vector

Managing the Gas Transition

Option preserving solutions to manage consumer risks from gas asset stranding

November 2023

Foreword

Investment in regulated long-lived infrastructure is underpinned by financial confidence of cost recovery by a mechanism known as financial capital maintenance. This enables infrastructure investments to be committed by parties with the confidence that costs incurred over their asset lifetimes will be recovered by tariffs paid by users of these investments. The economic regulation of such infrastructure is governed by Part 4 of the Commerce Act, implemented by the Commerce Commission.

While Part 4 of the Commerce Act, has historically served its original intentions, it was written for a different era and now poses significant risks in our energy transition. Our chief concern is that the principle of financial capital maintenance is at risk of being severely undermined. Potential regulatory failure leading to asset stranding will radically undermine the principles of financial capital maintenance. This risks damaging the confidence of investors in other regulated businesses such as electricity networks, slowing investments and driving up their cost of capital. This is a serious concern when such substantial energy infrastructure investments are required to drive electrification. Further, under their obligations under the Companies Act, directors of pipeline-owning companies will be severely challenged in their ability to approve ongoing investment or reinstating gas infrastructure pipelines if they do not have confidence that such investments will be recovered.

Our various scenario analysis indicates that a wind-down of the network, with no government or regulatory intervention, exposes infrastructure owners to a risk of under-recovering costs of $973 million over the period to 2050. Even more concerning is the cost to consumers of $7.9 billion for appliance switch-out costs in the event of forced consumer exit off reticulated gas.

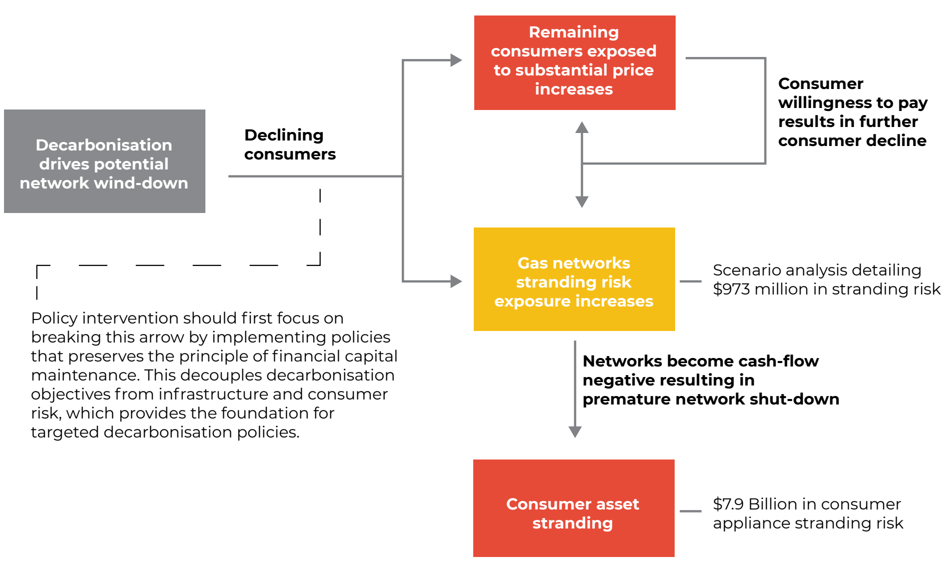
Rethinking our gas regulation and policy should pivot on the reality that a de-growth economic paradigm is fundamentally different from a growth-based model. Maintaining growth-based economic regulation in the face of a realistic prospect of declining consumers exposes all remaining consumers to exponential price increases, and materially increases the likelihood of stranded assets.

Vector is asking for policies that will give the wider energy sector regulatory coherence and investment confidence allowing New Zealand to manage the transition from fossil gas (be it a wind-down or transition to green gases). This paper presents a list of policy and regulatory pathways that, if designed correctly, will protect consumers from exponential price increases, protect gas networks from asset stranding, and give consumers time to transition their appliances at end-of-life.

The creation of a new streamlined Ministry of Energy, and energy regulator offers the clear prospect of better aligning regulatory and policy coherence and outcomes. In both designing a new Ministry and consolidating at least three different energy regulators, there is also an opportunity to achieve operational synergies between various energy policy and regulatory agencies in terms of expertise, data and resources as well as delivering improved value for money for taxpayers.

Further to this, an update of the Commerce Act to include decarbonisation and the realities of a de-growth paradigm is required to ensure that the principle of financial capital maintenance is preserved to protect future regulated infrastructure investment in general, realising its criticality to New Zealand's wider energy transition.

The gas transition has the capability of achieving the objectives of all - Government, consumers and infrastructure owners - in a way that enables a carefully managed and equitable transition, while avoiding unnecessary harm to energy consumers.



Key requests to Government

1. Amend the Commerce Act 1986 to direct the Commerce Commission to take climate change into account. Vector's view is that the existing economic regulatory regime was designed in and for a business-as-usual regime, and is not fit for purpose to manage the complexity of the decarbonisation transition.

2. Like any rational commercial entity, gas network infrastructure would likely be shut down whenever it becomes cash-flow negative, leaving consumers stranded on the network. Mitigating this risk by accelerating cash flows and depreciation is therefore a critical component of public policy. Set a clear policy statement that steers the Commerce Commission to implement no-regrets financial mechanisms to mitigate stranded asset risks and impacts on consumers. See page 15 for a list of financial mechanisms.

3. Preserve the principles of financial capital maintenance that supports infrastructure investment in New Zealand, noting that regulatory failure leading to stranded gas distribution assets will have contagion impacts on electricity distribution companies' access to debt and equity to fund the transition. See Financial capital maintenance - page 8 for more information

4. Decide who pays for network decommissioning at end-of-life. If network companies are to fund over time, implement policy that enables gas networks to start collecting an end-of-life fund from consumers while there are still sufficient consumers on the network. No decommissioning regulatory allowance is provided for in the current regulatory regime. See page 19 for more information.

5. Investigate securitising any prospective stranded-asset portion of the network through a government-backed bond and charge this portion to consumers via a securitisation charge. If implemented correctly it can reduce overall consumer cost and mitigate stranded asset risk with no additional cost to the government. The role of such a government backstop looks critical to the ongoing provision of gas infrastructure given the inherent and ongoing policy uncertainty or evolving/changing policy over successive governments. Securitisation looks to be one of the most rational options of a backstop while preserving important option value and resilience for New Zealand. See page 18 for more information.

6. Investigate the Danish Government's re-nationalisation of natural gas infrastructure and consider this approach to better streamline coordination, and for better alignment with Government objectives. See page 25 for more information.

7. Recognise that residential gas consumption only accounts for 5% of all natural gas use. Meaningful decarbonisation of fossil-gas is largely an exercise in reducing gas-fired electricity generation and industrial processes.

8. Establish a Ministry focussed on a wider energy and security of supply strategy for New Zealand to streamline greater coordination across wider energy regulation and policy. Such governance and focus is required to coordinate the complexity of whole of systems impacts. See page 11 for more information.

Executive Summary

Gas infrastructure companies, and their connected consumers are currently exposed to material transition costs, disruption, and gas-asset stranding risk. This risk is largely driven through uncertainty over the future of gas infrastructure, and a lack of clear policy direction to adequately manage this transition. Our chief concern is that the principle of financial capital maintenance, which provides foundational confidence for regulated infrastructure investment, is at risk of being severely undermined. Regulatory failure leading to asset stranding of gas pipeline infrastructure will radically undermine the principle of financial capital maintenance, which will then risk an impediment to investments in other regulated businesses such as electricity networks. This is a serious concern when such large and substantial energy infrastructure investments are required to drive electrification.

To mitigate this risk, we recommend a change to Part 4 of the Commerce Act to preserve the principles of financial capital maintenance and promote the net-zero carbon target more effectively. Historically, the system has served New Zealand well, but the rules of a de-growth economic paradigm under the influence of climate change are fundamentally different to a growth-based model, and updates to the Commerce Act and associated regulations need to provide greater certainty around cost recovery for regulated infrastructure.

Certainty of cost recovery not only protects regulated infrastructure investment in New Zealand, but also the impacts on future consumers. For example, policies that put infrastructure networks at risk of being cash-flow negative, may lead to those networks being shut-down earlier than socially optimal leaving consumers stranded. On the contrary, policies that preserve the principle of financial capital maintenance and allow for accelerated cash-flows not only serve to mitigate regulated infrastructure owners from stranded assets, but also protect future consumers from substantial price increases. The government has the opportunity to leverage these co-benefits to protect consumers and infrastructure owners simultaneously.

In this paper, we present potential pathways for a managed transition, which requires clear policy direction to drive certainty, regulatory intervention to accelerate and preserve cost recovery, and risk-abating commercial decisions from gas infrastructure businesses. The solutions presented are 'no regrets - no surprises' decisions which acknowledge the complexity of the transition, but maintain optionality. For example, if renewable gases were to materialise in 10 years, there would be a pathway to enable them. However if renewable gases do not materialise, then the network can still be wound down in an orderly manner without heavily burdening remaining consumers and ensuring regulated infrastructure investors are kept whole financially.

Multiple options will need to be combined to formulate this strategy. The sequence in how these options are adopted may be staggered as some can be implemented quickly while others require existing policies to mitigate adverse effects. For example, a gas connection prohibition would be a policy that is implemented only after key mechanisms for an orderly transition have been put in place. Failure to do so simply burdens existing consumers and investors with increased risk of network stranding.

The gas transition may also happen faster than we think. For example, a small change in consumer sentiment that increases the market value of a fully electrified house over a dual-fuel house could lead to an acceleration in gas disconnections and large electricity network implications. Such 'tipping points' lie independent of policy, yet need clear policy direction to manage.

This burden on consumers and gas infrastructure businesses is significant. Initial scenario analysis estimates that a wind-down scenario with no government or regulatory intervention would expose gas infrastructure pipelines to a risk of under-recovering costs of $973 million over the period to 2050. Even more concerning is the cost to consumers of $7.9 billion to transition assets in the event of an unmanaged closure of the gas network. Key drivers of the size of this risk are gas consumers' future demand and willingness to pay for gas transportation services, which largely drive gas infrastructure net cash flows. Projected cash-flow scenario analysis suggests that changes will need to be made to regulatory and policy settings for gas infrastructure pipelines to remain financially viable under a wind-down scenario.

Furthermore, energy and regulatory policy alignment across government is becoming increasingly urgent, and we note steps that the United Kingdom and Australia have taken in establishing dedicated governmental ministries for energy. Establishing an equivalent aligned policy agency, such as a Ministry of Energy and Net Zero, would be effective in ensuring strategy development, regulation, policy, resilience, security of supply, market design and oversight are all centrally coordinated with the necessary expertise and resources. The status quo which requires coordination across numerous governing bodies is a challenge due to dispersed capability and blurred accountability leading to outcomes that risk driving New Zealand towards a disorderly transition.

We have a strong interest in ensuring that the future of gas infrastructure is managed in a way that best meets New Zealand’s energy security, net-zero carbon future, affordability for consumers, certainty of investment recovery, and a healthy regulatory regime for infrastructure investment.

Proposal for a managed transition for gas

2023

Implement key mechanisms for a managed transition

Initiate no-regrets financial capital recovery mechanisms to mitigate stranded asset risk, consumer risk, and maintain the principles of financial capital maintenance. Examples include:

- Accelerated Depreciation - page 16
- Securitisation - page 18
- Fund for end-of-life treatment - page 19
- Removing Inflation Indexing - page 21
- Re-nationalisation - page 25
- Government back-stop to deliver confidence for ongoing investment

Create appropriate governance structures to manage the energy transition, such as via a Ministry of Energy and Net Zero - page 11.

2030 - 2035

Do renewable gases materialise in sufficient quantities?

No

Implement wind-down strategy

Government back-stop and assurance of no stranding asset risk enables capital deployment to safely maintain the network while gas distribution businesses use end-of-life fund to progressively shut down the network.

Network assets successfully recovered through accelerated depreciation thus maintaining the principles of financial capital maintenance. Securitised bonds paid off via securitisation charges.

Government support for any remaining vulnerable consumers transition out of natural gas. End-of-life fund used to safely decommission the gas network.

In this scenario, charges on fossil gases today are used to protect future consumers, pay for decommissioning, and prevent stranded regulatory assets.

Yes

Implement renewable gas strategy

Smaller network due to ongoing electrification over the past 10 years. End-of-life charges used for network-rightsizing.

Gas distribution tariffs could drop as capital has already been accelerated for a decade, allowing for faster uptake of renewable gases.

Note that this pathway may likely be a blend, whereby the residential sector remains on renewable gases while industry decarbonises or vice versa.

In this scenario, additional charges on fossil gases today are effectively used to accelerate renewable gases in the future. The gas network will see no additional profit/loss. Option value for renewable gases is preserved, without risking the 'no action' pathway.

A just transition delayed, is a just transition denied

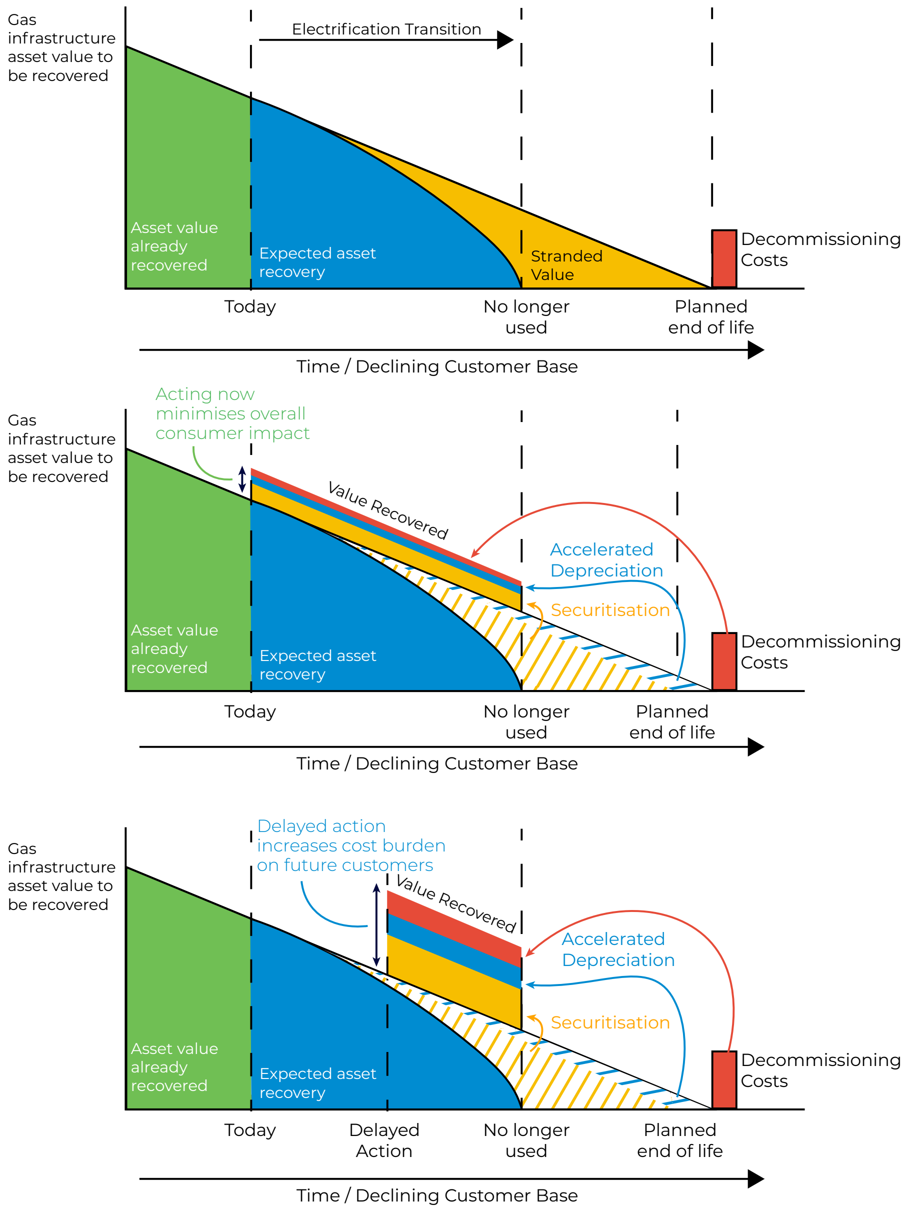
Figure 1

Illustrative description of asset recovery over time. In a business-as-usual scenario, asset investment is recovered over time to the 'planned end of life'. However, due to decarbonisation, the asset life may be cut short due to market or policy drivers. This exposes infrastructure owners to a stranded asset risk highlighted in the yellow area. See Figure 3 - page 9 for a quantitative projection of recoverable and unrecoverable revenue in a 'No Action', wind-down scenario.

No Action:
No regulated cost recovery leads to a stranded asset risk with consumers remaining on the network absorbing the price increases. In this scenario regulated gas pipelines are exposed to $973 million of regulated cost recovery risk, and may become cash-flow negative earlier, leading to a sudden and unplanned exit.
Disorderly Decarbonisation

Managed Transition:
Future costs and stranded value are proactively recovered through capital recovery models such as accelerated depreciation / securitisation. This minimises consumer impacts as the costs are spread over a larger consumer base. If renewable gases materialise in sufficient quantities, the network can still be repurposed with lower tariffs as the capital investment may have already been recovered.
Orderly Decarbonisation

Delayed Transition:
Delay in implementing capital recovery models increases the cost burden on future consumers. This raises energy equity issues as customers remaining on the network are likely those that are less able to afford the transition.
Disorderly Decarbonisation



Acting now preserves future value options, and will support uptake of renewable gases if that proceeds

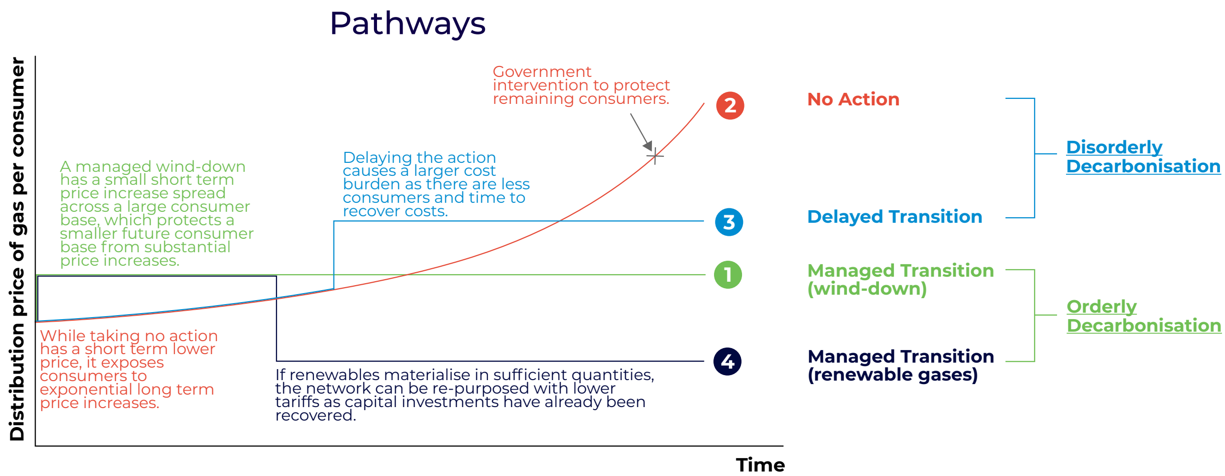


Figure 2

Illustrative description of consumer impact of the three wind-down pathways from Figure 1.

The government has three options:

1 Applying accelerated cash-flow recovery to minimise asset stranding (managed transition)

Apply financial capital recovery models to flatten the gas distribution price while significant consumers still remain on the network. This protects future consumers from exponential price increases 2, and if applied completely, will minimise prospects for future governments from a tax-payer-backed buyout or subsidies. This is a low-risk, options-preserving pathway.

2 Take no action

The government runs a lottery that sufficient renewable gases materialise in sufficient quantities to protect the residential sector. If they don't materialise, consumers remaining on the network will face exponential price increases leading to options such as government acquisition or subsidy to protect remaining vulnerable consumers. This is a high-risk pathway.

3 Delayed Transition

The government waits until 2035 to see whether renewable gases materialise before taking any action. If they don't materialise, applying financial capital recovery models would still result in a large price increase as there is less time, and a smaller consumer base remaining.

4 But what if renewable gases come?

If breakthroughs in technological innovation occur allowing for the pipeline injection of renewable gases in sufficient quantities, the Commerce Commission can continue to manage regulated recovery. As capital on the gas network will have been significantly recovered, the network tariff would be lower than the status quo as there is a smaller regulated asset base left to recover. Note that the gas networks would see no additional profit from this scenario. Essentially increased tariffs on fossil-gas now, supports the potential uptake of renewable gases in the future.

Financial capital maintenance

Fundamentals for regulated network infrastructure

The role of the regulator is to promote the long-term benefit of consumers in markets with regulated network infrastructure. Electricity and gas distribution businesses, fibre, and airports are such examples.

Infrastructure businesses raise or borrow money to build their respective infrastructure. The regulatory regime (Commerce Act Part 4) allows infrastructure companies to recover the return on and of capital through tariffs. The regulator balances the expectation of financial recovery, allowance of normal but not excessive profits, and keeping the consumer at the centre. This is also known as the Net Present Value = 0 principle.

Credible scenario analysis indicates that assets are at risk of stranding if no action is taken

Scenario analysis indicates that under current regulatory and policy settings the extent of network stranding across New Zealand could be very material, with estimated risk of gas networks of $973 million assuming a 2050 stranding date with no further regulatory or policy mitigations. Key drivers of the size of the risk are future gas demand and the consumer willingness to pay for price increases illustrated in Figure 2. This scenario is conservative as it is also plausible that the gas network becomes stranded before 2050 depending on Government decisions and policy changes [1].

Importance of being cash-flow positive

Gas infrastructure businesses need to be cash-flow positive to safely manage and operate the network. Figure 3 (middle) highlights a scenario which has a credible risk of gas infrastructure businesses being cash-flow negative in early 2040.

If they become cash-flow negative, there is a likelihood that the services would be shut down prematurely leaving consumers stranded. An example of this recently occurred in Esperance Australia where a premature shutdown of the gas network required government subsidies to support the consumer transition to electricity. See page 14 for more information.

Importance of having a return on investment

Gas infrastructure businesses make investments based on a return on investment proportional to the weighted average cost of capital (WACC). Scenario analysis shows that the return on investment in a wind-down scenario would decline over time proportional to revenue being recovered and - critically - fall below the cost of capital and become negative.

This becomes problematic for future investments such as repair after a natural disaster. Due to the combination of risk of capital recovery, and director duties under the Companies Act, it may be more rational to shut down the impacted network (in part or in full) prematurely rather than deploy capital for repair, leaving consumers stranded.

Impact on wider infrastructure businesses such as electricity

Denying the opportunity to recover costs risks raising the perceived cost of doing business, leading to lower than optimal allocation of investment in the provision of services. This has follow on implications for wider infrastructure investments under the same regulatory regime.

For example, Vector's electricity network plays a critical role in decarbonising industry and transport. Vector is able to make investments into the electricity system with the confidence of capital recovery under the regulatory principles of financial capital maintenance.

While unregulated companies can pivot their businesses pricing to avoid stranded assets, or price in a charged risk profile, regulated companies are constrained by the nature of the assets and the regulatory regime.

If stranding occurs in the gas business due to regulatory failure, this risks contagion implications for future infrastructure investments in New Zealand in general.

> *If stranding occurs due to government fiat, this may be viewed by financial markets as a form of opportunism. Participants in financial markets would incur greater transaction costs in investing in regulated sectors exposed to the potential for stranding.*
>
> - Tom Hird 2021 paragraph 16 [2]

Electricity networks are already faced with

Further reading:

[1] Gas Infrastructure Working Group. 2023. *Gas Transition Analysis Paper*

[2] Tom Hird, Competition Economists Group. 2021. *Stranding risk - depreciation vs uplift*

[3] Australian Energy Regulator. 2021. *Regulating gas pipelines under uncertainty - information paper*

[4] Australian Energy Regulator. 2021. *News article: AER allows revenue to support gas consumers in transition to renewables*

the complexities of funding a multi-billion dollar energy transition and there is a real risk that regulatory failure will impede confidence within capital markets, leading to additional funding challenges.

Future consumers will bear the cost of regulatory failure

Alongside this, it is critical to ensure a fair deal between current and future consumers. In the absence of long-term agreements with consumers, those that continue to use services when demand falls are exposed to price increases as highlighted in Figure 2 - page 7.

The Australian Energy Regulator stated in 2021 that:

> *To minimise future price increases, particularly for vulnerable consumers that might not be able to afford to switch, the AER's decision allows Evoenergy to accelerate the depreciation of new gas pipeline assets in NSW and the ACT.*
>
> - Australian Energy Regulator [4]

Who pays for decommissioning costs?

An unanswered question is the cost of decommissioning. Regardless of who pays, the costs are significant, and a fund needs to be set up now to pay for this future expense. There is more information on page 19 on decommissioning allowances.

It may be rational for gas infrastructure businesses to shutdown sections of their network sooner than is socially desirable if principles of financial capital maintenance are not upheld

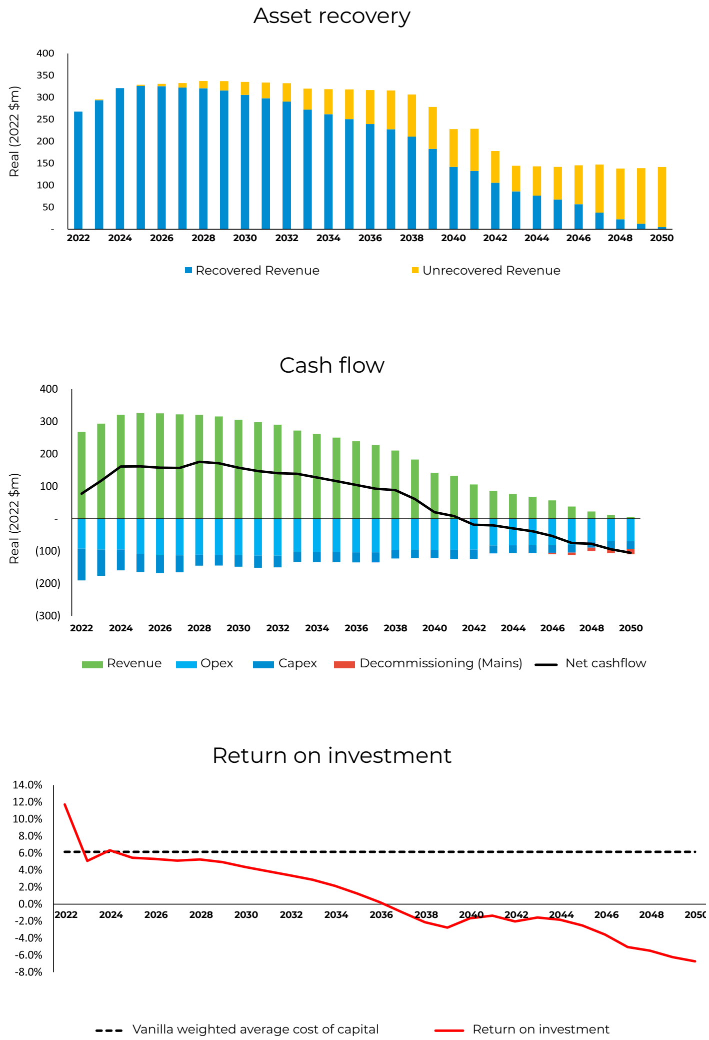


Figure 3

Scenario modelling results on the impacts of a network wind-down on gas distribution and transmission pipelines assuming no further governmental or regulatory intervention. (top) compares recoverable and unrecoverable revenues. (middle) details the cash-flow noting positive cash-flows for initial years, that then trend downwards as consumer numbers fall, and consumer willingness to pay is insufficient to recover the required value. (bottom) projection of return on investment against the regulated weighted cost of capital [1].

Tensions for government to manage

Current consumers vs. future consumers

Concerns over intergenerational equity will be one of the key drivers for balancing proposed solutions. Accelerated financial capital recovery models or levers (such as accelerated depreciation) do the most to protect future 'slow-to-switch' consumers via an increase in gas price on all current consumers.

Gas tariff payers vs. tax-payers

Gas network infrastructure will be shut-down when it becomes or anticipates being cash-flow negative (like any rational commercial entity). This could prompt the need for a government buy-out to protect the remaining consumers on the network and continue the supply of gas such as what has already been witnessed in Australia (see Case Study: Esperance - page 14).

High-income vs. low-income consumers

Consumers who are homeowners and able to afford the upfront capital costs of renovations may already switch to electricity. However, the high upfront capital cost of electrification forms a barrier to low income households and renters. This would result in low-income consumers and renters bearing the burden of future price increases while high-income households benefit from the advantages of electrification.

Gas users vs. electricity users

A disorderly gas transition leading to regulatory failure will also place a burden on electricity users as investments in the electricity system will become increasingly complicated and potentially delayed.

Industrial vs. residential

If industrial consumers accelerate in disconnections, then the remaining residential user base will be bearing the weight of the infrastructural investment. Is it fair for the residential sector to absorb these costs, or should it be front-loaded onto the existing industrial consumers to pay for the cost of the gas infrastructure before they disconnect?

Decarbonising via price vs. mandate

Intelligent pricing designs can be effective in preventing further investments in fossil fuel based appliances. For example, front-loading cash-flows to current consumers to reflect the true cost of gas may naturally deter some gas connections, while protecting future consumers. This is in contrast to a blanket ban which stops new gas connections with no financial security for future consumers.

> It will be crucial for the government to prevent vulnerable consumers from being unfairly burdened

Governance for a managed transition

Case for a ministry of energy and net zero

The energy transition needs streamlined coordination

New Zealand's Parliamentary Commissioner for the Environment Simon Upton describes the country as being on the cusp of the greatest energy transformation for generations.

Vector believes that if New Zealand is to accomplish this transformation and set itself for a resilient, affordable and low-carbon energy future, then we need to ensure we have policy making and regulatory functions that are fit for purpose.

Our current energy policy and regulatory arrangements are falling short.

The energy policy function is presently managed within one of our biggest government agencies, the Ministry of Business, Innovation and Employment (MBIE).

The responsible branch, Energy and Resources, is one of six branches in the Building, Resources and Markets Group, which in turn is one of eight groups in a department that reports to 26 ministerial portfolios.

The creation of a new Ministry of Energy and Net Zero, and a single energy regulator offers the clear prospect of streamlining the current bureaucracy. In both designing a new Ministry and consolidating at least three different energy regulators, there is an opportunity to achieve obvious operational synergies between various energy policy and regulatory agencies in terms of expertise, data and resources as well as delivering improved value for money for taxpayers.

Faced with comparable challenges and needing clearer definitions and management of energy outcomes, the UK and Australia have both recently established new Ministries that combine climate change action and energy to ensure a strong focus on these pressing challenges.

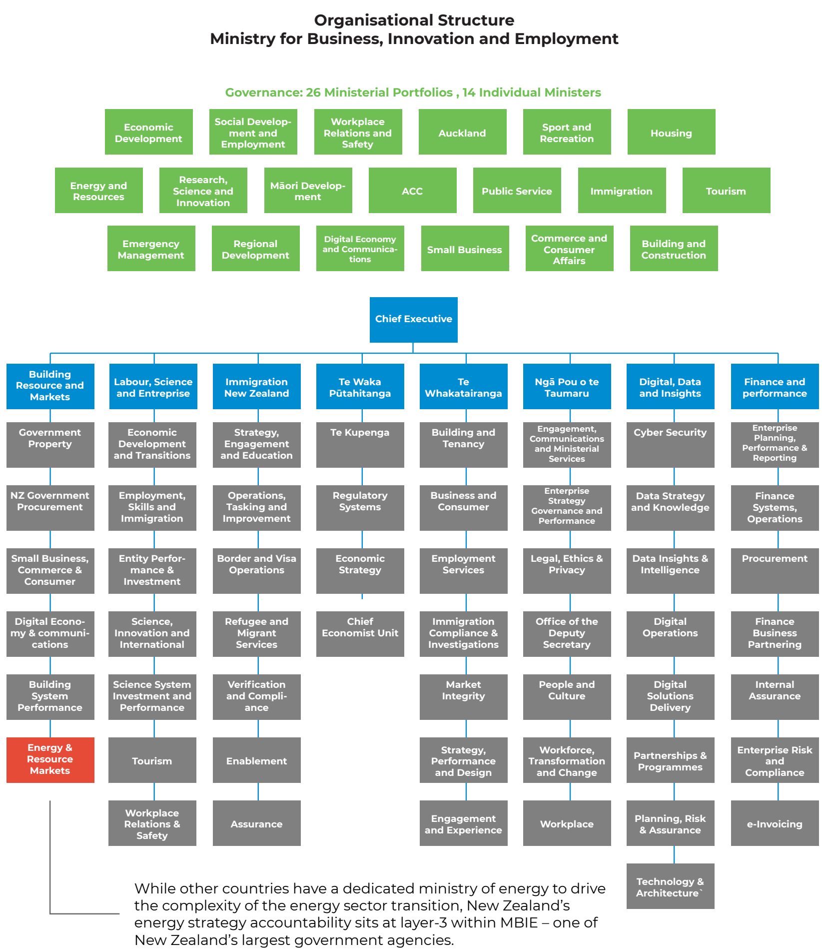


Figure 4

Organisational structure of the Ministry of Business Innovation and Employment.

Overview of natural gas

Natural gas use in New Zealand is largely used in industrial process, methanol production, and electricity generation. The residential sector accounts for only 5% of all natural gas-related emissions, yet makes up 95% of all natural gas connections (276,500 connections).

In Auckland, the Vector gas network consists of over 119,000 connections, of which the majority (111,000) are residential. Once again, the industrial sector consisting of just 200 connections is responsible for approximately 60% of natural gas use. While the residential and small commercial only contributes to 20% of emissions.

Meaningful decarbonisation of the gas system is therefore largely an exercise in reducing gas-fired electricity generation and industrial processes.

The gas network transition is currently managed by three parties

- Gas distribution networks that provide services and are bound by director duties to its shareholders.
- The Commerce Commission - which currently administers Part 4 of the Commerce Act 1986.
- The Government - which can make policy, administrative, expenditure, taxing decisions, and seek parliamentary approvals for legislation.

Coordination failure across the three parties risks driving New Zealand towards a disorderly exit.

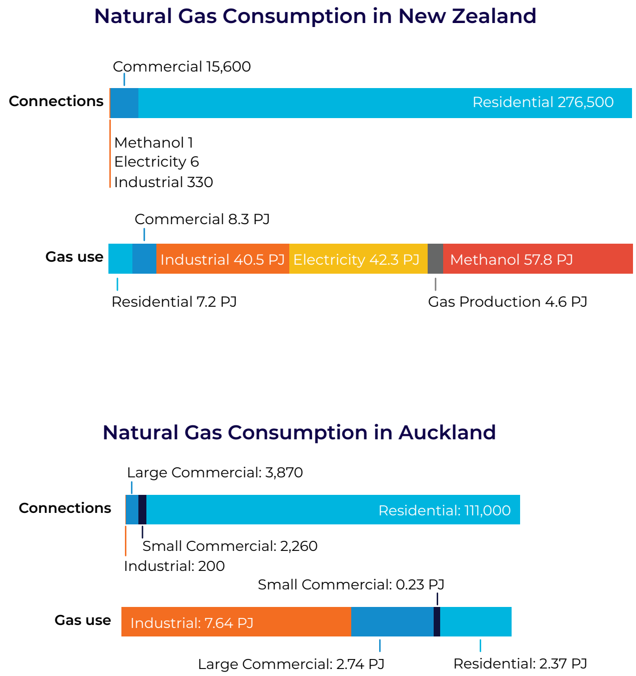
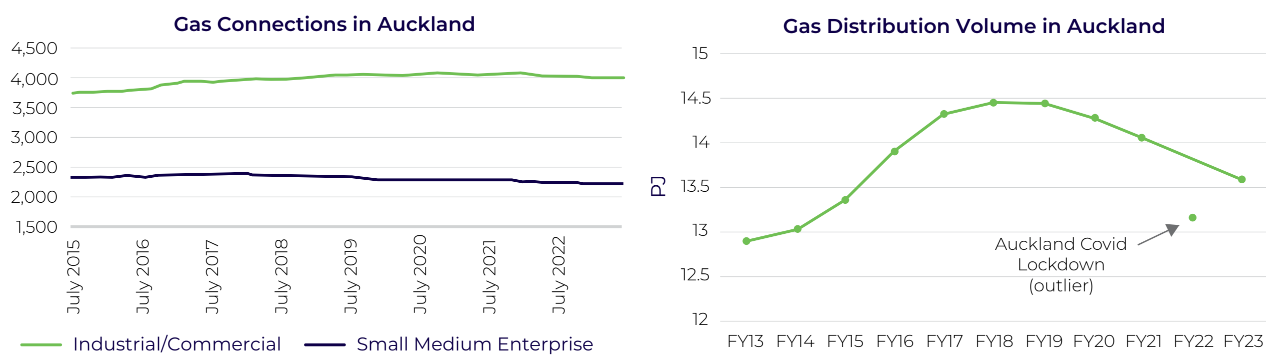


Figure 5

(above) Natural gas use and consumption in New Zealand, and Auckland. The residential sector accounts for just 5% of emissions, yet makes up 95% of gas connections.

Figure 6

(left) Gas connections for industrial and small medium enterprises in Auckland. (right) Gas distribution volumes trending down since Financial Year 2018. Note that COVID impacts caused a decrease in activity in 2022.



Principles for a managed gas transition

Effective decarbonisation

Implement solutions that reduce the greatest amount of greenhouse gases quickly in both the near and long term - noting that residential gas use only accounts for 5% of gas related emissions.

Elevate solutions for low-income households

Implement complementary solutions that prioritise support for low-income and disadvantaged households.

Our estimations of residential appliance switch-out costs come to approximately $7000 per household, or $2.1 billion for the whole country. Households that also use gas for space heating would be expecting costs upward of $20,000. When including commercial and industrial consumers this switch-out cost increases to $7.9 billion.

Set assets with declining consumers means those remaining on the network will face distribution price increases. While higher-income households may be in a position to start transitioning to electricity, those that are lower on the income scale or renting risk being burdened with increasing energy bills.

Government has an immediate role to preserve the principles of financial capital maintenance, thereby mitigating stranded asset risk for investors, and better managing long-term consumer prices. Doing nothing will lead to a disorderly transition. This will be discussed further in this report.

Preserve a clear regulatory compact that underpins all existing and future regulated infrastructure

While unregulated companies can pivot their businesses to avoid stranded-assets, or price in a changed risk profile, regulated infrastructure companies are constrained by the regulated regime. Regulatory failure leading to stranded assets will fundamentally undermine the principles of financial capital maintenance, which will then risk an impediment to investments in other regulated businesses such as electricity infrastructure.

De-growth economics sits in a different paradigm to growth-based economics

In classical business theory, investments or losses can be made today, with the plan of recovering those investments in the future. In the de-growth paradigm, they cannot be recovered in the future, meaning the recovery of future investments needs to be made in the present.

An example of this is future maintenance, such as when damage occurs due to a natural disaster, and capital needs to be deployed for repair. Due to the risk of capital recovery, and director duties, it may be more rational to shut down the impacted network prematurely leaving consumers stranded.

Managing this requires a fundamental shift in regulatory thinking, business planning and policy development to manage this high uncertainty across long time periods.

No regrets and no surprises

No regrets options should be prioritised and implemented as soon as possible. They should be clearly effective, have a low risk of unintended consequences, and not close off future optionality.

Furthermore, there should be no surprises. Gas infrastructure management is complex, and requires planned, transparent actions with sufficient long lead times to manage a limited pool of tradespeople, avoid consumer shock, and maintain the regulatory compact for investors.

Select policies that maintain real-option value

Policies designed in times of uncertainty should be reversible to maintain real-option value. An example of this uncertainty is renewable gases.

There are too many unknowns in renewable gas technology and markets to speculate as to whether it will save natural gas pipelines. However, the government can work with this unknown by preserving options. If breakthroughs in technological innovation occur allowing for the pipeline injection of renewable gases in sufficient quantities, policies should be able to pivot to accommodate for this future.

Note that taking no action does not constitute as options-preservation as it increases the burden on consumers and increases the risk of asset stranding.

Case Study: Esperance

An Australian example of a disorderly transition from gas

An unmanaged industrial exit

The Esperance Gas Distribution Company (EGDC) runs a small reticulated natural gas network on the south coast of Western Australia which connects the community of approximately 400 residents and a local gas-fired power station.

When the local gas-fired power station was shut down, and the new power station was built independently of the pipeline, there was no financial rationale to keep supplying the residential gas network. In 2021 the Esperance Gas Distribution Company told consumers it would stop operating the gas network in March 2022.

A sudden transition

It was simply not possible to transition all 400 consumers within this one-year period. To buy time, the state government agreed to pay the gas distribution company to keep the network running for another year.

A costly transition

The state government invested AUD$10.5 million of tax-payer money to transition the 400 affected consumers to electricity [7]. This cost AUD$26,000 per household. In contrast, our estimations of residential switch out costs in New Zealand come to approximately NZD$7000 per household[1].

Electrification was the preferred option

Horizon Power, the local electricity utility, launched an active electrification campaign which included bringing a celebrity chef to demonstrate induction cooking. Over 85% of residential consumers chose full electric or partial electric solutions for their homes over bottled LPG [6].

Local trades were critical

Coordination of local trades was critical to the success of the transition within the time frame. This was managed centrally through Horizon Power who ensured that they were fully qualified, completed the work to standard, and had all the necessary insurances.

What we can learn

Like any rational commercial entity, gas network infrastructure will likely be shut-down when it becomes cash-flow negative. Mitigating this risk by acknowledging and re-affirming capital financial maintenance is therefore a critical component of public policy. The goal is to avoid an Esperance-like case through proactive planning today.

> The state government invested AUD$10.5 million of tax-payer money to transition 400 affected customers. This cost AUD $26,000 per household

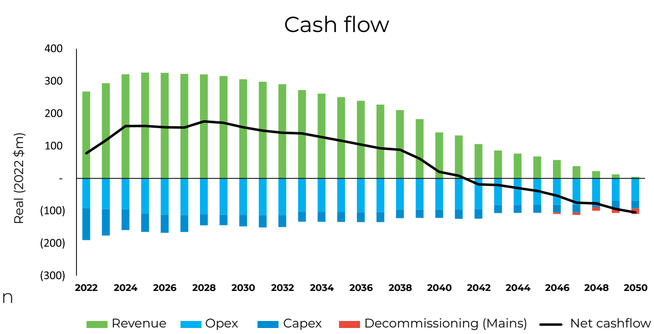


Figure 7

Modelling results of cash-flows of New Zealand gas pipeline infrastructure in a wind-down scenario with current regulatory and policy settings. There is a risk of gas infrastructure businesses being cash-flow negative in early 2040 [1].

Further reading:

[5] ABC news. 2022. *Esperance residents face uncertainty over household energy supply*

[6] Horizon Power. 2023. *Esperance Community Successful Transitions from Reticulated Gas*

[7] Kalgoorlie Miner. 2023. *Esperance transitions from reticulated gas to electric power*

[1] Gas Infrastructure Working Group. 2023. *Gas Transition Analysis Paper*

Pathways for a managed transition

See following pages for a detailed explanation

Preserving principles of financial capital maintenance and mitigating consumer burden requires a mix of complementary solutions. The solutions presented here should be combined to achieve the Net-Present-Value = 0 outcome. In other-words those that mitigate stranded asset risks for both infrastructure owners and gas users.

Accelerated depreciation *(page 16)*
Accelerated depreciation is a mechanism to minimise investor, consumer, and taxpayer risk by recovering the cost of an asset and progressively removing it from the regulated asset base in line with its intended useful life. This is in contrast with the currently assumed economic life used in regulatory models.

Asset securitisation *(page 18)*
Securitisation is the issuance of taxpayer-backed bonds to recover forecast stranded asset costs. Gas distribution companies no longer earn a rate of return on the securitised amount, but rather charge a 'securitisation charge' on remaining users to recover the interest cost of the government bond. Because government bonds require less interest, and gas distribution companies no longer earn a profit on the securitised assets, it can lead to overall consumer savings. Securitisation can be paralleled with the debt-financing model used for the New Zealand Ultra-Fast-Broadband model as a means to manage transition demand uncertainty.

End-of-life fund *(page 19)*
Regardless of the economic pathway to mitigate stranded asset risk, it will be critical to proactively plan for the end-of-life decommissioning costs for those gas assets. This includes, for example, the cost to decommission, de-pressurising, sealing, gas-flaring, capping, and potential removal of the assets completely. Over the period to 2050, the full wind-down has estimated decommissioning costs of $158 million and disconnection costs of $364 million based on rudimentary assumptions.

Move from a price cap to a revenue cap *(page 20)*
Gas distribution networks are regulated under a weighted average price cap model which incentivises gas networks to grow gas demand and connections. This lies in contrast with decarbonisation objectives that have sought to reduce demand.

Switching to a revenue cap limits the total amount of revenue that can be earned by a gas distribution business regardless of how much gas is distributed.

Removing inflation indexation to regulated asset base *(page 21)*
A further option to mitigate stranding risk is to no longer apply inflation indexation to the regulated asset base. Indexation exacerbates stranding risk by deferring cash-flows into future periods. Removing inflation indexing brings capital recovery forward.

Network right-sizing *(page 23)*
Network right-sizing, also known as targeted electrification, is where sections of the gas network that have a low number of users, or high upcoming capital investments (due to old pipelines), are proactively decommissioned. For network right-sizing to work, the value of those regulated assets would still be recovered over remaining consumers. This may have overall cost savings to the gas consumers.

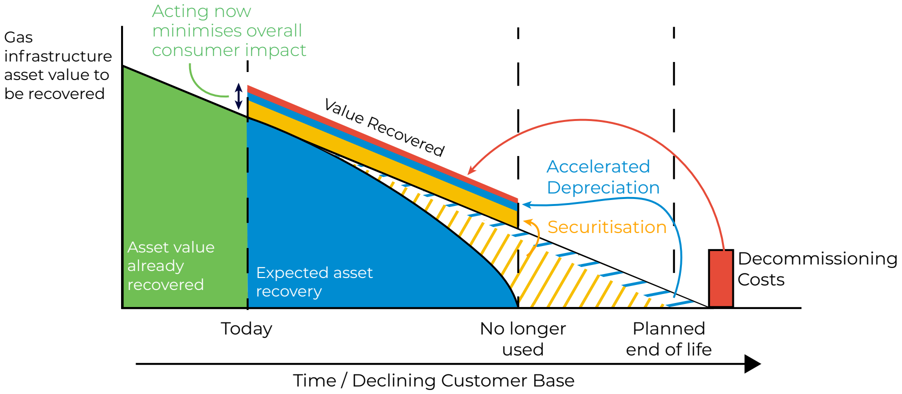
Re-nationalisation *(page 25)*
With such complexity, which also needs to be coordinated with the wider energy transition including a growing electricity system, a more interventionist approach is imaginable whereby gas networks are commercially acquired and then wound down as part of a government-run and controlled programme.

An example of this is Denmark, where the gas network was purchased over a five year period by the Danish Government. The Danish government then began providing funding to households to cover gas network disconnection costs.

> Every delay leads to an increase in potential stranded assets and increases the financial exposure of consumers and infrastructure owners

Figure 8

Illustrative example of how three of the proposed frameworks (accelerated depreciation, securitisation and end-of-life fund for decommissioning) are applied in parallel to mitigate stranded asset risk. Doing so also reduces overall consumer impacts as assets are recovered over the larger current consumer base.



Accelerated Depreciation

Accelerated depreciation is a mechanism to minimise investor, consumer, and taxpayer risk by accelerating the cost recovery of an asset and progressively removing it from the regulated asset base. By doing so, cash-flows are brought forward so that a larger present consumer base can absorb the majority of the capital costs. As the network winds down, the smaller future consumer base would pay for a smaller remaining asset value. This reduces the risk of an exponential price increase for future consumers that may not be able to be able to afford the transition to electricity.

Current State

The Commerce Commission has allowed for accelerated depreciation over the current price path period (DPP3). This model is a 'straight-line' depreciation to a target sunset date of 2056, see Figure 9b. This is a good start, however if a wind-down scenario is being targeted there is a likely reality that the gas networks cease supplying before 2056.

Furthermore, 'straight-line' depreciation does not provide adequate protection against an exponential price increase due to a declining consumer base. See Figure 9

Depreciation methods

The Commerce Commission uses 'straight-line' depreciation as a default as it is administratively simple. As the name suggests, the depreciation charge is distributed uniformly from one year to another. While this may reduce future price increases, it doesn't mitigate it as the future depreciation charge is still shared amongst a future smaller consumer base.

To mitigate this, accelerated depreciation must be front-loaded. Here are some examples of how this works

Diminishing Value: (Figure 9c)
Rate of depreciation is a fixed percentage of the remaining asset value. This results in larger depreciation in early years with less in later years. This method has been applied in the Netherlands [9].

Tilted annuity:
Rate of depreciation declines annually depending on the tilt. The tilt can be designed to match future gas volume declines to mitigate price increases on consumers. This method was applied to Chorus' financial loss asset.

Sum-of-digits: (Figure 9e)
The rate of depreciation declines linearly, by the same amount each year, from the year it is commissioned down to zero when it reaches the end of asset life. This approach has been implemented in the UK since 2013 by Ofgem [9] .

Flexibility, not rigidity

A feature of depreciation is its flexibility. Generally accepted accounting practice is that changes in the expected pattern of consumption of an asset warrants an adjustment to depreciation.

Reversibility

Accelerated depreciation is a policy aimed at ensuring a net-present-value of zero outcome for gas distribution businesses. In other words if no stranding occurs, future consumers benefit by having much lower prices than they otherwise would as illustrated in Figure 9f. Similarly if new information becomes available the pace of accelerated depreciation can be increased or reduced as appropriate.

The role of government

The gas transition plan should call for front-loaded accelerated depreciation, to a year closer to where current modelling shows infrastructure providers become cash-flow negative (and therefore potentially even cease operations). This would provide the Commerce Commission with the Government direction to act to ensure the principle of financial capital maintenance.

Accelerated depreciation can manage cost recovery by bringing forward recovery where appropriate. It is a 'no regrets' policy for both networks and consumers.

Further reading:

[8] Ofgem. 2021. *Decision on strategy for the next gas distribution price control* Para [8.7] - [8.11]

[9] Oxera. 2021. Regulatory tools applied to gas networks to accommodate energy transition

[10] Australian Energy Regulator. 2021. *News article: AER allows revenue to support gas consumers in transition to renewables*

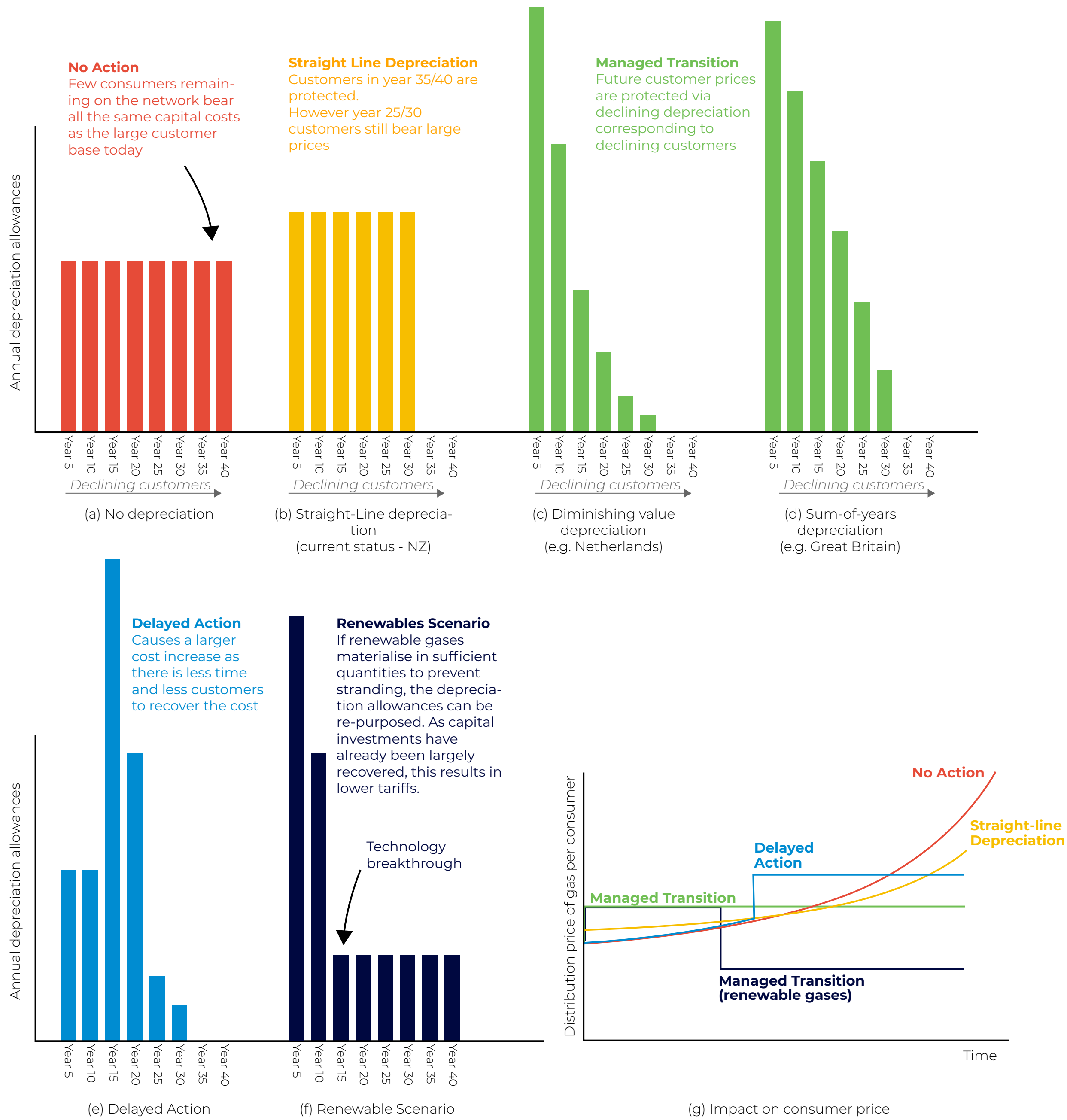


Figure 9

(a-f) Illustrative examples of different accelerated depreciation models. (g) Illustrative impact of different models on the distribution gas price per consumer.

Securitisation

Also known as a 'rate reduction bond'

What is securitisation

Securitisation can be seen as a government backed bond to transition the energy sector to a zero-carbon future. If implemented correctly it can accelerate electrification, mitigate stranded asset risk, reduce overall consumer cost, with no additional cost to the government [11].

It can be paralleled with New Zealand's Ultra-fast-broadband policy in 2011 whereby a government backed debt investment was used to accelerate the uptake of fibre, which would return over time and improve the connectivity of the country. The main point of difference is that securitisation supports a de-growth paradigm, whereby bonds are issued against future stranded assets. However for both cases, the bond would serve to address demand uncertainty.

Implementation

The securitised bond is valued (yellow hashed area in Figure 10), and fenced whereby gas distribution companies no longer earn profit on the securitised assets. The securitised bond is recovered via a securitisation charge on existing consumers.

Securitisation also has a 'true-up' mechanism so that consumer charges can be adjusted up and down. For example, if the securitised bond is at risk of stranding due to a faster than anticipated wind-down of the gas network, the consumer charge can be increased to protect the tax-payer.

Difference to Accelerated Depreciation

The main difference to accelerated depreciation is the impact on consumers.

Firstly, gas distribution companies no longer earn profit on securitised assets. Secondly, and more significantly, government backed bonds have a lower interest rate compared to the weighted average cost of capital.

For gas network companies, the stranded cost is recovered, thus reducing stranding risk and future exponential gas network tariffs.

Examples

California state has had past experience with utility securitisation for all three of its utilities in 1997 when the California Public Utilities Commission allowed a recovery of $7.3 billion in transaction costs as part of a transition from deregulation. Securitisation has also been used to cover storm damage expenses in Texas, and recover deferred power procurement costs in Maryland [12].

Role of the government

Securitisation may require legislative action to authorise gas distribution companies to charge a securitisation fee to recover the cost of the securitised assets. A special entity, sometimes called a 'Special Purpose Vehicle' issues the taxpayer-backed bond and sells it to investors using the proceeds to buy out the stranded assets.

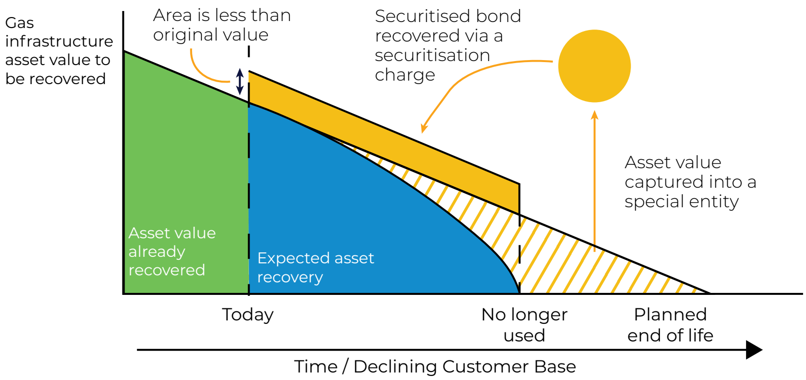


Figure 10

Adapted from [11]. The yellow area under the curve is securitised and charged to consumers via a securitisation charge. This works similarly to accelerated depreciation. However the solid yellow area is smaller than the hashed yellow stranded area as revenues yielded from securitisation have savings from avoided payments of profits and lower interest rates.

Further reading:

[11] Environmental Defense Fund. 2019. *Managing the Transition - Proactive Solutions for Stranded Gas Asset Risk in California*

[12] California Public Utilities Commission. 2012. *Trends in Utility Infrastructure Financing*

Fund for end-of-life treatment

Also known as a decommissioning tariff

End-of-life fund
In the event of a wind-down scenario, it will be critical to proactively plan for and appropriately fund the end-of-life costs for those gas assets. This includes, for example, the cost to decommission, de-pressurising, sealing, capping, and potential removal of the assets completely.

Current state
Gas networks were never designed for decommissioning meaning that there is currently no obligation, responsibility, regulatory compensation or fund to manage the end-of-life treatment of the gas network. Over the period to 2050, a full wind-down scenario has an estimated decommissioning cost of $158 million and disconnection costs of $364 million based on conservative and rudimentary assumptions [1].

Funding the decommissioning scenario
Gas infrastructure companies would need to start proactively planning for decommissioning. Adding an end-of-life tariff now, would enable gas infrastructure companies to gain the necessary funding to safely decommission the network at end-of-life, or right-size the network for a renewable gas future.

This decommissioning process should also ensure that the natural gas is flared not vented, as venting the volume of methane in Vector's pipeline alone would release approximately 100,000tCO_2e.

Decommissioning plan
It may be possible to use economies of scale to reduce overall disconnection costs. For example, instead of shutting the network by each individual connection point (which currently costs Vector $1500 each), it may be cheaper to disconnect a whole network segment from the mains line.

Role of government
Public policy would need to clearly define responsibility and the appropriate funding mechanism for decommissioning. If Vector and other gas networks were enabled to charge a decommissioning levy now this would seek to cover for this end-of-life treatment. Delays in implementing this increases the cost to consumers as there is less time to collect the fund.

Alternatively, the government may decide that the future tax-payer rather than the current gas-tariff payer should pay for this decommissioning.

Role of the regulator
The decommissioning balance could be overseen by the Commerce Commission so that if renewable gases materialise in sufficient quantities at cost-effective prices, the fund can be returned to consumers via lower pricing.

The full wind-down has estimated decommissioning costs of $158 million and disconnection costs of $364 million

Further reading:

[1] Gas Infrastructure Working Group. 2023. *Gas Transition Analysis Paper*

[11] Environmental Defense Fund. 2019. *Managing the Transition - Proactive Solutions for Stranded Gas Asset Risk in California*

Revenue Cap vs. Price Cap

Weighted average price cap

Price cap regulation sets limits on the prices gas distributors can charge. In this model, the Commerce Commission sets gas volume forecasts over a regulatory period.

If the actual gas demand is higher than forecast, gas distribution companies would earn more than the efficient costs required to deliver the gas service. Conversely, if demand turns out to be lower than forecast gas distribution companies would earn less.

The main economic rationale typically expressed by regulators when adopting a price-cap model is that it incentivises gas distributors like Vector to grow demand and connections as a means of increasing consumer welfare.

Conflict with decarbonisation

While a weighted average price cap works in a growth paradigm, New Zealand's policy and targets seek to reduce (rather than increase) fossil gas consumption. Furthermore, with industrial decarbonisation, it becomes increasingly complicated to forecast gas volumes over a four-year regulatory period.

Solution - revenue cap

A revenue cap limits the total amount of revenue that can be earned by a gas distribution business.

The UK regulator, Ofgem switched from a price-cap to a pure revenue cap for gas distribution businesses in 2007 and maintained that approach ever since.

A revenue cap can also be combined with an 'overs and unders' account which can ensure that gas distributors recover their prudent and efficient costs and no more.

Changing to a revenue cap however does not affect the stranded value risk of the regulated asset base.

Role of government

The Commerce Commission's justification for maintaining the price cap is as follows:

> *Under a Weighted Average Price Cap, the Gas Distribution Boards bear the within-period demand risk and are incentivised to grow demand while maintaining incentives for cost efficiency. Under a revenue cap, consumers bear the within-period demand risk.'*
>
> *- Commerce Commission 2022 paragraph E29 [14]*

This rationale from the Commerce Commission lies in contrast to government objectives which may seek to reduce demand.

The government have highlighted this risk in Chapter 9 of the Measures for Transition to an Expanded and Highly Renewable Electricity System. We strongly support the government's notion that amendments to the statutory objectives of both the Electricity Authority and Commerce Commission are required to ensure that sustainability is adequately reflected in market regulators, similar to the Australian approach.

Further to this we recommend an investigation as to whether our economic regulatory regime is fit for purpose amid the significant energy challenge that lies ahead of us.

Further reading:

[13] Frontier Economics. 2023. *The Merits of introduced a revenue cap for gas distribution businesses - a report prepared for Vector*

[14] Commerce Commission. 2022. *Default price-quality paths for gas pipelines businesses from 1 October 2022 [paragraph - E29]*

[1] Gas Infrastructure Working Group. 2023. *Gas Transition Analysis Paper*

Removing Inflation Indexing

Indexation

The regulated asset base is currently indexed to reflect forecast inflation over a regulatory period (which is four years).

By doing so, cash-flows for gas distribution businesses are pushed back to future periods. In other-words, the recovery of investments made today, is largely recovered near the end of its expected asset life.

Issue with declining consumers

In a de-growth paradigm, deferring cash-flow recovery to later periods is problematic, simply because there are fewer consumers to absorb the costs incurred in the present. In essence, inflation indexation works counter to previously discussed economic mechanisms such as accelerated depreciation.

Issue with stranded investment

Gas distribution businesses invest and operate their networks in ways that ensure the continued safe, reliable delivery of services whilst also allowing for a stable, equitable transition to electricity in line with the Government's climate objectives.

However, gas businesses are financially at risk of never recovering the capital as it is back-ended through indexation.

The case for removing inflation indexation

The removal of inflation indexing on the regulated asset base would bring capital recovery forward in a Net-Present-Value neutral manner.

In a similar manner to accelerated depreciation, this solution protects the mid to long term consumer interests from price increases by smoothing out the recovery over a large present consumer base.

Gas distribution businesses would also reduce the asset stranding risks they face.

Role of government

The Commerce Commission did not accept Vector's request to remove indexation claiming that it was neither necessary nor desirable. Once again, this brings into question whether Part 4 of the Commerce Act is fit for purpose in this uncertain future. Simply put, a de-growth economic paradigm is a fundamentally different environment to a growth-based model.

In a similar manner to accelerated depreciation, this solution protects the mid to long term consumer interests from price increases by smoothing out the recovery over a large present consumer base.

Further reading:

[15] Vector. 2023. *Input Methodologies Review 2023 - Response to Draft Decision* [paragraph 90- 111]

Gas connection prohibition

A prohibition would set New Zealand on No-Action trajectory

A gas connection prohibition seeks to mitigate future consumer appliance stranding costs by preventing them from being installed in the first place.

Still a no-action pathway

A prohibition of new gas connections risks setting the gas networks on a wind-down trajectory as there will be no new connections leading to net-disconnections. Unfortunately, the government and regulatory frameworks do not yet have appropriate financial capital maintenance assurance (see Pathways for a managed transition - page 15) in place to manage this wind-down scenario. Not having these fundamental principles in place would set the network on a disorderly trajectory resulting in a cost burden on existing consumers and infrastructure owners.

100% capital contributions on new connections

Vector has a 100% capital contribution policy on new gas connections. This means that connecting consumers pay for 100% of network costs to connect to gas. New consumers connecting therefore do not burden existing consumers.

Ban vs. price

The risk for new gas consumers is that they are connecting to the network based on current gas prices, without an educated understanding of future price increases.

If financial capital principles were in place so that consumers would be paying the true cost of gas - which potentially includes decommissioning costs, and any network wind-down scenario - it may create more accurate price incentives for consumer connections in the first place.

Further to this, policy and regulations could enable gas distribution businesses to charge a 'disconnection fee' when connecting new consumers. This would cover the portion of that consumer's disconnection cost.

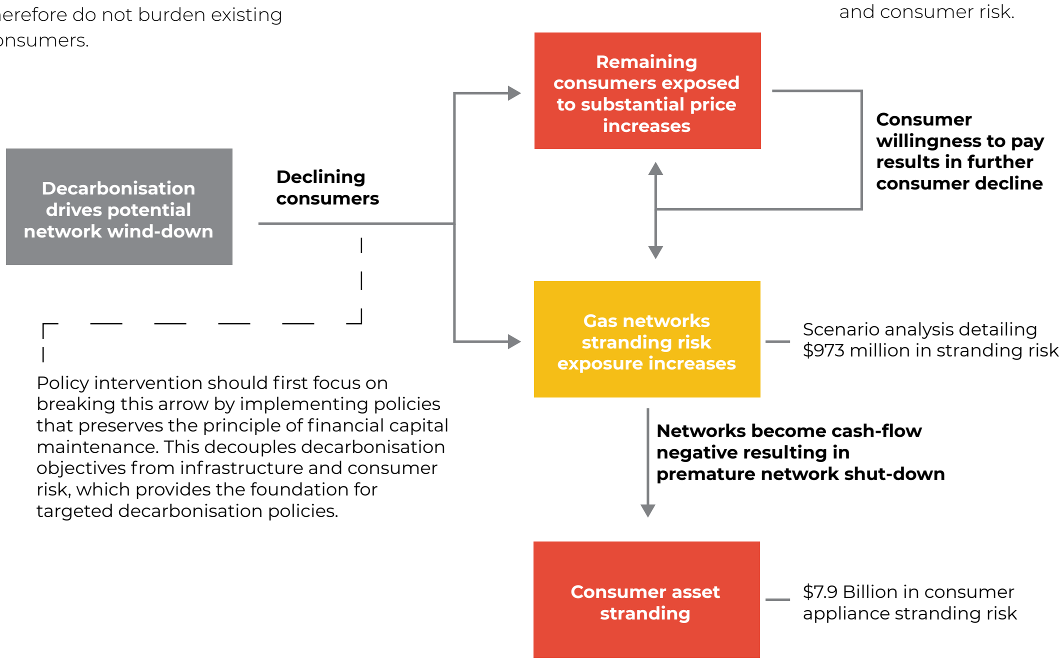
Role of government

A gas connection ban is only ever an appropriate policy once the key mechanisms for an orderly transition have been put in place. Failure to do so simply burdens existing consumers with an increased risk of network stranding.

Vector therefore opposes a gas connection prohibition unless the regulatory certainty of financial capital recovery is in place.

Figure 11

Importance of decoupling decarbonisation from infrastructure and consumer risk.



Network Right-Sizing

Also known as Targeted Electrification

Network right-sizing is where sections of the gas network that have low users, or high upcoming capital investments (due to old pipelines), are proactively decommissioned. For network right-sizing to work, the value of those regulated assets would still be recovered over remaining consumers. The goal is to reduce ongoing consumer costs through more efficient network use.

Case of low consumers

There are sections of distributed networks that already have low consumer numbers where the operational costs of maintaining the network may be greater than the revenue obtained.

Network right-sizing allows for targeted electrification, while still allowing capital recovery of the asset base.

Case of pipeline maintenance

Regions with old pipelines (pre-1985) need to undergo investments to maintain safety. Capital replacement costs come to nearly $1 million per km of pipeline. Network right-sizing in these areas could also result in overall consumer savings as it avoids these capital investment upgrades.

Limitations

One limitation is that the network decommissioning capital cost and residential appliance switch-out costs can be greater than the cumulative operational savings.

Coordination of trades

Consumer switching from gas to electricity requires access to tradespeople to convert consumer infrastructure. While small right-sizing projects should not be a significant issue, larger projects would need centrally managed coordination. In the Esperance case-study of 400 consumers, Horizon Power ensured that all tradespeople were fully qualified, completed the work to standard, and had all the necessary insurance. This process still took two years for just 400 households.

New Zealand has 300,000 natural gas consumers which highlights the importance of clear policy with sufficiently long lead times to manage these transitions in an orderly manner.

Role of the regulator

The regulated framework needs to enable Vector to continue recovering the assets of the right-sized network. If this is not allowed, then government compensation is required for the lost value.

Role of the government

The government needs to ensure that legal barriers (right to disconnect/ decommission) networks do not form a barrier. Furthermore, a fund for decommissioning must be enabled (see page 19) so that the cost of decommissioning is not absorbed by remaining consumers.

The first network right-sizing projects will form a blueprint for future network decommissioning. Low-income households would likely need government support to electrify.

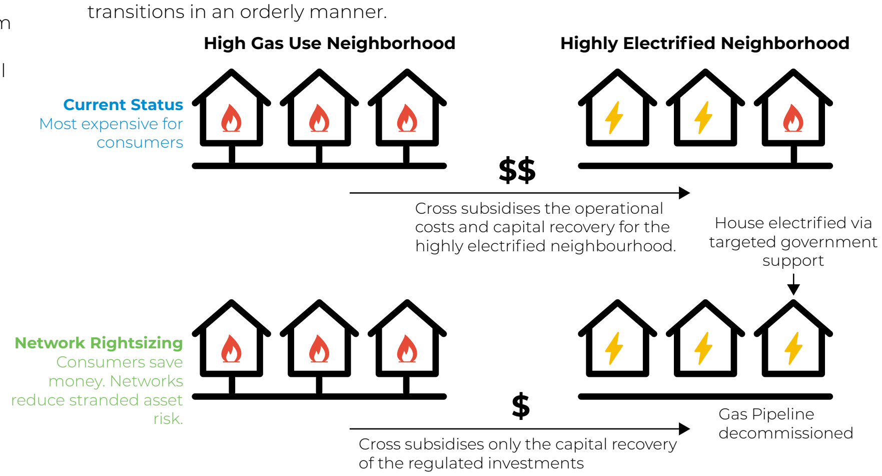


Figure 12

Illustration highlighting how targeted electrification strategies could allow for network right-sizing by decommissioning uneconomic sections of the gas network

Further reading:

[16] Gridworks. 2023. *Strategic Pathways and Analytics for Tactical Decommissioning of Portions of Gas Infrastructure in Northern California - Interim Report*

Decommission Resourcing

Appliance switch-out costs

There are nearly 276,500 residential consumers connected to reticulated gas. Assuming an average appliance replacement cost of $7000 per consumer, this comes to $2.1billion across the country. When including the costs for commercial and industrial users, this number increases to $7.9 billion [1].

Network costs

Gas networks are split into two categories. Mains pipes run through the city transporting natural gas. Service pipes connect the individual consumer to the mains pipe.

To maintain safety, when a consumer disconnects from the gas network, we disconnect the service pipe from the mains line. The existing service pipe is purged so that there is no natural gas remaining in the pipe, and any above ground piping is removed. This comes at an additional cost of $1500 per residential consumer.

Economies of scale could be achieved by disconnecting neighbourhoods instead of individual connections. This way a single mains pipe could be disconnected and purged, instead of disconnecting each individual service pipe.

Nevertheless this is a significant resource requirement, both in personnel and cost. See page 19 for more information on a targeted end-of-life fund.

Coordination of trades

Switching consumers to electricity requires access to a significant volume of tradespeople to convert consumer infrastructure. While small right-sizing projects should not be a significant issue, larger projects would need centrally managed coordination. In the Esperance case-study of 400 consumers, Horizon Energy ensured that all tradespeople were fully qualified, completed the work to standard, and had all the necessary insurance. This process still took two years for the 400 households.

New Zealand has 300,000 natural gas consumers which highlights the importance of clear policy with sufficiently long lead times to manage these transitions in an orderly manner.

Role of the government

It's important to acknowledge the complexity of gas network wind-downs, combined with the long lead times required.

If the government were to signal a wind-down of the gas network, a centrally coordinated working group would need to be established to efficiently disconnect areas of the network in a managed manner. This would ensure the principles of financial capital maintenance are upheld, that disconnection costs are minimised through coordination, and trade resources are appropriately coordinated.

It's important to acknowledge the complexity of gas network wind-downs, combined with the long lead times required.

Further reading:

[1] Gas Infrastructure Working Group. 2023. *Gas Transition Analysis Paper*

Re-nationalisation

What is re-nationalisation

Re-nationalisation is the process by which the gas infrastructure businesses/assets could be purchased in the future by Government.

Case Study: Denmark

In 2016, the Danish government made a decision to consolidate and take ownership of all gas distribution grids, a process which concluded in 2021. Denmark is aiming for all homes currently served by the gas grid (roughly 400,000 households) to switch to district heating or heat-pumps by 2030.

Denmark is a good case study for New Zealand due to comparabilities in network size, population, and GDP. See Table 1 below.

Case Study: Norway

Norway also plans to nationalise its gas pipelines by 2028. Norway however has significant gas production facilities, so may not be as comparable a case study as Denmark is to New Zealand.

Advantages of re-nationalisation

The gas transition is currently managed by three parties

- Gas distribution networks that provide services and are bound by director duties to its shareholders.
- The Commerce Commission - which currently administers Part 4 of the Commerce Act.
- The Government - which can make policy, administrative, expenditure, taxing decisions, and seek parliamentary approvals for legislation.

Coordination failure across the three parties risks driving New Zealand towards a disorderly exit.

Re-nationalisation would remove the economic regulatory overhead, and streamline government ambition with the businesses by being the shareholder.

In the Danish case, this includes a strong biomethane strategy that is tightly interlinked with the renewable electricity transition, combined with governmental support to transition half of all residential users to electricity.

If the government chooses not to re-nationalise early, and the regulatory system fails, leading to exponential price increases and stranding risks, a sudden and forced future government buyout is a possibility to protect remaining consumers on the network, such as the case in Esperance. This can be seen as a disorderly re-nationalisation scenario.

Table 1 Comparison of national statistics between Denmark and New Zealand

	Denmark	New Zealand
Population	5.9 million	5.1 million
Residential Gas Connections	400,000	290,000
Gross Domestic Product	US$398 billion	US$249 billion

Further reading:

[17] Evida. 2019. *The story behind Evida: From three companies to one*

[18] EnergieNet. 2022. *Long-term development plan for the Danish gas system*

[19] Danish Energy Agency. 2021. *Heat as a service - evaluation of a Danish support scheme for dissemination of new business concept for heat pumps*

Renewable Gases

An opportunity

Renewable gases present an opportunity. If successful it would enable consumers to maintain their existing appliances (thus mitigating the significant appliance switch out costs), mitigate network stranded asset risk, and provide opportunities for hard-to-electrify sectors to continue their businesses.

The barriers

While current biogas production in New Zealand is about 4.9PJ/year, there are numerous technical and economic constraints in upgrading this to biomethane and injecting it into the network - see the Māngere waste-water case-study on the following page. Further to this, there is direct competition for the gas at source. Examples of competition include:

Direct Use: As in the waste-water case study, it is currently more economical to convert biogas to electricity on site, rather than process and export it to the network. Note that globally, only 8% of biogas is upgraded to biomethane. The majority is combusted for direct electricity or heat [20].

Direct Industrial Off-take: Waste-water treatment plants and landfills have land that could be turned into industrial hubs. It would be cheaper to buy and combust biogas directly than upgrade it to network quality biomethane and pay for distribution charges.

Cost: It is still unknown whether residential consumers would pay for the higher cost of biomethane, versus replacing their existing appliances to electricity at end-of-life.

Further asset stranding: Any investments from Vector into biomethane run the risk of being stranded with the network. We therefore currently ask for 100% capital contributions from prospective renewable gas producers to mitigate this risk.

Green Hydrogen

While green-hydrogen can carry 20% blend of hydrogen by volume, it is important to note that this is only a 7% blend by energy due to the low density of hydrogen gas. It is important that we use the energy-related number to avoid confusing the decarbonisation potentials.

As a residential consumer would use six times as much green-hydrogen to heat their home compared to using a heat-pump, Vector recommends that the government focus on a renewable gas strategy should focus on biogases.

Nevertheless, existing grey-hydrogen production for chemical processes internationally accounts for roughly 3% of global greenhouse gas emissions - similar to aviation. The green-hydrogen economy is necessary to decarbonise these existing chemical processes [21].

There may therefore be an opportunity to off-take any surplus green-hydrogen in gas pipelines. Further investigation is required to ensure that the increase in NOx emissions from hydrogen combustion does not negatively impact household air quality [22].

Government support required

Renewable gases require whole of systems coordination, from waste collection, to processing, distribution and retail. Unfortunately within these siloed market structures, the commercially rational decision may not consider the future of renewable gases due to high uncertainty in technology readiness and feedstock availability. In other countries, governments have stepped in to support the uptake of renewable gases. An example of this is the UK, where a Green Gas Levy is charged to licensed gas suppliers to fund a Green Gas Support Scheme [23].

Preserving options in the unknown

There are too many unknowns in the renewable gas markets to speculate as to whether it will save natural gas pipelines. However, the government can work with this unknown by preserving options. Financial capital maintenance and a renewable gas strategy are complementary policies, not rival. Through clear design it is possible to have both a smaller gas network, and a complementary renewable gas strategy.

Denmark, for example, has both biogas subsidies and a network wind-down strategy simultaneously.

Further reading:

[20] International Energy Agency. 2018. *Biogas consumption by end use.*

[21] Hydrogen science coalition. 2023

[22] Cellek MS, Pınarbaşı A. 2018. *Investigations on performance and emission characteristics of an industrial low swirl burner while burning natural gas, methane, hydrogen-enriched natural gas and hydrogen as fuels.* International Journal of Hydrogen Energy

[23] UK Government. 2022 *Green Gas Levy (GGL): rates and exemptions*

Case Study: Wastewater to renewable gas in Auckland

The study

Māngere waste-water treatment plant has been cited by WoodBeca to be one of the most accessible biogas opportunities in New Zealand [24]. Watercare commissioned biogas engineers from Mott MacDonald to investigate options for upgrading current biogas to be used for purposes other than current electricity generation to support their decarbonisation goals. One option explored was to create a biomethane natural gas substitute and inject it into the Vector network. Vector was one of several parties who provided input to this study.

The potential

The study considered an option whereby the biogas produced was upgraded to biomethane and injected into the Vector gas network. This showed that with significant additional investment and operational changes, it would be possible to extract approximately 0.3PJ of biogas per year, which is roughly 2.3% of Auckland's current natural gas use. This is equivalent to decarbonising a large industrial user or converting 12% of residential households to biomethane.

The benefits

The study showed that this would reduce 14,500 tCO2e per year from the existing gas network, ramping up to 19,500tCO2e in 2048 demonstrating a strong decarbonisation case. A gas output of 0.3PJ could supply roughly 21,000 households in Auckland that use an average of 15GJ per house, saving approximately $150 million in appliance replacements across this cohort.

The production of biomethane also produces a concentrated stream of CO_2 that has potentially valuable uses.

Vector is continuing to work with other parties to further develop the biogas upgrading concept outlined in the study.

The barrier

The study showed the gas upgrading option is not economically competitive compared to the baseline case where Watercare uses the biogas for electricity and heat generation, running a net present value loss of $20.6 million.

The challenging financials for biomethane export is largely attributed to the self-reliant value of using the gas to generate behind the meter electricity as opposed to exporting it, and the additional capex/opex to produce and export the gas.

There is also future uncertainty regarding the sale value of biomethane and increased operational complexity as well as a lack of ability to attribute the carbon savings to Watercare's decarbonisation targets. The study therefore recommended for Watercare to retain the biogas and combust it on-site for electricity and heat generation.

Te Ao Māori Considerations

The study also included Te Ao Māori considerations and concluded that a by-product of human waste may be used when paru (dirtiness) has been removed. As this could happen through combustion, the biomethane could be used for heating or cooking.

The CO_2 stream that has other valuable uses is not appropriate for the infusion in the production of kai/food as the paru has not been removed. So biomethane from the production plant may be used for residential cooking, but the CO_2 streams that could emerge as a by-product of biomethane production may not be considered appropriate in food and beverage production.

The role of Government

This case-study highlights the role that Government could take to enable renewable gases. The next step of this project would require a detailed engineering design and economical optimisation.

In Australia, the Australian Energy Research Agency funded AUD$5.9 million towards the Sydney Wastewater to Biomethane project which would supply gas to 6,300 homes [25].

It is likely that New Zealand would also require governmental support in some form to get such projects across the line.

Establishing a formal mechanism for renewable gas trading would also mitigate some of the risks, opening options for third-party developers to process and sell the biomethane on Watercare's behalf and also attribute the benefits across the parties in the value chain.

Further reading:

[24] WoodBeca 2023. *Gas Transition Plan - Biogas Research Report*

[25] Australian Renewable Energy Agency. 2023. *Malabar Biomethane Injection Project*

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