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VTS information session on hydrogen

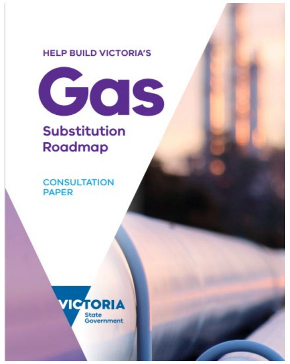
26 August 2021

Today is about sharing information and seeking constructive feedback

- The purpose of today's session is to discuss:
  - Why it is important to explore options to repurpose the VTS for hydrogen
  - Why it is important to start the process today
- We have not defined a scope of works, costs, or sources of funding so this is not for discussion today
- If the topic is of interest to the group we can continue the dialogue at future roundtables or additional sessions like this one

The Political environment is changing rapidly in response to decarbonisation

Hydrogen as a low carbon alternative to natural gas is a key component of Victoria’s gas substitution roadmap



Amendments to the National Gas Law are being expedited

“Ministers have agreed to expedite amendments to the National Gas Law; National Energy Retail Law and subordinate instruments so hydrogen blends, biomethane and other renewable methane gas blends are brought within the national energy regulatory framework.”

The likelihood that the VTS will be required to carry hydrogen blended gas before 2030 is increasing

Before hydrogen can be blended in the VTS, we will need to understand what the safety and integrity risks might be

The VTS can remain a critical part of Victoria’s energy system in a decarbonised future

Repurposing existing gas infrastructure for hydrogen is **lower cost** than building entirely new pipeline network or full electrification of energy system[1,2]

Improved **energy security** – Historically, Victorian gas customers experience an outage once every 36 years[3] compared with electricity network outages which occur frequently due to storms and system maintenance

Committing to early technical assessments to understand safety and integrity risks presents a no-regrets pathway that **provides optionality** in the future

The do nothing option has the potential to limit customer choice

Case Study: Gasunie – Netherlands’ gas transmission network

In November 2018, Gasunie, the Netherlands’ gas transmission operator, started transporting hydrogen along a 12km long stretch of repurposed natural gas pipeline. The pipeline will transport more than 4,000 tons of hydrogen per year for industrial purposes, saving over 10,000 tons of carbon emissions each year.

On 30 June 2021 the Netherlands Ministry of Economic Affairs and Climate Policy announced that it will commission Gasunie to develop the national infrastructure for the transport of hydrogen.

The project, with an estimated investment of €1.5 billion, is scheduled for completion in 2027.

The new national hydrogen network will consist of 85% reused natural gas pipelines, resulting in costs four times lower than if entirely new pipelines were laid.

All pipelines are different and we need to determine the viability of the VTS to transport hydrogen

1 Gas Vision 2050 published by APGA
2 Australian hydrogen market study published by CEFC
3 Gas distribution performance report published by the AER

Assessing the preparedness of the VTS network for hydrogen is complex

1. **Are** the pipelines hydrogen-compatible?

Fundamental question that must be addressed

Pipeline

Assess potential impacts on pipeline material, operational envelope, and overall capacity of the network

2. **How** can be the pipeline be converted to hydrogen-compatible?

Hydrogen Production

The volume of hydrogen blend that requires existing compressor stations to be modified and restaged

Compressor Station

Hydrogen compatible valves, seals, gaskets etc.

Ancillary equipment

How to detect blended gas, particularly if fluctuating; and impact on customer billing

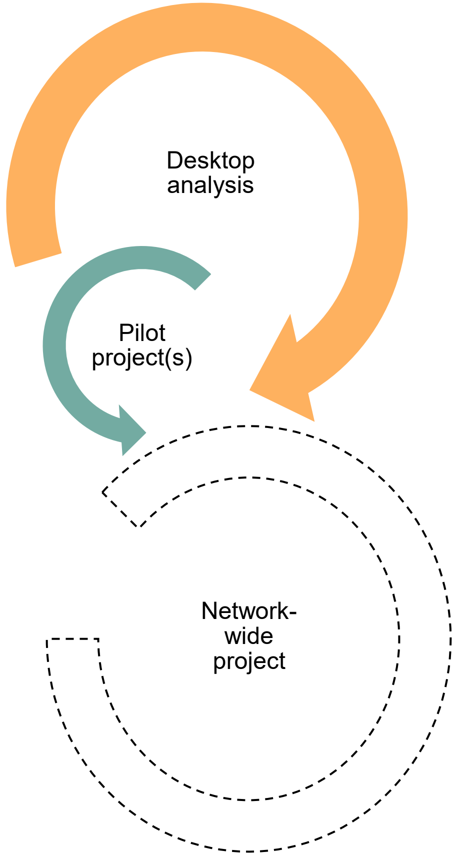
Metering

End user appliance (industrial and residential) compatibility

End Users

Interface with AEMO operations – and any impact on operational procedures

Updated procedures to maintain the safe operation and maintenance of the network



Understanding the impacts of hydrogen on the pipeline is critical due to hydrogen embrittlement

- When a steel pipeline is used to transport hydrogen, hydrogen is absorbed into the steel and affects the material properties.
- In particular, the ductility, toughness and fatigue life of the steel is deteriorated. Fatigue life reduction is materially determinantal for storage pressure-cycling of pipelines. This effect is referred to as Hydrogen Embrittlement. Embrittlement does not pose a major challenge for plastic pipelines.
- There is currently no Australian standard for hydrogen pipelines or conversions, but there is planning work in progress that will develop these over the next 5 years

Case Study

Networks are injecting 10% now, why can't we do the same for transmission pipelines?

Networks are designed and operate under a different prescriptive standard AS4645 compared to the risk based AS2885 pipeline standard.

The networks prescriptive design standard has inherent risk controls such as maximum design factor of 20% and 1050kPa MAOP meaning networks pipes are not subject to rupture, and consequence such as heat release are controlled.

Hydrogen degradation of steel pipe properties is related to partial pressure (PP) rather than hydrogen blend % alone – that is % H2 and Operating pressure.

APA is investigating the conversion of a section of gas pipeline in Western Australia to be hydrogen ready

Phase 1: Investigate if the pipeline can transport hydrogen

- Complete gap analysis of current standards
- Prepare safety management approach
- Collate existing pipeline data incl. properties and current condition
- Conduct laboratory testing of pipe sections in air at atmospheric pressure

Phase 1 outcome:
A preliminary design basis and proposed operating envelope for the future converted pipeline

12 months

Phase 2: Confirm how to convert the pipeline to hydrogen-ready

- Finalise safety management study
- Engage with technical regulator and WA State Government
- Complete supply and demand analysis and commence negotiations
- Conduct laboratory testing of pipe sections in a gaseous hydrogen environment

Phase 2 outcome:
Confidence in the likely behaviour of the pipeline under operational conditions

12-18 months

Phase 3: Prepare the pipeline for transformation

- Full-scale testing if required
- Assessment and conversion of above-ground and ancillary equipment changes required for hydrogen-ready
- Firm understanding of supply and offtake arrangements incl. points of connection

Phase 3 outcome:
The 43km section of Parmelia Gas Pipeline is ready to transport hydrogen

12-18 months

PGP is here (end of Phase 1)

Researchers at University of Wollongong undertaking hydrogen compatibility testing on sections of our Parmelia Gas Pipeline

For further information

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Victoria's gas infrastructure is extremely efficient at delivering energy

The Victorian gas transmission and distribution systems deliver energy far more efficiently than electricity networks

Table 1: Victorian 2019 Regulated Asset Base (RAB) and Revenues

	RAB ($m)	Actual Revenue ($m)
Electricity distribution and transmission networks[1]	17,329	2,825
Gas transmission and distribution networks[2]	5,631	774

Running the Victorian gas transmission and distribution networks costs around a quarter of running the electricity distribution and transmission networks

Table 2: Victorian 2019 Maximum Electricity and Gas Demand Expressed in GW

2019	Winter	Summer
Electricity - Maximum demand	7.6GW[3]	8.7GW[4]
Gas – Forecast hourly peak day demand in MW[5]	20.8GW	7.1GW

On a peak winter day the gas network delivered more than twice the peak energy demand of the electricity network. Electrifying the winter load would require the electricity network to handle three times its current load.

Table 3: Victorian 2019 Maximum Electricity and Gas Demand Expressed in GW

	Actual Energy Delivered (GWh)	Average annual cost to deliver a GWh ($)	Maximum demand (MW)	Average cost to deliver a MW of maximum demand ($)
Electricity distribution and transmission networks	41,480[4]	68,115	8,684[4]	325,362
Gas transmission and distribution networks	64,722[5]	11,965	20,834[6]	37,171

The Victorian gas infrastructure delivers:

- a GWh equivalent of energy approximately 6 times cheaper than electricity networks
- a MW of peak demand load approximately 10 times cheaper than electricity networks.

[1] AER, Electricity DNSP and TNSP network performance report 2020
[2] AER, APA VTS, Multinet, AusNet Services, Australian Gas Networks 2019 RIN data
[3] AER, Seasonal peak demand – regions: https://www.aer.gov.au/wholesale-markets/wholesale-statistics/seasonal-peak-demand-regions
[4] AER, Network performance report 2020, TNSP operational performance data 2006-2019
[5] AEMO, VGPR 2020 update, Table 1, 2019 Victorian Consumption of 233PJ converted into GWh
[6] AEMO, VGPR 2021, p.80, Peak hourly demand of 75 TJ/hour converted into MW

Electrification of Victorian gas use could be a very expensive and lengthy process

The future infrastructure scenarios being considered by Infrastructure Victoria have significant challenges

- Infrastructure Victoria is providing advice to the Victorian Government on possible 2050 gas infrastructure scenarios
- In its Interim Report, Infrastructure Victoria set out four possible scenarios which each make different assumptions about the decarbonisation path to 2050.
- The extent of the transmission infrastructure required under the various scenarios demonstrates the significant challenges posed by electrification alone.

Table 4: Electricity transmission installed under Infrastructure Victoria's scenarios

Scenario	2030		2040		2050	
Line Size	220kV	550kV	220kV	550kV	220kV	550kV
A	6,783 kms	100 kms	14,693 kms	100 kms	20,467 kms	100 kms
B	6,241 kms	100 kms	13,380 kms	100 kms	19,129 kms	100 kms
C	7,112 kms	100 kms	10,302 kms	100 kms	8,499 kms	100 kms
D	2,372 kms	100 kms	3,019 kms	100 kms	4,392 kms	100 kms

Source: DORiS Engineering Report for Infrastructure Victoria, p55

- AusNet Services' existing transmission network is approximately 6,700km long and took many decades to build. An effective duplication of this network is required under IV's scenarios.
- It is highly unlikely that this network investment can be achieved in the timeframes required.

$b

- Project Energy Connect between SA and NSW is 900km long and is forecast to cost over $2b.
- Using this benchmark demonstrates the potential cost of new Victorian transmission infrastructure.
- Electricity distribution infrastructure will be an additional cost.