

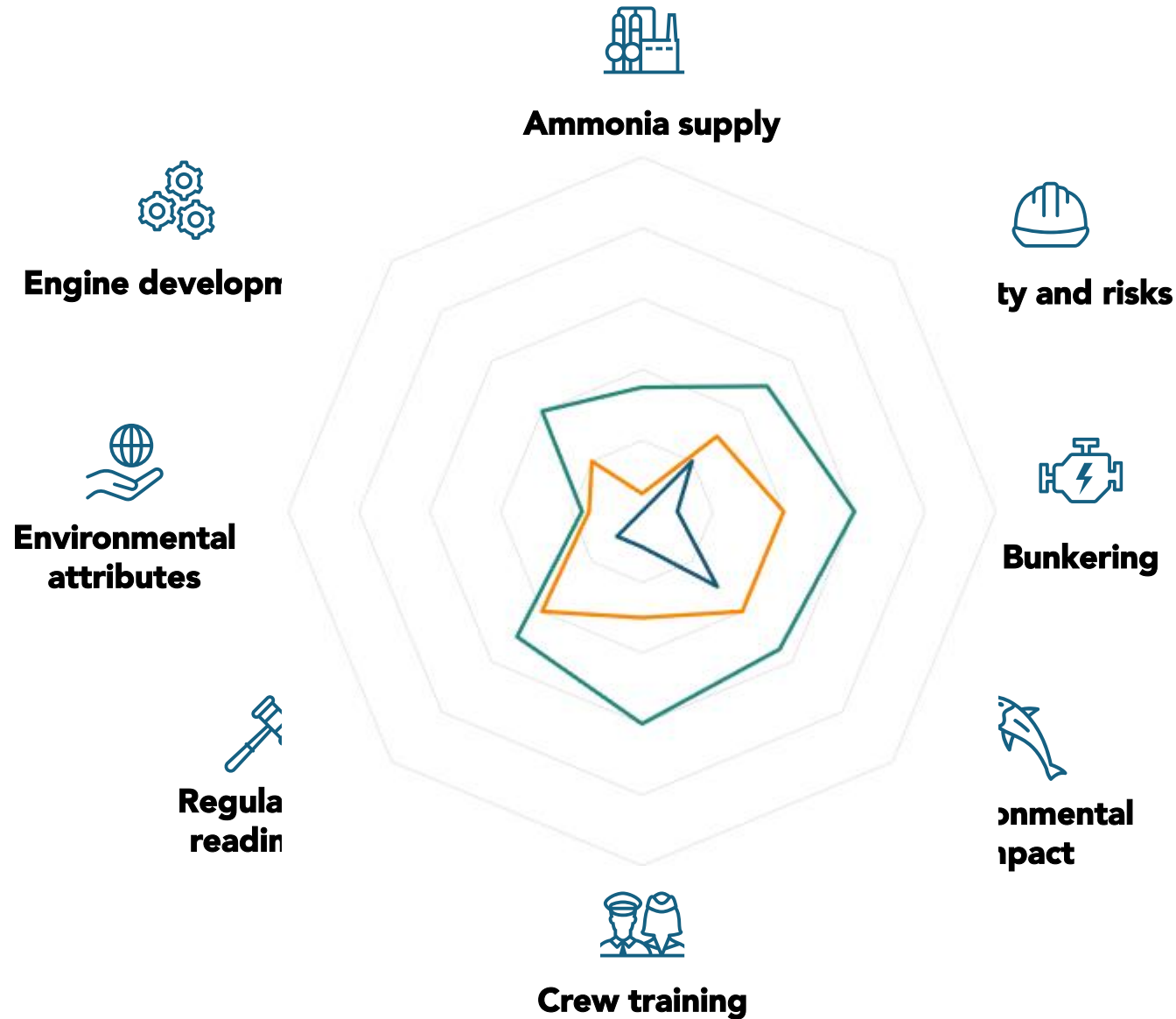


IMO technical seminar on the use of ammonia as marine fuel

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Readiness is improving across the ecosystem



- **Ammonia supply** | Existing ammonia infrastructure can kick-start scaling of low-emission ammonia
- **Engine development** | Engines now type-approved or in service
- **Safety and risks** | Fuel-specific assessments, resulting in guidelines and procedures
- **Training** | IMO seafarer interim guidelines approved May 2026
- **Regulatory readiness** | IMO interim guidelines for using ammonia as a fuel approved Dec 2024, May 2026
- **Bunkering** | Key ports are readying for ammonia bunkering
- **Environmental impact** | Reactive-nitrogen species not to be ignored
- **Environmental attributes** | MRV enables regulatory compliance and voluntary credits

Pilots pave the way for safe ammonia transfer + bunkering

Industry demonstrations (non-exhaustive)



What the industry has learnt

TRIAL-SPECIFIC LEARNINGS

NYK

NYK — Sakigake / Yokohama

- Engine / combustion technology validation
- Leak prevention & detection engineering
- Remote monitoring to cut crew exposure
- Operational manuals & maintenance protocols
- Engineer-driven safety design

GCMD

GCMD — Pilbara STS

- Sea-state limits & safe operating envelopes
- Plume dispersion behaviour
- HAZID / HAZOP risk mitigation
- Detection & emergency-response thresholds
- Fit-for-purpose ABV design

ROT

Port of Rotterdam (MAGPIE) — STS

- Equipment readiness gaps (borrowed LNG kit)
- Port safety framework validation
- QRA / safety-zone sizing
- Cross-party communication & coordination
- Port readiness benchmarking

INDUSTRY-LEVEL GUIDANCE

SGMF

SGMF — Bunkering Guidelines for Ammonia

- Release-type taxonomy (liquid / aerosol / vapor)
- Cross-industry knowledge transfer (LNG, ammonia cargo)
- Interim / early-stage guidance status

IMO

IMO — MSC.1/Circ.1687 Interim Guidelines

- Goal-based risk assessment framework
- Containment & structural design standards
- Detection & alarm thresholds
- Crew training & competency

IACS

IACS — Unified Requirement (UR H1/2)

- Release of ammonia from onboard systems for bunkering, storage, and usage
- Safety framework for ammonia release mitigation systems (ARMS) on ammonia-fuelled ships

Gaps, among many, that the industry still need to resolve

Risks



Limited understanding of ammonia behaviour in enclosed spaces onboard vessels

- Further validation of ventilation requirements needed
- Additional data helps refine safety measures and detection strategies



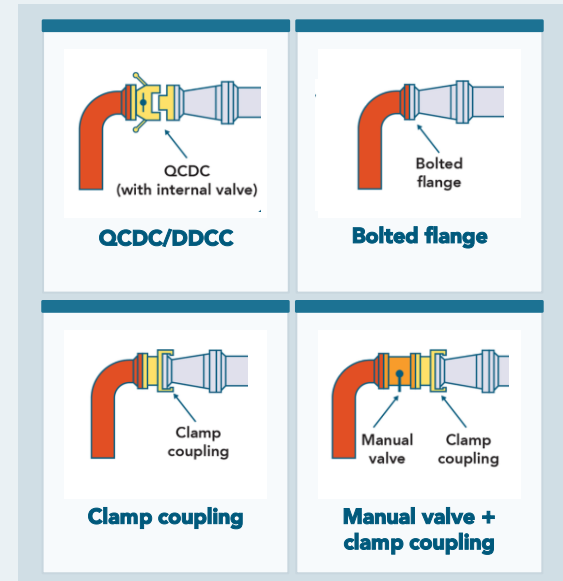
The 2017 Elk Grove Village ammonia release highlights the need to better understand ammonia dispersion, detection, and mitigation to enable safe recovery.

Operations



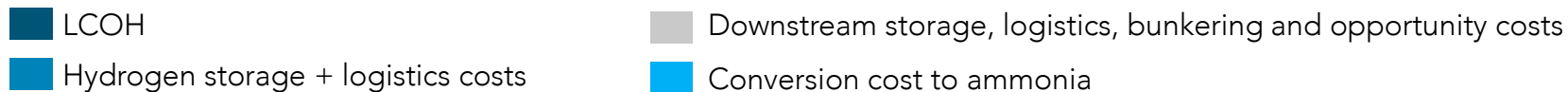
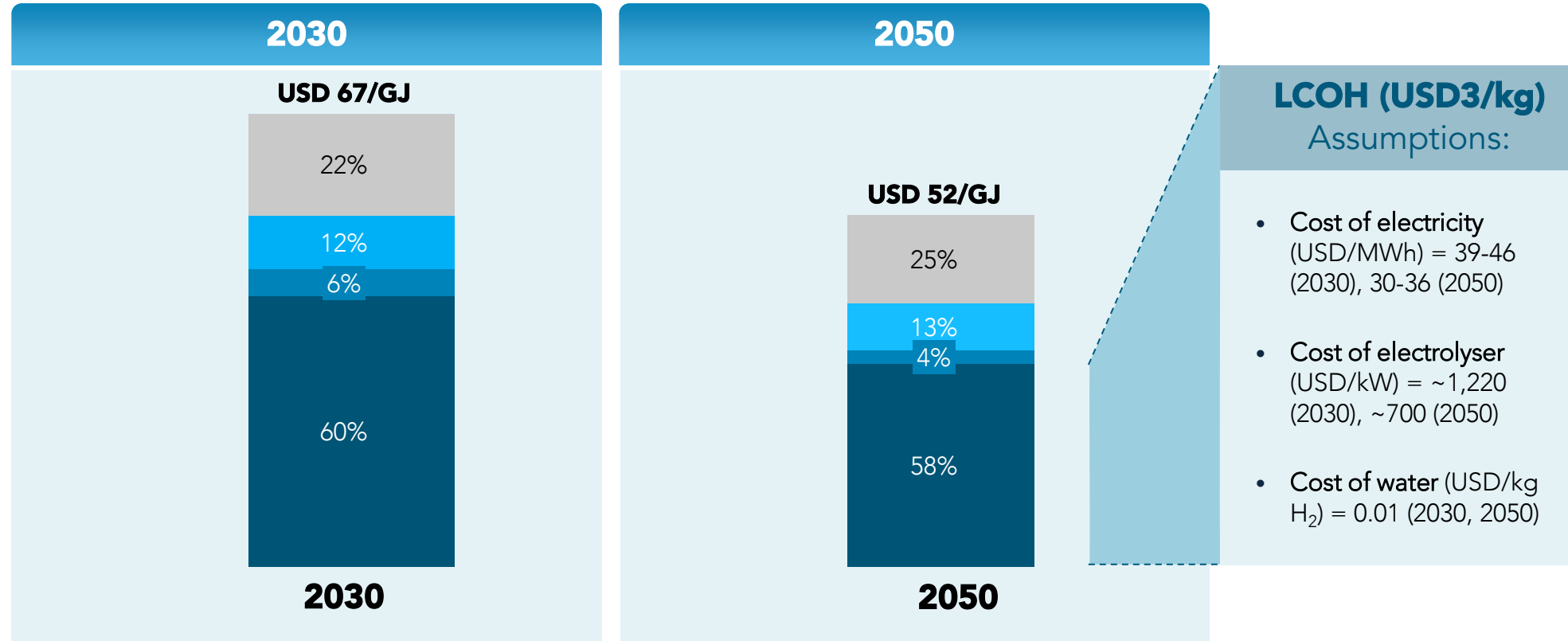
No prescribed operating procedure to achieve a dry-disconnect

- Current standards are high-level and goal-based
- Connectors exist (QCDC/DDCC, bolted flange, clamp coupling)
- Each comes with operational limitations and trade-offs



LCOH dominates e-ammonia's fuel use cost

Though transport and storage logistics, bunkering and opportunity costs occupy a quarter



The next gap to close is **trust**



To scale ammonia responsibly, the industry must prove that its emissions reductions are credible, traceable and comparable across schemes.



Life cycle accounting

MRV must account for life cycle GHG emissions.



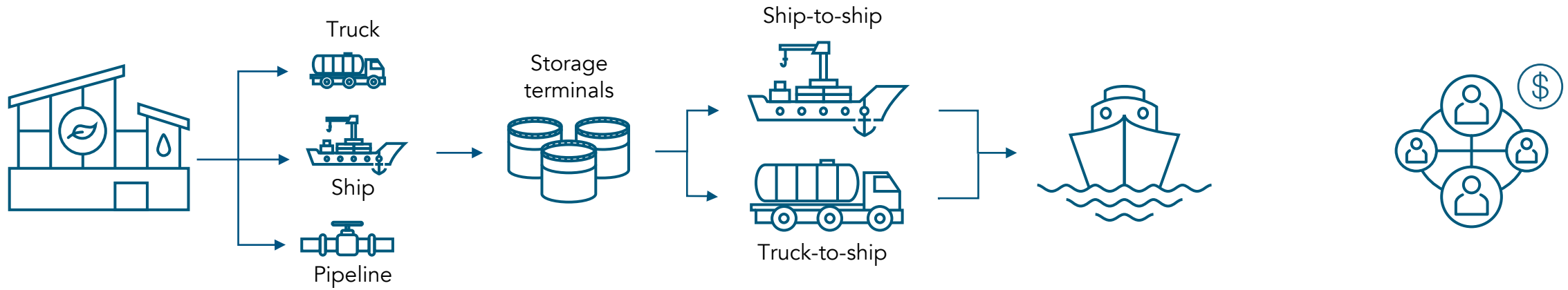
Consistent and harmonised

A harmonised MRV framework can enable interoperability among certification schemes, platforms, regulations, and technologies.



Integrated into commercial value

Trusted and verified data unlocks green premiums, preferential financing, and buyer confidence.



Production

Distribution + storage

Bunkering

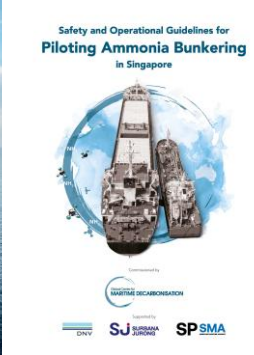
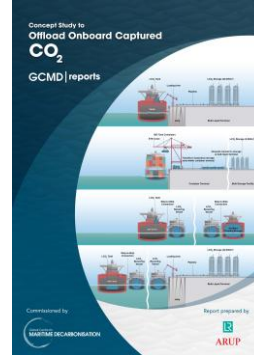
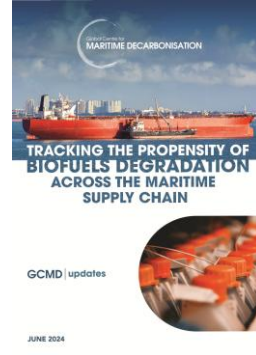
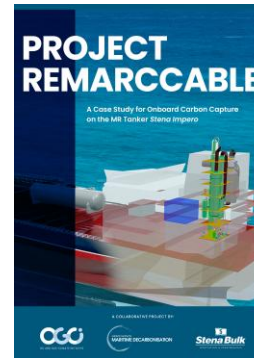
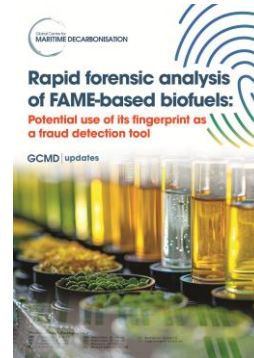
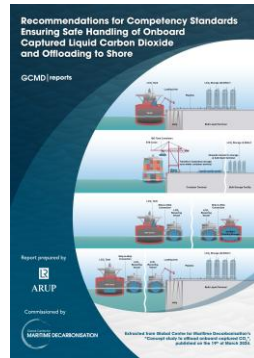
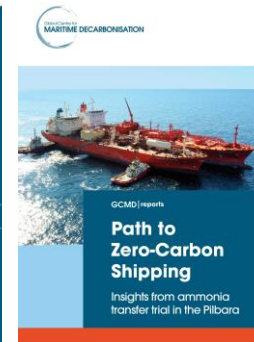
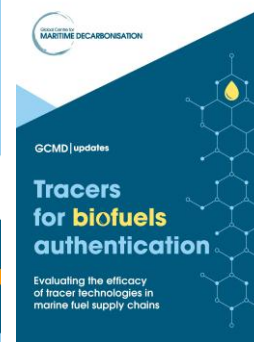
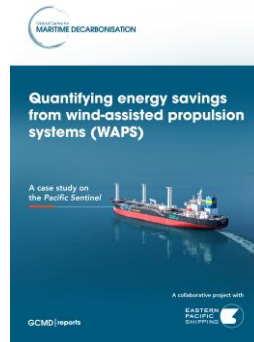
Application

Compliance and voluntary schemes

Thank you!



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