Achieving a Timely, Efficient, Equitable and Orderly Transition to Net-Zero Emissions for Transport and Heating in New Zealand

Webinar Presentation to the Law & Economics Association of New Zealand

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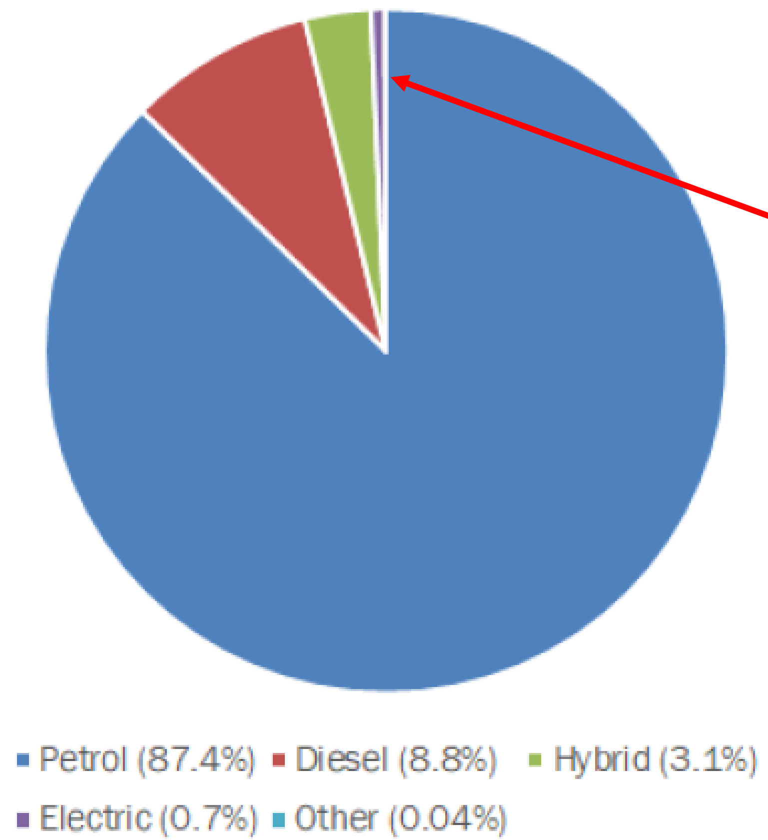
Introduction

- This is a high-level summary of a research-based, policy-oriented report completed for Vector, Powerco and First Gas:
  - The report represents my views, not these sponsors' – Vector and Powerco are primarily electricity distributors, while First Gas is exclusively in gas, so their interests are diverse.
- The report's main focus, like this presentation's, is on passenger transport – starting with the challenges, and then outlining some possible solutions.
- The report is **technology agnostic** vis-à-vis battery electric vehicles, hydrogen, e-fuels, etc – discussing pros/cons of each:
  - It is a general discussion document of how "best" to achieve the transition to net-zero by 2050 – i.e. *in a timely, efficient, equitable and orderly way*.

A Glimpse of the Challenge

Figure 1.1 – Composition of New Zealand's Fleet of Passenger Cars and Vans, September 2021

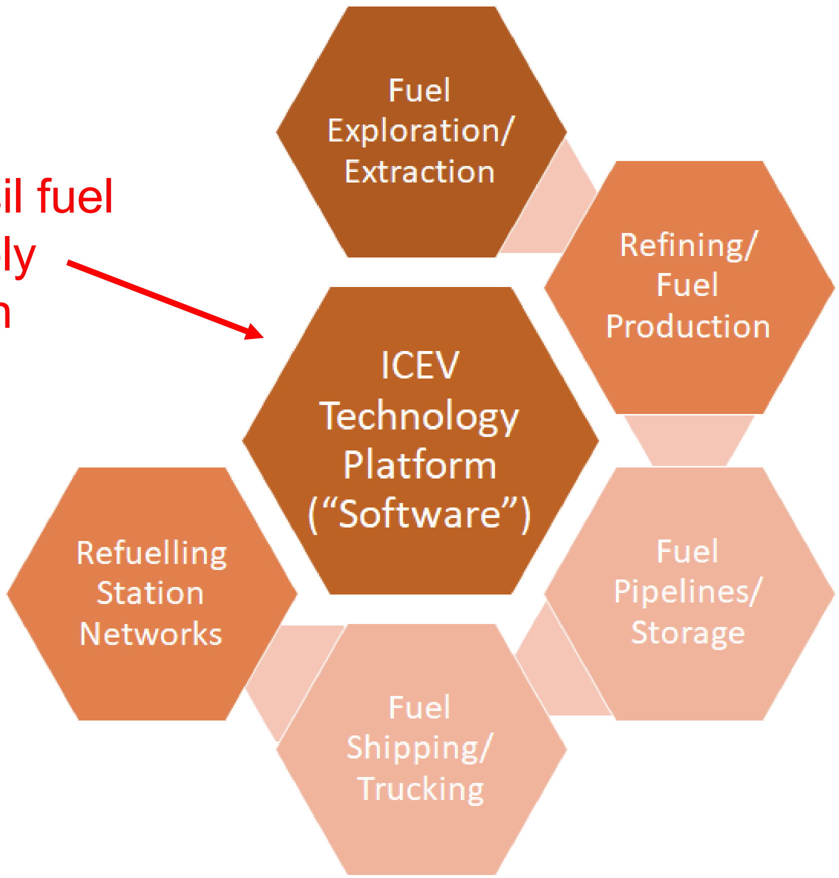


In September 2021 less than 1% of New Zealand's 3.5 million passenger vehicles were electric:
→ Starting the net-zero transition practically from "zero" (not in the good sense)!

Source: based on data from New Zealand Transport Agency.[2]

Diving Deeper – Transitioning to Net-Zero is all about Competition between "Platforms" …

Fossil fuel supply chain

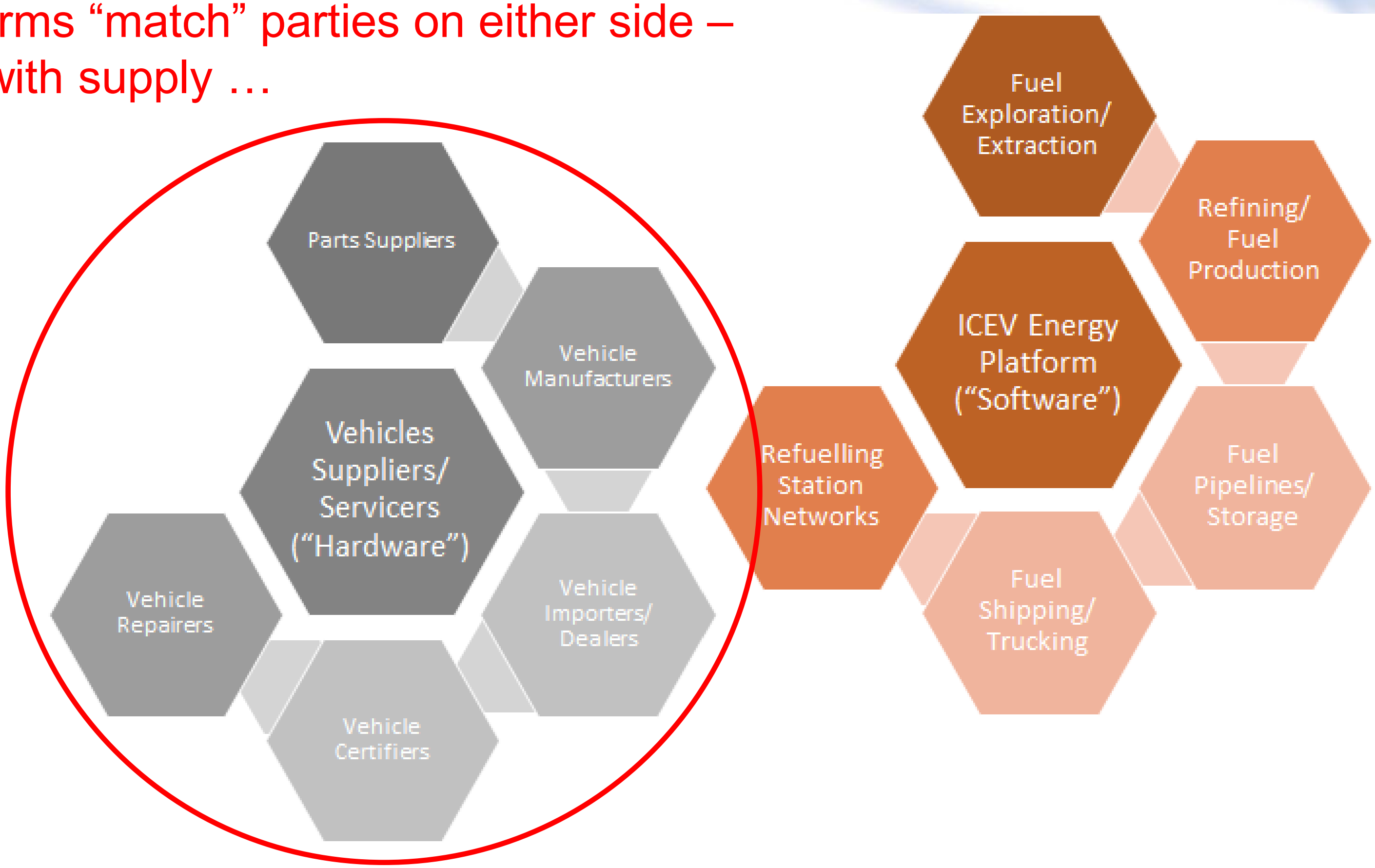


The fossil fuel supply chain is a deeply-entrenched (i.e. has an <u>enormous incumbency advantage)</u> energy platform for ICEVs:

- Developed over a century, with huge sums already invested;
- Capacity optimised to sustain current transport requirements;
- Might be converted to clean fuels more cheaply than building new supply chains …

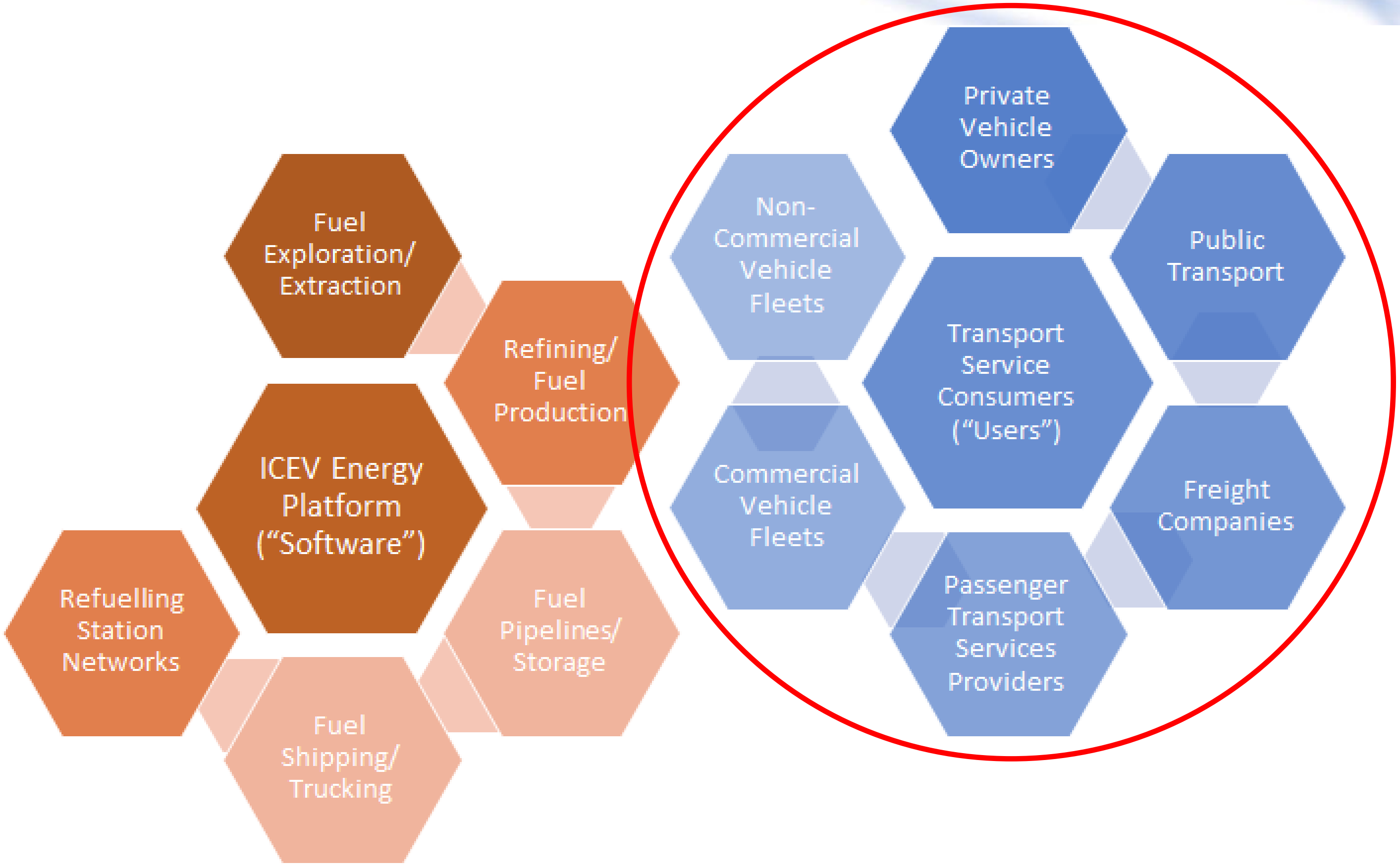
ICEV Energy Platform (cont'd) – Supply Side

Platforms "match" parties on either side – start with supply …



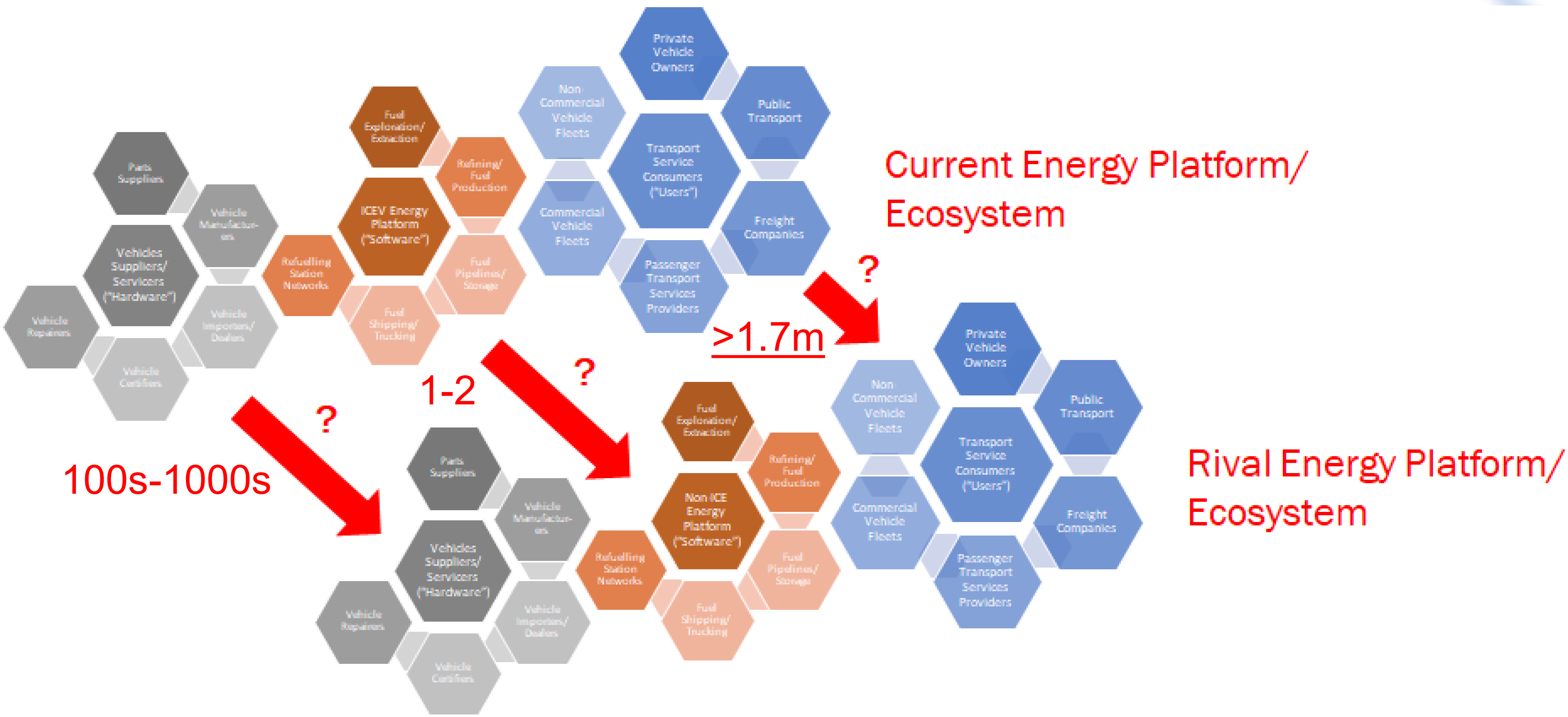
This side of the fossil fuel platform/ecosystem also has an enormous incumbency advantage – e.g. ICEV cost and performance is the "default"

ICEV Energy Platform (cont'd) – Demand Side

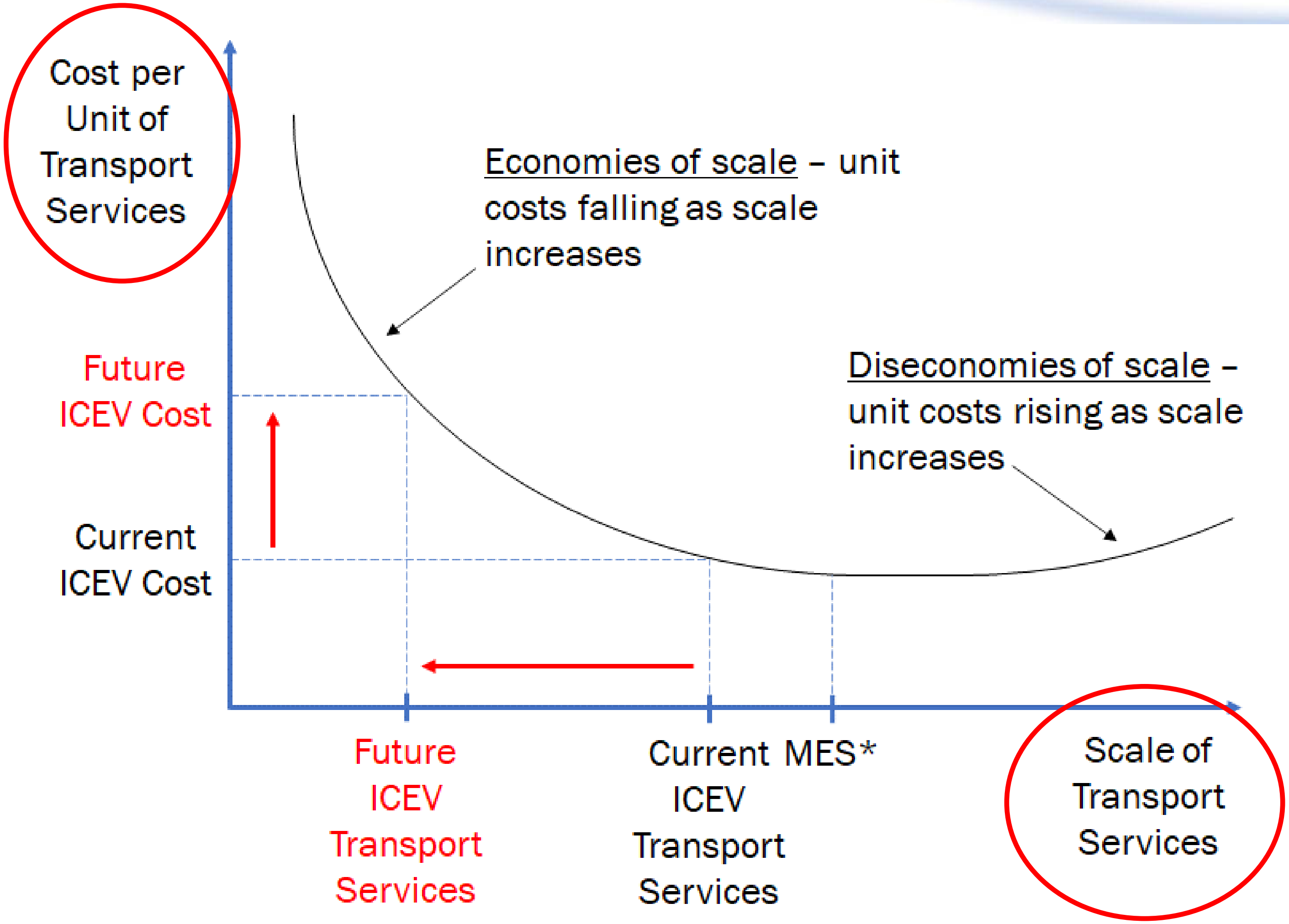


The demand side of the platform will have considerable inertia, reflecting not just past vehicle investments, but even more ingrained choices about where we live/work/play/shop, and how we travel and move stuff.

Key Challenge 1 – Transitioning to Net-Zero means Migrating 1.7m Households (Etc) and Hardware Suppliers/Servicers to a Clean Energy Platform (Which Doesn't Yet Fully Exist)



Key Challenge 2 – Platforms feature **Scale Economies** and Network Effects

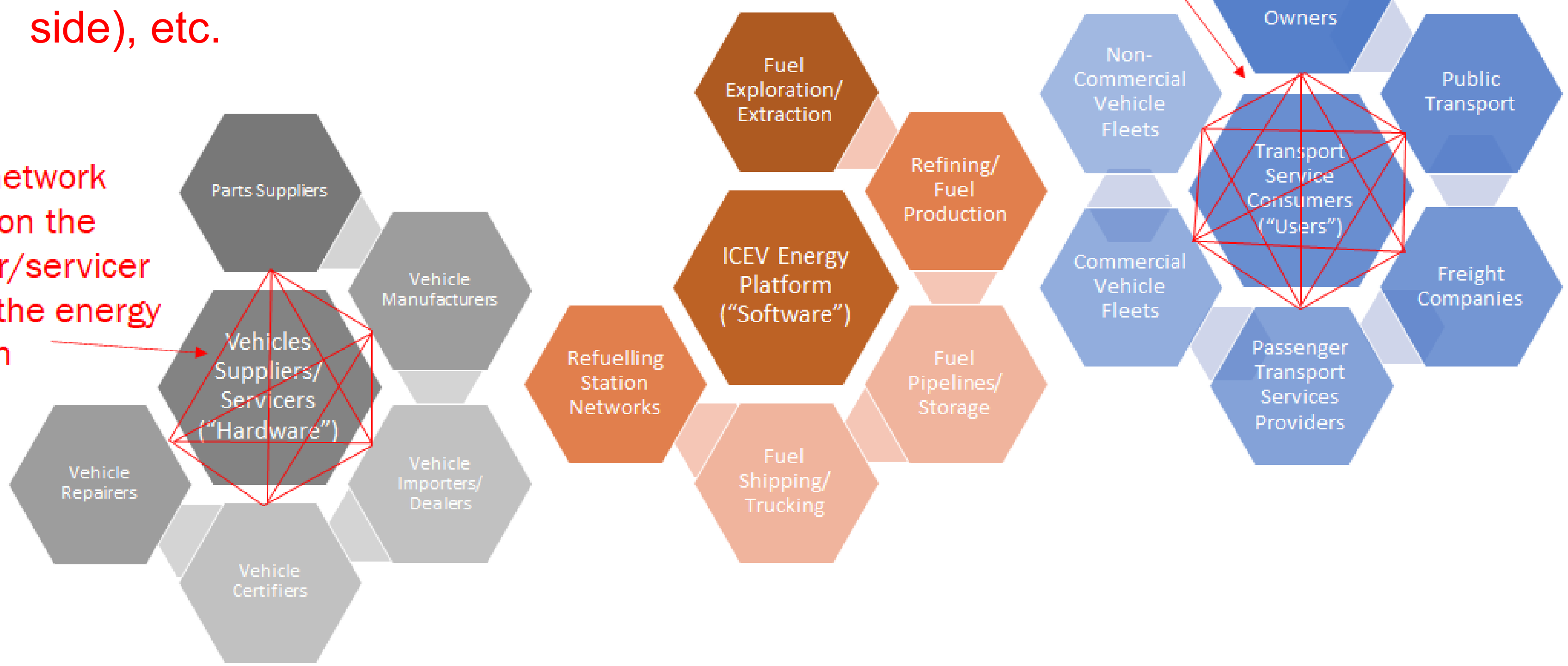


Key Challenge 2 – Platforms feature Scale Economies and **Network Effects** (cont'd)

E.g. vehicle manufacturers need vehicle servicers (S-side), vehicle owners need a second-hand market (D-side), etc.

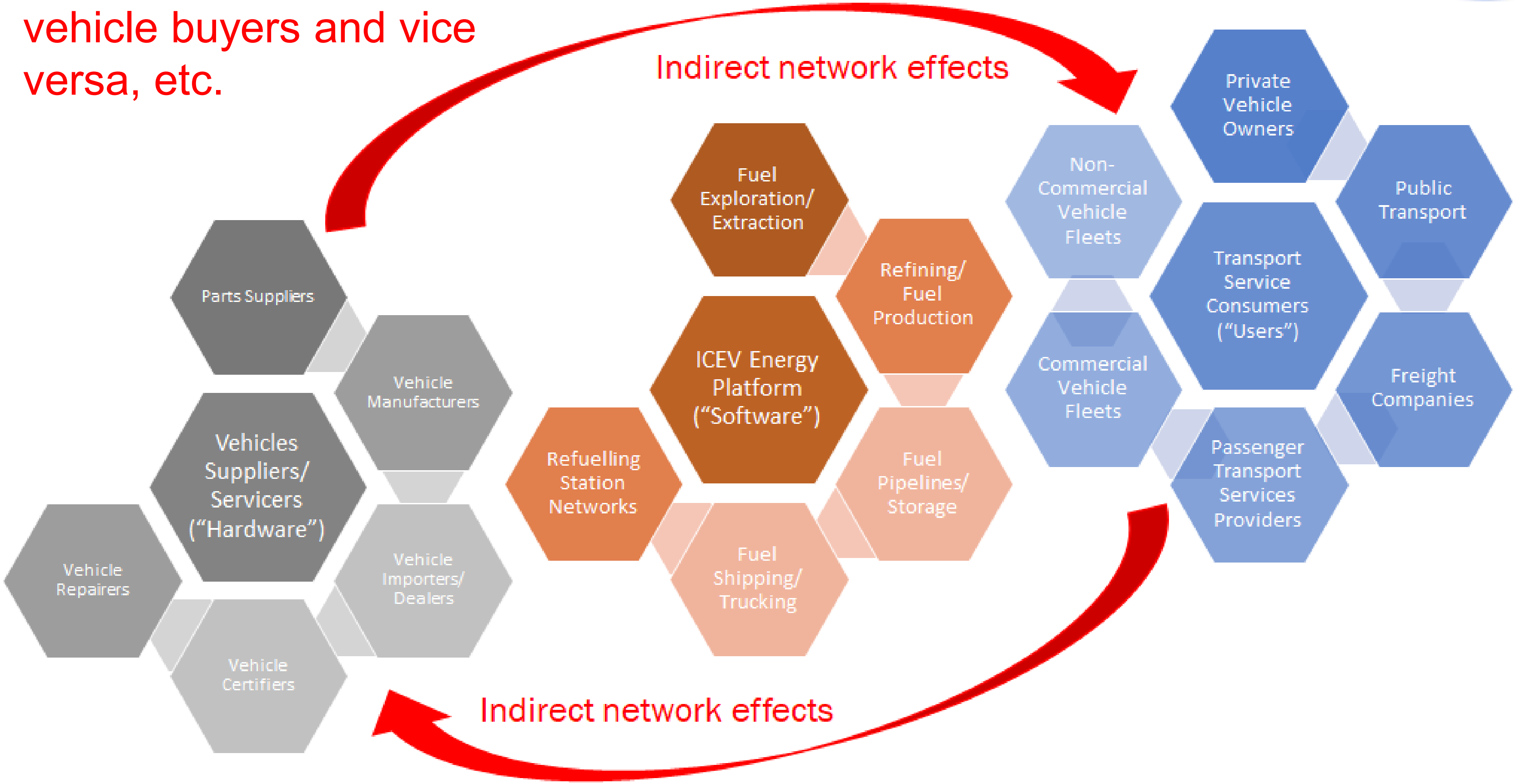
Direct network effects on the transport service consumer side of the energy platform

Direct network effects on the supplier/servicer side of the energy platform



Key Challenge 2 – Platforms feature Scale Economies and **Network Effects** (cont'd)

E.g. vehicle sellers need vehicle buyers and vice versa, etc.



Key Challenge 2 – Platforms feature Scale Economies and Network Effects (cont'd)

- Scale economies and network effects present particular challenges, e.g.:
  - **Path-dependence** – history matters (a lot);
  - **Coordination matters (a lot)** – chicken and egg problems abound, both within and across platform sides;
  - **Multiple equilibria** – some better for society than others, so which one do we want (since each is possible) and how do we get there?;
  - **Bigger is better** – tipping to monopoly is common;
  - Selective **pruning can *increase* network capacity;**
  - **Platform competition can result in inferior technologies being locked in ("excess inertia")!:**
    - E.g. Katz and Shapiro (1994), Economides et al. (2005), Weitzel et al. (2006), Brécard (2013), Onufrey and Bergek (2015), Greaker and Midttømme (2016), Krauthaus (2019), Filatrella and De Liso (2020), Halaburda et al. (2020), Amir et al. (2021).

Key Challenge 2 – Platforms feature Scale Economies and Network Effects (cont'd) …

Table 4.1 – Common Features of Technology Transitions

Feature	Description
Osborne effect	Consumers defer purchasing existing products in expectation that superior ones will soon be available (named after a computer manufacturer whose sales slumped after it prematurely announced an upcoming model)
Penguin effect[46]	Firms or consumers wait for others to be first to enter into a new area for fear of making a choice they then regret (like penguins not wanting to be first to dive into a sea in which predators might be lurking)
Sailing Ship effect[47]	Incumbent firms strategically improve their offerings when confronted with a potentially superior alternative, to delay or deter the alternative
Tipping[48]	The inclination for a market characterised by large economies of scale and/or strong network effects to end up with only one/few dominant alternative(s) despite starting with multiple competing alternatives
Matthew effect[49]	Related to tipping – larger or more successful alternatives prosper and dominate while smaller or less successful ones wither and die ("to every one who has will more be given, and he will have abundance; but from him who has not, even what he has will be taken away")[50]
Bandwagon and snob effects	Bandwagon effects refer to situations where consumers prefer to adopt a new technology when other users do (i.e. following the crowd). Snob effects refer to the opposite – some adopters may value prestige and exclusivity (e.g. adoption of high-cost new technologies as a signal of wealth, or only wanting to associate with an exclusive peer group). In this case mass adoption of a technology can cause such users to abandon it.
Vapourware	A product that is announced before it is available or even possible, often with the intention of convincing consumers to wait for the product rather than purchasing some rival product in the meanwhile and giving that rival product critical mass.

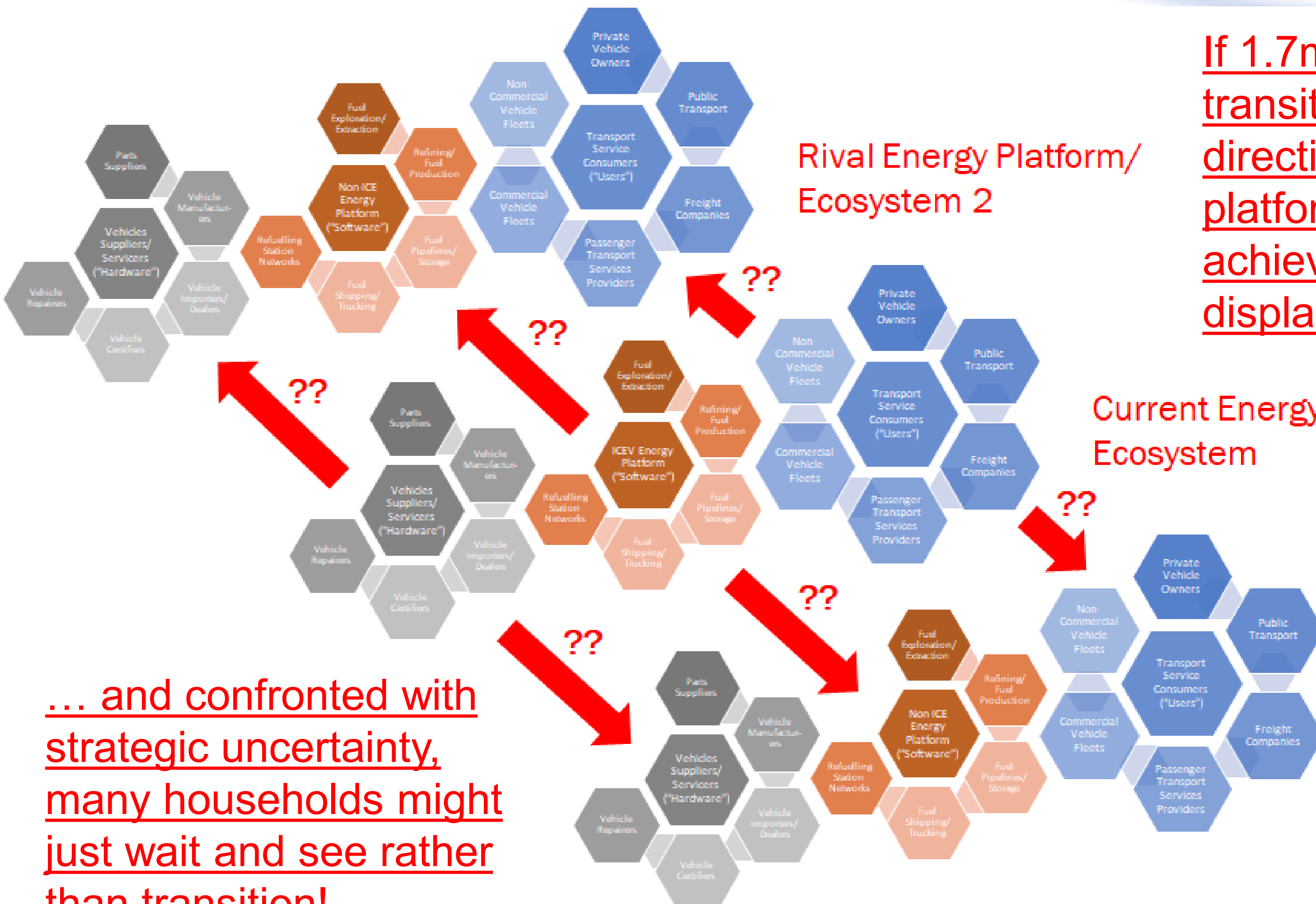
Technology transitions often feature scale economies and network effects, giving rise to a host of well-documented and sometimes counter-intuitive "effects" …

Key Challenge 2 – Platforms feature Scale Economies and Network Effects (cont'd)

Table 4.1 (cont'd) – Common Features of Technology Transitions

Feature	Description
Network paradoxes	E.g. in transport networks, adding road capacity or new roads can result in persistent congestion and/or longer travel times (Downs-Thomson paradox, Pigou-Knight-Downs paradox, Braess paradox).[51] In electricity systems, adding additional transmission capacity can reduce overall capacity due to how electricity flows through different constrained network paths (Kirchoff's laws)
First-mover advantage	Being first mover in a new area can create an incumbency advantage not available to later movers (e.g. a dominant market share – a.k.a. Stackelberg leadership in markets featuring imperfect competition among few firms)
Path-dependence	Related to first-mover advantage – the best decisions that can be made now are constrained by hard-to-reverse choices that were made in the past
Second-mover advantage	Sometimes a first mover helps to establish a new area only for a later mover to then dominate that area
Death spiral	A scenario in which an existing technology platform experiences user losses when a rival technology becomes sufficiently attractive. As users defect, the costs of sustaining the existing technology (e.g. if it is a network with large fixed costs) are passed on to a shrinking user base, and those costs also rise due to diseconomies of scale being introduced. Service quality can also suffer (e.g. due to the network being unprofitable to maintain). If the technology features network effects, user defections further reduce the benefits of the existing technology to other users. Such rising costs and prices, and declining service quality and network benefits, accelerate defections, with the process becoming irreversible if a tipping point is reached. The existing platform then dies.
Chicken and egg problem	Before investors in new technology platforms commit to making large and irreversible (e.g. network) investments, they want to know that there will be sufficient users of their platform (i.e. consumers, or suppliers) to make the investment profitable. However, users are reluctant to commit to using a new platform (e.g. buying specialised hardware that is not valuable unless the platform attracts sufficient other users) before they know platform investments will be made. This kind of "mutual penguin effect" can forestall platform take-off.

Key Challenge 3a – These Challenges are Exponentially Worse with Multiple Alternatives …



If 1.7m households transition in different directions then rival platforms struggle to achieve scale needed to displace incumbent …

… and confronted with strategic uncertainty, many households might just wait and see rather than transition!

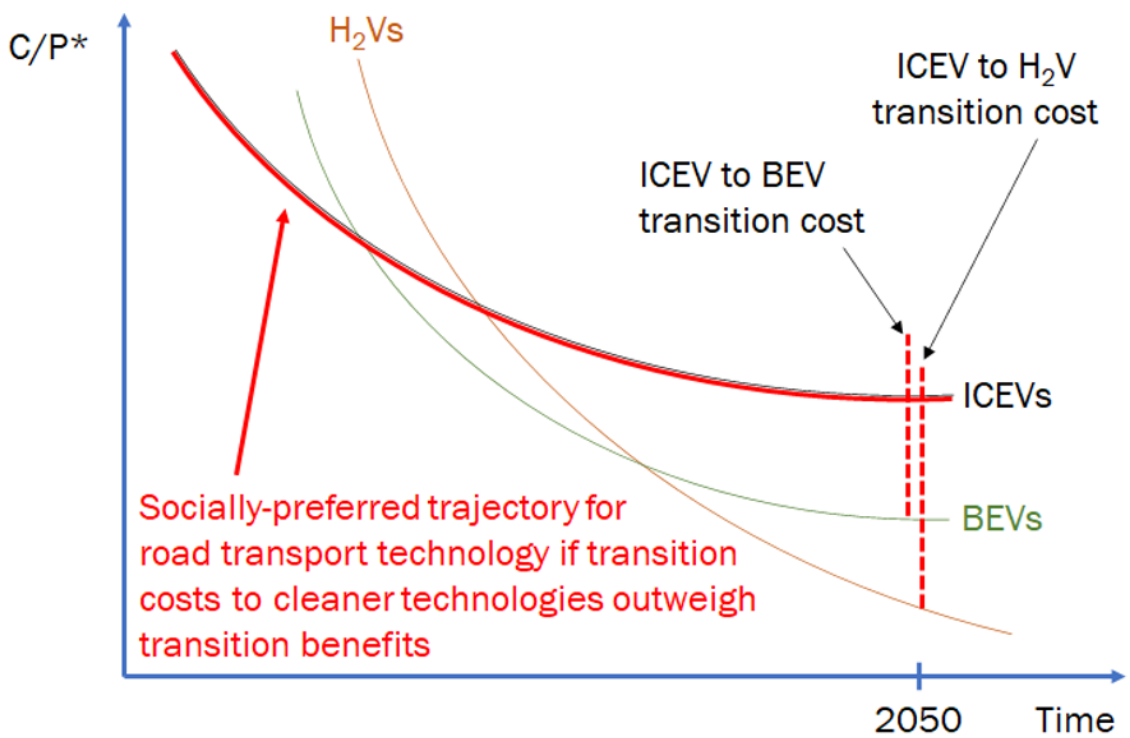
Key Challenge 3a – These Challenges are Exponentially Worse with Multiple Alternatives …

- Challenges like these mean we can't presume competition will lead to the desired outcomes – and certainly not within 28 years (i.e. by 2050) if major infrastructure changes and millions of coincident consumer choices are required (plus 1000s of supplier choices).

- To non-economists this might sound heterodox, but to trained economists it shouldn't:
  - Competition only ever promises to deliver efficiency – *not timeliness, equity, or order* (and static efficiency at that, which supposes that transition costs and dynamic considerations don't matter …);
  - In any case, the Welfare Theorems rest on the absence – not preponderance – of distortions like scale economies and network effects;
  - A world with scale economies and network effects is second (third?) best – the Theory of Second Best is the better tool to reach for than the welfare theorems → for a "good" transition we need to be thinking about least-worst countervailing distortions (cf, e.g., chemo for cancer …).

Key Challenge 4 – Transition Costs mean Not Even Cost-Performance Parity Ensures Change

Figure 4.6 – Lock-In to ICEVs when BEVs and H_2Vs Both Superior



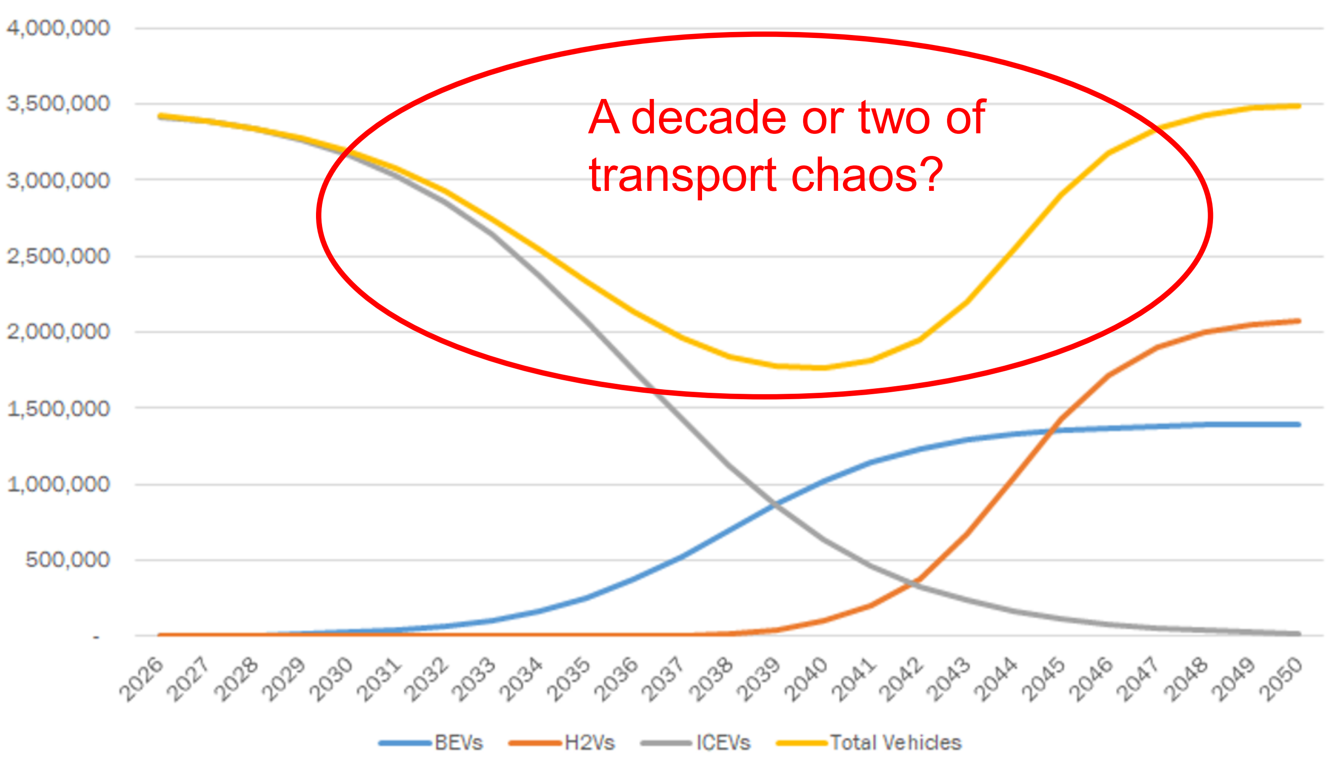
* C/P = cost to performance ratio, accounting for transport technologies' non-environmental as well as environmental performance

As before, it is not assured that the "best" technology wins! (though we can make choices affecting transition costs).

Section 4.5 of the report shows how transition costs can give rise to multiple different transition scenarios.

Key Challenge 5 – An Orderly Transition is by no means Assured

Figure 4.11 – Total Vehicle Numbers Crashing due to New Technology Vehicles Materialising More Slowly than Old Technology Vehicles are Disappearing



It's easy to destroy what already is. No amount of new legislation will magically build something to replace it (quickly, or in a synchronous way) – cf Brexit ...

Lessons from Past Transport Revolutions

- Think “dirt roads to canals”, “canals to trains”, “horses to ICEVs” – transport revolutions that transformed industry and society:
  - History mattered – lucky breaks, wrong turns;
  - New technologies that succeeded provided clear advantages over incumbent ones – *speed, cost, reliability, freedom*;
  - Incumbents fought back;
  - Standardisation made a huge difference for uptake;
  - Only the wealthy could afford private transport (excepting bicycles) until mass production and standardisation (Ford’s Model T …);
  - Chicken and egg problems were largely resolved by vested interests (i.e. industrialists) building new infrastructures for their own benefit.
  - Investment manias and “lost shirts” followed early successes.

Lessons from Past Transport Revolutions (cont'd)

New Zealand's Policy Levers (Report Section 6)

Table 6.1 – Policy Levers that might be used to Accelerate the Transition to Net-Zero Emissions

	"Push" levers (Discouraging emissions)	"Pull" levers (Encouraging low-emissions)	General levers
Demand-side levers (interact with supply-side due to indirect network effects)	Price measures: • Emissions pricing (reflecting network effects as well as environmental costs) • Levies on emitting hardware	Price measures: • Clean fuel subsidies • Clean hardware subsidies • Parking or toll road subsidies for clean transport users	• Creating coordination focal points for hardware suppliers, consumers/users, and infrastructure providers • Increasing commitment power of long-term policies (e.g. independent policy-making and implementation) • Wider regulatory/ policy coordination – urban design, transport, energy, etc • Safe harbours from competition law prohibitions on
	Non-price measures: • Sunset clauses (hard, soft) • Technology targets/ mandates	Non-price measures: • Sunset clauses (hard, soft) • Technology targets/ mandates • Certification/consumer information • Hardware leasing, or guaranteed buy-backs/trade-ins • Solutions for new technology end of life (e.g. battery recycling)	

The good news is that we have many levers to influence the transition path (detailed and evaluated in section 6 of the report), such as <u>demand-side</u> levers …

New Zealand's Policy Levers (Report Section 6)

Table 6.1 – Policy Levers that might be used to Accelerate the Transition to Net-Zero Emissions

	"Push" levers (Discouraging emissions)	"Pull" levers (Encouraging low-emissions)	General levers
Supply-side levers (interact with demand-side due to indirect network effects)	Price measures: • Emissions pricing • Levies on emitting hardware	Price measures: • Subsidies or co-investments for new infrastructure	prohibitions on desirable industry coordination • Regulatory forbearance for whole-of-life infra-structure pricing – e.g. sub-cost initial pricing to accelerate uptake, followed by higher later pricing to achieve required life-time fair returns)
	Non-price measures: • Sunset clauses (hard, soft) • Technology targets/ mandates • Progressive bans on emitting uses of fossil fuels, or on fossil fuel exploration • Coordination/coop-eration measures	Non-price measures: • Targets/mandates for minimum clean infrastructure capacity and service levels • Franchise bidding for monopoly rights to develop clean infrastructure(s)	

… as well as many supply-side levers.

For now, focus on one particular idea – franchise bidding …

Franchise Bidding Approach

- If vested interests don't champion the transition, we could be left facing incumbents whose interest is to deter the transition:
  - Competition between alternative new technologies actually helps them!

- Possible solution is to fix the retirement of the incumbent technology, but also auction rights to be the monopoly provider of the alternative technology (subject to specified service levels, price controls, time limits, etc):
  - **Changes the payoffs of the incumbents** – gives them a shot at realising upside from the new and not just losses from the old;
  - Might still be more profitable to deter the transition, **but if rivals get the upside and incumbents just face the downside … (prisoner's dilemma)**;
  - Could recycle auction proceeds to subsidise hardware uptake in targeted way – creates virtuous circle for bidders, and helps address equity issues;
  - Monopolist can use initially below-cost pricing and make profits later.

- Precedents – New Zealand's UFB initiative, toll road PPPs, …

Conclusions

- We can't just retire existing technologies and assume new ones will fill the gap in a timely, efficient, equitable or orderly way.
- The transition to net-zero is fundamentally about migrating from a compelling incumbent technology platform to competing alternatives that don't yet fully exist:
  - We can make choices to make the alternative(s) more compelling.
- There is no guarantee that platform competition will yield the outcomes we want/need:
  - If we want clean technologies to prosper, we might need to do some selective pruning – of new technologies as much as of old ones.
- Unless government wants to "go large" on clean energy infrastructures, we need large vested interests to take the lead – either industrialists, or legacy infrastructure owners:
  - We have policy levers to make it in their self-interest to do so.