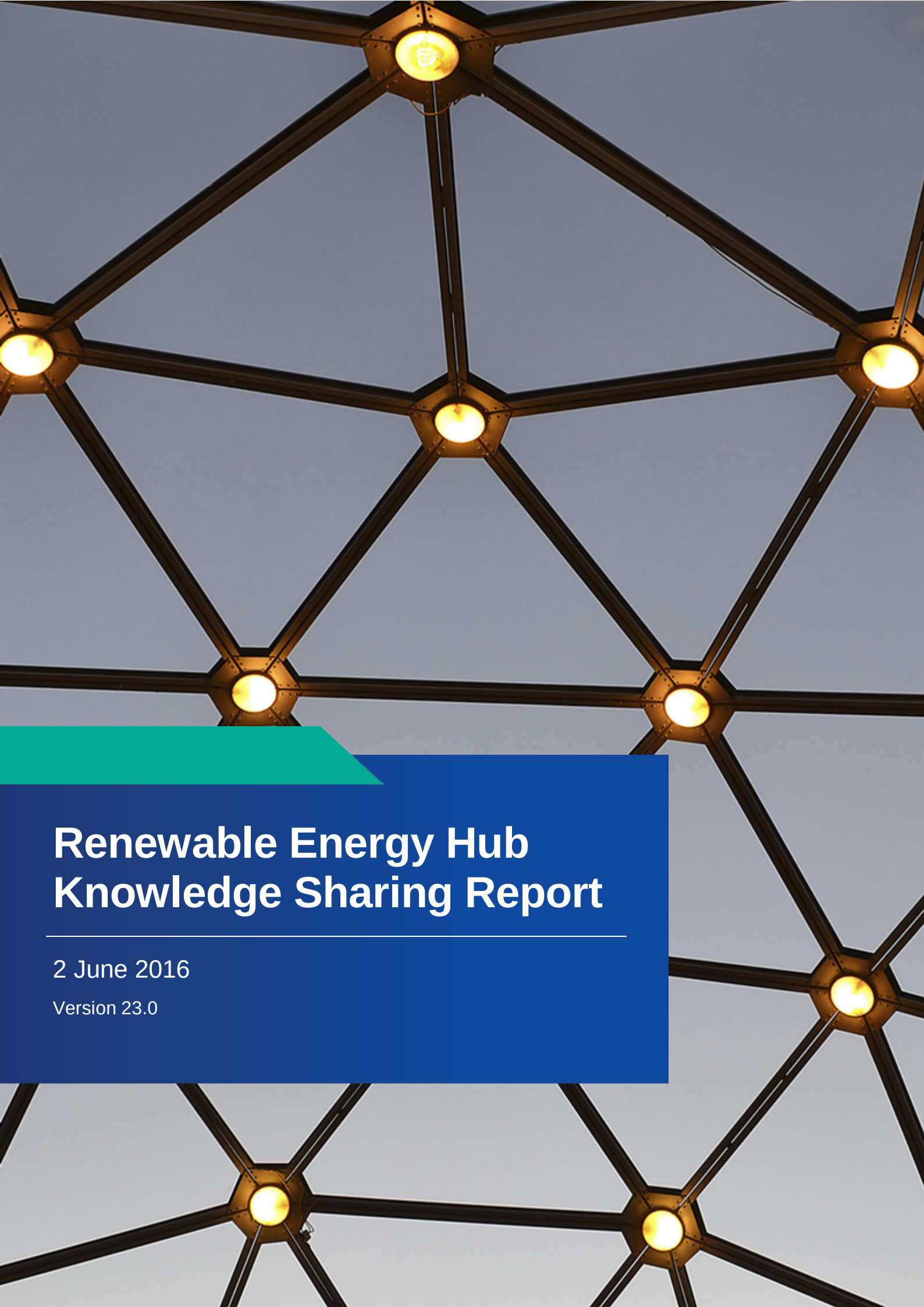


Renewable Energy Hub Knowledge Sharing Report

2 June 2016

Version 23.0

Acknowledgement

The production of this report has been generously supported with funding made available by the Australian Renewable Energy Agency and the NSW Office of Environment & Heritage. It would not have been possible without the extensive contributions of time and expertise from numerous individuals within the TransGrid team whose input is gratefully acknowledged. Specialist consultants from Advisian devised the commercial strategies under which a Renewable Energy Hub could be brought forward. We would like to also acknowledge the work undertaken by the teams at HoustonKemp, Parsons Brinkerhoff and Aurecon all of which provided a strong foundation for the conclusions drawn.

TransGrid Project Team
July 2016

Foreword

TransGrid is embracing the changing energy landscape and the increasing role renewable energy resources have in the future energy supply chain. TransGrid is investigating its role as a TNSP in enabling the increased integration into the grid of renewable generation at large scale, predominantly wind but including solar.

This report provides an overview of a feasibility study in the New England region in NSW where a number of renewable projects have been progressing independently of each other. While confidentiality provisions in the National Electricity Rules (NER) prevent TransGrid from disclosing details of parties who have made connection enquires in the same area, there has been sufficient information in the public domain over time to allow parties to identify each other and liaise with TransGrid to explore efficient ways of securing connection to the grid at the appropriate capacity.

A Renewable Energy Hub (REHub) or shared connection has the potential to provide a cost effective connection compared to the alternative of each project developing stand-alone connections. This benefits consumers in the long term. There are many factors to be taken into account in the final design of any REHub prior to implementation, including the different commercial approaches of each participant, national renewable energy policy and the National Electricity Rules.

Funding provided by ARENA and the NSW Government, matched by TransGrid, has allowed TransGrid to carry out a feasibility study investigating the technical and commercial aspects of a proposed REHub in the New England region. The study is intended to provide the foundation for a proof of concept for the construction of a REHub.

The REHub may encourage and attract further renewable energy development into a region. A key objective of the feasibility study has been to provide a framework that is repeatable in other locations to ensure that the uptake and rollout of REHubs can be achieved efficiently, ensuring communities and consumers benefit ultimately from clean and sustainable energy solutions within the National Electricity Market framework.

The main issues are commercial in nature rather than technical. It is unlikely that all potential generators will be in a position to commit to be connected at the time that the REHub is initially built. While a REHub will therefore most likely be developed in stages, there will be uncertainty as to whether all identified potential generators will ultimately actually connect. If the REHub is sized to accommodate more generation than does in fact connect, then the asset investor will experience sub-optimal returns. The study identifies ways to deal with this stranded asset risk and to ensure that the parties bearing this risk receive a return commensurate with the risk borne.

There are valid arguments for scale efficient grid connections in areas of superior renewable energy resource. Connections set up as local REHubs may prove to be an important ingredient in addressing the challenges associated with designing, managing and operating increasingly decentralised electricity supply from renewable sources.

Contents

Version 23.0

List of Tables

List of Figures

List of Boxes

1. Executive summary

Generators need timely, cost effective connections

Where multiple applications are received from generators for connection in the same area an early application will affect the outcome for following applications, perhaps to the extent of precluding them if the later connecting party faces higher connection costs. Where the network capacity is limited relative to the number of generators seeking to connect in an area with a strong energy resource, this can have the effect of leaving the resource underutilised, resulting in a less favourable national economic outcome as the generation supply side is progressively filled from sub-optimal sources.

One of the most significant challenges for renewable energy developers is the ability to secure appropriate connection to the electricity network. There is a need for scale efficient grid connections in areas of superior renewable energy resources. Appropriately priced these will help overcome first mover cost disadvantages. They will also serve to lower the barrier faced by following generators seeking connection locations with available capacity. Cost reduction and connection certainty will together encourage maximum use of good renewable energy resources.

A shared connection or **Renewable Hub (REHub)** is likely to provide connection at a lower cost when compared to the alternative of each project developing stand-alone connections. The design of a REHub and the regulatory classification of the services it provides will have an impact on the recovery over time of its costs, and which parties bear those costs. The presence of a REHub will give developers greater certainty of connection and will likely act to encourage further renewable energy development. Development of the first-of-a-kind REHub will provide a framework suitable for replication in other locations.

However, in agreeing to a cooperative framework for sharing connection assets, each generator is essentially facilitating the connection of a competitor at a lower price than they would otherwise pay. Broader commercial strategic considerations may tend to make generators less willing to cooperate with their competitors, despite the benefit of a lower connection cost and better financial project outcome for themselves.

Though styled here as a “Renewable” Energy Hub, the Hub concept is applicable wherever multiple, decentralised generators of any type require a grid connection.

Local characteristics favour some sites over others

The strength and distribution of the renewable energy resource, the characteristics of the network at the location of generator connection and the timing of such connections play a role in the electricity export performance that can be achieved.

Factors encouraging development of a REHub include:

- An area of good renewable energy resource
- A local grid of sufficient strength
- Policy and regulatory conditions supporting development of renewable electricity generation
- Favourable pricing available from the electricity market accessible to the new renewable generation
- Local community support for the generation and its grid connection
- Favourable pricing available from the renewable energy certificate market.

While the Renewable Energy Target scheme acts as a strong commercial driver in the near term, its influence will fade over time as its importance to generators as a line of revenue diminishes in comparison to revenue from the sale of electricity.

A REHub is similar to the SENE concept in the current regulatory framework

A REHub is attractive as a concept as it is likely to yield reductions in the overall cost of connection as a consequence of economies of scale. In this sense it is similar in concept to the scale efficient network extension (SENE) identified in the National Electricity Rules (NER) and is subject to the same potential hurdles for commercial development.

A 2011 Australian Electricity Market Commission (AEMC) rule change set the SENE framework. The Rules define a SENE as "an augmentation to a transmission network which is capable of facilitating the future connection to the transmission network of two or more generating systems in the same geographic area that have different owners, operators or controllers".

The AEMC's rule change created a new obligation on transmission businesses to undertake, on request, studies to estimate the potential opportunities for efficiency gains from the co-ordinated connection of generation in a particular geographic area (termed 'SENE Design and Costing studies'). The intention of this provision is to assist potential investors to make an informed, commercial decision to fund a SENE, having regard to the potential gains from co-ordinated, efficient generator connection arrangements and the potential costs of assets being 'stranded'.

However, since the SENE rule changes were implemented, no SENE Design and Costing studies have been requested or completed in the National Electricity Market (NEM). One reason may be that it is currently unclear whether the regulatory arrangements will allow investors to earn a return commensurate with the risks of the investment, for that part of the investment that is treated as a negotiated service under the regulatory arrangements. This tends to indicate that there is an opportunity to improve, or to at least clarify the arrangements as to how the costs of a SENE (or a REHub) (including a return commensurate with the risks borne) will be recovered. In the absence of a clear framework there is little incentive for a commercial party to pay for such a study.

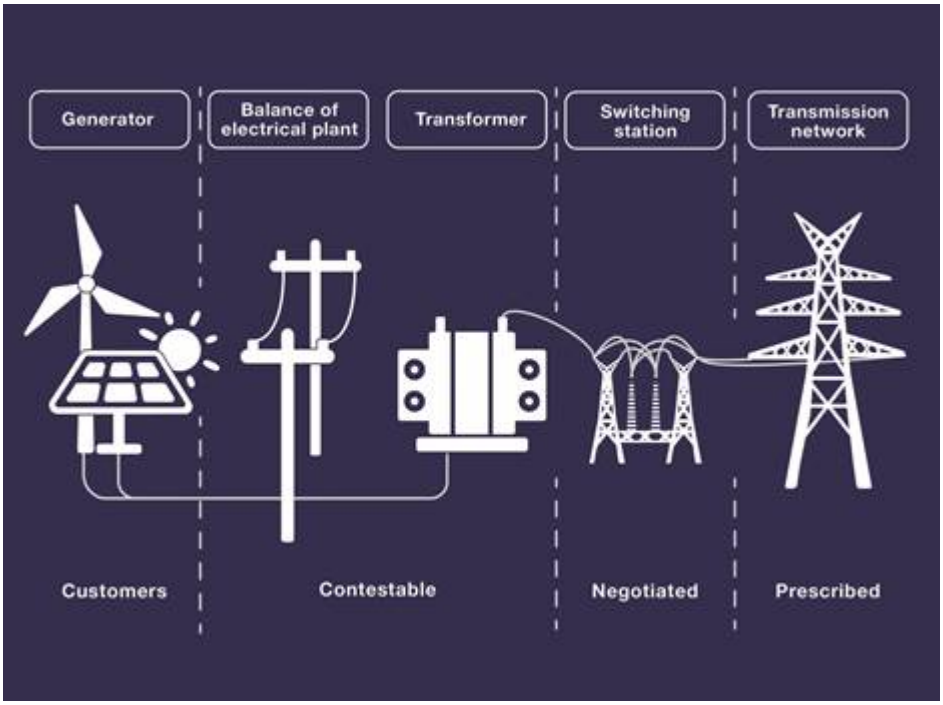
Stranded asset risk is a key consideration

By its very nature, a REHub development would most likely require an initial investment in higher specification, or 'oversized' common assets. Ideally, the additional capacity is eventually fully subscribed such that the economies of scale yield cost benefits. However, the investment carries the risk that not all the connections initially foreseen will eventuate, creating a 'stranded asset' risk: that is, the risk that the oversized asset may not end up being fully used. There is therefore a commercial risk for the equity participants (which might include the TNSP), the connecting parties and other investors.

REHub assets will primarily provide negotiated and contestable services

The services provided by the assets required for a REHub are expected to primarily fall into the regulatory categories of ‘negotiated’ and ‘contestable’ transmission services. They would therefore not form part of the ‘shared network’ that provides ‘prescribed’ services, and would not be included in the transmission business’ regulated asset base (RAB)[1].

1 The RAB is a regulatory construct that represents the asset base used to determine the revenue a business is allowed to earn from standard control services. It does not necessarily reflect all of the physical assets included as part of the network.



There are no regulatory restrictions on the contestable component of a REHub

There are no regulatory restrictions on that part of the REHub that is considered to provide contestable transmission services. This is essentially that part of the REHub that connects individual generators to the substation boundary (often referred to as an 'extension').

The charges for that part of the REHub are therefore able to be set as the outcome of commercial arrangements between the party funding those assets and the connecting generators, including the implied rate of return earned on those assets, and any arrangements for sharing the costs of those assets between generators.

However, in practice, arrangements under which the initially connecting generator funded the entire extension may represent a first-mover hurdle to such development. Conversely, generators face conflicting incentives to share costs with later, competing entrants.

Risk sharing pricing options are constrained by the regulatory framework

Some of the REHub assets would be considered to provide negotiated services. These are essentially the assets within the sub-station boundary. There are provisions in the National Electricity Rules (the NER) covering the charges that can be levied for negotiated services. These regulatory arrangements have potential implications for how the costs associated with a REHub may be recovered from connecting parties, and on whether the funding party can levy charges that reflect a rate of return commensurate with the risk it has borne in building the connection assets ahead of all generators connecting.

Should a REHub be built but the sequence of generator connections be only partly complete, the total investment in the REHub may be greater than the combined stand-alone connection costs for individual generators might otherwise have been. The NER rules prevent a transmission network service provider (TNSP) charging costs for negotiated connection services that are greater than the stand-alone cost (although this stand-alone cost can incorporate some degree of expandability to accommodate future generation). This implies that for this portion of the investment, the additional costs of sizing the REHub assets to also accommodate future generation would need to be borne by a party other than the connecting generators.

In addition, the negotiated service principles require the price for negotiated services to reflect the 'costs' of providing that service. Although it appears reasonable (and consistent with the AEMC's intent in the SENE Rule change) to interpret 'costs' to include the cost of the risk borne, the current wording of the NER does not put this beyond doubt.

The development of a REHub is framed so as to encourage additional generation to connect. If as a consequence the shared network assets also require an upgrade in order to relieve congestion, an investment in prescribed assets would be required. This investment would be subject to a regulatory investment test for transmission (RIT-T). If successful, the TNSP would be entitled to recover the cost of this prescribed investment from its transmission customers via their TUOS charges. In applying the RIT-T, the TNSP would need to demonstrate that relieving the congestion on the shared network was expected to result in an overall net benefit to the National Electricity Market – for example, as a result of an increased dispatch of lower cost generators.

Options for suitable commercial arrangements for developing a REHub

The commercial configuration underpinning the financing and operation of an REHub can take a number of forms which reflect the allocation of risk between the TNSP, the initiating generators, the following generators and government.

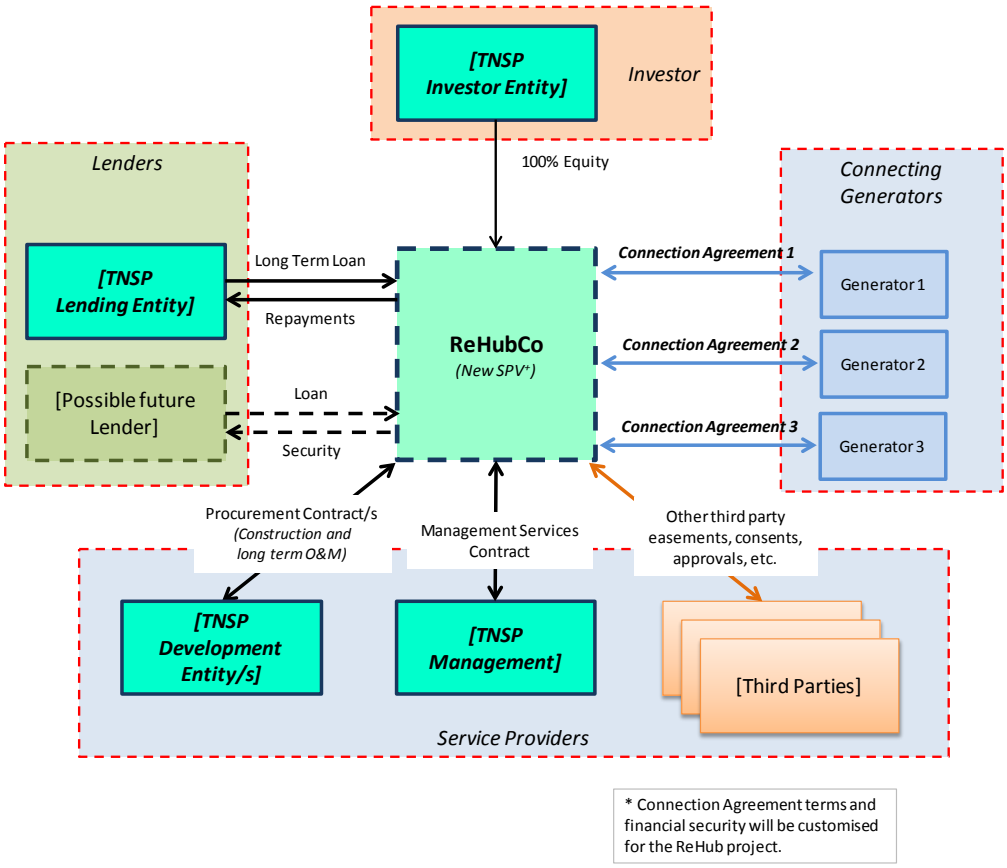
Four options have been considered for managing this stranded asset risk:

- Sharing the risk with the connecting parties
- Passing the risk to the first connecting generator
- The TNSP accepting the risk itself, or
- Introducing others to take the risk.

Key variables will act to influence the technical configuration and the commercial structuring. Each potential equity participant has its own risk appetite and is incentivised in different ways. Each REHub will have unique technical characteristics and its bespoke commercial structure which, while it may have similarities with predecessor arrangements, will respond to its own particular factors.

A special purpose vehicle corporate structure is proposed

A convenient commercial arrangement for a REHub would be one structured around a special purpose project vehicle (SPV) established specifically to undertake the REHub project. This structure potentially lends itself to the inclusion of equity investors beyond the TNSP itself. Where there remains uncertainty as to whether the technical capacity of a REHub will be ultimately fully subscribed, the pool of equity investors may be limited.



A special case arises under which the timing aspirations of generators coincide leading to full utilisation of capacity of the REHub from the outset. In that situation the stranded asset risk disappears. Even in this case there may be merit in establishing an SPV so that equity and debt arrangements can be flexibly adapted to the time.

An SPV structure provides a number of benefits including:

- Isolating the unregulated and negotiated assets of the REHub from the TNSP's regulated asset base
- Ease of legal and financial reporting
- Providing the opportunity to conveniently introduce third party debt or equity capital into the development.

Once the first REHub is built under a successful commercial model, replication can be anticipated with other investors for whom the then diminished risk would have become attractive.

Next steps in delivering the NE REHub

The provisional technical and commercial approaches set out in this report need further development to bring about the first-of-a-kind implementation. The next steps are:

1. TNSP to fine tune the scope and cost estimate for the preferred technical solution.
2. TNSP to determine its risk appetite and preferred legal structure and commercial framework for the development of the REHub.
3. TNSP to consult with relevant government and regulatory agencies to ensure the preferred solution meets the needs of these stakeholders.
4. TNSP to finalise terms of the proposed commercial framework with which to open commercial discussions with generators.
5. On the assumption that generators pursue project specific financial outcomes and are not diverted by broader commercial considerations then TNSP and generators to negotiate and agree the technical scope and commercial terms for the contractual arrangements required to enable the REHub development to proceed.

6. TNSP and generators to document and execute the contractual arrangements and connection agreements.
7. TNSP to commence the development processes required for the detailed design, construction and commissioning of the REHub assets.
8. TNSP to refresh this Knowledge Sharing Report with the framework and templates of the adopted commercial agreements and legal structures.

2. Considerations in the development of a Renewable Energy Hub

Summary

- Drivers behind a REHub include renewable energy resource availability, connection to the grid, market for the product, regulations and allocation of risk.
- Each party (developer, network operator, government, community) has its own objectives and risk appetite all of which need to mesh.
- Existing regulatory arrangements relating to scale efficient network extensions do not act to provide commercial encouragement, as the ability of a funding party to recover the costs of its investment (including a return commensurate with the risk borne) are not beyond doubt.
- A REHub may provide benefits of reduced costs throughout the value chain encouraging renewable energy development. Its physical form will vary depending on location on the grid. The commercial arrangements in the first-of-a-kind may be repeatable in other locations.
- Stranded asset risk exists when a generator does not connect as expected. A special de-risked case exists when all potential generators seek connection at the same time.
- The market conditions for the sale of renewable energy certificates are changing. The scheme ends in 2030 and the revenue encouragement for new, large scale generation facilities will diminish over the remaining time.

Under normal practice, developers of potential generation make applications to connect to a TNSP's network. Following a network analysis and a costing study, an agreement is struck between the parties for a stand-alone connection identifying rights and obligations as to construction, operation and payment. Where multiple applications are received for connection in the same area, they are processed in order of receipt. An early application may affect the outcome for following applications, perhaps to the extent of precluding them. Where the network capacity is weak relative to the prospective capacity of generators seeking to connect to exploit a particular energy resource (such as a strong wind resource) this can have the effect of leaving the resource underutilised, resulting in a less favourable national economic outcome if the generation supply side is then progressively filled from other, sub-optimal sources. For further discussion on this point, see Box 1: "Connection vs Access" following section 3.2.2.

The term Renewable Energy Hub (REHub) is used to describe a geographical area in which transmission assets are designed and built to provide multiple generators with cost-effective connections to a common point on the grid over time. A REHub is a connection asset (comprising both a substation and extensions to connect generators) that, as a consequence of its size, yields cost efficiencies and improved access to connection. It is effectively the same type of investment as a scale efficient network extension (SENE). Multiple generators may connect in a particular region due to the presence of a favourable energy resource in that area, such as the high quality wind resource in New England.

Though styled here as a "Renewable" Energy Hub, the Hub concept is applicable wherever multiple, decentralised generators of any type require a grid connection.

The emergence of multiple renewable energy projects in the same area proceeding on roughly parallel development timetables creates an opportunity for the Transmission Network Service Provider (TNSP) to consider the development of a REHub.

2.1 Drivers

A number of key drivers are relevant in deciding whether or not to proceed with the development of a REHub and what might be an appropriate approach to for the development, should it proceed.

These key drivers include:

- **Renewable energy resource**: Is the energy resource abundant and geographically diverse?
- **Market**: Is there a strong, long and certain market for the product (electricity and renewable energy certificates)?
- **Regulations**: Does the regulatory framework allow it?
- **Economies of scale and cost savings**: Will it yield savings and economies of scale for generators seeking to connect to the grid?
- **Development risk**: Is there a party, or group of parties, willing to assume the development risk?
- **Financial risk**: Is the risk acceptable and does the investment provide a commensurate return? If the risk is too high or the return too low, is free equity available by way of a grant?

It is useful to consider the enterprise from the perspectives of the potential project participants to consider cost savings, development of a replicable approach, suitable risk allocation and a fair return on investment.

The **network owner** will wish to create and operate an asset which earns it a suitable return. It will also want to extend the opportunity for connection to as wide a field of generators as possible.

Funders will wish to receive a secure return on their investment, commensurate with the risk they take.

The **initiating generators** will wish through economies of scale to achieve cost savings in their connection cost without inappropriate risk exposure as a consequence of being a first mover. They will not want to provide a commercial benefit to other generators against whom they compete for sale of LGCs and for PPA contracts.

Subsequent generators will also wish to achieve cost savings through economies of scale and a streamlined technical and regulatory process using a standardised set of templates for commercial, legal and regulatory arrangements. They will wish to have improved certainty of connection to the grid.

The **regulator** will wish for the regulations to be observed and any rule change improvements to be brought forward.

The **Commonwealth agencies** such as ARENA and CEFC will wish for their programme objectives to be furthered.

State Governments will wish for their policies to be furthered and for regional development to occur.

Local governments will be looking for job creation and economic development.

Local communities will be looking for their values to be respected and reflected in the developments they become home to.

2.2 Barriers

In 2011, the Australian Energy Market Commission (AEMC) published a rule determination in relation to scale efficient network extensions (SENE) to an electricity transmission network.

The Rule as made rejected the proposal to require customers to underwrite the cost (and risk) of building 'spare' transmission capacity in anticipation of future generator connections, where the cost was to be paid back through generator charges as the generation connected.

Rather, it provides a mechanism under which opportunities to capture scale efficiencies can be made transparent, via the ability of parties to commission a SENE Design and Costing Study.

While the SENE rules were introduced in 2011, there do not appear to have been any SENE Design and Costing studies completed in the nearly 5 years to date, nor have any been requested.

It appears that the SENE framework has not achieved the objective of facilitating multiple generator connections. While the REHub concept essentially overlaps the SENE concept in the current Rules, the potential hurdles to commercial development/funding of a SENE (including by TNSPs) is a threshold issue that needs to be addressed. In the absence of a clear framework for commercial development, there is no incentive for a commercial party to pay for a SENE study.

2.3 Benefits

Potential benefits for a TNSP, the generators and the renewables industry more broadly, may make the development of REHub attractive. The key potential benefits are:

- **Reduced capital expenditure** – connecting to the network via a REHub can lower the individual connection cost a generator faces by minimising the duplication of connection hardware when compared to connecting on a stand-alone basis via dedicated assets. There is an opportunity to share savings between the parties.
- **Lower transmission cost** – connection of multiple generators via a REHub can result in lower overall transmission costs than individual connections, where costs include both:
  - generator connection costs; and
  - costs associated with augmenting the shared transmission network to accommodate the output from the new generators.
- **Customer cost saving** - connecting to the network via a REHub can provide a cost saving to generators which will allow them to bid into the market for dispatch at a lower price. To the extent that this affects the clearing price, this may show up as a lower retail price to end-use customers.
- **Encourage renewables development** - the ability of a REHub to be easily expanded will encourage the development of more renewables projects in the region. This may help to maintain or increase the utilisation of the shared transmission network.
- **Commercial return** - The sponsoring entity may be able to earn an appropriate risk-adjusted return, depending on the regulatory classification of the installed assets within the most appropriate technical solution.
- **Replicable approach** - A successfully negotiated set of commercial, legal and regulatory arrangements for the proposed REHub will create a template to facilitate the development of REHubs in other parts of the TNSP's network. Successive iterations of the Hub concept will likely lead to improvements in the deal architecture which, while keeping confidential the commercial details, might be made public.
- **Preferred connection location** - Simply announcing the potential for the establishment of a REHub in a particular location can cause the REHub to become a preferred location for connection.

2.4 Risk

The choice of the most suitable technical and commercial framework will be heavily influenced by a thorough consideration of the project risks and their management.

Risk	Mitigation action
Existing NER in relation to charging for negotiated services are not sufficiently clear to underpin commercial development of a Hub.	Make certain that the charges for negotiated services can include a return commensurate with the risk borne.
Network upgrades will be required, preceded by a RIT-T	TNSPs could undertake a 'contingent RIT-T' to demonstrate that there would be market benefits from augmenting the shared network, if generators connected
REHub will prove to be over-sized when compared to the generation that ultimately connects, leaving the investors with a stranded asset	1. Seek to bring all identified potential generators forward at the same rate with the effect that all sign up at the same time to connect. 2. Establish a commercial model that allows investors to recover a reasonable premium to reflect commercial risk 3. Set a connection fee structure that proves attractive to subsequent generation

Risk	Mitigation action
Potential generators seek stand-alone connections for corporate strategic reasons, despite the higher cost to their project.	TNSPs engage with all potential generators to make clear the financial benefits of participating in a REHub.
No party wishes to take stranded asset risk because future take-up of spare capacity is too uncertain	Encourage government to provide policy certainty to make the long term pipeline of renewables developments more predictable, thereby giving the industry more confidence that future take-up of a Hub's capacity is likely. A firm commitment to a long term, continuing increase in the RET post 2020 would go a long way to achieving this.
The remaining period of the Renewable Energy Target will prove too short to provide a commercial benefit big enough to underpin the capital cost	TNSPs to work proactively with the renewable energy developers to bring them on line as soon as possible to ensure full benefit can be extracted from market price of LGCs as to both quantity and price.
Generators fail to make required payments to SPV	Ensure arrangements include financial securities
Local community does not support renewable generation farms	Establish meaningful and ongoing program of community engagement

2.5 Regulation

The National Electricity Rules (NER) sets out the regulatory framework applied to the different services provided by Transmission Network Service Provider (TNSPs). The regulatory framework applies to services rather than to particular assets. A REHub potentially involves a variety of transmission assets, which in turn are likely to fall into different categories of transmission services under the Rules, and therefore would be subject to different regulatory arrangements.

The current NER arrangements leave a degree of TNSP interpretation and discretion to the mapping of assets against services that they provide. TNSPs and connecting parties have developed differing interpretations of these rules to establish their obligations and rights with regards to connections. Notwithstanding this, it appears clear that the services provided by the REHub assets could potentially fall within the following three categories.

- **Contestable transmission services** – include extensions from the substation site to the generators' sites. These services can be provided by any party and are not regulated under the NER. These services are paid for by the connecting generators.
- **Negotiated transmission services** – include works within the substation site. Some of these assets may provide a 'shared service' as they would facilitate the connection of more than one generator, while other assets may be dedicated to a particular generator. Negotiated services are subject to regulation including a requirement to comply with specified negotiated service principles. These services are paid for by the connecting generators.
- **Prescribed transmission services** – if the REHub requires augmentation of the shared transmission network in order to reduce any transmission constraints associated with the connection of new renewable generation, such augmentation would fall within the scope of Prescribed transmission services and would be paid for by customers rather than connecting generators.

The AEMC is currently in the initial phase of assessing a rule change proposal submitted by the COAG Energy Council. The proposal seeks to enhance contestability in the provision of connections to transmission

networks, resulting in some negotiated services becoming contestable, and so no longer subject to the negotiated service principles in the NER.

Further comment is provided in Section 5.1 below.

2.6 Market operation

Generators sell electricity in the National Electricity Market (NEM) as well as Renewable Energy Certificates under the Mandatory Renewable Energy Target (MRET) scheme. Both are subject to the normal pressures of supply and demand.

The National Electricity Market (NEM) is the wholesale electricity market for the electrically connected states and territories of eastern and southern Australia – Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania. Generators sell all of their electricity through the market with AEMO matching supply to demand. Generating units are dispatched by AEMO to maximise the value of spot market trading. Complex rules control the operation of the market.

Generators and retailers often protect themselves from movements in the spot price by entering into hedge contracts.

Under the MRET scheme accredited renewable energy generators are entitled to create large-scale generation certificates (LGCs) based on the amount of eligible renewable electricity they produce above their baseline.

Once created and validated, these certificates act as a form of currency and can be sold and transferred to other individuals and businesses at a negotiated price. Large-scale generation certificates are usually sold to liable entities (electricity retailers), who are required to surrender a set number of certificates to the Clean Energy Regulator each year.

Further comment is provided in 5.2.3 below.

3. Technical characteristics of a Renewable Energy Hub

Summary

- A REHub seeks to establish a cost effective connection point for multiple generators in a region of high renewable energy resource.
- In most cases a REHub will be relevant where the energy resource and the preferred connection point are in reasonable proximity.
- The development timelines for each generation asset differ, reflecting the evolution of various contracts. This makes it difficult to align the connection agreements.
- The suitability of the network for a point of connection of scale requires consideration of stability constraints and line capacity.
- The levelised cost of electricity will reduce as a consequence of the cost reductions made possible by a REHub.

In areas where significant amounts of renewable energy generation have been proposed it may be appropriate to consider a REHub. The ability to capture all generation at any point in time is inextricably linked to the configuration of the network at that time. The precise point on the network where a generator connects and the timing of that connection, is a determining factor of the performance that it can expect from the network.

The REHub concept is driven by a desire to design and build cost effective, expandable transmission assets which could accommodate multiple connections in a specific region. The hub would typically provide:

- An energy collection system (transmission lines connecting each generator to a central point)
- The point of connection itself (e.g. hub station)
- Any other associated facilities.

The following technical issues need to be considered when developing technically feasible options:

- Project timing
- Existing network and system constraints.

3.1 Project timing

The development of separate renewable projects proceeds independently of one another. It is typical for multiple projects that may form the basis of a hub to be at different stages of development. The sizing of initial equipment and the configuration of the connection to the existing transmission network are some of the technical aspects that are impacted by the timing requirements of the various generators.

The coordination of shared connection arrangements, where individual generators are unlikely to commit to connection simultaneously, is a timing challenge in developing a REHub. The first generator will commit to pre connection once it has achieved the milestones for their project construction. While a minor cost benefit might accrue to the benefit of the first generator by waiting for other generators to progress their projects sufficiently to create the critical mass to justify a REHub , that carries a risk of project delay.

An additional timing complexity in developing a REHub is that while certainty of connection is important, the connection agreement is only one of the key contracts to be progressed and negotiated concurrently. Key contracts include:

- **Land and Leases** - land is progressively secured through options, leases or purchase from early site identification through to financial close.

- **Connection Agreement** - connection arrangements are typically initiated early in the approvals phase but given the financial commitments associated with connection will normally not be executed until financial close when all construction arrangements become certain.
- **EPC and O&M** - construction and operation contracts revolve around selection of generation plant which is typically initiated as a competitive process when project design basics are settled. Again, these contracts are typically not executed until financial close.
- **Power Purchase Agreement (PPA)** - PPA terms and conditions are usually the starting point for finalisation of project ownership and finance.
- **Finance** - finance will be dependent upon finalisation of ownership in the construction and operation phases and the "bankability" of all key contracts.

These timing challenges impact the technical, commercial and option modelling for a REHub.

3.2 Network considerations

The optimum technical characteristics of a REHub can vary markedly in response to the generation capacity seeking to connect, the nature of the network, and the timing of the connections.

Connection into the network can be constrained by various technical limits which are complex and which vary depending on:

- Stability constraints (voltage, transient and small signal)
- Line capacity.

In assessing network capability for the connection of additional generation, the characteristics of other generation in the vicinity are considered including nameplate capacity, separation of existing connection points, voltage controls and power factor controls. The capacity of the existing generation reduces the network capacity that the TNSP offers the subsequent generator applicant.

As part of the connection enquiry process, a TNSP will typically advise a prospective generator of its assessment of the network limitations, if any, that might apply for the generation-connection combination proposed by the generator. If this assessment indicates a possibility that the proposed generation will face network constraints, the TNSP will not seek to impose restrictions on the generator's development plans[2]. Rather, it will advise AEMO of the relevant constraints and the generator will run the risk that its output might be constrained by the AEMO dispatch process[3].

Connection agreements may include emergency access constraints including tripping and runback. Under a **transfer tripping** scheme, the generation asset will be instantaneously disconnected following the trip of a transmission line. Under a **runback** scheme generation is automatically reduced following transmission contingencies where loadings may exceed the contingency ratings of any of the remaining transmission lines. The runback will continue to operate and dispatched generation will be reduced until the transmission loadings are brought below their contingency ratings.

A TNSP will be bound by the terms of any such pre-existing connection agreements. The dispatch of electricity by a generator will be subject to those terms and the operative aspects of the electricity market under the NER.

3.2.1 Stability constraints

Stability refers to the ability of all generation connected to the transmission network to operate synchronously, and supply the connected demand with specified voltages and quality during normal operation of the power system, as well as following any disturbance in the network. Such a disturbance could include, with or without

---

[2] See also section 5.2.2 for further discussion on this point.

[3] Alternatively, the prospective generator, with the benefit of the TNSP's assessment, may choose to modify its development plans to reduce the risk that its generation will be constrained.

a fault occurring, the tripping of a large generator or the tripping of a transmission line or voltage control device. The connected generation is required to operate in a stable manner with the rest of the transmission system.

Stability of generation operation is determined by:

- Other generation and loads connected to the network
- The length of the transmission lines between the connection point and the nearest large generator or 330 kV connection point
- The generation technology employed: different types of technologies, such as steam, gas, hydro, wind and solar generation will likely have different level of influence on the stability of the transmission network.

The generation will be required to operate adequately as specified in the NER. Power system instability could manifest via any of the following mechanisms, hence is considered in network planning of developments and connections, and is continuously monitored during the operation of the system.

Stability is considered in three ways: voltage, transient and small signal.

Voltage stability

Voltage stability is mostly driven by the ability of the connected generation to provide reactive power support. Reactive power is used to provide the voltage levels necessary for active power to do useful work. If the system voltage is not high enough, active power cannot be supplied. Reactive power is required to move active power through the transmission and distribution system to the customer whereas active power is used to run a motor, heat a home, or illuminate an electric light bulb. New generation connected to a REHub performing at the automatic access standards, can prove beneficial in improving the voltage stability of power transfer.

Long Term (measured in minutes) voltage stability reflects the ability of the power system to maintain adequate voltages throughout the network in the long term. A network exhibiting long term voltage instability would have parts of the network with severely depressed voltage (less than 90% of nominal) potentially leading to voltage collapse. **Short Term** voltage stability reflects the ability of the power system to recover and maintain voltage at adequate levels after a disturbance that causes a sudden increase in network flows or loss of critical network elements.

Disturbances in the electricity transmission network often result in increases to the reactive power losses in the network and a consequent reduction in the voltage. Where the power system is operated at or below the short term stability limit, a voltage reduction could, within a short period of time (5 to 10 seconds), weaken the network sufficiently so that generators lose synchronism with other generators in the power system. This would normally occur within 5 -10 seconds after the occurrence of the disturbance.

For a REHub connecting at a point in the network, voltage stability considerations will determine a limiting threshold. Analysis will be required for flows into the network in both directions from the connection point.

Transient stability

Transient stability describes the ability of the generation connected to the power system to operate in synchronism during normal operation and following a disturbance (e.g. fault). If the power system is operated beyond the transient stability limit, a disturbance results in one or more generators losing synchronism with other generators. The timeframe for the power system to become unstable following a disturbance is dependent on the severity of the disturbance and could typically be in the range of 1-10 seconds.

For individual generators, the consequence is that they will eventually disconnect from the power system. Transient instability impacting on a large group of generators, could result in whole regions of the power system losing synchronism with other regions, potentially leading to widespread load interruptions, brown outs or black outs.

In the NEM, transient stability considerations could limit the maximum power flow between the regions. The interconnector "transfer limit" is that flow where the power system is only marginally stable if a fault on a critical transmission line were to occur.

In the New England example, the transient stability analysis indicates that renewable generation tends to have a beneficial influence on both export and import capability from NSW on the Queensland-NSW Interconnector (QNI).

Small signal stability

Small signal stability describes the stability of the power system to withstand a disturbance and be able to settle safely to a new operating state, with interaction between generators in different parts of the network being well "damped". Damping refers to how quickly those interactions settle and is categorised as follows:

- A well damped system will have interactions settling quickly.
- A poorly damped system will have generators that have prolonged oscillations in their outputs (active power, reactive power and/or voltage).
- An undamped system will have generators with increasing oscillations in their outputs, eventually tripping.

Interactions can occur between generators in different regions, which could cause oscillations to appear on the interconnector. The NER prescribe a minimum level of damping for these oscillations to provide a "safety margin" from unstable operation.

3.2.2 Line capacity

The line capacity or thermal ratings of transmission line conductors normally represent the maximum capacity available. These ratings vary with the prevailing ambient weather conditions. Ratings are currently defined by season (winter, summer, spring or autumn) with day and night variations. In some situations, the capacity of a transmission line may also be limited by the associated terminal equipment or protection / metering settings. In general, upgrading the capacity of the terminal equipment to realise the maximum capacity available from the line conductors can be achieved with relatively minor investment.

AEMO considers the available ratings of all relevant equipment connected to the network and dispatches generation in the NEM so that the transmission system will operate without exceeding any equipment rating during the normal operation of the network as well as during an outage of a single piece of equipment. Under some operating conditions (often during planned or forced outage of transmission lines), the maximum intra or inter regional flows may be limited by the thermal capacity of transmission elements, resulting in transmission constraints in the NEM.

Figure 1 below illustrates a REHub in the New England area connecting to the Queensland NSW Interconnector (QNI).

Figure 2 and Figure 3 show the network constraints vary for increasing theoretical REHub capacity.

Figure 1: New England Wind Farms – Grid Schematic

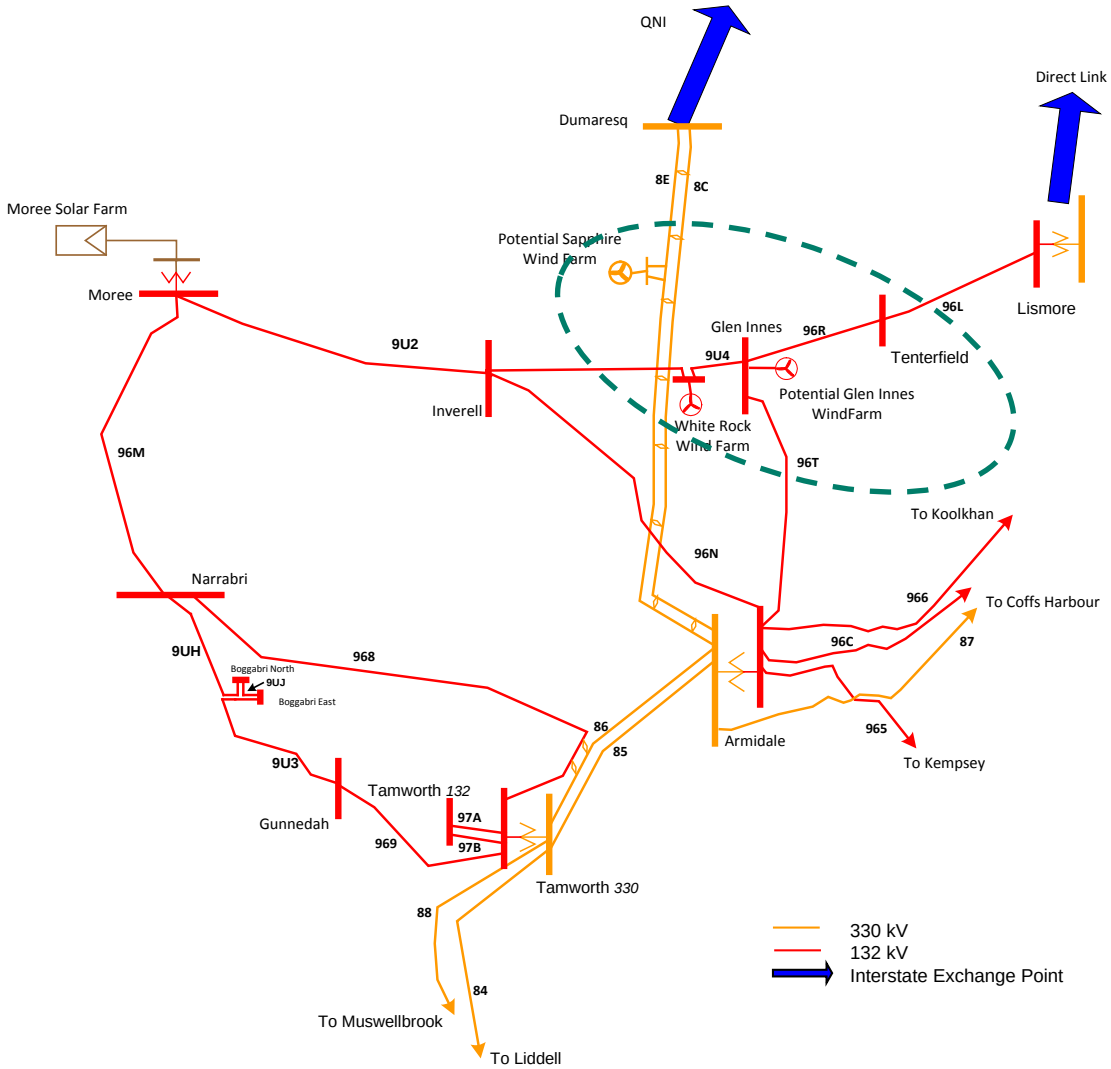
New England REHub in the grid

There is an abundant wind and solar resource in the New England area.

Three wind farm developers are in negotiations with the TNSP (TransGrid) seeking connection to the transmission network. As shown below in the schematic outline of the grid in northern NSW, the projects are located close to the high capacity 330 kV Queensland-NSW Interconnector and the east west 132 kV transmission lines joining Lismore to the east and Moree to the west.

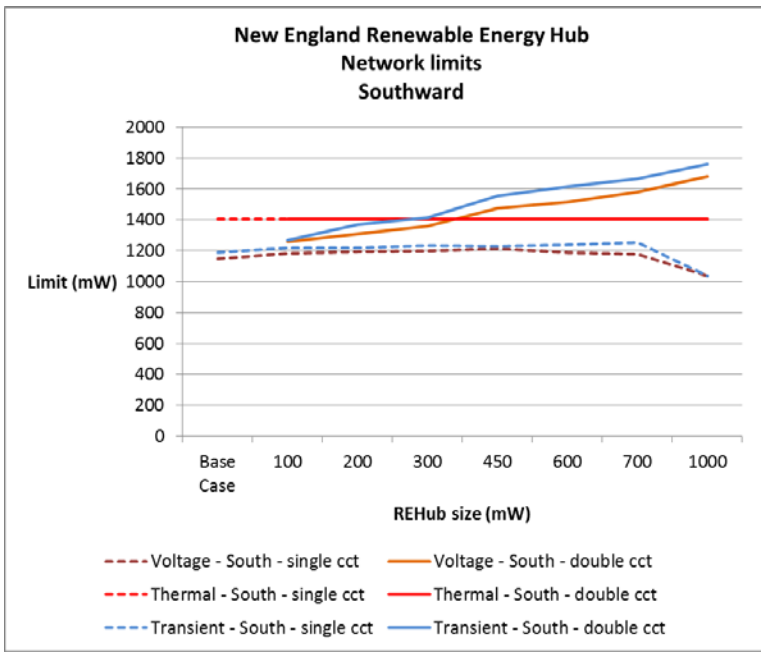
The development of individual, stand-alone connections for the wind farms is technically possible, but at a cost estimated to be some 18% higher than through a REHub.

Technical impediments would act to prevent too many large generation facilities from connecting individually in close proximity. A REHub will assist the effective exploitation of the available renewable energy resource in the area. New gas fired generation might also seek to connect.



Consider a single circuit cut-in to the QNI. When considering southward flows, the maximum generation injection is approximately 700 MW, beyond which the QNI voltage stability limit begins to reduce. Refer Figure 2.

Figure 2: Network Limits - southward

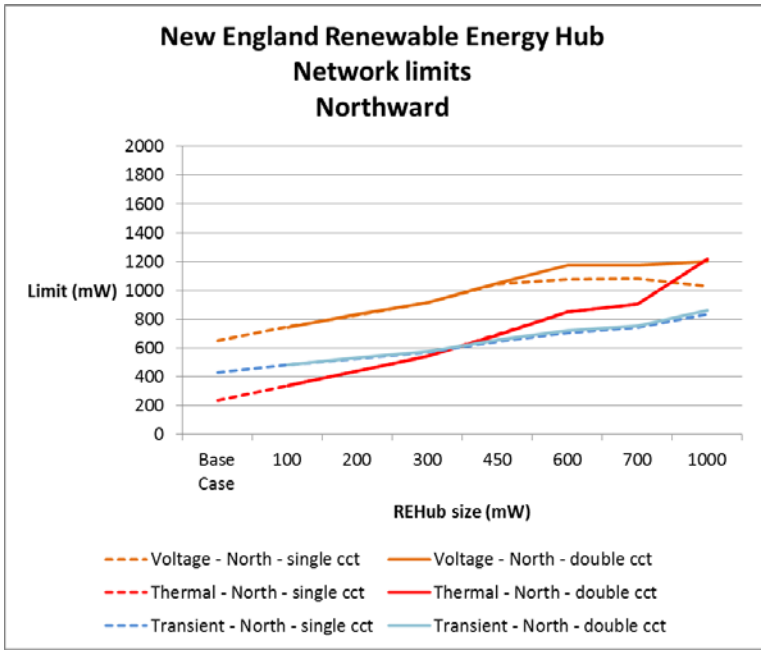


In a northward direction, the voltage stability limit begins to reduce when the generation injection reaches approximately 450 MW. Refer Figure 3

Where both circuits are cut-in the stability threshold is not reached even for 1,000 MW Hub.

The small signal stability limit is higher than the other stability limits and is not applicable in this case.

Figure 3: Network Limits – northward



Box 1: Connection vs Access

This report and the concept of the REHub is essentially concerned with the provision of connection services to generators, to enable them to become physically connected to the shared transmission network. We note that there is a distinction between the ability for a generator to physically connect to the shared network, and the subsequent ability for that generator to be able to access sufficient capacity on the shared network to be fully dispatched by AEMO. The generator's access to sufficient capacity on the shared transmission network to enable its output to be fully dispatched depends on the capacity of the shared network, rather than only the capacity of the generator's connection to that network. Although the two issues are clearly closely linked – with a generator's incentive to pay to physically connect to the shared network being highly dependent on its expectation of its resulting access to the shared network not being unduly constrained – they are distinct issues.

The current NEM framework is one where generators bear the risk that there is insufficient capacity on the shared network such that their output becomes constrained, either when they first connect to the network, or through time as the result of load growth and the location decisions of future generators. That is, the NEM framework is not one in which generators receive 'firm' access to the shared transmission network as a consequence of their connection agreement with the TNSP.

There are provisions in the current regulatory arrangements (the NER) which allow generators to pay for augmentation of the shared network (NER 5.18 'funded augmentations'). However, these arrangements have been little used in practice, as the funding of such augmentations does not give rise to any rights to the funding generators in relation to that capacity.

There are also provisions in the current framework (NER 5.4A(h)) that on face value would allow generators and the TNSP to negotiate compensation in the event that a generator is constrained off or on, in return for an access charge. However, the AEMC recently concluded that in practice this provision is unworkable because the scheme is not mandatory and all generators have open access to the network. The AEMC noted that, as far as it is aware, the provisions in NER 5.4A(h) have not been applied to date.

The issue of whether or not there should be 'firm access' rights for generators was extensively debated during the AEMC's 2010-13 Transmission Frameworks Review, and subsequent development of the optional firm access model. Ultimately this model has not been adopted.

TransGrid's consideration of the REHub concept does not seek to re-open the issue of whether or not there should be firm access to the shared transmission network. The issue of firm access is common to all generation connections, and is not unique to the REHub concept. Rather, the focus of TransGrid's feasibility study has been on whether the economies of scale associated with sizing connection assets to connect multiple generators can be realised through the REHub concept.

3.3 Cost of electricity outcomes

The levelised cost of electricity (LCOE) is often used for convenience to compare technology and project options. Its calculation requires a price point to be struck for both capital and operating costs both measured on a whole of life basis.

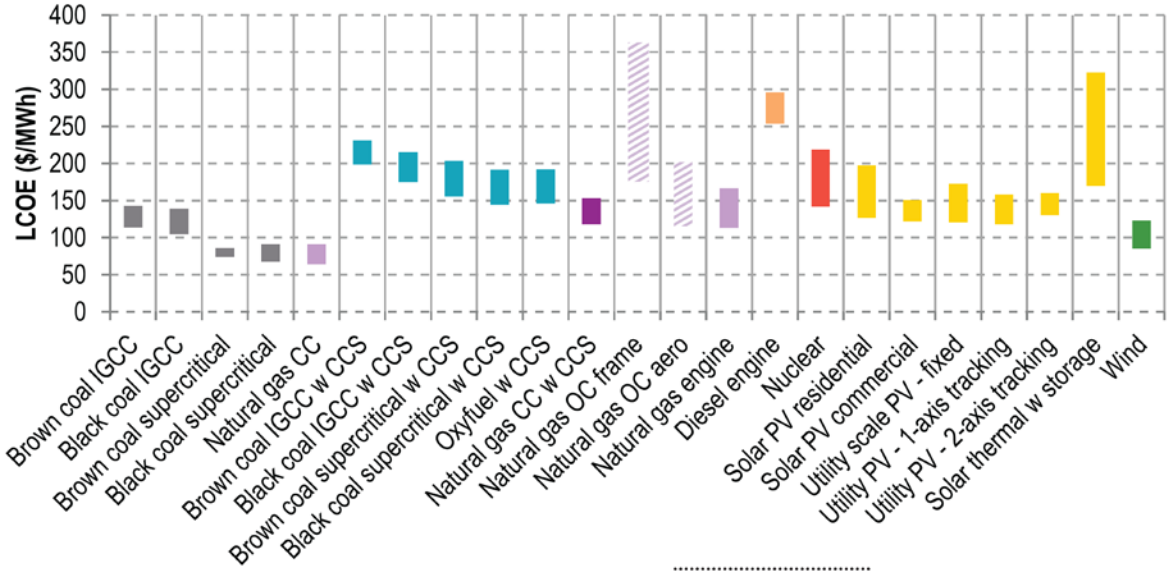
Capital costs reflect the cost of developing the project, engineering, procurement and construction as well as authorities' fees and charges. The nameplate capacity is sensitive to prevailing technology maturity, the conversion efficiency of equipment and the quality of the energy resource.

Each site presents unique challenges which are reflected in costs for site access, preparation and foundations. Each location carries costs associated with planning consent conditions, freight, availability of skilled labour, grid connection (substation, distance to grid, transmission line voltage), system integration and communications. Other cost centres include foreign exchange rates, project development and project delivery management.

Operational costs reflect maintenance staff, asset replacement and fees. For renewable energy projects, fuel is free and inexhaustible.

Difficulty in establishing a reliable cost arises when technologies have not been built at scale in Australia. That is not the case for either wind or solar PV generation and it is not the case for the grid connection aspect. Figure 4 shows the LCOE (2015) for all technologies. Wind generation is the current day lowest cost renewable low emissions technology although natural gas combined cycle and supercritical pulverized coal plants have the lowest overall LCOEs. The overall ranking of LCOEs for technologies in 2030 is not projected to change from 2015, but there is likely to be convergence in LCOEs across most technologies.

Figure 4: LCOE – all technologies, 2015[4]



While each generation facility is unique, the trend over time is to bring on line the next cheapest taking into account the factors peculiar to each site and technology.

As a proportion of up-front capital cost, the grid connection is generally less than 10% though it can be higher. It is sensitive to the distance of the generation asset from the connection point, the ownership of the land along the route and the voltage of the transmission line.

In the cased of the NE REHub, the cost economies available will reduce the cost of grid connection by approximately 18%. That would have the effect of reducing the grid connection component of the capital cost from 10% to around 8%. Capital cost is a dominant contributor to LCOE. Subject to many other considerations and all other factors remaining unchanged, the drop in LCOE would be of the order of 1%.

To put this in perspective a renewable generation facility of 200 MW with a capacity factor of 0.2 operating for 20 years would send out 200 x 365 x 24 x 0.2 x 20 = 7,008 GWh.

A 1% saving in LCOE from a starting point of $100/MWh realises a saving of $7m over the plant life. From an NPV standpoint, given that the capital costs are near term, the effect on the financial viability is heightened.

Should the recent international pricing of solar PV projects referred to in Section 5.2.3 prove sustainable, then the connection cost will become relatively more important than it is currently and the proportional saving in LCOE will rise.

[4] "Australian Power Generation Technology Report", Electric Power Research Institute, work completed November 2015, found at http://www.co2crc.com.au/dls/Reports/LCOE_Report_final_web.pdf

Perhaps the greater benefit of a REHub beyond the economies of scale is that it gives much greater certainty of being able to connect and thus creates an incentive for a generator to take advantage of the investment in the REHub. The primary beneficial effect is not one of LCOE reduction, which is marginal in the scheme of things, but rather that areas of good renewable energy resource can be exploited more comprehensively once a REHub is in place.

There is a counter to this argument. In some instances it may be incorrect to deduce that a lower cost of connection via the REHub would provide a market benefit by liberating local resources. The REHub may have the effect of facilitating generation that is less cost effective than generation in other regions, that would have lowered the cost more but which was “squeezed” out by the concentration of value in the REHub.

3.4 Technical and commercial readiness

ARENA notes[5] that the technology readiness level index is a globally accepted benchmarking tool for tracking progress of a specific technology through the early stages of the innovation chain.

ARENA uses a 9 stage Technology Readiness Levels to measure the technical readiness of renewable energy solutions. In the particular case of wind or solar PV generation connecting into an existing transmission pine, the technology is well proven and the cost base well understood. As a consequence, a TRI score of 9 is likely, with no change brought about by a first REHub Project

Considered against commercial readiness the RE Hub is a less mature concept. Impediments include commercial structure, legal arrangements and regulatory context.

ARENA notes[6] that it has developed a 6 level Commercial Readiness Index, provided in Table 1, to guide its analysis of funding applications. The index provides an objective structure for evaluating where industry sectors faces barriers.

Table 1: Commercial Readiness Index

Level	Descriptions
6	"Bankable" grade asset class driven by same criteria as other mature energy technologies. Considered as a "Bankable” grade asset class with known standards and performance expectations. Market and technology risks not driving investment decisions. Proponent capability, pricing and other typical market forces driving uptake.
5	Market competition driving widespread deployment in context of long-term policy settings. Competition emerging across all areas of supply chain with commoditisation of key components and financial products occurring.
4	Multiple commercial applications becoming evident locally although still subsidised. Verifiable data on technical and financial performance in the public domain driving interest from variety of debt and equity sources however still requiring government support. Regulatory challenges being addressed in multiple jurisdictions.
3	Commercial scale up occurring driven by specific policy and emerging debt finance. Commercial proposition being driven by technology proponents and market segment participants – publically discoverable data driving emerging interest from finance and regulatory sectors.

[5] http://arena.gov.au/resources/readiness-tools/ accessed on 2 Feb 2o16

[6] op. cit.

Level	Descriptions
2	Commercial trial: Small scale, first-of-a-kind project funded by equity and government project support. Commercial proposition backed by evidence of verifiable data typically not in the public domain.
1	Hypothetical commercial proposition: Technically ready – commercially untested and unproven. Commercial proposition driven by technology advocates with little or no evidence of verifiable technical or financial data to substantiate claims.

ARENA has developed a series of 8 indicators to guide the assessment. While the commercial maturity of the Australian TNSPs is high, the notion of a REHub has yet to find traction. The reasons are described at greater length in this Report but are summarised Table 2 and shown graphically in Figure 5.

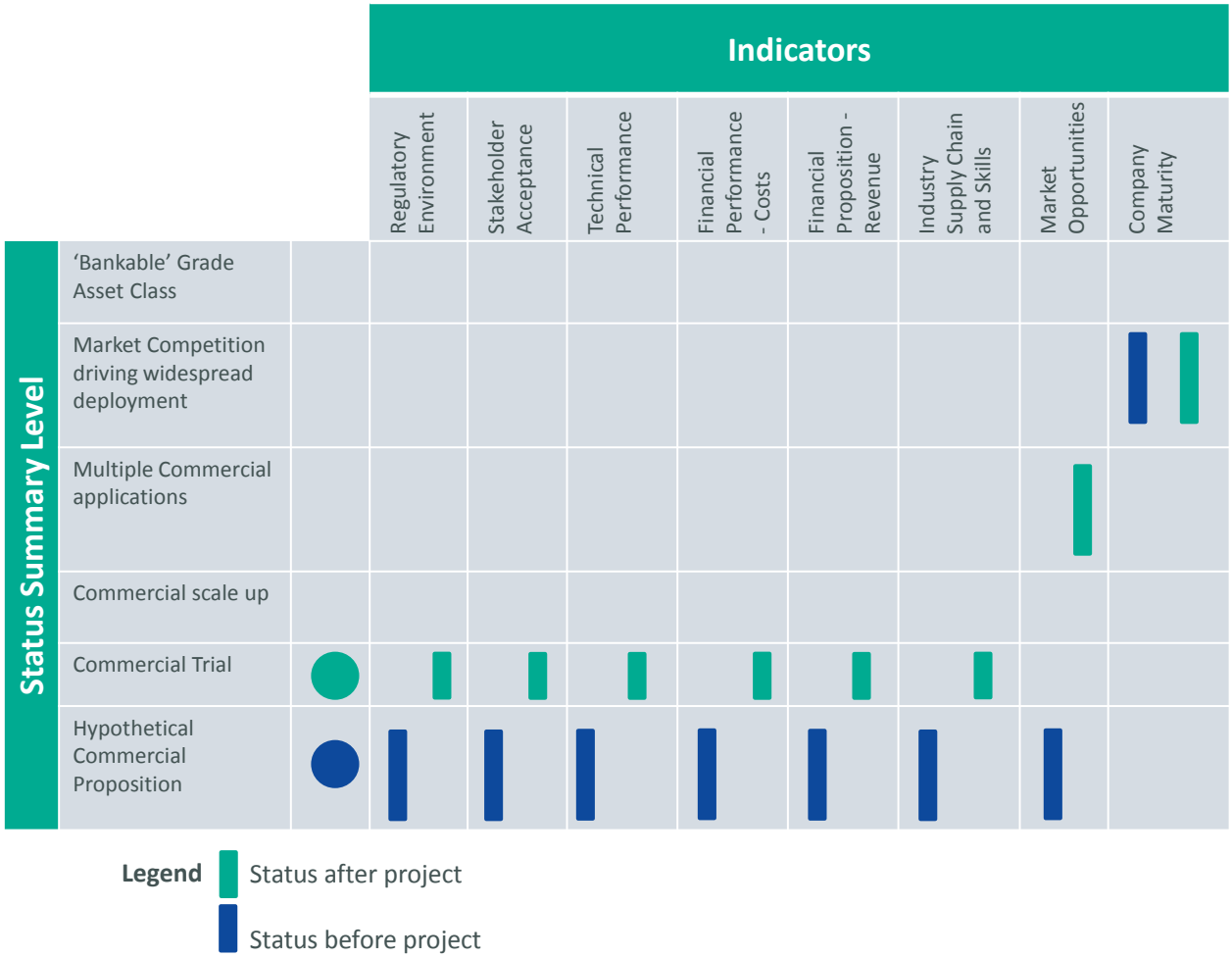
Table 2: CRI Indicators and effect of initial project

Indicators	Summary of Indicators	Status before and after the first REHub
Regulatory Environment	The maturity of the planning, permitting and standards relating to the technology.	The NER do not contain a mechanism for allocation costs in a way that properly reflects risk allocation and the need for entities to earn a commercial return.
Stakeholder Acceptance	The maturity of the process for evidence based stakeholder consultation linked to renewable energy integration into the energy markets.	No exemplars guide the way for either TNSPs or Generators such that they are encouraged to collaborate for the mutual benefit of all.
Technical Performance	The availability of discoverable technical performance information.	Satisfactory technical performance of a REHub once built can be expected. However the technical analysis of the network is complex to identify suitable locations and the maximum viable aggregated nameplate capacity. A mapping of viable locations prepared by the network owner(s) would assist potential generators to identify where to best focus their efforts.
Financial Proposition – Costs=	The availability of robust, competitive financial information linked to capital and operating costs and forecast revenues allowing investors to take increasing levels of future market and project risk.	The optimal physical form of a REHub is arrived at through iteration taking into account the potential aggregated generation capacity, the order of connection and the ability to build progressively in stages until the final full scope is on line.
Financial Proposition – Revenue		The equity ownership of a REHub might be shared between a number of parties including the TNSP, the generators and private venture capital. The revenue stream is linked to the ownership structure and its status within the NER. In one extreme, it could be a regulated return. In another extreme it could be a return based on negotiated arrangement reflecting capex, opex and risk allocation

Indicators	Summary of Indicators	Status before and after the first REHub
Industry Supply Chain and Skills	The development of a competitive and efficient industry product and skills supply chain required to support a commercially viable sector.	The technical and commercial skills are readily available in the industry, quite capable of replicating the architecture of the initial project
Market Opportunities	The development from a hypothetical commercial plan to the demonstration of a viable market (local and/or overseas) via competitive channels to market and sustainable business models.	The first in this REHub class will established its viability in the NER context and subsequent opportunities will be readily developed.
Company Maturity	The development of the sector to include established companies with strong credit ratings and established performance records.	The TNSPs are mature organisations in charge of sophisticated assets. Once the regulatory regime and optimal commercial model is determined successfully for the first in class, the bankability of replicate assets going forward should be straightforward.

The effect of developing, commissioning and commercially operating the first REHub is to lift the Commercial Readiness Indicator from Level 1 (Hypothetical Commercial proposition) to Level 2 (Commercial Trial).

Figure 5: Commercial Readiness Indicator transition brought about by first project



Version 23.0

4. Commercial considerations underpinning a Renewable Energy Hub

Summary

- There are significant potential benefits from pursuing a REHub, including cost savings, risk sharing, investment returns and replication.
- Development of a REHub would require an initial investment in higher specification, "oversized" common assets creating commercial risks for the TNSP and possibly the connecting parties. There is a risk that not all the connections initially foreseen will eventuate, creating a stranded asset risk (i.e. a risk that an "oversized" asset does not end up being fully used).
- The stranded asset risk could be dealt with in one of four ways (assuming the asset is developed by the TNSP): share the risk with the generators, pass some of the risk to the first connecting generator (subject to the NER), accept the risk itself, or introduce others to take the risk.
- Commercial arrangements for a REHub can be structured around a special purpose project vehicle (SPV) established by the TNSP for the specific purpose of undertaking the REHub project.
- Some of the benefits for the TNSP of structuring the hub development around a SPV are:
  - Isolates the assets providing unregulated and negotiated services from the renewable energy hub from the TNSP's regulated asset base, legally and for reporting
  - Provides the opportunity to conveniently introduce third party debt or equity capital into the development
  - Provides the potential to realise the project value created, by selling debt and/or equity interests to third party investors.

TransGrid has examined the feasibility of developing REHubs for connecting multiple renewable generators to grid. The attributes of potential connection points differ in respect of the nature of the renewable energy resource, the strength of the grid and the preferred time phasing for connection

A range of potential benefits tend to make a REHub attractive for TransGrid, the generators and the renewables industry more broadly. These can be categorised:

- Cost savings
- Risk sharing
- Return on investment
- Replicable approach.

Cost savings can arise and be shared through minimising the duplication of connection hardware.

Risk can be shared with other investors to minimise the commercial exposure of the TNSP should the connection capacity be built and paid for but not fully used.

Investment returns can be structured to properly reward the assumption of risk: the TNSP (and any equity partners) may earn an unregulated return on that portion of the installed assets that provide a negotiated or contestable transmission connection service, and a return overall that differs from the regulated cost of capital.

The connection process and costs for additional future generators can be made simpler through the creation of a single, easily expanded connection point to the main grid. Successfully implemented, this would create a replicable template for the development of REHubs in other parts of all network operators' grids. Additional hub projects may lead to further savings as implementation costs decrease with experience.

4.1 Stranded asset risk

Identifying the party which is to take the risk of asset stranding is the single most important commercial issue.

Under normal circumstances, when a generator seeks to connect to the shared network, it does so under a stand-alone arrangement. The contract is made between only the TNSP and the generator. The physical form of the connection responds to the status of the network at the time the connection application is made.

Where the connection asset is primarily for the benefit of the generator, the connection cost is paid for by the generator with 'negotiated' and 'contestable' components subject to individual resolution.

This arrangement does not provide the opportunity for economies of scale or avoidance of duplication which could reduce overall connection costs:

- Where two or more generators seek connection at or about the same time, and/or
- Where a REHub is developed that is larger than needed immediately but provides for the anticipated future needs of other generators that may seek connect.

These scenarios are likely to arise where a renewable energy resource is sufficiently abundant, and the transmission grid is sufficiently close, to encourage multiple entities to develop generation projects. Where they seek to connect near the same location, but over time, the prospect of an initially oversized connection asset, or REHub, becomes a real prospect.

Difficulties arise when seeking to determine a cost sharing and risk allocation mechanism. Consider the case of five individual projects connecting to the transmission network as shown in Table 3 and Figure 6 below. This serves to illustrate the conundrum presented by the REHub concept. The numbers are based on a particular configuration (generation size, proximity to network lines) in the New England area.

Absent commercial considerations, the lowest cost technical solution is $113m representing a substantial saving on five individual, stand-alone connections, the aggregate cost of which is estimated to be $137m.

In the stand-alone case, assume that no generator is precluded for technical reasons from connecting to the network at the closest location[7].

In the Hub cases, assume connections can be made in the numerical order shown.

Consider four mechanisms for sharing the cost of the REHub between the generators to represent their costs for connecting to the grid.

Hub 1 Each generator pays the marginal additional cost necessary to increase the size of the Hub for its purposes;

Hub 2 Generators share the cost of the Hub based on the proportion of its nameplate capacity compared to the Hub capacity

Hub 3 Generators share the cost by proportion, but an expected generator doesn't connect and the other generators carry that additional cost in proportion

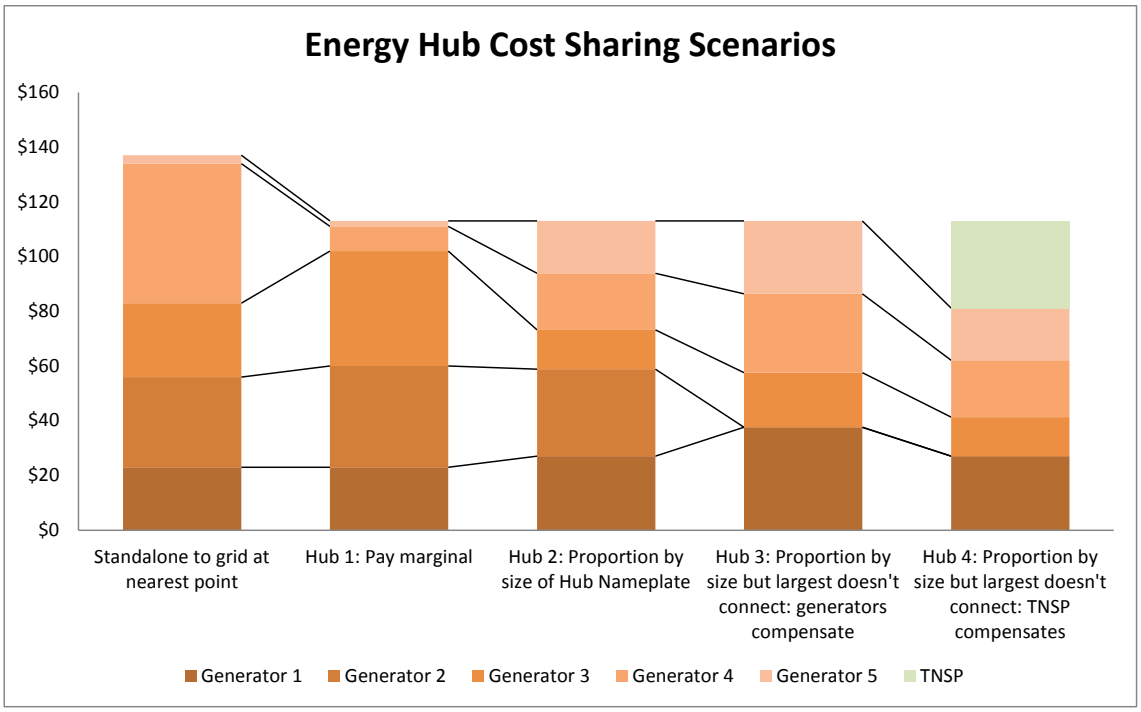
Hub 4 Generators share the cost by proportion, but an expected generator doesn't connect and the TNSP carries that additional cost

[7] For example, after the first four have connected, Generator 5 may be precluded from joining at the nearest point and may be forced to take a longer and more expensive route, or not connect at all.

Table 3: REHub cost sharing scenarios ($m, unescalated 2015/16)

Size (MW)	Standalone to grid at nearest point	Hub 1: Pay marginal	Hub 2: Proportion by size of Hub Nameplate	Hub 3: Proportion by size but largest doesn't connect: generators compensate	Hub 4: Proportion by size but largest doesn't connect: TNSP compensates
170 Generator 1	23	23	27	38	27
200 Generator 2	33	37	32	-	-
90 Generator 3	27	42	14	20	14
130 Generator 4	51	9	21	29	21
120 Generator 5	3	2	19	27	19
TNSP					32
710	**137**	**113**	**113**	**113**	**113**

Figure 6: Comparison of REHub cost sharing scenarios



Hub - arrangement 1

Under the Hub 1 commercial arrangement, generators each pay the marginal additional cost to increase the size of the Hub to accept the marginal capacity increase, always supposing that the Hub gets built to the full 710MW capacity. However there are unrealised and unshared commercial gains:

1. Generator 1 receives no share of the cost saving
2. Generators 2 and 3 each pay more than for a stand-alone connection (which is not permitted under the current regulatory framework, for the substation component of the development)
3. Generator 4 receives a substantial windfall benefit
4. Generator 5 has a very low connection cost measured as $m/MW.

There is little incentive for Generators 2 and 3 to connect and they may well seek other more productive geographic locations. This would tend to undermine the fundamental premise that the full Hub gets built and that all generators connect.

Hub - arrangement 2

Under the Hub 2 commercial arrangement, generators share the hub cost based on their nameplate generation capacity as a proportion of the full Hub connection capacity, again presuming that the Hub gets built to the full 710MW capacity. The commercial gains and losses change:

1. Generator 1 does marginally worse than if it had connected first, unencumbered by network technical constraints or Hub commercial arrangements
2. Generators 2 does better and Generator 3 does substantially better
3. Generator 4 does substantially better than it would have on a stand-alone basis but not nearly as well as it might have under the Hub 1 arrangements
4. Generator 5 fares much worse and might be dis-incentivised unless this REHub is the only viable technical mechanism for connecting and the business case made sense for it, noting that connection cost per MW nameplate would be equal to the others taking advantage of this wind resource.

There is little incentive for Generators 1 and 5 to connect and they may well seek other more productive geographic locations. This would tend to undermine the fundamental premise that the full Hub gets built and that all generators connect.

Hub - arrangement 3

This arrangement demonstrates the impact of building an oversized Hub. In this example, the assumption is that the generators share equity and risk in proportion of their nameplate capacity. Should an expected additional large generator not eventuate, they each bear a proportion of the cost of the unutilised Hub capacity. This will have the effect of lifting their cost of production, impairing their bottom line and reducing their internal rate of return.

Hub - arrangement 4

This example supposes that overcapacity is again realised but in this case it has been assumed that the TNSP is the sole equity participant and is responsible for the capital cost for unutilised capacity. Should the overcapacity eventuate the TNSP is exposed to the requirements of the National Electricity Rules which govern the TNSP's flexibility in respect of charging for the negotiated connection service component of the REHub.

Both Hub 3 and Hub 4 demonstrate the risk of a stranded asset, differentiated by who pays.

The benefits of a REHub are primarily reduced connection costs and improved financial returns. This has to be true for all participants for it to be a viable commercial enterprise.

In order that the REHub technical solution can deliver the most cost effective result, generators will need to change the connection plans they might otherwise have developed on a stand-alone basis.

A generator will naturally be reluctant to pay for a scope that is any more than the absolute minimum needed to make their individual, stand-alone connection possible[8]. And, for the *negotiated* services component of the REHub, NER clause 6A.9.1(2), says that the price should be "*no more than the cost of providing [the service] on a stand-alone basis*", although the stand-alone cost can include a degree of expandability, where this is consistent with the sub-station design philosophy adopted by the TNSP.

TNSPs have historically typically not taken speculative development risk on transmission assets. A TNSP would not ordinarily contemplate meeting the incremental cost of oversizing the REHub substation unless it had a connection agreement and acceptable financial security from each of the connecting project owners covering, in aggregate, the entire works.

---

[8] The prospect of a first connector facing a higher cost of connection than later connectors is the "first mover disadvantage" often encountered in network extension situations, at both the transmission and distribution levels.

Should a first wave of generators all emerge at the same time and should they all commit under agreements brought to a conclusion at a single signing event, then a TNSP may find a REHub viable. Such a process would increase the transactional complexity and that may well be beyond the appetite of the pioneer generators.

TNSPs would need to carefully consider an investment decision to go further and speculate capital for a further increase in capacity for as yet unidentified additional generation.

4.2 Management of stranded asset risk

A TNSP could seek to deal with the stranded asset risk in one of four ways:

1. Cooperative framework: share the risk with the generators
2. Allocate the stranded asset risk to the first connecting generator, for the contestable portion of the REhub assets
3. Take the risk itself
4. Introduce other commercial parties who will share the risk

Whichever party carries the risk, its commercial return will diminish to the extent that the asset is not fully utilised with revenue earning traffic. However, where the asset is fully utilised, the return earned may be potentially above the regulated rate of return, reflecting the additional risk borne.

4.2.1 Cooperative framework – share the risk

To mitigate the stranded asset risk, a TNSP could require up front commitments from the three generators to begin development of a REHub on a cooperative basis. That is:

- TNSP contracts to build all the Hub assets to the required specification, including the necessary oversizing
- The pioneer generators simultaneously contract with the TNSP to pay, and to provide financial security for, their agreed share of the Hub development, including the oversizing.

However, development of a REHub on the basis of such a cooperative framework would face some significant commercial hurdles:

1. **NER 6A.9** – For *negotiated* transmission services, NER clause 6A.9.1(2), says that the price charged by a TNSP should be “no more than the cost of providing [the service] on a stand-alone basis”.
2. **Generator Competitive Tension** – In agreeing to a cooperative framework, each generator is essentially facilitating the connection of a competitor at a lower price than they would otherwise pay. Broader strategic considerations may therefore make generators unwilling to cooperate with their competitors, despite the benefit of a lower connection cost for themselves.
3. **Diverse Timing** –The pioneer generators are on broadly similar, but not identical, development timelines. For them to commit together, each will need to have advanced their projects to the point where their boards can commit to a Connection Agreement and lodge the required financial security.
4. **Commercial Uncertainty** – If they agree to a cooperative framework, the generators become mutually dependent. If one is delayed or unable to proceed, it may affect the progress of connection works for the others and even open the delaying party to a liability to compensate the others. This interdependence may not be commercially acceptable to the generators, notwithstanding the connection cost savings available to be shared.
5. **Developer financial capacity** – the timing of the REHub may require a generator to commit to its participation before it has all the necessary approvals in place for its particular generation project, and therefore before it has obtained committed finance for that project. In this case, in the absence of a confirmed project, the generator may not have the financial capacity to participate in the REHub, even if it wished to.

4.2.2 Allocate stranded asset risk to first connecting generator

If the commercial hurdles above conspire to make a cooperative framework unworkable, the TNSP could proceed to negotiate a Connection Agreement for the Hub with the first connecting generator/s on the basis that the generator pays the full cost of the initial connection (to the extent permitted by the NER) even though it will be 'oversized'.

This approach creates for the participating generator an obvious first mover disadvantage – that is, a higher connection cost than it would otherwise incur on a stand-alone basis.

This problem could be addressed by requiring later connecting generators to contribute to the cost of the original installation by making a retrospective payment to the party which bore the original cost (in addition to paying the direct cost of their connection). Precedents for such cost sharing arrangements exist in the "pioneer schemes" established by some DNSPs in relation to their connection charges.

The participating generator may be willing to bear the cost recovery risk if:

(a) The incremental cost is small relative to its overall development budget and/or
(b) It considers there is a high likelihood that later generators will connect and so enable it to share the overall cost of the connection (ie, both the incremental cost plus part of what would otherwise be the generator's stand-alone cost, through cost sharing arrangements).

On the other hand, a pioneer generator may be unwilling to participate as it may give a benefit to a competitor.

Another feasible outcome involves the first connecting generator managing the stranded asset risk by seeking to ensure the full capacity is taken up. It might do this in a number of ways:

(a) Coordinating and cooperating with other prospective generators; or
(b) Consolidating the other development opportunities into one holding under its control.

4.2.3 TNSP take the stranded asset risk

If the TNSP is unable to pass some or all of the asset stranding risk to the generators, either 'cooperatively' or singly, then it may consider bearing the risk itself. It would do this by meeting the cost of installing assets with the required oversizing but recouping from each participating generator only the cost the generator would have incurred if it connected on a stand-alone basis.

Should the TNSP determine that it chooses to assume the stranded asset risk itself, it can specify the REHub configuration in any way it chooses to encourage additional connections.

Although the TNSP bears the oversizing cost risk under this approach, it does have the opportunity to set the size of subsequent payments from later connecting generators at a level which includes a financial return commensurate with the risk it has borne (though possibly constrained by the NER in relation to negotiated services). This approach overcomes the 'free rider' problem: that later connecting generators would otherwise save connection costs by taking advantage of the oversized assets paid for by others.

In general, the most efficient project outcomes are achieved when project risks are allocated to the parties best able to manage them. In the context of the ReHub, TransGrid is better placed than the generators to assess, and manage, the risk of a complex connection, giving this approach some appeal.

However, as discussed elsewhere in this report[9] , the current NER arrangements do not put it beyond doubt that the TNSP can include a return on additional risk as part of its charges for the negotiated portion of the REHub (although this would be consistent with the AEMC's intent in introducing the SENE arrangements).

---

[9] See 5.3

Whichever approach is taken, the party bearing the additional cost of the oversized assets is exposed to the risk that later connections and the associated refund/additional connection payments will not materialise.

The regulatory implications of such a cost recovery approach have been examined by HoustonKemp[10].

4.2.4 Stranded asset risk is taken by others

In the event that neither the TNSP nor any generator is willing to take the asset stranding risk inherent in the oversizing of connection assets, it is possible to envisage a structure where the risk is taken by a third party investor, in relation to those assets that are providing contestable services.

That is, an investor who is prepared to bear the additional cost of the oversized assets in the expectation that the cost can be recouped, together with an appropriate financial return, by providing a REHub connection service to future connecting generators, the emergence of which is presently uncertain.

Under such a structure, the third party investor would establish a special purpose business to provide its REHub services. The investor would fund the construction of the REHub assets from its own resources, having engaged the TNSP to build and operate them, and progressively recoup its investment by charging service fees to generators as they connect progressively. The investor would take the risk that enough new connections, and service fees, eventuate for it to recoup its investment.

The details of a corporate structure that would make such a third party investment possible are discussed in section 4.3 below.

However, there are at present no obvious candidates for this third party investment role. The number, timing and size of future connections are sufficiently uncertain that the investment proposition presently falls outside the realm of normal commercial risk-taking. Naturally, this uncertainty simply reflects the uncertainty that at any time surrounds the likelihood that any one or more renewable projects will actually get built.

4.2.5 Other approaches to mitigating asset stranding risk

For arm's length investors to be enticed into an investment in the Hub would likely require the stranding risk, which is effectively customer take-up risk, to be reduced in some way. This could be achieved by, e.g. a full or partial guarantee of future customer take-up by, say, a government agency.

Government agencies, particularly CEFC and ARENA, have been mentioned as potential participants in this space as facilitators, to encourage the development of efficient connections in regions of prospective renewable resources, consistent with broader renewables policy objectives. However, to date there have been no formal proposals for CEFC or ARENA involvement. A key issue tending to act against government involvement is a perceived difficulty in giving preferential treatment to the generators who benefit from the hub, at the expense of competing generators elsewhere.

Another approach could be for a TNSP, having recognised a prospective grid location in a region of exploitable resource, to work up the Hub connection opportunity as a technical and commercial 'package' and to invite proposals, including commercial terms, from the market generally for the opportunity to participate. The benefit of this more public approach – akin to an auction of Hub capacity – would be a boost to the number of prospective participants, increasing the likelihood that a) the asset stranding risk can be shared or transferred to parties that value the opportunity most highly, and b) the Hub development will proceed.

A higher level approach might be for the Commonwealth Government to amend renewables policy in a way that makes the long term pipeline of renewables developments more certain, thereby giving the industry more confidence that future take-up of a Hub's capacity is likely. Announcing a firm commitment to a long term, continuing increase in the RET post 2020 would go a long way to achieving this.

---

[10] HoustonKemp, "TransGrid's proposed renewable energy hub" final report, April 2016.

4.3 Proposed corporate structure

It is proposed that the commercial arrangements for the Hub be structured around a special purpose project vehicle ("SPV") established by TNSP specifically to undertake a generic REHub project. The corporate structure considers four key groups of stakeholders:

1. The investors
2. The lenders
3. The connecting generators
4. The service providers (construction, O&M, management services etc.).

4.3.1 Benefits of the SPV Structure

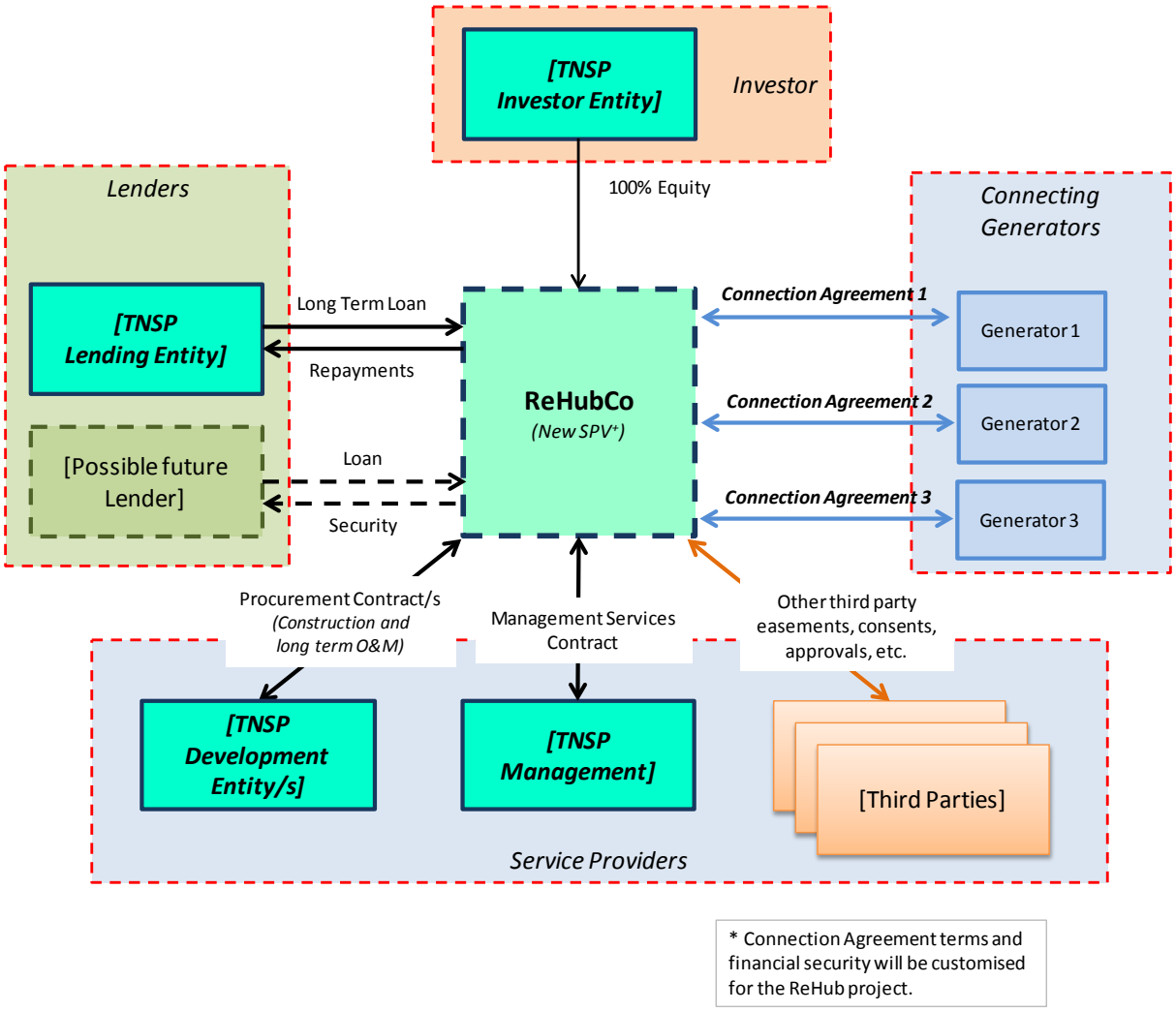
The SPV corporate structure described below has a number of benefits for the TNSP:

1. The structure isolates the unregulated Hub assets from TNSP's regulated asset base both legally and for reporting purposes.
2. The self-contained structure gives the TNSP the opportunity to easily introduce third party capital to the REHub project in the form of debt or equity, or both. TNSP may wish to introduce external capital as a means of sharing the financial risk of the project with a third party/s.
3. The ultimate owner of the equity in the SPV structure need not be TNSP alone, even from the outset. The REHub Co structure could be owned, either wholly or partly (alongside TNSP) by an external investor who wants to invest in the business of providing a common hub connection service to local generators.
4. Once the key contractual arrangements and associated financial flows have been bedded down, the self-contained structure gives the TNSP the ability to convert the future value of the project it has created to an up-front payment, by selling its debt and/or equity holdings in the project structure to a third party.

4.3.2 Key features of the corporate structure

The overall structure is illustrated in Figure 7.

Figure 7: Proposed corporate structure



The main features of the proposed structure are:

1. The TNSP establishes a special purpose subsidiary ("REHub Co") to undertake the REHub development works.
2. REHub Co is the principal development entity that enters into the Connection Agreements with the generators and all other contractual arrangements with third parties required to develop the Hub assets.
3. If required, REHub Co seeks either registration with AEMO as a NSP or an exemption from the AER under National Electricity Rule 2.5. The requirement here will need to be determined by a detailed legal review of the particular circumstances of the REHub proposal.
4. REHub Co will need to pass its connection obligations – both initial construction and longer term O&M – back to an appropriate development entity/s in the TNSP group, in a contracted arrangement that is back-to-back with the Connection Agreements.
5. REHub Co will fund the construction works with either equity subscriptions from the TNSP, via HubCo HoldCo, or by negotiating a financing arrangement with the TNSP development entity/s or another TNSP financing entity.
6. If at some future time external loan finance or grant funding is introduced to fund the project, it is envisaged that REHub Co will be the borrower or grantee.

Box 2: Ring-fencing of Prescribed Services

TransGrid as a regulated transmission business is subject to a ring-fencing requirement, imposed under the NER (clause 6A.21).

Ring-fencing provisions establish arrangements to segregate (or 'ring-fence') a transmission network business' activities in providing prescribed transmission services (i.e. those services relating to the shared network paid for by all customers) from its activities in providing other services.

The NER requires the AER to develop transmission ring-fencing guidelines and a TNSP to comply with those guidelines. These guidelines may include, but are not limited to, legal separation of the TNSP's business that provides network services from any of its businesses providing other services, and the establishment and maintenance of consolidated and separate accounts for prescribed transmission services and other services.

The current ring-fencing guidelines applying to TransGrid separate the functional and accounting aspects of prescribed transmission services from other services provided by TransGrid.

In setting up the SPV for the REHub, consideration would need to be given to how best to structure the arrangements so as to comply with these ring-fencing provisions.

4.4 Contractual relationships

The unique nature of the REHub proposal will require a number of unusual commercial issues to be addressed with special purpose documentation, either as separate documents or as customised amendments to a standard TNSP Connection Agreement.

The proposed contractual arrangements for the Hub illustrated in Figure 7 are expected to comprise contracts under several distinct headings:

1. **Individual Connection Agreements** – each of the generators will enter into a Connection Agreement with REHub Co for the supply and operation of the connection assets relevant to its project. The combined scopes of the Agreements will encompass all the assets needed to create the Hub. Each generator will provide financial security to TNSP/SPV to back the commitments made in its CA. Assuming that TNSP has decided it will accept the asset stranding risk, it (through REHub Co) will explicitly agree to pay the cost of oversizing the Hub assets so that the cost for any generator does not exceed the stand-alone connection cost it would otherwise incur.
2. **Construction & Operation Agreement** – REHub Co will need to pass its connection obligations back to an appropriate development entity in the TNSP group, in an arrangement that is back-to-back with the Connection Agreements.
3. **Funding Agreement** – REHub Co will meet its obligations to pay [TNSP Development] for the construction and commissioning of the REHub assets by drawing on a loan provided by [TNSP Lending entity].
4. **Management Agreement** – as REHub Co will not itself employ any staff, it will engage TNSP to provide management services for the day-to-day administration of the project.
5. **Third Party Agreements** – TNSP/SPV will enter into agreements with third parties as required to give effect to other elements of the Hub. The main items under this heading will be development approvals, easements if necessary and the like.
6. **Extension Connection Agreements** - In addition to the common REHub works, generators may choose to engage REHub Co to construct and/or operate individual substations and extension connections within their respective wind farms. Such arrangements constitute the supply of contestable transmission services and, if agreed, will be documented separately from the REHub Connection Agreements.

The key commercial features of these contract groups are discussed in the following sections.

4.4.1 Individual Connection Agreements

Each of the pioneer generators will enter into a Connection Agreement with REHub Co for the supply and operation of the connection assets relevant to its project. The agreements will be based on TNSP's standard CA, amended as needed to accommodate the special circumstances of the REHub . The principal special amendments are described below.

(a) NER Connection Framework

Connections to a transmission network are generally bespoke to meet the unique needs of the connecting party, as well as maintain technical standards and system security requirements of the network. Therefore, TNSPs tend to have a common yet flexible approach to connections.

Generators and load customers seeking to connect to a TNSP's transmission network have different commercial drivers and requirements which need to be taken into account in the connection process (with recourse to commercial arbitration if agreement cannot be reached).

In NSW as an example, TransGrid's connection framework is in accordance with the NER and consists of a number of stages that have been developed based on experience, and designed to closely align with common customer internal project governance requirements and decision gates.

Figure 8: TransGrid connection enquiry process

(b) Structure of Service Payments to REHub Co

The parties will need to agree the structure and timing of the payments to REHub Co for the long provision of the connection services. It is anticipated that REHub Co will enter into a long term agreement with each generator under which the generator will make quarterly payments to REHub Co for the provision of the service.

The size of the service payments will be set to recover the capital cost of the installed equipment, the ongoing O&M costs and a fair investment return to REHub Co reflecting the development risk it has taken.

As described elsewhere in this report[11], the negotiated and contestable assets to be developed by ReHub Co fall outside the 'ring fence' containing the TNSP's Regulated Asset Base. The commercial terms for the provision of the associated services therefore will be set by direct negotiation between the TNSP and the generator, not by the Regulator.

Because of the increased commercial risk involved in developing the REHub, compared to a regulated asset, it is likely that the financial return inherent in the negotiated arrangements will exceed the return a TNSP is allowed by the Regulator to earn on its regulated assets.

(c) Financial Security

Each generator will be required to provide financial security to REHub Co to secure its payment obligations under its Connection Agreement such as through a bank guarantee.

(d) Cost Share Terms

The opening agreement with generators may need to set out the terms for the payment of cost share payments by subsequent projects developed by the same generator and which use the common assets – similar to the "Pioneer Scheme" arrangements adopted by some DNSPs. In the absence of any regulatory framework covering these circumstances in the transmission space, the final outcome will be

[11] See e.g. explanatory box at the end of section 4.3.

determined by the course of arm's length commercial discussions with the generator participants, which are yet to commence.

4.4.2 Construction & Operation Agreement with TNSP

REHub Co will have no staff or operating resources of its own. It will therefore need to pass its connection obligations under the Connection Agreements back to an appropriate development entity/s in the TNSP group for the delivery, commissioning and long term operation of the REHub assets.

As closely as practicable, the terms of the Construction & Operation Agreement with TNSP will mirror, in aggregate, the obligations REHub Co has entered into under the Connection Agreements with the generators.

4.4.3 Funding Agreement

REHub Co will meet its obligations to pay [TNSP Development] for the construction and commissioning of the REHub assets under the Construction & Operation Agreement by drawing on a loan provided by [TNSP Lending entity].

In practice, [TNSP Lending] may be [TNSP Development] itself.

The repayment provisions of this loan will be designed to largely mirror the income derived from the generators under the Connection Agreements. That is, the payments will be sized so that a roughly constant proportion of the payments made by the generators is devoted to debt service.

4.4.4 Management Agreement with TNSP

As REHub Co will not itself employ any staff, it will engage TNSP to provide management services for the day-to-day administration of itself and the project. Commercially, such services could be provided on a cost-plus basis, at least initially. Later external investors may prefer greater certainty and require a capped cost arrangement.

4.4.5 Third party agreements

The planning approvals for proposed generations will likely include the construction of new high-voltage electrical infrastructure within the proposed areas of the windfarms. TNSPs will likely prefer to own and operate that infrastructure. They will require tenure over the land on which the high-voltage infrastructure is located and the preferred position is:

- Freehold in the case of substations and the like, with access easements thereto.
- Permanent easements in the case of linear infrastructure such as transmission lines – 45 metres wide in the case of 132kV lines, 60 metres wide in the case of 330kV lines.

Where proponents will acquire non-permanent leasehold tenures over all the parcels of land within the proposed areas of the windfarm, the proponents as leaseholders only would not be able to grant the permanent tenures that the TNSPs require, and would instead have to negotiate with the freehold landowners to secure the necessary property rights on behalf of the TNSP.

4.4.6 Extension Connection Agreements

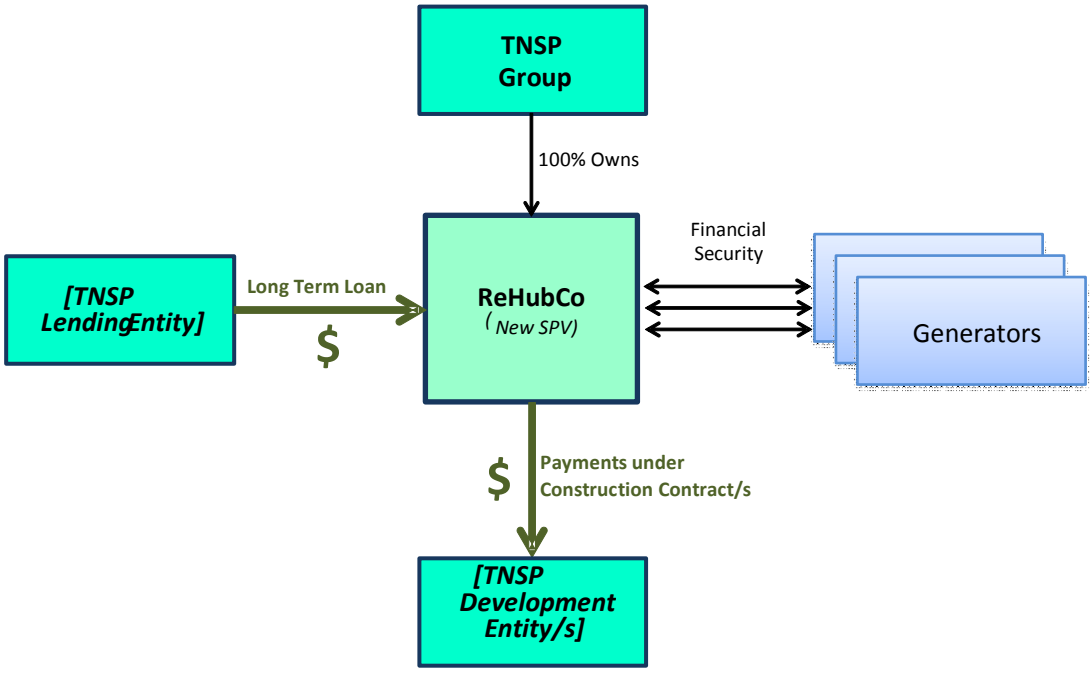
In addition to the common REHub works, generators may wish to engage REHub Co to construct individual substations and extension connections on and to their respective wind farms that would ordinarily be the responsibility of the generator to construct. Such arrangements, if agreed, will be documented separately from the REHub Connection Agreements. Ownership of the extension connection assets constructed by the TNSP would remain with the relevant generator.

4.5 REHub Co funding plan

4.5.1 Funds flows during construction and operation

Funding plans for REHub Co for the construction phase and the operating phase are illustrated and described below.

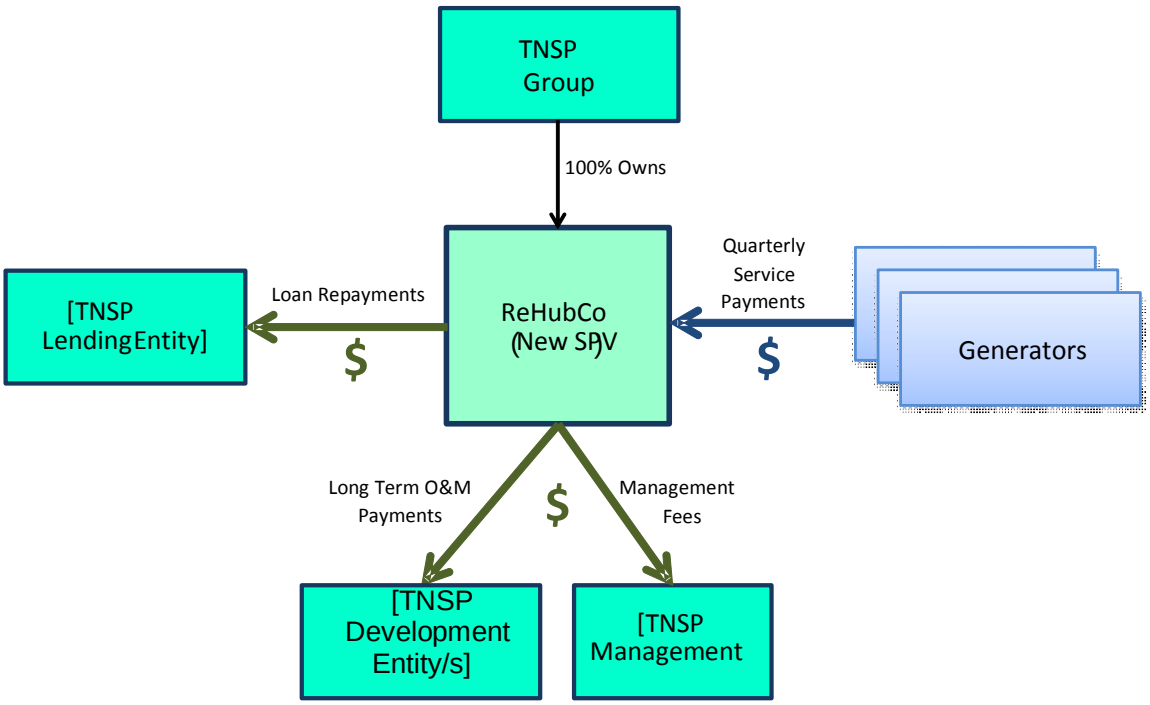
Figure 9: Construction Phase Funding Plan



REHub Co will enter into a Construction and O&M Contract with [TNSP Development] for the delivery, commissioning and long term operation of the REHub assets. REHub Co will meet its payment obligations under this contract by drawing on a long term loan from [TNSP Lending]. In practice, [TNSP Lending] may be [TNSP Development] itself.

The generators will not contribute directly to the cost of constructing of the REHub but as a condition of entering into the Connection Agreements they will be required to lodge financial security with REHub Co to secure their obligation to make long term service payments under those Agreements.

Figure 10: Operating Phase Funding Plan



Costs - In the operating phase, REHub Co will have two categories of costs to meet:

1. Direct operating costs. These will principally comprise long term payments under the O&M contract with the relevant TNSP entity and also include management fees paid to TNSP for the day to day administration of REHub Co.
2. Loan repayments to the TNSP Lending Entity. The term of the TNSP loan will be [the same as] the term of the Connection Agreements with the generators.

Revenue For the purposes of this study it is assumed that the value of the quarterly service payments by the generators will be set at a level which, in aggregate, meets all of REHub Co's contracted payment obligations and, after the payment of direct operating costs, provides REHub Co with an appropriate internal rate of return (IRR) on the cost of providing the REHub services.

Because of the increased commercial risk involved in developing the REHub, compared to a regulated asset, it is likely that the return inherent in the negotiated arrangements will exceed the return a TNSP is allowed by the Regulator to earn on its regulated assets.

4.5.2 Forecasting cash flows and project returns

The repayment terms of the construction loan from [TNSP Lending] and the size of the quarterly service payments to be made by the generators will typically be calculated to deliver an acceptable IRR (reflecting the different cost components such as the Hub and the line/substation) to [TNSP Lending] on its loan principal.

Other key assumptions which will act as inputs to the financial model include:

- Construction Program duration and start
- Staging of connections
- Total capital expenditure
- Connection Service Fees
- Operating costs
- Cost base date
- CPI

Version 23.0

- Corporate tax rate
- GST
- Operations term
- Debt terms and conditions (if external loans are introduced)
- Debt to Equity ratio (gearing).

4.5.3 Financial risks

The key financial risk for the TNSP is non-payment of quarterly service payments by a generator, which TNSP/REHub Co will address by requiring financial security from the generator as a condition precedent to each Connection Agreement.

The TNSP will also be exposed to the risk of capex overruns. The Connection Agreement signed with each generator will set a fixed (subject to escalation) level of connection service fees. The TNSP will therefore be exposed to reduced returns if, because of overruns, total capex exceeds the expected amount.

4.5.4 Possible external finance

The corporate structure diagram at 4.3.1 above includes a possible external lender (which could also be a grant provider) being part of the structure.

Setting up the REHub project as a self-contained corporate structure gives the TNSP the opportunity to arrange external construction finance (or a grant, if available) from third parties, instead of providing the finance itself.

The ability to leverage the SPV with external debt will give the TNSP the opportunity to increase the rate of return on its equity investment in the development – though the downside risk is also magnified.

4.5.5 Possible realisation of development premium

The self-contained corporate structure proposed for the NE REHub gives TNSP the ability to convert, should it so wish, the future value of the project it has created to an up-front payment, by selling its debt and/or equity holdings in the project structure to a third party. That is, TNSP will have the opportunity to realise any development profit inherent in the contractual arrangements it enters into with the generators.

Once the initial round of REHub development is complete, the business owned and operated by REHub Co will have characteristics that make it potentially attractive to third party investors:

- Reliable, low maintenance assets, designed and installed to high standards
- Secure, long term streams of service payments from generators, backed by appropriate financial security
- Low operating costs secured by a suite of long term contracts by which all necessary operating functions are outsourced [to TNSP] at commercial rates; and, most importantly
- Resulting reliable, long term net cash flows.

TNSP will set the size of the generator service payments at a level that over time will recoup all construction costs, meet ongoing operating costs and provide TNSP with a financial return on its investment.

With all the key contractual arrangements executed, and construction completed, the REHub project will have been substantially “de-risked”. That is, the remaining risk that forecast commercial performance won’t be achieved will be relatively small.

In these circumstances, it is likely that an arm’s length investor would value REHub Co’s de-risked, long term net cash flows using a discount rate that is considerably lower than the IRR the TNSP used to set the size of the generator service payments. All else being equal, this would result in the investor placing a higher value on the business than it cost the TNSP to establish. The value uplift is the development premium TNSP has created through the process.

TNSP could realise some or all of this value in several ways:

- Sell the equity it holds in REHub Co to the investor
- Sell the loan facility it has extended to REHub Co to the investor
- Introduce an external lender to refinance the loan facility at a premium to the original face value; or
- A combination of the above.

It is expected that the long term, predictable cash flows generated by REHub Co would be particularly attractive to financial investors with long term investment horizons, like major superannuation funds.

Box 3: Marginal Loss Factors

While transmission networks are efficient at conveying large amounts of energy, they are not perfect conductors of electricity. A small amount of electricity is "lost" when being transported from one point to another. The proportion of power generated that is lost depends on the location of generation and load connection points, with more remote connection points generally incurring higher losses. It follows that it is important to minimise the losses in the transmission networks to the extent that it is cost effective to do so.

Marginal Loss Factors (MLFs) for load and generation transmission network connection points provide a signal for loss minimisation. That is, MLFs within each NEM region approximately represent the impact of marginal network losses on nodal prices at the transmission network connection points at which generation and loads are located.

For each individual generator's investment case, MLF's provide for the dispatch of generation that is as economically efficient as possible. That is, the use of MLFs ensures that the network loss impacts on economic efficiency are properly incorporated into dispatch decisions. Therefore MLFs are an important input for each connecting generator in establishing potential revenue and hence long-term project viability.

It is also important to note that marginal loss factors are average values calculated from historical network flow data from the previous financial year. Indicative forward looking loss factors are calculated by AEMO for interested parties noting that any changes in the system and/or market (i.e. demand, generation, networks, etc) could result in variations to calculations at any point in time.

5. Market and regulatory framework

Summary

- Assets required for a REHub are expected to fall into the categories of negotiated and contestable transmission services
- The SENE process requires transmission businesses to undertake and publish, on request, specific locational studies to reveal to the market potential opportunities for efficiency gains from the coordinated connection of expected new generators in a particular area
- No SENE Design and Costing studies have been requested or completed in the NEM.
- The SENE framework has not achieved the objective of facilitating multiple generator connections.
- The AEMC is currently in the initial phase of assessing a rule change proposal submitted by the COAG Energy Council, which seeks to enhance contestability in the provision of connections to transmission networks. However this is not expected to fit into the timeframe for the NE REHub.
- TransGrid engaged HoustonKemp to undertake research and provide expert advice surrounding the regulatory implications of an Energy Hub, including its overlap with the SENE framework

The role of the electricity market, how it functions and how it is regulated influences the options and issues to be considered in the development of a REHub.

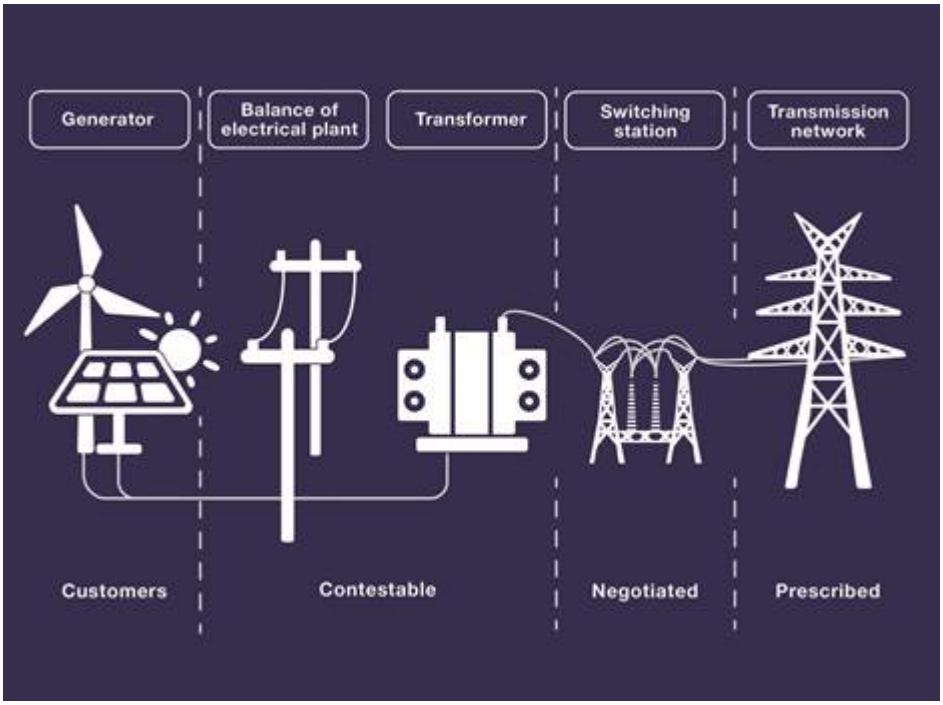
5.1 Regulation in the National Energy Market

Networks in the NEM are subject to regulation under the National Electricity Law and National Electricity Rules. The Rules set out the framework for economic regulation that applies to the different services which can be provided by transmission network service providers (TNSPs) such as TransGrid to connecting parties. Connecting parties include generators, distribution network service providers and directly connected load (such as industrial customers).

It is important to understand the regulatory framework and how it would apply to the concept of a REHub as it is possible that the provision of a hub could include different forms of regulation, depending on what services the assets that comprise the hub are providing. The different categories of transmission services determine how a TNSP is allowed to charge for providing the services of the hub.

5.1.1 Categories of transmission services

Figure 11: Stylised mapping of assets to services



The regulatory framework applies to services rather than to particular assets. The National Electricity Rules outline three categories of services that TNSPs can provide. The nature of the service (and who benefits from the TNSP providing that service) determines what kind of regulation the TNSP is subject to. The three categories of service are:

- **Contestable (or non-regulated) transmission services**: refers to services that are neither prescribed nor negotiated services (i.e. they can be provided on a competitive basis). Examples include extensions from a sub-station site to a generator's site as would be required in the case of the NE REHub. As this category of service is specifically for the benefit of the connecting party, it is paid for by the connecting party. These types of services are open to competition and the pricing arrangements are not subject to economic regulation under the National Electricity Rules.
- **Negotiated transmission services**: refers to services that that can only be provided by that TNSP and are provided to an identifiable party. An example would include work within a substation site to connect a generator. This would be required in the case of the case of the NE REHub. Negotiated services are subject to regulation under Chapter 6A of the Rules, including a requirement to comply with specified negotiated service principles. These services are paid for by the connecting generators and prices are set by negotiation in accordance with the TNSP's approved negotiating framework. In respect of negotiated services the rule provides that the generator should not be charged more than the stand-alone cost of a connection. It is silent on the design standards that determine the scope and therefore the cost of such a stand-alone connection.
- **Prescribed transmission services**: refers to services provided by network elements which benefit network users generally rather than a single consumer or user of the network element (for example, connections between a transmission network and a distribution network). Given that the benefit is attributed to many, the appropriate value of that part of the network is included in the Regulated Asset Base (RAB) and the revenue entitlement is included in the total revenue cap of a TNSP. That is, the services are paid for by customers generally rather than the connecting generators. Pricing of individual services is then set in accordance with the TNSP's approved pricing methodology and the requirements of Chapter 6A of the Rules.

In the particular case of the NE REHub, it is not expected that the shared network will require augmentation because the Queensland NSW Interconnector has ample capacity, so there should be no requirement for costs referable to prescribed transmission services.

The AEMC is currently in the initial phase of assessing a rule change proposal submitted by the COAG Energy Council. The proposal seeks to enhance contestability in the provision of connections to transmission networks, potentially resulting in some negotiated services becoming contestable, and so no longer subject to the negotiated service principles in the NER.

The development of a REHub is framed so as to encourage additional generation to connect. If as a consequence network assets also require an upgrade then an investment in prescribed assets would be required which would be subject to a regulatory investment test for transmission (RIT-T). The investment would be justified if a beneficial change in dispatch patterns outweighed the cost of the upgrade. The TNSP would be entitled to revenue from its transmission customers via their TUOS charges to provide a regulated return on the new assets.

In the special case where the network is upgraded but the additional, anticipated generation fails to eventuate, transmission customers will have paid for an underutilised augmentation of network capacity. In that sense, the wider TNSP customer base bears some of the stranded asset risk where the asset is the prescribed network asset, as distinct from the REHub. The use of scenario analysis in the RIT-T assessment is intended to take into account the uncertainty associated with future market developments as a way of minimising this risk.

5.1.2 Regulation applicable to a REHub

The NE REHub consists of transmission assets designed and built to accommodate solely the connection of a number of generators in that geographical area over time. The NE REHub involves assets providing only negotiated and contestable services to these generators and no augmentation is required to the shared network.

Under the Rules, the extent of prescribed transmission services is determined by the standard level of service that must be provided to a connection applicant. The standard level of shared transmission service is prescribed and determined by the network performance requirements set out in the NER and in any relevant jurisdictional legislation. For generators, the standard level of shared transmission service is zero. Therefore, any change to the transmission services to provide a new service required by a generator is generally considered to be a negotiated transmission service and is funded by the generator.

In some cases transmission investments to remove network constraints may provide ‘prescribed’ transmission services even if these are driven by a generator connection, to the extent that the transmission investments pass the RIT-T[12].

Similarly, if in the future assets providing **negotiated** transmission services or **non-regulated** transmission services also provide **prescribed** transmission services, then a proportion of the costs of the assets may be reallocated to the provision of those prescribed transmission services in accordance with a TNSPs cost allocation methodology. In the case of the NE REHub described above, this is unlikely to be the case.

5.1.3 SENE regulation

The Australian Energy Market Commission (AEMC) makes and amends the National Electricity Rules which govern the operation of the National Electricity Market. The AEMC is also an advisor to governments on the development of the market and regulatory framework.

In 2011, the AEMC published a rule determination in relation to scale efficient network extensions (SENE) to an electricity transmission network.

---

[12] See Box 1: Connection vs Access for further discussion about generator access to the network.

The original SENE rule change request proposed that customers would initially fund some spare capacity, which would be recouped over time as future generators connected. Specifically, the proposed Rule allowed transmission capacity to be built in anticipation of future generator connections by requiring customers to underwrite the cost (and risk) of spare capacity, to be paid back through generator charges where all generation connects as forecast.

The final Rule as made rejected this approach and sought to allocate cost and risk to market participants or investors, rather than to consumers. Specifically, it does not compel anyone to bear the risk and cost of stranded assets. Rather, in the first instance it provides a mechanism under which opportunities to capture scale efficiencies can be made transparent, via the ability of parties to commission a SENE Design and Costing Study.

While the SENE rules were introduced in 2011, there have been no SENE Design and Costing studies completed in the nearly 5 years to date, nor have any been requested.

It appears that the SENE framework has not achieved the objective of facilitating multiple generator connections. While the REHub concept essentially overlaps the SENE concept in the current Rules, the potential hurdles to the commercial development/funding of a SENE (including by TNSPs) is a threshold issue that needs to be addressed. In the absence of a clear framework for the recovery of the costs of a commercial development, there is no incentive for a commercial party to pay for a SENE study.

TransGrid, the TNSP in NSW, engaged HoustonKemp to undertake further research and provide expert advice surrounding the regulatory treatment of a REHub including taking into account work to date on SENEs. HoustonKemp notes that the AEMC considered that the decision to invest in oversized assets is best made by market participants or investors with the appropriate information, ability and incentive to manage the asset stranding risk.

The prevailing regulatory framework does not place any restrictions on the commercial agreements that can be reached between parties to fund extensions to the transmission network to connect generators at such a hub location.

While a REHub, acting as a scale efficient network extension, is likely to provide economies of scale and thus lower connection costs, there exists no path within the NER for a TNSP to initiate one and be certain of recovering its costs for that portion of the REHub that provides negotiated services (essentially the substation component). Either a REHub has to be fully subscribed at the time of initiation under a multi-party commercial agreement, or an initiating party takes the risk of owning an under-utilised and thus stranded asset, with an uncertain prospect of being able to earn a return commensurate with the risk borne, for part of the investment.

There may be a role for public bodies to play by initiating and paying for SENE Planning and Costing studies thus providing information to the market in respect of network suitability and costs.

5.1.4 Regulation of connection charges

Connections to a transmission network are generally bespoke to meet the unique needs of the connecting party, as well as maintaining technical standards and system security requirements of the network. Therefore, TNSPs tend to have a common yet flexible approach to connections. In TransGrid's experience, every generator and load customer seeking to connect to its transmission network has had different commercial drivers and requirements which need to be taken into account in the connection process (with recourse to commercial arbitration if agreement cannot be reached).

Substation standards that allow for expansion

Each TNSP in the NEM can decide how to specify an approach for the construction of substations that would facilitate future connections, particularly in areas where the connection of multiple generators appears likely.

TransGrid, the TNSP in NSW, requires new network connections to be compatible with expected future generation developments, and to be designed so that they can be developed in stages to meet the future capacity needs of the connection location. In determining the design for a new substation, TransGrid

considers the ultimate capacity that is expected to be required at that substation, and the potential for staged expansion. In particular, provision is made to accommodate the land requirements of the ultimate substation configuration. However new substations are planned in stages so that the establishment costs carried by each new connection are minimised.

ElectraNet, as the TNSP in South Australia, and the Australian Energy Market Operator (AEMO), as the TNSP in Victoria, do specify configurations for new substations:

- ElectraNet specifies the appropriate configuration of substations to a standard that is easily expandable at a later date
- AEMO explicitly references 'expandability' as a criterion for determining relevant substation configuration in its guidelines for shared transmission connection in Victoria.

In the case of AEMO the substation configuration would form part of the 'stand-alone costs' for the connecting generator, however where additional works are incorporated in the substation design to allow future expansion, these costs are considered to be outside the 'stand-alone costs' and would be subject to the Regulatory Investment Test for Transmission (or equivalent cost benefit test).

Prospect of change in substation regulation

The AEMC is currently in the initial phase of assessing a rule change proposal submitted by the COAG Energy Council. The proposal seeks to enhance contestability in the provision of connections to transmission networks. The rule change request is largely based on the connection and planning recommendations made by the AEMC in its Transmission Frameworks Review, which was completed in 2013.

In terms of changes to the current connections process the proposal aims to:

- Clarify the definitions for connection assets, connection services and classifications
- Enhance contestability in the connection arrangements, by treating some connection assets that are currently considered to provide negotiated services as contestable, where they are provided by a party other than the local TNSP
- Improve the transparency of information for negotiated transmission services.

Under consideration is the classification of the services provided by assets within the substation perimeter which have the potential to be shared by more than one generator, including areas of land set aside for future substation assets.

Within a substation some assets are dedicated to a particular generator, and other assets could be shared between different generators. The latter assets would be sized as part of a REHub to allow for the connection of future generators through the same substation. The rule change would result in a formal distinction between these two types of substation assets, with the shared assets becoming contestable rather than negotiated, where provided by a party other than the local TNSP.

Given the complexity of this rule change, the AEMC has extended its timeframe, and now expects to publish its final determination in March 2017. Clarification in this rule, if made, may be relevant to future hub concepts but it would not fit the timeframe for the NE REHub and the potential connecting parties in that region.

5.2 Electricity market considerations

5.2.1 National Electricity Market

The National Electricity Market (NEM) is the wholesale electricity market for the electrically connected states and territories of eastern and southern Australia – Queensland, New South Wales, the Australian Capital Territory, Victoria, South Australia and Tasmania. The NEM generates around 200 terawatt hours of electricity annually, supplying around 80% of Australia's electricity consumption. The NEM began operating in 1998. Western Australia and the Northern Territory are not connected to the NEM. They have their own electricity systems.

The NEM facilitates the exchange of electricity between generators and retailers. Retailers resell the electricity to businesses and households. Some large consumers also purchase electricity directly from the market. High voltage transmission lines transport electricity from generators to electricity distributors, who deliver it to homes and businesses on lower voltage 'poles and wires'.

The NEM is an energy-only gross pool with mandatory participation. Generators sell all of their electricity through the market which matches supply to demand. From the generators' offers, the market determines the combination of generation to meet demand in the most cost-efficient way. The market is managed by the Australian Energy Market Operator (AEMO). AEMO will constrain dispatch from generators to ensure the system operates within the technical operating envelope. It dispatches and constrains generators to achieve the lowest possible spot market price.

Large scale renewable energy generators are market participants in the NEM, but due to the variability of the resource used to generate electricity, such as wind, these generators are classified as 'semi-scheduled'. This allows AEMO to account for the effect of electricity generated by renewable sources on demand.

The market determines a spot price every half-hour for each of the five regions of the NEM. Generators and retailers often protect themselves from movements in the spot price by entering into hedge contracts.

Renewable energy generators either contract or accept spot prices for their output. In addition they receive income from the sale of Renewable Energy Certificates, traded in the NEM under the Renewable Energy Target (RET) scheme.

5.2.2 Market interaction with REHub developments

Network analysis considers the potential limitations for additional capacity in a geographical region taken as a whole. Hub entities within such regions are not defined in the NER and TNSPs do not attempt to consolidate independent projects. Rather TNSPs seek to provide scale efficient and cost effective connections to the transmission network for generator applications separated in time.

Each connection is considered independently in order of connection.

Where a TNSP receives multiple applications to connect, it has an obligation to offer connection, set out in a commercial agreement, for each application. The obligation to each applicant exists regardless of:

- Whether other connection applicants have previously accepted the TNSP's offer to connect to the same transmission line; or
- Whether the TNSP is in the process of preparing offers to connect to the same transmission line for other connection applicants; or
- The capacity of the transmission line to transfer the output of one or more generating facilities that could be connected by one or more applicants to that transmission line.

This obligation on the TNSP reflects the 'open access regime' established in Chapter 5 of the NER requiring that all registered participants should have the opportunity to form a connection to a network.

As the number of new generation developments making connection increases, especially where they are geographically concentrated around a favourable resource, local network capacity will be more fully used. This will increase the likelihood that new generation will cause network constraints to be experienced either by the new generator itself or by existing generators. The increasing possibility of network constraints, fostered in part by the 'open access' provisions of the NER, is an issue that may need to be addressed by the AEMC.

Where congestion is experienced in a network, the decision on the actual amount of electricity which can be exported from a connection point at any time is made by AEMO which makes dispatch decisions completely independently from the TNSP.

AEMO needs to know about network constraints, including temporary constraints. For each trading interval AEMO must publish information on when and where network constraints may limit generation dispatch. Market participants are therefore required to submit capacity estimates for scheduled network services.

Figure 12: Feedback loop – network constraints

Generating units must be dispatched by AEMO to maximise the value of spot market trading[13]. 'Value' is based on dispatch bids less the combined cost of generation, network and ancillary service dispatch offers which applies to both scheduled and semi-scheduled generation. Wind farms built post-2013 and which exceed 30MW are assumed to be semi-scheduled.

Lower-priced offers must be given priority in the dispatch process. The central dispatch principle of value maximisation is subject to network constraints and arrangements to ensure pro rata loading of tied offers. That is, if there is a tied bid, NER requires that generators must be dispatched by AEMO on a pro rata basis.

While there is no provision in Chapter 3 of the NER for TNSP network connection agreements to prescribe generator dispatch arrangements, connection agreements can contain specific provisions relating to what happens in the event of a temporary network constraint of typically less than 15 minutes duration. This could include generation runback schemes to cover such short term contingencies. Longer constraints are typically reported to AEMO which will then factor the constraint in to its dispatch process.

5.2.3 Renewable Energy Certificates

The Renewable Energy Target (RET) scheme distinguishes between Large Scale Renewable Energy Targets (LRET) and small-scale renewable energy scheme (SRES) mostly in the form of rooftop PV solar systems.

It works by allowing large-scale renewable power stations to create certificates for every megawatt hour of power they generate. The certificates are then purchased by electricity retailers who have legal obligations under the Renewable Energy Target to surrender certificates to the Clean Energy Regulator, in percentages set by regulation each year. This creates a market which provides financial support to renewable energy power stations.

In June 2015, the scheme was amended by legislation with the effect that the large-scale renewable energy target was reduced from 41 000 GWh to 33 000 GWh in 2020 with interim and post-2020 targets adjusted accordingly. In its current architecture the scheme expires in 2030 after which a large scale generator will lose the line of revenue which it currently enjoys from the sale of LGCs.

---

[13] NER 3.8.1(b).

The individual obligations for each liable entity are determined based on its electricity consumption and the renewable power percentage (a measure that specifies the number of certificates per MWh consumed). The renewable power percentage for each year is calculated in advance and is based on the legislated target and expected power consumption for that year. If an entity does not surrender sufficient LGCs, they are required to pay a penalty for each certificate not surrendered. This penalty is $65 per certificate and this cost is not tax deductable[14].

The penalty characteristic of the RET is levied on a retailer for failure to comply with the requirement to annually surrender certificates. The penalty of $65/MWh is not indexed so is falling in value. There may be a time when a retailer is commercially better off paying the penalty rather than purchasing LGCs. Should this occur, the scheme outcome will cease to encourage development of new renewable energy generation.

In the absence of subsidies provided by the RET, wind farms[15] do not yet earn adequate revenue in the wholesale electricity market to cover their upfront investment costs. LGCs provide a crucial, additional source of revenue. A generator's investment will be profitable if the combined revenue earned from the wholesale market and the sale of LGCs is sufficient to ensure cost recovery, including an appropriate return on the investment.

The RET is therefore a major driver of investment in renewable energy generation. The target of 33,000 GWh from 2021 to 2030 translates to around 18,500 GWh per annum of renewable generation from projects that are yet to be completed. In terms of new construction of wind farm capacity, this equates to around 6,000 MW of wind farm capacity, based on an assumed capacity factor of 35 per cent. While it is unclear whether the new LRET of 33,000 GWh will be met, installed capacity ideally needs to be in place within four to five years (when it peaks) to take best advantage of LGCs in the market to underpin capital expenditure.

Forecasts of the LGC price are varied as a consequence of considerable uncertainty over recent years. Should there be no lingering policy and revenue concerns, the industry might be expected to respond quickly and bring the required new generation online in the next few years. Should the investors be more cautious, the new generation might take longer to come on line, if at all, leaving a shortfall of LGCs and bringing in to play the tax adjusted penalty. In the event that capacity is built in excess of the 33TWh target then an LGC price of $0 for the uncontracted excess is possible. Thus time is the most significant issue with the next few years being critical.

In a project finance sense, as time goes by, the revenue support underpinning capital expenditure is diminishing in relevance when compared to the sale of the electricity generated. This will have the effect of progressively diminishing the encouragement to the development of new renewable energy generation. It is generally considered that a seven (7) to ten (10) year revenue stream is the minimum necessary to underpin capital expenditure which suggests in turn that a new renewable generation facility needs to be on stream by 2020, before the RET stops increasing. Given that the development cycle including construction for a new large scale generation facility is of the order of three (3) years, financial commitment for a new facility needs to be made before the end of 2017.

Taking the 2030 sunset date and the mechanics of operation of the penalty, the window of opportunity is closing. If increasing pressure on viability begins to restrict the number of renewable developments being proposed then it follows that the opportunities for Hub style developments, which serve the needs of multiple projects, will also be restricted. However other market forces, greater than those leveraged in the RET, are having effect. Recent international pricing[16] of PV developments are tending to indicate that utility scale grid connected renewable generation has a strong future and with it the usefulness of REHubs.

---

[14] Circa $92.80 adjusted for company tax

[15] Nor most other forms of renewable generation.

[16] http://www.pv-magazine.com/news/details/beitrag/third-phase-of-dubais-dewa-solar-project-attracts-record-low-bid-of-us-299-cents-kwh_100024383/#axzz47Xz6LRex

On a positive note, these time imperatives should have the effect of concentrating the time horizons of the various renewable energy developers which may in turn bring about the commercial architecture needed to support a renewable REHub as further described in Section 4.

5.3 Risk Management

5.3.1 The ability to earn a return commensurate with the allocation of risk

A TNSP may of its own volition build a connection hub that is larger than that necessary for a stand-alone connection. There appears to be no restriction within the regulatory framework preventing TNSPs from charging a risk adjusted price to subsequent generators seeking for the contestable extension component of the cost of hub that reflects the risk initially borne by the TNSP. However, in practice, there is likely to be commercial restrictions on the ability of a TNSP to bear the risk without certainty that it will able to earn a return that reflects bearing that risk.

The existing Rules that relate to negotiated services require prices to be based on the cost to deliver that service. To interpret 'costs' for the negotiated component of hub assets (i.e. substation assets), for later connecting generators, HoustonKemp advised that it appears reasonable and consistent with previous AEMC statements, to include a return that reflects the risk borne by TNSP in providing those assets. However, it is not beyond doubt.

The current Rule change before the AEMC may clarify this issue. However, as the Rule change is still in progress, this view is not beyond contention and this is a potential disincentive for TNSPs opting to bear the risk.

5.3.2 Cost sharing mechanisms to recover costs

A cost-sharing mechanism is one way to share the risk associated with constructing hub assets. The National Electricity Rules allow for DNSPs (distribution networks) to apply 'pioneer schemes' as part of their connection policies which are effectively a cost-sharing mechanism where distribution connection applicants make a contribution towards extension works that provide a connection to their premises where the initial connection was previously funded by another customer, the "pioneer", provided that the initial connection was within the last seven (7) years. Under that concept, the connections are separated in time.

No such arrangement exists in the NER in respect of transmission connection policies. However, there are currently no provisions that act to prevent the development of agreements that share the costs paid for by the initial generator for the hub with future joining generators for the contestable portion of the hub. Moreover, for negotiated service the NER actually requires cost-sharing arrangements to be developed. The arrangement would necessarily respond to the allocation of risk which will be greater when the connections are separated in time, than if the connections could be brokered to happen by agreement at the same time.

Under a cost sharing mechanism, the first connecting generator(s) bear some (or all) of the risk associated with the hub assets. The cost sharing mechanism could also be applied in a framework where a third party (such as a TNSP) could bear the stranding risk associated with hub assets, as a way of sharing the cost of that part of the hub assets paid for by the initial generator(s) with subsequent generators.

Box 4: Transmission Pricing

From July 2016 TransGrid is moving to the modified cost reflective network pricing methodology (CRNP) to allow network utilisation to be factored into transmission pricing. The intention is to encourage better utilisation of existing assets by discounting the costs allocated to under-utilised elements relative to those that are more heavily utilised.

This mechanism is used to calculate the prescribed TUOS services – the locational component of prescribed transmission prices. In essence modified CRNP calculates utilisation-adjusted, optimised replacement costs and applies an average return on these assets to determine the locational component of shared network charges.

While generation assets such as the hub provide negotiated services and so are excluded from the shared network, the impact of any new generation on network flows, and hence on the utilisation of network elements, will ultimately have an impact on pricing.

Utilisation factors for each network element are calculated based on the maximum loading over a range of operating conditions to ensure that lightly loaded elements recover proportionately less revenue from locational charges than heavily loaded elements.

In the context of this report, TransGrid acknowledges that any new generation, including the hub, will have an impact on transmission pricing. However, the extent of any impact is subject to complex modelling within the annual transmission price setting process as described in the NER, and is outside the scope of this report.

6. Community

Summary

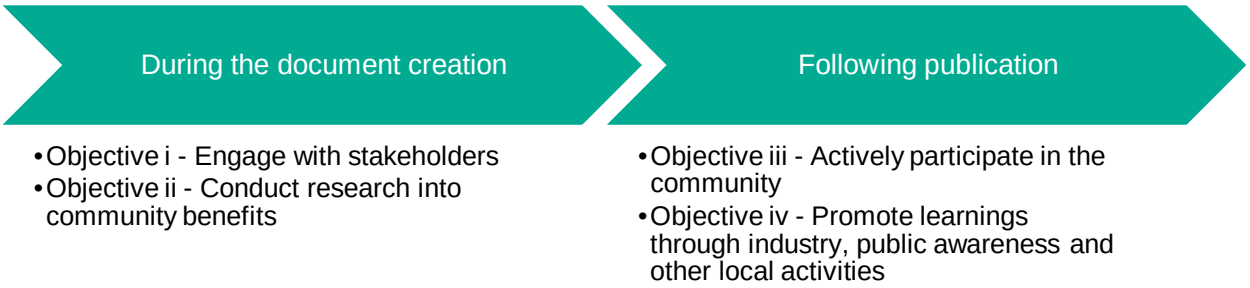
- A REHub would generate considerable economic benefits for a local area, region and the state.
- From a social perspective, the population change and community value benefits are expected to outweigh negative impacts.

6.1 Communications

Proper stakeholder engagement is vital for the success of any major infrastructure project. Planning and executing communications in a co-ordinated and consistent manner develops and maintains a project's social licence to operate in the affected community and among broader jurisdictional authorities.

In 2014, TransGrid solidified a four staged approach to consulting with stakeholders on projects. Currently, the New England Renewable Energy Hub is at the 'Identify Need' stage. As such, we have commenced our journey to inform and garner feedback from stakeholders on topics that they have tangible impact. At each step we will reassess the style of consultation based on feedback we receive. In line with TransGrid's Stakeholder Engagement model, this communications plan has four objectives:

1. Engage with stakeholders
2. Conduct research into community benefits
3. Actively participate and support the New England Community
4. Knowledge sharing plan.



6.2 Stakeholder consultation

Emphasis should be placed on people that live in the vicinity of proposed wind and solar farms and those that may be impacted during their construction Centrally coordinated key messages regarding a REHub and its extended options ensures questions from a diverse range of stakeholders do not unintentionally mislead audiences, driving genuine engagement leading to trust and stakeholder support.

Stakeholder attitudes and concerns that might be expected in respect of a REHub concept are described below.

Table 4: Stakeholder Feedback

Topic area	Summary of feedback and recommendations from preliminary consultation
Stakeholder engagement	> Promote the key points about the REHub that are relevant to the community > Ensure earlier community consultation and communication that is public, transparent and uses existing bodies such as NBN Co ISP's stakeholders > Create local buy in to win the hearts and minds of the local community > Provide the community with more facts and information about the REHub > Ensure there is an agreement between the developers of the REHub > Specify which proponent of the REHub will lead and coordinate communications and engagement with stakeholders and the community.
Views and understanding of the REHub	> Allow for discussion around the naming of the REHub > Outline the pros and cons of having a REHub > Clarify what the scale of the REHub will be > More explanation around how the REHub will look on the grid > Outline how the REHub will be measured and validated > Provide opportunity to develop innovative ideas around the REHub > Consider the ecological impacts of the REHub > Outline the design of the REHub > Clarify whether the REHub will be independent or not > Outline the timing of when the REHub will be developed > Outline what is needed after the feasibility study > Clarify whether the Mandatory Renewable Energy Target (MRET) has been considered during the investigation into the REHub > Suggest establishing a network similar to the South East Region of Renewable Energy Excellence > Explain the process of construction and how the REHub will be operated and maintained.
Economic issues and funding	> Clarify the business model that will be used to accommodate the REHub > Ensure a range of funding models are explored > Clarify the business model that will be used to accommodate the REHub > Clarify whether local/ regional residents and businesses can invest in or co-fund the REHub > Clarify if there are opportunities for business development and to create local funding > Explore whether a community fund can be created and used to power money in the region > Clarify the benefits to local residents in being able to purchase renewable energy from retailers > Explain whether a REHub will result in cheaper power or a dividend.
Local benefits to the New England region	> Promote benefits through local community programs to ensure: – Inward migration to the region is encouraged – Employment figures are clearly defined – The positive impacts for the environment are outlined.

Topic area	Summary of feedback and recommendations from preliminary consultation
Future development	> Outline whether there will be capacity for future development of renewable energy following the REHub's implementation > Clarify whether the feasibility study will have an impact in mapping out future corridors.
Risks and politics	> Outline and identify the risks to initial proponents i.e. will external funding reduce risk for initial proponents? > It is identified that politics could slow the process of the REHub's formation > Early consultation with potential lobbyists.
Leadership and responsibility	> Clarify which group or agency will assume leadership and responsibility for the REHub and the discussions on renewable energy solutions in the local area > Clarify the role of the TNSP > There is a need for better collaboration and streamlined processes between the federal and state governments.

It is important to note that topic areas and recommendations will evolve as TransGrid undertakes further engagement activities and invites feedback from the community. This feedback will be used to continuously improve our planning and ensure we have heard from our stakeholders on what is important to them.

Effective stakeholder engagement should allow for meaningful interactions and include the following elements:

1. Community information sessions.
2. Ongoing engagement program using community reference group meetings and community updates through local media, letterbox drop, online and social media.
3. Local business development support program including exploration of economic regeneration and creation of local jobs.
4. Community champions.
5. Engagement with lobbyists.

A TNSP leading development of a renewable energy hub will be in a position to encourage establishment of a coordinated community engagement strategy that neither ignores one section of the community nor over engages with another.

6.3 Community benefits

A socio-economic assessment to better understand the impacts of the overall investment made by all parties involved in REHub infrastructure (hub station, transmission lines and collector systems) on local government areas would consider:

> Environmental assessments and approvals for each of the projects that will make up a REHub
> Existing socio-economic profile of the communities impacted
> Outcomes of consultation with key stakeholders conducted by individual project proponents and councils relating to potential impacts and existing community lifestyles and values.

In an indicator project the socio-economic assessment indicates that a REHub would generate considerable benefits for the local area, region and the state economy. From a social perspective, the potential benefits and negative impacts are more balanced, but the potential for a REHub to add value through population change and community value outweigh potential negative impacts.

The assessment balances the greater economic and social activity created through the increased energy generation created through development of a REHub compared to a 'business as usual' (BAU) scenario under which limited new renewable generation would be connectable.

In undertaking an assessment, input parameters for the benefits can be derived using a broad set of industry reports from both Australian and, as supporting information, international assessments. These reports included socio-economic assessments to justify potential projects, reviews of costs of project post-completion and wider studies on the benefits of wind farms.

Calculations on employment outcomes can be framed as Full Time Equivalent (FTE) jobs for one year. For example, four FTE jobs could be one person employed for four years or four people employed for one year. Outcomes should consider both direct and indirect jobs that are expected to arise from the additional renewables investments that the Renewable Hub facilitates.

The employment numbers are undertaken as subset calculations where the employment in the local area is a subset of the employment in the State, which itself is a subset of employment in Australia.

The key metric as an output from the economic modelling is Gross Value Added (GVA) to the economy (defined as the value of output at basic prices minus the value of intermediate consumption at purchasers' prices).

For a 710 MW Project studied by TransGrid in a specific location the positive outcomes serve as a useful indicator and can be summarised:

- Creation of over 3,300 FTE Local positions and almost 12,500 Australian positions
- Increase of $270 million in Local GVA and $1,160 million in Australian GVA over the life of the project
- Reduction of 30m tonnes of CO2 impacts
- Slowing population decline in the local area
- Support for local area and regional community services and facilities through participation and formal community benefits programs provided by proponents
- Renewable energy promotion and the potential to develop the local area as a 'Centre of Excellence' enabling skill development.

6.3.1 Direct employment

The modelling and analysis derived the potential impact that these projects have on direct employment in the local area/region and country of around 1.1 FTE for local jobs per MW during construction and 0.06 FTE per MW during operations as shown in Table 5 below.

Table 5: Direct FTE parameters applied in the modelling

	FTE Jobs per MW during Construction			FTE Jobs PER MW during Operations		
	Local	Regional	Australian	Local	Regional	Australian
Most Likely	1.1	2.2	2.8	0.06	0.09	0.15
High	1.3	2.5	3.2	0.09	0.15	0.20
Low	0.9	1.8	2.5	0.05	0.05	0.10

Over the construction and indicative 25 year life of a windfarm, this translates to approximately 733 direct local FTE's for construction and 797 direct local FTEs for operations as shown in Table 6 below.

Table 6: FTE Direct Positions

Region/Category	Local	State	Australian
Construction	733	1,578	2,072
Operations	797	1,195	1,991
Total	**1,530**	**2,773**	**4,063**

Note: The numbers provided are FTE jobs for one year meaning that an estimate of four FTE jobs could be one person working for four years, or four people working for one year. The calculations are inclusive as the number of local jobs is also included in the regional jobs total with the Australian jobs including the regional and local contribution.

6.3.2 Indirect employment

The production impact that arises as suppliers to the industry experience greater demand for their services, and the income impact as increased income flows through the economy combine to result in increased employment.

The modelling and analysis derived the potential impact that these projects have on indirect employment in the local area/region and country of around 1.2 FTE for local jobs per MW during construction and 0.08 FTE per MW during operations as shown in Table 7 below.

Table 7: Indirect FTE parameters applied in the modelling

	FTE Indirect Jobs per MW during Construction			FTE Indirect Jobs per MW during Operations		
	Local	Regional	Australian	Local	Regional	Australian
Most Likely	1.2	4.4	6	0.08	0.21	0.3
High	1.4	5	7	0.1	0.25	0.4
Low	1	4	5	0.05	0.17	0.2

Over the construction and indicative 25 year life of a windfarm, this translates to approximately 800 indirect local FTE's for construction and 996 indirect local FTEs for operations as shown in Table 8 below.

Table 8: FTE Indirect positions

Region/Category	Local	State	Australian
Construction	800	3,156	4,440
Operations	996	2,788	3,983
Total	1,795	5,944	8,423

6.3.3 Economic Value – Direct Turnover

The modelling has worked up the economic value to the local area/state/region using a series of percentages against the cost of the renewable generation. The key focus in the assessment has been on Gross Value Added (GVA) to the economy which is defined by the ABS as "'The value of output at basic prices minus the value of intermediate consumption at purchasers' prices".

The modelling reviewed the impact of the incremental wind farm capacity on the local, state and Australian turnover. During construction this was based on an average capex of $2.4m/MW with a percentage local spend of 12%, regional spend of 40% and Australian expenditure of 60%. The same percentage split has also been applied to the transmission investment in the Hub.

The operational spend is estimated at $80,000 per MW per annum based primarily on the 2012 CEC study with a small adjustment for inflation. It is estimated that 28% of this is spent locally, 42% regionally and 95% in Australia.

The analysis examined the Turnover to GVA ratios that were applied in a number of studies for construction. The CEC study for the generic 50 MW wind farm used a ratio of 33% for all regions and applies the same for operational activities. This is slightly lower than the Hallett Farm Study, which used a ratio of 50%. The UK study for DECC adopted different ratios for GVA/Turnover depending on the region of the expenditure with 51% applying locally, 42% regionally and 27% on a country basis. The modelling assumption applied in this analysis was consistent with the CEC study with 33.3% used as a ratio for all regions and for both operations and construction expenditure.

The turnover and GVA from the Renewable Hub and additional Wind Generation is shown in the tables below. It demonstrates that particularly in the regional/Australia assessment the construction turnover is much more material than the operational impact. This is partly influenced by the selection of the 7% discount rate as a lower social discount rate would have increased the PV of the operations benefits.

Table 9: Direct Turnover and GVA for an aggregated 710MW wind farm project

	DIRECT TURNOVER $M AUD			DIRECT GVA $M AUD		
	Local	Regional	Australian	Local	Regional	Australian
Construction	160	533	799	53	178	266
Operations	130	195	440	43	65	147
Total	290	727	1,240	97	242	413

Source: "New England Renewables Hub - Socioeconomic Impact Assessment", WSP | Parsons Brinckerhoff, March 2016

6.3.4 Indirect Turnover and GVA

The total turnover and GVA impacts for each region are heavily influenced by the indirect impact that is assumed to apply from the wind farm construction. This depends on the multiplier that is applied between direct and indirect income with the following assessment provided in reports reviewed.

- CEC in their assessment of a generic wind farm estimated that the direct to indirect multiplier was just over 3 for construction and exactly 3 for operations (i.e. every additional dollar of direct turnover results in two additional dollars of indirect turnover)
- The Mount Emerald Wind Farm assessment showed a multiplier of direct to indirect turnover assuming that household income is added on to the output totals of around 2.6.

This is a relatively small subset of data and many of the international comparisons did not have directly comparable data. A fairly large range was therefore applied for the direct to indirect turnover/GVA multiplier with 2.8 as a central number and a range between 3 and 2.5. This means every $1 of direct turnover results in an additional $1.8 of indirect turnover for both the production and income impacts. This is slightly below the employment ratio at the country and regional level for construction, but above that applying at a local level. Recognising the low number of data points, the same ratio has been applied for the local/state and National regions. However, the turnover/GVA multipliers may be lower for the local region if it aligns with the employment multipliers.

The assumptions made on the direct/indirect ration for turnover/GVA resulted in the following table of results.

Table 10: Indirect Turnover and GVA for an aggregated 710MW wind farm Hub

	Indirect Turnover $m AUD			Indirect GVA $m AUD		
	Local	Regional	Australian	Local	Regional	Australian
Construction	288	959	1,439	96	320	480
Operations	234	350	793	78	117	264
Total	521	1,309	2,231	174	436	744

Source: "New England Renewables Hub - Socioeconomic Impact Assessment", WSP | Parsons Brinckerhoff, March 2016

6.3.5 State and national government

State and national governments have a declared interest in supporting regional investment, the creation of high skilled jobs and developing the renewable energy industry.

Engaging with government throughout a Hub planning, scoping and development process ensures alignment with jurisdictional rules and regulations, including planning, environmental and community concerns.

As the need to align competing commercial interests arises during the Renewable Hub scoping process, Government stakeholders provide an influential and independent point of contact and can enable maximum development where appropriate.

The support of the NSW Government, and Commonwealth Government through the Australian Renewable Energy Agency, will be instrumental in the development of the feasibility for a REHub.

The Renewable Energy Action Plan is the cornerstone of the NSW Government's leadership in, and active support for the renewable energy sector. Released in 2013, the Plan aims to increase renewable energy generation at least cost to energy and with maximum benefits to the state. The Plan has 24 actions under three goals:

1. Increase renewable energy investment and projects
2. Build community support for renewable energy
3. Attract and grow renewable energy expertise.

Implementation of the Plan is one of the Government's 2015-19 election commitments.

The REHub will support implementation of the Plan by improving the process of network connection for large-scale renewable energy projects, as well as facilitating investment and jobs in the sector. In particular, the Government recognises the potential for the REHub to attract new investment and projects into NSW. Once proven, this model could be replicated across NSW, resulting in increased jobs, investment and emissions reductions driven by the State.

Government stakeholder interests are summarised in Table 11 below.

Table 11: Key Government Stakeholders

Stakeholder	Preferences/Needs
Minister for Industry, Resource & Energy, NSW	> Mandate to increase high skilled jobs in regional NSW. > Desire to develop sustainable industries across rural and regional NSW. > Cost benefit analysis to consider socio-economic impact of investment
Minister for Planning, NSW	> Statutory planning leading to pre-approved processes for industry development, including renewable energy generation pre-approvals
Minister for Environment, NSW	> Carbon emission impact of developing clean energy generation in NSW > Responsible for Clean Change Fund funding for Renewable Hub feasibility
Member for New England, NSW	> Jobs and investment in electorate > Ensuring and supporting adequate community relations effort
Local Federal Member	> Jobs and investment in electorate > Ensuring and supporting adequate community relations effort
Department of Industry **Division of Resources & Energy**	> Supports the energy industry to develop and invest in NSW. > Responsible for progress of the Renewable Energy Action Plan
Office of Environment and Heritage	> Manages local Clean Energy Co-ordinators for community engagement across NSW > Delivering Climate Change Fund funding
Federal Minister for the Environment	> Environmental benefits of hub > Growth of domestic renewable energy industry > Portfolio Minister for ARENA
Clean Energy Finance Corporation	> Looking for innovative renewable projects to fund > Need robust financial case to engage > Possible interest in post-feasibility stage of the Renewable Hub
Local Council	> Local council, supportive of encouraging renewable energy development in area
Australian Renewable Energy Agency	> Cost benefit to renewable energy development in return for funding > Making renewable energy industry competitive > Influential among ARENA selection panel and executive

7. Potential for other REHubs

Summary

- TransGrid has identified sites that can accommodate additional generation capacity with new connections in areas with superior wind or solar resource.
- There are other regions within New South Wales and Victoria where REHubs may prove beneficial.
- Negotiation with potential connecting generators is the next step in order to bring about the first-of-a-kind Renewable Energy Hub

7.1 Energy Policy

At its December 2015 meeting, the Energy Council of COAG agreed it had a significant contribution to make in a national, cooperative effort to better integrate energy and climate policy. A key plank in this effort is the National Energy Productivity Plan (NEPP) which concentrates on energy efficiency in light vehicles, residential buildings and commercial buildings. It also deals with more efficient energy markets and energy market reform.

The NEPP recognises that in the pathway to a low carbon economy, the introduction of clean power generation is an important element, even though at a higher marginal cost of abatement than energy efficiency.

A Work Plan prepared by COAG includes a measure reviewing emerging technologies in the electricity system. Specifically it has framed a strategic work programme

> *'…..considering the impacts of technological and market changes in the electricity sector, such as the emergence of solar PV and storage options, which are challenging the centralised, grid-based supply model on which the energy regulatory frameworks are based. This work will assess whether existing regulatory arrangements are likely to be sufficiently flexible to enable future market change which will allow customers to benefit from innovative products and services while ensuring that appropriate consumer protections and safeguards.'*

7.2 Growth potential

7.2.1 Increase capacity

AEMO's Electricity Statement of Opportunities (ESOO) uses current information provided by industry to report on the adequacy of existing and committed generation and transmission capacity in the National Electricity Market to meet maximum demand and annual operational consumption forecasts over the next 10 years. The 2015 report shows strong generation investment in NSW focused on wind and solar projects. However, the market has also announced 3,315 MW of generation capacity withdrawal which under the medium scenario, could breach the Reliability Standard in NSW from 2022-23.

Within NSW, TransGrid has been working with generators to optimise potential new developments, ensuring efficient and effective connections have positive impacts on the network and on energy consumers throughout the network. As a part of its collaborative approach to working with generators looking to connect, TransGrid has provided a high level indication of the opportunities available for generation connection (summarised below) in terms of location and most suitable network capacity given the dynamic nature of the network. The locations identified (Balranald, Buronga, Broken Hill, Darlington Point, Griffith, Wellington, Parkes, Tamworth), are still only indicative and therefore require further detailed work, depending on the size and nature of the connecting generator.

It may be valuable to extend the planning role of AEMO to include in its annual National Transmission Network Development Plan a regular assessment of renewable resources that are not near current networks

(and therefore unlikely to be looked at closely by a local TNSP) but may become viable if the network were extended to create a local Hub.

7.2.2 Collaborative technologies

Large scale renewables play a dominant role in the ongoing development of new renewable generation. Their continuing success depends fundamentally on the ongoing strength and resilience of the grid.

South Australia averages 43 per cent wind generation in July, and for some days (typically in September) wind and solar provided all of the state's electricity demand with some left over to export into the NEM. AEMO's optimistic scenario suggests that rooftop solar will account for nearly 25% of the state's total annual demand within a decade rising to 33% 2034/35, when the rooftop solar market reaches "saturation". The state is in the fortunate position of having diverse sources of wind and solar but it is replicated to an extent in the rest of the country where low cost land and solar resource are both abundant. The most productive harvesting occurs with the addition of battery storage to the grid network.

Apart from these forces conspiring to increase integration of renewable electricity generation, there are a number of associated emerging trends and considerations that will equally impact the ability of a TNSP to reliably operate a more complex power system into the future. These include supporting changing electricity demand patterns incorporating predictable demand management, improving effectiveness of distributed energy resources, and ensuring resilience under severe weather events like floods and bushfires.

A REHub might quickly evolve through addition of energy storage and emergence of concepts like virtual power plants and microgrids. Siemens defines a microgrid as encompassing:

> *"…. multiple interacting components spread across a defined geographic space. The components are connected and monitored with advanced sensing, control and communications technologies and can be configured to meet the needs of a variety of dynamic load types and operate under a range of grid conditions."*

Evidence of this type of thinking is already emerging in the Australian market as electricity generator/retailers take up stakes in battery storage solutions.

7.2.3 Energy storage

Various factors increasingly enable consumers to engage in the use of new technologies and the current pricing structure of network services supports them. They include the changing mix of generation, the falling price and availability of solar generation, increasing network charges to maintain transmission and distribution networks (the 'death spiral'), declining trends in electricity peak demand growth and innovation in storage (particularly battery).

Energy storage deployed at any level on the electricity system can add value, however, due to the scale and configuration of connections at the transmission level it is likely to be some time before energy storage will provide an economic solution to challenges faced by a TNSP operating in the disaggregated Australian electricity market.

A recent report by the CSIRO notes that the choice of storage technology for a particular application will depend on careful technical design to match its required operational characteristics and nuances with the main goals of its deployment. They conclude that a great deal more real-world deployment experience is required in Australia to understand the optimal fit for storage technologies, to quantify technology lifespans and to assess the commercial viability of each solution

TransGrid research into storage thus far has indicated that of a range of grid-scale storage technologies currently available in the market suited to transmission applications, battery storage systems are the most likely choice but are unlikely to be cost effective for some time.

International research[17] indicates that customer-sited energy storage systems can provide the largest aggregate capacity to the grid at large and therefore are the most suitable solution to providing the best economic outcome. The same research also notes that distributed energy resources such as behind-the-meter battery energy storage have matured faster than the rates, regulations, and business models needed to support them as core components of the future grid.

7.3 Network Connection Opportunities

TransGrid has undertaken a review of its NSW network to identify sites that can accommodate additional generation capacity (new connections) that are also adjacent to known wind or solar resources. The sites identified based on existing network capability and consider current peak demand forecasts and normal network operating conditions.

The analysis presented below should be used as a guide only as it relies on a number of underlying assumptions such as new generation connections within the NEM, retirement of aged generation, inter and intra state transmission flows and network outages.

At this stage eight locations seem to have potential as additional REHub connection sites.

Table 12: REHub Connection Opportunities in NSW

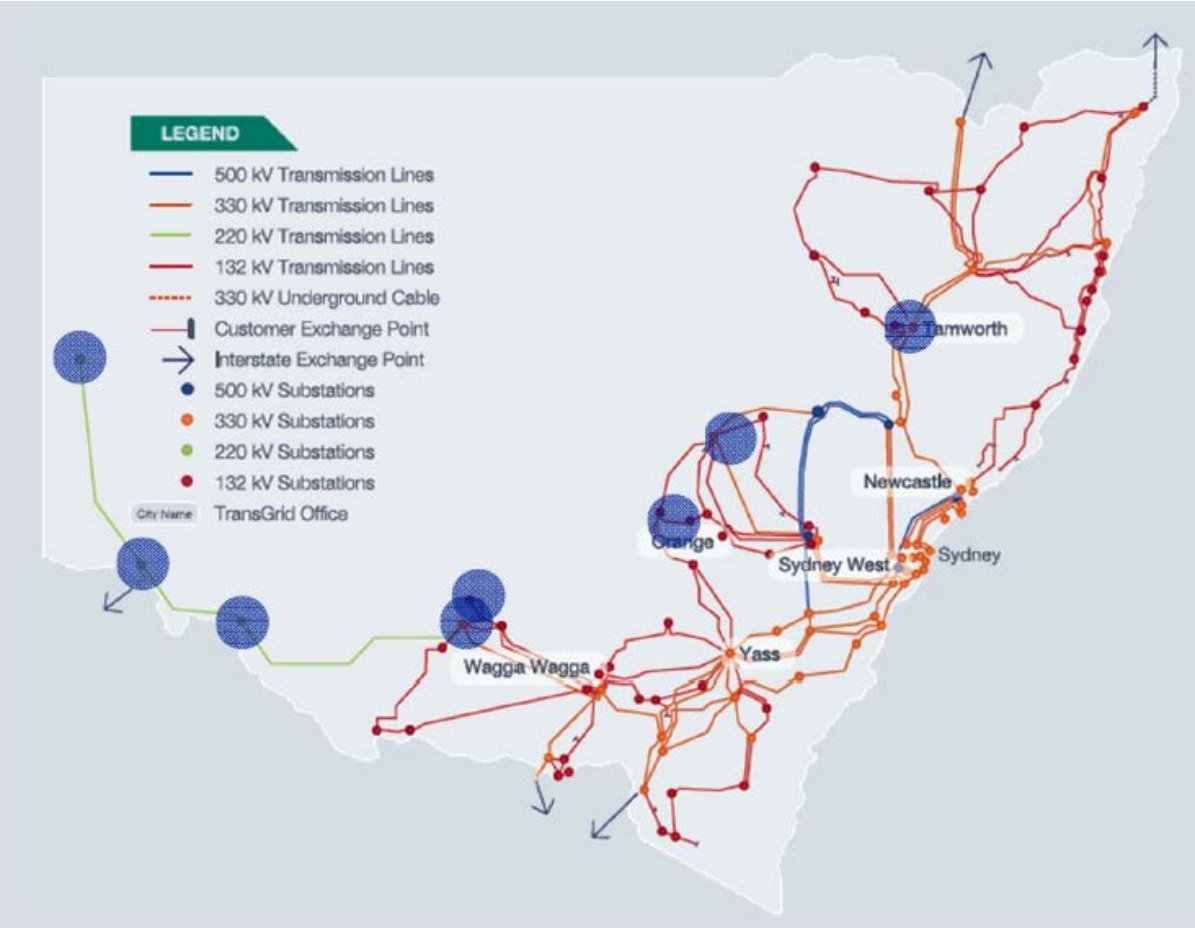
Connection Site	Voltage Level	Current Connection Capacity MW	Ultimate Connection Capacity MW
Balranald	220 kV	205	700+
	22kV	30	30
Broken Hill	220 kV	95	400
	22 kV	60	200
Buronga	220 kV	240	700+
Darlington Point	330 kV	610	700+
	132 kV	470	700+
Griffith	132 kV	285	340
	33 kV	60	60
Parkes	132 kV	260	390
	66 kV	140	140
Tamworth	330 kV	700+	700+
	66 kV	60	270
Wellington	330 kV	700+	700+
	132 kV	700+	700+

Achievement of the current connection capacities may require some minor network modifications including protection or metering system works, however, achievement of the ultimate connection capacities will require major network modifications including transmission line upgrades and/or substation plant installation. New

[17] Rocky Mountain Institute

generation located at a particular connection site could act to reduce other connection capacities because of the interdependency resulting from transmission flows.

Figure 13: Potential Hub Locations in NSW



7.4 Market challenges

There are changes occurring in the demand and supply sides of the market which potentially will have a significant impact on the electricity industry over time. Deciding how best to develop the transmission network and optimise utilisation of assets will be a constant challenge for TNSPs.

Approximately 370 megawatts of large-scale wind generation connected to TransGrid's network since 2008, with additional ongoing connection enquires. Penetration of distributed energy sources including rooftop solar panels is continuing to rise, demonstrating that the nature, location and quantum of future electricity generation is uncertain and being driven by factors which include political, climate and environmental objectives.

While views on the future of the grid itself are mixed, fuelled by speculation about the impact of distributed energy resources and customer choice, the CSIRO's Electricity Transformation Roadmap has highlighted that Australia is at the frontier on key aspects globally that are signalling a scale and pace of change in the industry not seen since the dawn of electrification. TNSPs need to accommodate this uncertain future under governance and regulatory arrangements designed to encourage efficient investments in network assets based on best current available knowledge. Electricity transmission is a long-term business with average asset lives of typically more than 40 years. Additional capacity increments are generally large.

One of the most significant challenges for renewable energy developers is the ability to secure appropriate connection to the electricity network. There is a need for scale efficient grid connections in areas of superior renewable energy resource, to help overcome both first mover cost disadvantages and subsequent barriers

as accessible connection locations with available capacity are exhausted as a result of sites with good renewable resources being those that have been developed first.

In this context, connections set up as local hubs may prove to be an important ingredient in addressing the challenges associated with designing, managing and operating an increasingly decentralised electricity supply arising from renewable and other decentralised sources.

7.5 Other prospective sites

A number of proposed wind farms across NSW and Victoria are at an advanced stage of development, in. Grouping opportunities are listed below, based on the location, potential to grid access, quality of resource and competitiveness of individual developments (cumulatively referred to as their "commercial rating"). Further detailed investigation is recommended to ascertain the benefits and viability for pooling projects around shared connection access facilities.

Table 13: Other prospective sites – NSW/ACT Border East groupings

Grouping	Projects	OY	Main Project Proponent
Upper Lachlan Grouping	Biala	2020	Newtricity
	Collector	2018	RATCH
	Crookwell 2	2018	Union Fenosa
	Crookwell 3	2020	Union Fenosa
	Paling Yards	2020	Union Fenosa
Boorowa/Yass Valley Grouping	Bango	2020	CWP
	Conroys Gap	2018	Epuron
	Rye Park	2020	TrustPower
	Rugby	2020	Senvion
	Yass Valley	2020	Epuron
Palerang Grouping	Capital 2	2018	Infigen Energy
	Jupiter	2020	EPYC

Table 14: Other prospective sites – South West Victoria groupings

Grouping	Projects	OY	Main Project Proponent
Ararat Grouping	Ararat	2017	Partners Group
	Bulgana	2018	Elecnor/Enerfin
	Crowlands	2018	Pacific Hydro
Ballarat East Grouping	Lal Lal	2018	West Wind
	Moorabool	2018	West Wind
	Yaloak South	2018	Pacific Hydro

Grouping	Projects	OY	Main Project Proponent
Ballarat South Grouping	Berrybank	2018	Union Fenosa
	Dundonnell	2022	TrustPower
	Salt Creek	2018	TrustPower
	Stockyard Hill	2018	Origin Energy
Hamilton/Portland Warrnambool Grouping	Penshurst	2020	RES
	Ryan Corner	2018	Union Fenosa
	Tarrone	2022	Union Fenosa
	Willatook	2022	Wind Prospect
	Woolsthorpe	2018	Wind Farm Developments

Utility scale solar has the potential to be the dominant renewable technology from 2018 onward if the assumptions underlying expectations of technology competitiveness are correct. Utility solar development is much quicker and easier than utility wind and thus it is expected to receive broader market interest once competitive equalisation with other technologies is achieved.

Unlike wind, solar irradiation is a more evenly distributed and predictable resource, and consequently the benefits for a shared and expandable electricity network access facility could prove beneficial in enabling multiple development opportunities to proceed concurrently.

Subject to other enablers (land availability, development permits, cost of construction) it is conceivable to develop a scalable connection hub that, supported by available capacity in the backbone electricity network, can continue to scale up as the market demand expands. Currently existing substations owned by TransGrid are experiencing multiple user demand for large scale solar developments willing to co-locate network access arrangements. It could prove beneficial to make such arrangements accessible to further potential users provided the capacity in the backbone of the network can support additional supply.

7.6 Next steps

In analysing the feasibility of the NE REHub, with the cooperation of the prospective generators, TransGrid developed a view of suitable technical and commercial approaches. These need further development to bring about the first-of-a-kind implementation.

The next steps are:

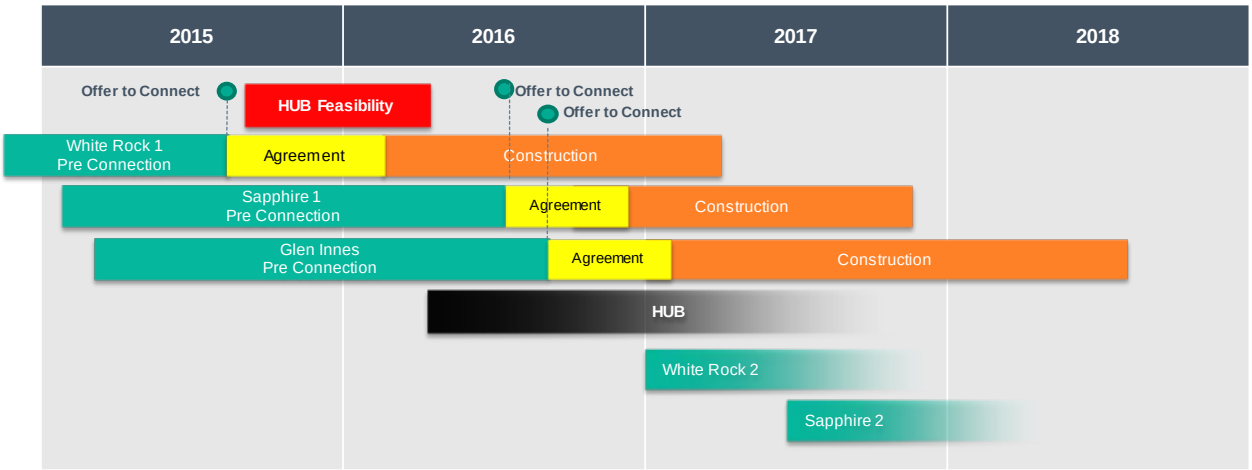
1. TransGrid to fine tune the scope and cost estimate for the preferred technical solution.
2. TransGrid to determine its preferred legal structure and commercial framework for the development of the REHub . In particular, TransGrid to determine its preferences for a) the allocation of asset stranding risk and b) corporate structure (i.e. whether to adopt a special purpose development vehicle as described here, or some other structure).
3. In parallel with 2, TransGrid to consult with relevant government and regulatory agencies to ensure its preferred solution meets the needs of these stakeholders.
4. In parallel with 2, TransGrid to finalise terms of the proposed commercial framework with which to open commercial discussions with generators.
5. TransGrid to obtain in-principle agreement from the generators that they will cooperate between themselves to the extent necessary to implement the REHub .

6. TransGrid and the generators to work together to agree the technical scope and commercial terms for the contractual arrangements required to enable the NE REHub development to proceed.
7. Commercial terms may include the outline terms of retrospective contribution payments to be made to initial generators by later connecting generators. These terms may be communicated to the market so that prospective future generators can factor them in to their development planning.
8. TransGrid and generators to document and execute the contractual arrangements agreed between them in individual Connection Agreements.
9. TransGrid to formally commence the development processes required for the detailed design, construction and commissioning of the REHub assets.
10. TransGrid to refresh this Knowledge Sharing Report with the framework and templates of the adopted commercial agreements.

Indicative timing for the NE ReHub

Over the course of this report, the goals, timing and objectives of each generator have been progressing independently. The White Rock 1 pre-connection process was completed in 2015, while the pre-connection process for Sapphire 1 and Glen Innes is expected to be completed during 2016. Once Connection Agreements have been executed, construction will commence for each of these projects, with construction completion anticipated during 2017 and 2018, as shown in Figure 14.

Figure 14: Approximate New England REHub project timing



8. Project Delivery

Summary

- REHubs are a complicated infrastructure asset class made difficult by the competing and sometimes conflicting needs and wants
- Planning approval requires consideration of sites, connection characteristics and voltages.
- Public engagement is an important attribute in securing planning approval.

8.1 Development

A REHub includes not only the connection asset but also the generation assets themselves and the lines connecting them.

As such, the task of appropriate consultation is complex: it likely extends over time and is likely conducted by different entities. The leaders in such consultation have to break new ground while the followers have to contend with the attitudes developed in response to the earlier rounds.

8.1.1 Community Engagement

Throughout the development of the feasibility study of the projects, the community and key stakeholders should be provided with information on the progress of key aspects.

As various projects will all be communicating with the same community groups, it is important to ensure that messages and level of information provided are aligned between the proponents.

It is in the commercial interests of all REHub participants to coordinate and cooperate.

8.1.2 Approvals

Environmental approvals and property acquisitions are key aspects of the renewable hub development.

8.1.2.1 Environmental

Timing of approvals will be different for the multiple generators and the REHub. Approvals can lapse if construction doesn't start with in a mandated time frame. A Proponent can apply for a modification to the planning approval including to extend the time frame.

A complication arises when the proposed location of a renewable REHub is located within one of the windfarms or solar farms that currently has an environmental approval.

Some elements of the REHub are covered by the environmental assessment (EA), project approval and EPBC Act approval including the majority of sections of transmission line which traverses the generation facility project area and some proposed substation locations.

Where prospective generation facilities do not yet have planning approval, there is a risk that it may not be granted or may be granted with unacceptable conditions such that the additional facility might not be able to connect to the REHub.

The planning approval process should be considered from a holistic program perspective that aligns and coordinates the required approvals in the most appropriate manner.

8.1.2.2 Self-Determining Rights

A TNSP may have access to rights to self-determine planning approval for a Hub. It is unlikely those powers would be used to the benefit of a third party.

8.1.2.3 Property

For connections of wind farms to the REHub, the question of property ownership and easement arises.

A TNSP would require tenure over the land on which the high-voltage infrastructure was located and the preferred position would be:

- Freehold in the case of substations and the like, with access easements thereto; and
- Permanent easements in the case of linear infrastructure such as transmission lines.

Generation/connection proponents will have either acquired, or intend to acquire, non-permanent leasehold tenures over all the parcels of land within the proposed areas of the windfarm. As leaseholders, the proponents would not be able to grant the permanent tenures that TNSP requires, and would have to negotiate with the landowners (freeholders) to obtain same on TNSP's behalf.

For the development of the hub, there is a potential that different landowners would be affected by the proposed new connection routes to the hub. The additional time and potential risks associated with land lease negotiations should be factored in to any development plan for the REHub.

8.1.3 Governance

The development of the common aspects of a renewable REHub can be viewed as a program of works (i.e. a number of projects that are delivered simultaneously). As such, coordinating the development of the hub aspects of the projects would best be managed through a program steering committee that would include high level representation from all the renewable project proponents as well as the TNSP. The purpose of this group would be to ensure alignment of the development of the REHub, management of key interfaces and assisting in alignment of approval submissions regarding the hub development.

End--------

Abbreviations

Term	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
CA	Connection Agreement
CEFC	Clean Energy Finance Corporation
COAG	Council of Australian Governments
DEWHA	Department of Environment, Water, Heritage and the Arts
DNSP	Distribution Network Service Provider
DP&E	Department of Planning and Environment
EEC	Endangered Ecological Community
EPBC	Environment Protection and Biodiversity Conservation Act 1999
FTE	Full Time Equivalent
GVA	Gross Value Added
IRR	Internal Rate of Return
kV	Kilovolt
MRET	Mandatory Renewable Energy Target
MW	Mega Watts
NEL	National Electricity Law
NEM	National Electricity Market
NEMDE	National Electricity Market Despatch Engine
NER	National Electricity Rules
NE REHub	New England Renewable Energy Hub
O&M	Operations and Maintenance
QNI	Queensland and New South Wales Interconnectors
REF	Reviews of Environmental Factors
REHub Co	Renewable Hub Company
RIT-T	Regulatory Investment Test for Transmission
SENE	Scale Efficient Network Extensions
SPV	Special Purpose Project Vehicle

Term	Definition
TNSP	Transmission Network Service Provider
TSC Act	Threatened Species Conservation Act 1995
TUOS	Transmission Use of System charges