COMPETITION ECONOMISTS GROUP

The relative efficiency of self-supply vs arm's length supply of flexibility services

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1 Introduction and summary

1.1 Context

1. Vector has asked CEG to review submissions made on the New Zealand Commerce Commission's 2023 Input Methodologies (IM) Review Process and Issues Paper.

2. We have been specifically asked to critique submissions by electricity retailers to the effect that prohibitions or other constraints should be placed on the ability for EDBs to self-provide flexibility services. The term "flexibility services" covers a broad range of activities that relate to shifting load and/or generation of electricity to the most efficient time and/or location.

3. The retailers' submissions argue that EDBs should not be allowed to own and operate their own battery energy storage systems (BESS) or directly contract with households to supply flexibility services (e.g., to allow the EDB to directly control their appliances in return for compensation from the EDB in some form).

4. The retailers' submissions start with a presumption that it will be more efficient if those services are provided at arm's length, including by themselves. The analysis in this report suggests that the opposite will commonly be true. That is, the costs of arm's length procurement rather than self-supply are often likely to be higher.

5. Notwithstanding that conclusion, it would be a mistake to prohibit retailers (or any other party) from attempting gain access to flexibility services and sell them to EDBs. When retailers can deliver those services at lower costs than self-supply then EDBs should be given an incentive to purchase from retailers. However, when, as is likely to be commonly the case given the nature of transaction costs, there are many instances where self-supply is lower cost for an EDB they should be incentivised to do so.

1.2 Report overview

6. While the maximum potential (and expected) value of distributed flexibility services is large, with the exception of legacy "ripple control"[1] for electric hot water systems they are currently provided at a relatively small scale compared to their potential in Aotearoa and elsewhere. This reflects the recent nature of many of the technological

[1] Ripple control is an old technology where EDBs in New Zealand own and operate ripple control plant which sends audio-frequency signals through the electricity network. These signals are detected by ripple relays at consumers' premises. The relays respond by switching off certain electrical appliances, mostly hot water systems. This technology is expected to be superseded within 10 years by superior technological platforms that will also facilitate flexibility services from other devices, See, EECA, Ripple Control of Hot Water in New Zealand September 2020

changes that have created this potential value as well as a number of barriers to the provision and realisation of the value of flexibility services.

7. In order to identify the value of distributed flexibility services EDBs need to better understand and monitor flows on their networks. This is required in order that they know where and when to coordinate flexibility responses to ensure safe and efficient use of the physical network resources. This coordination function is commonly described as an EDB playing the role of a "distribution system operator" (DSO). This is analogous to the current role played by Transpower as the system operator responsible for coordinating large scale generators located on the high voltage transmission network to meet demand while taking into account the constraints of the electricity transmission network and the security of the system. As noted in Smartco's submission:[2]

> *EDB infrastructure is critical to the availability of electricity to consumers, the connection of renewable distributed generation, and the development of distribution system operator. It is hard to disassociate the development and maintenance of electricity networks from other electricity industry disciplines, as they are inter-related.*

8. Once EDBs have a platform for identifying where and when flexibility services will be of most value, the next question is how they can most efficiently procure these services. This is the focus of the question that Vector has asked CEG to address. The remaining structure of this report is as follows.

9. Section 2 describes what flexibility services are and describes why the efficient procurement of flexibility services can already substantially lower electricity supply chain costs and why this will become increasingly important overtime;

10. Section 3 addresses the questions we have been asked.

    - Section 3.1 summarises the retailers' submissions;
    - Section 3.2 critiques what we regard as Meridian's mischaracterisation of the NZCC's 2018 guidance on EDB recovery of costs associated with providing controllable electric vehicle (EV) charging. We describe our understanding of that guidance (which we agree with) and formulate a general rule for the recovery of EDB expenditure on flexibility services. Specifically, costs in eliciting flexibility services should be recoverable in the EDB's regulated cost base so long as:
        - the costs incurred by an EDB are necessary to elicit the relevant flexibility service (i.e., the EDB is not paying more than is necessary to elicit the relevant value of the flexibility services); and

[2] Smartco, Process and Issues/Draft Framework submission, 27 June 2020.

    - the expected benefits from the relevant flexibility service (e.g., in avoiding/delaying substitute grid investments) exceeds the costs of eliciting the flexibility service.

- Section 3.3 summarises the economic literature on when it is efficient to self-supply versus to purchase services at arm's length (more detail on the same question is also provided at Appendix A). A key conclusion of that literature is that self-supply is more efficient when transaction costs (broadly defined) of external supply are large relative to the value of each transaction.
- Section 3.4 explains why we consider that the self-supply of flexibility services by EDBs will often be lower cost than purchasing those services at arm's length. We provide an illustrative case study of the relative efficiency of EDB's purchasing grid connected BESS services at arm's length rather than owning and operating the BESS directly. We explain why the difficulties in specifying "complete contracts" to govern arm's length contracts with BESS suppliers can reasonably be expected to make self-supply lower cost.

11. Appendix A provides more detail on the relevant economic literature that addresses the efficient boundary of the firm (i.e., when it is more efficient to self-supply than to purchase at arm's length).

2 What are flexibility services (and why are they important)?

12. The term "flexibility services" covers a broad range of activities that relate to shifting load and/or generation of electricity to the most efficient time and/or location. Shifting load and/or generation can provide economic benefits by:

- Avoiding/delaying electricity grid expansions by reducing peak load; and
- Reducing aggregate wholesale generation costs by making more use of electricity when it is cheap to generate (i.e., shifting or increasing consumption to when the "sun is shining" and the "wind is blowing"); and
- Reducing the cost of ensuring a stable network (e.g., frequency control costs).

13. Currently in New Zealand, and in most of the world, almost all flexibility services are provided by large scale generators connected to the high voltage transmission network.[3] However, there is the potential for significant additional economic value to be created by developing greater provision of distributed flexibility services from households and businesses connected to the low voltage distribution network.

14. The potential for, and value of, distributed flexibility services is growing rapidly with technological change including:

- The growth of intermittent renewable energy generation (driven by falling costs for photovoltaic solar generation and wind turbine generation technologies). This tends to increase the value of load shifting/energy storage services;
- Falling costs of battery energy storage systems (BESS) which can be installed either by a consumer "behind the meter" or connected directly to an EDB's grid (e.g., at a substation or more widely distributed throughout the network);
- Increasing electrification of energy demand, which is likely to, absent an increase in the provision of distributed flexibility services, lead to large increases in peak demand and, therefore, significant increases in the need for grid investments;
- The fact that a large part of that new demand will likely come from charging of electric vehicles which is a potential source of controllable load in the form of "smart charging". Noting that with "smart charging" covers both the potential for electric vehicles to also provide negative load (be a source of generation) during peak periods;

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3 These generators respond to price signals in the wholesale electricity market to adapt supply to total demand in New Zealand. These price signals account for any congestion in the transmission grid – so that the most favourably located generators are incentivised to supply demand first.

- Falling costs of communication, computing and software systems used for real time control "smart devices" (e.g., BESS, electric heat pumps, electric vehicle chargers etc) integrated with advanced smart meters and home automation systems that can transmit two-way information on current consumption and send signals to consumers' appliances (which can potentially themselves to respond to load and price signals sent by smart meters).

15. If harnessed, distributed flexibility services have the potential to significantly reduce whole of supply chain costs for energy consumption.

- Save on energy generation costs by: a) storing energy when its plentiful (when the wind is blowing and the sun shining) to use when it is scarce and expensive; b) shifting flexible consumption (EV charging, HVAC[4], pool pump/heating, irrigation etc) away from periods of generation scarcity to periods of plentiful periods of supply;
- Save on distribution and transmission by: a) building a smart grid and using smart appliances including EV charging, to shift load away from periods of network congestion; and b) generating (rooftop solar PV) and/or storing (BESS) energy closer to where it is consumed;
- Build the distribution grid to accommodate higher peak load (to the extent this cannot be avoided – see previous point) and periods of high distributed generation;
- Reduce outages and system stability costs by: a) having a fully digitised grid and detailed models (including forecast models) of electricity flows not just on the transmission network but also on the distribution network; b) using control over batteries and smart appliances to ensure lowest cost balance between supply and demand even during extreme conditions.

16. Figure 1 below illustrates the dramatic (and ongoing) decline in solar and wind generating costs and is based on data from IRENA.[5]

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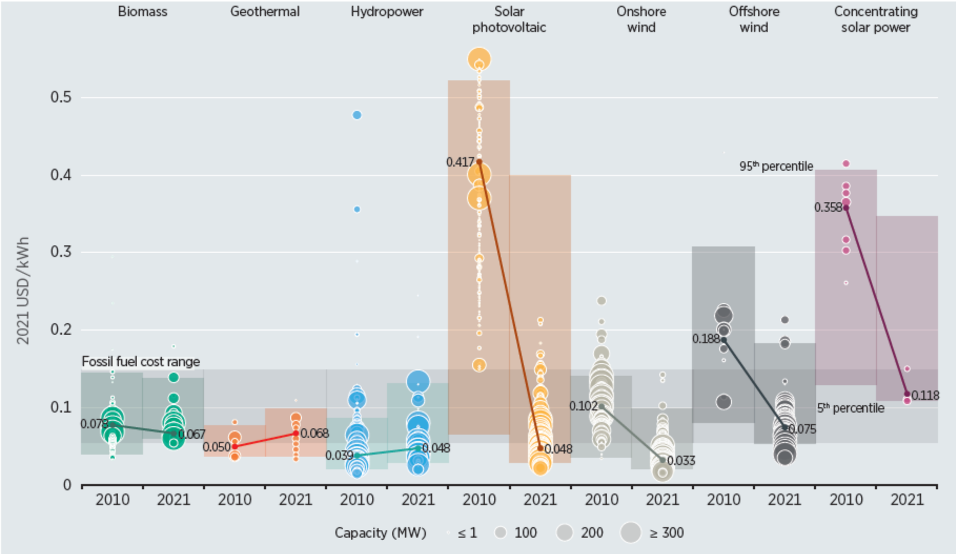
4 Heating, ventilation, and air conditioning.

5 We note that IRENA has separately estimated falls of at 13% to 15% in solar and wind generation costs across 2021 to 2022. Although IRENA have noted this trend may be temporarily disrupted in 2022-23 by materials and supply chain issues – which will equally affect other generation technologies

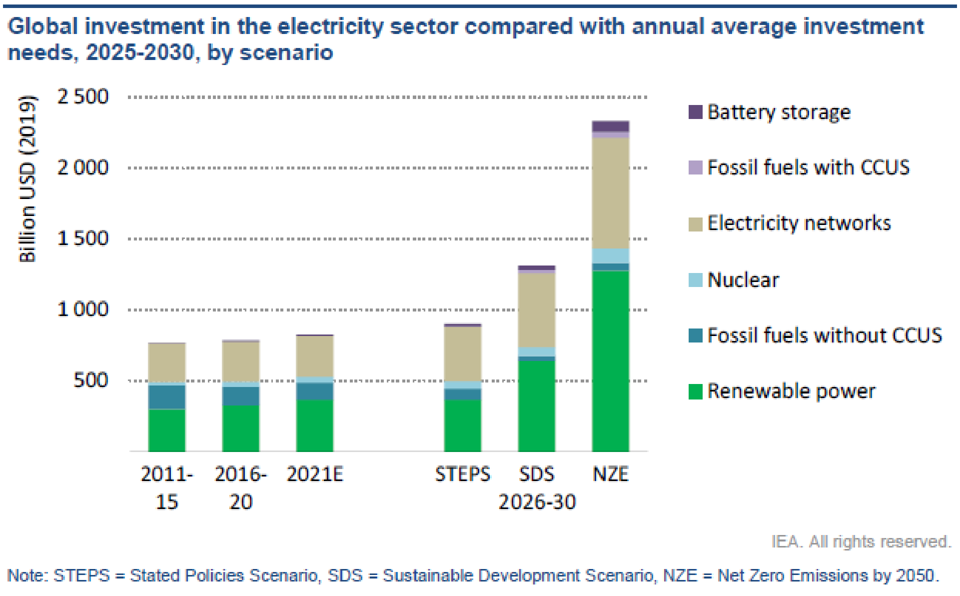
Figure 1: Global weighted average LCOEs from newly commissioned, utility-scale renewable power generation technologies, 2010-2021



Source: IRENA Renewable Cost Database.

17. However, electrification of transport and heating means that, absent substantial investment in flexibility, very material investment will be needed in both electricity grids and generation capacity (capacity that will tend to be redundant most of the year). The International Energy Agency (IEA) estimates a more than doubling in global grid and generation capacity investment over 2026-30 if a net zero by 2050 target is to be achieved.

Figure 2: IEA estimates of grid and generation investment 2026-30



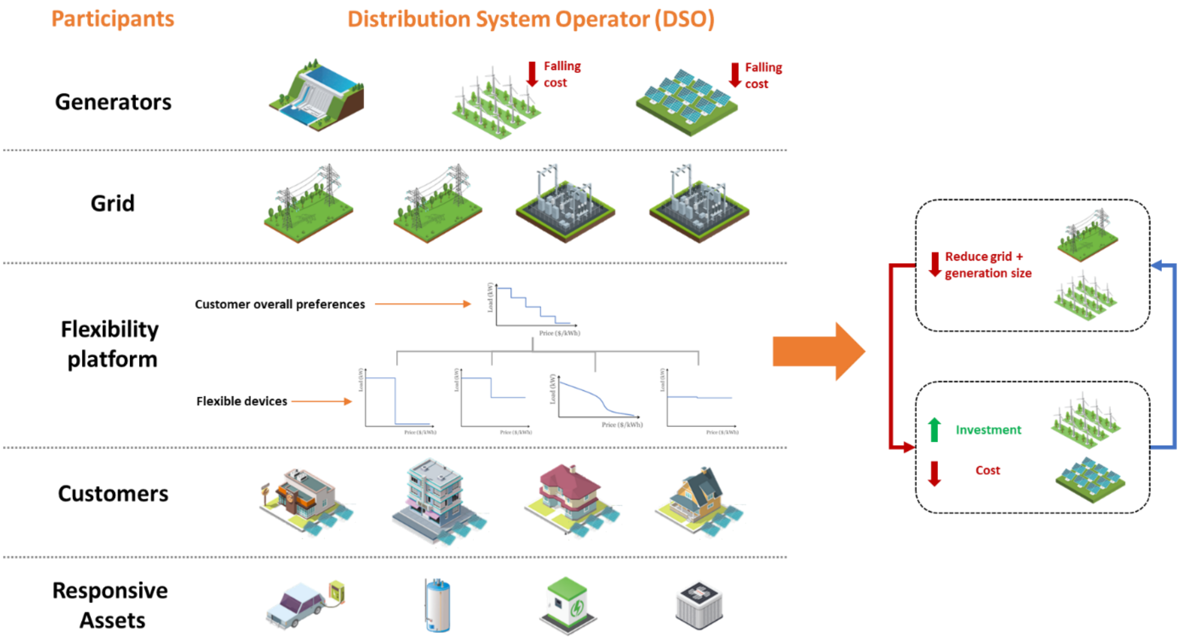
18. The "good news story" is that the electrification of energy use (e.g., via electric vehicles) will likely lower total energy costs for New Zealanders. But this is especially true if the full power of distributed flexibility services is harnessed via investment in a smart grid and associated flexibility. In this case, large portions of the IEA forecast increase in grid and generation capacity investment can be avoided or delayed.

19. A graphical illustration is provided in Figure 3 below. The generation layer of Figure 3 includes new sources of intermittent low cost generation (solar PV and wind) only recently available and the cost of which is expected to keep falling. The "Grid" layer includes transmission and distribution connecting, respectively, distant and embedded generation to customers.

20. The "flexibility platform" layer of Figure 3 reflects the potential for growing distributed flexibility services. This platform coordinates the "responsive assets" layer to manage peak demand and optimally match consumption/storage to when generation is plentiful (and *vice versa*). The coordination of responsive assets on the distribution network will fall to the EDB in their role as "distribution system operator" (DSO) and the TSO (transmission system operator, which we use as short-hand for the wholesale energy and ancillaries services markets). This does not necessarily mean that the DSO controls the responsive assets directly but, at a minimum, it must provide price or other signals to those who do.

21. This is especially valuable as more low cost intermittent generation is added to the generation layer and/or peak demand grows with electrification (e.g., from EV charging). In doing so, utilising the "flexibility platform" means the system can reliably serve a given number of customers with less generation and a smaller grid than would be needed without the platform. That is, the flexibility platform lowers whole of supply chain costs for the final consumers of electricity.

Figure 3: Graphical illustration



22. Moreover, there is a form of “virtuous circle” between the “flexibility platform” and the addition of low cost intermittent generation. By shifting demand towards the periods with low cost renewable generation, the “flexibility platform” improves the economics of investment in renewables through higher utilisation which, in turn, improves the economics of the flexibility platform – all of which result in lower supply chain costs for the final consumers of electricity.

23. A state of the art study of the benefits of distributed flexibility services was performed for the US Department of Energy and published earlier this year.[6] It estimated that distributed flexibility has the potential to reduce supply chain (grid plus generation) costs by 12% to 19%. The lower end of this range is associated with existing levels of wind and solar generation in the Texas “ERCOT” electricity supply chain. The higher bound estimate of 19% is associated with deeper penetration of intermittent renewable generation (solar and wind) and, therefore, greater benefits from flexibility.

24. The lower end (12%) cost saving is associated with the following breakdown across the supply chain.

[6] The US Department of Energy engaged Pacific Northwest National Laboratory to undertake detailed technical and cost modelling of the overall supply chain benefits to end customers associated with developing DSO capabilities.

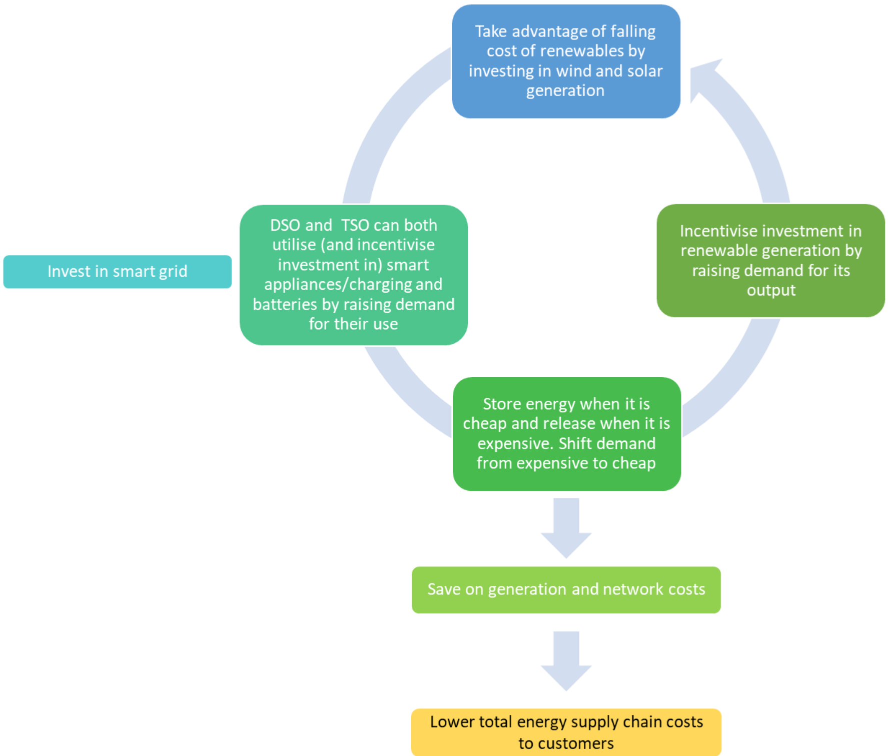
- 4% to 8% pa reduction in distribution hardware expenditure;[7]
- 10% pa reduction in transmission expenditure; and
- 22% pa reduction in generation expenditure.

25. The promotion of distributed flexibility services has the potential to create a "virtuous circle" whereby the combination of growing investment in renewables and flexibility services go hand-in-hand to lower overall supply chain costs.

- New Zealand consumers benefit from new low cost wind and solar generation;
- But this only takes New Zealand Inc "so far" without flexibility (because the value of wind and solar generation is constrained if New Zealand Inc isn't able to shift load or store excess production when generation is plentiful);
- With flexibility the true potential of renewable generation is unlocked which both lowers grid and generation cost;
    - Consumers and investors have incentives to invest in batteries and smart appliances because the mechanisms exist by which they are compensated for the services provided;
    - This action by consumers and investors not only lowers system cost immediately but, by shifting demand to make the most of low cost renewables, this incentivises more investment in renewables.
    - This in turn incentivises more provision of flexibility services.
    - And so on in a virtuous circle.

7 Although there are offsetting costs at the distribution level required to coordinate distributed flexibility services such that distribution expenditures are, on net, roughly unchanged

Figure 4: Graphical illustration of "virtuous circle" with flexibility markets enabling growth in renewables and vice-versa



26. But as Figure 4 makes clear, the full realisation of this vision relies on the existence of distributed flexibility services at the disposal of the electricity supply chain including the EDB/DSO but also the TSO.

3 Retailer submissions and summary critique

3.1 Retailer submissions

27. The submissions made by energy regulators argue that EDBs should be forced to purchase flexibility services at arm's length. For example, that the EDB should contract for flexibility from an arm's length BESS owner rather than owning and operating the BESS itself. Similarly, the retailers propose that EDB's be prohibited from purchasing flexibility services directly from customers. Instead, they propose that an EDB be required to purchase these from "middleperson" intermediaries that acquire flexibility services from households/businesses and on-sell them to the EDB (in their role as DSO).

28. For example, Meridian states (emphasis added):[8]

> *In Meridian's opinion, the regulatory regime should encourage EDBs and Transpower to use flexibility services* ***but in such a way that services are procured through open competitive processes*** *to identify the least cost provider from the market. In Meridian's opinion, the Commission should* ***resist expanding the scope of the regulated lines service into emerging contestable markets for batteries, electric vehicle charging control, or other sources of demand flexibility****. If networks want to build these technologies themselves then they should only do so either:*
>
> - *outside of the regulated lines service so there is no regulated revenue and the EDB is exposed to the same risks as any other participant in these markets; or*
> - *if the investment is within scope of the regulated lines service, then it should only be allowed through the related party transaction rules so that competitive pressure drives efficiency,* ***i.e., networks should only invest in non-network solutions through open tenders to find the least cost provider from the competitive market rather than preferring self-supply by default.***
>
> *As well as addressing this issue through the IMs review, the Commission should consider recommencing the joint Spotlight on Emerging*

8 Meridian submission to Process and issues paper for the Part 4 Input Methodologies review, 27 June 2022.

Contestable Services with the Electricity Authority. ***The Commission has previously helped to improve clarity in the industry about Impact of emerging technologies in monopoly parts of electricity sector, in particular the regulatory treatment of EV charger costs and revenue****:*

> *"The main purpose of EV chargers is to charge cars, not the provision of the regulated service (defined as conveyance of electricity by line). Therefore, our starting point is that we would not expect the costs and revenues associated with EV chargers to be within the scope of the regulated service."*

Whether through the IMs review or the Spotlight project, the Commission should seek to provide similar clarity in respect of other emerging technologies including batteries, demand response control and other sources of flexibility. ***Many providers are positioning to compete to provide services in these emerging markets and need clarity on whether they will be competing on a level playing field with EDBs*** *(or alternatively if EDBs will be able to de-risk investments by including them in their regulated asset base, limiting the ability of other parties to compete).*

29. Other retailer submissions echo this sentiment in their submissions.

30. In our view, policy makers need to tread carefully when considering calls to limit the involvement of EDBs in self-providing flexibility services. As we explain in the following sections, prohibiting/constraining self-supply of flexibility services by EDBs will likely result in:

- under-supply of flexibility services; and
- higher costs (and even higher prices charged to the EDB) for those flexibility services that are supplied by, for example, retailers.

31. That is, artificial constraints on EDB self-supply of flexibility services will lower amount of flexibility, and raise its cost, relative to the efficient levels.

3.2 Meridian's description of the NZCC open letter

32. Meridian's submission, as quoted at paragraph 28 above, implies that the NZCC's 2018 open letter "clarified" that EDB's should not attempt to self-supply flexibility services by providing EDB customers with smart EV chargers.

33. However, this is a mischaracterisation of the NZCC's 2018 statement. The Meridian quotation only includes paragraph 30 from the NZCC letter and omits the critical next two paragraphs. The relevant passage is provided in full below (emphasis added).

> 30. *The main purpose of EV chargers is to charge cars, not the provision of the regulated service (defined as conveyance of electricity by line). Therefore, our starting point is that we would not expect the costs and revenues associated with EV chargers to be within the scope of the regulated service.*
>
> 31. *However, there are **two main exceptions**:*
>
> > 31.1 ***where the EDBs have active control** over the EV charger, such that it can be controlled to manage network load (eg, for the purpose of deferring capital expenditure on the distribution network), **and the controller is not separable from the EV charger**; or*
> >
> > 31.2 *where the EDB installs the EV charger to charge the EDB's own electric vehicles and is therefore a cost incurred by the EDB in order to provide the regulated service.*
>
> 32. *Under the two exceptions, a proportion of the costs of the EV charger can be considered to be within the scope of the regulated service.*

34. In this passage the NZCC is clearly contemplating that an EDB could engage in marketing and installing smart controllers and that 100% of those costs could be recovered in the EDB's cost base.

35. This is consistent with our view as to how the NZCC should approach the self-provision of flexibility services. Specifically, costs in eliciting flexibility services should be recoverable in the EDB's regulated cost base so long as:

    - the costs incurred by an EDB are necessary to elicit the relevant flexibility service (i.e., the EDB is not paying more than is necessary to elicit the relevant value of the flexibility services); and
    - the expected benefits from the relevant flexibility service (e.g., in avoiding/delaying substitute grid investments) exceeds the costs of eliciting the flexibility service.

36. The above is a general rule for all EDB spending on flexibility services (self-supplied or procured at arm's length). Indeed, it is a general rule for all EDB spending.[9]

37. Rather than the NZCC passage "clarifying" a prohibition on EDB's including the cost of directly procuring flexibility services (e.g., via investing in control of electric vehicle chargers), it explicitly states that these cost should be recoverable in the regulated cost base under certain circumstances.

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[9] That is, replacing the term "flexibility service" with "outcome".

38. The NZCC's statement also clearly states that provision of a dumb EV charger (one that is incapable of providing flexibility services) would not be able to be included in an EDB's cost base. This is, again, entirely consistent with the criteria we propose in paragraph 35 above. The expenditure on a "dumb charger" would deliver no flexibility benefit and, therefore, could not be justified under any circumstances as an efficient substitute for grid investment.

39. Similarly, the NZCC contemplates a scenario where a smart controller is not separable from an EV charger and states "a proportion of the costs of the EV charger" may be recovered in the EDB's costs base. However, the open letter, quite sensibly given the context, does not attempt to detail exactly how that proportion between 0 and 100% should be set.

40. We address this question now in the context of the general rule set out at paragraph 35 above. Like any other expenditure, an EDB should be able to include the lowest of the following values in its cost base:

   a. The expenditure incurred to procure flexibility services;

   b. The value of flexibility services derived from that expenditure; or

   c. The cost of deriving the same value of flexibility by a lower cost method (such as a network infrastructure investment).

41. That is, an EDB should only include 100% of its expenditure in its cost base if the expenditure was efficient in the sense that it delivers a net benefit (or more benefit than it cost) and that benefit could not have been derived at lower cost by some other method.

42. This general rule does not depend on the exact form the expenditure takes. For example, imagine two approaches where an EDB could procure flexibility services from a smart controlled EV charger:

   a. Install, for a cost of $1,000 to the EDB (but free to the customer), a smart controller to work with the customer's separately purchased EV charger. The EDB can then pay the customer a lump sum amount of $2,000 to have rights to control that charger for the next 10 years; or

   b. Install, for a cost of $3,000 to the EDB (but free to the customer), an EV charger with a built in smart controller. However, this is done on condition that the customer assigns rights to control that charger for the next 10 years.

43. The two approaches are economically identical. In both cases the EDB gains the same flexibility services for the same present value cost ($3,000). The only difference is that, in the second scenario, instead of paying the customer cash to provide flexibility services the EDB provides them with an EV charger to the equivalent value. The important question is whether the total compensation provided to the customer was less than the value the customer provided the EDB in

the form of flexibility services (not in what form the compensation was provided to the customer (e.g., cash or in kind benefit).

44. It could easily be imagined that the second scenario has lower costs of procuring flexibility services than the first (say, $2,000 per customer rather than $3,000).[10] In which case it would be more efficient to supply the free or subsidised integrated charger and make zero additional payment to the customer for flexibility services.

45. In this context, retailers may reasonably argue that if they could supply the same 10 years of control over smart EV chargers for less than $2,000 per customer then the EDB should purchase this from them. That argument would be correct and the regulatory regime should incentivise this. However, the regulatory regime must not force EDB's to buy such a service from retailers at more than $2,000 if they could self-supply the same services for less than $2,000.

46. In the future, the EDB as DSO will be buying flexibility from customers in order to avoid spending on grid investment. The question the regulatory regime will increasingly need to address will be at what point does congestion on a specific part of the network need to be mitigated and what is the best way to achieve this in the long-term interests of consumers via: installing Network owned and operated flexibility resources (such as BESS); increasing network capacity (such as a substation upgrade); or procuring more flexibility services from customers in that location?

47. To the extent that retailers can and do sell flexibility to EDBs at a lower cost than the EDB procuring flexibility directly from its customers then the regulatory regime can and should be incentivising EDBs to buy that flexibility at the lowest cost. However, it would be a grave error if EDB's were forced to buy all flexibility services at arm's length before there is any evidence that this results in the lowest costs to consumers. Indeed, it would be an especially grave error when there is reason to believe, as surveyed in section 3.4, that purchasing flexibility services at arm's length will, at least in some circumstances, be higher cost than self-supply.

3.3 The economics of self-supply vs market supply

48. The retailer submission proceeds on a presumption that, if it is conceivable that a service is "contestable" and can be provided via an "open competitive processes",

10 For example, it could be lower cost to procure smart chargers with integrated controllers than the retrofit controllers to dumb chargers. Similarly, it may lower transaction costs for the EDB to take control of the supply chain costs (including installation) than for the customer to do so (this includes lower transaction costs to the customer in devoting time and attention to the relevant decision points). This may mean that the lowest cost way of convincing a customer to allow an EDB to gain control of their charger may be for the EDB to install it. This may especially be the case if the customer understands that the scheme they are participating is an activity regulated by the NZCC to ensure it is to the long-term benefit of the customer.

then it follows that it is also efficient for that to occur. That assumption is not correct and is not consistent with the well understood economic theory surrounding the theory of the firm.

49. As is well understood in the economic literature, if "contestable" provision by "open competitive processes" was always the most efficient way to coordinate economic activity then there would be no "firms".[11] The very existence of firms tells us that self-supply is often more efficient than supply via arm's length markets. This economic literature is summarised in Appendix A.

50. Appendix A also describes the fact that many, if not most, business-to-business supply-chain transactions are relational rather than arm's length (e.g., are between firms with longstanding cooperative relationships that do not involve constant "market testing" or tendering). That is, even these "market" transactions between independent entities are not "open competitive processes" in the sense that individual transactions are subject to an open tender or some other form of contested supply.

51. In this context, it is not enough for the retailers to simply state that there could/might be supply via arm's length market. In order to justify a prohibition on EDB self-supply they would need to demonstrate, with a high level of confidence, that arm's length supply will always be lower cost.

52. In section 3.4 we explain why we consider that the opposite will often be the case. Specifically, that arm's length purchase of flexibility services will often come at a higher cost than self-supply. Of course, this is not a reason to prohibit retailers from attempting to procure these services and on-sell them to EDBs. Retailers and EDBs (and any other party) should attempt to procure flexibility services at the lowest possible cost for their particular need case. EDBs should be given an incentive to choose external supply whenever it is lower cost than self-supply – just as EDBs are currently incentivised to do so in other areas of their operation (e.g., IT services, vegetation management, field services and maintenance and some construction services).

53. There may be legitimate concerns in certain circumstances that an EDB may inefficiently prefer self-supply to a lower cost arm's length supply of the service by a third party. The task for good regulatory design will be to identify and disincentivise this conduct. For example, an EDB may be required, in certain circumstances, to provide a cost benefit analysis where they directly compare costs of self-supply versus external supply. However, a prohibition on self-supply is an extreme response to such concerns – and one that will almost certainly raise rather than lower costs to end customers.

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11 In economics, the term "firm" is used to describe a sphere of economic coordination where is found to be more efficient to organise economic activity by top-down managerial direction than by "open competitive processes".

3.4 Why arm's length procurement can raise the cost of flexibility services supplied to EDBs

54. The retailers' submissions propose that the NZCC effectively constrain EDBs to only buy flexibility services at arm's length (including from retailers themselves). In this section, we discuss why such an action can be expected to raise the cost of flexibility services to EDBs and, therefore, raise the entire supply chain costs for the electricity sector. In doing so we use an illustrative example of procuring flexibility services from grid installed BESS assets.

3.4.1 A brief note on institutional arrangements

55. Flexibility services are likely to deliver value across the supply chain. This includes in currently existing energy wholesale markets as well as in the provision of grid support services. To the extent that an EDB did self-supply flexibility services (e.g., a BESS system) for the primary purpose of providing grid support services then it would be economically efficient for that EDB to also operate those flexibility services to provide ancillary benefits. In particular, charging the BESS when energy prices are at their lowest and discharging when energy prices were high (even if, at that time, the local grid was not operating near capacity).

56. To the extent that existing institutional arrangements do not currently reward/incentivise this outcome then they should be amended to do so. The remainder of this report is written on the assumption that the institutional arrangements do evolve to ensure that this is the case.

57. By way of example, an EDB operating BESS for grid support could earn net revenues by participating in the wholesale energy market (buying at prices prevailing when charging and selling at prices prevailing when discharging). These revenues (actual or forecast[12]) could then be included in regulated revenues – partially offsetting the amount that customers pay for the BESS for grid support.

3.4.2 Procuring flexibility from grid connected BESS

58. In this section we consider a scenario where an EDB is installing a battery on the low voltage network to provide grid support functions. Here the investment cost is measured in $m (and potentially thousands of dollars in the future). The EDB could attempt to facilitate this by buying and operating a BESS. In which case, the EDB would still market test the price of the BESS.[13] However, once installed, the

[12] The regime may prefer to use (or give weight to) forecast revenues from the BESS business case in order to ensure that the EDB has no incentive to overstate these ancillary benefits.

[13] This may involve holding a formal arm's length tender or purchasing/installation of the BESS or it may involve purchase from one of a set of third-party suppliers that the EDB procurement team have built long term relationships with a self-supply of installation.

EDB would have full control over the future operation of the BESS. This would include the ability to operate the asset to provide the maximum value over time; including the ability to relocate the asset to other parts of its network should this become a better use of the asset.

59. By contrast, the EDB could develop a contract for a third party to supply the BESS services and hold an arm's length tender for the right to fulfil that contract. That contract would need to attempt to specify all of the potential contingencies that might occur over the life of the contract and what is to be done by the relevant parties in the event of those contingencies.

60. The problem with the latter approach, as identified in the economic literature, is that any such contract is difficult to write. Inevitably the contract will be "incomplete" in that some contingencies, and the associated efficient actions in the event of those contingencies, are too difficult to specify in a legal contract (and many contingencies may not be able to be specified). (See Appendix A for a discussion of the economic literature on the transaction costs of contracting and why avoiding the cost of "incomplete contracts" is an important rationale for self-supply of services within the firm rather than via external market supply.)

61. For example, consider the situation where a BESS is installed in one network location in an attempt to avoid a substation expansion. However, imagine that after the passage of time it is no longer efficient to locate the BESS at that location. This might be because peak demand did not increase to the level that was feared or because it rose further/faster and the substation capacity expansion went ahead in any event. Further, imagine that, in this contingency: it was believed to be most efficient to do one of the following:

   a. Mothball the BESS until a new constraint developed on the EDB's network;

   b. Immediately relocate the BESS to a different location on the EDB's network;

   c. Immediately relocate the BESS to manage a constraint on a different EDB's network; or

   d. Use the BESS at another location for another purpose (e.g., at a wind turbine generation plant).

62. If the EDB owns and controls the BESS it can simply perform the action specified in contingencies a. and b. Similarly, it could negotiate directly with the alternative user of the EDB imagined in contingencies c. and d.

63. However, if the EDB has entered into a long-term contract with an arm's length owner/operator of the BESS then any of these actions would need to be negotiated within the confines of the contract. One way to deal with this would be for the contract to allow the EDB to terminate the contract whenever they could demonstrate that the BESS was no longer required for the original purpose. If the contract includes such a termination clause, then the full rights to the BESS would

revert to the arm's length party on termination and they then take on the risk associated with finding an alternative use for the asset – which might be one of the contingencies listed in a. to d.

64. Of course, any attempt by the EDB to use such a termination clause would be likely to be legally contested if the effect of it would be that the arm's length provider would be financially disadvantaged (e.g., if the value in the alternative uses was less than the remaining value of the contract payments from the EDB). The contract could include compensation in the event of termination but the required compensation could never be known in advance (without knowing the value of alternative uses at the time of termination). A general compensation provision could be written such as "compensation for economic loss" but this would just be another source of legal conflict in the event of attempted termination.

65. Alternatively, the contract could have no termination right conferred on the EDB but the EDB could simply negotiate with the arm's length provider in the event that the BESS was no longer useful. For example, the EDB could offer to pay the arm's length provider to relocate the battery to a new, more useful, location on the EDB's own network. Alternatively, the EDB could agree to allow the arm's length provider to move the BESS off its network (e.g., in contingency c. or d. above) and negotiate a reduction in the amount it continued to pay under the original contract. Of course, if the contract gives the arm's length service provider the right to reject such offers it will have the upper hand in such negotiations and will attempt to negotiate only a small reduction in payments from the EDB even if it can profitably redeploy the BESS elsewhere.

66. The above discussion relates to the costs associated with managing a contract once it is in place. There are also transaction costs for all parties, includes the tenderers, associated with designing a contract and running the tender process. The final price of a tender must be expected, on average, to cover the costs of the project plus all the transaction costs of the tenderers in tendering (not just the costs of successful tenderer).[14] Even if the final contract is "perfect" in that it covers all contingencies and leaves no residual risks with any party, it will still be costly for all parties to come to this understanding and to put in a bid that reflects this. If these transaction costs are large relative to the size of the BESS system it may simply be inefficient to incur these costs rather than self-supply (even putting aside the potential issues with managing the contract over the life of the asset).

14 If this was not the case in expectation then nobody would rationally participate in tenders. Given that a party to a tender has a less than 100% probability of winning every tender they must, rationally, bid to recover mor than 100% of their costs in each tender (in order to ensure that, on average across all tenders that they participate in, they do recover all of their costs). This is why there is a well-known trade-off between having additional tenderers to promote more competitive pricing while still giving each tenderer a reasonable expectation of actually winning the tender.

67. The above discussion serves to illustrate the potential advantages of self-supply over operation of the BESS via contract with an arm's length third party supplier. That is not to say that, in some circumstances, it may be efficient to enter into arm's length contracts. However, it would be a mistake to simply assume that this is always the case.

68. Put another way, just because it is possible that BESS services could be supplied in a contestable tender process does not mean that it is efficient for this to occur. Forcing EDBs to buy these services in a "competitive market" will often just not be economically sensible. There are similar reasons why it is not sensible that the EDB tender to third parties to build and own substations and the EDB contracting for the services from those substations. While it is possible to put many services out to tender, it is not always efficient to do so.

Appendix A Economic literature on the theory of the firm

69. Ronald Coase was awarded the Nobel Prize in economics, in part, for his 1937 work identifying transaction costs as explaining why firms exist and the efficient boundary of the firm.[15] Specifically, why some services are self-supplied and organised internally by managerial discretion within a firm and other services are purchased at arm's length from other firms.

70. The Economist magazine summarises Coase's theory as follows:[16]

> *…in 1937, a paper published by Ronald Coase, a British economist, pointed out a glaring omission. The standard model of economics did not fit with what goes on within companies. When an employee switches from one division to another, for instance, he does not do so in response to higher wages, but because he is ordered to. The question posed by Coase was profound, if awkward for economics: why are some activities directed by market forces and others by firms?*
>
> *His answer was that firms are a response to the high cost of using markets. It is often cheaper to direct tasks by fiat than to negotiate and enforce separate contracts for every transaction.*

71. The answer proposed by Coase was "transaction costs" defined to cover a broad range of costs – including the costs of monitoring and enforcing contracts. Higher transaction costs are the primary disadvantage associated with arm's length procurement and an important reason why it might be lower cost for a firm to self-supply the service. Indeed, transaction costs are the primary reason for the existence of firms in the first place.

72. Subsequent economic analysis has developed Coase's idea and focussed on the difficulty in setting out fully specified contracts to govern all possible eventualities. Again, The Economist summarises this literature as follows.

> *Central to it was the idea that it is difficult to specify all that is required of a business relationship, so some contracts are necessarily "incomplete".*
>
> *… for many business arrangements, it is difficult to set down all that is required of each party in all circumstances. …*

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15 R H Coase, *The Nature of the Firm*, Economica, 1937.

16 The Economist, *Coase's theory of the firm*, July 29th, 2017.

Where it becomes costly for a company to specify all that it wants from a supplier, it might make sense to acquire it in order to claim the residual rights (and the profits) from ownership. But, as Messrs Grossman and Hart noted, something is also lost through the merger. The supplier's incentive to innovate and to control costs vanishes, because he no longer owns the residual rights.

73. This highlights the critical trade-off at the efficient boundary of the firm. There are advantages associated with self-supply due to the greater flexibility and adaptability of self-supply versus management by detailed legal contract or repeated auction/tender. However, these advantages may come at a cost if internal supply of the service reduces the incentives for innovation in the supply of those services.

74. This also means that the true boundary of a firm (as a matter of economics as opposed to legal form) will often be blurry. For example, the supply chain for an iphone or a Toyota will typically involve transactions between a number of legally distinct entities. However, rather than being awarded based on regularly held arm's length tenders, these supply chains will often be governed by long-term relationships where supplier and purchaser are closely tied[17] allowing them to adapt together to changing circumstances (e.g., to work together on developing new product specifications). These relationships can be broken but this is not done lightly and they are certainly not managed by ongoing arm's length tender (e.g., every time a new product specification is desired).

75. This is described by Delgado and Mills (2017) as follows:[18]

Successful partnerships between Japanese automakers and their suppliers have long been documented in the supply management literature (Cusumano and Takeishi, 1991). Toyota's <u>*relational*</u> *contracts with their suppliers have been associated with more effective innovation by the automaker and its suppliers, in contrast to General Motors' short---term, arm's length relationships with suppliers. Lead firms should consider methods that allow them to foster and value collaborations with suppliers. See Helper S. and R. Henderson (2014). "Management Practices, Relational Contracts, and the Decline of General Motors," Journal of Economic Perspectives28 (1), 49–72.*

76. In summary, transaction costs are a key driver of how a market economy is organised:

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17 Sometimes via cross-ownership of equity.

18 Delgado and Mills, The Supply Chain Economy: A New Framework for Understanding Innovation and Services, MIT Innovation Initiative, 2017.

- Many transactions take place **within** a firm subject to managerial discretion over what resources are used when and where;
- Of the remaining transactions **between** firms:
  - Many are coordinated in stable supply chains governed as much by long-term relationships as by long-term contracts;
  - Only a fraction of transactions are governed by repeated "auction" processes such as arm's length competitive tenders.

77. That is, many, if not most, "market" transactions (i.e., between firms) are not of the kind where an auction is held to find the lowest cost supplier.