WHEN TRUST MATTERS

Decarbonization Initiatives

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What does it take to make to significantly reduce emissions related to drilling operations?

- Planning of the drilling operations with focus on emission reductions
- Set requirements to emission reductions in ITT
- Incentivise the drilling contractors to reduce fuel consumptions
- Leadership, culture and management system focused on emission reductions
- Implementation new technologies and related infrastructure

Short term measures

Work with Energy Efficiency Excellence

Typical energy and emission improvement project outline in the oil and gas segment

Baseline establishment

- Data collection and assembly of benchmark data

Energy review

- Assess the assets energy efficiency compared to benchmark and map improvement measures implemented and potential measures feasibility.

Performance management regime

- Establishment of performance management framework and potential need for development of data capture regime.

Processes and procedures

- Development of governing principles, processes and procedures tailored for implementation in management system.

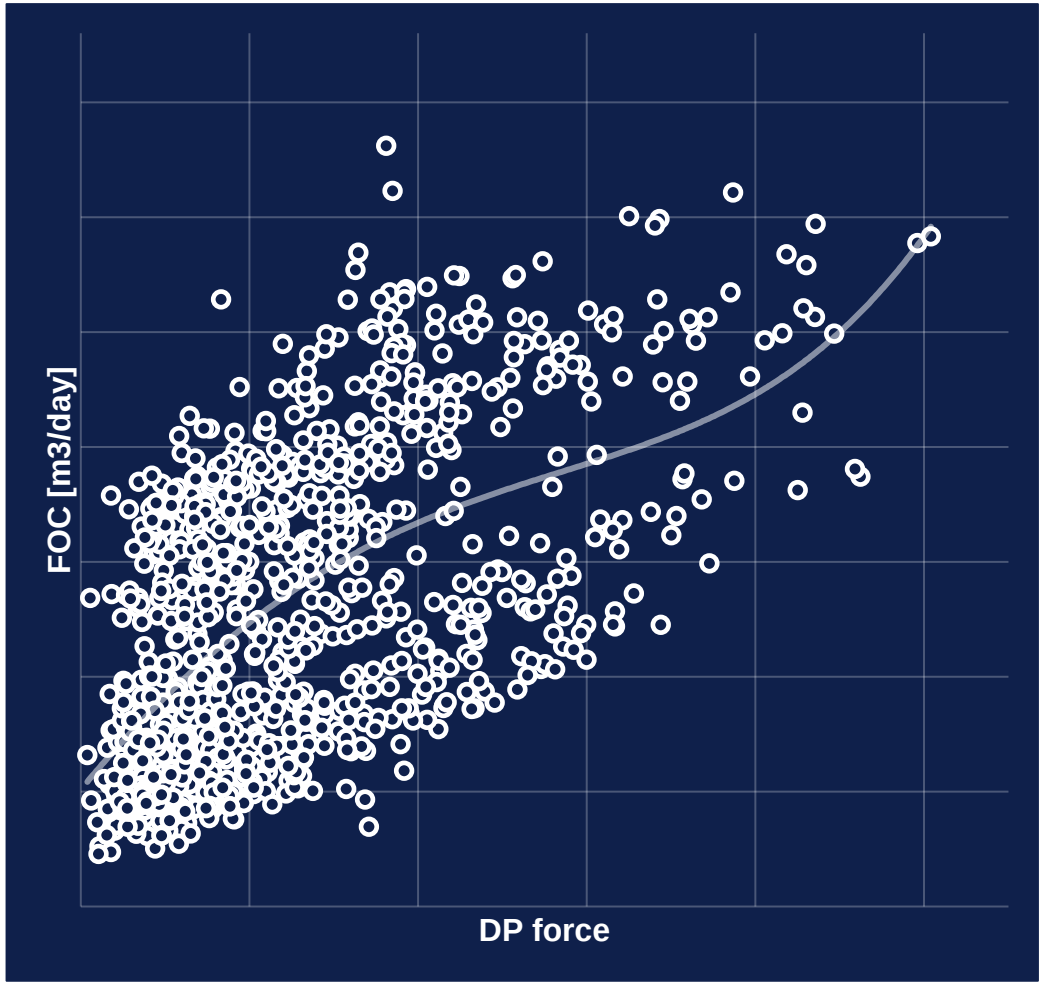
Success depend on leadership and culture

- Collaboration and leadership in the value chain
- Tone from the top pushing for emissions reductions
- A culture for continuous improvement
- Willingness to apply new technology

Establishment and assurance of energy and emission benchmark used for improvement work and

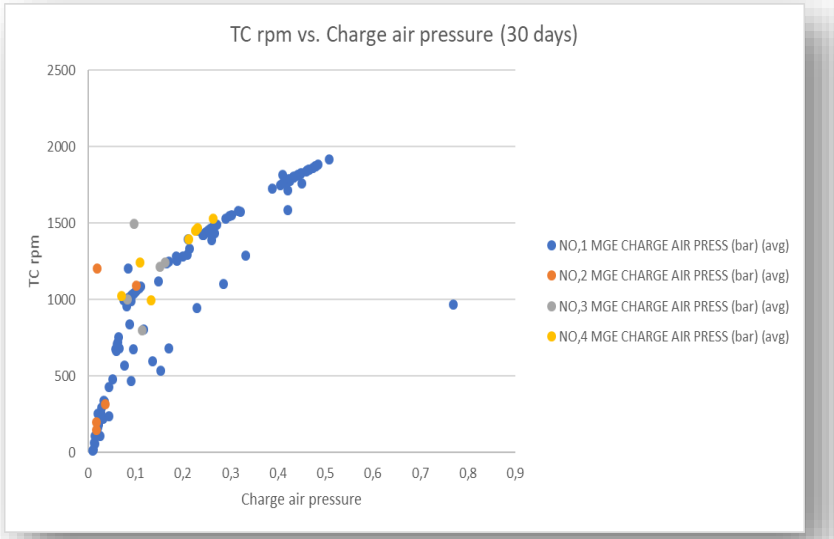
Group/Sub-group	Operational				Non-operational		
	Drilling	Tripping	Well test	Other	Transit	Standby	Yard/ Anchorage
Total Consumption	38,8	32,8	32,1	30,2	35,4	29,1	16,4
DG Consumption	33,5	28,3	27,6	26,5	30,9	25,3	11,9
- Drilling/ topside equipment	15,7	10,8	6,7	8,9	6,0	8,9	3,0
- Hotel & marine	14,2	13,4	13,0	12,3	13,4	11,9	8,6
- Thrusters	4,1	3,7	8,2	5,2	11,6	4,5	0,4
Boiler Consumption	5,2	4,5	4,5	3,7	4,5	3,7	4,5
Well test equipment	0,0	0,0	22,4	0,0	0,0	0,0	0,0
Mixing of well fluid during well testing	0,0	0,0	37,7	0,0	0,0	0,0	0,0

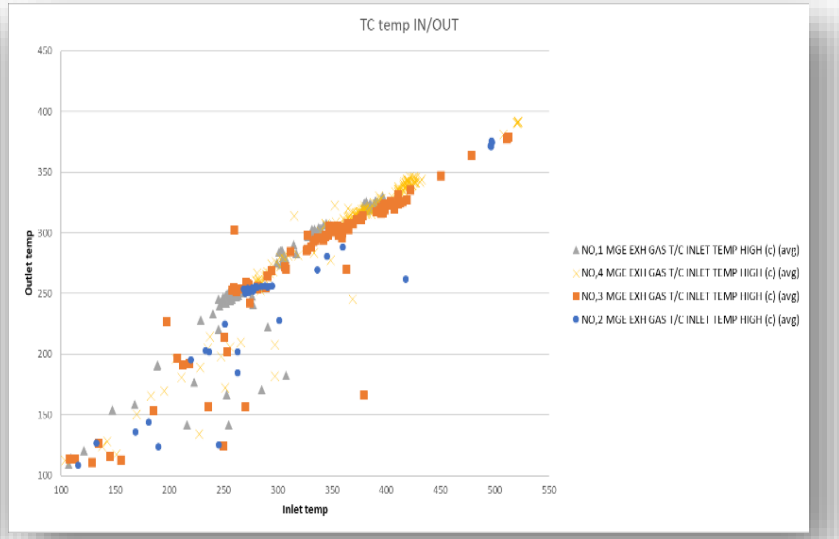
Weather characteristics	Modest	Harsh	Modest	Harsh	Modest	Harsh	Modest	Harsh	Modest	Harsh	Modest	Harsh	Modest	Harsh
DG consumption	28,0	39,6	23,7	33,4	23,0	32,6	22,1	31,2	N/A		21,2	29,9	N/A	

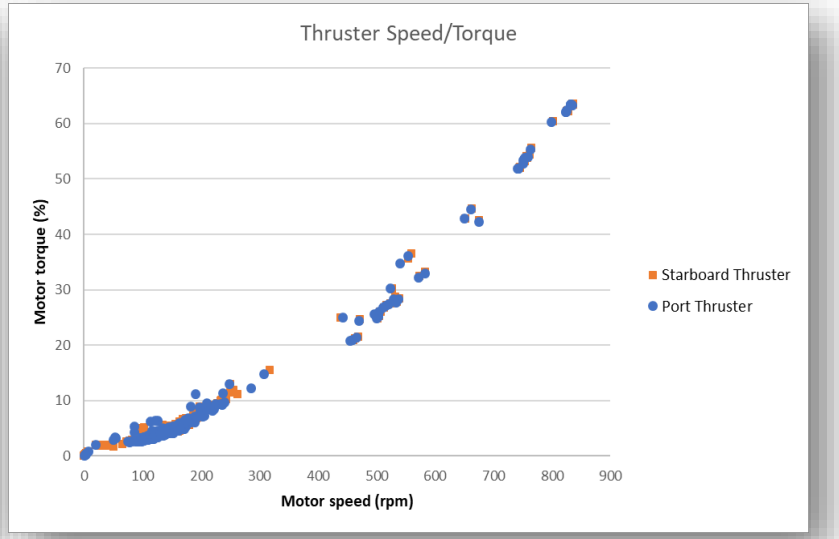


Monitoring of data is key to understand performance and potential improvements – Data from different sources to be combined to get the full picture

- In order to improve performance consumption and energy data needs to be monitored at the right level of detail.
- In order to understand rationale for performance sensor data needs to be combined with operations and environmental, data and in addition a baseline information.
- Data on its own is not the solution – need to drive decision making.







DNV energy efficiency work built on standard approach employed since 2005 with vast experience in relation to measures effect and implementation effort

Voyage performance

- Voyage planning & execution
- Speed management

Ship performance

- Hull condition
- Propeller condition

Fleet performance

- Fleet planning and schedule assessment
- Chartering/contracts
- Fleet composition
- Vessel type and size
- Transport system optimizing

Engine

- Engine efficiency
- Engines utilization
- Generator efficiency
- Hybrid solutions (Battery)
- Closed bus operation

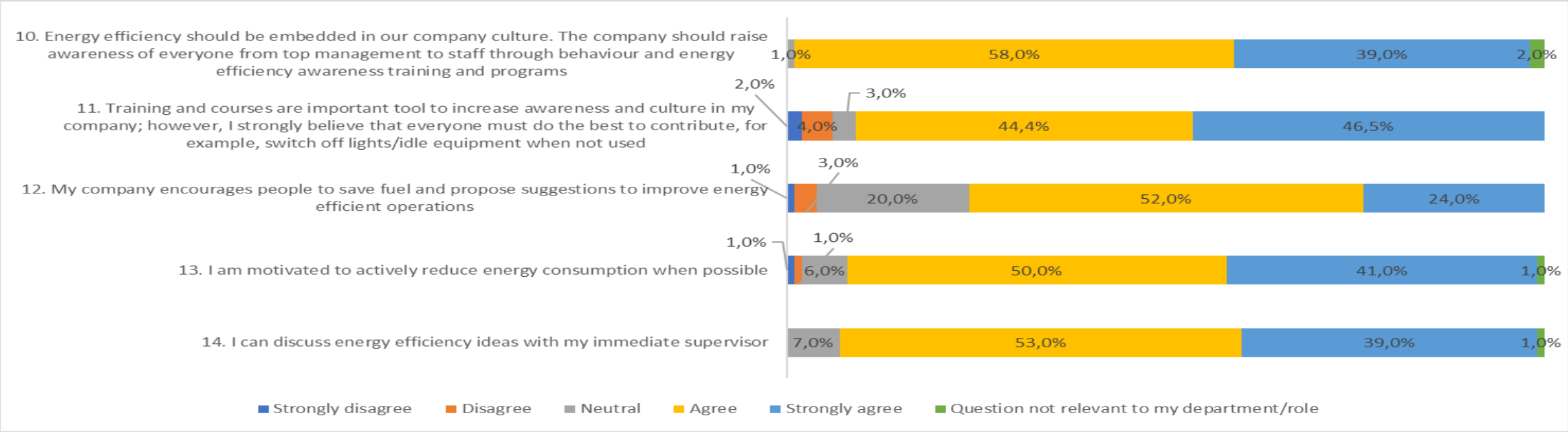
Management & Organisation

- Organizational setup, roles, responsibilities
- Policies, processes and procedures
- Communication and training
- Company culture
- Performance mgmt.

Consumers

- Deck equipment operations
- Thruster operations
- Ventilation, HVAC, cooling/ freezing, lights, frequency drives
- Insulation and heat losses
- Misc. consumers

Energy review and asset specific energy management plans
Understanding culture awareness is key based on DNV experience

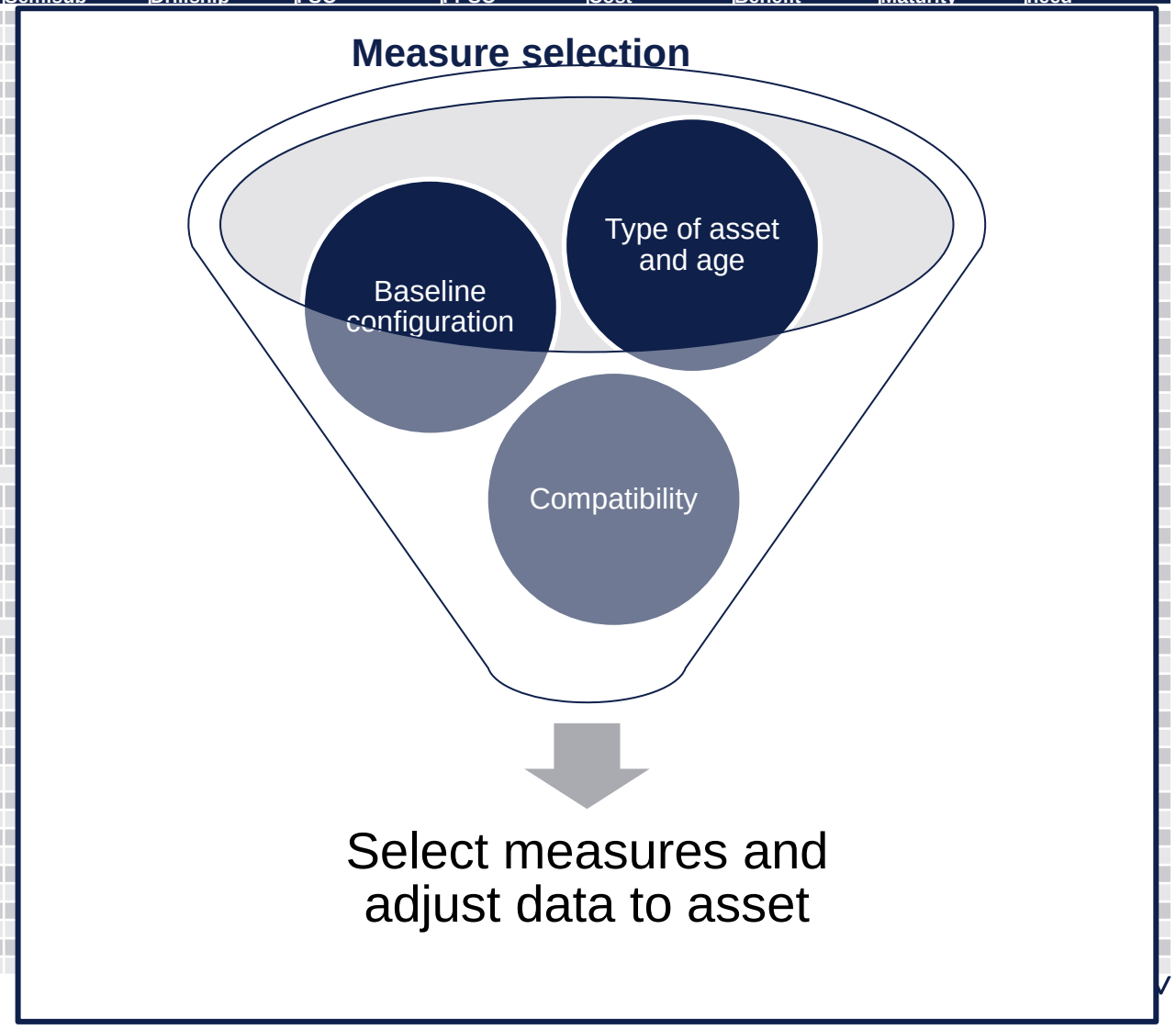


DNV experience that cultural surveys provide benefits in many dimensions:

- Effective means for marketing efforts within energy and emission improvement work
- Identify areas for development
- Repeat surveys to continuously monitor development

Energy review and asset specific energy management plans
What are possible measures - DNV experience provide a basis library

System approach	Measure	Semisub	Drillship	FSO	FPSO	Cost	Benefit	Maturity	Competence need
Transit	Speed management								
	Weather routing								
	Propeller polishing								
	Hull cleaning								
	Thruster operation								
Power management	Engine performance optimisation								
	Load and utilisation optimisation								
	Hybridisation/Energy storage /battery								
	Common bus solution								
	Renewable fuels								
	Fuel cell								
	Power hub for several assets								
	Power from shore/other asset								
	Carbon capture and storage								
Steam system	Installation of economisers								
	Waste heat recovery								
	Heat insulation paint on piping								
Consumers	Rtrofitting of Variable frequency drives (VFD)								
	HPU optimisation								
	Energy recovery deck equipment								
	HVAC optimisation								
	Energy efficient lightning								
	Installation of electric lube oil heater								
	Installation of solar films to reduce HVAC need								
	Installation of electric lube oil heater								
	Installation of reverse osmosis plant for freshwater production								
Other	Back load well fluid								
Behaviour and culture	Power management and performance monitoring								
	Energy management, behavioural								
	Optimised equipment operation								
	Optimised layup operational procedures								
	Performance management								
	Strengthen engine performance management								
	Improve communication related to requirement for services								
Processing plant – Gas treatment	Compressor revamp/re-rate								
	Optimal cooling before compression								
	Smart use of compressors								
	Flare management								
	Flare recovery								
	Flare modification								
	Reduction of continues, remote Flaring								
Processing plant – process optimization	Retrofitting oil export pumps								
	Revamp/re-rate oil export pumps								
	Harvesting from depressurization								
	Process control/optimization								
	Reducing pipeline friction								
	Subsea compression								
Seawater injection	Retrofitting water injection pumps								
	Revamp water injection pumps								
	Renewables								
Production manifold	Manifolds with several pressure levels								
	Energy recovery from well								



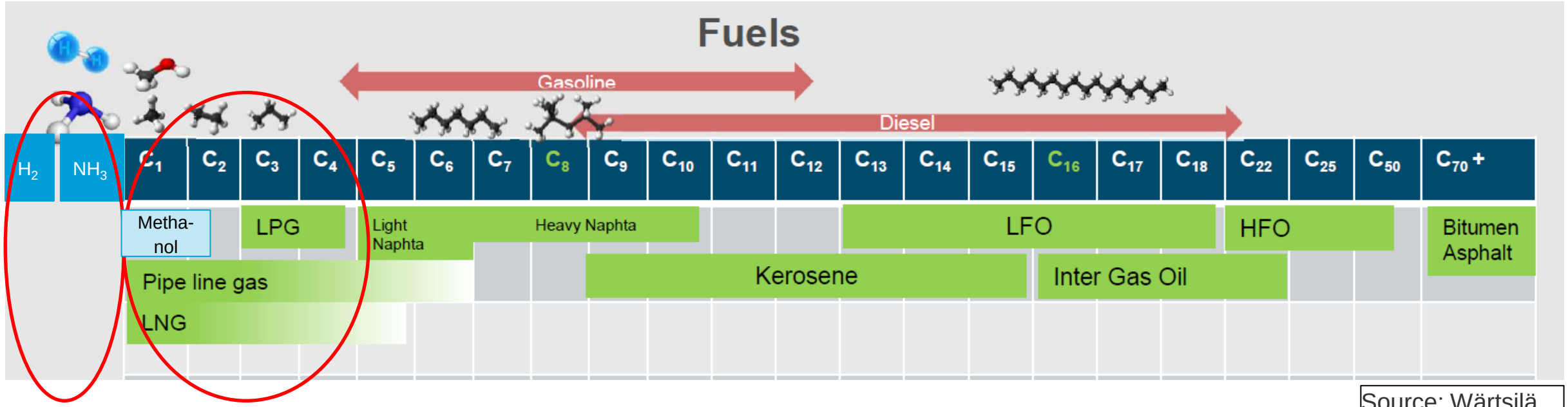
Development of management system to cater for improved operation

	Item	Status	Observations
6.1	Actions to address risks and opportunities	◑	Defined for 14001 in procedure 1234. To be amended for energy management
6.2	Objectives, energy targets and planning to achieve them	◑	Defined for 14001 in procedure 123456. To be amended for energy management
6.3	Energy review	○	To be further specified and established. DNV to draft.
6.4	Energy performance indicators	◔	Process in place, amend for energy management. DNV will provide suggested wording update/process/procedures
6.5	Energy baseline	◔	To be specified and established. DNV to draft.
6.6	Planning for collection of energy data	◑	Process in place, amend for energy management. DNV will provide suggested wording update
7.1	Resources	◑	Defined for 14001 in procedure 6789. To be amended for energy management
7.2	Competence	◑	Defined for 14001 in procedure 00101 and other document, e.g. Compliance training matrix, Onboard training matrix. To be amended for energy management
7.3	Awareness	◑	Defined for 14001 in procedure 11111 and other document, e.g. awareness training, handover. To be amended for Energy management.
7.4	Communication	◑	Defined for 14001 in procedure 0000. Process in place. To be amended for Energy management.
7.5	Documented information	◑	Defined for 14001 in procedure 8765. Process in place. To be amended for Energy management.

○ Not started ◔ First items available ◑ Major items available ◕ Minor items missing ● Finalized

Taking the next step - going to the zero carbon unit

What are our fuel options?



Source: Wärtsilä

Carbon-free

10-20% Lower carbon content compared to MGO-HFO

New energy carriers

In use – Mature technology

Electrification

Application

- **525** vessels in operation and in order book.
  - 75% hybrid
  - 25% full electric
- Strong uptake over last few years.
- Full electric only suitable for shore operation period close to shore.

Maturity GHG

- -10 to -100%

LNG

Application

- **563** vessels in operation and in order book.
- Considered **transition fuel.**

Maturity GHG

- -10 to -100%

DNV rules in place

Tested – Mature technology

LPG

Application

- 12 LPG carriers - retrofits
- 24 new LPG carriers ordered

Maturity GHG

- -17%

Methanol

Application

- 1 passenger vessel
- 9 methanol tankers
- 15 new methanol tankers ordered
- Main challenge: Fuel cost
- Easy to produce as bio-/synthetic-methanol

Maturity GHG

- -10% onboard-fossil methanol
- -80% bio methanol

DNV rules in place

Future – Under development

Hydrogen

Application

- 2 Passenger ferries ordered
- Main challenges:
  - CapEx
  - Fuel cost
  - Storage space
- Mainly for short operation time

Maturity GHG

- H2 from NG: same as oil
- Renewable H2: -100%

DNV is working with industry partners to remove barriers for hydrogen and ammonia

Ammonia

Application

- Can be used in internal combustion engines
- Suitable for extended operations
- Easy to store
- Main challenge: Toxic and corrosive
- Ammonia tankers already interested

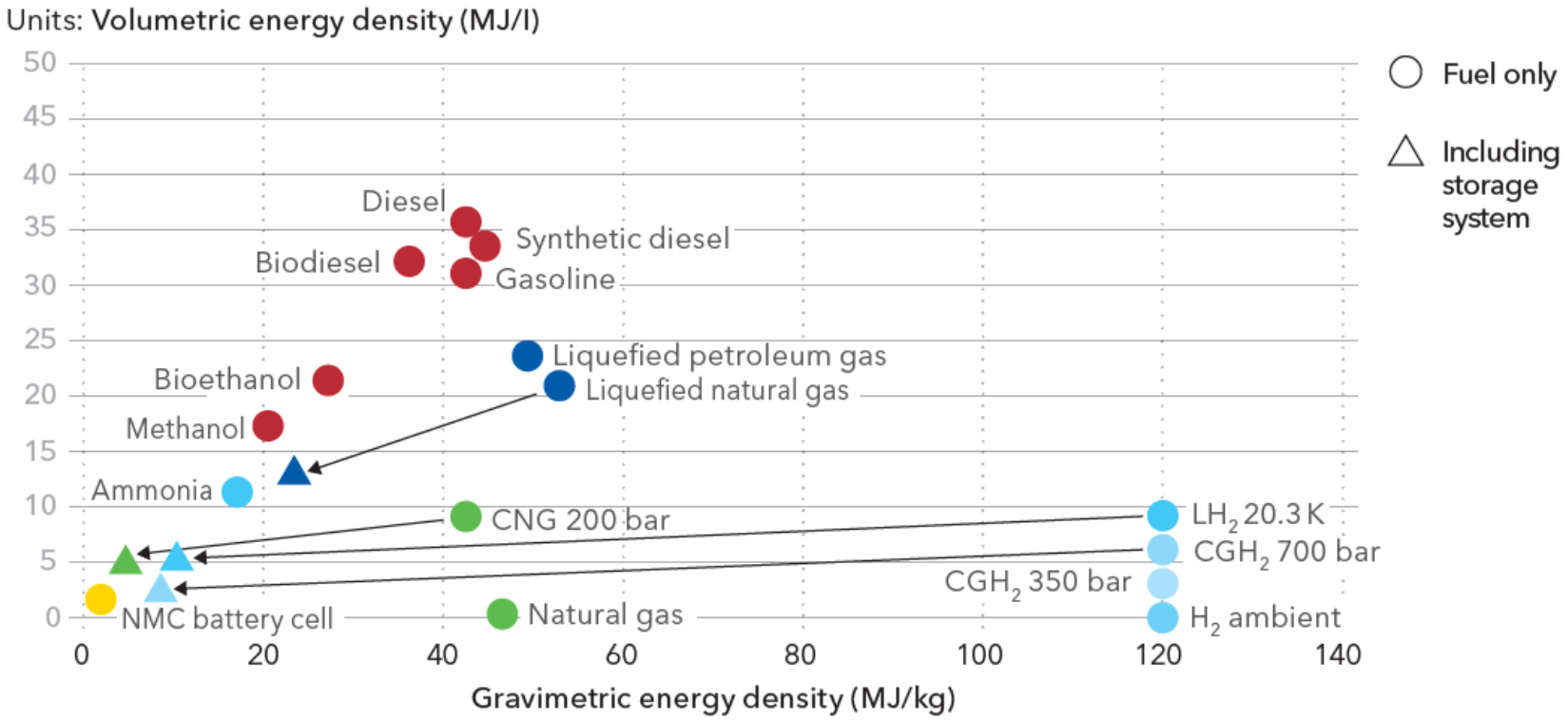
Maturity GHG

- Significant savings only when produced from renewables

DNV is working with industry partners to remove barriers for hydrogen and ammonia

New fuel options - New challenges for storage

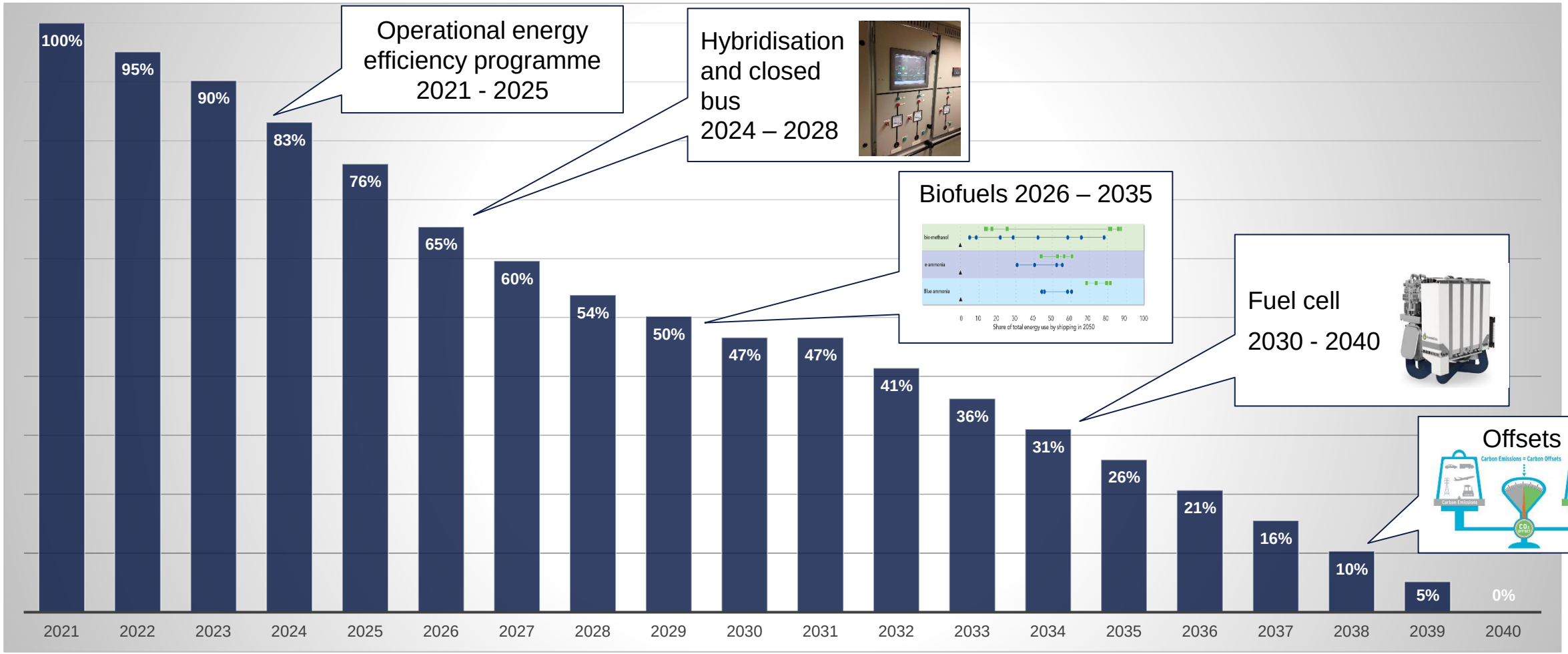
Comparison of gravimetric and volumetric storage density for fuels



Note: Arrows show shifts in energy density when storage is required.
Key: CGH_2, compressed gaseous hydrogen; CNG, compressed natural gas; H_2 ambient, hydrogen at ambient temperature; LH_2 20.3 K, liquefied hydrogen at 20.3 kelvin; NMC, lithium nickel manganese cobalt oxide

Source: Inspired by Shell (2017) and MariGreen (2018)

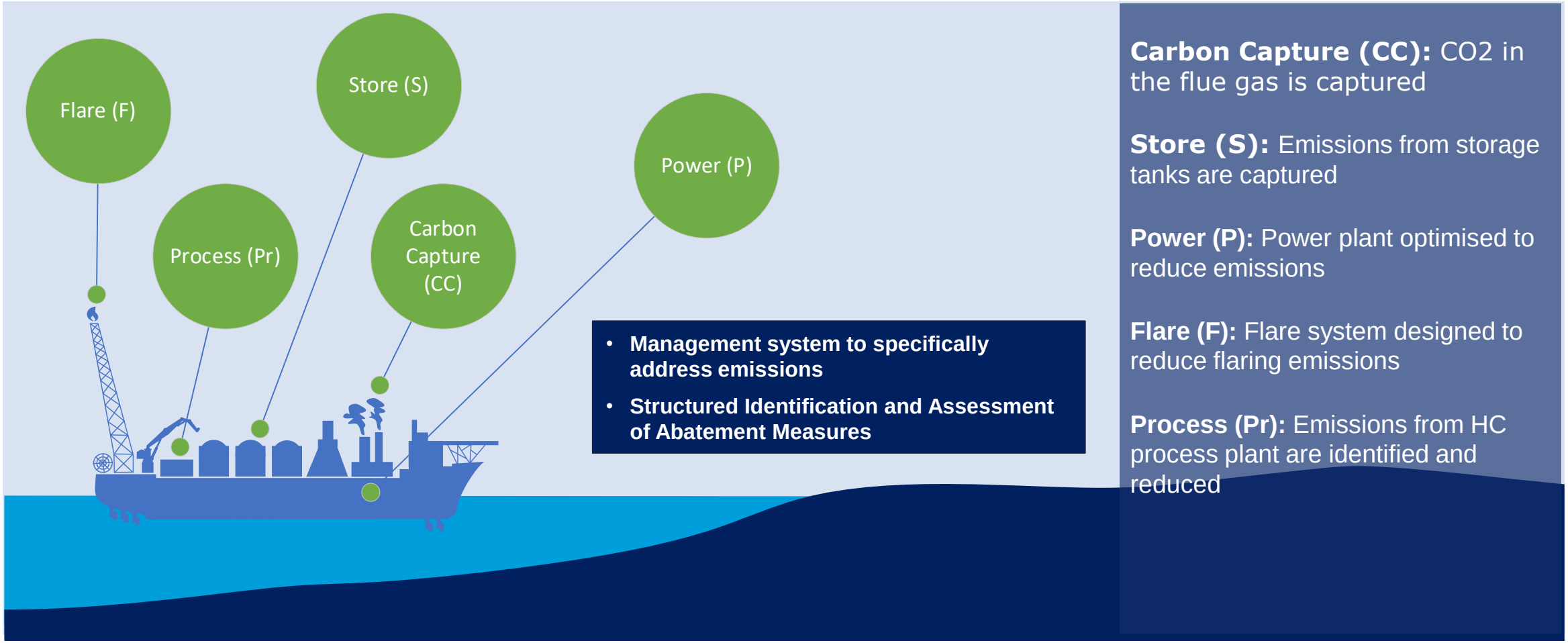
What can be done ? Aggressive decarbonisation strategy to demonstrate how to reach zero emissions!



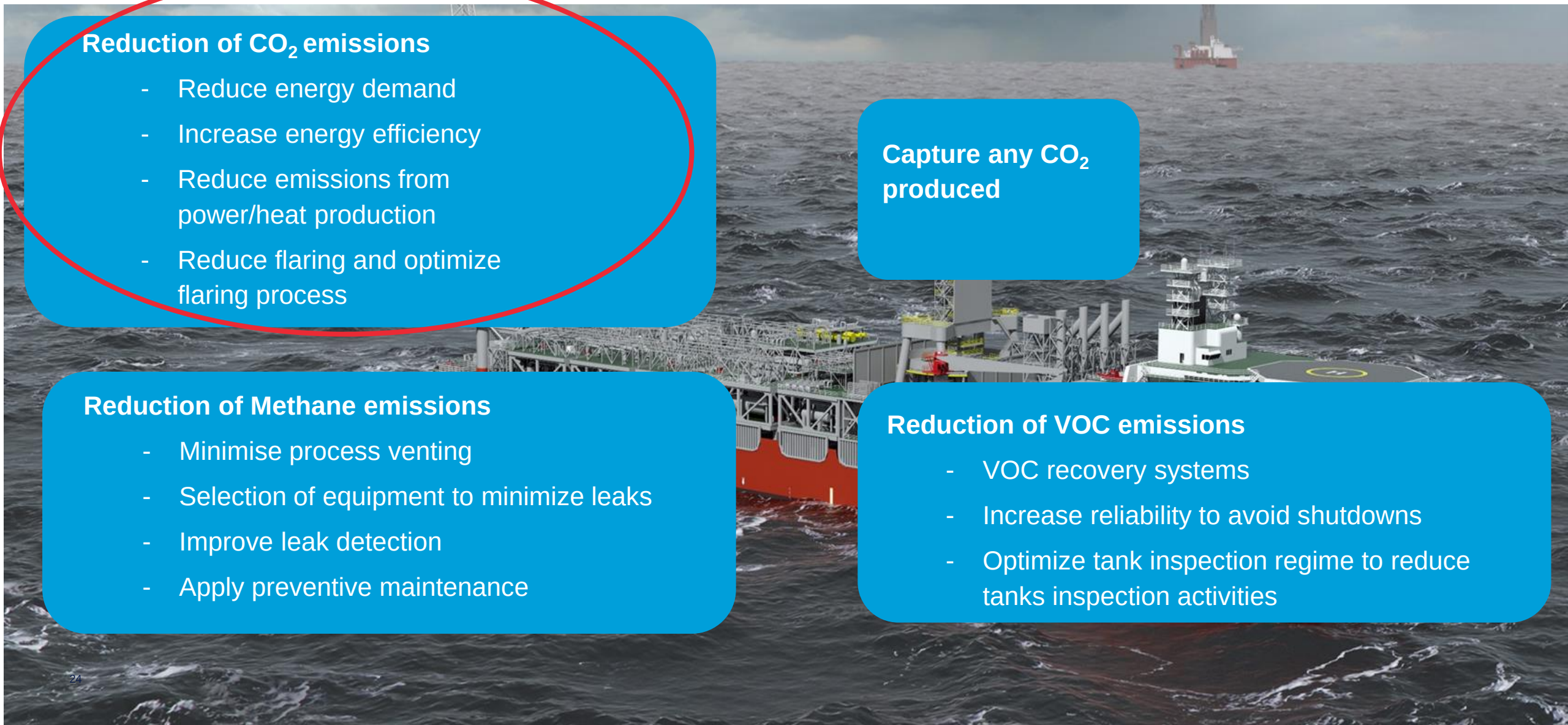
New class notation - Abate

For FPSOs, FLNG and DRU

Greenhouse gases focused in the voluntary Abate Notation



Potential Abatement Measures



Reduction of CO_2 emissions

- Reduce energy demand
- Increase energy efficiency
- Reduce emissions from power/heat production
- Reduce flaring and optimize flaring process

Capture any CO_2 produced

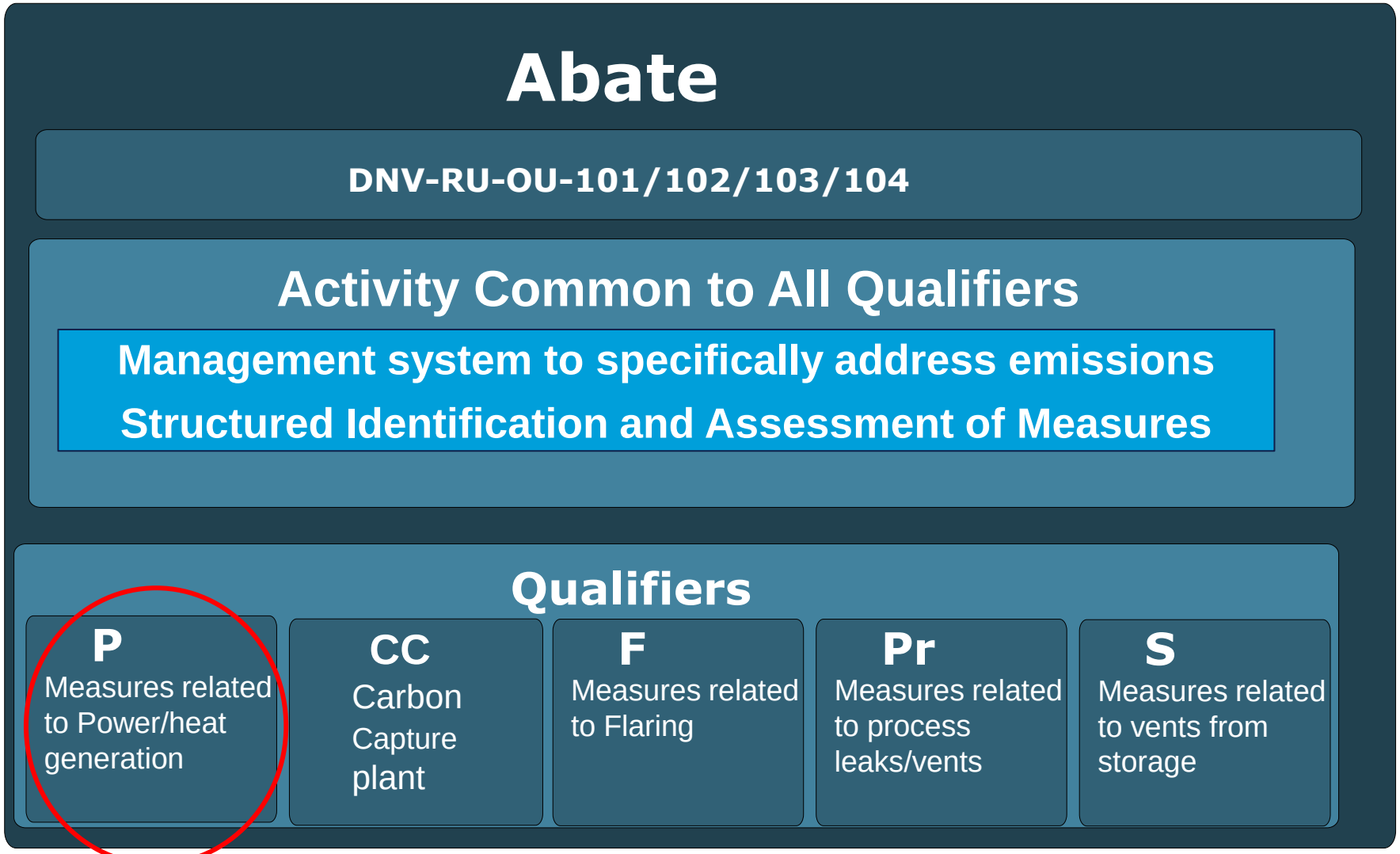
Reduction of Methane emissions

- Minimise process venting
- Selection of equipment to minimize leaks
- Improve leak detection
- Apply preventive maintenance

Reduction of VOC emissions

- VOC recovery systems
- Increase reliability to avoid shutdowns
- Optimize tank inspection regime to reduce tanks inspection activities

Abate notation (framework)



Voluntary and Modular Class Notation

Requirements in rules (for FPSO, FLNG, FSO, Drilling)

Management system review and abatement measures identification and assessment

….based on implementation of measures

DNV Abate notation
Abate fundaments - Emissions Management System

- The Owner shall include emission management as part of the overall company management system. The management system should provide the technical, commercial and environmental justification for the management of emissions.

- Emission management shall follow similar principles as those documented in ISO 50001 which addresses Energy Management, i.e.
  - a policy with respect to emission abatement
  - targets and objectives to meet the policy
  - How to use data to better understand and make decisions about emission abatement
  - Means to measure the results
  - Procedure to review how well the policy works
  - Feedback to continually improve emission management

- Where applicable, the results of the emission abatement consideration **shall** be incorporated into specification, design and procurement and operational activities.

- Maintenance of the Abate Notation in the Operations phase will involve review of continued application of the emission abatement policy, with relation to for example:
  - Monitoring
  - Application to modifications/equipment change-out
  - Assessment of Best Available Technology

DNV Abate notation
Abate (P) - Requirements

Emissions from Power/Heat generation

- An **emissions philosophy** related to releases from power/heat generation **shall** be documented as part of the Emission Management system.
- Measures identified to **optimize/reduce energy demand**, giving consideration to power management and power system design are to be implemented.
- A system to **monitor power consumption** is to be put in place to confirm assumptions and identify potential for energy performance improvement.
- Measures **shall** be taken to **optimize efficiency of power/heat generation** (e.g. closed bus, economisers)
- Where assessment shows that use of **sources of power** with lower greenhouse gas emissions as part or all of the power supply is feasible and practical this **shall** be implemented (e.g battery).
- Where use of **sources of power with lower emissions** as part or all of the power supply is feasible and practical this is to be implemented.
- **Procurement shall** consider selection of equipment based on efficiency and emission levels.

DNV is a partner for reducing greenhouse gas emissions

- Review of consumption baselines
- Cultural change
- Energy efficiency plans
- Management system changes
- Development of reporting regimes
- Develop performance monitoring and visualisation solutions
- Qualification of new technologies
- Notations (ABATE/SMART) to support improvement and demonstrate results

The benefits of active work with emission abatement

- **Meet expectation on climate actions and energy transition from community, customers and shareholders**
- **Ensure compliance with specific environmental requirements to production units in upcoming tenders**
- **Securing access to finance as capital markets favor lower emission projects**