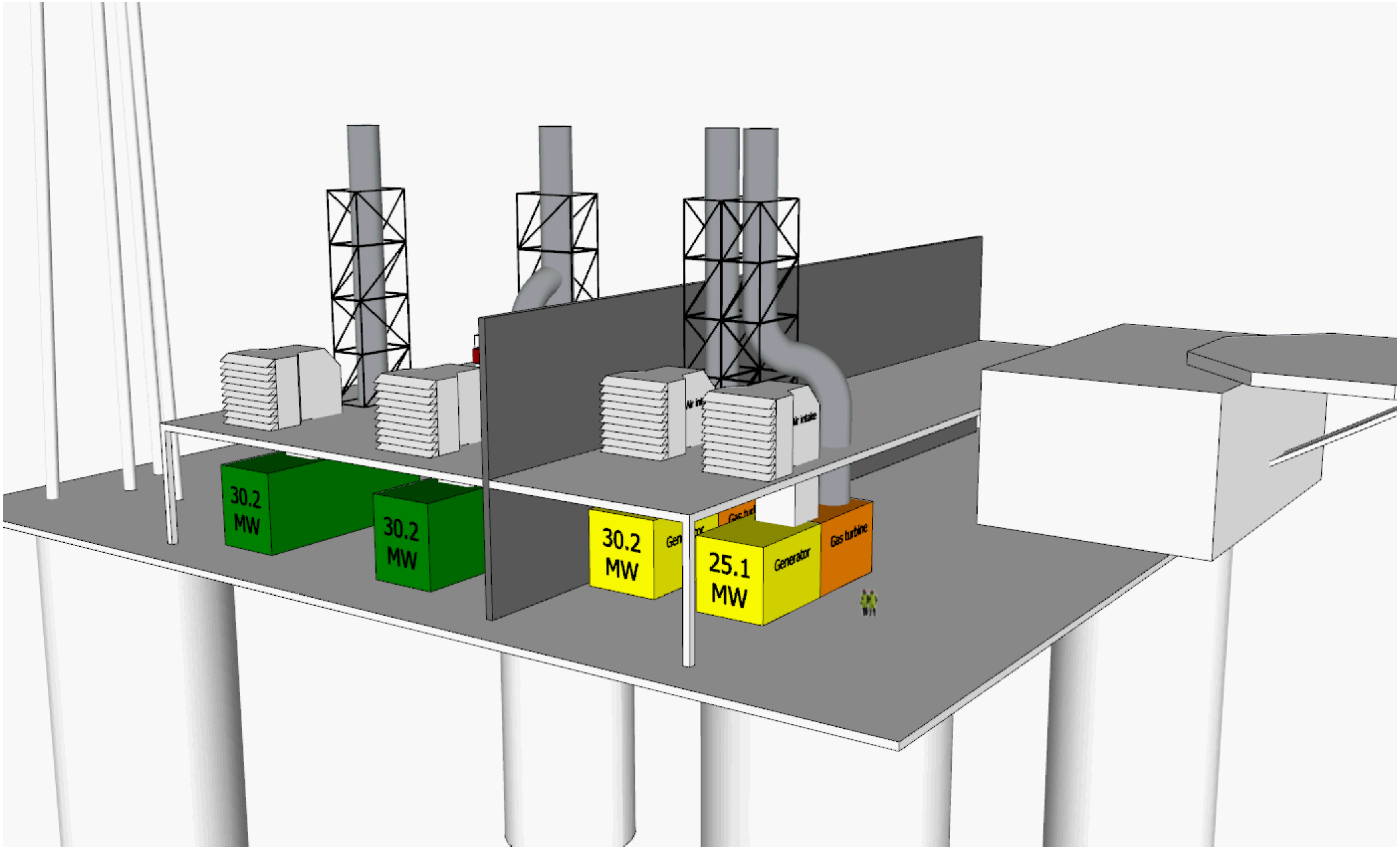


Scenario 2: Remove Turbine and Install Bottoming Cycle on Other Turbine

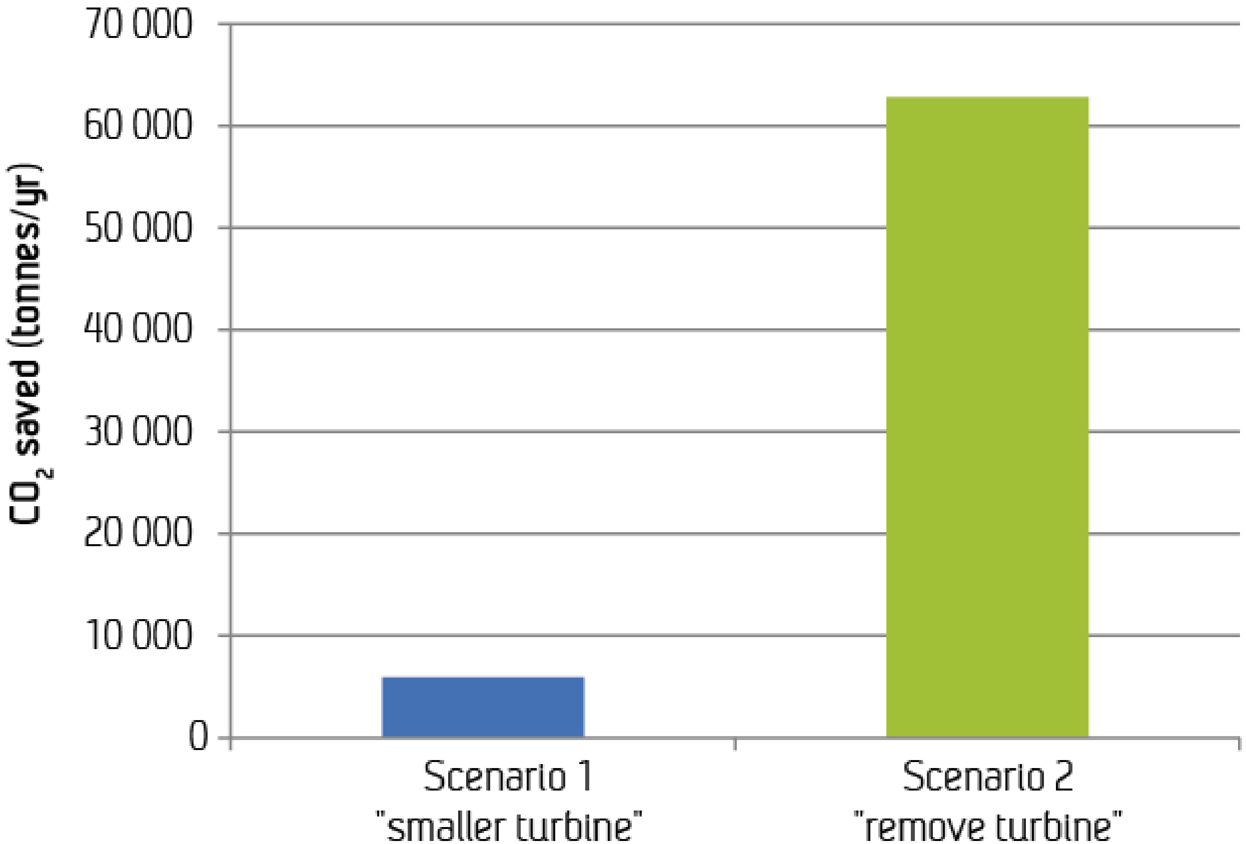
Internal electrification of plattform.

- Share power generated by many turbines to run more effectively
- Install bottoming cyle on one turbine and make other turbine redundant
  - No effect on platform's heat demand as WHRU is installed on a different gas turbine
  - Minimal weight addition as weight of gas turbine is ~ 200 tonnes and weight of bottoming cycle ~ 350 tonnes

Scenario 2: Replace 4th Turbine with a Bottoming Cycle

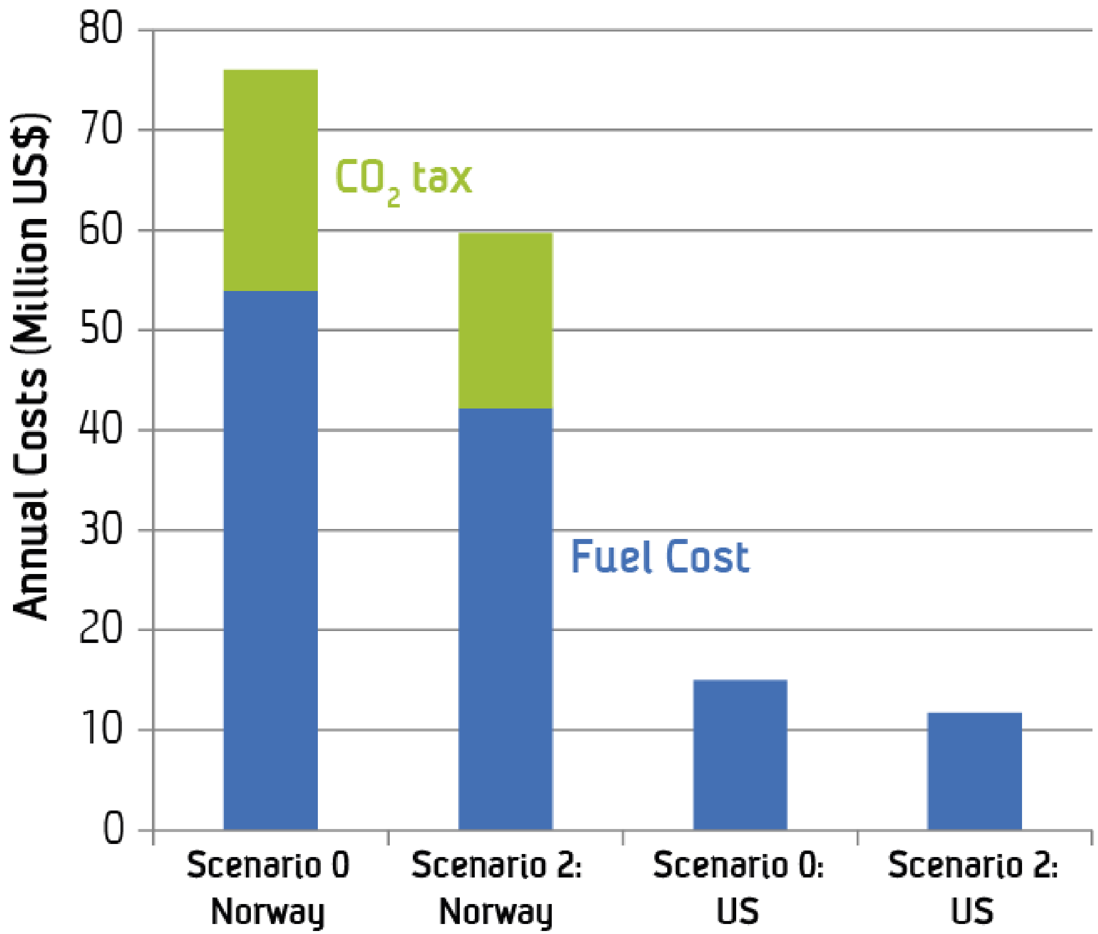


Adding Bottoming Cycle Can Reduce CO_2 Emissions by 63 000 tonnes/year



- CO_2 Reduction of 1.1 M tonnes CO_2 over the remaining life of the platform
- 22% reduction

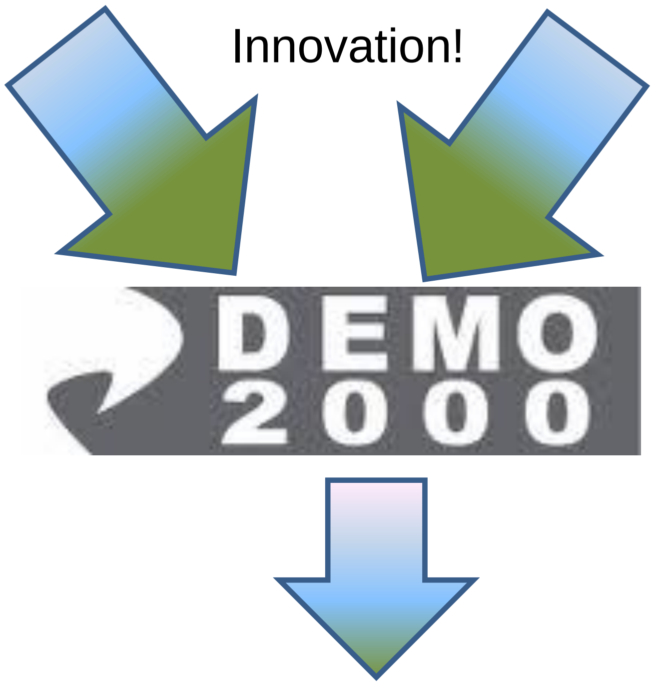
Cost Savings from Reduced Fuel Consumption and Tax (Norway)



Scenario 0: "As is"
Scenario 2: "Replace turbine with Bott. Cycle"

Development and Implementation

- Several spin-off projects planned
- Several opportunities in Norway for DEMO projects suitable for these technologies
  - DEMO 2000,
    Research Council of Norway
  - ENOVA



Conclusions

- **"Low hanging fruit"**
  - Internal electrification of platform to improve efficiency
  - Replace turbines running at low load with smaller turbines running at higher load –particularly towards end of life of platform- part of maintenance schedule
- **"Gas turbine replaced with a bottoming cycle"**
  - **22 % CO_2 reductions of 1,1 M tonnes** over the remaining life of the platform or 63 000 tonnes/year for the 18 years investigated
  - Annual savings in operational costs would be US $17 Million if on the NCS
- **CO_2 release on the NCS was 10.2 Million tonnes in 2010**
  - Potential max CO_2 reduction : 2.65 Million tonnes annually!
- **Implementation -technical and political factors**

Highly effective and not overly costly path towards reducing emissions of climate gases

Acknowledgements / Thank You / Questions

Acknowledgements
The author(s) acknowledge the partners: Statoil, TOTAL E&P Norway, Shell Technology Norway, PETROBRAS, NTNU and the Research Council of Norway, strategic Norwegian research program PETROMAKS (203310/S60) for their support.
Thanks to Daniel Rohde, SINTEF Energy for design of animations.

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