Review of distributor's capacity to respond to changing technology

Market performance review

16 April 2019

Market Performance

Version control

Version	Date amended	Comments
V1.01	09/05/2019	Initial draft for Market Performance team review
V1.02	27/05/2019	Second draft
V1.03	05/06/2019	Third draft
V1.04	14/06/2019	Draft including SLT comments
V1.05	05/07/2019	Draft for Transpower to review
V1.06	08/07/2019	Incorporating Transpower's feedback

Executive summary

Overview

The Electricity Authority (the Authority) undertook this study to gather information it will need to ensure it meets its statutory objective. Specifically, the Authority is considering how to effectively promote competition, reliable supply and efficient operation of the New Zealand electricity industry for the long-term benefit of consumers through a technology-driven transition.

The core of the study was a survey of New Zealand electricity distributors (distributors) which took place between November 2018 and March 2019. A question and answer based survey and face to face interview was used to gather information and perspectives from distributors. The survey structure allowed distributor responses to be compared with responses from broader industry survey results.

We also surveyed and interviewed a selection of industry stakeholders to gather information on how stakeholder views compared with distributor views.

The primary focus of the study was to obtain an informed perspective on how distributors are adapting to technology-driven change in their operating environment.

Our key findings covered a broad range of topics

Analysis of the survey responses revealed that distributors display some characteristics distinct from those seen in other businesses. Distributors report higher rates of innovation than other businesses in New Zealand and internationally. Distributors report innovation at around three times the rate of all other firms and twice the rate of large firms in New Zealand.

These numbers are high by international standards but are not unprecedented in the electricity, gas, water and waste industries.

The survey results and the information gained from interview feedback indicated that distributors, with a few exceptions, are:

(a) not seeing new technology adaptation as competing with, or replacing, existing distribution network services

(b) generally unconcerned about the impacts of technology-driven changes on their networks for at least the next five to ten years

(c) considering that they will be able to manage most anticipated technical challenges

(d) seeking to obtain more information to better understand the potential impacts

(e) focusing on the technical implications in their strategic plans

(f) yet to build organisational or cultural transformations into their plans

(g) investing in research and development initiatives, including pilot programmes

(h) collaborating with other distributors, eg, on smart grid initiatives

(i) building, or planning to build, new technical skills and capabilities in-house

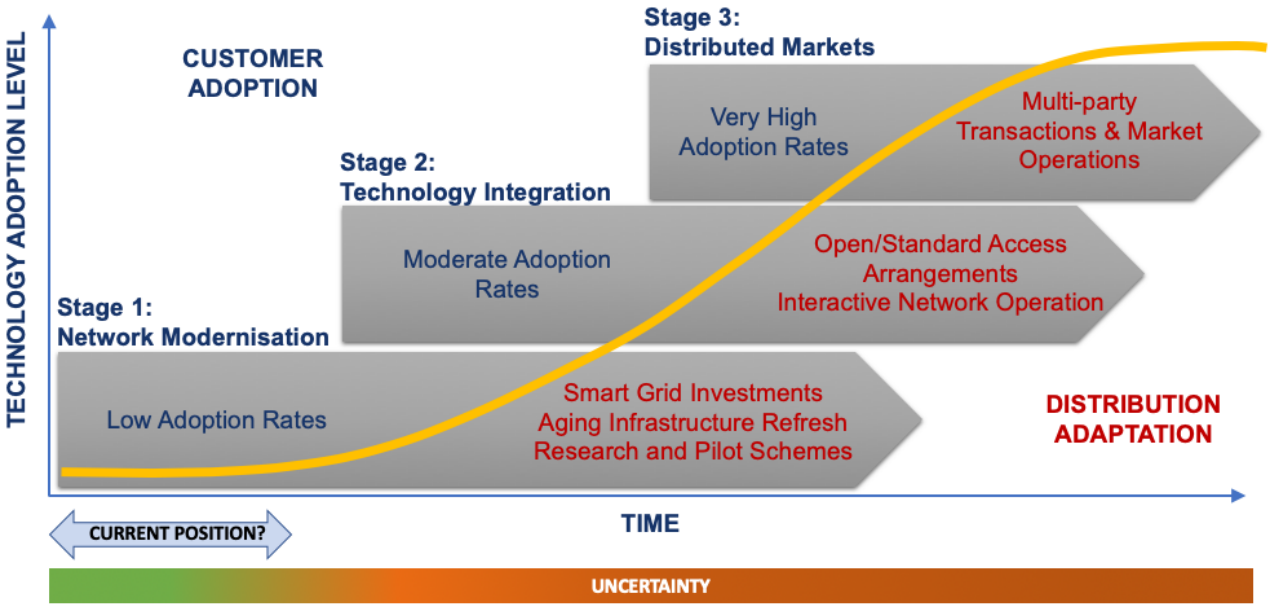
(j) more likely to adapt to, or adapt more quickly to, changes in technology that lead to reductions in costs, rather than enabling new services.

The following topic areas summarise the main themes identified in the study.

In general, distributors do not sense imminent issues and intend to adapt in measured ways

We found some consistency in distributor perceptions of the potential timeframes in which network issues might emerge and the view that technology-driven transformation of electricity supply is in its very early stages. Whilst distributors saw some issues arising in the next ten years, their responses generally indicated they could cope with these if necessary. However, distributors indicated that a rapid change in technology uptake, either over the entire network or in clusters, would lead to quite a different response.

This view is consistent with the early stages of the development pathways seen within international jurisdictions.



Whilst most stakeholders agreed with distributors on the current speed of uptake of new technologies, some considered technology-driven changes could happen swiftly, leaving distributors struggling to catch up. The difference in views appears to be about the speed at which change will happen rather than doubting that it will happen. Most distributors considered that technology around electric vehicles and the associated charging load would experience the most rapid change.

55% of surveyed distributors indicated they had already responded to technology-driven changes in demand.

Uncertainty emerged as a primary risk for distributors to consider and manage.

Distributors are applying an operational and technical focus when approaching adaptation

Distributors appear to view impending technology-driven change as providing operational and technical challenges, in areas such as technical standardisation, monitoring and data acquisition, low voltage network visibility, cost-based pricing and demand controls. For most, strategic organisational reform (eg, organisational structure, cultural change) is not yet emerging as an area of key adaptation focus.

The study revealed many examples of distributor-to-distributor collaboration. It also indicated that most distributors take the views of customers and employees into account when they develop strategies and plans. Not all distributors sought and took into account the views of suppliers and other stakeholders. Distributor engagement with broader stakeholders is likely to be important in future, as technology brings more complexity to network management and operations.

Barriers to innovation are not considered to be significantly high

On average, distributors report somewhat more difficult business environments than do other firms, although not substantially so. For example:

a) a proportionately higher number of distributors report difficulties recruiting trades, technical and managerial staff – but the extent of these difficulties is not as severe as in other industries

b) a proportionately higher number of distributors report deficits in information technology (IT) and communications infrastructure (eg, mobile and broadband).

However, there is wide variation amongst distributors in terms of the prevalence and severity of factors (constraints) likely to limit their adaptability or innovation.

Distributor capability enhancement is mainly achieved through acquisition of skilled technical resources, primarily specialist IT functions. Some distributors have appointed specialist managerial roles responsible for technology response, but this approach is not widespread.

Visibility of technology adoption is a concern for distributors

Distributors are concerned with their current lack of visibility on technology uptake and its impact on their networks. The reasons given for this were primarily technical (ie, the potential implications for network asset management and operations).

Some distributors and stakeholders saw new monitoring and control technologies providing tools with which they can view close to real time changes in energy flows at the low voltage network level. Variants of these tools can include features that enable electrical equipment, appliances and distributed energy resources (DER) to respond to price or control signals by increasing or reducing the service they draw from the network.

Half hourly smart meter import and export data could also be useful to distributors because it can be used in models to simulate changing consumer demand patterns and their effect on the capability of the local network. In areas where retailers own smart meters, distributors have to negotiate access to data. Some distributors have had mixed success in achieving these agreements, and one said that it wasn't funded for data, so it didn't intend to pay for it. Stakeholders expressed concerns that distributors may use data obtained from smart meters to compete with them in non-network markets.

Standards and/or regulations may be needed for monitoring and control systems

The transition of monitoring and control technologies, from development to mainstream, will be important to the speed at which distributors can adapt to rapid technology-driven changes in the services required from their low voltage networks. These technologies are currently undergoing development by both larger network equipment suppliers and smaller local technology developers.

Because new monitoring and metering technologies are likely to provide broader features and benefits than those directly attributable to distribution network management, issues may arise around ownership, access for installation, and use of the associated information and control

systems. Stakeholders raised the same issues about connection and operation of equipment such as electric vehicle battery chargers. One stakeholder was concerned that at least one distributor had indicated it could decide what equipment could be installed within the consumer's electrical installation, ie, on the consumer's side of the meter.

Several distributors and stakeholders considered that standards and regulation are likely to be needed to ensure open access to both electricity networks and information and control systems.

There is an opportunity to act now

New Zealand has the opportunity—for a time, at least—to change regulation while all options are still available.

We can benefit from our slower start to DER by becoming an efficient fast follower. We can watch and learn from Australian distributors grappling with technical network issues, particularly as they affect their low voltage networks, and their thinking about a possible distributor system operator role.

The Authority can provide regulatory certainty by adopting internationally developed technical standards that ensure DER equipment is resilient to expected future challenges.

We note that IPAG, in its equal access advice to the Authority, considered that the need to adapt our regulation of electricity networks to new technology was urgent. This report is an input into the Authority's open networks development programme which is responding to that IPAG advice, including on matters of priority and urgency.

There are potential indicators that could be valuable to monitor progress

We assessed a range of potential indicators identified within the survey and interview responses, together with those included in relevant roadmaps developed by distributors, in particular the recent network transformation roadmap published by the Electricity Networks' Association (ENA).

We found that our potential indicators fit reasonably well within the strategic themes of the standard balanced scorecard methodology. Accordingly, we have developed potential:

a) financial indicators

b) customer indicators

c) learning and growth indicators

d) business process indicators.

We also consider that parts of the survey used in this study would provide valuable information on how distributors are changing and responding to technology-driven change.

Establishing workable indicators will require broad collaboration

Distributors and stakeholders together identified regulation as both a driving and restraining force for the adaptation for new technology. In interviews, many comments about information acquisition and sharing related to uncertainty of future market participant roles, and of the regulators' roles.

Distributor and stakeholder views highlight a need for regulation and market frameworks to also adapt to the potential impacts of new technology adoption. Establishing suitable indicators to monitor the need for, and timing of, regulatory adaptation will require collaboration between regulators and all industry stakeholders. This may raise some interesting jurisdictional issues for the industry regulators.

The nature of the services available from distributed energy resources will likely require establishment of new trading arrangements and markets. These markets may require supporting frameworks that could be provided within the Electricity Industry Participation Code.

Developing suitable indicators and a monitoring regime will likely be best achieved through collaboration between the Authority, the Commerce Commission, distributors and stakeholders. The insights obtained through this study may assist formation of a suitable oversight platform.

This report complements Authority work programmes

The Additional Consumer Choice of Electricity Services (ACCES), Open networks and Distribution Pricing projects aim to develop regulatory settings that allow consumers to benefit from services that could emerge from greater DER penetration. These projects are not predicated on a particular future, but aim to produce regulatory settings that are resilient to whatever the type and level of technological uptake is. Open networks is aimed at ensuring a level playing field for access to networks. Distribution pricing will ensure that decision makers face efficient price signals. The ACCES project will produce the regulatory settings necessary for consumers (as buyers and sellers of electricity services) to interact with multiple service providers.

This report and the ongoing monitoring set out above will provide the basis for monitoring distribution pricing, open networks and ACCES over time. This will allow regulatory settings to be evaluated on an ongoing basis which will be essential given the uncertainty that is inherent in technological change and uptake.

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1 Introduction and study purpose

The study informs the Authority's strategic planning

1.1 New Zealand's electricity industry, electricity consumers and broader stakeholders anticipate a significant change in the way electricity is produced and consumed. The change is technology-driven and responds to global concerns about decarbonisation. At this stage, the nature and timing of the transition contains significant uncertainties.

1.2 Importantly, the changes underpin increasing choices for electricity consumers, particularly smaller consumers in households, and small and medium-sized businesses. To ensure potential consumer benefits are realised, electricity distribution businesses (distributors) will need to adapt and develop the capability and capacity to provide a number of new services for consumers.

1.3 The Electricity Authority (Authority) undertook the study to gather information relevant to its statutory objective. Specifically, the Authority is considering how to effectively promote competition, reliable supply and efficient operation of the New Zealand electricity industry for the long-term benefit of consumers in the context of a significant technology-driven transition.

1.4 The overall aim of the study was to establish how to measure and assess the capability and capacity of distributors to adapt to the impending technological changes.

1.5 The objectives set for the study were to:

(a) establish evidence-based indicators of distributor capabilities to react to the impending technological disruption, in ways that benefit consumers

(b) understand and assess any beliefs or myths electricity retailers, and other industry stakeholders, may have regarding the capability of distributors to adapt.

1.6 The objectives required consideration of both distributor and broader stakeholders views in order to inform the development of evidence-based indicators. Through this process, the Authority expected to obtain objective indicators supported by credible, evidence-based justification.

1.7 To achieve the objectives, the Authority scoped the study to address the following questions:

(a) Currently, how are distributors placed to deal with the challenges and opportunities from impending technological change?

(b) What indicators will show the extent to which distributors are able to adapt to the impending technology change in ways that benefit consumers?

(c) What indicators and other methods can be used to track the development of distributor capability?

1.8 The Authority anticipated that the study would require the following tasks:

(a) a review of past technological changes and how distributors responded to them

(b) a review of case studies demonstrating how comparable sectors have successfully adapted to similar technology-driven changes

(c) using survey and other qualitative measures, establish:

(i) the current and potential future technology uptake by distributors

(ii) the incentives on distributors to respond to consumers' evolving service requirements

(d) identify, test and demonstrate indicators that could be used to measure a distributor's ability to provide services to support new technology

(e) recommend a method to monitor, on an ongoing basis, distributors' abilities to respond to technology-driven change.

We engaged Strata and Sense Partners

1.9 The Authority engaged Strata Energy Consulting together with Sense Partners to design, facilitate and present outputs from the survey, to conduct the interviews and analyse and summarise the information gathered.

The study included distributor surveys and interviews

1.10 The study methodology gathered information about how distributors have planned for, or have already begun to adapt to, a changing technological context.

1.11 The methodology had two main parts:

(a) Part 1 was a set of questions in a written survey format, completed in December 2018 and January 2019

(b) Part 2 was an in-person interactive interview with each distributor, carried out between February and April 2019.

1.12 We received survey responses from 23 distributors, covering 25 out of New Zealand's 29 distribution networks.

1.13 We visited and interviewed chief executives and senior managers at all but one distributor.[1]

[1] Whilst we did not interview Nelson Electricity, we did interview both of that distributor's owners (Network Tasman and Marlborough Lines)

Table 1 – Distributor participation

		Survey returned	Interview
1	Alpine Energy	Yes	Yes
2	Aurora Energy	Yes	Yes
3	Buller Network	Yes	Yes
4	Centralines	Yes	Yes
5	Counties Power	Yes	Yes
6	EA Networks	Yes	Yes
7	Eastland Networks	Yes	Yes
8	Electra Ltd	No	Yes
9	Horizon Energy	Yes	Yes
10	Mainpower	Yes	Yes
11	Marlborough Lines	No	Yes
12	Nelson Electricity	No	No
13	Network Tasman	Yes	Yes
14	Network Waitaki	Yes	Yes
15	Northpower	Yes	Yes
16	Orion	Yes	Yes
17	PowerCo	Yes	Yes
18	PowerNet (EI, OTGO, TPC)	Yes	Yes
19	Scanpower	Yes	Yes
20	The Lines Company	Yes	Yes
21	Top Energy	Yes	Yes
22	Unison	Yes	Yes
23	Vector	No	Yes
24	Waipa Networks	Yes	Yes
25	WEL Networks	Yes	Yes
26	Westpower	Yes	Yes
27	Wellington Electricity	Yes	Yes

1.14 We received survey responses from all but four distributors. Given Vector's size, the absence of a survey response might appear to be an issue. As no weightings were applied to individual responses, the impact on the survey results is relatively small. Vector did take part in an interview and this allowed us to gather and take account of Vector's views.

1.15 The Authority very much appreciates the time set aside by distribution managers to participate in the study. The high survey response rate, and the level of participation in the interviews, has enabled a well-informed study.

1.16 In addition, the study surveyed and interviewed managers of seven industry stakeholders. The stakeholders were selected to represent a broad range of potential stakeholders and included:

(a) Transpower

(b) large and small electricity retailers

(c) new-concept energy providers

(d) new technology suppliers relevant to the industry.

We drew from other studies when developing the survey

1.17 When developing the survey, we considered recent studies[2] that investigated variations in organisational ability to innovate and adapt to change. We drew from these studies and others to help us identify potential managerial and economic measures of organisational ability to innovate and adapt. The survey design was influenced by the repeated observation that organisational capability is a latent characteristic that cannot be readily measured from simple outcome or operational activity measures. This suggested taking a reasonably broad view of differences between distributors across a range of measures of organisational behaviour and strategy.

1.18 We designed the survey to include generic questions about commercial context, strategy and innovation. This was intended to tease out differences in general practices that reflect upon organisational capabilities and to allow us to differentiate between external forces and local circumstances and the underlying capability of distributors to respond to change. These questions were very closely aligned with questions asked by Statistics New Zealand in its Business Operations survey. The questions relating to innovation come from the standard international framework for measuring adaptation and innovation – the OECD/Eurostat "Oslo Manual".

1.19 This approach has enabled distributor responses (individual and combined) to be compared to other businesses both in New Zealand and internationally.

We used robust methodologies when assessing strategic response

1.20 Well established approaches, methods and indicators exist for assessing and measuring the strategic response capability of organisations. These include the use of balanced score cards, strategic management maturity measures and the tried and tested 'SWOT analysis', which focuses on strengths, weaknesses, opportunities and threats.

1.21 We used established strategic planning tools for the study. Whilst we considered a wide range of potential strategic indicators, the application of these is limited in practice by the availability of, and access to, relevant information and data.

1.22 Recent studies have taken steps to develop measures of an organisation's ability to innovate and adapt to change. Relevant papers introduce some potentially interesting indicators, such as 'absorptive capacity', which is generally defined as a firm's ability to internalise external knowledge. We have drawn from these studies to identify potential statistical and economic measures of an organisation's ability to innovate and respond to external innovation.

1.23 International studies indicate a potential technology adaption technology timeframe. In a 2015 report,[3] the Smart Electric Power Alliance (SEPA) provided a view of the potential development pathway through which distribution networks could transform their businesses as technology adoption increases. We adopted the format of the SEPA pathway diagram to provide a view of an equivalent pathway for New Zealand.

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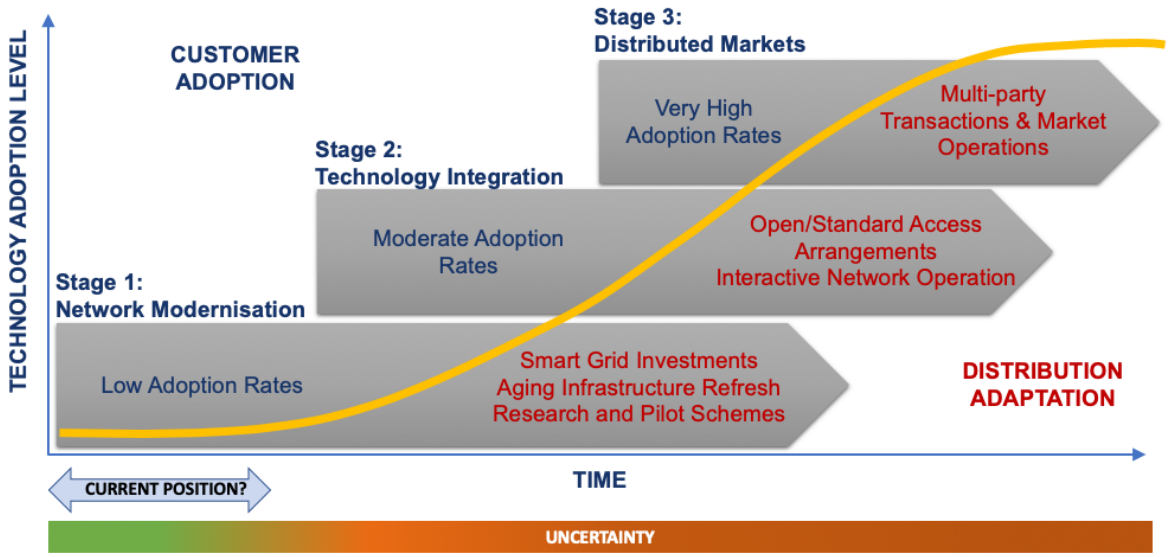
[2] New Zealand Productivity Commission Working Paper: Measuring the innovative activity of New Zealand firms, June 2015

Towards a capability theory of (innovating) firms: implications for management and policy, David J. Teece, April 2017

Absorptive capacity in New Zealand firms: Measurement and importance, Richard Harris and Trinh Le, February 2018

[3] https://emp.lbl.gov/sites/all/files lbnl-1003797.pdf

Figure 1 – Development pathway to a distributed energy future



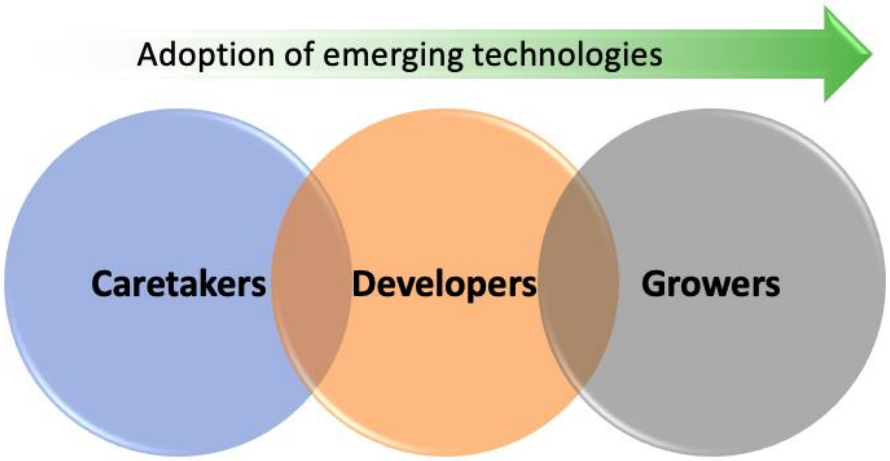
Source: Strata Energy Consulting – based on an original diagram by SEPA[4] Distribution Systems in a High Distributed Energy Resources Future

1.24 The SEPA pathway is generally consistent with the transition proposed by the Electricity Networks' Association (ENA) in its April 2019 Network Transformation Roadmap.[5] Starting with the SEPA and other views on technology-driven transformation pathways, we developed the indicative New Zealand development pathway shown in Figure 1.

1.25 We also developed three hypothetical categories for distributors we used to explore perspectives on strategic responses to the impending transformation. The categorisation helped to test whether different distributor circumstances might be driving different strategic responses.

1.26 Figure 2 shows the strategic response categories followed by the category definitions.

Figure 2 – Three high-level strategic response categories



[4] Paul De Martini, California Institute of Technology and Lorenzo Kristov, California Independent System Operator Distribution Systems in a High Distributed Energy Resources Future

[5] Electricity Networks Association, New Zealand Electricity Distributor Network Transformation Roadmap, April 2019 - see https://www.ena.org.nz/dmsdocument/483

(a) Caretakers – are focused on the existing network and services, watching early movers in technology adoption, including both smart grid and Internet of Things (IoT), but are sticking to delivering their current network services until the future becomes more certain. Caretakers do not intend to grow the business outside the regulated boundary.

(b) Developers – remain focused on the network and providing network services but are leading in the development and implementation of new network technologies, such as smart grid technologies, including network-connected energy storage and distributed generation to support the network. Developers are currently not developing new business opportunities in 'beyond the meter' IoT technologies such as distributed solar PV, distributed energy storage or energy management systems. Developers are not intending to grow their business outside of the current regulated boundary.

(c) Growers – also maintain the current network and services but are also developing smart grid technologies and some beyond-the-meter IoT technologies. Growers intend to grow their business outside the current regulated boundary.

1.27 Through available data,[6] we undertook an initial allocation of distributors into our three categories. We then applied the survey results and information gathered during the interview discussions to test and refine our initial views.

The categories represent equally valid strategic responses

1.28 Importantly, the characteristics of all categories are equally valid strategic responses. A distributor undertaking a Caretaker role may be as valid a strategic response as one that is actively developing its network capabilities or growing its business in a new direction. The benefit of applying the strategic response categories emerged during the interviews, as distributors described their current thinking against the definitions.

1.29 The categorisation of strategic response models assisted the study to gain an understanding of how different strategic responses might be driving the thinking and approaches of distributors.

1.30 Where appropriate, we used other metrics to better understand the responses to the survey and interviews. For example, we looked to see if differences were potentially driven by network size (eg, number of ICPs, extent of network) and location (eg, urban or rural).

1.31 When thinking about emerging technologies, we found that definitions used for smart grid and IoT technologies can vary amongst different parties. For this study, we defined:

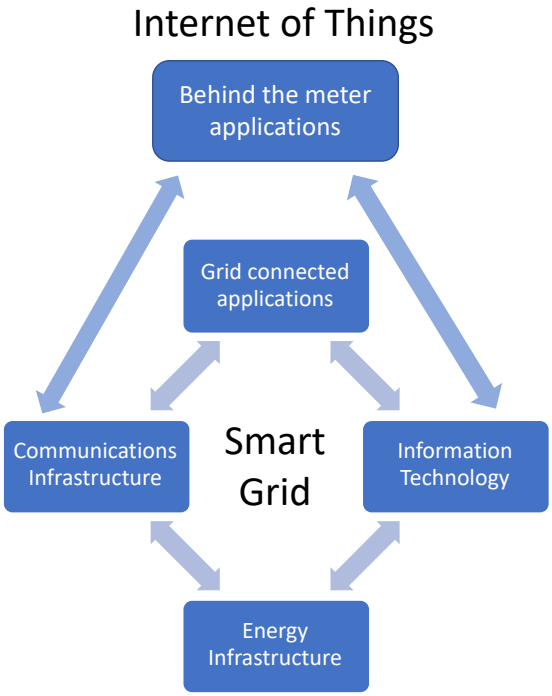
(a) smart grid technologies as those that are supporting two-way information flows across the energy infrastructure, including grid-based applications, such as for monitoring and control

(b) IoT technologies as being technologies installed on the consumer's side of the meter.

1.32 Figure 3 provides a graphical representation of these definitions.

[6] We used the data available from the Commerce Commission at: https://comcom.govt.nz/__data/assets/excel_doc/0014/100670/Electricity-distribution-businesses-emerging-technology-data-10-October-2018.xlsx

Figure 3 – Smart grid and IoT boundaries



1.33 The term distributed energy resources (DER), is also frequently used when discussing new electricity technologies. It means technologies such as solar PV, distributed generation, electric vehicles, batteries, home energy management systems, and includes demand response (eg, centralised active demand management).

1.34 We applied our smart grid and IoT boundaries, using relevant historical investments distributors provided in information they disclosed to the Commerce Commission, to give an initial allocation of distributors to our categories (see Appendix A for our initial allocation).

The study is aligned with other similar initiatives

1.35 We considered the burden that completing surveys and participating in interviews places on businesses and noted that the Commerce Commission and ENA had recently gathered information related to emerging technologies. For this reason, we took steps to ensure the study was complementary to, and avoided duplication of, the information gathered through other initiatives. These steps included:

(a) discussions and meetings with the Commerce Commission on its objectives for gathering information and the alignment of this with the Authority's objectives and information requirements

(b) discussions with ENA about its smart technology working group, including consideration of the information it obtained through distributor surveys

(c) including ENA and distributor representatives in a focus group assisting us at an early stage of the review

(d) running a pilot survey to identify any overlap and alignment issues before we asked distributors to complete the survey.

How this report is structured

1.36 Section 2 starts by setting out our findings about the current situation confronting distributors related to the local onset of new technology drivers. It draws on quantitative survey information about when distributors expect change to affect their business. It also considers the extent that distributors are confronting technology-related issues already.

1.37 Section 3 looks at key factors shaping distributor responses to the challenges raised by emerging technologies.

1.38 Section 4 considers factors relevant to distributor strategies and the strategic decision making processes.

1.39 Section 5 uses survey and interview responses to understand how distributors are innovating and undertaking targeted investments in response to anticipated technology-driven change.

1.40 Section 6 looks at distributor engagement and collaboration with other parties as the sector seeks to understand the impact of impending change and develop suitable responses.

1.41 Section 7 considers a range of indicators that may assist with monitoring progress as distributors assess and adapt to technology-driven change.

2 Views about the current environment

2.1 This section considers the local business context within which individual distributors are operating and provides a forward view of when distributors expect to encounter technology-related issues.

2.2 Distributor expectations of the speed of technology uptake is important because it can provide insights into each distributor's perception of the urgency needed to respond – are the issues clear and present or are they on the edge of the radar?

2.3 The second part of this section looks at issues that might already be occurring – how widespread and how frequently are they being experienced?

There is some consistency amongst distributor perceptions of potential timeframes

2.4 We asked distributors for their views on the timeframes within which technology-driven change is likely to impact the demand for distribution services and potentially cause issues for networks. The timeframes discussed covered the next five years and ten years.

2.5 We asked about problems related to increasing levels of DER that might occur in the following areas:

(a) system/asset capacity (thermal limits)

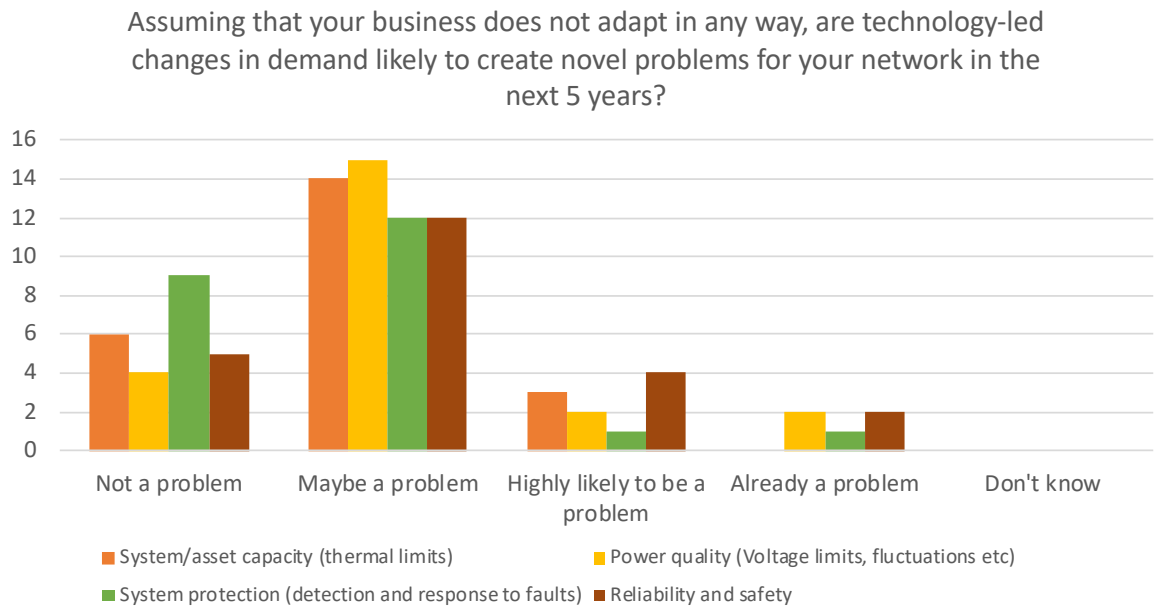
(b) power quality (voltage limits, fluctuations etc)

(c) system protection (detection and isolation of faults)

(d) reliability and safety.

2.6 The responses indicate that most distributors thought that problems in the above areas were not occurring at the moment but might emerge over the next five years – see Figure 4.

Figure 4 – Distributor views on emerging technology-driven network problems (5 year horizon)



2.7 Several respondents commented that they had sufficient capacity and redundancy built into their networks to manage moderate penetration levels of DER. On some networks, the capacity headroom was enhanced by falling demand over the last decade. Others commented that the slow pace of technology uptake was the critical factor.

2.8 Distributors build new capacity into their distribution networks as and when demands arise, eventually leading to overloading and power quality issues if not addressed proactively.

2.9 Some distributors considered that issues might emerge on parts of their networks if DER were to emerge in local concentrations (clusters) over a short period of time. Some expressed concern that a high uptake of larger scale solar PV installations on commercial premises (ie, with capacities in the hundreds of kilowatts) could create localised issues.

2.10 Some distributors considered adoption rates of new technologies was likely to be slower in lower socio-economic areas and in areas with a high number of holiday homes. This comment was repeated frequently in the interviews.

2.11 Some distributors had already experienced power quality issues arising from the devices used to interface direct current (DC) generators to the alternating current (AC) network, known as inverters. Inverters incorporate power electronic components that can, if poorly designed, give rise to relatively high levels of voltage and current harmonics.[7] Specific examples cited in interviews included:

(a) farm irrigation pumps that employ variable speed drives

(b) solar PV inverters, including where adjacent inverters could interfere with each other, eg, if settings conflict.

[7] Harmonics are (mostly) undesirable voltage and current components that occur in networks at frequency multiples of 50 Hz, eg, 150 Hz (3rd harmonic), 550 Hz (11th harmonic) etc.

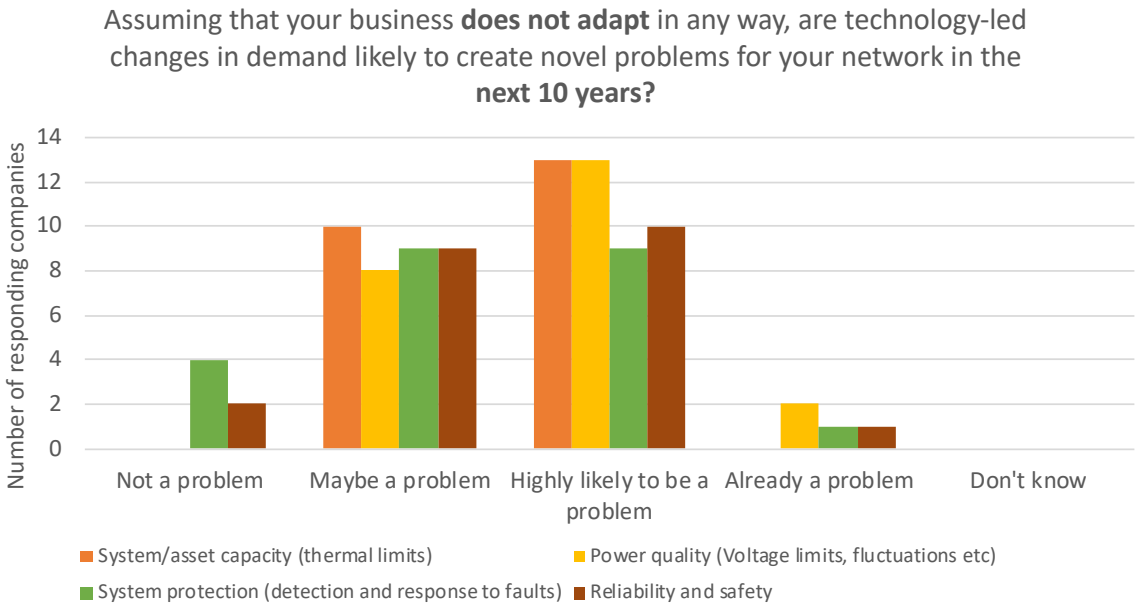
2.12 Some distributors were concerned that changing (falling) fault levels[8] could lead to reliability issues with protection systems. Another cited possible safety issues if inverter anti-islanding protection failed or was set incorrectly. Others noted they had inspected solar PV installations and found them to be substandard, raising serious safety, network reliability and power quality concerns.

2.13 One distributor anticipated that the most significant challenge was likely to be managing the participant transactions required to manage security of supply.

2.14 Whilst most respondents cited possible low voltage network issues, some considered that pressure from increased industrial demand would impact the higher voltage levels in distribution networks, for example, due to industrial process electrification, manufacturing automation, tighter on-farm milk storage hygiene standards and electric bus charging.

2.15 Distributor expectations of technology impacts change when the timeframe is extended to ten years. Figure 5 shows that most distributors expect technology-driven changes to emerge and start causing problems within the five to ten year timeframe.

Figure 5 – Distributor views on emerging technology-driven network problems (10 year horizon)



2.16 Most comments from respondents cited forecast increases in adoption of DER, (ie, solar PV, energy storage batteries and electric vehicle charging) as the primary driver of the emerging issues.

2.17 Others considered an increasing focus on the decarbonisation of the economy would accelerate the switch of industrial and commercial energy demand from fossil fuels to electricity, potentially impacting the higher voltage levels in networks.

2.18 Distributors frequently pointed to their current lack of monitoring of low voltage networks as a major concern, since power quality and capacity problems could go undetected for

[8] Fault levels are a measure of the network's ability to provide sufficient current into a fault (eg, a short circuit), so as to reliably activate protection relays and isolate the fault. Too little fault current may result in relays failing to operate when they should. On the other hand, an excessively high fault level can exceed the capacity of circuit breakers to interrupt the fault current and thereby pose a serious safety issue.

some time, if issues are not raised by customers when they occur. Others foresaw a need to develop and install low voltage monitoring and control systems that would provide early and ongoing identification of power quality and capacity issues. We will discuss this topic in more detail later in the report.

2.19 Some emphasised the need to adopt consistent DER equipment standards and to develop the means to actively manage network demands imposed by electric vehicle charging, so as to avoid large coincident demand peaks occurring on networks.

2.20 Some distributors noted that they were conducting technology trials to improve their understanding of the issues that can arise from increased adoption of DER. Examples included:

(a) participating in the EECA electric vehicle charging initiative

(b) pilot trials of advanced distribution management system (ADMS) technologies for directly monitoring low voltage networks

(c) leveraging ICP billing data to discover usage trends

(d) refining processes for safety management

(e) conducting focused studies by engaging specialist external consultants.

2.21 One considered that issues will only become problematic if distributors are prevented by regulators from becoming involved in technology solutions or if market solutions fail to develop in time.

2.22 In a similar vein, one distributor reflected that a 'whole of system' response is required. This would include setting standards and gaining a common purpose between political, regulatory, distribution and retail levels so that adoption of DER can occur seamlessly, driven by technology providers, system integrators and 'prosumers'.[9]

Distributors consider they can manage many of the issues by adapting

2.23 Figure 6 and Figure 7 highlight distributor views about their ability to manage technology-driven problems through adaptation. These charts should be compared with Figure 4 and Figure 5 above, as this indicates the extent of the problem resolution distributors believe they can achieve if they adapt.

2.24 The survey responses indicate that within a five year horizon, by adapting where appropriate, distributors consider they can generally manage issues. However, moving out to ten years, confidence in their ability to manage problems is not so strong for half of the respondents.

[9] The term 'prosumer' refers to an electricity consumer that has adopted one or more forms of DER.

Figure 6 – How distributor actions can reduce network problems (5 year horizon)

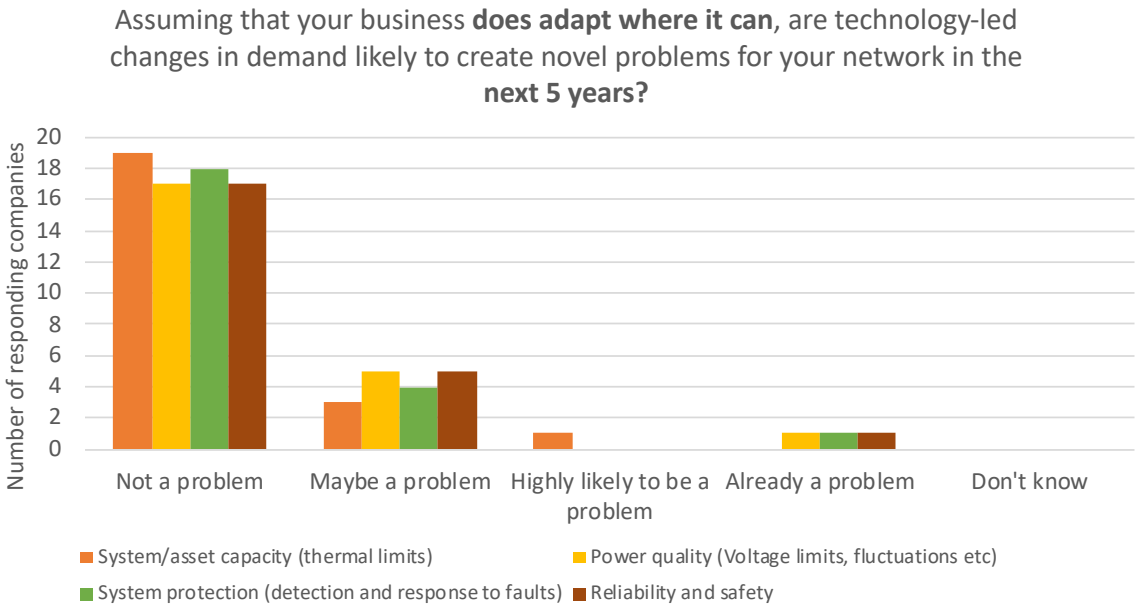
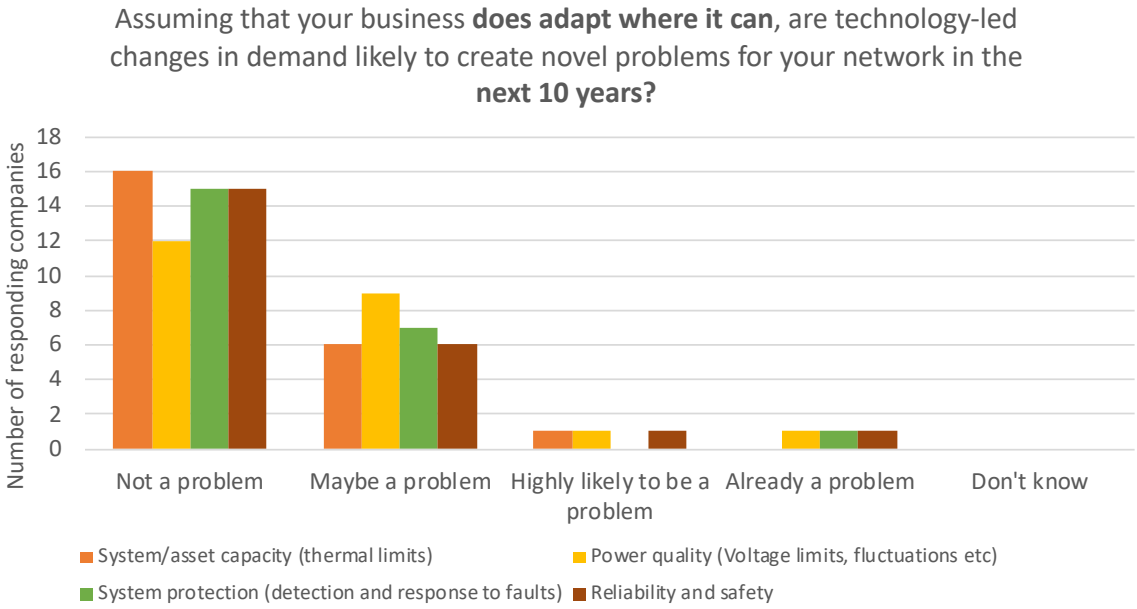


Figure 7 – How distributor actions can reduce network problems (10 year horizon)



2.25 The speed at which technology uptake may occur was a recurring theme with distributors, whether in survey responses or in interviews. Many said that electric vehicles were the most likely technology to rapidly increase demands on networks and thereby have the greatest potential to cause problems. This view appears to be reinforced based on forecast penetration rates for electric vehicles of around 20% of the vehicle fleet in the next ten years.

2.26 Electric vehicles also potentially pose challenges for distributors with higher cost and sparsely populated networks. Although they expect low growth in local ownership of electric vehicles, they equally expect transient and potentially large increases in load associated with tourist vehicles, such as camper vans, transiting their network region. This introduces a challenge by requiring network investment to accommodate increased

demand, and determining how best to recover those costs without placing undue burden on local consumers, who are frequently beneficiaries of the local network through some form of trust ownership.

2.27 Some distributors raised concerns about retailers not passing through time-of-use (TOU) distribution service price signals to consumers. The primary concern was that, if not passed through, low evening delivered electricity prices from retailers could incentivise high coincident electric vehicle charging peak demands. Low/high price period cutover times (eg, at 9 pm) were also cited as a potential pinch point, when peak-controlled (switched off) vehicle charging loads might all switch on at the same time.

2.28 Uncertainty regarding the speed of technology uptake was an issue cited by most distributors. Many said that network problems would arise if technology uptake significantly exceeded expected uptake levels. Some noted that they were developing scenario-based adoption models to keep abreast of potential hot spots.

2.29 Access to data, particularly the data recorded by smart meters, was frequently cited in interviews as a major current issue for many distributors. In addition to understanding evolving consumer demand patterns, some distributors saw smart meters as being able to provide network-relevant data in time periods closer to real time. In contrast, others considered that smart meters have been primarily designed for 'once a day' polling of consumption records (ie, efficient but traditional meter reading) and that other more network-centric monitoring and control technologies will be required.

2.30 Some distributors considered that the issue is with both smart meter functionality and the low bandwidth communications channel used by most smart metering systems. These design choices—while perfectly consistent with retailers' data needs—may render some smart metering systems unsuitable for use in real-time network monitoring applications. In contrast to areas where retailers led smart meter roll-outs, these issues have not plagued the group of distributors that elected to become members of the distributor-led SmartCo smart metering initiative. These factors result in distributors being data 'haves' or 'have nots'.[10]

2.31 Several cited an initiative by a New Zealand distributor that is actively developing a system of small, networked, relatively inexpensive monitoring and control devices designed to be installed on consumer switchboards and/or at the distribution transformers that power the low voltage networks. Also cited in this category were other commercially available systems, such as a system developed by GE Power, that could perform similar monitoring and control functions.

2.32 The problems caused by access to data from existing smart meters are but one example given by distributors of the perceived issues relating to industry-wide adaptation and solutions. One respondent summarised this succinctly: *"It's more than just us and our own adaptation that will be needed to resolve joint industry problems. Significant collaboration across industry sectors will be required."*

[10] The Authority notes here that smart meter data access is a complex issue that requires it's own detailed consideration, beyond the scope of the study.

Some distributors have already adapted in response to technology-driven change

2.33 About half of distributor respondents indicated that they had already responded to technology-driven changes in demand, for example:

(a) some have provided for new demands arising in the more remote parts of their networks – eg, electric vehicle fast charging stations along highways

(b) some have seen increasing urban network demands for electric vehicle charging stations, such as high capacity electric bus charging stations

(c) some distributors experiencing increasing levels of solar PV connections have developed cost-reflective price categories

(d) a distributor has installed sensors at distribution transformers powering low voltage networks and is collecting data to understand load variation trends, inform asset management decisions and provide insight into the need for a distribution system operator function

(e) some are working closely with subdivision developers seeking to incorporate DER technologies as a feature, treating these as early opportunities to research needs and issues and to trial ADMS network monitoring/management technologies

(f) some noted having had to address a number of technical operational issues triggered by:

(i) inverters that operationally interfere with other nearby inverters on the same network feeder (settings coordination issues)

(ii) reducing fault levels (reducing protection operation reliability)

(iii) ineffective or missing anti-islanding protection (safety issues).

2.34 Those that have not experienced issues to date made the following observations:

(a) DER uptake is starting from a very low base, so there is a general lack of current demand – networks are not heavily loaded or, in some cases, peak demands have fallen, in some cases by quite significant amounts, creating additional capacity for growth

(b) many state that they have sufficient capacity and redundancy built into existing networks and consider they can accommodate moderate levels of DER uptake

(c) some forecast low levels of demand increase for the foreseeable future, eg, they don't expect low socio-economic areas to see significant DER uptake

(d) some expect that urban uptake, serviced by shorter feeders, will be faster than rural uptake, where long 'thin' feeders are frequently encountered

(e) over a 5-year timeframe, the problems referred to are likely to be localised to areas with high degrees of DER clustering – any problems are expected to be ad-hoc and relatively rare.

Stakeholders views reflected the current uncertainty on technology adoption

2.35 Stakeholder views on the level of new technology adoption generally aligned with distributor views; that is, that currently few problems had emerged and that future levels of technology adoption were uncertain.

2.36 Half of the stakeholders interviewed had sought to connect new technology to distribution networks. None of these stakeholders had experienced issues with connecting new technology solutions to distribution networks, including with system/asset capacity (thermal limits), power quality (voltage limits, fluctuations etc.), system protection (detection and response to faults), operational reliability or safety.

2.37 The primary issue identified by some stakeholders was that they had experienced material delays in progressing connection of some new technologies to distribution networks. The delay examples given to us related to the progress of individual connection applications rather than to specific barriers to technology connection. However, one stakeholder identified an issue relating to a distributor suggesting that it may decide which technology brand it would allow to be connected to its network.

2.38 Stakeholders views on the speed of technology adaptation varied. Most focused on the potential for rapid growth in connection of electric vehicle charging stations and the associated increase in electric vehicle ownership. Like distributors, stakeholders considered that the growth rate of technology adoption in New Zealand is currently at a low level, with an uncertain future trend.

2.39 Most stakeholders viewed new smart grid technologies as a key issue for distributors. They considered distributor adaptation to accommodate these technologies would be an important enabler for other new technologies. For example, new metering, communication and control devices could be used to avoid future network issues that would otherwise prevent the connection and operation of distributed technologies. The question about who would own and operate these technologies and how open access to information would be achieved were key issues for stakeholders.

2.40 Some stakeholders suggested that much could be learned from international experience such as the impact of rapid increases in solar installations in some Australian states. One stakeholder noted that Norway's high level of electric vehicle uptake should provide an indication of the potential issues New Zealand distributors might face if similar adoption levels were to occur here.

2.41 Whilst one stakeholder considered that distributors were 'asleep at the wheel', others suggested that in the uncertain environment a cautious approach using research, pilot projects and collaboration was an appropriate course for distributors to take.

3 Key factors shaping distributor responses to technology-driven change

3.1 The survey included a section based on a 'force field' model, which graphically shows the relative strengths of:

(a) driving forces, which are the factors compelling a business to adapt or change

(b) restraining forces, which are the factors that might hold a business back from adapting or making a change.

3.2 The driving and restraining forces (factors) represent a respondent's assessment of their business context relevant to an area of change; in the current case, this is change driven by increasing connection levels of DER that are beginning to impact traditional network operations.

3.3 Respondents ranked factor strength on a 1 to 5 scale, with 1 representing a weak force and 5 a strong one. The length of the chart bars in Figure 8 (averages of distributor

responses) and Figure 9 (averages of stakeholder responses) is therefore proportional to the relative factor strength.

Distributors expressed reasonably consistent views about the driving and restraining forces

3.4 In the distributor interviews, we provided interviewees with two views of the force field data:

(a) a chart with the respondent's own factor rankings, if they had provided a survey response (which the majority had)

(b) a chart presenting the average of all distributor force field factor responses.

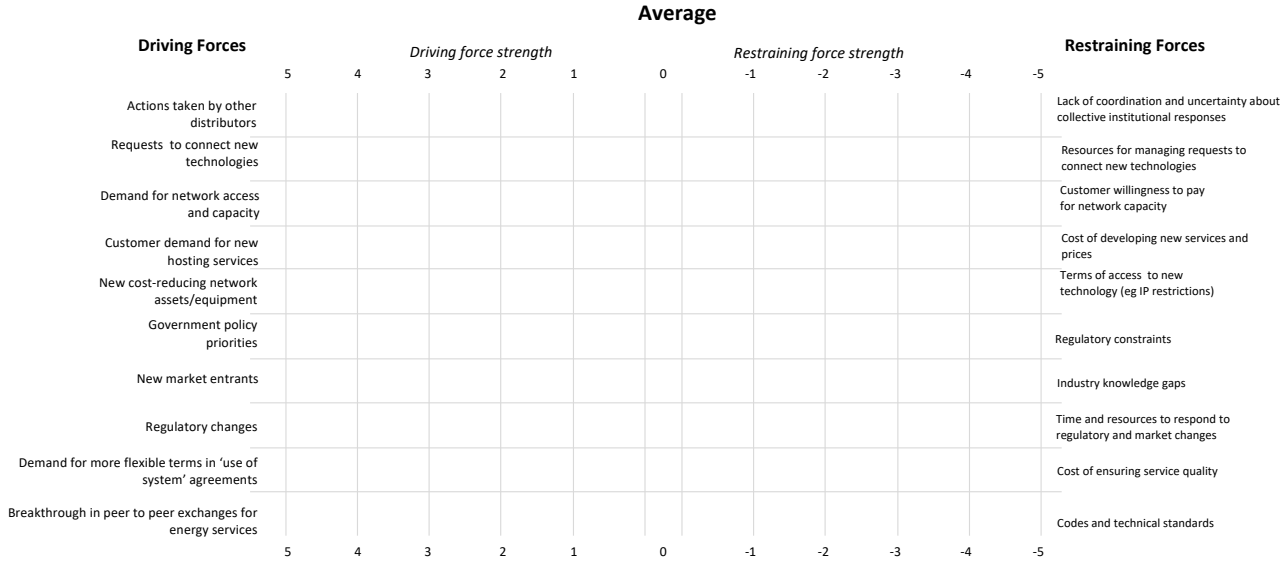
3.5 Interviewees were able to consider and discuss with us:

(a) the driving and restraining forces, including if there were any factors missing

(b) how their own business's survey respondent had ranked the factors (as not all interviewees had participated in completing their survey)

(c) how their responses compared with the average of all distributor responses.

Figure 8 – Force field analysis – average of all distributor survey respondents



3.6 From the averaged distributor survey responses, looking first at driving forces, we note:

(a) most of the driving force averages are greater than a 3, suggesting these are significant factors in distributors' perceptions

(b) some awareness of the issues experienced by other distributors, particularly in respect of geographically closer distributors

(c) quite strong levels of customer requests for DER, albeit off a very low base, as we noted earlier

(d) some reflection on technologies that support distributors to reduce the costs of existing services – an enduring focus on reducing service costs by innovating was a point reinforced by many interviewees

(e) quite strong reflection of Government policy and regulatory change as a driver – Government 'policy' appears to have been interpreted by most respondents as

incorporating decarbonisation and environmental concerns, factors that are now virtually universally treated as a given

(f) relative to other factors, a lesser level of new market entrants requesting new services from distributors or distributor support for new market participants to develop their own new services.

3.7 Turning to restraining forces, we note:

(a) the general picture that there are more, stronger factors driving technology-induced change than are restraining it

(b) relative to other restraining forces, a strong view that regulatory constraints are a significant restraining force, although, in interviews, few distributors highlighted specific regulatory constraints to support this view – ie, the concern seemed to be about regulation in general, although a few did raise the concern that MBIE had not yet updated to the latest version the safety standards cited in the Electricity (Safety) Regulations 2010 that apply to inverters), which, in their view, perpetuated regulatory uncertainty

(c) in contrast, others saw no regulatory impediments to the types of initiatives they were considering – is it possible this reflects a more general concern about regulator-imposed impediments in general from the point of view of a regulated business?

(d) customer willingness to pay as the next strongest restraining force, supported by the frequent references made by interviewees to the proportion of lower socio-economic consumers in their overall customer base

(e) that access to resources to think about and develop new services came through quite strongly as a restraining force – this point is linked to interview discussions about collaboration, including with local educational institutes, (eg, universities) and electricity industry research and development (R&D) businesses, (eg, Mitton Electronet) as a means of providing access to a pool of skilled resources and technical R&D capabilities.

(f) an omission noted by some was the specific issue of access to smart meter data, which is discussed elsewhere in this report – distributors lacking such access consider that to be a significant restraining force.

3.8 Distributors provided further views about the driving and restraining forces during the interviews. Qualitatively summarising the factors that appear to influence individual distributor views, the following differentiators stand out:

(a) the nature of local geography and the degree of urban and rural land within each distributor's territory – in particular, how these factors play out in respect of electric vehicle commute distances and the current state of range anxiety amongst the driving population

(b) customer socio-economic demographics

(c) the overall condition of existing network and the effort and focus required to bring poor performing areas up to standard so as to meet current customer capacity, security and reliability needs

(d) the portion of existing networks that are uneconomic to maintain

(e) ownership influence and focus

(f) leadership influence and focus

(g) the ability to invest – eg, considering balance sheet strength, owner's priorities etc.

Stakeholders indicated that driving forces were stronger than restraining forces

3.9 In the stakeholder interviews, we again provided interviewees with two views of the force field data:

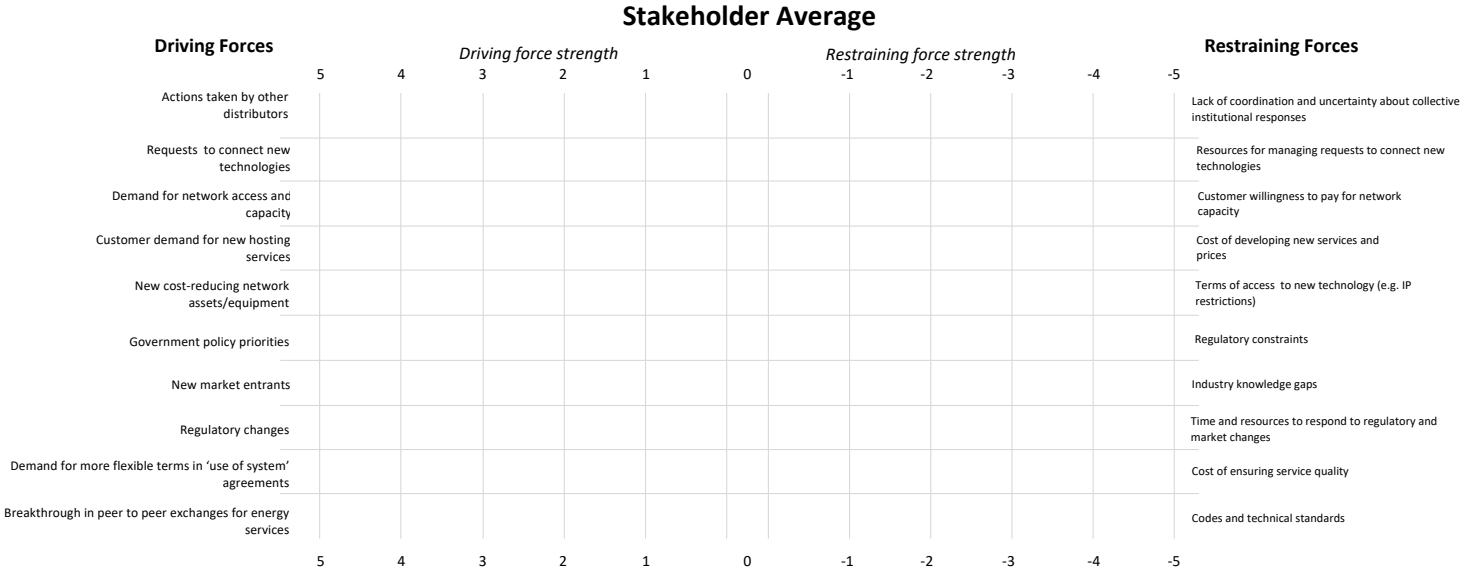
(a) a chart with the respondent's own factor rankings, if they had provided a survey response, which the majority had

(b) a chart presenting the average of all stakeholder force field data responses.

3.10 In interviews, stakeholders freely considered and discussed with us the driving and restraining forces on distributors, including if they thought there were any factors missing. Most – but not all – stakeholder interviews tended towards discussion about the forces that applied to their own activities rather than those applying to distributors.

3.11 On average, stakeholders responses to the force field question indicated that driving forces were stronger than restraining forces.

Figure 9 – Force field analysis – all stakeholder survey respondents



3.12 On average, stakeholder responses indicate that they see the role of regulators as the strongest driving force. In interviews, stakeholders provided the additional context that regulation drivers include open access arrangements and information sharing frameworks. Other strong driving forces identified by stakeholders related to the changing demands on distributors around requests to connect new technologies, demand for network access and capacity and new cost-reducing network assets and equipment.

3.13 Driving forces that featured strongly in stakeholder interviews included the following:

(a) information exchange: stakeholders recognise the need for distributors to access data, but consider that data exchange can go both ways. There is a need for protocols and protection of commercially sensitive data, possibly involving shared access through a controlled database or a contracted-out data service model

(b) opportunities for demand side management (DSM) to interact with energy and network management – this was linked with the need for appropriate distribution pricing signals

(c) the appointment of new technology managers by some distributors was identified by stakeholders as a potentially strong driving factor for those distributors

(d) a stakeholder considered that increasing electric vehicle uptake will become a major driving force but that the potential issues for distribution networks might be being overstated (which would be a restraining factor)

(e) the need to understand what networks will need to look like in the future

(f) the need to develop standards for technologies such as electric vehicle charging stations

(g) the need to increase collaboration and provide spaces for innovation. A stakeholder noted that there were many initiatives, such as trials and experimentation, currently being undertaken by distributors; these originated from traditional needs to find new technical solutions to legacy issues such as ageing assets

(h) the pressure to do more with less – driven by both regulation and commercial pressures, driving the need to engage new skills and methods

(i) a stakeholder considered the strongest driving force for all network operators was the ever-present need to avoid the 'lights going out' (CEO's get fired for this); whereas a failure to invest in new and/or uncertain developments is not such a strong driving force (CEO's don't get fired for this)

(j) a stakeholder considered that collective momentum on climate change would produce a significant driving force; acknowledging that timing is uncertain, their view was that this momentum would drive the need for a paradigm shift in distributor strategies.

3.14 Stakeholders provided the following comments about their survey responses on restraining forces:

(a) distribution pricing was raised as a potentially strong restraining force on technology-driven change. Several stakeholders considered that variable distribution prices were not cost-reflective and that the absence of cost-reflective prices would restrain realisation of technology benefits in the future. One stakeholder provided an example of where a distributor introduced a form of time-of-use (TOU) pricing without any consultation with stakeholders

(b) distributor and stakeholder access to data and information was raised as a restraining factor as well as a driving force. Comments included the absence of a formal data sharing framework

(c) potential competition issues related to data sharing was identified as a potential barrier to technology adaptation

(d) distribution cross-subsidies between regulated and market income was seen as a restraining force experienced by one stakeholder; the example given was at least two distributors offering free electric vehicle charging

(e) one stakeholder considered the large number of distributors was a potential issue that could restrain technology adoption

(f) distributors are undertaking multiple trials and some stakeholders consider there was a need to collaborate and share the learnings. Examples of trials cited by stakeholders included electric vehicle charging and TOU pricing

(g) one stakeholder indicated that the potential risk of stranded investment was likely to be a strong restraining force to both distributors and others when making technology-related investments

(h) one stakeholder considered that some distributors would be restrained by difficulties in recruiting suitable staff, eg, due to their location.

3.15 Other stakeholder comments included

(a) there is value in having 'one version of the truth' when considering the management of risks from new technologies. Having reliable and consistent data would provide a sound foundation on which to build more confidence and gain insight. This would be particularly important when investing in high cost assets and more futureproof asset management approaches.

(b) there is value in distributors understanding mindsets that are different to theirs. Distributors will need to undertake broader and different types of engagement than they traditionally have, to overcome restraints due to entrenched mindsets.

(c) the is value in establishing a specialist business unit created the headspace needed to consider the strategic issues presented by emerging new technologies. This unit had also sought to collaborate more broadly with external parties, such as Creative HQ, to overcome legacy mindsets.

4 Strategic change and capability development

Section overview

4.1 This section discusses how distributors innovate and develop strategies to respond to changes in the business environment and the associated risks.

4.2 We found that most distributors:

(a) don't consider that barriers to innovation are at a particularly high level

(b) are experiencing difficulties recruiting skilled staff in some areas – but the extent of these difficulties are not as severe as in some other industries.

4.3 For some distributors:

(a) cost and risk barriers are a concern when innovating

(b) lack of information was an issue when considering innovation.

4.4 Lack of appropriate personnel is also more frequently cited as a barrier to innovation by distributors, than they are for businesses in the wider economy. Other barriers cited more widely by distributors are (a) costs to develop or introduce new products or methods and (b) lack of management resources.

4.5 The higher levels of constraints are a material consideration when thinking about distributors' abilities to adapt to changing circumstances.

Firms set strategies in response to a range of opportunities and threats

4.6 Distributors are, in many respects, businesses like any other. All organisations balance a range of concerns when deciding their strategies. Distributors do have distinctive responsibilities and organisational structures (such as consumer trust ownership), but there is wide variation amongst distributors in terms of approaches, culture, strategies and objectives or governance structures.

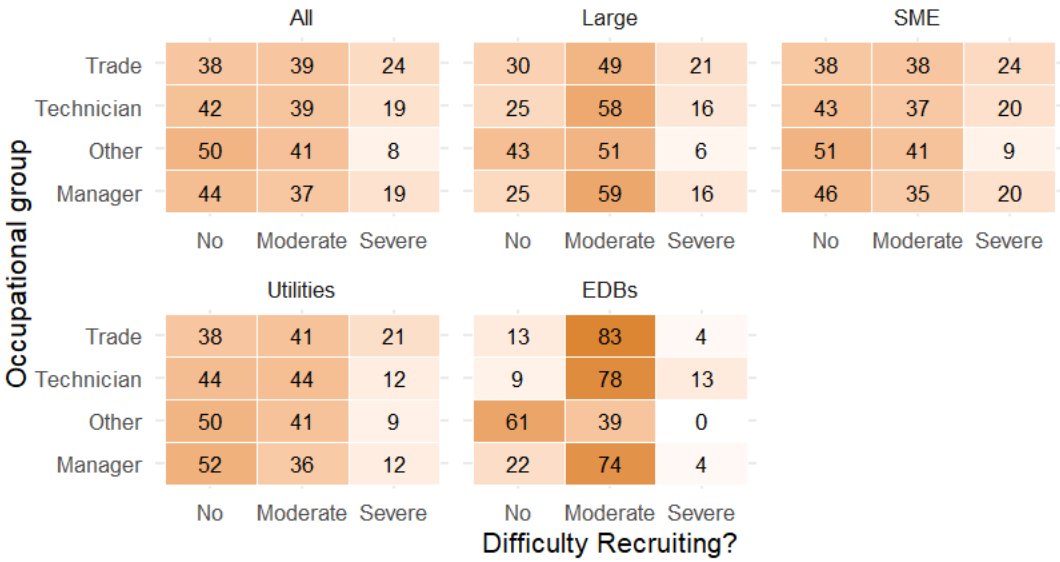
4.7 On average, distributors report somewhat more difficult business environments than do other firms, although not substantially so. For example:

(a) a proportionately higher number of distributors report difficulties recruiting trades, technical and managerial staff – but the extent of these difficulties are not as severe as in other industries (see Figure 10)

(b) a proportionately higher number of distributors report deficits in IT and communications infrastructure (eg mobile and broadband) (see Figure 11).

Figure 10 – Difficulty recruiting staff

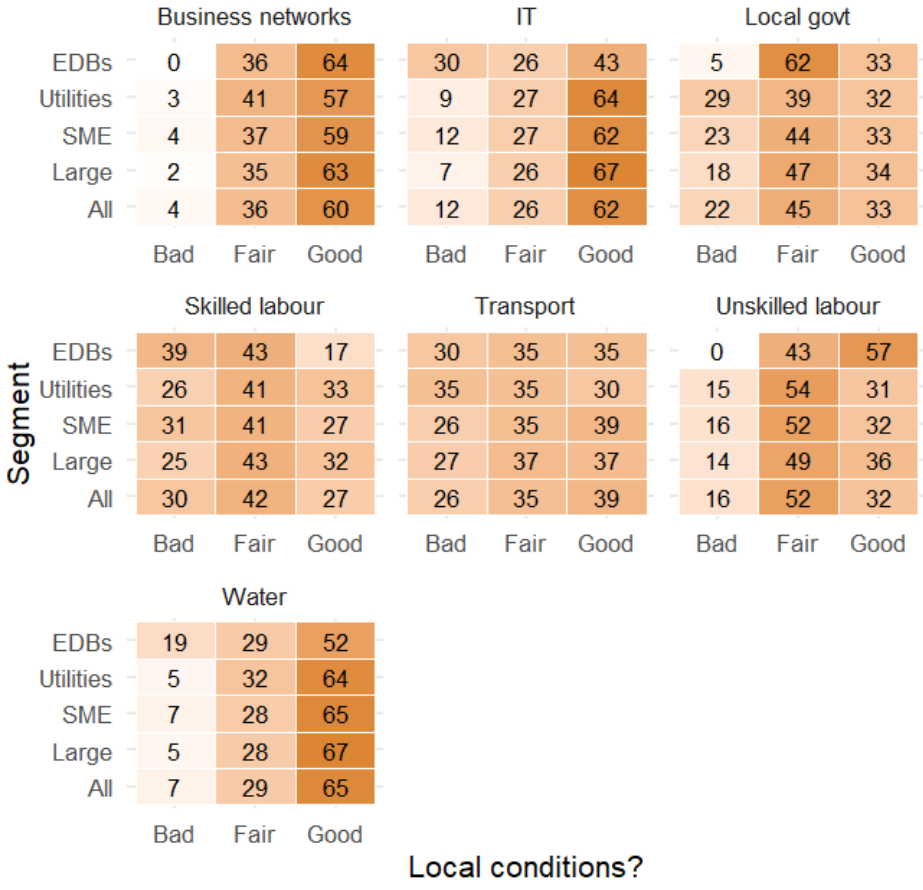
Percentage of NZ firm responses[11]



[11] The BOS data for this table comes from the 2017 survey – the most recent available survey results when this analysis was carried out.

Figure 11 – Views on local infrastructure and business conditions

Percentage of NZ firm responses



4.8 We consider that these higher rates of reported constraints are possibly a result of distributors' more diverse geographic representation than firms nationally. That is, 54% of businesses[12] reside in 'City' council areas (Auckland, Hamilton, Palmerston North, Wellington, Christchurch Dunedin, Invercargill), while distributors span a range of rural and urban areas with no attempt made to weight survey responses for, eg, market size. So, to the extent that the business environment varies across the country, this is much more likely to be reflected in our survey results than it is in a national business operations survey.

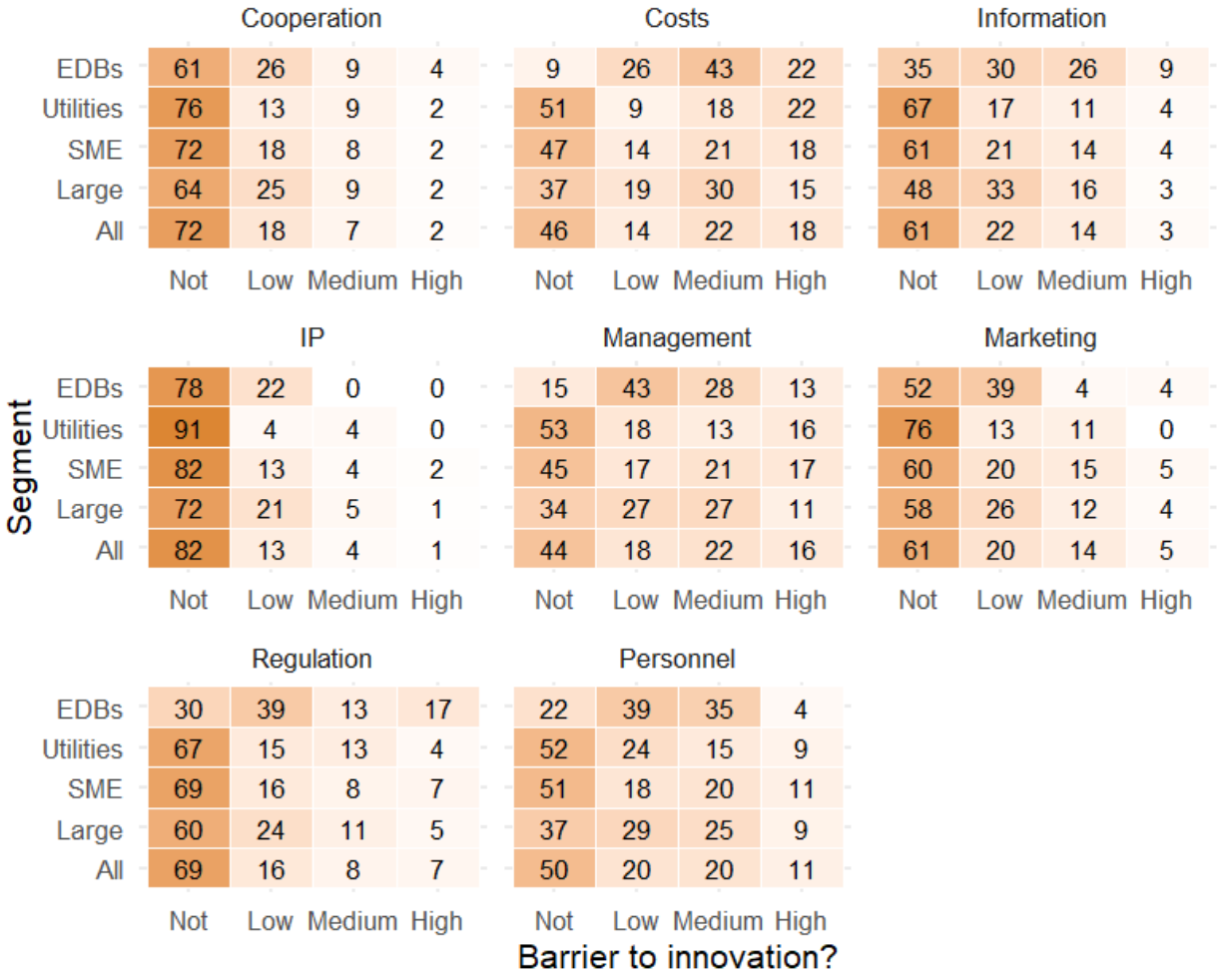
4.9 These higher levels of constraints are a material consideration when thinking about distributors' abilities to adapt to changing circumstances. Other things equal, we should expect that difficulties finding labour might reduce adaptivity. Although they do not appear to constrain innovation to a significant degree (only 4% of distributors cited personnel as a high barrier to innovation, in Figure 12, compared with 11% of all businesses), they indicate potential differences in adaptive capabilities for those distributors where constraints are most prevalent or particularly severe.

[12] Specifically, geographic units of businesses, as opposed to parent companies or enterprises (Statistics New Zealand Business Demography statistics, values for February 2018).

4.10 Lack of appropriate personnel is more frequently cited as a barrier to innovation, by distributors, than by businesses in the wider economy. While 50% of all businesses say that a lack of appropriate personnel is not a barrier to innovation, only 22% of distributors agree with this while 78% of distributors say that a lack of appropriate personnel is a barrier to innovation albeit to varying degrees of severity (see Figure 12). The other two categories of barriers cited more widely by distributors are costs to develop or introduce new products or methods (cited by 81% of distributors as being low, medium or high barrier, in Figure 12) and lack of management resources, eg, time (only 15% of distributors said this was not a barrier, as shown in Figure 12).

Figure 12 – Barriers to innovation

Percentage of firm responses



4.11 There is, however, wide variation amongst distributors in terms of the prevalence and severity of factors (constraints) likely to constrain distributors' adaptability or innovation.

Cluster analysis indicates that differences are idiosyncratic rather than determined by distributor characteristics

4.12 Cluster analysis generally suggests considerable similarity amongst distributors and differences that tend to be idiosyncratic rather than predictable with information about local network characteristics or costs. Cluster analysis is a data-reduction technique that involves, for example, grouping subjects based on similarities in their characteristics, opinions or other variables or the extent to which characteristics or opinions have similar variations. For example if two distributors tend to answer strongly positively to questions

about innovation activity and strongly negatively to questions about constraints to innovation, then these distributors will be identified as being similar to each other and part of a common group or cluster.

4.13 These observations may be indicative of differences in culture, leadership, or similar factors unrelated to conventional network attributes. That would accord with findings from interviews with distributors.

4.14 For example, cluster analysis on constraint-related questions suggests seven clusters is appropriate for describing groupings of responses to questions regarding constraints, such as difficulty finding labour and barriers to innovation. By contrast, when we cluster responses to survey questions associated positively with distributors' capability, we find a distinct two-dimensional grouping of distributors. One group is associated with strong responses to questions positively related to firm - such as large numbers of innovation-related activities, wide ranging cooperative arrangements, R&D activity and innovation. The other group is less likely to answer so positively on these capability-related questions.

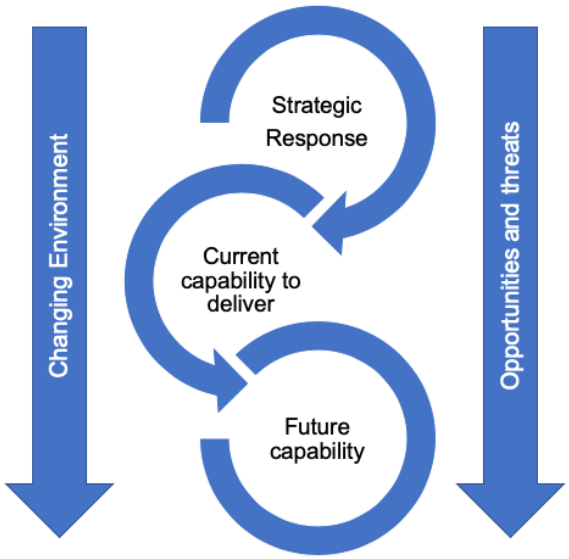
4.15 We have provided an example of groupings based on responses to capability-related questions is presented in Appendix B.

Distributors are considering capability development

4.16 As demands for distribution services change, distributors must develop the capability to meet those demands. If distributor capability falls short, it will present a barrier to customers realising the benefits available from technology adoption.

4.17 In this study, we considered that capability development is a strategic response to a changing business environment. We sought to gain an understanding of distributors' current capabilities and how these would need to change over time to respond to the technology-driven change in their business environment.

Figure 13 – Strategic response to a changing environment



4.18 In the survey, we asked distributors questions about the capabilities of their business and their capacity for adapting to technology-driven changes. We asked questions about what skills distributors would need to improve and about the barriers that might prevent a distributor's ability to respond to change through innovation.

Views on factors hampering the ability to innovate varied across distributors

4.19 We asked distributors about the degree to which the following factors might hamper their ability to innovate, focusing on the last two years:

(a) risk or uncertainty about returns to innovation

(b) costs to develop or introduce

(c) lack of information

(d) lack of marketing expertise

(e) lack of cooperation with other businesses

(f) lack of management resources (eg time)

(g) economic regulation, (ie, Part 4 of the Commerce Act)

(h) lack of appropriate personnel

(i) market or industry-specific regulation (eg, the Electricity Industry Participation Code)

(j) other regulation.

4.20 We asked distributors to rate each of the above factors on the following scale:

(a) high degree

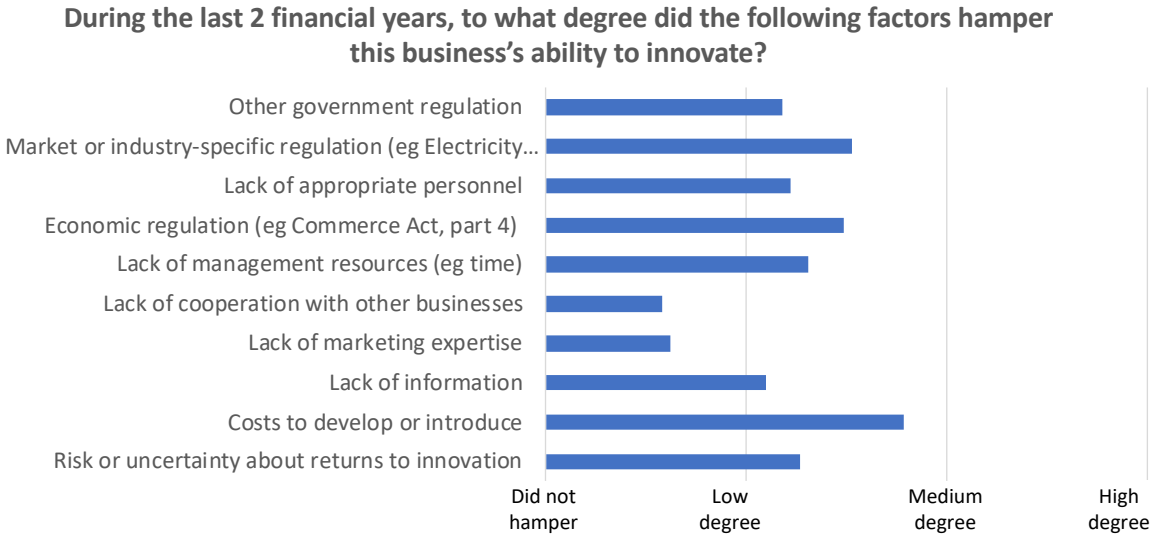
(b) medium degree

(c) low degree

(d) did not hamper.

4.21 The average response across all distributors, shown in Figure 14, indicated that distributors don't consider that barriers to innovation are at a particularly high level. Only *costs to develop or introduce* rated as being close to a medium degree of impact.

Figure 14 – What factors hamper distributors from adapting?



4.22 The comments provided on this question and interview discussions indicated that innovation formed part of continuous improvement initiatives that distributors develop through annual business planning cycles. Some noted that their key focus was on core

business improvement opportunities, which included consideration of the capacity to change.

4.23 Some distributors noted that the availability of management and staff time was a limiting factor in innovation and that the high background level of regulatory activity and demand contributed to this issue. One distributor commented about the difficulty they had experienced in aligning political, regulator and retailer involvement with the direction the distributor wished to take.

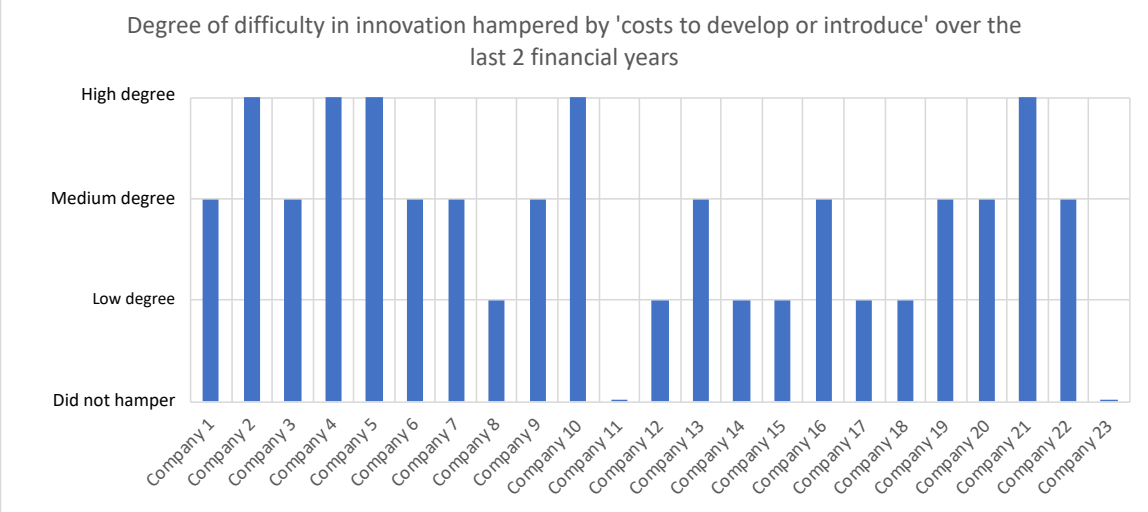
4.24 Others indicated that the potential for a commercial return was needed if shareholder funds were to be invested in innovation. One cited restrictions their investor owner imposed on the business for any new/innovative activities that might change the risk profile of the business, that would in turn increase the owner's required rate of return.

4.25 Whilst the average across all distributors did not point to significant issues hampering innovation, individual distributor responses for each factor were quite variable. Some distributors indicated that some of the factors were hampering innovation to a high degree.

Cost and risk barriers posed a concern for some distributors

4.26 The 'cost to develop or introduce' was seen as hampering innovation to a high degree by five distributors and to a medium degree by ten distributors (Figure 15). Our Developer category[13] included four of the five distributors rating this factor as providing a 'high degree' of difficulty, indicating they had recently undertaken some innovation in the smart grid technology area. Four of the five Growers considered cost hampered innovation to a low degree or not at all.

Figure 15 – 'Cost to develop' as a potential barrier to innovation



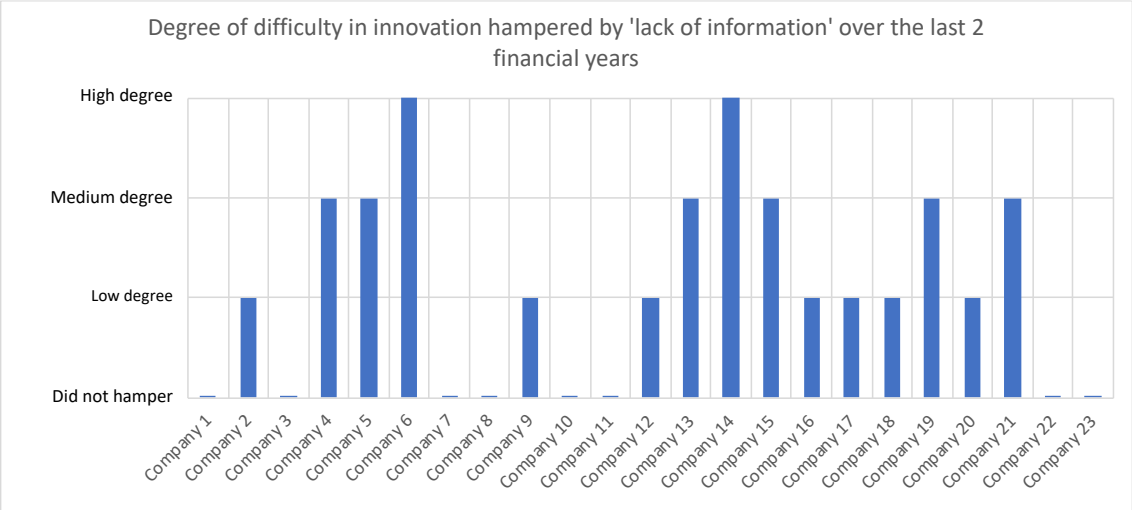
4.27 None of the Growers considered *risk or uncertainty about returns to innovation* was hampering innovation to a high degree. Distributors that considered this factor was hampering them to a high degree had predominantly urban networks.

Lack of information was an issue for some distributors

4.28 Lack of information was rated by two distributors as hampering them to a 'high degree' and by six distributors to a 'medium degree' (Figure 16).

[13] We defined the three distributor categories in paragraph 1.26.

Figure 16 – Degree of innovation difficulty due to availability of information



4.29 Distributors use a range of sources of information. However, during the last two financial years, ten or more distributors did not rate customers, universities or polytechnics, Crown Research Institutes, other research institutes, research associations or Government agencies to be important as sources of information or ideas for innovation. Distributors identified the following as their primary sources of information or ideas driving innovation:

(a) other businesses

(b) suppliers

(c) books, journals, patent disclosures or internet

(d) existing staff

(e) new staff

(f) industry or employer organisations

(g) conferences, trade shows or exhibitions

(h) professional advisors, consultants, banks or accountants

(i) overseas sources

(j) experience gained from studies and pilot trials.

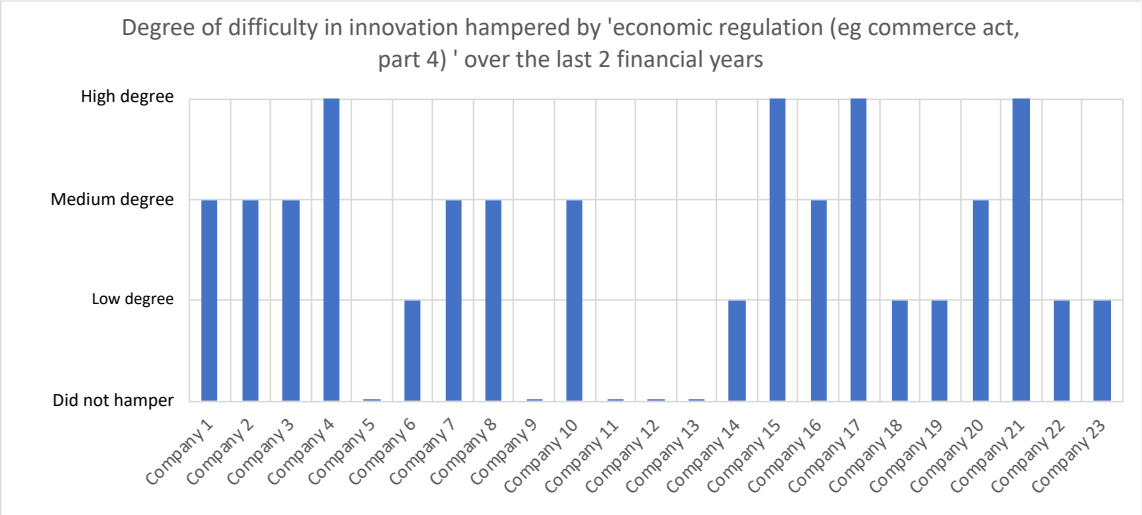
4.30 One distributor identified that overseas study trips had provided great insights, whilst another expressed the need for caution when reviewing international information as such lessons may not be scalable to the New Zealand environment.

4.31 One distributor commented that most ideas came from existing staff, a point that was frequently encountered in survey responses.

Some distributors see economic regulation as hampering innovation

4.32 More than half the distributors saw that economic regulation was hampering innovation to either a high or a medium degree. However, comments provided few details or examples of this.

Figure 17 – Innovation difficulty due to economic regulation

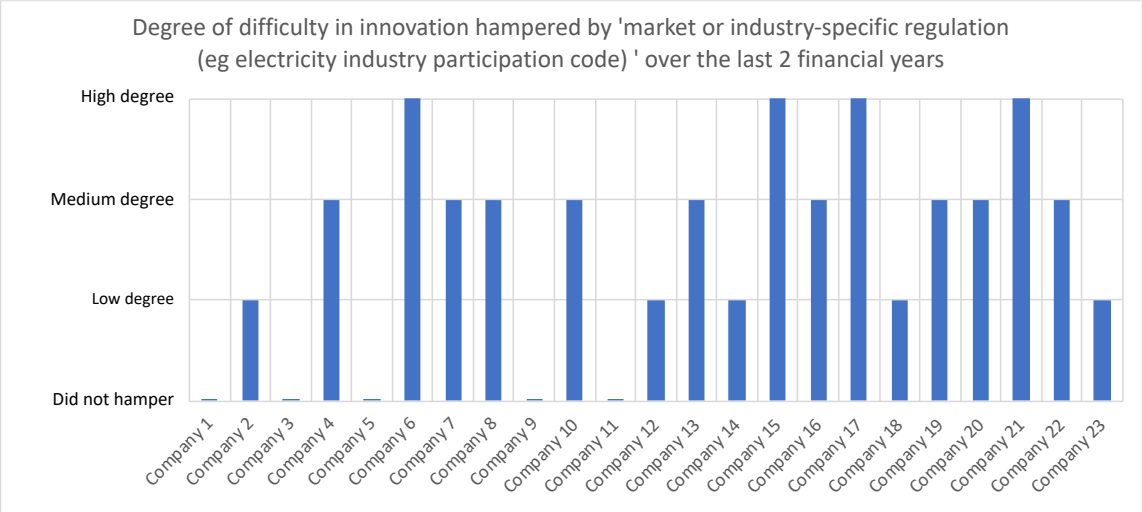


4.33 One distributor considered regulatory activity in general was '*eating up management and staff time*', which could otherwise be used for more innovative activities. Examples given included the Electricity Price Review, the Authority's review of distribution prices and the evolving information disclosure regime.

4.34 We note that 3 of the four that gave 'high degree' ratings for this factor had recently participated in Commerce Commission non-compliance reviews.

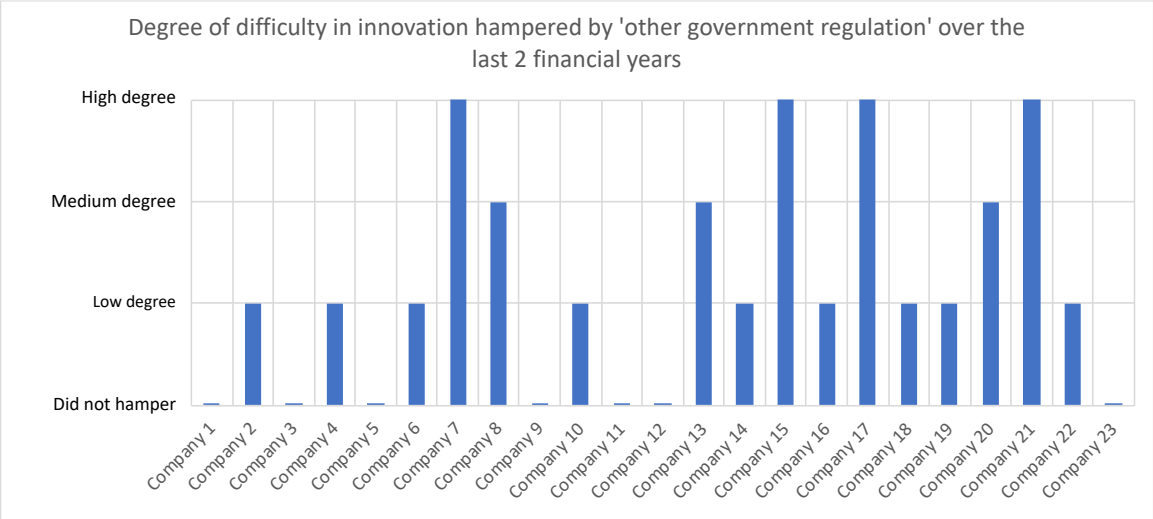
4.35 In their survey responses, most distributors did not differentiate, or had the same views on, the impact of (a) economic regulation and (b) market or industry-specific regulation. The views on the degree of hampering due to market or industry-specific regulation were mixed across our distributor categories. Figure 19 indicates that distributor views on the level of difficulty presented by market regulation is quite mixed. In comments distributors did not identify any specific issues relevat to market regulation.

Figure 18 – Innovation difficulty due to market regulation



4.36 Views on other types of Government regulation indicated that it did not impact to such a high degree of difficulty as industry-specific regulation. Three distributors gave the same high degree response for all three regulators – this could indicate a general predisposition to regulatory matters or indicate that those distributors face specific regulatory issues.

Figure 19 – Innovation difficulty due to other regulation



4.37 All distributors in our Developer category gave either ‘low degree’ or ‘did not hamper’ ratings on innovation difficulties from other Government regulation. Views on the degree of hampering due to other regulation were mixed across Grower and Caretaker distributor categories.

4.38 In the comments provided by respondents about this survey question, some distributors highlighted their view that regulation absorbs significant amounts of management time that could be applied to more ‘beneficial’ activities. The lower degree of concern in this area for distributors may be based on the lower level of regulator engagement required to deal with non-industry specific regulation (ie, regulators other than the Commerce Commission, the Authority and MBIE).

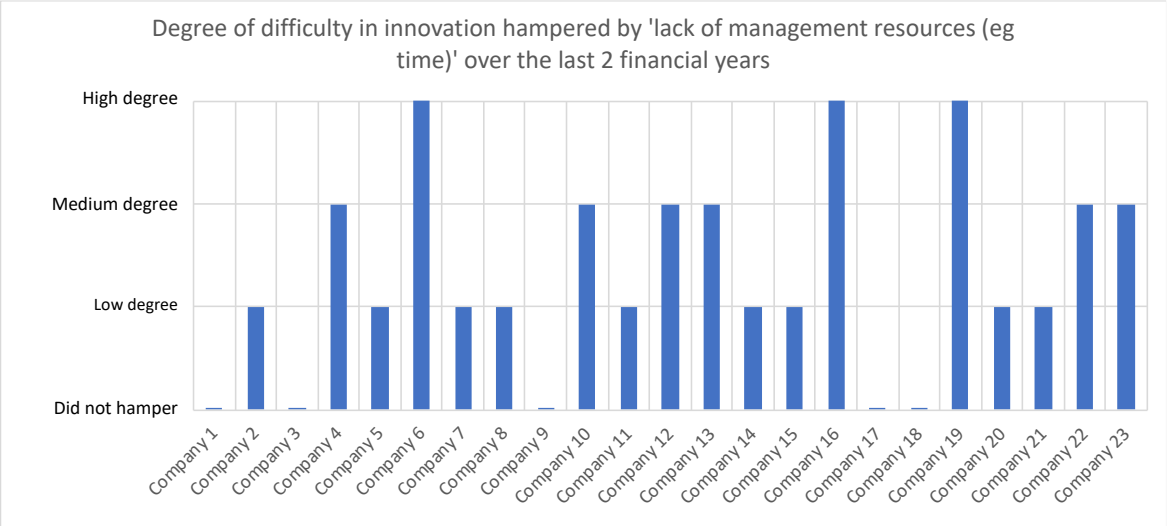
Lack of management resources appears to be an issue for some distributors

4.39 The three distributors citing a ‘high degree’ of difficulty relating to lack of management resources are in our Caretaker category; two of these are currently undertaking major network reinvestment programmes.

4.40 For other distributors, a lack of management resources is not highlighted as a major issue. Distributors indicating a medium degree of difficulty are likely to be experiencing location-specific issues, (eg, location attractiveness to potential recruits, the local cost of housing etc).

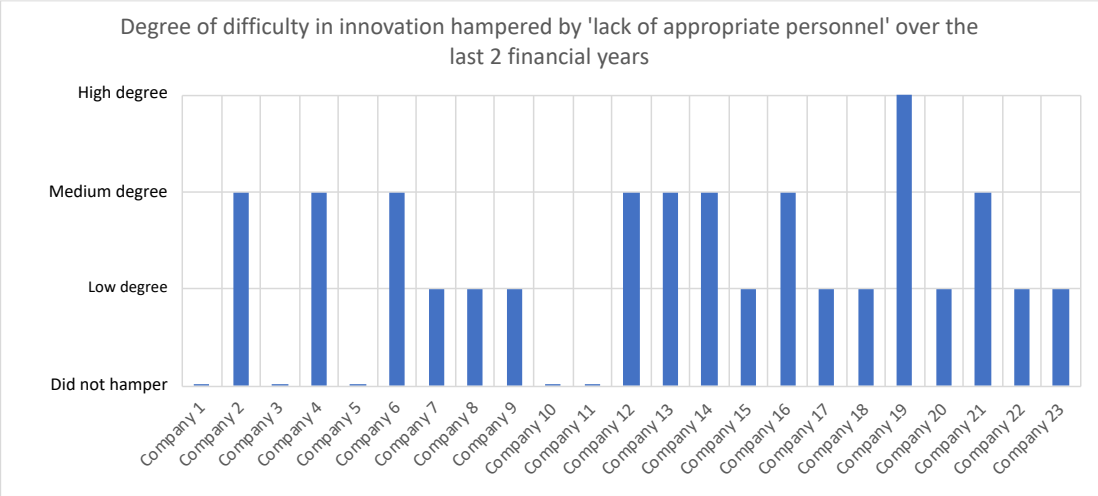
4.41 In general, survey responses did not indicate that difficulty in recruiting management resources was hampering their ability to innovate. Interview responses generally backed this up.

Figure 20 – Innovation difficulty due to lack of management resources



4.42 We note a similar perspective for the factor 'lack of appropriate personnel'. However, for this factor only, a single distributor is experiencing a high degree of difficulty. All five of our Grower distributors indicated a low level of difficulty for this factor.

Figure 21 – Innovation difficulty due to lack of appropriate personnel



4.43 The survey responses generally indicated that lack of management and personnel resources was not a widespread issue for respondents and that difficulties may be specific to particular distributor circumstances.

Some skillsets require improvement

4.44 Utilising the skills and experiences held by existing employees is an efficient and effective way of enhancing business capability. The survey asked distributors which of the following skillsets they considered existing employees most need to improve:

(a) customer service/sales skills

(b) trade related skills

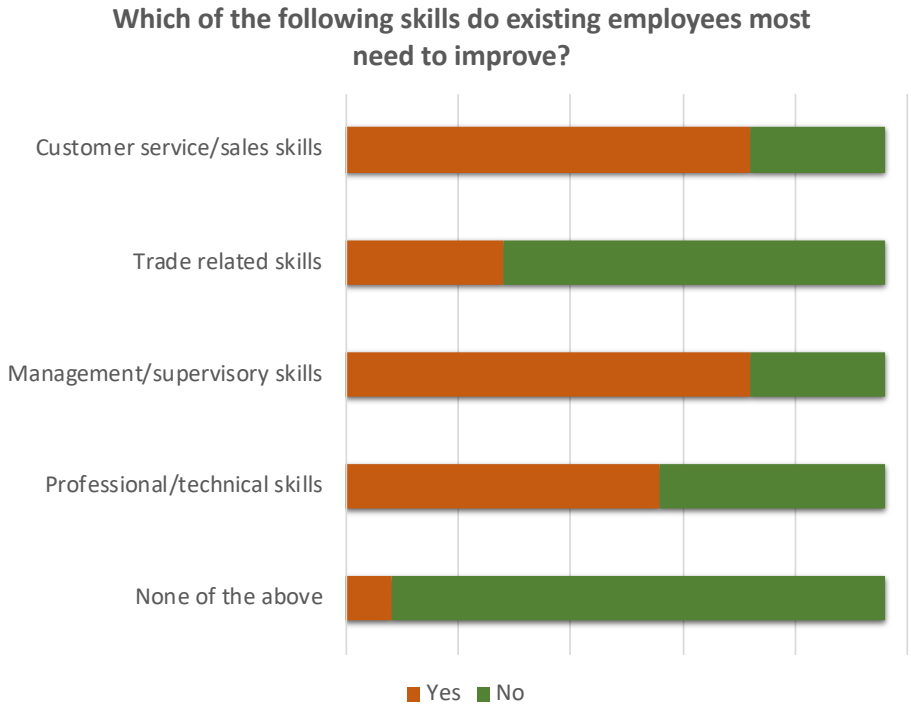
(c) management/supervisory skills

(d) professional/technical skills

(e) none of the above.

4.45 The highest rated areas for improvement were ‘management/supervisory’ and ‘customer service/sales’ skills. One distributor considered it did not need to improve employee skills in any of the listed areas, however this respondent provided no further comments about their response.

Figure 22 – Employee skills distributors say they need to improve



4.46 Some distributors commented that management and supervisory skill improvement initiatives are highlighted in personal development plans. Several distributors indicated their awareness that there are always potential improvements and expressed a willingness to identify these.

4.47 Development of technical skills highlighted in comments included IT innovation and new technologies. Interviewee comments added data management skillsets to this list; some considered this was increasingly an essential skillset to address modern needs.

4.48 One distributor commented that its focus for improvement was on customer service.

Some skillsets are difficult to recruit

4.49 We asked distributors if they had experienced difficulty in the last financial year obtaining any of the following skills from job applicants:

(a) customer service/sales skills

(b) trade related skills

(c) management/supervisory skills

(d) professional/technical skills

(e) none of the above.

4.50 Figure 23 shows the proportions of distributor yes/no responses to the above question. Professional and technical skills were seen as the most difficult to recruit. Figure 24 shows individual distributor responses, which indicate that four distributors have experienced recruiting difficulties in each of the four skill set areas.

Figure 23 – Difficulty in obtaining job applicants with specific skills – overall

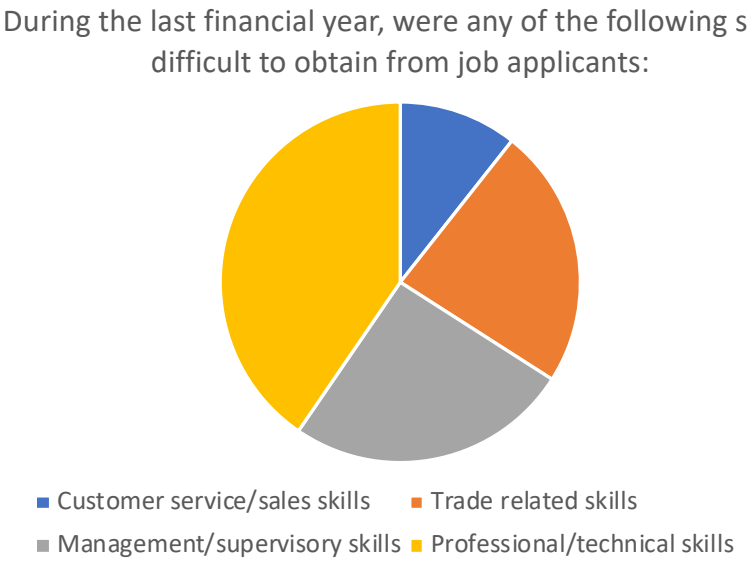
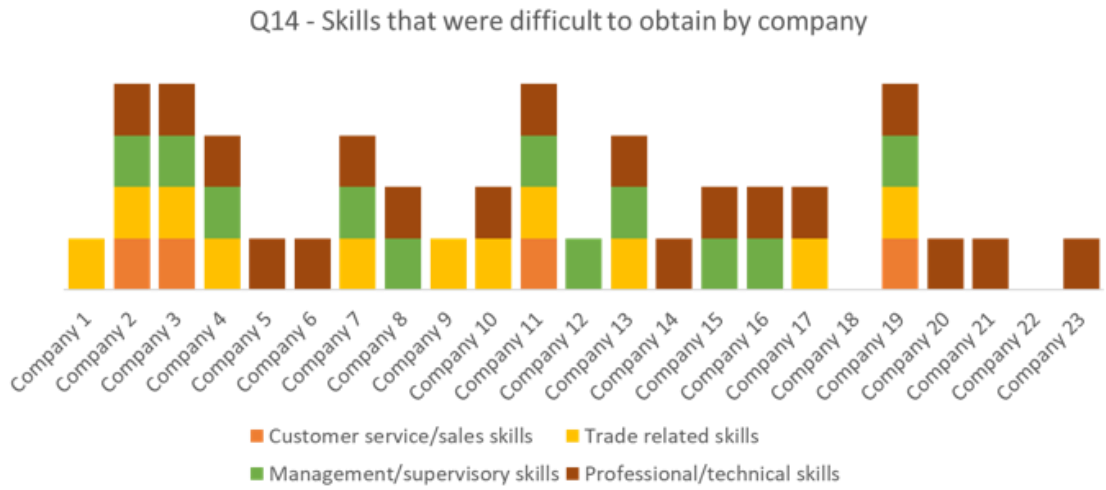


Figure 24 – Difficulty in obtaining job applicants with specific skills – by distributor



4.51 Distributors highlighted specific issues with recruiting technical skills but also noted that the line between management and technical skills was blurred as, in many cases, both management and supervisory skills were needed by professional and technical staff. In addition, the difficulties experienced could be for specific technical skills such as IT innovation, line crews and professional engineers.

4.52 Whilst some had experienced little or no difficulty recruiting, there was a suggestion that migration from Auckland to the provinces had been reducing recruitment difficulty but that this may reverse. One commenter extended this to the international market, saying that the recruitment market is very competitive and that some technical skills are in great demand internationally.

4.53 In responses to this question, some distributors again highlighted the technical skills required to adapt to technology-driven change and that these could include specialised IT technical skills. Respondents identified these skills in particular as being currently difficult to recruit. Interview responses added ‘data science skills’ to the IT category.

Comments from distributors noted the following experiences:

(a) general administration and management skills are available in the region, technical skills are getting more scarce but we were able to fill all vacant roles

(b) the recruitment market is very competitive and some technical skills are internationally in hot demand

(c) difficulty obtaining line crews and professional engineers

(d) lack of available staff has limited impact due to a collaborative management arrangement with another distributor

(e) there are particular areas for which it is more difficult to recruit staff, for example planning engineers, asset management experts and data scientists

(f) there is a continual shortage of qualified and experienced staff in the electrical supply industry

(g) there is a general industry shortage of trained staff

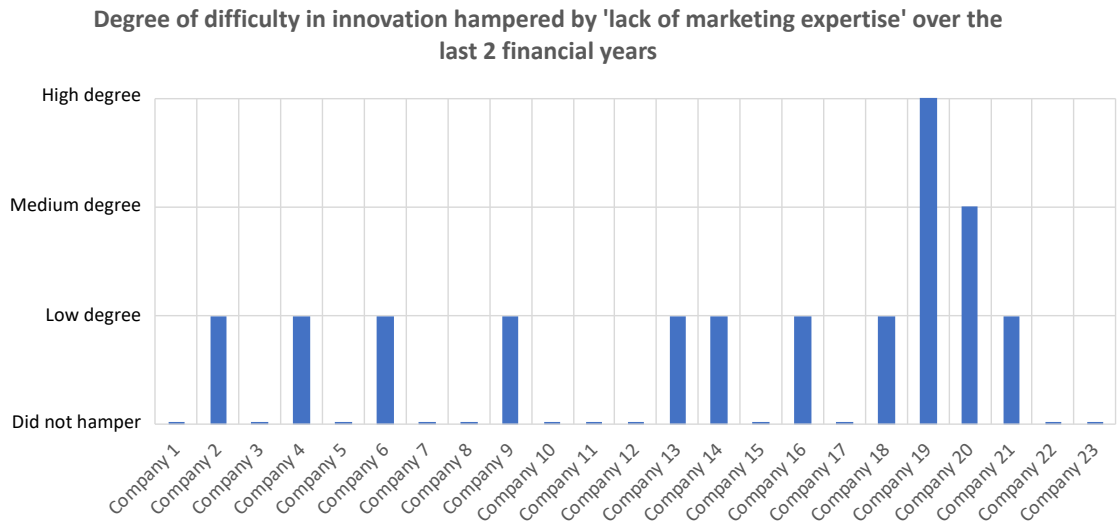
(h) over the last two years we have changed approximately 30% of our staff – initially this was challenging but the process has become increasingly easier

(i) sourcing suitable candidates can be challenging at times due to a regional location not being desirable for everyone

(j) difficulty is mainly around core skills such as fault crew and HV construction crews.

4.54 Whilst respondents saw a lack of customer service and sales skills as the area most in need of improvement, they did not generally see that lack of marketing expertise was hampering innovation (Figure 25).

Figure 25 – Innovation difficulty due to lack of marketing expertise



4.55 The ‘did not hamper’ and ‘low degree’ responses may indicate a perceived reality facing a regulated monopoly business with little opportunity to expand market share and develop new or enhanced products and services. The comments in responses to this question did not shed light on the reasons underlying these responses. Similarly, marketing skills did not come up as a discussion topic with interviewees.

4.56 If rapid technology-driven change occurs, it will be interesting to see to what degree the distributor perspectives observed in Figure 25 change as more market-focused needs emerge.

Drawing performance comparisons with other businesses challenged some respondents

4.57 Survey comments indicated that most respondents had struggled to answer the questions that asked them to compare their business against:

(a) other New Zealand distributors

(b) other non-electricity distribution businesses.

4.58 Generally, the difficulty appears to have arisen from a lack of relevant information.

4.59 To address the lack of relevant information, some used the annual disclosures required of distributors under the Commerce Commission's information disclosure requirements. Others took a small sample of comparable distributors. Some simply gave a 'don't know' response. A sample of the response comments follow:

(a) The distribution industry has a wide range of companies, making comparison difficult.

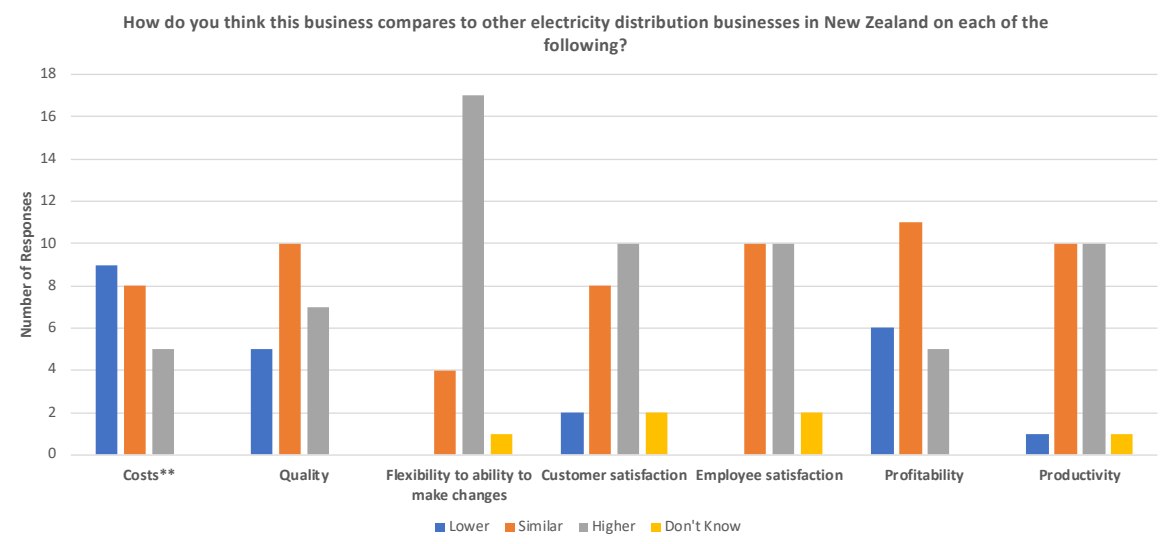
(b) [Our] answers based on information disclosure benchmarking.

(c) We don't have access to information on satisfaction levels of other distributors.

(d) This is largely a subjective view. The business measures all of these performance indicators in some way (ie staff satisfaction surveys, customer surveys, management reports etc) but do not benchmark against other distributors in all areas. Some of these performance indicators are reported through disclosure requirements and that provides a comparative against other distributors.

(e) Responses based on 2018 information disclosures where possible. We do not undertake industry comparative surveys for flexibility, customer and employee satisfaction, and productivity - accordingly, there is no sound basis for a response.

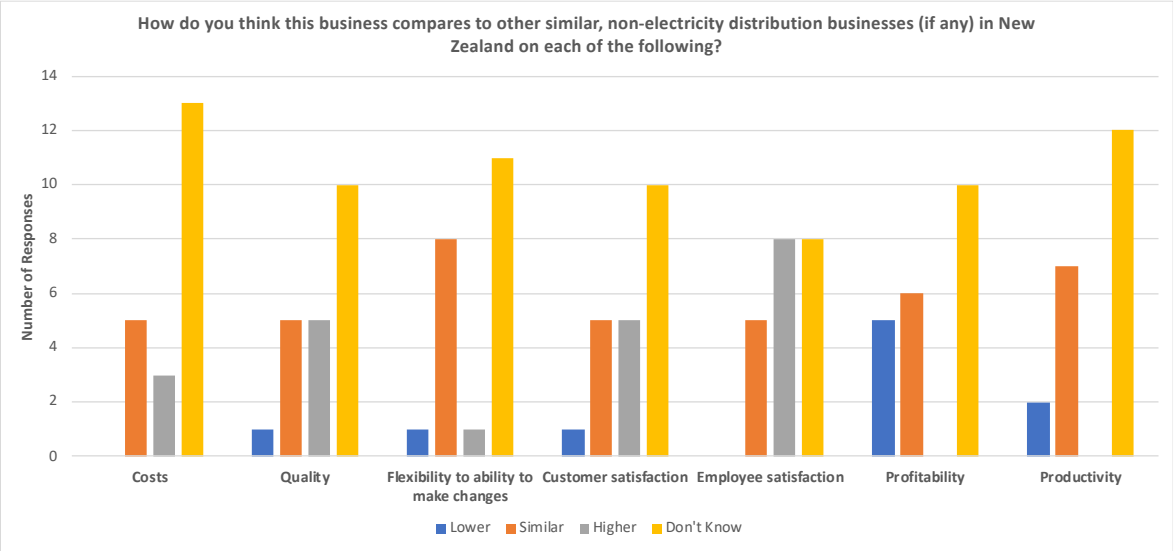
Figure 26 – Distributor views about comparison with other distributors



4.60 Generally, distributors struggled to address the question because they do not currently collect data to allow comparison. Despite this constraint, 17 out of the 23 distributors responding to the survey considered that they performed higher than other distributors on flexibility and ability to make changes.

4.61 Further, the high number of ‘don’t know’ responses make it clear that most distributors do not undertake – or contemplate – comparisons of their businesses with similar non-electricity distribution businesses.

Figure 27 – How distributors think they compare to other types of businesses



4.62 On the comparison of flexibility and ability to make changes, just one distributor considered it compared higher than other businesses.

4.63 Several distributors found it hard to comprehend how an electricity distributor could be compared with other businesses. Some relevant comments:

(a) an apples with oranges comparison is an interesting question and difficult to answer

(b) we will have different versions of similar non-distributors, and the service is different

(c) unsure of what a similar non-lines business would be

(d) very difficult to make generic comparisons to businesses in all other industries (other than electricity distribution)

(e) we do not monitor cross industry benchmarking except for employee engagement

(f) unable to comment on different industries

(g) unsure how a non-distributors can be similar to an distributors. No rational basis for comparison.

4.64 The responses to this question may suggest that distributors hold the view that electricity distribution businesses are quite unique and comparison is either not possible or is pointless. If this is correct, it may present a hurdle for distributors when they need to adapt to transformational change. Comparison with apparently dissimilar businesses can provide valuable perspectives for input into strategic planning.

4.65 The high ‘don’t know’ response on costs is interesting because the cost of electricity is frequently compared with other consumer products and services. Similar comparisons could have been made on most, if not all, topic areas in this question.

4.66 The key takeaway from these two questions is that distributors appear to not often step outside the regulated information requirements when assessing business performance.

In an increasingly uncertain world, in which the demand for services is changing and collaboration is important, access to a broad range of information will become increasingly important for distributors. The responses to the survey suggest that this may not be on most distributor radars currently.

5 Innovation and investment responses to anticipated technology impacts

Section overview

5.1 In this section we discuss how distributors are responding and innovating to technology related impacts on their business.

5.2 We found that distributors:

(a) are reporting high levels of innovation-related activity

(b) outsource rather than develop innovations in house

(c) are focused on controlling costs, which may bias innovation

(d) exhibit optimism bias when it comes to assessing their own flexibility

(e) are likely to have a natural bias towards improving conventional services

(f) are not going to be a source of disruptive innovation

5.3 We should expect that innovation from distributors will generally be more evolutionary than revolutionary.

How we classified innovation for this study

5.4 In the survey, innovation is classified as any new development inside the past two financial years involving:

(a) new products or services

(b) new operational processes

(c) new organisational or managerial methods.

5.5 These new developments can either be adoption of existing products or methods (new to the firm or new to New Zealand) or invention of new products and methods (new to the world). These are the same definitions and classifications used in innovation surveys in New Zealand and around the world.[14]

Distributors report high levels of innovation-related activity

5.6 Our analysis of the survey responses revealed that distributors display some distinctive characteristics to those seen in other businesses. Distributors have higher rates of innovation than other businesses in New Zealand and internationally. As shown in Figure 28, distributors report innovation at around three times the rate of all other firms and twice the rate of large firms in New Zealand.

5.7 These numbers are high by international standards but not unprecedented. For example, in Australia, 70% of large firms (200+ employees) in the electricity, gas, water and waste

[14] Eurostat, OECD, & EU. (2005). Proposed Guidelines for Collecting and Interpreting Technological Innovation Data. https://doi.org/10.1787/9789264192263-en

Industry report innovation of some kind. In the EU, Luxembourg reports product innovation in 74% of businesses in the electricity generation, distribution and transmission industry.[15]

5.8 Nonetheless, the rates of innovation reported by distributors are outliers, when compared to other industries' and countries' averages. OECD data shows an average, across countries of 71% of large firms undertaking innovation of some kind as compared to 96% (22 out of 23 surveyed) of distributors in New Zealand (see Figure 29).

5.9 Furthermore, 78% of distributors report engaging in R&D in the past two years. R&D is an important potential pre-cursor to innovation. Comparable figures for other businesses in New Zealand, from the Statistics New Zealand Business Operations Survey (2007-2017), include:

(a) 22% of large firms (100+ employees) reporting R&D

(b) 13% of all firms reporting R&D

(c) 11% of utilities industry businesses reporting R&D.

5.10 High rates of innovation-related activity amongst distributors, including R&D, relative to other businesses in New Zealand and overseas, cannot be readily explained by the data we have. It could simply reflect different compositions of firms within industries or across countries – that is, if we had samples of other distribution sectors in the world these results might not stand out.

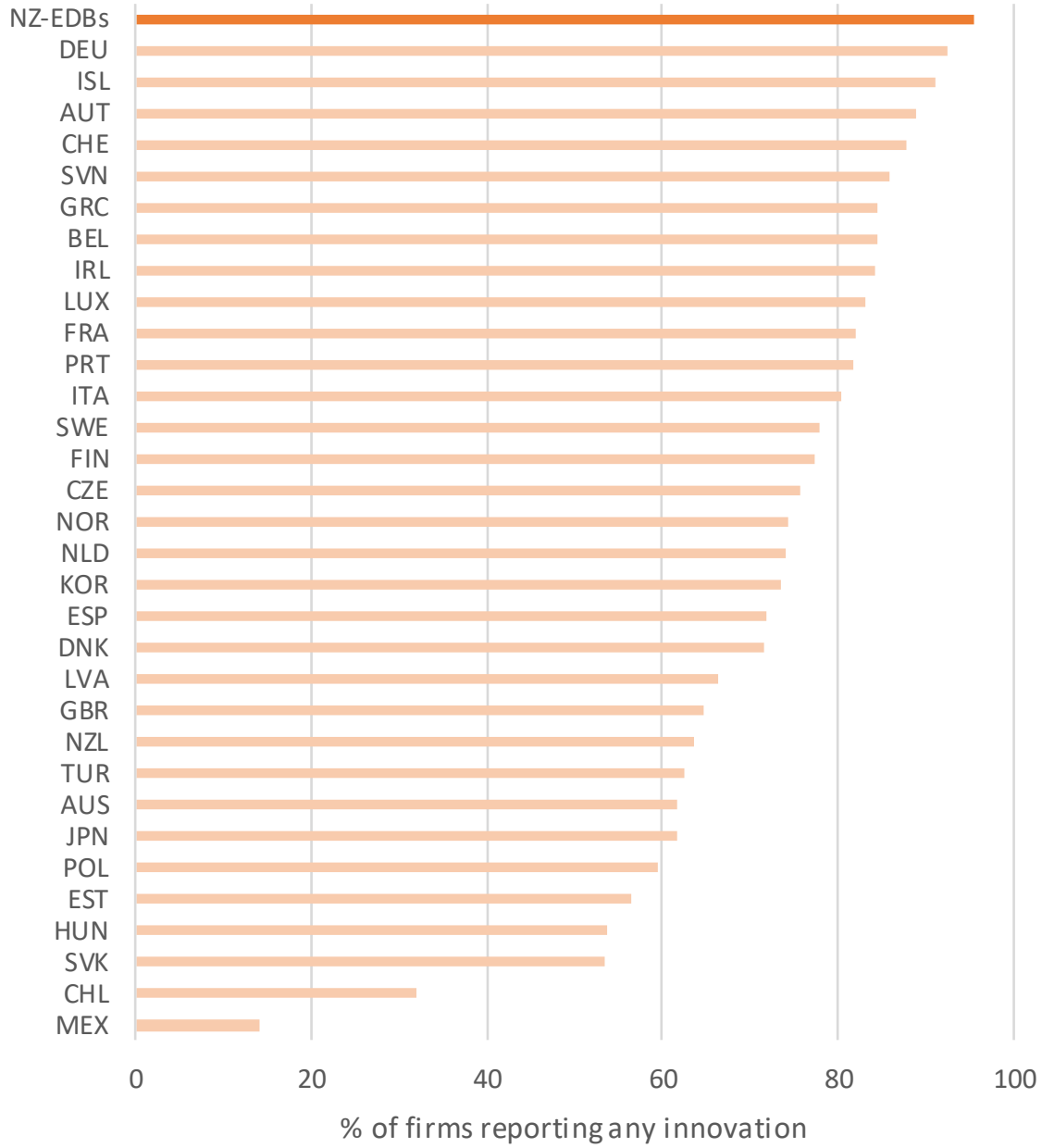
5.11 However, of importance to this study is that, at a minimum, we find no evidence of a deficit of innovation activity compared to other firms or industries. This is one important indication that distributors are capable of adapting to changes. There is some, admittedly weak, evidence that firms who report innovation, in the Statistics New Zealand Business Operations survey, tend to live longer than firms that do not report innovation.[16]

[15] EU classification NZACE Rev.2 D35.1.

[16] Wakeman, S., & Conway, P. (2017). Innovation and the performance of New Zealand firms (Staff Working Paper No. 2017/2). New Zealand Productivity Commission

Figure 28 – NZ distributor rates of innovation compared to OECD surveys[17]

Any type of innovation reported, percentage of firms. OECD data is 'large' firms.



[17] http://www.oecd.org/innovation/inno/inno-stats.htm. The OECD data is for the period 2012-2014. More recent (2017) data is available for select countries in the EU and for Australia and those later data are the data referred to elsewhere unless the OECD has been explicitly referenced.

Figure 29 – Share of firms reporting innovation, by type of innovation

Percentage of NZ firms reporting innovation

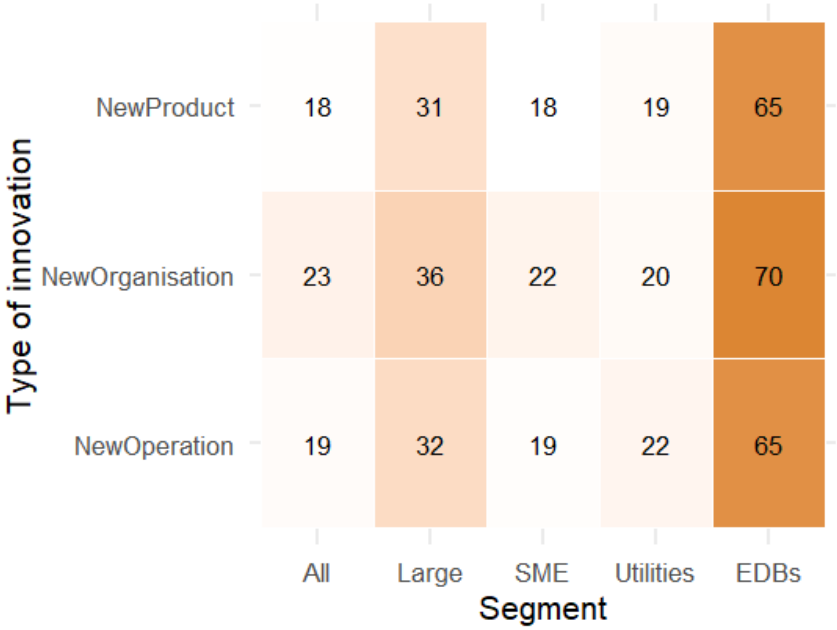
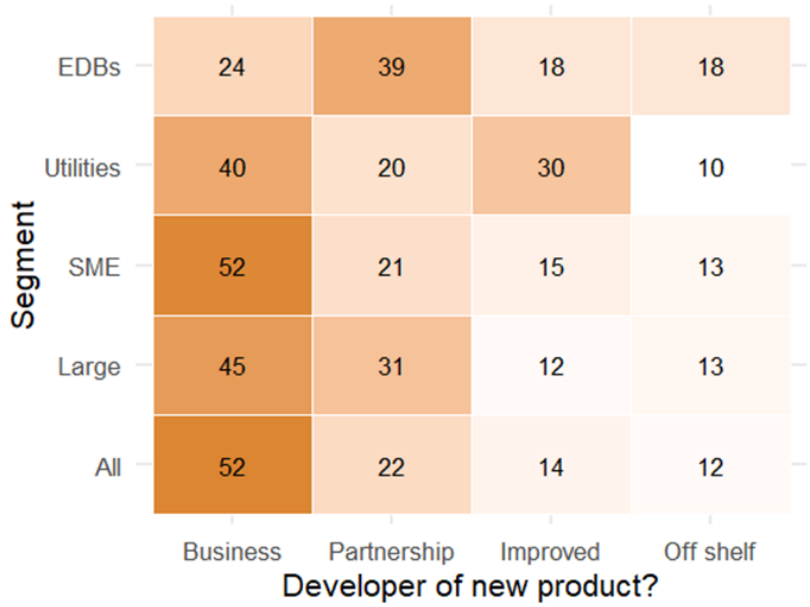


Figure 30 – Source of product innovations

Percentage of NZ firms reporting product innovation



Distributors outsource rather than develop innovations in house

5.12 Distributor innovation is more likely to reflect adoption of new products, processes or methods developed by others but that are new to the firm, rather than innovations that are developed in the business. For example, in the case of new products (see Figure 30) only 24% of distributors report innovation developed within the business. This compares to 40-52% of other businesses developing products within their business (amongst those

firms that have introduced a new product). In the Australian utilities sector approximately 85% of firms reported developing innovations in-house.[18]

Distributors are focused on controlling costs, which may bias innovation

5.13 Distributors are more likely to adapt, or to adapt more quickly to, changes in technology that lead to reductions in their costs, rather than new services. This is reflected in the fact that distributors report focusing on cost control, when it comes to innovation (see Figure 31) and in terms of identifying risks and opportunities when setting strategies (see Figure 32). This focus is a function of both regulation of revenue and of quality of lines services and also risk aversion associated with the culture of the industry and the incentives that the industry faces (from stakeholders and from regulators).

5.14 On its own, this focus on cost control could result in a bias in distributor innovation towards adoption of new, lower cost, network assets and management methods rather than assets and methods that enable new services or novel ways for consumers to use networks.

5.15 Yet we find also that distributors are as likely as other firms to say that they innovate in pursuit of new market opportunities. Furthermore, distributors are more likely than other firms to say they innovate to replace old products (goods and services) and generally only stand out in relation to issues that bear on the distinctive nature of electricity distribution, namely:

(a) a much lower propensity to pursue innovation to obtain market share, which is a less obvious and possibly less profitable strategy for local network monopoly than for other firms

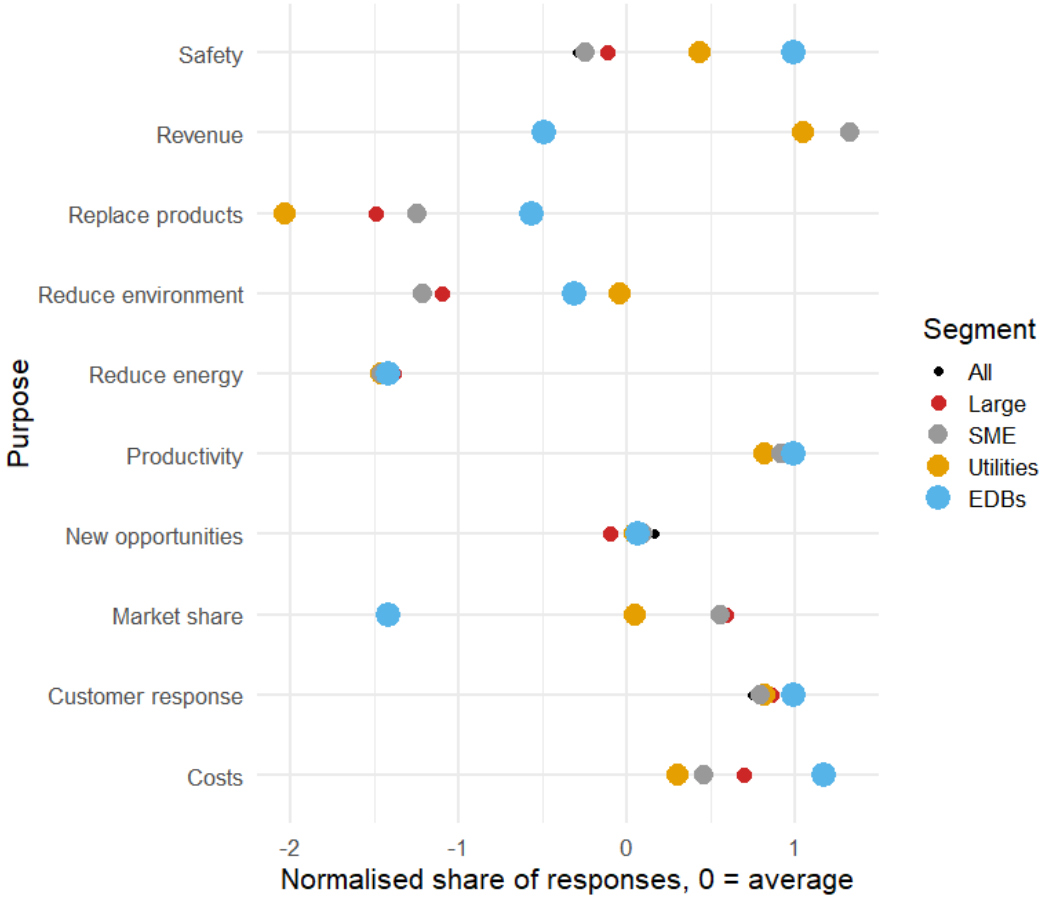
(b) a much lower propensity to innovate for the purposes of increasing revenue, which is a similarly less obvious and possibly less profitable strategy for companies whose revenues are, at least partially, regulated

(c) safety, which is likely to be much more significant for a distribution network owner than for the average (typically services) firm.

[18] Australian Bureau of Statistics 2017 Innovation in Australian Business survey. This estimate has a high standard error, such that the true value may only be as large as 50%, but this would be still be much larger than the proportion of distributors reporting in-house development of innovation.

Figure 31 – Purpose of innovation

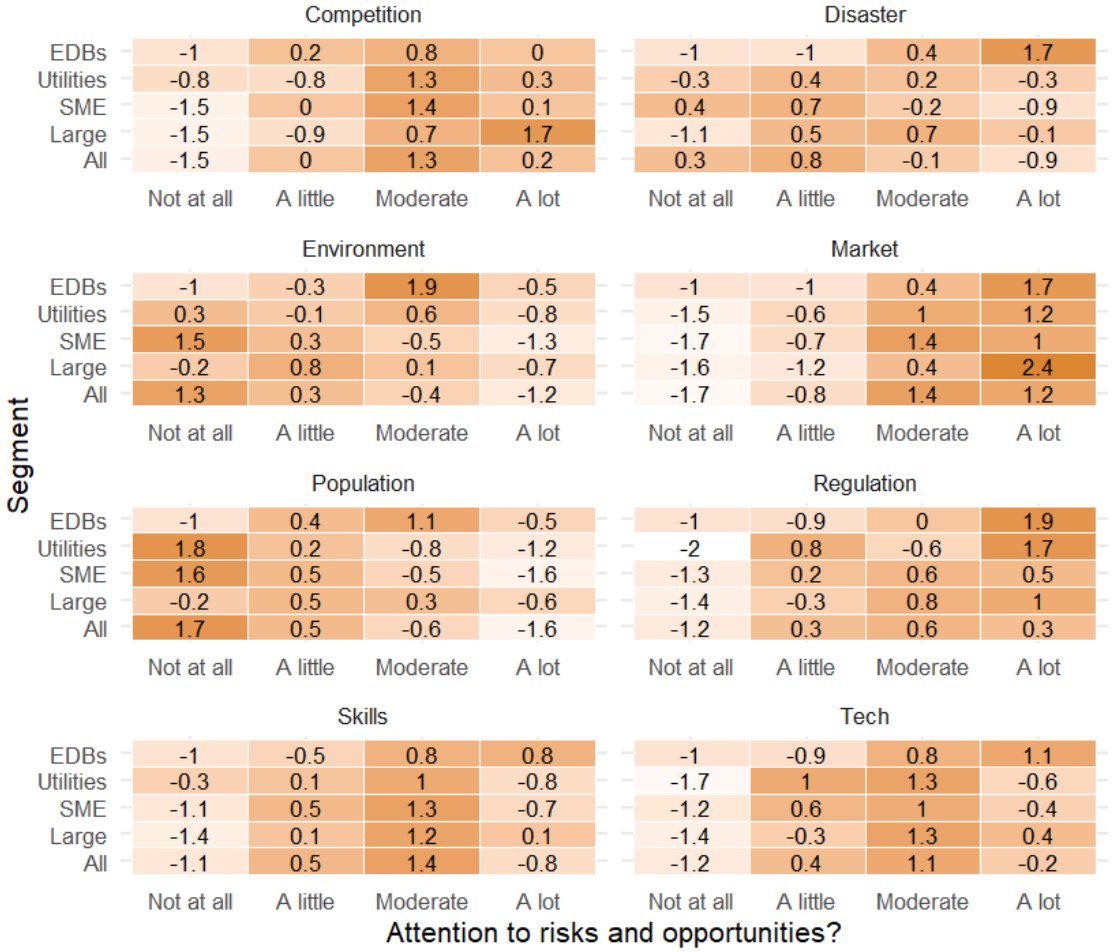
Relative importance based on percentage of responses. Values normalised so that 0 indicates cited by an average number of respondents and a value of 1 (-1) indicates a purpose that is one standard deviation more (less) widely cited than the average.[19]



[19] Values have been normalised in this figure and in the next figure so that it is possible to see which issues tend to be emphasised by EDBs, compared to other businesses. A value of 0 indicates that an issue is not of particular importance or unimportance, relative to the other purposes, while a value greater than 0 indicates that an issue is of more importance and a value less than zero indicates an issue of less importance.

Figure 32 – Attention to risks and opportunities

Relative importance based on percentage of responses, normalised (average = 0), with values greater (lower) than 0 indicating issues of more (less) importance

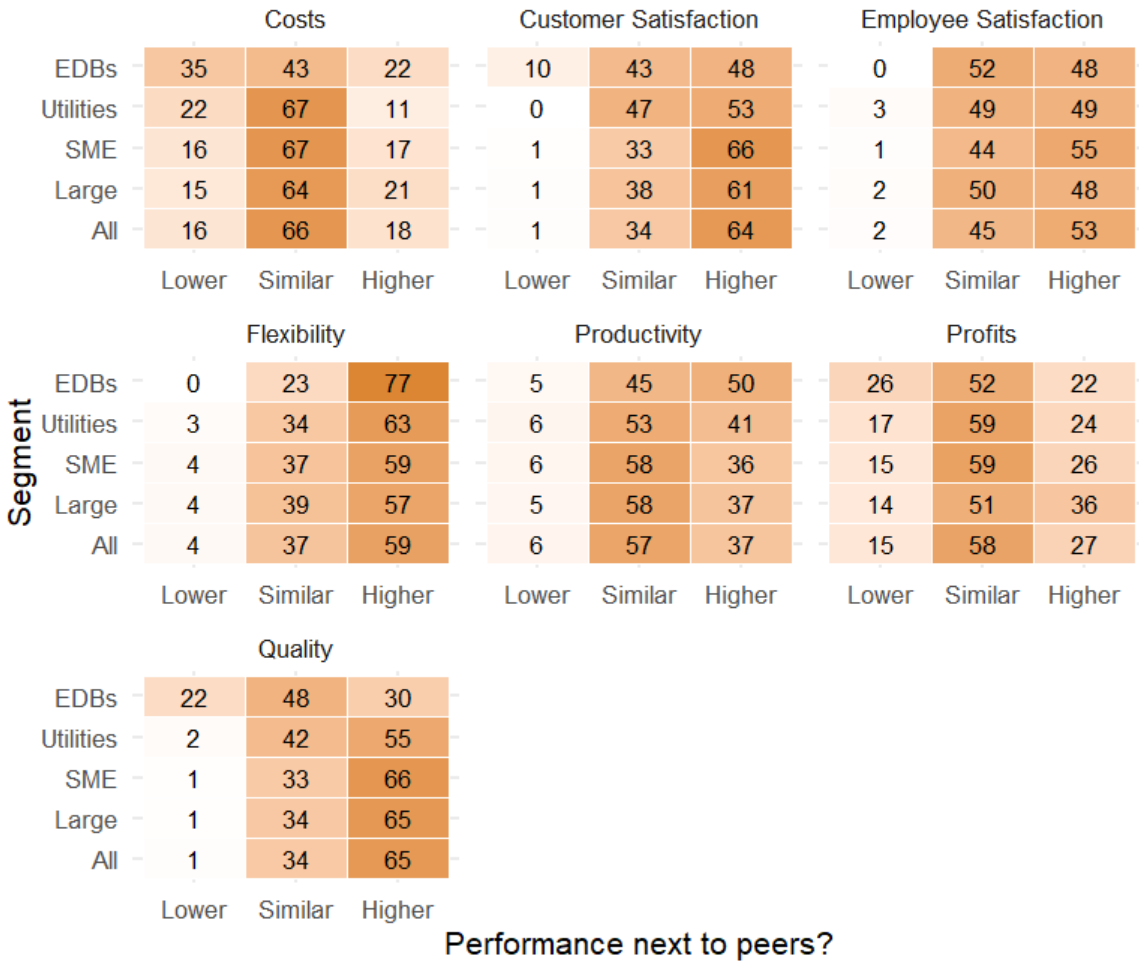


Distributors exhibit optimism bias when it comes to assessing their own flexibility

5.16 Distributors exhibit a high degree of optimism bias in terms of their own adaptive capability (Figure 33). A majority believe they are more flexible than other distributors, though this is clearly not arithmetically possible and contrasts with a more feasible distribution of self-assessed performance on other measures, such as costs.

5.17 It is common for firms to exhibit some degree of optimism bias – generally in areas where they are less likely to have good information about how they compare to competitors. This includes flexibility, where firms generally think they are more flexible than the average. However, distributors stand out as being especially optimistic about their flexibility. This could be a problem if it causes the industry to focus solely on cost control and conventional system supply, at the expense of adapting to changing consumer requirements.

Figure 33 – Self-assessed performance against peers (percentage of responses)



Established businesses are likely to have a natural bias towards improving conventional services

5.18 Adapting to new customer requirements is not something that most firms do well, so a natural bias towards improving conventional services is to be expected. Most firms are better at allocating resources to existing customer requirements, ie, the mainstay or majority of conventional customer services and demands, or within existing business models. This is so-called 'sustaining' innovation and is likely a good fit for distributors.[20]

5.19 Innovation can be classified as being sustaining or disruptive.[21] Within the category of sustaining, innovation can be further divided into evolutionary and revolutionary. Christensen (1997) describes evolutionary innovation as changes in products or processes that occur in ways that consumers might expect (faster connection, improved power quality, lower prices) versus changes that happen in ways consumers don't expect.[22]

[20] See eg Christensen, C. M., McDonald, R., Altman, E. J., & Palmer, J. E. (2018). Disruptive Innovation: An Intellectual History and Directions for Future Research. *Journal of Management Studies*, 55(7), 1043–1078.

[21] Alternative classifications include the distinction between radical and incremental innovation (akin to evolutionary and revolutionary innovation).

[22] Christensen, Clayton M. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston, MA: Harvard Business School Press, 1997.

Distributors are not going to be a source of disruptive innovation

5.20 The distinguishing features of disruptive innovation are that they alter markets and business models, irrespective of the ostensibly radical nature of technological change itself, and that they begin at the fringes of customer demand where innovation is not generally most profitable but ultimately come to create new markets that have a tendency to unseat existing markets and business models (Christensen et al 2018). On this definition it is fair to say that we cannot expect disruptive innovation from distributors. Disruptive innovation comes from outside the mainstream, almost by definition.

Revolutionary innovation is possible, but less likely than more incremental, evolutionary innovation

5.21 In principle, we might expect some degree of revolutionary innovation in electricity distribution. In practice, based on survey responses, it seems more likely that distributors are focused, on average, on evolutionary innovation. This assessment follows from the observation that distributors tend to be less focused on the emerging needs of customers than on the existing customers. It also follows from distributors' broad focus on costs. Again, this appears to be entirely reasonable given incentives on distributors to be risk averse and to focus on conventional services.

5.22 Distributors claim that they incorporate the views of consumers in the strategies and planning; however, their businesses tend to operate at arm's length from consumers day to day demands – at least compared to other businesses. For example, while 26% of distributors report seeking customer feedback more than twice a year, this is less than other businesses and half the proportion of large businesses in the overall economy that seek customer feedback at least twice a year. It seems likely that this difference reflects that other businesses, primarily in the services sectors, are naturally more frequently in contact with customers, so soliciting feedback is a more habitual rather than a deliberate process.

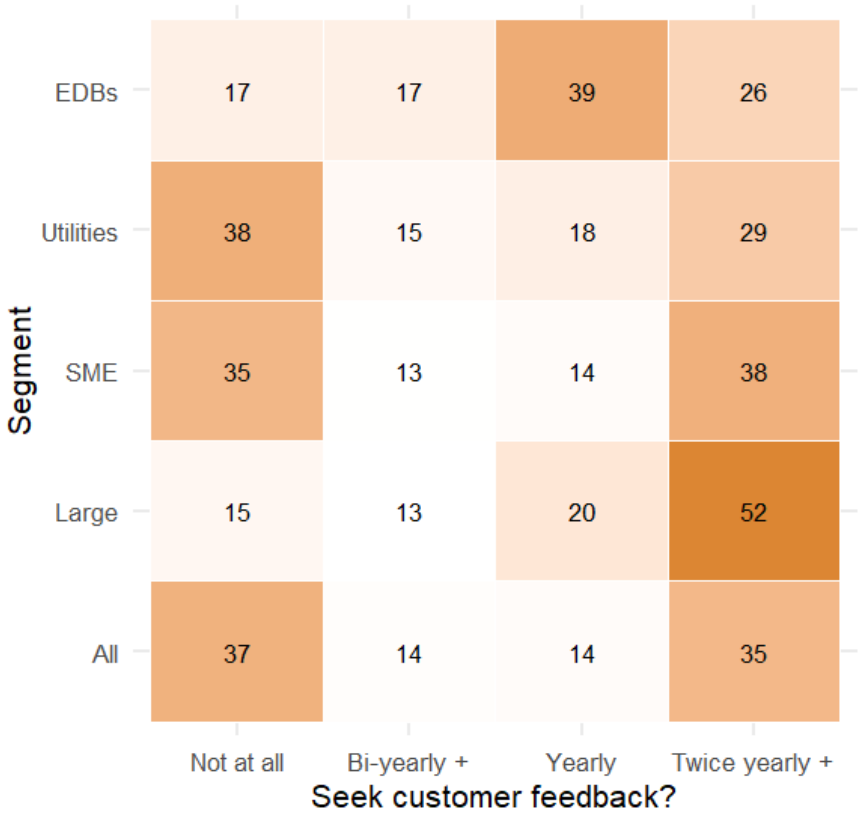
5.23 Nonetheless, the comparatively arm's length nature of the distribution sector does mean that we should not expect distributors to have the sorts of customer interaction and responsiveness that might be observed in other parts of the economy. And, as a result, we cannot expect consumer-led innovation to take place amongst distributors at the same rate that it might in other industries.

5.24 A focus on evolutionary innovation is likely to create frictions in future if it isn't already – slowing changes in the electricity industry that would otherwise benefit consumers by slowing the uptake of new practices, business models and technologies.

5.25 An as yet unresolved question is whether there is anything that a regulator might do to avoid or mitigate this.

Figure 34 – Frequency of customer feedback

Percentage of NZ firm responses



Expect market leaders to emerge and bring others along

5.26 It only takes one distributor to adapt in ways that cause major changes in services or service delivery methods and demonstrate the efficacy of innovation – in terms of profitably or feasibly serving new demand.

5.27 Whilst all distributors should be expected to deliver a reasonably reliable supply of electricity at reasonable cost, it does not follow that all distributors should adapt at the same rate or with the same methods to technology-led changes in demand.

5.28 A key question is whether or not distributors are sufficiently open to learning from the experiences of others and sufficiently adaptive to be able to follow the lead of one or more of their peers. Our assessment, based on qualitative evidence, is that they can, or at least there are indications that they can. This is certainly something that could be monitored or subjected to further research in future. It is also something that regulators should be mindful of.

Distributors innovate in many areas

5.29 We asked distributors if, within the last two financial years, they had tried to innovate in each of a number of areas we specified.

5.30 Responses indicated that the strongest reasons triggering innovation in distributors were to:

(a) improve work safety standards

(b) increase responsiveness to customers

(c) reduce costs

(d) improve productivity.

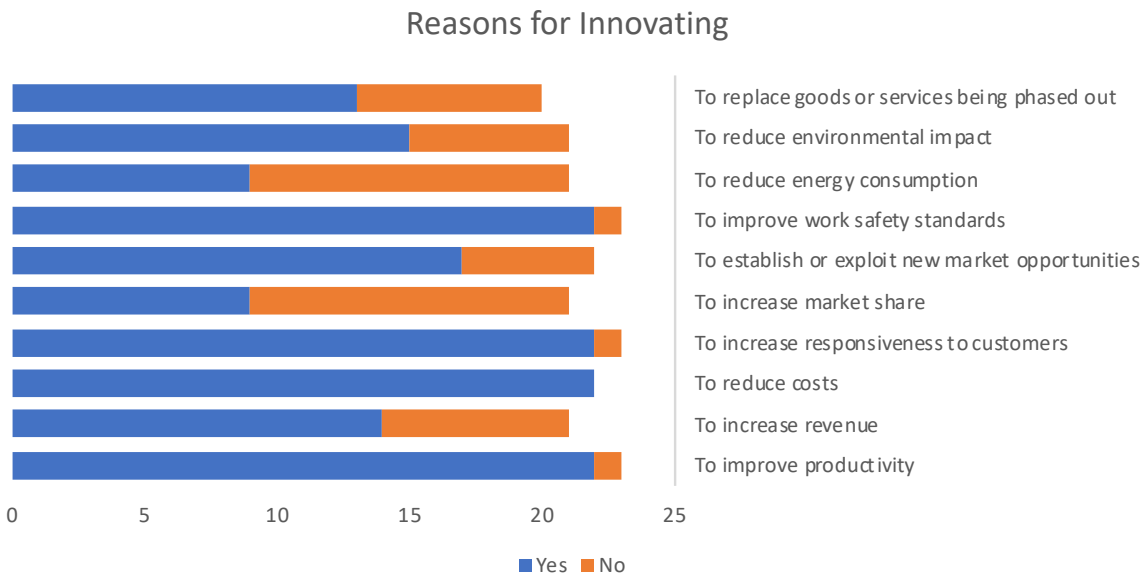
5.31 The weakest reasons triggering innovation were to:

(a) increase market share

(b) reduce energy consumption.

5.32 Figure 35 provides the distributor responses for each option.

Figure 35 – Why distributors innovate



5.33 Survey comments provided examples of initiatives distributors considered to be innovative:

(a) the use of helicopters instead of diggers to minimise environmental damage

(b) energy audits and waste reduction initiatives in the office building

(c) engagement with customers around service levels, pricing and new technology

(d) developing sustainability and environmental impact mitigation initiatives

(e) smart metering, data analysis, battery technology and network infrastructure

(f) investigation of a hybrid generation solution to support reliability and resilience

(g) development of an advanced distribution management system

(h) development of a customer relationship management tool

(i) restructuring to focus on customer enquiries, service requests and issues

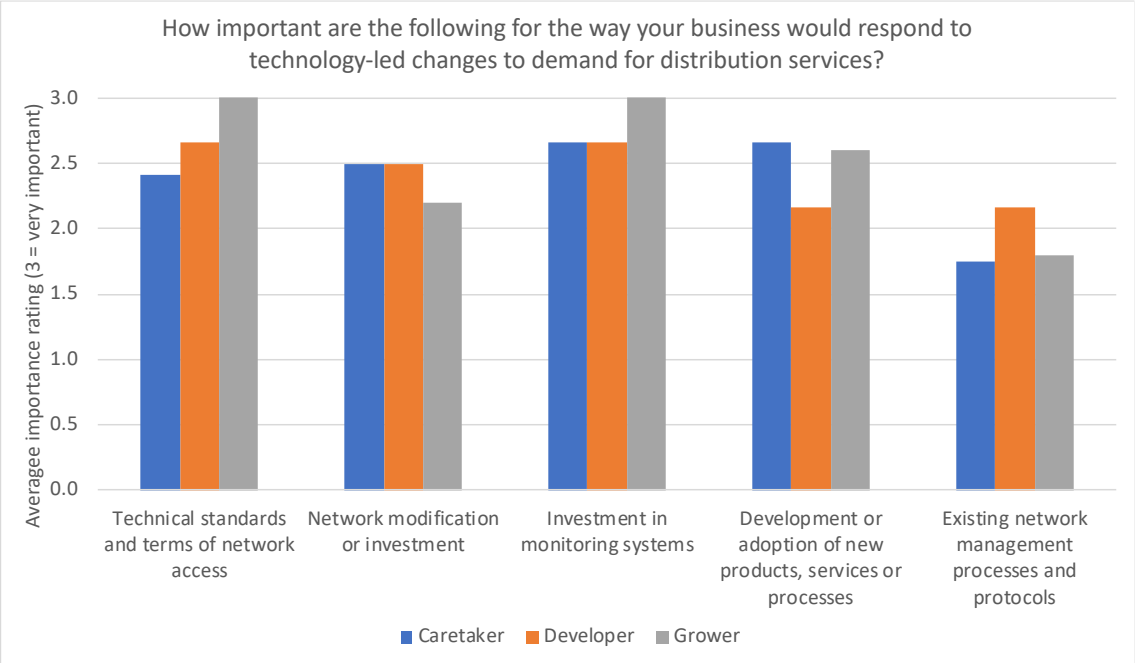
(j) development of integrated ICP cost of supply and pricing model

(k) smart grid development and network-connected battery trial

(l) development of an outage app for customers.

5.34 We asked distributors about the importance of five factors that might affect their ability to respond to technology-led changes in demand for distribution services. Figure 36 shows the average importance ratings allocated by distributors, separating distributors into the three distributor categories.

Figure 36 – Important factors for enabling technology-driven adaptation



5.35 Whilst all distributors recognise the importance of technical standards for network access, the early investors in smart grid and IoT technologies on average indicate a stronger level of importance. The results suggest that Grower category distributors will push harder for investment in monitoring systems.

5.36 The least important factor for all distributor categories was existing management processes and protocols. This could be a further indicator that distributors are currently focusing more on technical responses rather than on strategic organisational and management factors.

Distributor strategies can provide perspectives on innovation

5.37 How distributors develop and apply strategies provides a window through which current and future innovation and adaptation can be seen. Specific strategic issues that a distributor is focusing on gives an indication of where it is, and will in the future, apply its resources.

5.38 The survey included questions on how distributors develop strategies, key strategic focus areas and risks.

Distributor strategic focus is on price and quality

5.39 Distributors expressed consistent views on the relative importance of five factors:

(a) price

(b) quality

(c) flexibility

(d) delivery

(e) innovation/improvements.

Figure 37 – Important strategy inputs for distribution businesses

5.40 Distributors responded most strongly to quality, price and delivery of services as the most important strategy inputs for their business. This is understandable, given the price/quality regulation environment in which distributors currently operate. Flexibility and innovation in goods and services rated lower, though they remain important strategic focus areas.

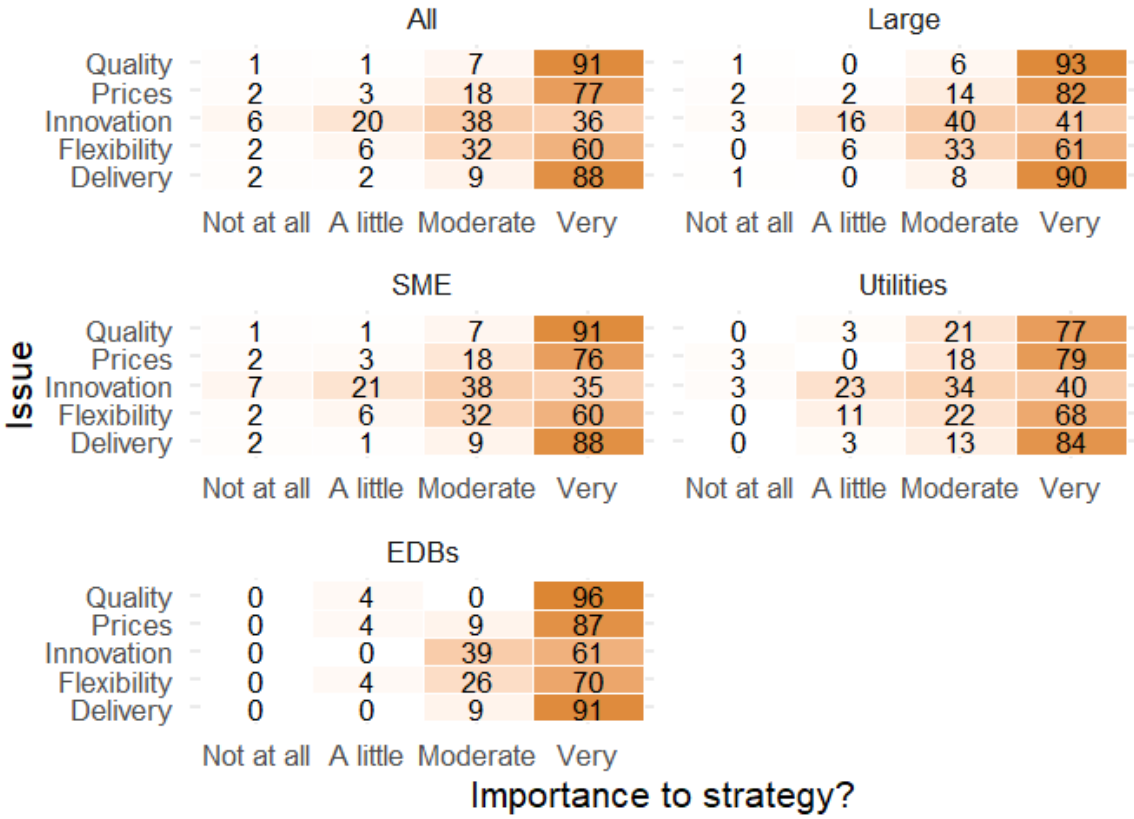
5.41 However, in comparison with other businesses, innovation stands out as the most distinctive factor for the distribution sector. In their survey responses, distributors view innovation as moderately important (39%), or very important (61%), to strategy (Figure 38). The proportion of distributors citing innovation a very important factor is significantly higher than for other businesses.

5.42 Distributors do appear to be more likely to rate all factors presented to them in our survey as at least a little important, while other businesses are more discriminatory. Nonetheless, if we control for this, by considering the relative size of the reported importance of innovation against other factors, it remains the case that distributors, as a whole, are more likely to emphasise innovation than other businesses. In contrast, price and quality are cited as very important factors for strategy at the same rates as for all other businesses.[23]

[23] We cannot exclude the possibility that respondents to our survey were primed to respond positively about innovation-related questions, given the survey's objective and the current salience of innovation-related issues in industry circles.

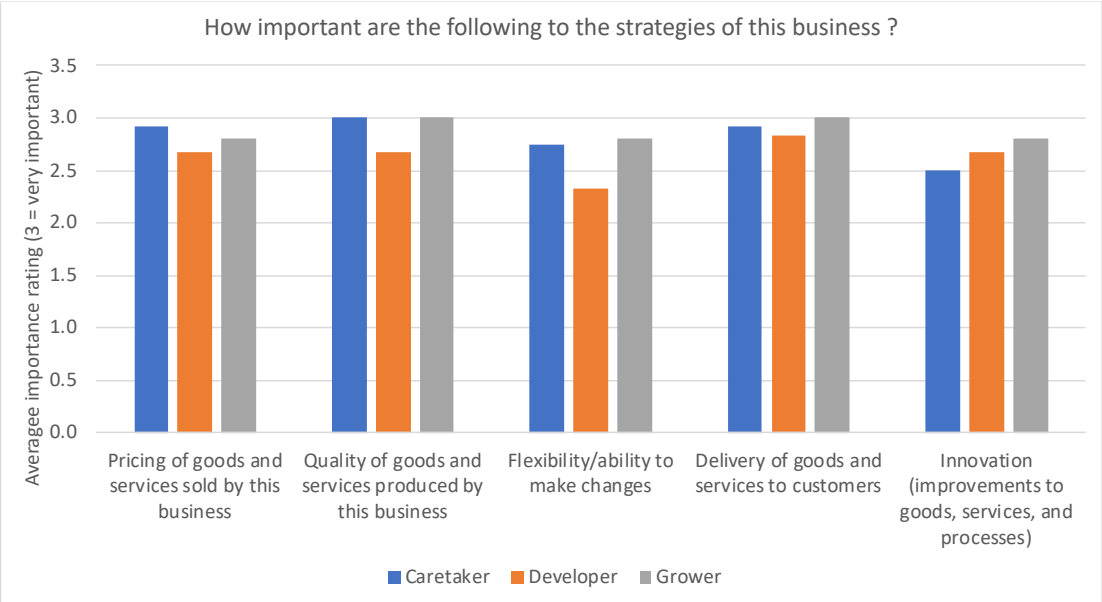
Figure 38 – Importance to strategy: comparison with other businesses

Percentage of NZ respondents



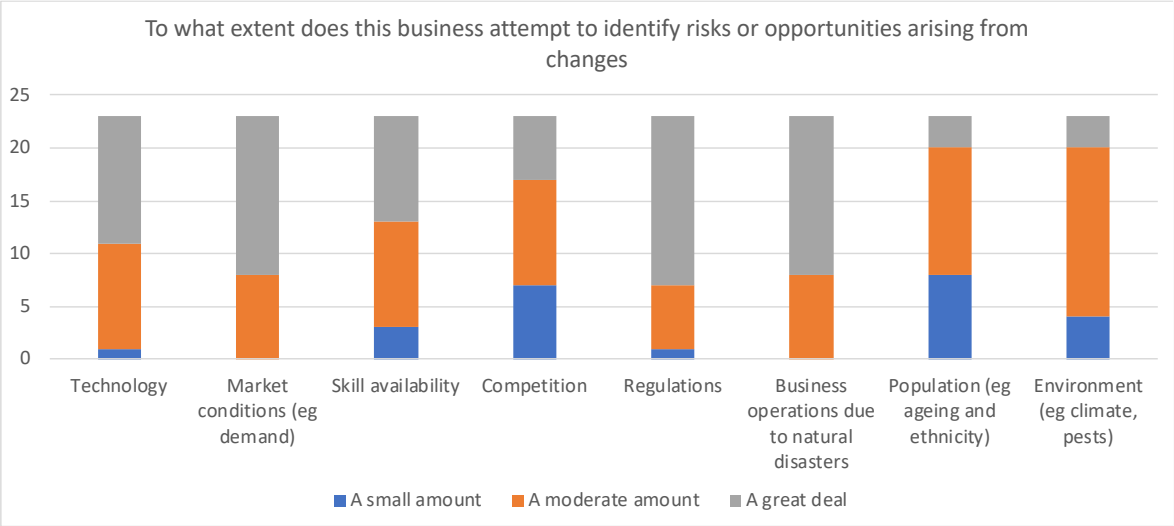
5.43 Looking from the perspective of our three distributor categories, there is consistency of views on the relative importance of the strategic focus areas. As may be expected, Developers and Growers (ie, those already investing in new technologies) rated innovation/improvement in services higher than Caretakers did (Figure 39).

Figure 39 – Important strategies for distribution businesses



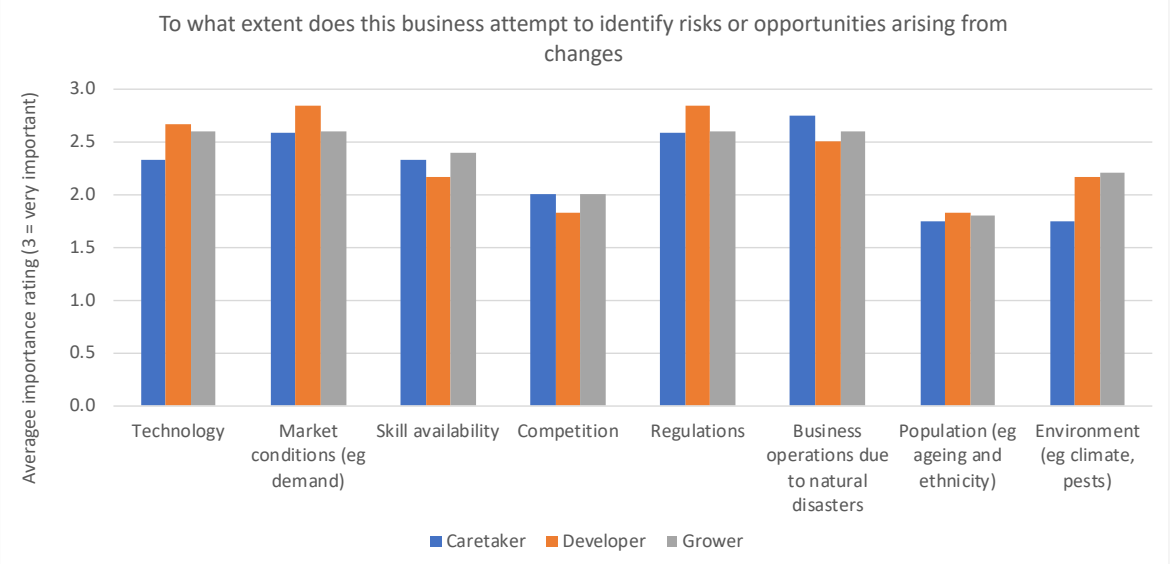
5.44 Distributors were also consistent when rating regulations, market conditions and business operations as being the most important risks and opportunities. Competition had the third lowest rating, with population and environment scoring lowest (Figure 40).

Figure 40 – How distributors identify and rank technology change risks



5.45 Looking at the identification of risks and opportunities for the three categories shows similar consistency. However, Developers and Growers rated environment higher than did Caretakers, which could indicate a slightly sharper focus on climate change mitigation by these distributors (Figure 41).

Figure 41 – Growers and Developers placed importance on environmental risks

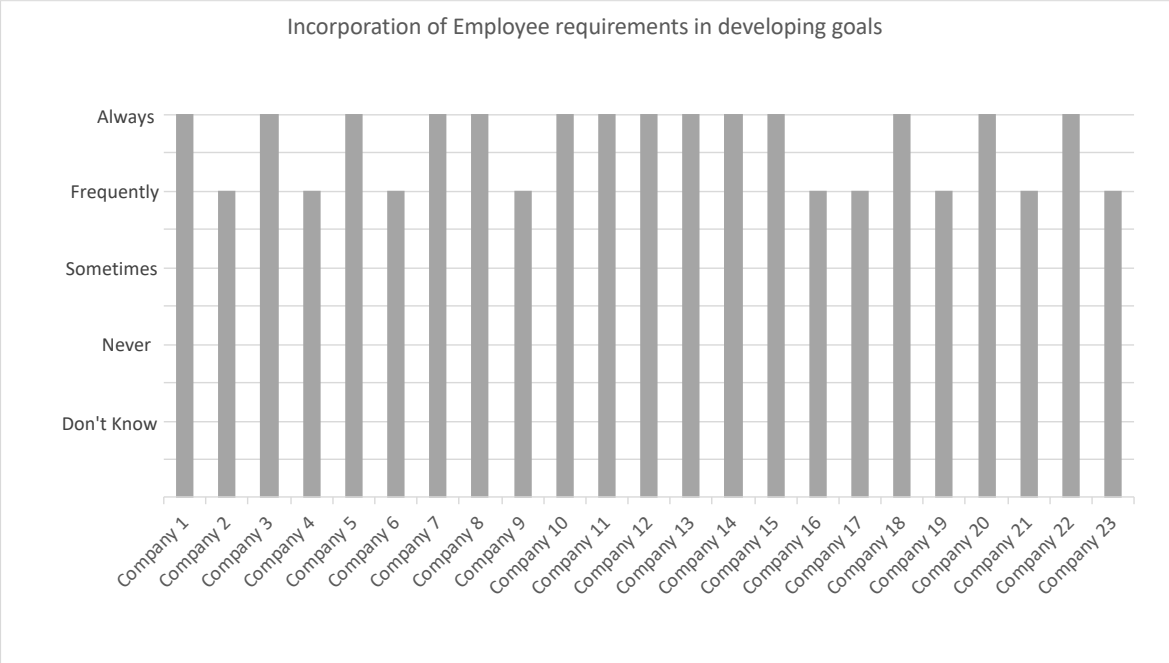


5.46 When developing strategic goals, all but one distributor identified that incorporation of customer requirements were always or frequently taken into consideration (Figure 42).

Figure 42 – Goals always incorporate customer requirements

5.47 All distributors identified that incorporation of employee requirements was always or frequently taken into consideration when developing goals (Figure 43).

Figure 43 – Goals always incorporate employee requirements



5.48 Under half of distributors always or frequently took supplier requirements into consideration when developing goals. Three distributors never took suppliers into consideration when goal setting (Figure 44).

Figure 44 – Goals do not always incorporate supplier requirements

5.49 Distributors consider supplier requirements less frequently, with just two distributors indicating they always considered supplier requirements. This result is interesting as future technology changes may require distributors to consider the requirements of a much broader range of stakeholders.

Does ownership influence investment and innovation?

5.50 Two distributors are owned by offshore investors, which may affect the way those businesses adapt to technology-driven change. For example, an offshore owner might be able to provide easy access to a range of resources, skills and knowledge that would not otherwise be available within the New Zealand distribution sector. Other distribution businesses within the owner's portfolio could provide valuable insight to future issues. On the other hand, an offshore investor might perceive adaptation as changing the risk profile of the business and seek to restrain technology-driven adaptation, particularly adaptation that might require risky investments.

5.51 The two distributors with offshore owners fell within the Caretaker category; however, the survey did not highlight material inconsistencies in these businesses when compared with the community and private ownership models. Of course, this could emerge in the future.

5.52 Six distributors identified that they had ownership stakes in overseas businesses. Overseas interests might provide more access to a range of resources, skills and knowledge that would not otherwise be available or provide additional scale for potential development projects.

5.53 The survey did not identify any material differences between distributors that had overseas interests from those that don't. Distributors with overseas interests were a mixture of community, private and overseas ownership models.

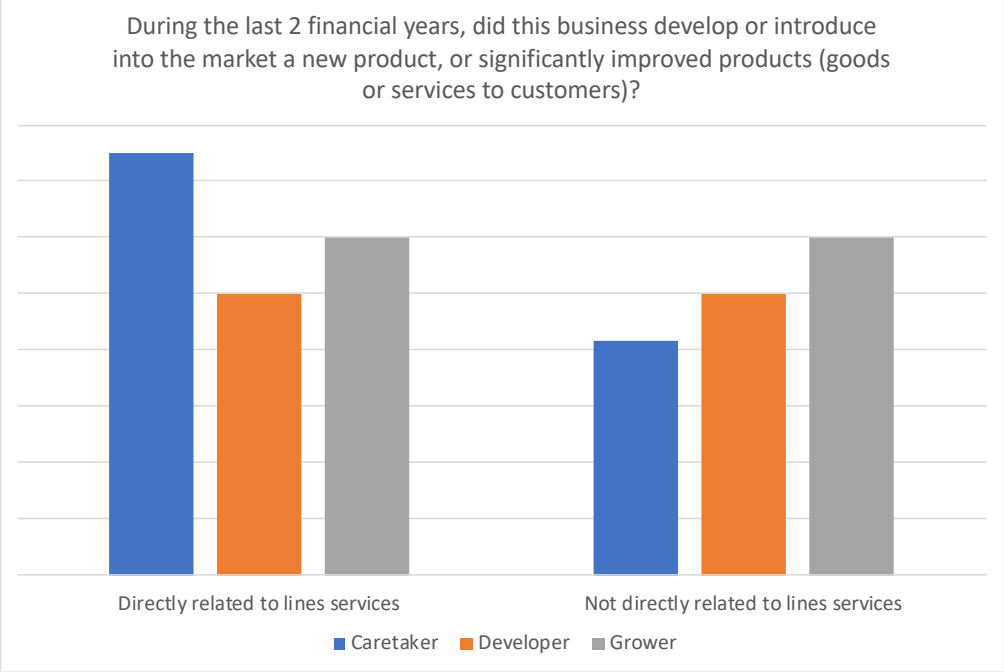
Distributors are investing in R&D

5.54 Of the distributors surveyed, 19 of the 23 identified that they had invested in R&D activity during the last financial year. The survey responses indicated differences in R&D

expenditure between the three distributor categories. The Caretaker category was on average undertaking more R&D activity than other categories; however, this does not take into account the level of R&D expenditure. It is therefore an indicator of the number undertaking R&D expenditure rather than the level of R&D expenditure. This may explain the somewhat counterintuitive responses.

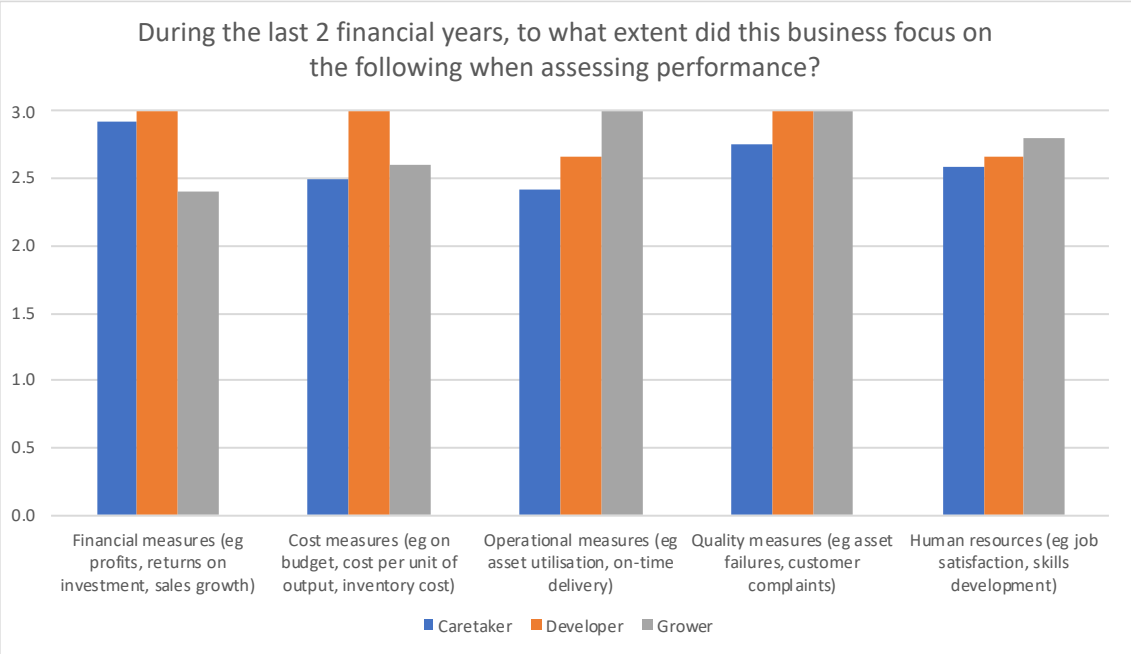
5.55 The number of distributors developing or introducing new products and services over the last two financial years is shown in Figure 45. Caretakers have focused more on improvements directly related to existing distribution services. Growers and Developers have on average focused on improvements to both directly-related and not related-products and services.

Figure 45 – Distributors introducing new products or services



5.56 Whilst the responses for the three distributor categories were similar, the Growers tended more towards qualitative measures. Caretakers and Developers tended to focus more on financial and cost measures.

Figure 46 – Focus areas for performance assessment

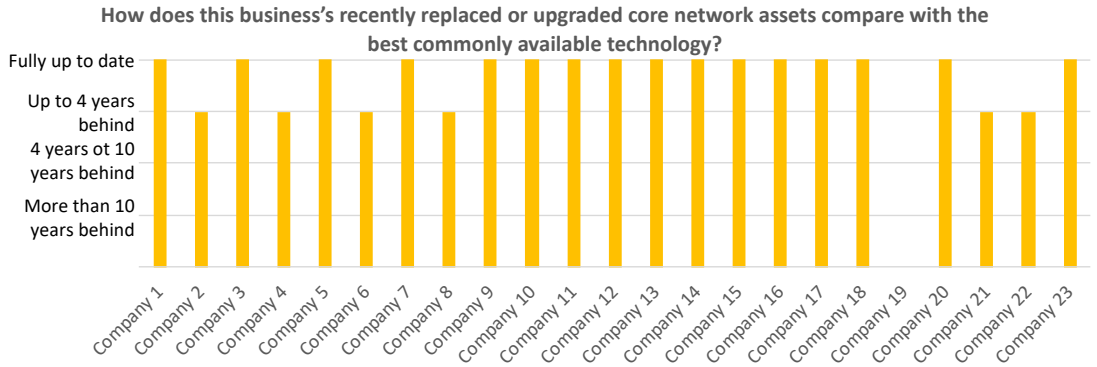


Recently replaced or upgraded core network assets compare with the best commonly available technology

5.57 None of the distributors that responded to this question indicated that they installed core network asset replacements or upgrades that were more than four years beyond best available technology.

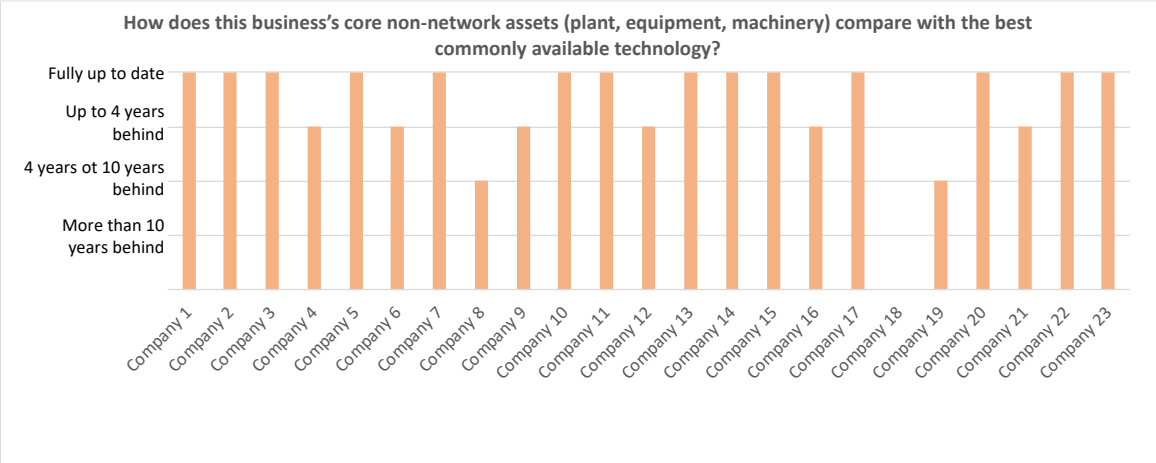
5.58 When replacing or upgrading core network assets, 16 distributors indicated that they invest in the best available technology. Six distributors indicated that their replacements and upgrades are up to four years behind the best available technology (Figure 47).

Figure 47 – Most distributors are replacing core network assets with best available technologies



5.59 For non-core assets, distributors appear to run a slightly older asset fleet. Fourteen distributors had fully up to date technology, six had assets at up to four years behind and two were up to ten years behind (Figure 48).

Figure 48 – Non-core network asset technology is variable across distributors



5.60 Some distributor survey responses included comments that provided additional insights into their decisions. The comments indicated that distributors were primarily focused on core network asset updates and replacements.

5.61 Those installing technology up to four years behind 'best available technology' expressed the view that this reflected a prudent approach for a fast-follower.

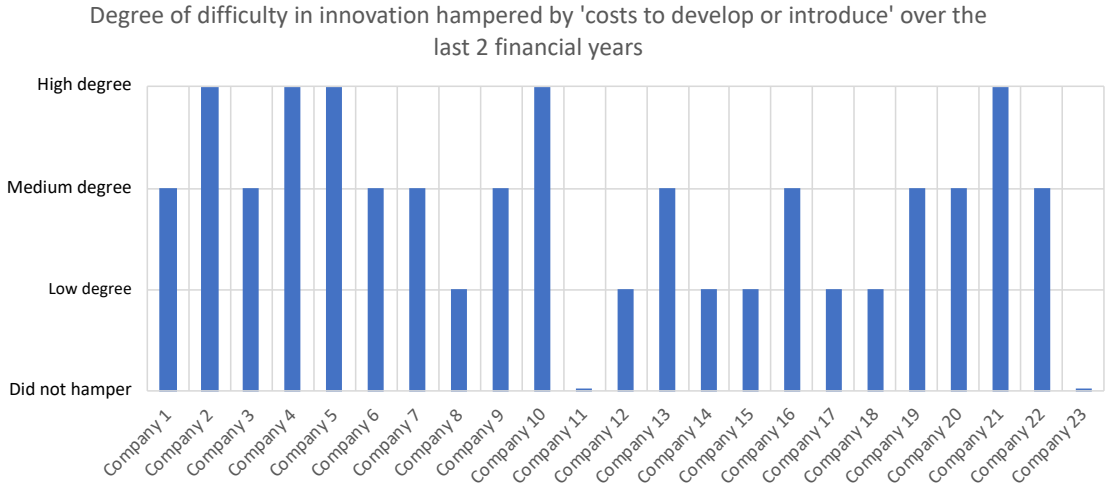
5.62 Several considered that IT and communications infrastructure (GIS, CAD, DMS, OMS, SCADA systems) were more aged and were being scheduled for replacement.

5.63 Several indicated that their vehicle fleets were kept up to date.

Funding innovation is an issue for some distributors but not others

5.64 In the survey responses, most distributors indicated the costs to develop or introduce new technologies or services had hampered innovation during the last two financial years. Only two distributors indicated that these costs had not hampered innovation (Figure 49).

Figure 49 – Cost to develop or introduce has hampered innovation for some distributors



5.65 In general, Developers considered that the cost to develop or introduce had hampered innovation more strongly than Growers. Caretaker responses indicated that their innovation had been hampered to a medium degree by cost to develop and implement.

5.66 Few comments related to the cost to develop and implement were included in the survey responses. Considering survey responses alone indicates that most distributors consider that costs are materially hampering innovation.

6 Engagement and collaboration are important for adaptation

Section overview

6.1 In this section we consider how distributors are engaging and collaborating with customers and stakeholders.

6.2 We found that distributors:

(a) are reporting higher rates of collaboration than other organisations

(b) are collaborating across a range of initiatives and that this may indicate existence of a healthy innovation ecosystem

(c) collaborate more frequently with other distributors than with stakeholders

(d) are seeking to again improved visibility of low voltage networks and collaboration may enable this to happen

(e) are beginning to define customers more broadly.

High rates of collaboration increase distributors' capacity for innovation

6.3 Distributors have much higher rates of reporting cooperative arrangements with other organisations, for the purposes of innovation, than firms in the wider New Zealand economy or in other countries.

6.4 A considerable majority of distributors (91%, 21 out of 23 surveyed) report having co-operative arrangements for the purposes of innovation. This compares to 24% of large business in New Zealand and 15% of business in the New Zealand Utilities industry reporting cooperative arrangements for the purposes of innovation. In Australia, 17% of businesses and 25% of large businesses report co-operative arrangements for the purposes of innovation. Across the OECD, the average (by country) rate of co-operation for the purposes of innovation is 12% for all businesses and 34% for large businesses (with greater than 200 employees).

6.5 Thus we conclude that distributors are distinctively more likely to cooperate for purposes of innovation. This is reflected in the fact that while distributors are less likely to develop new products or processes in-house, they are more likely than other firms to produce new products or processes in partnership with other organisations. This can be seen, for example, in Figure 52.

6.6 On its own, a low propensity for in-house innovation, as discussed above, would cause us to question whether distributors' high reported rates of innovation tend to overstate the adaptive capabilities of distributors as an industry.

6.7 However, high rates of co-operation or collaboration moderate any such conclusion because active partnerships for the purpose of innovation can help distributors to leverage off the expertise of others and can be an efficient and effective way to adapt. Outsourcing, for example, can be a sound response for firms facing rapid technological change. This is because risks associated with fixed investment in new products or processes (the risk that they may not yield useful or profitable results) can be distributed

over a larger number of organisations through cost-spreading.[24] Partnerships have similar effects in terms of spreading risk. We would also expect that this is of particular importance for smaller distributors with a lower capacity to bear risks around trialling or developing new products or processes.

A variety of collaborations and innovation activities indicate a healthy innovation ecosystem

6.8 High rates of collaboration could be problematic if it implied a concentration of effort in a handful of common initiatives across most distributors. There is a trade-off between diversity of trial and error initiatives and ideas, which increases scope for learning and thus adaptability, and scale that comes from collaboration.

6.9 However, distributors report a wide range of initiatives and partnerships both in survey responses and in interviews. These include:

(a) engagement with early stage pilot trials of innovative advanced distribution management system (ADMS) components

(b) working with a retailer on a grid-scale battery trial

(c) participation in the SmartCo smart metering initiative[25]

(d) a smaller distributor investigating coordinating with other distributors via a technology fund

(e) working with a metering equipment provider (MEP) to use the smart meter communications network to provide demand response capability

(f) working with Transpower on initiatives related to demand response

(g) collaborating with a neighbour about network operational control that could possibly extend into a future ADMS collaboration.

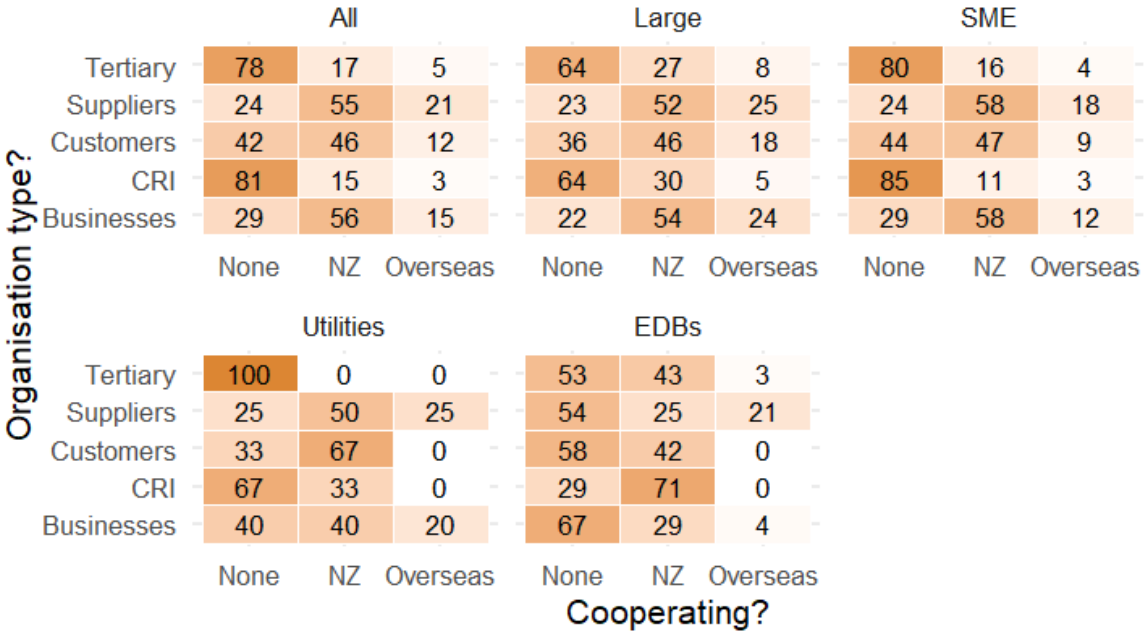
6.10 Consequently, we do not see any cause for concern that distributors are putting their innovation eggs into too few innovation baskets.

[24] Bartel, A. P., Lach, S., & Sicherman, N. (2014). Technological Change and the Make-or-Buy Decision. The Journal of Law, Economics, and Organization, 30(1), 165–192.

[25] SmartCo owners are Alpine Energy, Counties Power, Electricity Invercargill, Network Tasman, On Metering, The Power Company and WEL Networks (see https://smartco.co.nz).

Figure 50 – Cooperative arrangements for the purposes of innovation

Percentage of NZ firms



6.11 Furthermore, we understand from interviews that where distributors are collaborating with each other there is a tendency to form partnerships with similar distributors in terms of size and geographical characteristics. This is positive in so far as this means that these initiatives are more likely to produce lessons that are tailored to the distinct circumstances of different distributors, in terms of:

(a) variable adaptive and organisational capabilities

(b) fundamental economic and physical network characteristics (such as sparse or dense networks, need to service major electricity uses within a region (eg, irrigation) or comparatively high or low cost of service)

(c) differences in customer characteristics (such as rural vs urban consumer demand, population density effecting demand for emerging technologies like distributors, and prevalence of poverty).

Views on the changing distribution customer came through strongly in the study

6.12 In response to an interview question about who distributors consider to be their customers, respondents clearly and consistently identified their network-connected consumers as their primary customers. Very few identified retailers as their customer but some did identify retailers as important stakeholders. Frequently, end consumers also own the local distribution business, via a trust or a cooperative arrangement.

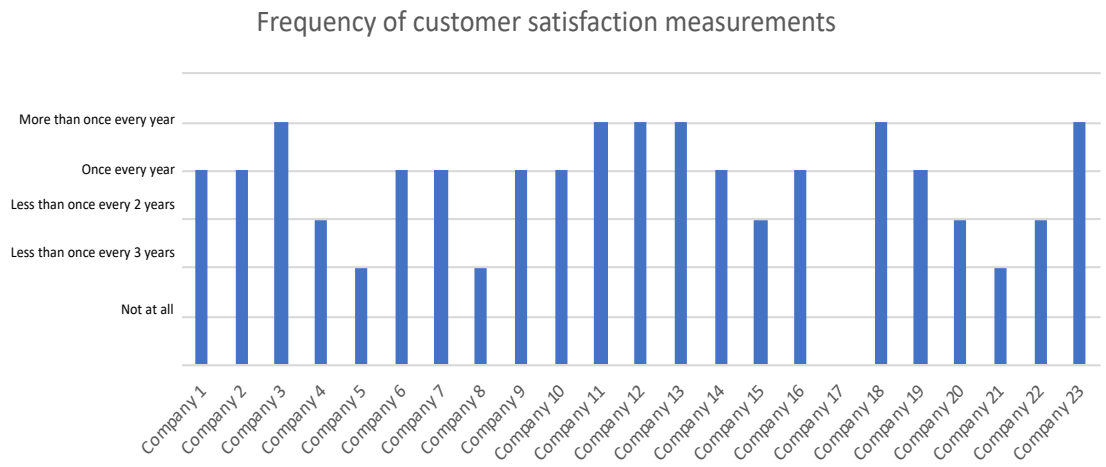
6.13 Conversely, the retailers we interviewed considered they were the distributor's customer – they almost always hold the contract for distribution services and pay the distributor's monthly bill. In many cases, retailers provide frontline (call centre) customer service support for the distributor and communicate with customers about planned outages.

6.14 In interviews, most stakeholders considered the lines between customers, stakeholders, suppliers and service providers will change in the future.

6.15 Stakeholders generally supported the view that distributors would need to engage more closely in the future with a range of stakeholders, including consumers. For their part, distributors frequently described ongoing and/or improving levels of engagement with a wide range of customers and stakeholders.

6.16 Survey responses indicated that most distributors are currently conducting systematic (formal and significant) measurement of customer satisfaction at least every year. Six distributors indicated measurements more frequently than once a year and three distributors reported carrying out measurements every three years.

Figure 51 – Systematic measurement of customer satisfaction



6.17 The survey results indicated that distributors undertake systematic (formal and significant) measurement of stakeholder satisfaction less frequently than for customers. Distributor comments provided examples supporting the level of consultation with customers:

(a) one runs a five yearly ownership review process that includes surveying their entire customer base

(b) one conducts monthly service monitoring, an annual customer pulse survey and an annual service monitoring survey

(c) one typically surveys customers every other year

(d) one seeks and receives constant customer feedback and conducts a periodic formal survey

(e) one runs monthly surveys to learn the experiences of customers that had interacted with the company

(f) one carries out two yearly customer surveys by telephoning samples of customers, followed by face to face interviews with select larger customers.

6.18 One distributor explained a change in their approach aimed at achieving more targeted customer surveys:

> *We have changed tact [sic]* on mass market surveying as it doesn't provide rich insights nor changes in behaviour. Instead we operate surveys immediately following customers affected by a work process or

for customers affected by an unplanned outages on one of our worst performing feeders.

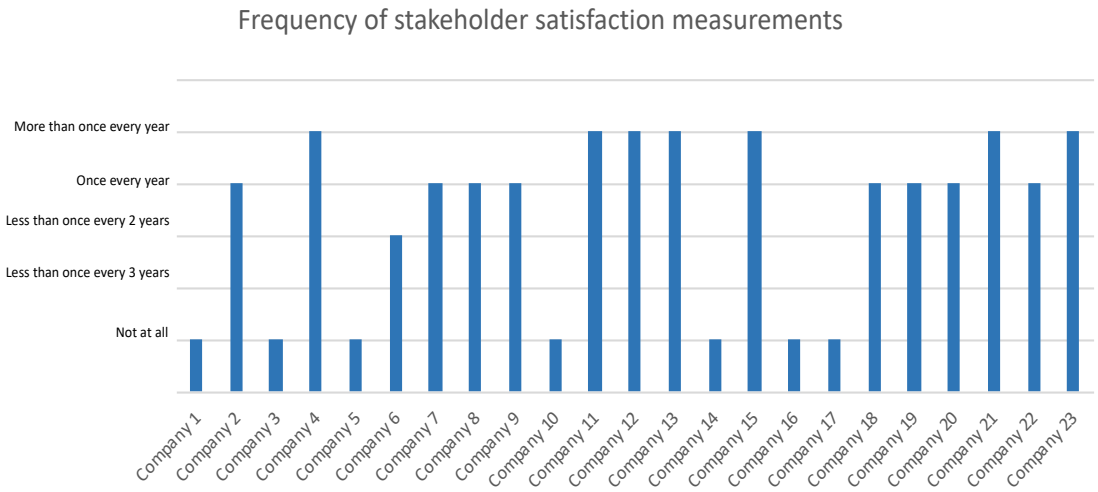
6.19 Interestingly, the question we asked related to systematic, (ie, formal and significant) measurement of customer satisfaction and was not limited to customer surveys. The comments indicated that, on the whole, distributors generally measure customer satisfaction through surveying methods.

6.20 One distributor provided information on its use of focus groups in collaboration with ENA:

> *We formally measured customer satisfaction through surveys for the past decade. A new annual customer survey was completed in 2018 through an external research agency. This was a comprehensive survey which used a standard customer ratification framework to derive customer satisfaction. We have also completed face to face focus groups, in conjunction with the ENA, on network pricing options and targeted surveys eg 110kVA [sic]* transmission upgrade.

6.21 Fifteen distributors indicated that they formally measure stakeholder satisfaction at least on a yearly basis (Figure 52).

Figure 52 – Systematic measurement of stakeholder satisfaction



6.22 Distributor comments provided context to their stakeholder satisfaction measurement methods:

(a) one, that had not to this point carried out systematic engagement, described existing plans to commence engagement in 2019

(b) one ran quarterly and two-monthly shareholder meetings and six-monthly meetings with banks but carried out no systematic satisfaction measurements

(c) for another, this is an area of emerging focus and development

(d) one runs an annual public meeting, which provides them with a guide of stakeholder satisfaction – additionally, they run a five-yearly trust ownership review which they consider provides a formal and significant measurement of stakeholder satisfaction.

6.23 One distributor considered that key performance indicators (KPIs – and reverse KPIs) in its contracts, combined with an escalation process:

> *… ensured that services provided and services received meet the expected performance criteria.*

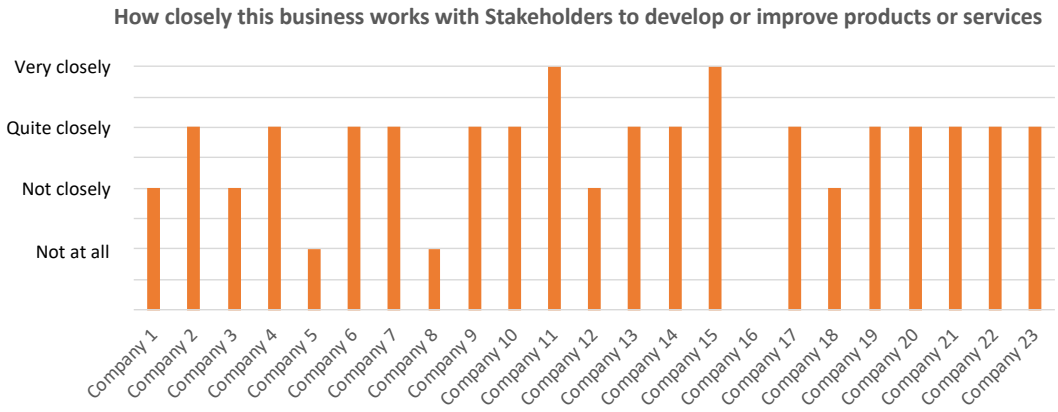
6.24 Comments from the retailers in our stakeholder sample suggested engagement with stakeholders may not be occurring as frequently as distributors are indicating:

(a) one stated that, on average, they get about two distributors a year (out of 29) asking them about their level of satisfaction

(b) another noted they do periodically receive some satisfaction surveys from some distributors but consider it is not at all consistent or on any regular timeframe.

6.25 We also asked distributors about how closely they work with stakeholders to develop new products and services. Most distributors said they worked quite closely with stakeholders. Two distributors considered they work very closely with stakeholders (Figure 53).

Figure 53 – Distributors working with stakeholders on new products/services



6.26 Our sample of stakeholders generally indicated their experience was that distributors did not work closely with them. One stakeholder noted they were working very closely with distributors on the development of metering and control technology. Stakeholder comments provided some context to their responses:

(a) one noted that some distributors even ignore basic (annual) pricing change consultation obligations in use of system agreements

(b) one stated that just 17% of distributors work with them to understand new technology impacts/trends, standards, new business models, adoption of such and internal and external advocacy to help implement change at consumer to ministerial level

(c) another stated that, beyond ad hoc consultation on pricing reform, they have very little engagement – they consider this is an area where they would like to see more effort expended.

6.27 Retailers noted that some distributors were directly engaging with their customers. Their comments suggested that direct distributor contact with their customers was not necessarily expected or welcome, and that problems could occur, eg, due to the low level of customer understanding of distributor and retailer roles.

6.28 We also asked our stakeholder sample if, in the last financial year, they had requested a distributor to do any of the following:

(a) improve products or services

(b) improve pricing

(c) improve management practices and reporting

(d) increase staff training and development

(e) use digital technology more often

(f) use other new technologies

(g) improve health and safety practices or reporting

(h) use product or service standards more often

(i) achieve organisational certification.

6.29 Most stakeholders had asked for improvements in products and services and in pricing. Some had asked distributors to use digital or other new technologies more often. Generally, the stakeholder group had not made requests on other topics.

6.30 The quite wide divergence of views evident in the comments by distributors and stakeholders supports a view that we are very likely seeing some bias in both distributor and stakeholder responses. Nevertheless, we consider there is significant potential for improvement in engagement and communication between distributors and stakeholders, particularly retailers.

6.31 Given the potential for increasing technology-driven interconnectivity between distributors, stakeholders and customers, the ability for all parties to engage and communicate effectively will be critical. This will be particularity important in the area of information and data exchange and, as previously noted, this is already a frequent issue.

Collaboration between distributors occurs frequently but less frequently with stakeholders

6.32 In the interviews, distributors identified a range of collaboration occurring with other distributors and stakeholders. Examples included:

(a) sharing of technical and staff resources, particularly in times of emergency response eg, during storms

(b) pilot programmes for metering and load control technology

(c) developing and sharing network technical standards and best practices

(d) installation of electric vehicle charging stations

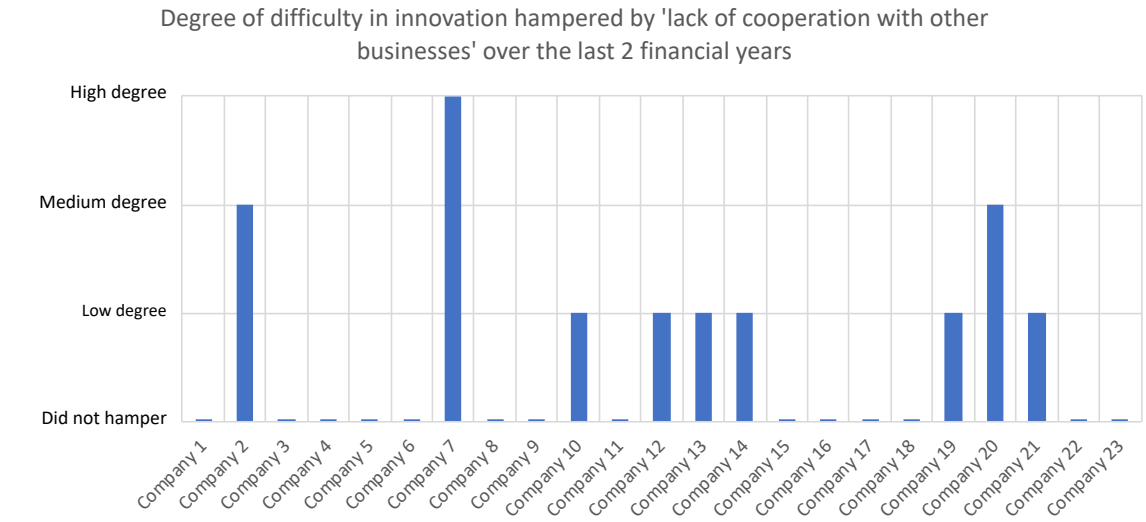
(e) pilot programmes for community energy projects

(f) in conjunction with ENA, work on many distribution sector initiatives including development of the technology transition roadmap.

6.33 In the survey responses, only a few distributors considered that lack of cooperation with other businesses had hampered their ability to innovate (Figure 54).

6.34 A small proportion of distributors provided examples of where they were collaborating with international stakeholders and this collaboration was seen to be benefiting both parties.

Figure 54 – Difficulties due to lack of cooperation with other businesses



6.35 As previously discussed in this section, most distributors considered that they work closely with stakeholders, however, from their perspective, stakeholders were not so positive. We asked the same question about the closeness of collaboration distributors have with large and small customers when improving products and services.

6.36 Distributor responses indicated that, on average, they work closely with major customers but not so closely with small (mass market) customers. This is not surprising given the more manageable number and relative value of major customers (Figure 55).

Figure 55 – Collaboration with major customers

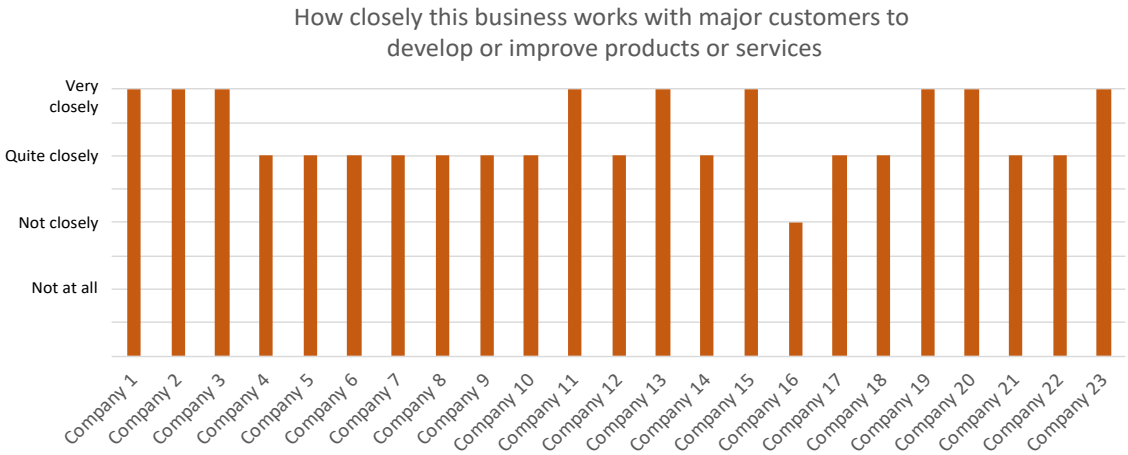
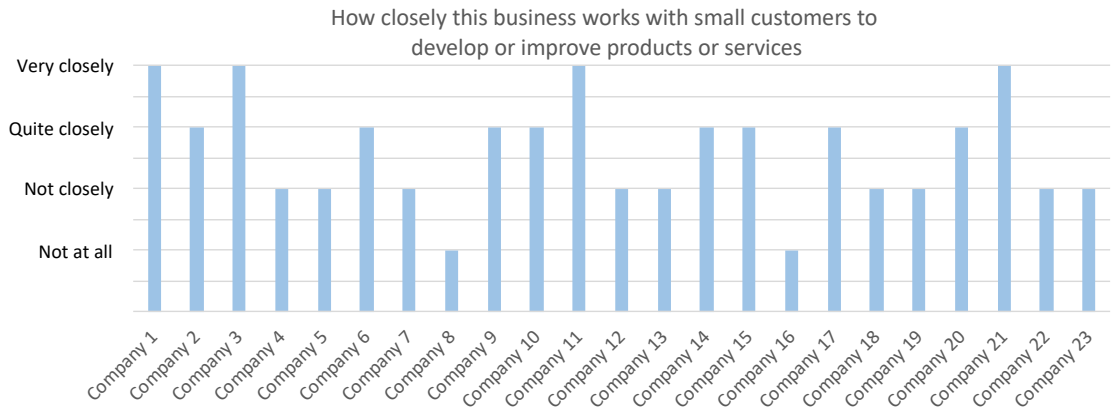


Figure 56 – Collaboration with small customers



Distributors increasingly need visibility of their low voltage networks

6.37 In section 2, we discussed how distributor views about their ability to manage the impact of new technologies could change if their current expectations about the rate of technology uptake turned out to be significantly underestimated. Distributors considered access to information and data that could provide early indications of the rate of change was critical.

6.38 Distributors gave examples of new technologies that have the potential to impact networks in different ways, they include:

(a) in-home distributed generation, such as rooftop solar PV, is an intermittent, daytime-only power source, with a typical capacity in the range 1–5 kW

(b) in-home electric vehicle charging is a potentially large new consumer power demand, typically 2 or 7 kW maximum demand (ignoring their potential 'vehicle-to-grid' capabilities)

(c) in-home batteries must be controlled and are both a local power demand and a power source, typically up to 7 kW in either direction.

6.39 Distributors will likely experience the relative rates of uptake of the various new technologies in location-dependent clusters, particularly in the early stages of adoption. In this context, distributors, acting as local system operators, will need access to information about new technology deployments and usage at a very granular level specific to individual low voltage feeders.

6.40 In-home electric vehicle charging was universally cited by distributors as the new 'prosumer' technology with the highest potential for rapid uptake, once electric vehicle adoption passes a tipping point. Ubiquitous electric vehicle charging could significantly impact the safe and reliable operation of low voltage networks, as currently configured – and could possibly impact higher voltage equipment (feeders, transformers etc) in upstream networks.

6.41 To manage the impact of rapid technology deployment, most distributors indicated they would, at some future point, need to gain visibility and control of their currently unmonitored, passively controlled low voltage networks. Some have made progress towards that end and are trialling suitable technologies. Of note is that unmonitored low voltage networks exposed by strong DER uptake (at least strong as compared with New

Zealand) are a global issue being tackled by global electricity network equipment suppliers.

6.42 Stakeholders supported these views reflecting that (for other than off-grid supply situations) efficient, reliable and secure distribution networks will be critical to realising the full benefits of technology adoption for consumers.

6.43 Of note regarding DER that will connect to low voltage networks is that:

(a) new and upgraded distributed generation, such as a rooftop solar PV installation, is legally subject to application to, and approval by, the local distributor under Part 6 of the Code; but

(b) new loads, such as 7 kW in-home electric vehicle chargers, are not required to be notified to distributors; to detect uptake, distributors will require access to new sources of information that most distributors currently do not, or cannot, access.[26]

6.44 Distributors cited network technical and operational concerns here as the primary reason for their concern; network segments could become overloaded or operate at excessively high and/or low voltages, impacting the safety of people and electrical equipment, the reliability of continuous service, and the power quality experienced by consumers.

6.45 Access to smart metering data is an important issue for most, but not all, distributors. This is because access to such data can enable:[27]

(a) analysis of how consumption and DER patterns are changing over time and across different network regions

(b) assessments of how changing usage patterns impact the service efficiency, security and reliability provided by the local network

(c) network planning studies that determine the need for efficiently-timed and scoped network upgrades, including considering options of alternatives to traditional solutions via network investments.

6.46 Others expressed interest in using the capabilities of smart meters to provide near real-time notice of:

(a) underlying supply problems that can be hard to diagnose, such as broken neutral conductors

(b) the location of feeder faults that lead to a power outage – this can allow proactive dispatch of fault response crews.

6.47 Of course, these more network-centric smart meter capabilities can be limited by the capacity of the communications networks they rely on (eg, collapsing mesh radio networks under network fault conditions or limited capacity GPRS mobile networks).

6.48 Some distributors saw that new devices that can be deployed alongside existing smart metering systems can provide enhanced, network-centric real-time monitoring capabilities. Such technologies are known as advanced distribution management

[26] An exception here is distributors that can source relevant consumption information from smart meters, whether from their own or other metering equipment providers (MEPs). Nevertheless, information about the nature of any new prominent load will still require analysis of half hourly data.

[27] Depending on the specific smart meter functionality provided and enabled.

systems (ADMS). Several distributors expressed active interests in such systems, including in:

(a) considering, and in some cases trialling, commercially available products from global manufacturers

(b) developing their own technology solutions within an associated electro-tech related party business.

6.49 Some noted that in some configurations, deployed with suitable communications capabilities, ADMS can support future markets. An example of this could be a demand response product involving dynamic control of:

(a) electric vehicle charging

(b) solar PV export curtailment

(c) battery mode of operation, (ie, charging or discharging).

6.50 Some distributors considered that, to continue to meet their legal obligations under electricity safety law, (eg, distributor must maintain supply voltage within +/- 6% of nominal), they would need to have direct knowledge and control of high capacity, (ie, 7 kW) electric vehicle chargers and solar PV inverters. Their thinking here is aligned with the control they have traditionally exercised over storage hot water cylinder demands via ripple control and pilot wire systems.

6.51 Others expressed the view that distributors would struggle to gain new control capabilities as of right, (ie, as a condition of connection). This topic will clearly require further thought by distributors, stakeholders and regulators.

6.52 A further topic linked to ADMS relates to a function commonly referred to as a distribution system operator (DSO), which has some similarities to the network operations and market interface roles undertaken by Transpower as the System Operator. Some distributors discussed the DSO role in interviews and we noted the following points:

(a) all were supportive of the need for DER interface devices to conform to basic equipment technical standards, eg, inverter compliance with the AS/NZS 4777 standards suite

(b) some consider a DSO role will be required at some stage but opinions varied about timing

(c) most that discussed DSO felt that 29 DSOs was an unlikely, undesirable outcome but stopped short of expressing an opinion about the optimum number of DSOs New Zealand might need.

7 Monitoring a range of indicators will help to track progress

Section overview

7.1 In this section we consider potential indicators that could improve the visibility of how distributors are responding to challenges due to new technology.

7.2 We concluded that indicators can keep track of progress and that approaches used in other jurisdictions and those identified by distributors, provide a good starting point.

7.3 We used a balanced scorecard to assess potential indicators. Through this approach, we identified indicators in financial, customer, learning and growth and business process areas.

7.4 Whilst the development of indicators will be challenging, we consider that the information available from appropriate indicators will be valuable.

Developing and using appropriate indicators will be challenging

7.5 Monitoring distributor adaptation will be challenging. Distributors preside over a bottleneck service where emerging customer demand can only reveal itself to the extent that distributors allow it. That being so, we are likely to observe differences across distributors in terms of the emergence of new demand and new technologies. Some of those differences will be down to fundamental differences in consumer demand and some of it will be down to fundamental differences in a distributor's culture, strategies and approaches to dealing with constraints.

7.6 It will also be challenging to draw a line between distributors rights and responsibilities with respect to serving conventional demand and serving emerging demand. Firms that deal less well with revolutionary or even disruptive market changes are often those that focus on serving existing customer demands "the very thing that makes an organization successful – gearing itself toward the needs of its customers – hinders it in making the appropriate decision regarding a new technology or innovation" (Gans, 2016, chapter 3).[28] That being so, it may be unreasonable to expect distributors to simultaneously perform well in accommodating changes in consumer demand and technology while meeting existing, conventional, performance requirements.

7.7 This study has provided a perspective on how distributors are currently adapting and how this may affect the technology-driven transformation of electricity supply and consumption over time.

7.8 In broad summary, the survey results, and the information gained from interview feedback, indicate that distributors, with a few exceptions:

(a) are not seeing new technology adaptation as competing with, or replacing, existing distribution network services

(b) are generally unconcerned about the impacts of technology-driven changes on their networks for at least the next five to ten years

(c) consider they will be able to manage most anticipated technical challenges

(d) are seeking to obtain more information to better understand the potential impacts

(e) are focusing on the technical implications in strategic plans

(f) have yet to build organisational or cultural transformations into their plans

(g) are investing in R&D initiatives, including pilot programmes

(h) are collaborating with other distributors, eg, on smart grid initiatives

(i) are building, or planning to build, new technical skills and capabilities, generally in-house.

[28] See eg Gans J (2016) The Disruption Dilemma, MIT Press, Cambridge MA.

7.9 Distributors qualified their responses by referring to assumptions about the rate of uptake of new technologies. Most distributors considered that rapid uptake of some technologies, particularly electric vehicles, would likely raise significant challenges for existing distribution networks, requiring a material change in response.

7.10 Common themes that emerged through the surveys and interviews with both distributors and stakeholders included the following:

(a) uncertainty about the rate of new technology adoption by consumers was a key issue and the ability to anticipate and monitor tipping points was seen as important

(b) access to information and data is critical to distributors and commercially important to stakeholders – this is a current industry-wide issue

(c) how DER (and electric vehicle chargers, particularly V2G-capable chargers) is controlled and who has this control could facilitate or present barriers to technology adoption

(d) through customer and stakeholder engagement, identifying where adaptation barriers might occur is important

(e) a range of quantitative indicators are possible, such as the rate of DER connection applications and the time taken to progress connection applications, eg, under Part 6 of the Code (noting that this would not include electric vehicle chargers, as they are not within the scope of Part 6 of the Code)

(f) standards for connecting and operating DER are important to both distributors and stakeholders, but for different reasons, eg:

(i) system protection is important to distributors (safety of people and equipment); but

(ii) standards would be seen by consumers and other stakeholders as being unreasonably onerous if they impose what they consider are unnecessary constraints

(g) quantifying and making public information about distribution hosting capacity is important to stakeholders

(h) effective collaboration between distributors and stakeholders could provide swifter and more efficient service adaptation

(i) appropriate distributor investment in smart grid and low voltage network monitoring/management technologies can facilitate the evolution of IoT and DER technologies; accordingly, periodic indications of investment levels and value created could be valuable

(j) monitoring technology-related business start-ups and investment levels in technology-related enterprises may provide insights in evolving markets.

7.11 In addition to the above, indicators of changes in the skillsets sought and engaged by distributors could provide valuable insights into changing strategies and cultures.

Indicators can keep track of progress

7.12 This report reflects a snapshot of the situation in early 2019. In line with the Authority's market monitoring role, we considered whether a series of indicators could be developed to track distributors' progress over time.

7.13 The study did not identify development of any systematic methods through which distributors were monitoring and forecasting future technology uptake levels. However, we know that distributors have been working proactively to establish KPIs and monitoring progress, coordinated through ENA.

7.14 Collectively, distributors have developed a 'transformation roadmap' that describes a series of stages of adaptation to technology-driven change. The roadmap identifies specific actions distributors consider they will need to undertake at various stages. The timeframe for completing the identified actions is ten years.

7.15 Table 2 sets out the transformation roadmap components.[29]

Table 2 – Transformation roadmap components

Component	Objective	Action areas
Consumer insights	Understand consumer motivations and behaviours to determine: (1) the impact on DER deployment and consumption patterns (2) new load requirements.	Access to smart meter data Understand DER deployment Understand new loads Understand new distributed generation
Monitor uncertainties	Stay abreast of technology developments and update the distribution industry. Update this roadmap to remain relevant.	Monitor uncertainties
Open network framework	Access to the electricity distribution network by existing and new consumers and traders to connect and operate any equipment they desire (specifically DER and new loads) with appropriate consideration of: (1) cost of access (2) network operation and system security (3) standard equipment (4) standard access arrangements.	Enable distribution network trading Third parties provide DER and demand response for network support Demand response framework
Standardise	Provide a consistent method of	DER Connection

[29] Source ENA, New Zealand Electricity Distributor Network Transformation Roadmap, April 2019, (with minor edits to fit this report)

Component	Objective	Action areas
technical arrangements	connection of any equipment (DER or appliances) across all distribution areas. Ensure equipment complies with approved standards to minimise its impact on the electrical power system.	Standards Appliance and DER equipment standards Network engineering Cyber security and autonomous DER
Network operation, monitoring, and stability	Ensure the stability of the open network through deeper monitoring of the network and improved planning techniques.	Low voltage network monitoring & visibility Network stability Provision of network information
Build and adapt distributor capability	Understand networks in greater depth, their ability to host DER, congestion, and contracting for network support. Ensure working understanding of regulations and obligations of those.	Network understanding Develop contracting for network support capabilities to support action (2) of the open network framework (above) Improving asset management practice Off-grid power supplies

7.16 The components and action areas included in the transformation roadmap are broadly consistent with our findings in this study. Of note is that the transformation roadmap focuses mainly on technical areas. The 10-year timeframe suggests no particular urgency and the roadmap report identifies no major concerns.

7.17 We consider a number of the transformation roadmap components are directly relevant to the Authority's market monitoring role, undertaken in accordance with its statutory objective. As potential indicators, the items listed in Table 3 represent a set of more outward looking, less technical components.

Table 3 – Potential indicators from the transformation roadmap

Consumer insights	Distributors seek to gain a greater understanding of consumer motivations and behaviours. This is important to understand how electricity supply networks and systems will need to adapt and develop. For the Authority's purposes this indicator would need to be extended to 'prosumers' and others, (eg, technology suppliers and operators). A potential indicator might include the nature of the information exchanged between distributors and stakeholders and the frequency of stakeholder engagement.

Monitor uncertainties	Uncertainty is identified as a risk and monitoring is identified as the control method for this risk. Uncertainty in the rate of technology uptake, and the associated potential for rapidly emerging network issues, is driving the need for distributors to have increased levels of operational visibility of their low voltage networks and of prosumer activity in premises. If technology uptake significantly picks up pace, distributors could seek to apply controls, (eg, through network and operations standards) to protect their networks which could in turn place barriers to the realisation of technology benefits via new markets. Indicators that provide information on the speed of technology uptake will assist in managing the potential barriers to technology-driven market development.
Open network framework	Access to network connection and services is critical to the realisation of long term benefits to consumers from technologies. The four indicators provided in the transformation roadmap (cost of access, network operation/system security, standard equipment, standard access arrangements) are input-focused. Creating output-focused indicators (eg, ease of access, access pricing, service quality/reliability etc.) would be beneficial for monitoring the barriers to entry for new technology applications.

Indicators used by others provide good reference points

7.18 Technology-driven change is impacting distribution networks internationally. We researched roadmaps and pathways that suggest indicators that can be monitored. We looked at an initiative in the USA that provided some interesting potential indicators.

7.19 In California, the More Than Smart Working Group[30] developed a list of mutually exclusive and collectively exhaustive potential DER value components, including avoided costs and societal and customer benefits. A working group developed the list to support California's Distribution Resources Plans and considered that the list could form inputs to system-wide and locational net benefits analysis.

7.20 For electricity distribution, the More Than Smart Working Group identified the following DER value components:[31]

(a) reduced need for capacity upgrades of local distribution, sub-transmission, substations and feeders (eg, by adopting distribution alternatives)

(b) improved transient and steady state voltage, harmonics and power factor

[30] Transactive Energy, Real World Applications for the Modern Grid, April 2019 https://sepapower.org/resource/transactive-energy-real-world-applications-for-the-grid

[31] Distribution Systems in a High Distributed Energy Resources Future, Paul De Martini, California Institute of Technology and Lorenzo Kristov, California Independent System Operator

(c) lower cost of delivered energy due to reduced distribution system losses between bulk supply points and distribution points of delivery, (ie, ICPs)

(d) reduced frequency and duration of outages and the ability to withstand and recover from external threats

(e) improved public safety and reduced potential for property damage.

7.21 These value components provide potential output-focused indicators related directly to the expected benefits from new technology and distributor adaptation.

7.22 In New Zealand, the lower cost of delivered energy could be extended to include the local impact of technology connection on nodal wholesale electricity prices. The indicators will also be valuable to the Commerce Commission for its price/quality path regulation of distributors.

7.23 Realisation of expected benefit indicators for distributors would provide an alternative perspective on the potential lost value arising from barriers due to distributor adaptation issues.

7.24 Moving to recent relevant initiatives in Australia, the relatively rapid adoption of solar PV has created issues for distributors, consumers and stakeholders:

> *The latest results from Open Energy Networks indicates that zone substations in some areas of Adelaide and south east Queensland have already met the threshold for reverse demand/power flows or will do so before 2025. At this level of solar penetration, voltage challenges can be a significant issue causing power quality and reliability problems and damage to appliances. Without action, solar customers will increasingly need to be constrained from exporting into the grid. The cooperation of networks and customers is therefore a crucial part of the transition to a distributed energy world.*[32]

7.25 In 2017, Energy Networks Australia (Australia's equivalent to New Zealand's ENA) developed its Electricity Network Transformation Roadmap (roadmap),[33] which is based on a balanced scorecard methodology. The roadmap included five areas for which measurable goals had been set for overall customer outcomes by 2027 and 2050.

7.26 The goals are:

Table 4 – Australian transformation roadmap goals

Goal	Measures
Customer choice and control	number of customers using onsite resources (solar PV and batteries)
	concessions and incentives
Lower bills for valued service	avoided network investment
	savings to households

[32] Electricity Networks Australia, Electricity Network Transformation Roadmap, Final Report, April 2017 https://www.energynetworks.com.au/sites/default/files/entr_final_report_web.pdf

[33] ibid, page 2

	reduction in average network bills
Fairness and incentives	distributor payments for DER services avoided cross subsidies
Safety security and reliability	planned and efficient market response avoids security and reliability risks robust physical & cyber security management. real time balancing, reliability and quality of supply at small and large scale, with millions of market participants.
Clean energy transition	electricity sector carbon abatement electricity sector achieves zero net emissions by 2050

7.27 Given that Australian States are already experiencing disruption from technology adoption, the above output measures are worth considering within the New Zealand context.

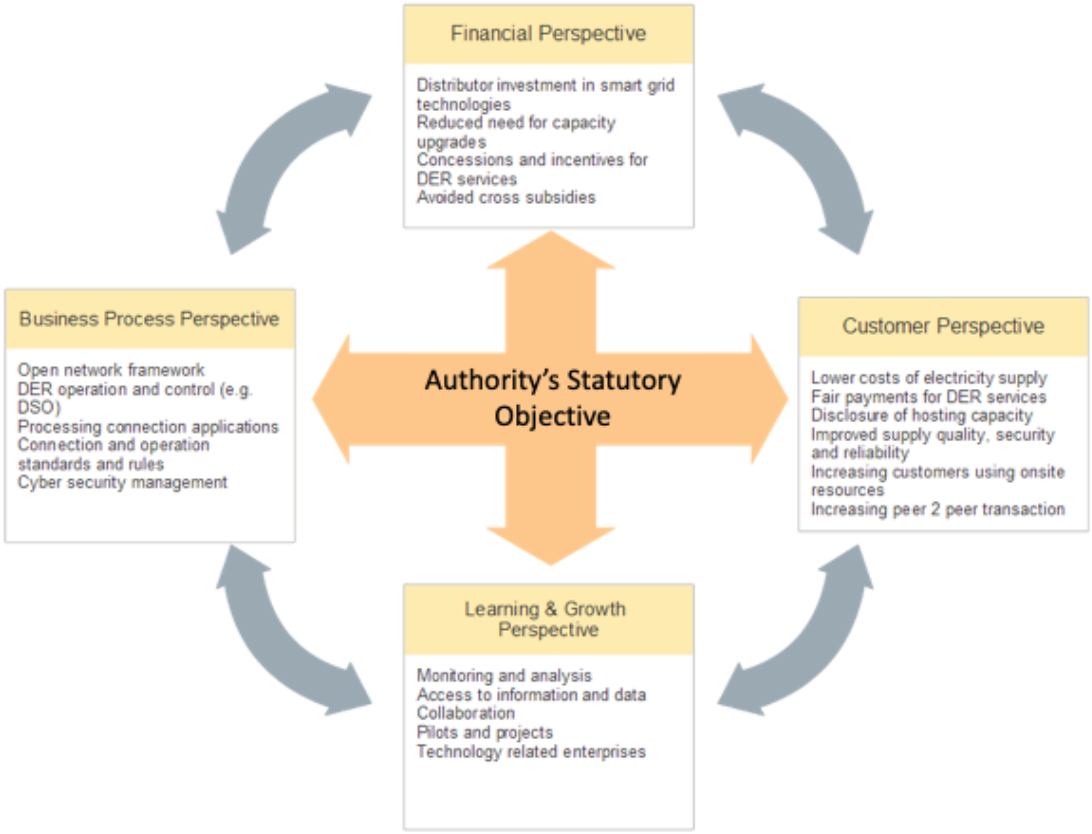
We propose a balanced scorecard approach to defining indicators

7.28 We applied a balanced scorecard approach to assess the potential indicators identified from the survey and interviews together with those seen in the various roadmaps. We found that the potential indicators identified fit reasonably well within the strategic themes of the standard balanced scorecard.

7.29 The balanced scorecard methodology is well established and should be familiar to a wide range of industry stakeholders.

7.30 Bringing the inputs from distributors, stakeholders and other research together, we have developed the following potential adaptation and capability indicators for further consideration and development (Figure 57 and the following paragraphs).

Figure 57 – Potential indicators using on a balanced scorecard



7.31 Financial indicators:

(a) distributor investment in smart grid technologies (% of base year)

(b) reducing need for network capacity upgrades (% enhancement and development (E&D) capex vs historical)

(c) payments made to providers of DER services ($/year, $/ICP)

(d) costs to connect and operate DER and IoT ($ per connection, $/year)

7.32 Customer indicators:

(a) lower costs of electricity supply (average household electricity cost index)

(b) improving supply quality, security and reliability (low voltage quality measures and number of customers with on-site supply options)

(c) number of customers with access to on-site resources (% of ICPs, kW/ICP)

(d) availability of peer-to-peer transaction services (number of transaction operators, transactional liquidity)

7.33 Learning and growth indicators:

(a) monitoring and analysis – understanding DER markets (progress/completion of transformation roadmap actions)

(b) access to information and data (progress on establishing data sharing between participants)

(c) hosting capacity transparency (number of distributors providing hosting capacity information – note that Part 6 of the Code already requires that distributors publish static information about network congestion)

(d) collaboration pilots and projects (evidence of case studies and examples)

(e) technology-related enterprises (number of new enterprises established)

7.34 Business process indicators:

(a) recruitment of specialist technology-related staff (people/year)

(b) open network framework planning and implementation (capability assessment against criteria)

(c) DER operation and control (number of distributors undertaking DER control)

(d) hosting capacity management (low voltage feeder hosting capacity (kW) vs base year)

(e) processing connection applications (average application processing time)

(f) connection and operation standards (standardisation of these standards nationally, the number of distributors applying the nationally-consistent standards).

7.35 When developing potential indicators it is important to consider the implied assumptions that may affect a user. For example, an indication showing little change from previous positions may be seen as indicating poor achievement when taking action may not have been the appropriate thing to do.

Collaboration between regulators, distributors and stakeholders is the best approach to establish indicators

7.36 There is an interesting and important regulator jurisdictional issue to consider when assessing the potential indicators.

7.37 Under its price/quality path regulation, the Commerce Commission, amongst many other factors, focuses on asset management; this includes efficient investment in network assets and reliability performance. The Commerce Commission has implemented an extensive information disclosure framework through which distributors provide annual data relevant to many aspects of their networks, levels of expenditure (capex and opex), performance (SAIDI and SAIFI) and price. The Commerce Commission also requires that distributors publish regular asset management plans and compliance statements.

7.38 To ensure they can meet the Commerce Commission's requirements, distributors monitor and respond to changes in the demand for distribution services across their networks. This includes forecasting future demand for services. Forecasts currently have a 10 year horizon but given the long life of most distribution assets, distributors take a longer view when considering the full life cycle of assets and the business case for investing to maintain and enhance network capacity.

7.39 As noted earlier, current distributor operational monitoring of low voltage assets is very limited. However, the impact of DER technologies will increasingly mean that historic assumptions cannot be relied on for network planning and operation purposes. Because of this, distributors will need to improve the visibility of their low voltage networks – including the flow-on effects to the higher voltage networks.

7.40 Much of the information and data collected will also be valuable to stakeholders because it will provide information on hosting capacity headroom and the potential for future

network constraints to impact on the operation and economic viability of technology investments.

7.41 The Code regulates arrangements for customer metering and data sharing (eg, through the registry). The Authority also administers contractual arrangements between distributors and distribution customers (ie, through Part 12A of the Code). Trading of the outputs from distributed energy resources will likely require the establishment of new trading arrangements and markets. These markets may require supporting frameworks that could be provided through the Code, including the establishment of standard contractual arrangements.

7.42 Both distributors and stakeholders identified regulation as both a driving and restraining force in adapting to accommodate new technology. In interviews many comments on the acquisition and sharing of information related to uncertainty of roles of future market participants and of regulators.

7.43 Distributor and stakeholder views have highlighted a need for regulators and market frameworks to also adapt. Establishing suitable indicators to monitor the need for and timing of regulatory adaptation will require collaboration between regulators and across distributors and other stakeholders.

7.44 Forming suitable indicators and a monitoring framework will likely best be achieved through collaboration between the Authority, the Commerce Commission, MBIE, distributors and stakeholders. The material and insights obtained through this study would form a suitable platform for building collaboration on a cooperative monitoring framework.

Appendix A Distributor categorisation assessment

A.1 We considered that using some form of categorisation groupings may provide useful insights when viewing distributors' survey responses. In particular, we wanted to see if recent levels of technology-related expenditure by individual distributors were linked with different thinking and approaches.

A.2 We used data from distributor responses to a new technology-related information request made by the Commerce Commission. The information specifies the average amounts each distributor spent on development and growth-related activities in the last four years. We developed three hypothetical distributor categories and called these Caretakers, Developers and Growers. We associated each distributor's disclosed expenditures as amounts and activities that Growers might spend and Developers might spend:

A.3 Developer investments included large scale generation, smart grid technology and network-connected energy storage batteries.

A.4 Grower investments included distributed generation, electric vehicle chargers, distributed energy storage batteries, metering and home automation.

A.5 To form the category boundaries, we applied a set of test values. To obtain a '1', the distributor's expenditure per ICP must be above the test value. In Table 5, the test values are set at $5/ICP for Grower-related investments and $40/ICP for Developer-related investments. Distributors that score below both test values are considered to be Caretakers. Table 5 shows the results.

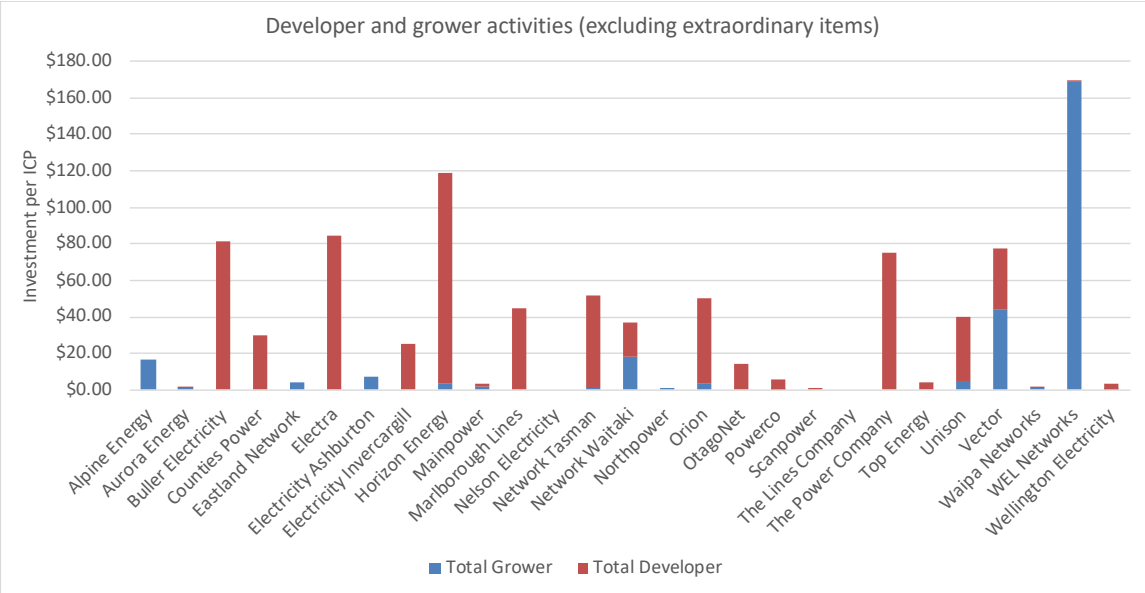
A.6 Of course, the categorisation method is coarse, as it relies on a single set of data and a simple hypothesis. We found that the categorisation provided an interesting discussion point in the distributor interviews. In many cases distributors provided additional information indicating they felt their business strategy and focus aligned more closely with a different category.

Table 5 – Distributor category assessment

		Test values	$5	$40		
	Total Grower	Total Developer	Grower	Developer	Caretaker	
Alpine Energy	$17.04	$0.00	1	0	0	
Aurora Energy	$0.86	$0.23	0	0	1	
Buller Electricity	$0.00	$81.76	0	1	0	
Counties Power	$464.40	$29.71	1	0	0	
Eastland Network	$4.07	$0.00	0	0	1	
Electra	$0.00	$84.72	0	1	0	
Electricity Ashburton	$7.48	$0.00	1	0	0	
Electricity Invercargill	$0.00	$25.02	0	0	1	
Horizon Energy	$3.46	$115.28	0	1	0	
Mainpower	$2.26	$0.84	0	0	1	
Marlborough Lines	$0.00	$44.48	0	1	0	
Nelson Electricity	$0.00	$1,737.32	0	1	0	
Network Tasman	$1.13	$50.96	0	1	0	
Network Waitaki	$18.34	$18.45	1	0	0	
Northpower	$0.14	$0.00	0	0	1	
Orion	$3.49	$46.91	0	1	0	
OtagoNet	$0.00	$14.59	0	0	1	
Powerco	$0.04	$5.95	0	0	1	
Scanpower	$0.00	$0.03	0	0	1	
The Lines Company	$0.00	$0.00	0	0	1	
The Power Company	$0.00	$75.18	0	1	0	
Top Energy	$0.00	$4.39	0	0	1	
Unison	$4.66	$35.79	0	0	1	
Vector	$44.22	$33.16	1	0	0	
Waipa Networks	$1.05	$1.18	0	0	1	
WEL Networks	$168.43	$1.27	1	0	0	
Wellington Electricity	$0.38	$3.37	0	0	1	
Average	$27.46	$89.28	6	8	13	27

A.7 Figure 58 provides a graphical view of the above table.

Figure 58 – Distributor categorisations



A.8 The application of the categorisation approach produced the following categorisations.

Grower	Developer	Caretaker
Alpine Energy	Buller Electricity	Aurora Energy
Counties Power	Electra	Eastland Network
Electricity Ashburton	Horizon Energy	Electricity Invercargill
Network Waitaki	Marlborough Lines	Mainpower
Vector	Nelson Electricity	Northpower
WEL Networks	Network Tasman	OtagoNet
	Orion	Powerco
	The Power Company	Scanpower
		The Lines Company
		Top Energy
		Unison
		Waipa Networks
		Wellington Electricity

Appendix B Cluster grouping example

7.45 The following is an example of groupings based on distributor responses to capability-related questions. Figure 59 illustrates[34] how clusters are established by first assessing distances between question responses and identifying the next closest business – to form a cluster of two businesses, the bottom level of Figure 59. From there the algorithm considers the distance[35] between clusters and keeps grouping distributors until there is only one grouping, of all distributors. On the right we see the emergence of the lower capability distributors (as measured by survey responses) – containing eg Aurora Energy, Unison, Northpower and Buller Electricity. On the left of the figure are groupings that reflect relatively strong capabilities.

7.46 The method used here to identify clusters is not very precise in the sense that one or two distributors tend to be borderline cases. For example, Westpower sits on the border of the high and low capability distributors (based on survey responses). This uncertainty of associations reflects surprisingly little variation in survey responses amongst distributors.

7.47 Notably, there is no strict association between measures of capability and characteristics that might be thought to predict distributors capability. Small or rural distributors, for example, are not necessarily identified as having relatively low capability. There is a positive association between network density, revenue and number of ICPs and higher estimated capability, but the association is weak.

[34] The method presented in the figure (hierarchical clustering) is similar to but is not the precise method used for the final clusters identified in this report. In the final analysis, we use the clustering method known as 'Partitioning around mediods' (PAM). The two methods deliver similar results but the PAM method avoids identifying very small clusters, at least in this data set. It does not matter a great deal in the sense that these clusters are not very precise and are only used here for descriptive purposes, to reduce the dimensions of the survey data and for drawing general conclusions.

[35] We measure distance using 'Gower Distance'.

Figure 59 – Distributor groupings based on capability-related questions