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Digitalization, AI & Asset Integrity in Lithium Extraction Leveraging Oil & Gas Practices

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Agenda

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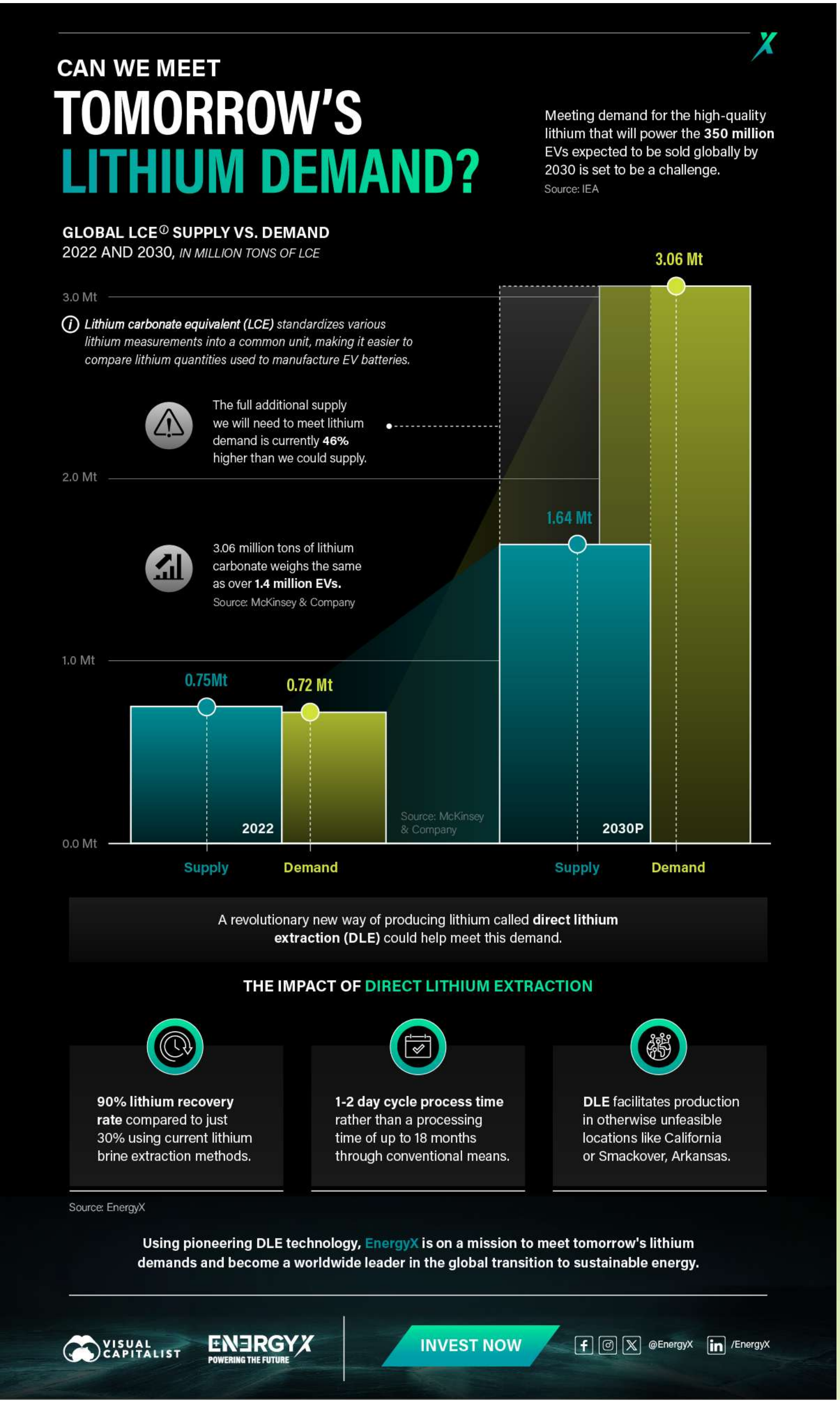
1. Why Asset Integrity & Digitalization Matter
2. DLE vs. Evaporation – Process and Risk Comparison
3. Oil & Gas Synergies
4. Leveraging Oil & Gas Practices in Lithium
5. Current Adoption Status
6. Conclusion & Takeaways



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Why this matters

- Global lithium demand >3 million tons/year by 2030
- Supply is projected to lag significantly
- DLE will be a major vector to address the shortfall
- DLE offers speed and sustainability but is technically demanding
- Asset integrity and digitalization are critical enablers for DLE scaling

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2. Comparison of process and risk

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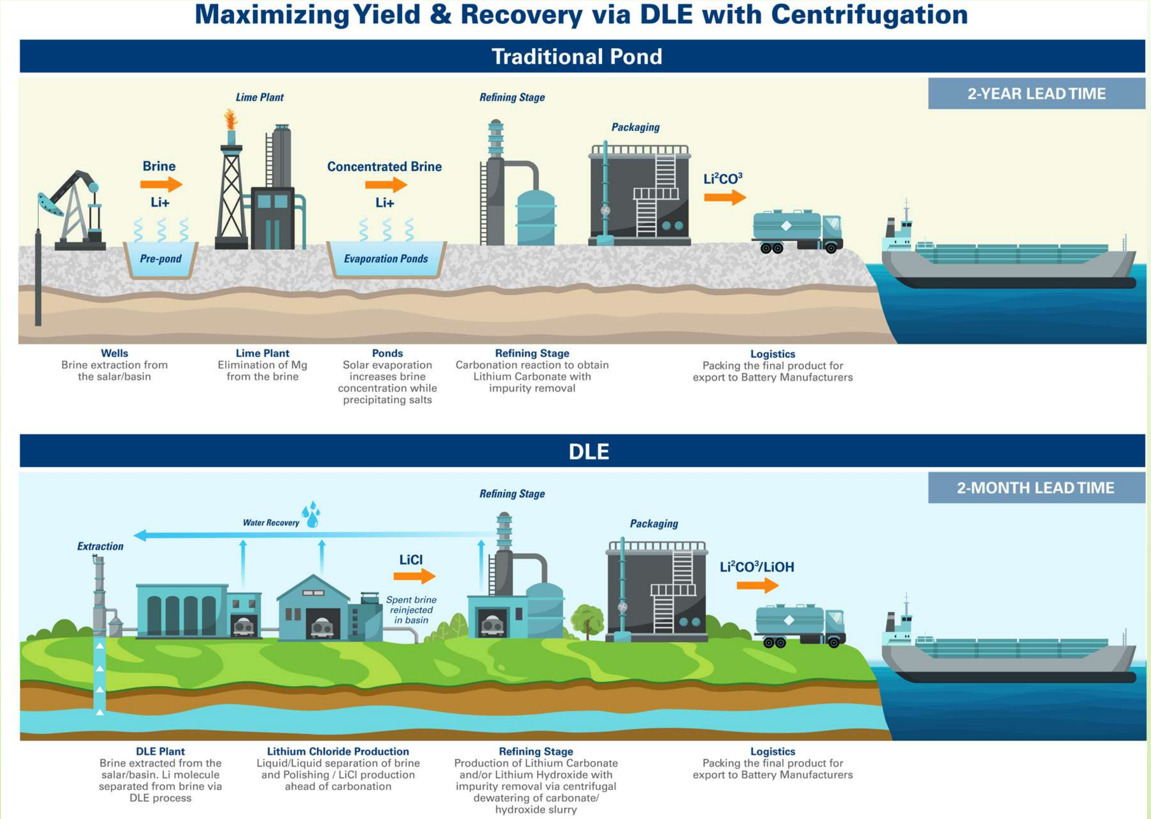

Feature	Evaporation	DLE
Timeframe	12–18 months	Hours to days
Lithium Recovery	~40–50%	70–90%
Water Use	High	Low
Footprint	Large ponds	Compact facilities
Instrumentation	Minimal	High
Sustainability	Moderate	High potential

Process and Integrity Risks

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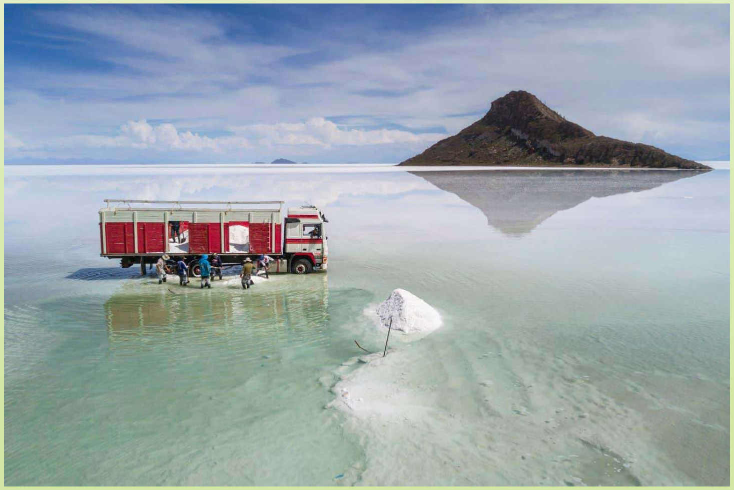
- ⚒ Evaporation: Land alteration, water loss, liner failures
- ⚒ DLE: Corrosion, scaling, resin degradation, chemical leaks
- ⚒ Complex fluids require rigorous Process Safety Management (PSM)

DLE vs Evaporation – Operational & Digital Complexity



- Evaporation ponds: Passive, low instrumentation, long cycle (12–18 months)
- DLE-Modular, continuous, and real-time sensitive process
- Requires advanced instrumentation, control, and remote diagnostics
- Strong case for AI and predictive digital technologies

DLE and Evaporation Maturity

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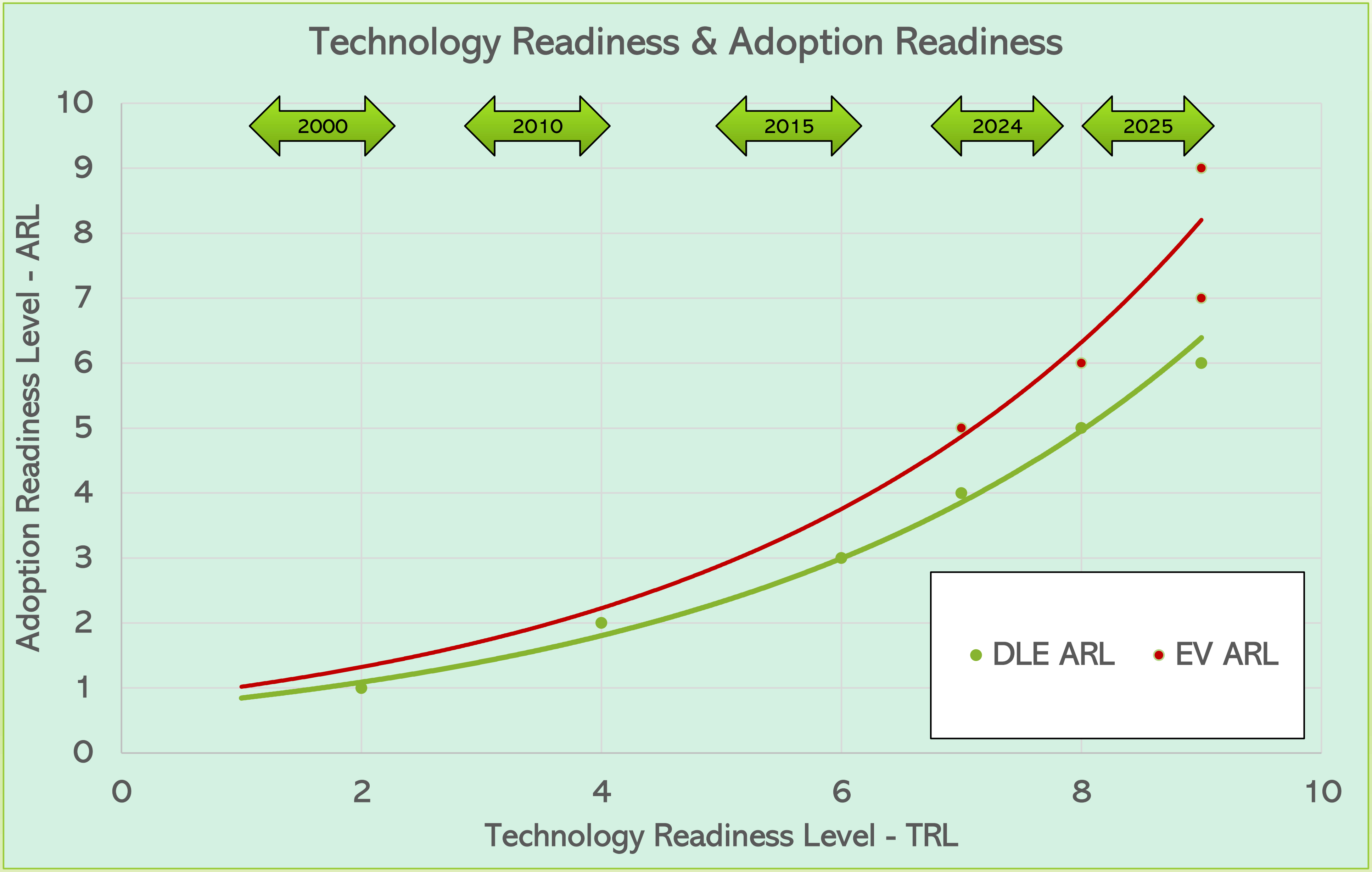

DLE - PSM, AI and Operational Risks

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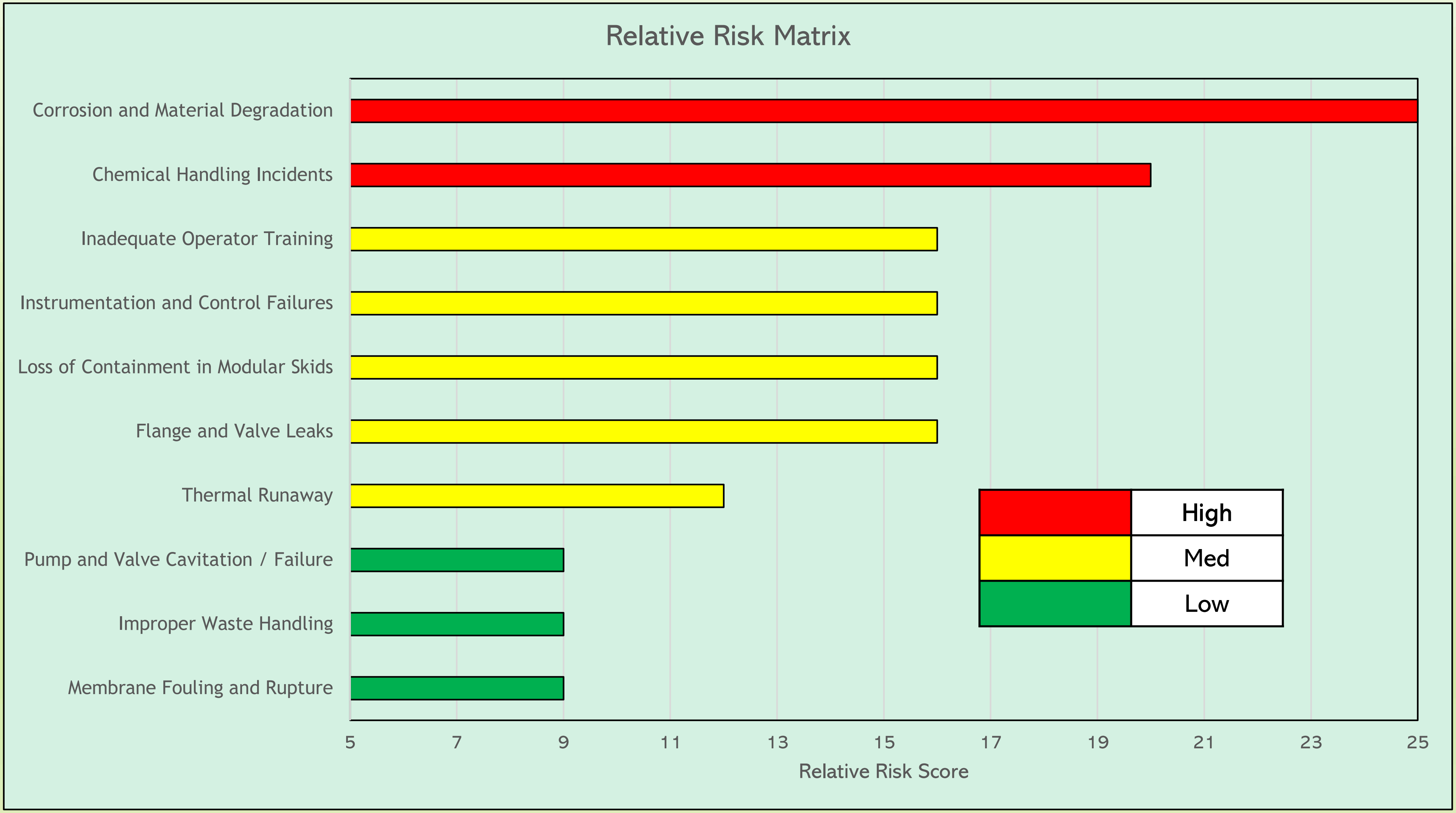

3. O&G and DLE Analogues

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DLE and O&G Common Challenges

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- ⚒ Subsurface & fluid handling
- ⚒ Chemicals and safety risks
- ⚒ Need for Asset Management & Culture
- ⚒ Need for Digitalization and monitoring-at scale
- ⚒ High environmental and ESG stakes

DLE - PSM, AI and Operational Risks

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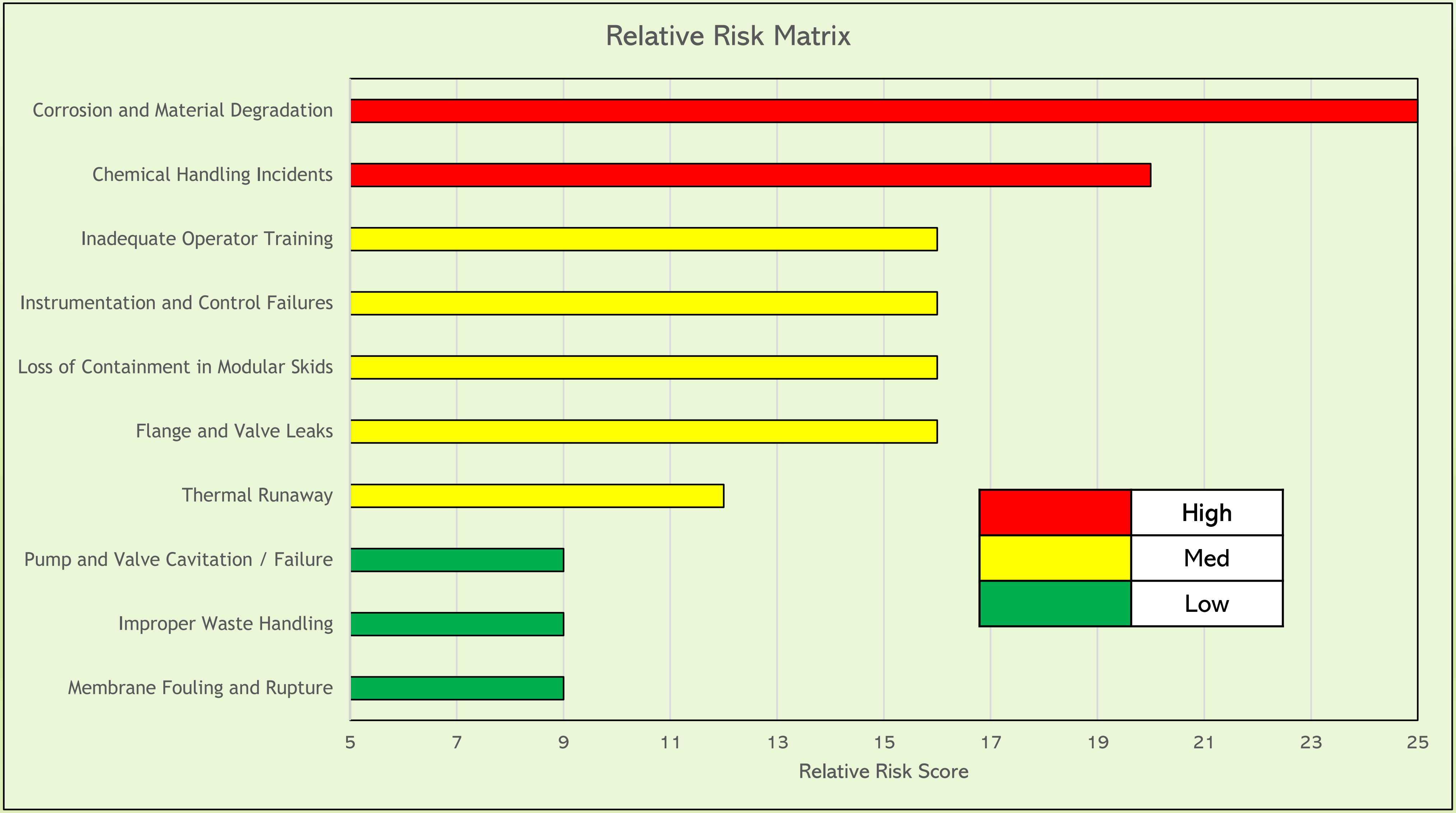

4. Leveraging Oil & Gas Expertise for DLE

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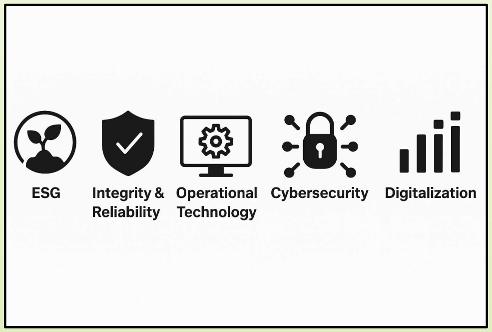

- ⚒ Integrity & Reliability
- ⚒ Operational Technology
- ⚒ Digitalization
- ⚒ Cybersecurity
- ⚒ ESG

Application Areas

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Operational Tech
- Digital twin
- Flange management
- AI-assisted Remaining Useful Life (RUL) estimation
- Natural Language Processing (NLP) to extract risk events from inspection reports

Integrity & Reliability
- IOW, RBI
- LOPA, barrier management
- Drones, robots
- Advanced sensing and monitoring
- AI, LLM

ESG
- Safety cases
- Envt. Monitoring
- Real-time discharge monitoring
- AI for lifecycle emissions estimation
- Sensor networks for monitoring

Cybersecurity
- Cyber-asset inventory and threat detection in OT networks
- Redundancy and fail-safe systems in critical control loops

Digitalization
- Digital Twins of production facilities and pipelines
- IoT-enabled real-time condition monitoring
- Integrated Operations Centers for remote diagnostics and control

Example use cases

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Theme	Area	Challenge in Lithium	O&G Practice / Technology	Potential DLE Adaptation
ESG	Environmental Risk	Brine leakage, groundwater impact, land use	ESG risk quantification, containment integrity monitoring	Containment monitoring, brine reinjection safeguards
ESG	Standards & Compliance	Need for formalized risk and quality standards	API, ISO 55000, NACE codes, IEC 62443	Apply to brine piping, injection wells, cybersecurity
Integrity & Reliability	Well Integrity	Corrosion, scaling, reinjection stress	ISO 16530, API well integrity standards, well integrity logs, corrosion probes	Well casing diagnostics , pipeline sensors, corrosion in brine systems
Integrity & Reliability	Corrosive Process Fluids	Acid/base handling, brine scaling, H_2S	PSM, NACE corrosion control, material selection	Corrosion monitoring, material compatibility in acidic brines
Integrity & Reliability	Asset Lifecycle Management	From pilot to commercial scale	Reliability-centered maintenance, RBI, FMEA	Lifecycle-based maintenance plans for DLE components
Integrity & Reliability	Emergency Response	Acid spills, toxic gas release, pond failure	Fire and gas detection, ESD systems, ERP plans	Real-time toxic gas detection, automated response protocols
Integrity & Reliability	Predictive Maintenance	Downtime due to mechanical failures	AI for vibration, thermal, acoustic data analysis	Condition monitoring of pumps, columns, motors
Integrity & Reliability	Drones & Robotics	High-risk manual inspections	UAVs, robotic crawlers for tanks/pipelines	Pond inspection, tank surveillance, robotic inspection
Integrity & Reliability	Advanced Sensing	Real-time chemical/process monitoring	Fiber optics, analyzers, fugitive gas detectors	Real-time Li analyzers, WirelessHART, turbidity/scale detection
Operational Tech	Digital Operations	Distributed assets, scaling control, remote sites	Digital twins, remote monitoring, predictive analytics	DLE plant/process twins, ML models for scale prediction
Operational Tech	Digital Twins	Complex real-time process optimization	Reservoir and plant twins with soft sensors	DLE process twins for real-time dosing, flow, adsorption
Operational Tech	Remote Ops & SCADA	Remote operations and diagnostics	Centralized control rooms, automated sites	Integrated SCADA, remote control of wells/plants

Some low hanging fruit

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Theme	O&G Practice / Technology	DLE Adaptation
ESG	ESG risk quantification, containment integrity monitoring	Containment monitoring, brine reinjection safeguards
Integrity & Reliability	ISO 16530, API well integrity standards, well integrity logs, corrosion probes	Well casing diagnostics, pipeline sensors, corrosion in brine systems
Integrity & Reliability	PSM, NACE corrosion control, material selection	Corrosion monitoring, material compatibility in acidic brines
Integrity & Reliability	Reliability-centered maintenance, RBI, FMEA	Lifecycle-based maintenance plans for DLE components
Integrity & Reliability	Fire and gas detection, ESD systems, ERP plans	Real-time toxic gas detection, automated response protocols
Operational Tech	Digital twins, remote monitoring, predictive analytics	DLE plant/process twins, ML models for scale prediction

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5. Adoption Status

Adoption Status

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Digital Domain	DLE – Already Implemented	Evaporation – Already Implemented
Asset Integrity	✅ Digital well diagnostics, corrosion monitoring on brine lines, digital asset registers	⚠️ Limited – manual inspections, some corrosion protection on ponds and flowlines
Predictive Maintenance	✅ Used in SQM & Eramet DLE plants – Andritz Metris system, ML-based alerts for pumps/filters	⚠️ Emerging – some pilot monitoring (e.g., pumps in processing plants), but not yet AI-driven
Drones & Robotics	✅ UAVs used for inspection of wells, tanks, and leaks in Argentina and Chile DLE plants	✅ Widely used – especially for evaporation pond monitoring, 3D pond modeling, structural inspection
Digital Twins	✅ SQM and Schlumberger: digital twins of DLE plants, brinefields, sorbent performance	⚠️ Limited – mainly being piloted for plant-level simulation, not yet widespread
Advanced Sensing	✅ WirelessHART, real-time analyzers for Li concentration, pH, flow, pressure in DLE units	⚠️ Limited – mostly manual sampling; some conductivity, level sensors used in ponds
Remote Ops & SCADA	✅ Present in new DLE plants (e.g., Eramet): centralized control, remote monitoring of wells/plants	⚠️ Basic SCADA present for flow control; few fully integrated remote operations
Standards & Compliance	✅ O&G-derived standards applied: API for well integrity, NACE for corrosion, ISO for asset management	⚠️ Some legacy evaporation operations still evolving compliance; digital standards adoption underway

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6. Conclusion

Summary – 5 Key Takeaways

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- ⚒ Asset integrity is foundational – and digitalization is its enabler
- ⚒ Predictive maintenance boosts uptime and safety
- ⚒ Drones and robotics de-risk and automate inspection
- ⚒ Digital twins transform decision-making from reactive to proactive
- ⚒ O&G experience offers a shortcut to maturity for lithium operators

What is next？

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- ⚒ Pilot digital twin or predictive maintenance program
- ⚒ Train workforce using oil & gas safety culture examples
- ⚒ Create specific risk-based inspection RBI plans for DLE
- ⚒ Collaborate with O&G tech partners to accelerate adoption