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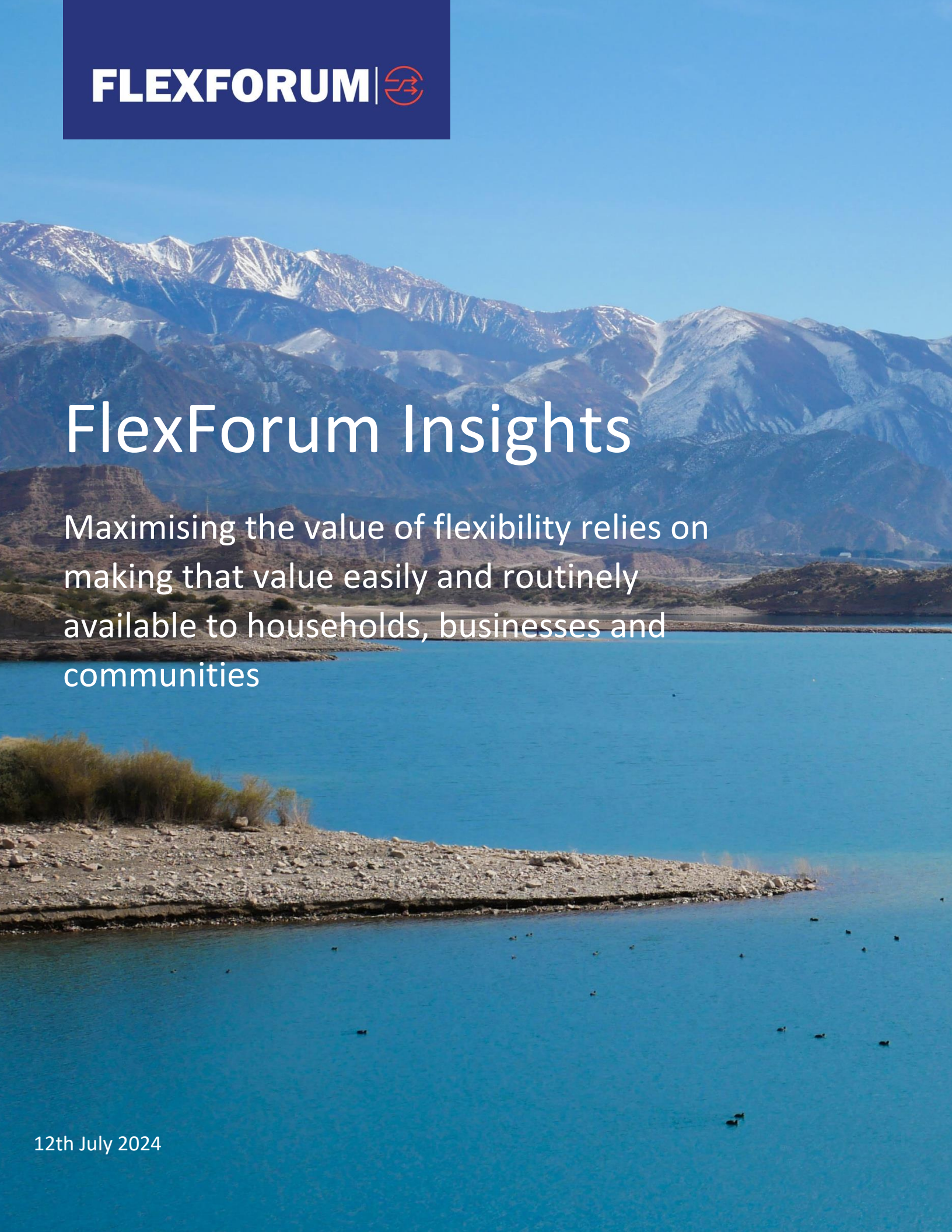

FlexForum Insights

Maximising the value of flexibility relies on making that value easily and routinely available to households, businesses and communities

12th July 2024

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Maximising the value of flexibility requires people being able to easily and routinely realise that value

Flexibility can provide multiple electricity services. Things like electric vehicles (EV), EV chargers, solar, battery storage, heating and cooling equipment and energy management systems can operate 'flexibly' to do both their main job and provide multiple services and value to households, businesses, communities and across the electricity supply chain.

There are a bunch of these flexible resources which could be put to work now and into the future if the owners of these resources – households, businesses and communities – were routinely rewarded for providing flexibility when and where it is valued. Flexible resources can provide multiple services and value streams and maximising the value of flexibility requires these value streams to be combined – or 'stacked'.

The value or prize of deploying flexibility is worth chasing. An estimate from Boston Consulting Group (BCG) reckons about 2 gigawatts (GW) of flexibility is needed in Aotearoa New Zealand by 2030 and 5.8 GW by 2050, underpinning $10 billion plus savings (net present value) available from a smarter and more flexible electricity system that minimises the costs of electrification.

But first we need to make sure that each part of the value stack is routinely converted into financial rewards for flexibility resource owners. We need to understand the value stack – what does it look like today, and what does it need to look like if we want to reward flexibility according to its value to the system.

Today, there are holes in the value stack. Either services are not being fully monetised or monetised services are not being properly converted into a reward for the flexibility owner.

- **Value is monetised through prices, but flexibility owners are only partly rewarded**. This relates to the use of flexibility to help manage short-notice wholesale events, such as the energy shortfalls experienced on 9-10 May 2024 or 9 August 2021. There are limited or no price signals or rewards put on the table for households, businesses and communities to commit to providing their flexibility at short notice, at anywhere near the value created in those events.
- **Value is monetised without price signals, and rewards are approximate and incomplete.** This mostly relates to managing network capacity. While long-run-marginal cost (LRMC) based network pricing may approximate the value of network investment deferrals, it is not reflective of the value of managing short-term network congestion.
- **Value is sometimes monetised, but people cannot get any reward** because regulatory settings get in the way, such as in the case of ancillary services, or export from a battery during peak network times.

Each individual service or use case needed to operate the power system needs to be monetised. Ideally, this monetisation occurs through transparent prices to routinely signal the value of flexibility for an electricity service (eg, spot prices). These prices are critical, transforming the value of flexibility from a conceptual idea into a tangible benefit – either cold, hard cash or reduced costs (a benefit) for the resource owner.

And the monetised value of the services provided by flexibility needs to be converted into rewards (ie, a payment) for flexibility owners. Parts of the supply chain produce these signals, but people (and the electricity sector) will only provide flexibility when there is a reward and sufficient incentive – the reward is the benefit received from doing something while the incentive is the size of this benefit.

People are not going to invest in or provide their flexibility when value is not routinely monetised, or the reward is not routinely made available. The best things in life might be free, but flexibility is not. People need to be routinely rewarded to provide their flexibility and the reward needs to be reliable and sufficient to make doing so worthwhile. The size of the existing or expected reward matters because it drives investment by manufacturers to make devices flexibility-capable and ready to realise the rewards available. It also drives investment in the tools and capability needed for people to obtain advice and make choices about what devices they buy and what electricity products and services to choose to maximise value.

Maximising the value of flexibility is a good thing

FlexForum is an incorporated society with Members[1] from across the electricity ecosystem committed to working together to make it easy for households, businesses and communities to maximise the value of flexibility and electrification.

Flexibility is our focus because it is central to affordable and reliable electrification and a key enabler of a truly consumer-centric electricity market and system.

Flexibility[2] – from things like electric vehicles (EV), EV chargers, solar, battery storage, heating and cooling equipment and energy management systems – gives households and businesses greater agency and autonomy over their energy costs and outcomes and provides another tool for ensuring a reliable and affordable electricity system.[3] The full benefits of flexibility will be realised by integrating flexible resources into the electricity system and market.

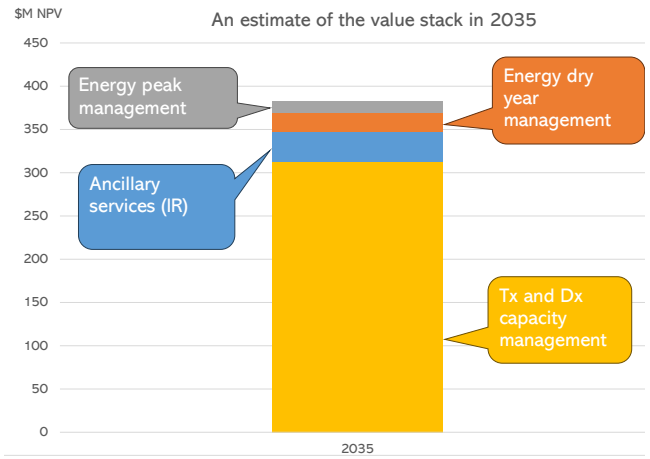
The value or prize of deploying flexibility is worth chasing. Boston Consulting Group (BCG) reckons about 2 gigawatts (GW) of flexibility is needed in Aotearoa New Zealand by 2030 and 5.8 GW by 2050, underpinning $10 billion plus savings (net present value) available from a smarter and more flexible electricity system that minimises the costs of electrification.[4]

Figure 1 shows an estimate by Sapere on behalf of the Electricity Authority of the economic surplus of deploying flexibility to provide electricity services. The value on the table is about $380M NPV in 2035.[5] The net economic surplus represents "the monetised value of the total wellbeing to NZ from DER penetration" and from using flexibility to provide electricity services to the supply chain and to households, businesses and communities.

A further estimate for the Energy Efficiency and Conservation Authority (EECA) found that flexible EV charging could create $4 billion in value by 2050 by reducing total system costs.[6]

Importantly the value and benefits of flexibility are shared between the resource owners, the electricity supply chain and across the community and economy.

Figure 1: An estimate of the stacked value which could be provided using flexibility in 2035



Source: FlexForum and Sapere, September 2021, Cost-benefit analysis of distributed energy resources in New Zealand. A report for the Electricity Authority

- People with flexible resources benefit because they spend less to keep their lights on, homes warm, vehicles running and to produce things ranging from accounting services to cherries.
- The electricity supply chain benefits because it has an extra tool that is sometimes cheaper than the traditional options used to operate the power system getting power to the people safely, reliably and affordably, e.g., building more network or building a new power station.

[1] FlexForum Members are listed at https://flexforum.nz/about/. Members span the electricity ecosystem and include electricity generators, retailers, metering services providers, EV charger manufacturers, energy management software firms, Transpower, distributors, advisory services firms, industry associations universities, and individuals.

[2] For readers looking for a definition, we think flexibility is the modification of generation injection and consumption patterns, on an individual or aggregated level, often in reaction to an external signal, to provide a service to the owner or within the power system.

[3] The benefits of flexibility are flagged by a range of parties including Transpower, the Market development advisory group, and the BCG Climate change in New Zealand: the future is electric report.

[4] Boston Consulting Group, The future is electric, page 6.

[5] See Sapere, Cost-benefit analysis of distributed energy resources in New Zealand. A report for the Electricity Authority, September 2021.

[6] See EECA, Residential smart EV chargers and demand flexibility, March 2024.

- The wider community and economy benefit because it costs the electricity supply chain less to operate and provide the network and generation infrastructure needed to keep the lights on.

Flexibility can provide multiple electricity services

The electricity system is a massive and complex machine that spans the length of the country, has millions of moving parts, and operates according to a millions of instructions each day given and received by the power stations, transmission and distribution networks, retailers, other intermediaries, and people. [7] The system is operated using a market (or collection of markets) with prices for the various services involved in producing and delivering electricity to households, businesses and communities. These prices orchestrate the required outcomes to a cost that keeps the lights on at least.

Flexibility can and does play a key role in operating the system because it can deliver electricity services across the electricity supply chain and deliver outcomes to households, businesses and communities. The Flexibility Plan identifies the range of services and outcomes[8] available from using flexibility.

1. Minimise connection costs because 'I want the most affordable connection to the network to meet my requirements'
2. Minimise energy-related ongoing costs because 'I want the most affordable ongoing energy costs to meet my requirements'
3. Manage reliability and resilience because 'I want a specific level of resilience and reliability of supply'
4. Reduce emissions because 'I want to reduce my total emissions'
5. Monetise flexibility resources by supplying energy, network and ancillary services across the electricity supply chain because 'I want to maximise the value of my flexible resources'.[9]

These outcomes reflect the perspective of the household, business or community, but each involves one or more of the electricity services which underpin operation of the electricity system.

Flexible resources can stack up to 13 separate services and value streams

FlexForum used a Rocky Mountain Institute (RMI) framework developed to identify the value available from battery storage to categorise the services and value streams from flexible resources.

Figure 2 shows the 13 different value streams which can be provided by both battery storage and other flexible resources.[10]

The services identified by RMI align with the outcomes listed in the Flexibility Plan.

- Minimise ongoing costs covers the services termed: increased PV self-consumption, demand charge reduction, time of use (TOU) bill management and energy arbitrage.

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[7] Sidenote: the electricity supply chain is complex because it involves coordinating millions of constantly moving parts, not because it was designed by Heath Robinson.

[8] The outcomes emerged from a series of workshops between April and August 2022. You can check out the discussions at https://flexforum.nz/session-notes/. Starting with outcomes was a deliberate effort to ensure the Flexibility Plan reflects the perspective of a household, business or community – who may have flexible resources either now or in the future – making choices about flexibility and wanting to maximise the value of their resources for themselves, their community and for the wider economy.

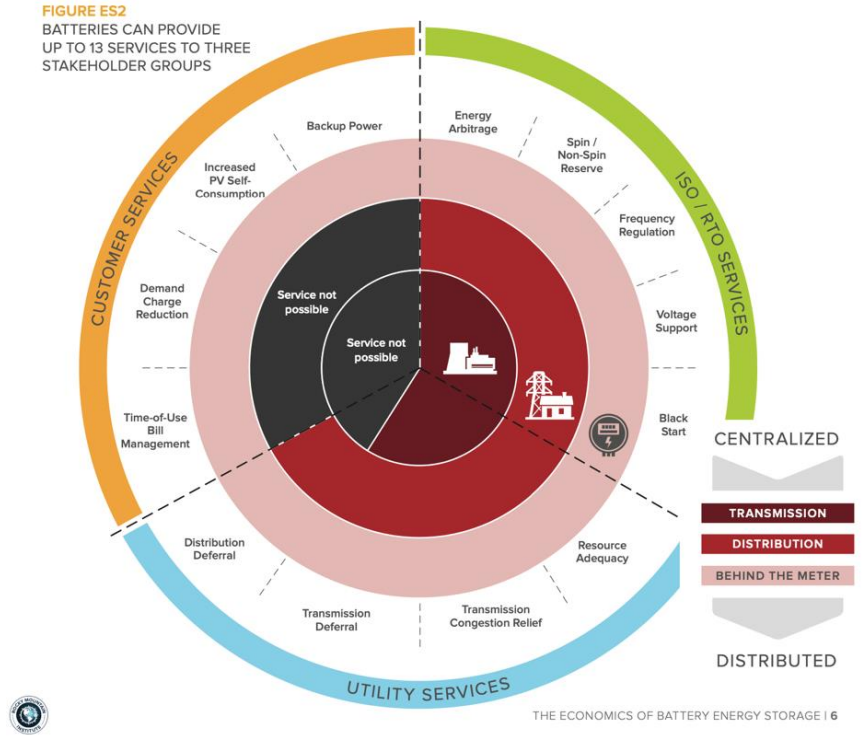
[9] Keen readers of Flexibility Plan 1.0 will at this juncture ask why we are referring to 5 outcomes rather than the 7 actually listed…the reason is the 3 outcomes relating to providing services across the electricity supply chain have been combined because they are variations of the same thing.

[10] The services listed in the RMI framework are described using terminology adopted in the United States of America. Equivalent services exist in Aotearoa New Zealand but under different names.

- Monetise flexibility resources covers the services termed: spinning reserve, frequency regulation, voltage support, black start, resource adequacy, transmission congestion relief, transmission and distribution deferral.
- Manage reliability and resilience covers the service termed: Backup power.
- Minimise connection costs covers the services termed: demand charge reduction and distribution deferral.

The RMI work highlights the opportunity to maximise value of a resource by using it to provide multiple services and turn what might otherwise be an economically unviable investment into a cost-effective, multi-use asset that provides net benefits to the owner and to the system.

Figure 2: Services which can be provided using flexibility



Source: Rocky Mountain Institute, September 2015, The Economics of Battery Energy Storage

Resources need minimum capability and functionality to deliver a service

Not all flexible resources can provide all services, but some flexible resources are very good at providing some services.

Each service involves specific outcomes which require specific capability to modify generation or consumption patterns (ie, be flexible) and specific functionality to hear and respond to signals, programme operating parameters and measure activity.

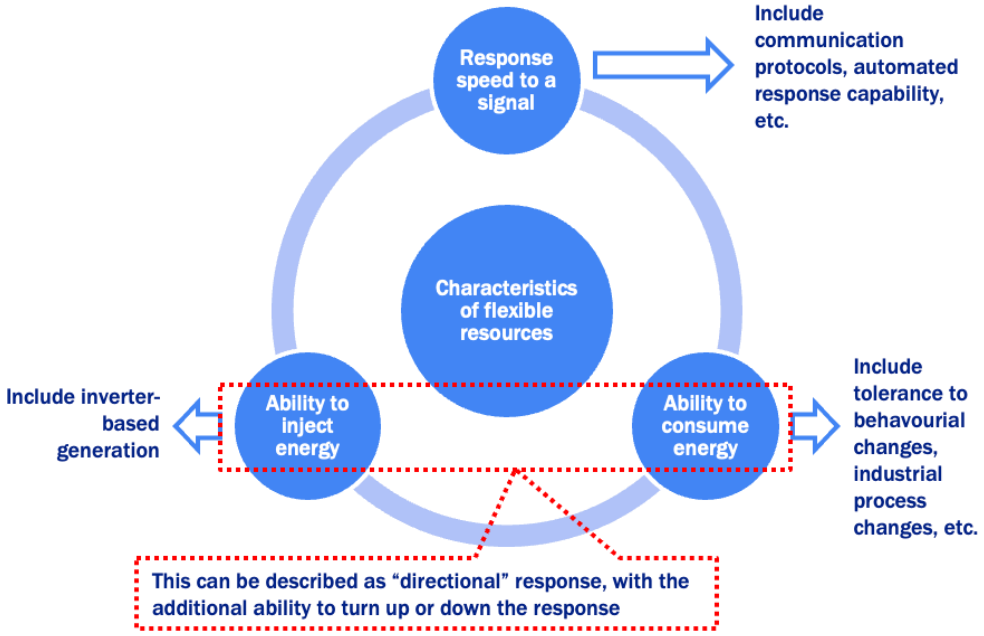
For example, to deliver instantaneous reserve (ancillary) services a flexible resource needs to be able to inject or consume energy and respond immediately to a request to provide the service – the performance requirements mean a resource must have the capability and functionality to immediately hear and respond to a request. In contrast, a household seeking to minimise ongoing costs through TOU bill management needs to be able to schedule when electricity is used based on the TOU price structure – the performance requirements mean someone could look at a clock and physically turn devices on (or off).

Each service has specific performance requirements which boil down to:

- the service requiring the production or consumption of electricity
- speed of response to the request
- the service running or responding optionally.

A description of the basic capability and functionality a flexible resource must have to provide each electricity resource is included in Table 2 in the Appendix.

Figure 3: Representation of the technical characteristics of flexible resources



Source: FlexForum

There are a bunch of flexible resources hanging around which could be put to work

Households, businesses and communities currently possess resources – an EV, solar panels, space heating etc – which are, or could easily be, flexible and used to provide services across the electricity supply chain.

FlexForum estimates that there is between 280 to 420 megawatts of flexibility currently available at any one time from residential and commercial space heating and cooling equipment, hot water, EVs and EV chargers, and battery storage. The amount of flexibility available from household, business and community devices is shown in table 1.

Our estimates are supported by Electricity Authority survey findings indicating about 450MW of demand-side flexibility could be available now, including 160MW of reported hot water and ripple control, which may already be offered into the reserve market.[11]

[11] Electricity Authority, 26 June 2024, at https://www.ea.govt.nz/news/eye-on-electricity/how-demand-side-flexibility-can-contribute-to-security-of-supply/.

We are confident that our estimate is wrong, and considerably more flexible resources would be available if their value were monetised.

Table 1 Source and estimated amount of flexibility available from households, businesses and communities

Device	Estimate of potentially available flexibility
Air conditioning units (domestic and commercial)	6 to 30 MW
Electric vehicles and EV chargers (light fleet)	20 to 40 MW
Hot water storage	100 to 200 MW
Industrial Processes (based on public information)	Min 77 MW
Battery storage systems (residential, commercial and industrial)	~75 MW

Source: FlexForum estimates. Assumptions are documented in Table 4 in the Appendix.

An overview of the electricity services which can be provided by each type of resource (because they have the relevant capability, if not functionality) is included in Table 3 in the Appendix.

Some of these resources are already being used to provide electricity services. For example, we know that some residential hot water resource is used in various ways to provide distribution and transmission deferral services and ancillary services – but we do not know whether the full value of the resource is maximised.

More flexibility is available, including from larger scale distributed generation and households. The Consumer Advocacy Council has identified that about a third of households will use at least one high-consumption appliance when the network or system is operating close to full capacity.[12]

The benefit and value of harnessing the flexibility from people shifting the time of use of electricity is highlighted by the response to Transpower beseeching people to reduce electricity use on 9 and 10 May 2024. Transpower concluded that 200 MW of a 260 MW reduction in electricity use came directly from households.[13] Many of these households were responding voluntarily and would not have received any benefit or reward, despite market participants receiving a direct financial benefit of at least $500,000 based on FlexForum estimates.

Flexibility is used, but not routinely or across all services

Flexible resources owned by households, businesses and communities are being used, but not routinely or across all possible electricity services.

Based on a desktop survey and Member experience, FlexForum thinks flexibility is used most often by households, businesses and communities to minimise ongoing costs by producing their own power (eg, using solar) and to shift their electricity use across time to arbitrage spot prices and TOU pricing.

People also use flexibility, though less routinely, to provide back-up power during power outages and to minimise connection costs.

[12] Consumer Advocacy Council, Electricity consumer behaviour survey, December 2023, see page 42. 35% of households use their dishwasher, washing machine or clothes dryer during 'peak times' when the network or system is operating close to full capacity.

[13] Transpower, media release, 10 May 2024, Transpower thanks New Zealanders for reduced power use this morning and Transpower, Facebook post, 9 May 2024, Thank you New Zealand

Flexibility is used least routinely to directly provide electricity services, such as distribution and transmission capacity management, generation resource adequacy and ancillary services. Providing services across the electricity supply chain rely on the service being procured by the user, typically through an intermediary such as a retailer or flexibility coordinator.

Examples of flexibility being procured to support operation of the electricity system are listed in Table 5 in the Appendix. The list is not intended to be comprehensive and highlights a mix of buyer – coordinator[14] – owner relationships.

Holes in the value stack and other reasons the full value of flexibility is not being maximised

Flexibility creates value when it delivers a service at less cost than the alternatives available to the user, who can be the system operator, a distributor, an electricity retailer, or a household.[15] We know when and where to provide a service through the pricing of electricity services – prices tell the buyers and sellers of a service the value at that time and place.

Value stacking is a term used to describe the ability to use an energy resource, such as distributed battery storage and other flexible resources, to provide or stack multiple electricity services to maximise revenue and maximise the value of the resource.[16]

Value stacking relies on the existence of and access to prices which reward the use of flexibility for an electricity service. People will provide flexibility when there is a reward and incentives. The reward is the benefit received from doing something while the incentive is the size of this benefit.

Holes in the value stack exist where the reward for providing flexibility is not available or transparent to people or not sufficient to get people to invest in and offer flexibility.

From the point of view of households, businesses and communities there are two ways of pricing and rewarding the supply of electricity services.

- prices which tell people how much they will pay to use electricity at a time and place. People are most familiar with retail pricing products which include usage charges which can vary based on time of day (TOU structures). People do not need to respond but can reduce their power bills by shifting when they use electricity in response to pricing which signals the amount of electricity or network capacity available.
- direct payments for having flexibility ready to be used and for providing that flexibility when requested. People are expected to respond to provide the service. For example, a flexibility buyer contracting for a frequency regulation service will require high-level of response certainty.

Each electricity service has different pricing and reward structures based on the certainty of response needed. A service requiring more certainty of response will be rewarded through a direct payment. A service not requiring certainty of response will be rewarded through the opportunity to shift the time of electricity use to reduce power bills. Some services will be rewarded through a mix of pricing and payments.

[14] Sidenote: the term coordinator or flexibility coordinator is used in place of the terms aggregator, intermediary, flexibility supplier and flexibility trader because coordinator best describes what the entity is doing – it is coordinating flexible resources.

[15] For example, building a bigger transformer, new power line, power station, or using gas instead of electricity.

[16] A resource with more information about value stacking is available at: https://greeningthegrid.org/energy-storage-toolkit/topics-resources/grid-services-and-value-stacking.

Prices tell people what, when and where the value is

Each of the four main input services needed to keep the lights on has one or more price tags (or signals).

- **energy services** cover the generation, storage and shifting the time of use of electricity. The market (spot) price of electricity is set every 5 minutes at various points across the country and co-optimised with reserves. People can elect to be supplied to the market (spot) price, but most choose retail products which shield people from spot pricing volatility by using financial risk management products, eg, hedges.
- **transmission services** cover the provision of higher voltage network capacity to transport power from producers to users. Transmission prices are fixed because the spot price is expected to provide signals to users to respond to transmission congestion. Payments are offered ad hoc for non-transmission (flexibility) solutions in specific areas, eg, upper South Island, but this is not routine or widespread.
- **distribution services** cover the provision of lower voltage network capacity to transport power from producers to users. Distribution prices typically have fixed, and variable, components designed to recover the fixed and variable costs of providing the network service. The trend is to link the variable component to time of use, i.e., a higher rate at peak times (evenings and mornings) and vice versa to provide signals to users to respond to distribution congestion. Distribution prices can include a discount on the variable component for households offering the flexibility of their electric hot water cylinder (and sometimes other devices). The discount is a defacto payment for flexibility used for capacity management. Payments are made for providing flexibility for capacity management, but this is not routine or widespread.
- **ancillary services (system and distribution)** cover things like voltage support, frequency keeping, black start, and instantaneous reserves at one or both of system and distribution level. These services are procured by the System Operator, and sometimes by distributors, through contracts.

These input prices are often packaged up by intermediaries – e.g., a retailer – to provide a sticker or retail price for the package of energy services and retail products and commercial offers exist to enable individual households and businesses[17] to maximise the value of their flexibility. These offers often rely on TOU pricing to package energy and network signals to reward the use of flexibility.

Prices and value streams are not comprehensive for these four main input services in Aotearoa New Zealand which creates these holes in the value stack.

Services	Value streams	Holes in the value bucket…
Energy	People are rewarded for using flexibility to respond to the spot price or signals in TOU-based retail products.	Rewards are not routinely available to get flexibility to respond to events like dry years or the peak energy shortfall on 9-10 May 2024.
Distribution capacity	People are rewarded for using flexibility for distribution capacity management through network pricing structures and discounts for controlled load.	Rewards are not routinely available for flexibility to respond to short notice network congestion events.
Transmission capacity	People are rewarded for using flexibility for transmission capacity management through spot prices and occasional contracted payments.	It is not clear whether the rewards incentivise sufficient flexibility to provide transmission network capacity management services.
Ancillary	People are rewarded for using flexibility for ancillary services as a paid service when the resource complies with the relevant technical rules.	The technical rules need to adapt to allow all capable flexible resources provide ancillary services.

More detail about the value streams and pricing signals for existing electricity services is provided in Table 6 in the Appendix.

[17] Products directed at communities are not routinely available because the market settings are based on selling power to individual households and businesses.

13 reasons why value is not put on the table

FlexForum found 13 reasons why parts of the value stack are being fully realised using a root cause analysis asking why "parts of the value stack are not fully realized by households, businesses and communities". The reasons come in 3 flavours:

- people don't have the **opportunity** to access the full value of their flexibility. For example, the value may not be priced or the value may not be routinely available.
- people don't have the **motivation** to access the full value of their flexibility. For example, the reward on the table may not be sufficient to encourage someone to provide flexibility
- people don't have the **capability** to access the full value of their flexibility. For example, you may need to be a market participant or use an intermediary to maximise value.

The 13 reasons are described in Table 7, Table 8, and Table 9 in the Appendix.

Holes in the value stack exist where services are not fully monetised or are not converted into rewards

Taken together the 13 reasons are causing a situation where the value of flexibility is not being monetised or converted into rewards for flexibility owners because buyers cannot buy flexibility (e.g., some ancillary services) or don't want to (e.g., can get it for free or have commercial reasons for preferring a different resource) or don't have to (e.g., incentives to use flexibility are not strong enough). At the same time, sellers are not selling flexibility because there is no reward, or the reward is not sufficient to justify providing flexibility, even when it is the cheapest option.[18]

The value of flexibility is generally recognised for energy, transmission, distribution and ancillary services. To be confident that we can maximise the value of flexibility we need to make sure:

- that value is being routinely **monetised** within the electricity system – by market prices, contract tenders, or reduction in operating costs for the flexibility owner
- that monetised value is being routinely converted into a **reward** for flexibility owners to provide an incentive that aligns with the value provided to the system.

Value is monetised but flexibility owners are only partly rewarded

Value is monetised for some services through transparent market prices, but flexibility owners are only - at best - partly rewarded. This happens for the use of flexibility to help manage short-notice wholesale market events, such as the energy shortfalls experienced on 9-10 May 2024 or 9 August 2022. The wholesale market clearly monetises the value of flexibility for retailers and other purchasers through the transparent wholesale price – if demand was reduced, purchasers would reduce their costs. We can identify exactly the amount of this cost reduction. There is no ambiguity.

There are few incentives or rewards put on the table for households, businesses and communities to commit to providing their flexibility at short notice. Other than for spot-exposed customers, reward is only delivered to the household or business through static time-of-use tariffs. These tariffs do not relate in any way to the types of prices – and therefore purchase costs - that would be experienced during short-notice scarcity events.

[18] There is no problem with a seller not selling a flexibility resource that is expensive and deploying it would cost more than the value provided to the system.

In some situations, the way value is monetised is complex, uncertain and non-transparent, and rewards are approximate, incomplete and static. Distributors and Transpower have found it difficult to monetise the value of flexibility for capacity management (e.g., deferring the need for investment and managing short-term network capacity issues) for several reasons such as:

- the costs and benefits are monetised across multiple 5-year regulatory periods, while network pricing structures and levels are set annually to recover costs associated with the current regulatory period.
- an ongoing preference for capital expenditure which, despite the best endeavours of the regulatory settings and aspects of the input methodologies, can artificially suppress the monetisation of value
- hesitancy in the face of the not quite known (creating uncertainty about the magnitude of the benefit)
- perceptions that not enough flexibility is reliably available to use (which is a classic chicken and egg situation given resources would quickly emerge if the service were monetised and rewarded).

A consequence of this complex and non-transparent monetisation of capacity management services is that the size of the reward put on the table is conservative, and largely limited to network pricing structures and levels that are set annually. Regulatory and distributor efforts to move to long-run marginal cost pricing may better *approximate* the long-term impacts of reducing consumption, these same prices are not available to all types of flexibility (e.g., export from batteries). Neither are they accurately reflecting the dynamic conditions on a part of the network at a particular point in time, and therefore do not reward short-notice response.

Value is monetised, but people cannot access the reward

People cannot get the rewards already on the table in two situations due to regulatory settings.

Some ancillary services have prescribed technical requirements designed for a thermal-based, centralised electricity system which preclude the use of flexibility, particularly that coming from households, businesses and communities. This means resources are locked out of providing the service and realising value.

Secondly, households and businesses are required to sell electricity they produce from solar or discharging a battery to the retailer supplying them electricity. This prevents the owner from maximising the value and rewards of their resources due to trade-offs between the buy and sell package unless spot exposed on import and export.

People are not going to invest in or provide their flexibility when value is not routinely monetised or the reward is not routinely put on the table

The best things in life might be free, but flexibility is not. People need to be rewarded to provide their flexibility and the reward needs to be sufficient to make doing so worthwhile. The size of the existing or expected reward matters because it drives investment by manufacturers to make devices flexibility-capable and ready to realise the rewards available and in the tools and capability needed for people to obtain advice and make choices about what devices they buy and what electricity products and services to choose to maximise value.

Various holes in the value stack are being plugged by various parties in various ways, for example recent Transpower request for proposals for non-traditional solutions, the Octopus Energy saving sessions, and the Ara Ake and SolarZero winter peak pilot. These initiatives provide learning-by-doing that show the way to value, routinely monetise, and reward flexibility. However, these do not permanently fill the relevant holes in the value stack. To meaningfully shift the dial of flexibility, the services that flexibility can provide must be routinely monetised across the supply chain and the rewards easy for households, businesses and communities to access. People will only discover, assess, enable and operate flexibility if they can trust the reliability of the reward.

Appendix

More information about basic capability and functionality a flexible resource requires to provide each electricity service

Table 2 Basic capability and functionality a flexible resource requires to provide each electricity service

RMI value stream	Electricity service	Produce electricity	Use electricity	Response speed	Notes
Energy arbitrage	**Energy services** (Spot market participation)	Yes	Yes	Within 5 min	The ability to buy energy at a low price, store it, and resell it when prices are high
Spin/non-spin reserve	**Ancillary services**	Yes	No	Immediate	This is to ensure generation capacity is online and capable of injecting power in case of a contingency event
Frequency regulation	**Ancillary services**	Yes	Yes	Immediate	Depending on the nature of the frequency event, either increasing or decreasing load or generation will be required
Voltage support	**Capacity management**	Yes	No	Within 1 min	Localised intervention on the network – also an ancillary service procured by the System Operator.
Black Start	**Ancillary services**	Yes	No	Within 1 min	Distributed resources could be used to re-energise the grid in the event of a total failure
Resource adequacy	**Generation investment deferral**	Either or	Either or	Within 5 min	Flexible resources lower spot prices by adding supply / reducing demand, therefore attenuating price signals to add (build) generation capacity
Transmission congestion relief	**Capacity management**	Yes	No	Within 1 min	Capacity management by raising generation or reducing use of electricity based on conditions.
Transmission deferral	**Transmission investment deferral**	Either or	Either or	Within 1 to 5 min	Both transmission and distribution deferral involve decreasing peak demand by raising generation or lowering usage when the network is congested.
Distribution deferral	**Distribution investment deferral**	Either or	Either or	Within 1 to 5 min	
Time-of-use bill management	**Demand response**	No	Yes	Slow	People managing their electricity use in response to TOU price signals
Demand charge reduction	**Demand response**	No	Yes	Within 5 to 30 min	People managing their electricity use in response to network charges signalling peak demand
Increased PV-self consumption	**Energy services (generation)**	Yes	Yes	Within 5 to 30 min	People managing their electricity use based on spot prices, retail prices and the output of their solar
Backup power	**Resilience and reliability**	Yes	No	Variable	In case of a grid failure, distributed generation can provide power for a period

Source: FlexForum

Estimates of existing flexible resources possessed by households, businesses and communities

Table 3 Source, estimated amount and electricity services that can be delivered using flexibility possessed by households, businesses and communities

Device	Estimated potential resource	Services that could be delivered (RMI framework)	
Air conditioning units (domestic and commercial)	6 to 30 MW	• Transmission congestion relief • Transmission deferral Voltage support • Resource adequacy	• Distribution deferral • Time-of-use bill management • Demand charge reduction
Electric vehicles and EV chargers (light fleet)	20 to 40 MW	• Spin/non-spin reserve • Voltage support • Resource adequacy • Transmission congestion relief	• Transmission deferral • Distribution deferral • Time-of-use bill management • Demand charge reduction
Hot water storage	100 to 200 MW	• Voltage support • Resource adequacy • Transmission congestion relief • Transmission deferral • Distribution deferral	• Time-of-use bill management • Demand charge reduction • Increased PV-self consumption
Industrial Processes (based on public information)	Min 77 MW	• Voltage support • Resource adequacy • Transmission congestion relief • Transmission deferral	• Distribution deferral • Time-of-use bill management • Demand charge reduction
Battery storage systems (residential, commercial and industrial)	~75 MW	• Frequency regulation • Spin/non-spin reserve • Voltage support • Black Start (maybe) • Resource adequacy • Transmission congestion relief • Transmission deferral	• Distribution deferral • Time-of-use bill management • Demand charge reduction • Increased PV-self consumption • Backup power

Source: FlexForum estimates. See next table.

Table 4 Assumptions for the estimates of the source and amount of flexibility available from households, businesses and communities

Device	Total capacity	Potential flexibility	Basis for calculation
Air conditioning units (domestic and commercial)	~6 GW	6-30 MW	According to EECA [1], 1.1 million units were sold between 2019 and 2023. Assuming an average size of 5.5kW, and a coincidence factor of between 1 and 5% (i.e. 1 to 5% of the population will operate at the same time) and assuming they can reduce their consumption by 10%. Estimate is likely to be conservative: • there is no data available differentiating residential and commercial units which are usually larger • the estimate reflects 5 years of sales, which doesn't represent the whole fleet
Electric vehicles and EV chargers (light fleet)	~400 MW	20-40 MW	Transpower's March 2023 monitoring report [2] identified that the cumulative energy available in EV batteries is ~400 MW (noting the limitation of the chargers). We assume that 5-10% of the fleet can entirely stop their charging at any one time.
Hot water storage	~987 MW	100-200 MW	Amount of network load connected to ripple control based on EECA's September 2020 report [3]. We assume that 10 to 20% of this load can be accessed at any one time. Estimate is likely to be conservative.

Device	Total capacity	Potential flexibility	Basis for calculation
Industrial processes	Unknown	Minimum 77 MW	• NZAS and Meridian: 20 MW - limited to 12 weeks over winter [4] • Meridian and Open Country Dairy [5]: 27 MW • Simply Energy and NZ Steel [6] – 30 MW • Meridian [7] is targeting a total of 50 MW of demand response by 2025. We are aware that other demand flexibility contracts exist, but the details are not publicly available.
Battery energy storage systems (residential)	More than 30 MW	~30 MW	SolarZero provided a 30 MW demand response service during winter 2023 using ~10,000 battery systems [8]. Vector owns 643 residential BESS systems [9], however there is no data about the total capacity. The Electricity Authority has implemented changes to the electricity registry to identify solar and battery system resources and capacity [10]. At 31 January 2024, 4158 connections had solar and battery storage with solar capacity of 23.168 MW and battery capacity not reported.
Battery energy storage systems (commercial and industrial)	~45 MW	~45 MW	• WEL network [11]: 35 MW • Vector: 9 MW [12] (combined) • Powerco: 2 MW [13] • SAFT and Meridian have a 100MW project underway at Marsden
Total	~7.5 GW	278 to 422 MW	

Sources and references:

- [1] https://www.eeca.govt.nz/insights/eeca-insights/e3-programme-sales-and-efficiency-data/
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- [3] https://www.eeca.govt.nz/assets/EECA-Resources/Research-papers-guides/Ripple-Control-of-Hot-Water-in-New-Zealand.pdf
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- [8] https://www.araake.co.nz/assets/Winter-Peak-Innovation-Pilot_learnings-and-insights-report.pdf
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- [10] https://emi.ea.govt.nz/r/oof1r
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- [14] https://www.meridianenergy.co.nz/public/Investors/RUAKAKA-BATTERY-ENERGY-STORAGE-SYSTEM.pdf

Examples of flexibility being procured to support operation of the electricity system

Table 5 Examples of flexibility being used to support operation of the electricity system

Flexibility buyer	Flexibility coordinator	Flexibility resource owner	Service
Aurora Energy	SolarZero	Households / SolarZero	Distribution capacity management in Wanaka and upper Clutha using household solar and battery. Outcome is lower network costs due to investment deferral.
Powerco	SolarZero	Households / SolarZero	Distribution capacity management in the Coromandel using household solar and battery. Outcome is lower network costs due to investment deferral.
Vector	Vector	Vector	Distribution capacity management using battery storage at substation and other locations. Outcome is lower network costs due to investment deferral.
Powerco	Powerco	Powerco	Generation using battery storage at Whangamata. Outcome is lower network costs due to investment deferral and reliability of supply thresholds met
Meridian Energy	Meridian	NZAS	Demand response by NZAS reducing use of electricity at specific times. Outcome is lower energy costs.
Simply Energy; Meridian Energy	Simply Energy; Meridian	Various industrials customers	Demand response by businesses reducing use of electricity at specific times. Outcome is lower energy costs
Octopus Energy	Octopus Energy	Households	Demand response using household EV charging and hot water. Outcome is lower energy costs
System Operator	SolarZero	Households / SolarZero	Ancillary services (reserves) using household solar and battery.
System Operator	Distributors	Households	Ancillary Services (interruptible load) using household hot water obtained by offering a discount on the variable component of network pricing structure
Electric Kiwi, Mercury Energy	Electric Kiwi, Mercury Energy	Households	Demand Response using household hot water. Outcome is lower energy costs
Vector	Evisi	Auckland Transport / NZ Bus	Demand Response using coordination of EV (Bus) charging. Outcome is distribution capacity management and avoided network connection investment

Source: FlexForum

Services, value signal, source and existing value on the table

Table 6 Survey of sources of value for providing electricity services

Service	What is it?	Value signal and source	Value ($) on the table for households, businesses and communities
Energy services	Generate, store and shift the time of use of electricity to: • maximise the price of electricity generated • minimise the cost of electricity used	Retail tariff products with energy-linked time of use (TOU) value	Yes, eg, Electric Kiwi etc periods of free power and TOU products
		Spot prices reflect supply and demand for energy every 5 minutes	Yes, for people opting for spot products to buy/sell electricity

Service	What is it?	Value signal and source	Value ($) on the table for households, businesses and communities
		Retailer payment	Difficult to maximise value ● DG buyback rates. People are restricted to selling to the retailer they buy from ● Payment for demand flexibility is not routine, eg, Octopus, retailer hot water control products
Transmission capacity management	Alternative to transmission capacity upgrades	Transpower payment There is no 'variable' transmission charge. Spot prices are assumed to signal the value of using flexibility	Not routine. Payments offered ad hoc for non-transmission (flexibility) solutions in specific areas, eg, upper South Island. Not guaranteed flexibility option will be procured. Not clear if value is passed back to people
Distribution capacity management	Alternative to distribution capacity upgrades	Retail tariffs with network TOU	Yes ● network TOU structures ● controlled rate discount for hot water control
		Distributor payment	Not routine (practically no) ● Payments by [2] distributors to flexibility coordinators, ie, Aurora and Powerco to solarzero ● Vector DER tariff offers $47/year to connect DER to its DERMS
Ancillary services	System support, ie voltage support, frequency keeping, black start, and instantaneous reserves Distribution support services not defined	System Operator payment for defined services	Not routine ● Via flexibility coordinators unless very large user ● A proportion of HWC offered by distributors, but value may not return to humans

Source: FlexForum

13 reasons people are not able to maximise the value of flexibility

Table 7 Opportunity-related reasons people are not able to maximise the value of their flexibility

Reason	Description	Examples / Observations
Buyers have obligations to guarantee a minimum level of service	Flexibility is part of the toolbox electricity market participants can use. However, despite being a more economical tool for the entire eco-system, the level of risks the solution offers is too high both from a supply or reputational risk perspective	Network companies have price-quality targets (SAIDI/SAIFI) that are part of the decision-making process when comparing options The risk profiles, appetites and mitigations adopted by buyers influence decision making, eg, it is also possible that the risk aversion can be exacerbated by the personal liability borne by directors.
The response from households, businesses and communities to signals is not consistent or predictable	Flexibility buyers need to have extra risk mitigation in place to cover the risks of the flexibility service not being delivered.	A retailer who cannot obtain enough generation coverage for the consumption of its customers will be required to buy energy on the wholesale market. However, risk management is core business for a retailer.
Buyers are limited to the type of signal they can use	To trigger flexibility, there are different tools available. Market participants may be constrained to pricing options because of market rules or legislation.	Distribution networks can only use "static" network charges, whereas some of the flexibility requires "dynamic" tariff structure (e.g. for congestion management). Fit for purpose pricing structures and signals are needed.
The procurement for some services does not contemplate using DER (e.g. ancillary services)	Ancillary services were designed for a thermal-based, centralised electricity system. Technological advancement in DERs means that they could replace traditional solution, but it needs the provision requirements of ancillary systems to be reviewed.	SolarZero's VPP pilot has demonstrated the technical feasibility of using residential batteries to respond to System Operator needs. The technical requirements for ancillary services should be updated.
There is no critical mass to respond to localized needs (e.g. distribution deferral)	Some parts of the value stack (e.g. Network deferral) require having enough flexibility available in localised area of the system to meet the needs of the buyer.	To reduce substation load using demand response, only the flexibility resources available behind the substation will be useful. This is a chicken and egg problem, however putting value on the table will encourage people to make resources available
Other market signals are trumping the signal sent by the buyer	Flexibility participants are receiving different signals and will react differently to them. This can either be by convenience (e.g. night tariffs always start at 9pm) or by economic analysis (e.g. despite being exposed to high network prices, the spot price is lower).	Retail offerings with "free" energy do not expose the customers to any network charges for the duration of the "free power" period. Pricing should enable people to choose how to maximise the value of their resources by signalling the value of providing flexibility. Buyers not obtaining the flexibility they need have options including signalling value by directly contracting with the provider (or via an intermediary) or increasing the reward.
It is harder for buyers to get a return from using flexibility compared to other solutions (e.g. OPEX / CAPEX trade-off)	Flexibility is only one tool that buyers can use to meet their needs. They will undertake a through economic assessment to ensure that the product they are buying can meet their needs and allow them to make an economic return.	Refer to the FNF and Resiflex projects. Both show that the timing of the 5-year regulatory periods for distributors give them OPEX and CAPEX allowances that cannot easily be moved from one type of expenditure to another.

Source: FlexForum

Table 8 Motivation-related reasons people are not able to maximise the value of their flexibility

Reasons	Description	Examples / Observations
The roles and responsibilities in the market aren't optimal	Different parties can buy and/or benefit from flexibility on the electricity system. However, some participants using flexibility can play several roles by default, limiting the choice households, businesses and customers have on how they want to offer their value stack.	A flexibility owner, eg, a household offering to export energy into the system is constrained to use the export offer of their retailer. A flexibility coordinator who's not a retailer will impact the energy sales of the retailer at that location. Roles and responsibilities should enable people to maximise the value of their flexibility.
There is not enough awareness about the benefits of flexibility for households, businesses and communities and the value they can extract	Several examples show that the owners of flexibility resources or capable of shifting their electricity consumption based on behavioural changes are not all aware of the benefits for the whole system, or their individual benefits. EECA survey found that only 42% of respondents said it would help them reduce the cost of charging by charging off-peak.	Awareness of value and benefit is fundamentally about access to information and advice about the value on the table. People do not have easy access to good advice.
Households, businesses and communities have contracts that prevent them from offering flexibility to others	Households, businesses and communities enter contractual agreements that allow third parties to control their equipment. This needs to be clearly communicated to them so they can make an informed choice.	In most cases, hot water is control controlled by the networks. However, there is a benefit for retailers to control hot water and manage their energy purchasing requirements that they could then pass on to customers.

Source: FlexForum

Table 9 Capability-related reasons people are not able to maximise the value of their flexibility

Reason	Description	Examples / Observations
Flexibility is a product, but wh at is actually being traded on the wholesale market is energy	Flexibility has a direct impact on the consumption of households, businesses and communities, electricity suppliers (retailers, and by extension, generators), reducing the accuracy of energy and peak demand forecasts.	Following the 10 May 2024 energy shortfall event the demand response observed by Transpower was ~260MW, measured between the forecast and actual consumptions. This response had a downward effect on wholesale prices. Integrating flexibility into the market would enable it to be considered (and valued) in the price discovery process for wholesale prices.
The requirements to become market participants are too high for Households, Businesses and Communities	Under the Electricity Industry Participation Code, flexibility owners need to be a market participant to trade energy on the wholesale market and maximise the value of their flexibility. We note that some retailers might develop offers like this in the future, as was Flick Energy exposing customers directly to the wholesale prices.	The Forest Lodge Orchard has been able to benefit from high wholesale prices in May 2024 by selling their stored energy to the grid. However, they could only do this under a wholesale contract where they take full exposure risk. In the financial services sector, we have seen platforms like "Sharesies" allowing customers to trade on the share market without having to bear the costs of becoming a participant.

Source: FlexForum