



The Relative Advantages of New and Repurposed Hydrogen Infrastructure

→ APGA Building Hydrogen Infrastructure Symposium
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Introduction

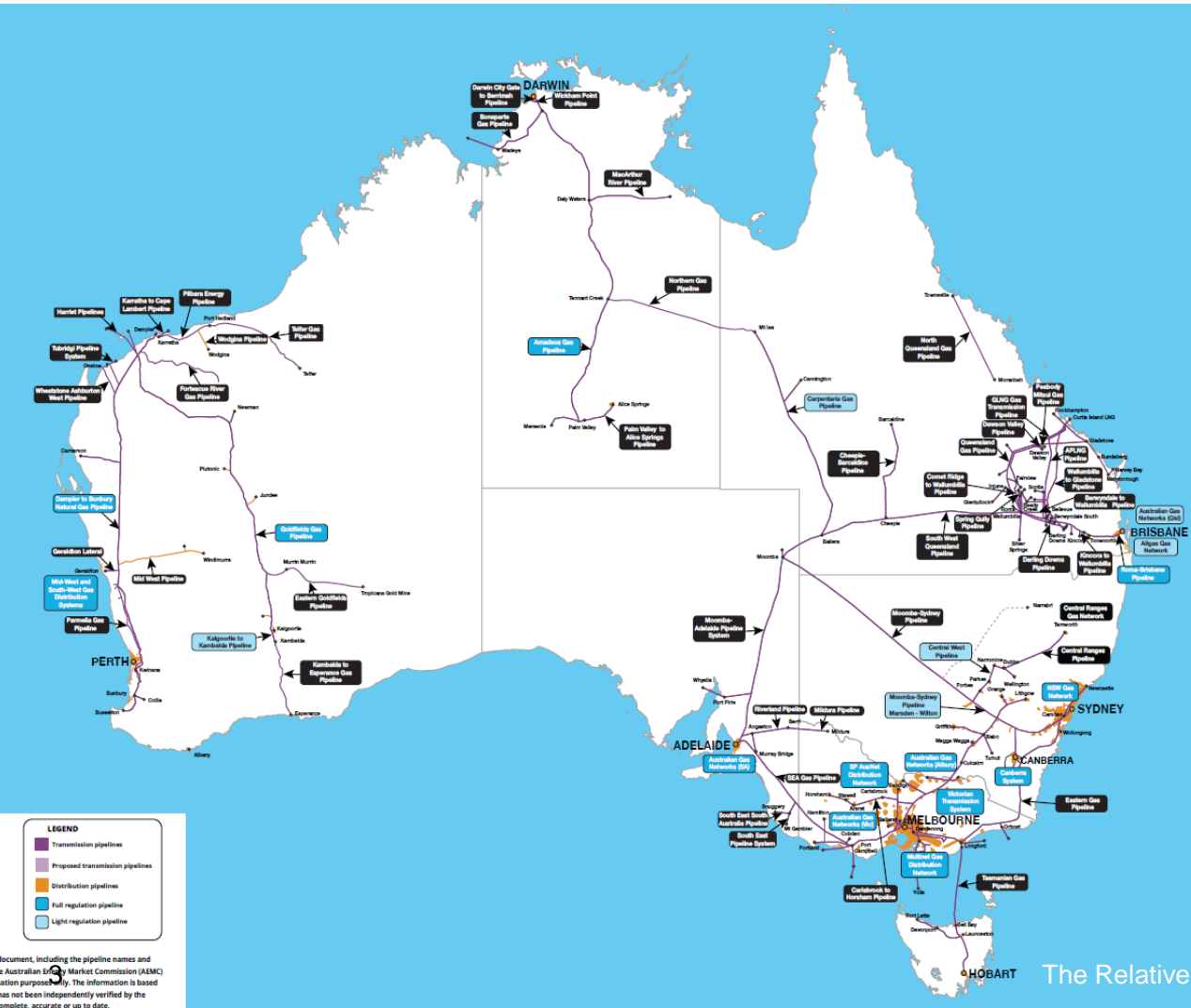
The Relative Advantages of New and Repurposed Hydrogen Infrastructure



- Today:
 - Contextualize discussion with high level overview of the ‘pro’s and con’s’ of repurposing vs new builds
 - Review considerations of operational, commercial, and social license implications
 - Highlight a practice that has been used for a long time in North America and Europe but hasn’t seen much application in Australia.
- Repurposing:
 - Repurposing is the process of engineering assessment and change management to inspect, assess, modify, and relicense a pipeline from existing service to transport hydrogen or hydrogen blends
 - Not a new process: Air Products and Air Liquide have operated repurposed pipelines for Hydrogen service for over 30 years
- New Build Pipelines:
 - New pipelines have a value proposition in context of supply and end use demand
 - New infrastructure will continue to be required to support new onshore energy supply and export projects
- Cost-benefit and total lifecycle cost implications to consider in approach

Context Overview

- Evolution of Australian pipeline infrastructure
 - NG pipelines from point-to-point pipelines from supply basins to demand centers [1960's → 1990's]
 - Integration and expansion of pipeline into network as traditional supply sources deplete and new and unconventional supply develop [1990's – Present]
 - Debottlenecking and bi-directional flows as demand locations change with new export and industry requirements [2000's → Present]
- Similarity can be seen in proposed hydrogen developments such as export hubs:
 - High productivity renewable energy zones (REZ) remote from demand centers
 - Requirement to store (short and long term) for energy balancing and demand levelling
 - Requirement to be able to move between different production / supply sources to demand centers
- Existing pipeline infrastructure crosses east and west coast Australia connecting many demand centers often nearby REZ and other supporting infrastructure
- New pipeline infrastructure will be required to support new forms of energy and new supply locations



Repurposing

Pro's

- Lower capital cost
- Expected shorter delivery schedule
 - Reduced physical works / site works
- Shorter approvals / lower approvals risk
 - To be confirmed in practice
- Easements and land access
- Reduced environmental / cultural heritage impact
- Less impact to community and stakeholders

Con's

- Technically complex assessment process
 - Availability of existing asset records
 - Integrity condition
 - Inspection and testing program requirements
- Operating envelope defined by existing asset
 - Reduced throughput capacity and storage
- Technical risk management
- Regulatory and approvals process
- Existing GTA / Operating contracts and off takers – end use constraints
- Higher operational cost

New Build

Pro's

- Designed to capacity and operational requirements
 - Optimized route and location
 - Materials and equipment specified for hydrogen compatibility readiness
 - Lower complexity inspection and testing requirements
- Lower technical risk - safety factors incorporated to design
- Product purity / quality controlled
- Project specific GTA / commercial contracts or owner-operator specific operation
- Lower operational cost

Con's

- Higher capital cost
- Long project delivery timeline
 - Time for approvals & licensing
 - Land access and stakeholder engagement
 - Construction
- Increased supply chain and geopolitical market impacts
 - Line pipe & compression supply
 - Construction workers
- Increased community and land user disruption

Hypothetical Example

- Regional – urban industrial pipeline 200km
 - Production → Usage
 - Industrial / GPG Offtake
 - Free flow pipeline approximately 25 years old
 - DN500, API 5L X60, 12.7mm WT
- New Build: \$2.5 – \$3.0M / km (\$500 – \$600M)
- Repurposing: \$55 – \$75M
- Repurposing proportional cost consistent with overseas sources
- OPEX: due to age of asset and associated conversion risk management higher OPEX cost could be expected for Repurposing case

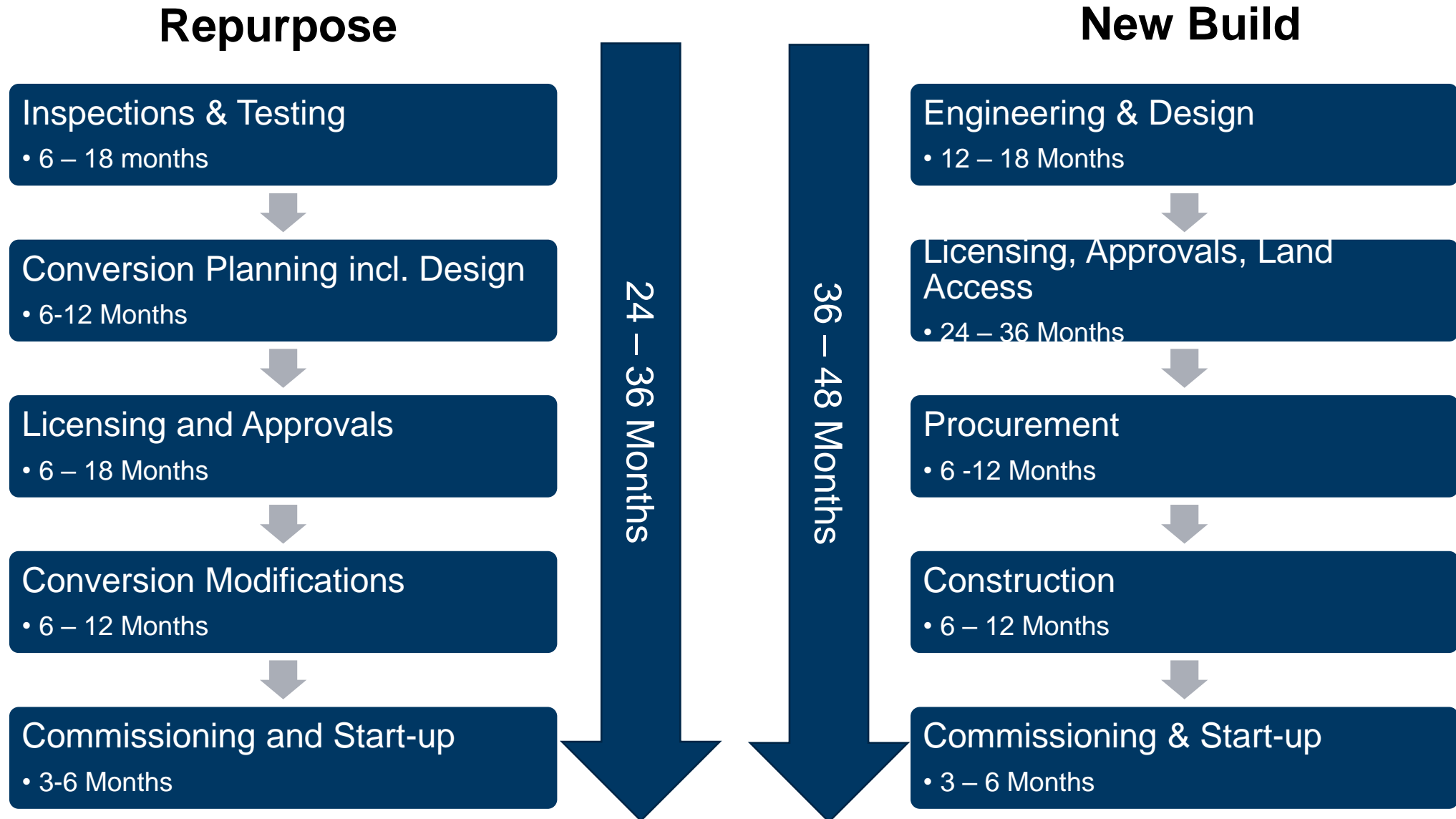
Notes:

- Simplified example of point-to-point pipeline – does not reflect actual existing infrastructure
- Concept costs for illustrative purposes only
- Pipeline costs only, does not consider downstream user modification costs, costs for storage infrastructure modifications or upstream production facility costs

Hypothetical Repurpose Estimate (AUD):

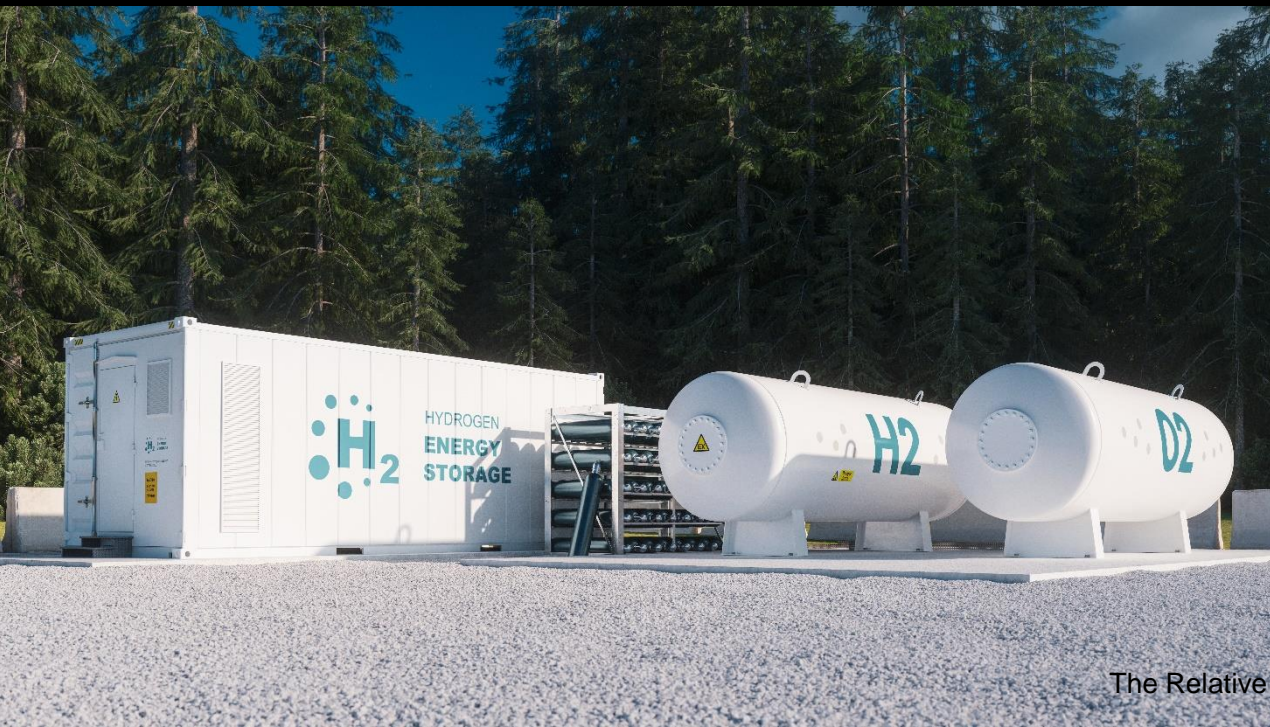
- Inspections, Sampling, and Testing: \$16 – \$18M
 - In-line Inspection (ILI)
 - ILI investigations and repairs
 - In-situ pipe / fittings inspections
 - Pipe sample cut-outs for testing
 - Pipe hydrogen testing
- Assemblies, Facilities, and Modifications: \$20 - \$25M
 - Pipeline cleaning
 - Scraper station replacement
 - MLV Inspection and upgrade
 - Disconnect and isolate redundant facilities
 - New receipt and delivery stations
- Project and Delivery Costs: \$10 - \$15
 - Project Management
 - Engineering and Design
 - Approvals
 - Stakeholder Engagement
- Contingencies: \$11 – \$14M

Hypothetical Schedule Example



Hypothetical Example Considerations

- Pipeline capacity and operating envelope capability to meet service demand
 - Like-for-like pipeline throughput capacity reduces slightly and line pack significantly
 - Technical considerations such as fatigue and fracture may limit practical operating envelope of repurposing
 - Technical safety and operational constraints
- Location of existing infrastructure to supply and demand centers
- Hydrogen infrastructure use case
 - Significant portion of existing backbone feeds population & industrial centers
 - Onshore vs export use cases
 - Hydrogen blended into natural gas or hydrogen gas
- Project lifecycle cost
 - CAPEX and OPEX
 - Project scalability



Approvals & Social License

- Repurposing appears to present lower risk for approvals:
 - Expect processes to be less onerous – change of service
 - Lower environmental, cultural heritage and landowner engagement requirements
 - High stakeholder engagement requirements
 - Higher technical safety and risk considerations
- New build has risks and opportunities for approvals:
 - Approvals timeline expected to be comparatively long
 - Perception of lower technical risk
- Common infrastructure considerations
 - Multi-user infrastructure to minimize infrastructure duplication
 - Minimizing community and environmental impacts
- Stakeholder engagement in hydrogen infrastructure projects either repurposing or new build expected to be high
 - Stakeholder value in project and project outcomes
 - Duplication, reuse or repurpose of existing assets
 - Environmental, social, and community impacts



Commercial Context



- Does repurposing make sense commercially compared to new infrastructure
 - From an export scale project perspective – pipeline costs is likely small fraction of overall cost
 - Infrastructure reliability and operability for project life and service are key drivers
- New hydrogen infrastructure projects can be challenged by overall costs
 - Repurposing provides lower cost solution where technically feasible
 - As a scale-up concept repurposing provides a pathway
 - Overseas experience has shown this is a cost-effective pathway
- Pipeline transport provides cost-effective long-distance energy transportation
 - Existing pipeline grids provide opportunity – e.g. blend/deblend
- Is repurposing practical to meet commercial and contractual requirements
 - The availability of pipeline capacity, service diversity, and storage can be critical to end users
 - Existing commercial contracts - existing end users ability to accept hydrogen

Summary

- Both New-Build and Repurposing have a role to play in developing a hydrogen infrastructure backbone
- Existing pipeline infrastructure operates across Australia much in proximity to potential hydrogen supply sources and demand centers providing opportunity to support both export and domestic use cases
- Repurposing provides an opportunity to reduce project capital cost, provide scale-up, and to transport energy long distances using existing infrastructure, but needs consideration of OPEX and asset operational capabilities
- Repurposing existing infrastructure may be limited technically by operating envelope, or by end user considerations including existing commercial contracts
 - Need to consider that like-for-like energy a repurposed pipeline will have slightly lower capacity and reduced line pack
 - Technical considerations such as fatigue and fracture may limit practical operating envelope of repurposing
- New infrastructure will be required, for example where no existing infrastructure exists or where scale and operating requirements dictate – either through lack of existing infrastructure, operating capacity or operating requirements
- Repurposing is expected to be able to be delivered more quickly than new build infrastructure
- New build and repurposed infrastructure needs consideration of project and operational social license – particular focus on large scale export learnings from LNG boom and emerging electricity infrastructure projects

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