

Knowledge Sharing Report 1

Contract Performance Report

Renewable Energy Hub

November 2020



Project Summary	
Project	Renewable Energy Hub: A Wholesale Renewable Energy Firming Marketplace Demonstration Project
Project Number	2019/ARP052
Recipient	Renewable Energy Hub
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Disclaimer

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Glossary of Terms

AEMO	Australian Energy Market Operator
ARENA	Australian Renewable Energy Agency
Cap Contract	A cap contract trades a fixed volume of energy for a fixed price when the spot price exceeds a specified price. It provides electricity purchasers with insurance against high prices.
DERs	Distributed Energy Resources
FCAS	<p>Frequency Control Ancillary Services deployed to stabilise system frequency. AEMO operates eight FCAS markets covering two types of service:</p> <p><u>Regulation FCAS</u>: Immediate and automatic response to a change in locally-sensed system frequency.</p> <p><u>Contingency FCAS</u>: Capacity that is online and able to serve load immediately in response to an unexpected event.</p>
Futures Contract	A futures contract is a legal agreement to buy or sell energy at a predetermined price at a specified time in the future.
Firming	Firming up supply means guaranteeing supply from other sources in the event of intermittency issues with solar and wind generation. Typical physical firming resources include battery or pumped hydro storage. Firming may also be achieved through the use of financial instruments whereby price risk is managed or ‘hedged’ through use of futures contracts.
Hedge Contract (energy)	A hedge contract involves establishing a (contracted) position in the futures or options market that is equal and opposite to a position at risk in the physical energy market. It is intended to offset potential losses or gains that may be incurred by rising or falling energy prices.
LCOE	Levelised Cost of Energy. A measure of the average net present cost of electricity generation for a generating plant over its lifetime.
MAG	Market Advisory Group. Renewable Energy Hub has established the MAG as a key group of stakeholders to guide the Project.
Option Contract (energy)	An options contract offers the buyer the opportunity (but not the obligation) to buy or sell—depending on the type of contract they hold—the underlying energy. Unlike futures, the holder is not required to buy or sell the asset if they choose not to.

Offtake Agreement	An offtake agreement is an arrangement between a producer and a buyer to purchase or sell portions of the producer's energy from one or more generation assets.
OTC	Over the Counter - refers to trading done directly between two parties, without the supervision of an exchange. Intermediaries, such as brokers may facilitate bilateral agreements between counterparties.
PPA	Power Purchasing Agreement - an example of an offtake agreement.
Pumped Hydro	A type of hydroelectric energy storage used by electric power systems for load balancing. The method stores energy in the form of gravitational potential energy of water, pumped from a lower elevation reservoir to a higher elevation
REH / RE Hub	Renewable Energy Hub
Swap	A swap is a type of futures contract whereby a floating (or market) price is exchanged for a fixed price, over a specified period(s) of time. Energy consumers and retailers utilise swaps in order to fix or lock in their energy costs, while energy generators utilise swaps in order to lock in or fix their revenues and/or cash flow.
VPP	Virtual Power Plant; is a pooled set of decentralised units (or DER) in a power network. They are operated by a common, centralised IT control system.
VRE	Variable Renewable Energy

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Executive Summary

Context

Renewable Energy Hub (REH) has commenced an 18-month project (the “Project”) with support from the Australian Renewable Energy Agency (ARENA). The project will work with market participants to develop specifications for a suite of innovative, standardised hedge contracts that are suited to both variable renewable energy (VRE) generators and new sources of clean dispatchable capacity (e.g. battery storage, pumped hydro storage and demand response), as well as the changing needs of energy retailers and large customers.

Though the energy transition is gaining momentum with increasing volumes of VRE assets coming onto the market, there is a lack of volume and diversity in hedge contracts to support forward markets for these asset classes. This lack of products reduces choice, impacting liquidity and in the long run increases the difficulty of new participants entering the market and participating in an effective and efficient manner.

In addition to developing new hedge contracts, the Project also involves the development of a digital platform that will enable prospective counterparties to access live market pricing, assess the value of the new hedge contracts, evaluate the risks of different contract positions under a range of scenarios and provide a point of market access for new and emerging clean energy providers.

Summary Findings

The purpose of this first Knowledge Sharing report is to track the performance of the hedge contracts launched to date with a focus on recent trading activity in these new products. The commentary provided in this report is based on quantitative data collected during the Project, feedback collected during Market Advisory Group (MAG) meetings, several in depth interview undertaken with market participants who have actively traded the REH hedge contracts.

A summary of key findings is provided in Table 1.

Product	Key Findings	Report Section
Super Peak Contract	<ul style="list-style-type: none">The Super Peak product has been well received by the market - strong traction and the right product for the current market by providing buyers with an effective risk management tool for the most volatile periods of the day. The introduction of a standardised product facilitates greater	Section 2

	<p>transparency and has created more liquidity in the market.</p> <ul style="list-style-type: none"> • Retailers have bought Super Peak contracts to cover high price events during morning and late afternoon shoulder periods, while managing a short position in the middle of the day when demand is low and spot prices are depressed due to the abundance of solar generation. • Natural sellers of the product have been those generators who can ramp up quickly including hydro and pumped hydro. • After launching the Super Peak product into market in April, REH has supported 35 transactions involving nine different counterparties, with a total traded volume of 445 MW. It has been most actively trading in Queensland. • The Super Peak has traded at an average difference in value to the baseload futures contract of 181% and to the peak contract of 133%. 	
Solar Shape Contracts	<ul style="list-style-type: none"> • Two products (Solar Shape Swap and Inverse Solar Shape) have been developed; tailored to the specific profile of solar generators. In particular, the products are targeted to assist generators manage intermittency as solar generation output changes with the time of the day. • REH has facilitated 89 transactions in the Solar Shape contracts since the start of 2019 for 542MW of traded volume across a variety of tenors. • In 2020 markets for Solar Shape contracts have been subdued reflecting overall decline in spot prices dampening interest in hedging forward this contract shape. The most recent trade (15/07/20) was at 98% of the value of the baseload contract on the same day. • Participants are using Solar Shape products to support enhanced risk management within their portfolios. To date no participants have used the products to take speculative positions and exploit arbitrage opportunities. • Buyers (esp. retailers without generation capacity) noted Solar Shape can bring liquidity, more transparent pricing and less contract overheads in comparison to traditional PPAs. • While current conditions with depressed spot prices have led to low liquidity, future circumstances in the NEM, such as coal retirements may mean retailers will be more 	Section 3

	<p>inclined to hedge prices in the middle of the day which may swing interest back to solar products. The product is therefore expected to become increasingly popular.</p> <ul style="list-style-type: none"> There is an opportunity (subject to sufficient demand) for the product to be expanded from one standard shape across NEM states to a custom shape for each state to reflect different solar irradiance. In response to earlier market feedback, REH has created the Solar Shape and Inverse Solar <\$300 product options to exclude any cap value, however these products are yet to trade. 	
Virtual Storage Contract	<ul style="list-style-type: none"> This product is designed for buyers and sellers of stored energy. The objective is to enable participants to agree upon a set spread between the 'charge' and 'discharge' (the buy and sell legs of the trade) price for storage operators. It is anticipated that merchant battery operators will be the main sellers of this product (enabling de-risking of their energy arbitrage revenue), while energy retailers looking to cover high priced periods of the day will be the natural buyers. The market expects Virtual Storage products to become increasingly utilised when market moves to 5-minute settlement in 2021. REH has commenced initial discussions with potential counterparties for pilot transaction opportunities. 	Section 4
Digital Market Platform	<ul style="list-style-type: none"> The Hub Market platform will facilitate price discovery, evaluation of market opportunities and ultimately liquidity in the new hedge contracts. The target market for the platform is wholesale market contract traders (existing 'gentailers', retailers, banks & funds), renewable energy project developers and asset owners, and large energy users. REH is continuing to engage with market participants: energy retailers, project developers, large customers and government agencies. Public release of the Hub was delayed from July to October due to the disruption to working arrangements caused by COVID-19. 	Section 5

Additional Knowledge Sharing Material	<p>Stakeholders interested in further information in relation to the Project can access several other reports and outputs through our ARENA project page.</p> <p>Renewable Energy Hub has prepared Lessons Learned Reports covering key activities, discoveries and insights since the Project's inception. Further, we have developed a Legal Overview guide and template Term Sheet in collaboration with global law firm White & Case to provide information on the legal arrangements underpinning transactions in hedge contracts and PPAs. Finally, we have also provided interested stakeholders with a snapshot of the digital Hub Marketplace Platform through our overview report.</p> <p>Readers wishing to access the Hub platform can register on our website - https://www.renewableenergyhub.com.au/marketplace</p>
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Table 1: Knowledge Sharing Report 1 - Summary findings.

Renewable Energy Hub is delighted by the level of industry support exhibited for the project to date and looks forward to further progressing this ARENA-funded project.

1 Project Context

1.1 Background

The rapid transformation of the Australian electricity system towards a higher penetration of variable renewable energy (VRE) requires commensurate innovation in financial markets. The Project aims to contribute to innovations in the financial markets as the system transitions towards a high renewable energy future.

The current suite of hedging products (swaps, caps and options) used in the financial market were designed several decades ago and developed around coal and gas supplies. Since then they have not changed materially to accommodate the transforming supply, demand and price dynamics created by the rapid deployment of VRE (both utility scale and behind the meter).

Traditional hedge contracts allow energy retailers and large electricity users to manage the price risk associated with the electricity they buy. Generators also rely on hedge contracts to manage the risk of volatile wholesale electricity prices, smooth revenue flows and support financing for new projects.

The rapid and sustained growth in VRE generation is changing the hedging needs of market participants. This requires new hedge contracts for those parties to be able to cover their exposure.

Drawing on the technical expertise of both REH and a Market Advisory Group (MAG), the Project is designing a suite of new financial hedge contracts. These will be tailored to the physical characteristics of both VRE and clean dispatchable capacity assets. These new financial instruments will create a point of access to the contracts market for VRE and dispatchable capacity projects. Creating a liquid forward market in firm hedge contracts opens new sources of revenue for clean energy providers, potentially supporting finance for these assets. It enables a range of new participants to contribute to VRE growth and support the energy transition across the NEM.

Likewise, creating new hedge contracts that more efficiently manage the risk and volatility of the changing supply/demand and price dynamics in the National Electricity Market (NEM) will enable energy retailers (and by implication, their customers) to more cost effectively hedge the price of electricity in a high renewables system.

The Project will also develop a digital platform that will enable prospective counterparties to access live market pricing, assess the value of the new hedge contracts, evaluate the risks of different contract positions under a range of scenarios and provide a point of market access for new and emerging clean energy providers. In doing so, this platform will improve transparency and hedge contract liquidity.

1.2 Current market challenges

The NEM is a gross pool, energy only market characterised by high volatility. Given such characteristics, contracting through forwards contracts is critical to accessing financing, hedging risk, and increasing revenue certainty. Given the novel nature of renewable or VRE assets classes, the development of OTC contracts is in their infancy.

It is critical that such products emerge to support forward markets in VRE because:

- Transparent standardised forward markets perform an important role in stabilising markets¹.
- Such contracts provide further certainty and confidence for further investment in VRE and renewables.
- Wind and solar are now a proven technology, and within Australia, the lowest cost form of new build generation capacity². For the energy transition to succeed VRE must be proven across not just technical but also commercial and market domains.

With the Renewable Energy Target (RET) largely met, and with it the primary driver for retailers signing long term PPAs, renewable energy projects need new sources of revenue certainty. The Clean Energy Regulator has noted that some of this may come from corporate demand for renewable energy supply³, however, there is also a need to facilitate participation by clean energy providers in the wholesale contract market.

1.3 Project Objectives

The objectives for the Project seek to address the limitations set out above:

- The Project will enable **greater utilisation of the contracts market by VRE generators and clean dispatchable capacity providers**. By creating a market in hedge contracts tailored to the physical characteristics of both VRE and clean dispatchable capacity assets, the Project will open new sources of revenue for clean energy providers.
- Creating new hedge contracts that efficiently manage the risk and volatility of the changing supply, demand and price dynamics of the NEM will **also enable retailers (and by implication, their customers) to more cost effectively**

¹ AEMC, Market making arrangements in the NEM, Rule determination, 19 September 2019
<https://www.aemc.gov.au/sites/default/files/2019-09/Final%20determination.pdf>

² Graham, P.W., Hayward, J, Foster, J., Story, O. and Havas, L. 2018, GenCost 2018. CSIRO, Australia
<https://www.csiro.au/en/News/News-releases/2018/Annual-update-finds-renewables-are-cheapest-new-build-power>

³ Clean Energy Regulator, The Renewable Energy Target 2019 Administrative Report - The acceleration in renewables delivered in 2019, 17 September 2020
<http://www.cleanenergyregulator.gov.au/DocumentAssets/Documents/The%20Renewable%20Energy%20Target%202019%20Administrative%20Report%20%E2%80%93%20The%20acceleration%20in%20renewables%20delivered%20in%202019.pdf>

hedge the price of electricity in a system with an increasing proportion of renewable energy.

These outcomes will be demonstrated through utilisation of the new hedge contracts, participation on the trading platform and engagement in knowledge sharing activities and outputs by market participants including generators, renewable energy developers, retailers, large customers and investors.

1.4 Project Outputs and Deliverables

The outputs and deliverables of the Project are listed below.

- The Project will produce a series of new hedge contract specifications tailored to the needs of VRE generators, clean dispatchable energy providers and energy retailers. The number, type and form of hedge contracts will be determined in consultation with the MAG as well as through broader market consultation processes.
- As part of the Project, REH will facilitate a series of pilot transactions in the new hedge contracts which will test their market value, credit, risk and legal requirements.
- REH will construct and operate an online market platform that will facilitate price discovery, enable evaluation of trading options, provide access to market data and reduce transaction costs.
- The Project will produce a series of knowledge sharing outputs (such as this document) including reports and workshops, as well as provision of market data, including pricing and availability of contracts, volumes, trends and transaction reporting.

1.5 Delivery Phases

The Project involves four workstreams implemented over an 18-month period. These workstreams will be delivered in a series of overlapping cycles and will not be sequential. This will allow rapid and ongoing iterations of new products to be developed and pilot transactions completed. In parallel to product development, market engagement and testing, REH will develop the online market platform and undertake a series of knowledge sharing activities.

The Project's four workstreams are as follows:

1. **Product development:** REH will develop specifications for a range of new hedge contracts. These product designs will be built upon through consultation with the market advisory group as well as broader market consultation processes. Several of these new products are presented in this report.
2. **Pilot transactions:** The new hedge contracts will be progressively released into the market to test that they can be used in negotiated pilot transactions between parties. Pilot transactions will be used to build familiarity with

contract specifications and requirements, prepare legal documentation to support trades, as well as enabling market participants to build an understanding of the drivers of value and pricing.

3. **Platform build:** This workstream involves the design, build and delivery of an online market platform to support the new hedge contracts. The platform will provide users with up-to-date pricing and product information, tools to enable comparison of different hedge contracts so buyers and sellers can establish fair value, tools to test the performance of hedging strategies under different scenarios and support trade execution and confirmation.
4. **Knowledge sharing:** The knowledge sharing activities and deliverables of the Project will include a series of reports (such as this), presentations and workshops on the performance of new hedge contracts as well as the market impact of the Project.

1.6 Market Advisory Group

The Market Advisory Group (MAG) has been an invaluable resource for testing, validating and ideating on existing and new products. The nature of the engagement and level of feedback provided by participants has shown that the group is functioning well due to the significant level of input provided by participants which has been a value-add to product development activities.

Specifically, the MAG has assisted with providing detailed guidance on product specifications and the likely product attractiveness across key market participants including generators, retailers, traders, and large energy consumers. In addition, the group has provided feedback on early versions of the digital platform, testing prototypes and participating in user testing sessions.

The MAG consists of the following organisations:

- Renewable Energy Hub
- Alinta Energy
- Origin Energy
- Total Eren
- Energy Australia
- ERM Power
- Snowy Hydro
- Enel Green Power
- Habitat Energy
- Neoen
- AGL
- Stanwell
- Shell New Energy
- TFS Green
- White & Case
- Macquarie Bank
- Enel X
- ARENA
- Bold Trading
- Tesla
- HydroTasmania
- Marchmont Hill Consulting

About this Report

This is the first Knowledge Sharing report for the Project. The purpose of this report is to provide insight into the relative performance of the new hedge contracts and where appropriate, make any recommendations for changes to product specifications. It will consider the perspectives of the multiple hedge contract counterparties.

This report will review the progress of four products:

1. Super Peak Contract (Section 2)
2. Solar Shape Swap Contract (Section 3)
3. Inverse Solar Shape Contract (Section 3)
4. Virtual Storage Contract (Section 4)

For each product reviewed, feedback has been solicited from market participants and performance evaluated against the following product attributes (noting that the Virtual Storage Contract has only been recently launched with pilot transactions under discussion):

Product Attribute	Description
Financial Performance	Evaluate the value captured by contracts using the volume weighted average price outcomes over the last 12-month period. In addition, trade prices are assessed relative to standard futures (baseload / peak) pricing.
Utilisation	Assess market take-up by assessing volume of trades, total value and the number of counterparties.
Functionality	Qualitative assessments of how contracts are being used for portfolio management. E.g. Are they being used for risk management? Do they unlock arbitrage opportunities?
Transition-proof / Enabling	Describes how the contract has/will assist participants on buy and sell side navigate the changing dynamics in the physical system/market.

2 Super Peak Contract

2.1 Product Overview

The ‘Super Peak’ swap contract targets intra-day and seasonal peaks offering a new hedging option for participants with exposure during emerging ‘super peak’ shoulder periods.

The product seller is likely to be suited to dispatchable, peaking generators (e.g. hydro) and energy storage operators (e.g. pumped hydro and batteries). The natural buyers of the product are energy retailers looking to more efficiently cover high volatility periods of the day.

The contract covers the high demand hours of the morning and evening peaks when solar output is low. In summer months (Q1 & Q4) the contract covers from 15:00-19:30 and for winter months (Q2 & Q3) the contract covers 06:00 - 09:00 and 16:30 - 19:30. The product trades as one price for the summer evening peaks and for both the winter morning and evening peaks.

Specifications for the Super Peak Contract are summarised in [Table 2](#).

Super Peak Contract	Draft Specification
Region	All nodes
Contract Term / Tenor	Quarterly, out to T+2 years (longer tenor transactions can be negotiated)
Description	<ul style="list-style-type: none">• Swap contract targeting intra-day and seasonal peaks• Hedging option for participants with exposure during emerging ‘super peak’ period• Suited to dispatchable, peaking generation and storage• Contract is modelled to be as closely aligned with market requirements as possible
Product Shape	Summer (Q1 & Q4) - Starting 15:00. Ending 19:30 Winder (Q2 & Q3) - Starting 06:00. Ending 09:00. Starting 16:30. Ending 19:30
Price Range	<ul style="list-style-type: none">• All prices
Settlement Calculation	<ul style="list-style-type: none">• Party A buys a Super Peak (all prices) at \$175• For each trading interval, the buyer receives (pays) MWh’s * (RRP - \$175)• The MWh’s are determined by the profile of the super peak product

Super Peak Contract	Draft Specification
Settlement Frequency	As per AEMO calendar
Product alternatives discussed with market	<ul style="list-style-type: none"> • Price range (all prices, or just underlying <\$300) • Times and duration for super peak periods • Weekdays only

Table 2: Super Peak contract draft specifications.

<p>Super Peak settlement calculation per trading period for the buyer:</p> $\text{Settlement} = X \text{ multiplied by } (RRP - SP)$ <p>Where:</p> <p>X = Contract Volume (MW)</p> <p>RRP = Regional Reference Price (\$/MWh)</p> <p>SP = Super Peak Contract Price (\$/MWh)</p>

The shaded areas in [Figure 1](#) below show the half hourly profile of the contract: an evening super peak in Q1 and Q4, and both a morning and evening peak in Q2 and Q3.

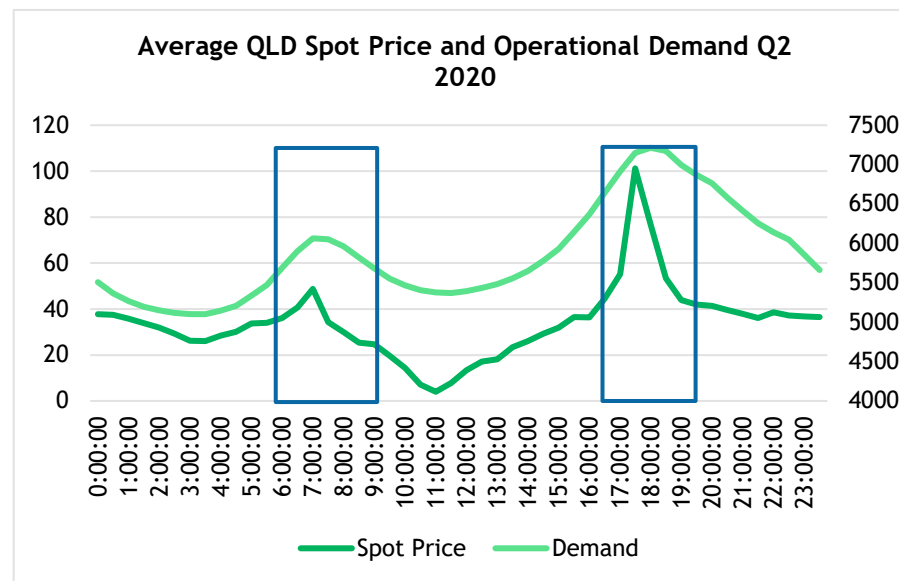
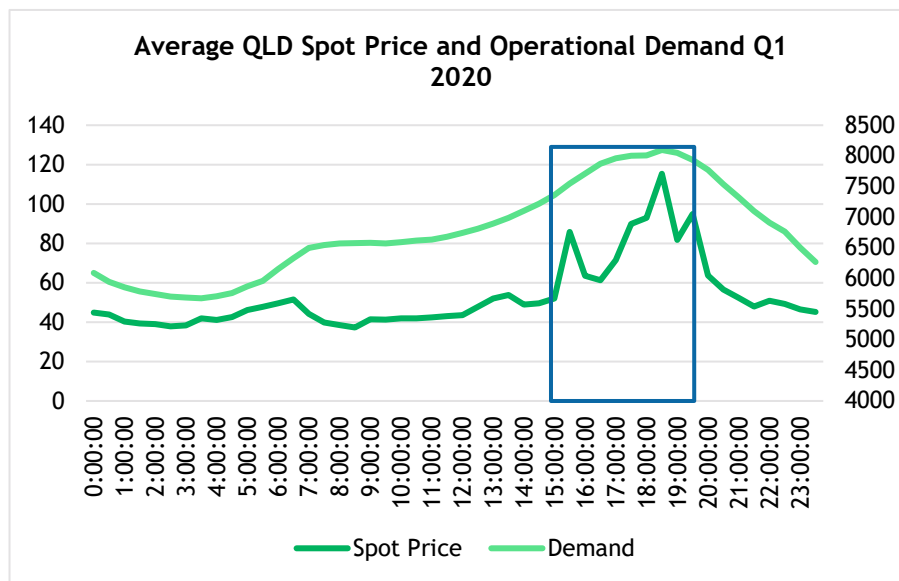


Figure 1: SUPER PEAK PRODUCT PROFILES: Q1 (Starting 15:00. Ending 19:30) and Q2 (Starting 06:00. Ending 09:00. Starting 16:30. Ending 19:30). Demand and price data is from 2018.

2.2 Product Evaluation

2.2.1 Evaluation Part 1: Financial Performance

Volume Weighted Average Prices

Figure 2 shows the monthly Volume Weighted Average Price (VWAP) for the Super Peak contract over the last 12-month period across the NEM (ex-Tasmania). VWAP provides an indication of the value captured by the contract when looking back at historical spot price outcomes. It is one way to evaluate contract value, however, VWAPs need to be considered alongside the forward-looking price outlooks, discussed in the following section.

The chart below shows the very high price events experienced in Victoria and NSW in January of 2020 during periods covered by the Super Peak contract. These high price events drag the monthly VWAP for the contract in those regions to close to \$500.

After the volatility of Q1 2020, the chart shows a decline in the VWAP across all regions which reflects the impact of declining spot prices experienced across the NEM in 2020.

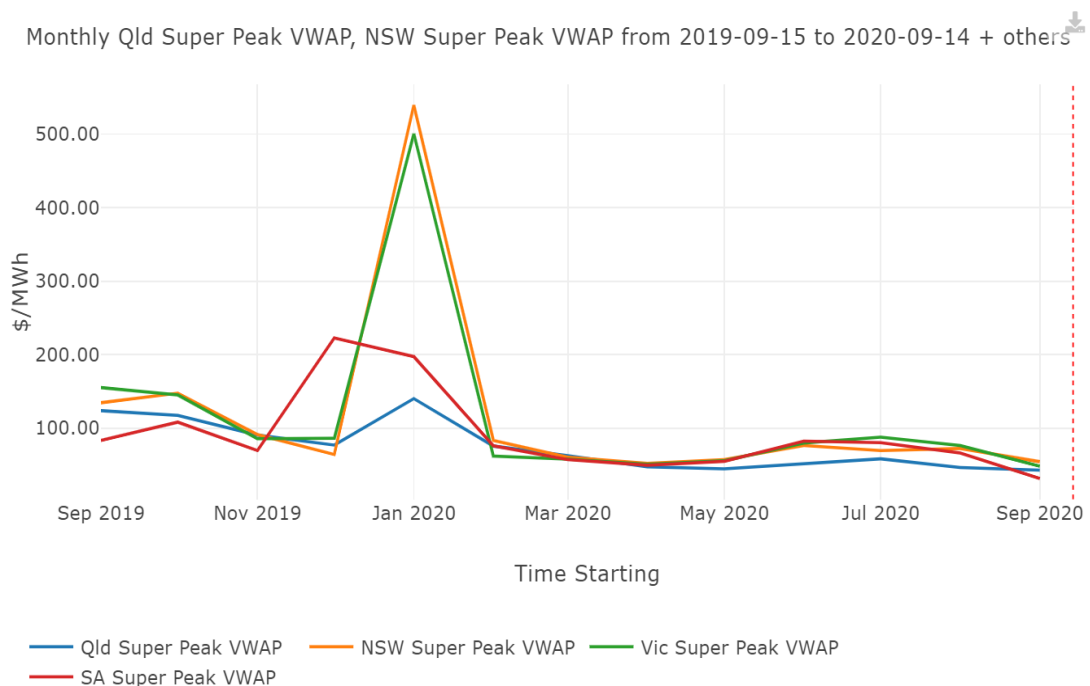


Figure 2: Monthly Volume Weighted Average Price Super Peak (Sept 2019 - Sept 2020)

The utility of the Super Peak contract in providing coverage for retailers against price volatility is best illustrated via an example. Table 3 below compares the cost of 10MW of retail load in Victoria in Q1 2020 based on an unhedged (merchant) exposure and a range of strike prices for the Super Peak product.

BUY VIC Q120 Super Peak 10MW

	Unhedged (merchant)	Hedged at strike prices				
		\$50	\$75	\$100	\$125	\$150
Revenue / Cost	-\$751,657	\$549,157	\$447,907	\$ 346,657	\$ 245,407	\$144,157
Δ to unhedged	-	+ \$1.30m	+ \$1.20m	+ \$1.10m	+ \$1.00m	+ \$0.90m

Table 3: Super Peak contract illustrated via example.

The merchant scenario costs the retailer approximately \$750,000, whereas by hedging that load they would have been able to achieve net revenue from their contract position with a net difference of \$1.3m (at \$50 strike price) to \$0.90m (at \$150 strike price). Such significant differences between the hedged and unhedged positions therefore highlights the utility of the Super Peak contract to retailers as cover against volatile price periods.

Financial performance relative to baseload and peak futures

Based on Super Peak contract trades to date, Table 4 shows the relative value to the equivalent baseload (or “flat”) and peak futures contracts on the same date as the trades occurred. The average difference in value to the baseload contract is 181% and to the peak contract 133%. Note that these averages are based on all regions and all tenors traded to date and from a relatively small sample of reported trades, however they do provide market participants with an indication for pricing levels.

	Super Peak - Flat	Super Peak - Peak
Value relative to equivalent baseload / peak contract	181%	133%

Table 4: Super Peak contract average differences relative to the value of equivalent baseload (or “flat”) and peak futures contracts on the same date as the trades occurred.

While the face value of the Super Peak contract is higher than the standard Baseload or Peak contract, due to the lower volume (MWhs) covered by this new contract they potentially represent a more cost effective and efficient hedging tool for retailers. Given the new intra-day pricing dynamics in the spot market, buyers of Peak and Baseload contracts are potentially over-hedged (i.e. overpaying for energy) in the middle of the day when spot prices are lower. With the product innovation introduced by the Project, natural buyers such as retailers have additional hedging options to help manage spot market volatility.

2.2.2 Evaluation Part 2: Utilisation

The ‘Super Peak’ swap contract was launched by Renewable Energy Hub in March 2020, with an inaugural trade between Snowy Hydro and a confidential buyer announced on 31st March.

To the end of August 2020, REH had supported 35 transactions of the new contract involving nine counterparties and totalling 445 MW. This level of engagement by the market has exceeded expectations and demonstrates the utility of this new contract.

Total MW	445
Total trades	35
Total counterparties	9

Table 5: Super Peak trading volumes (since March 2020)

Table 6 and Figure 3 following presents a state-based breakdown of the trades executed to date.

	QLD	NSW	VIC
Total volume (MW)	340	100	5

Table 6: Contract volumes (MW) by state

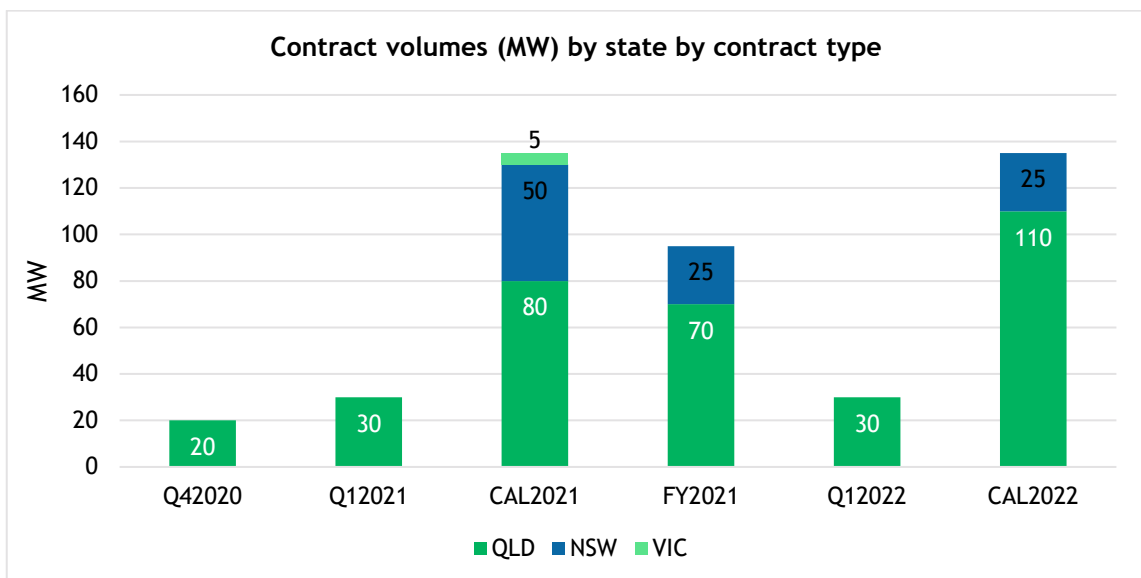


Figure 3: Contract volumes (MW) by state by contract type.

The state-based breakdown presented in Figure 3, shows that the Super Peak contract has been most actively trading in Queensland. One possible reason for this activity in Queensland is the growing ‘duck curve’ demand profile and associated spot price outcomes that are being witnessed in the Queensland market. The duck curve demand profile and associated morning and evening price spikes are providing a clear driver for utilisation of alternative hedging contracts such as the Super Peak. Note the duck curve refers to the fall off in demand during the middle of day that is increasingly exacerbated by the rapid deployment of solar PV.

Figure 4 below provides the average spot price and operational demand outcomes in Queensland for FY20. The chart shows the demand and price peaks occurring in the morning and early evening shoulder periods. The impact of the very high deployment of solar PV on spot prices in Queensland is further illustrated by comparing the average spot price at midday (\$26.97) to 6:30pm (\$109.41) over the 2020 financial year.

Hedging this volatility is a key driver for retailers with customer load in Queensland, as well as providing a strong price signal for peaking generation and energy storage in the state.

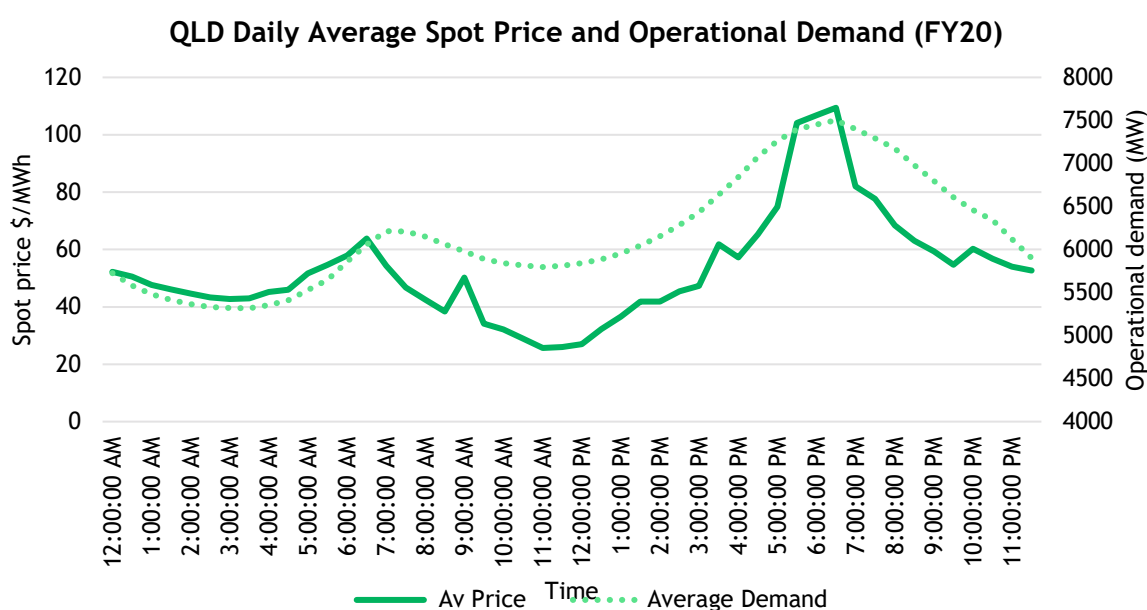


Figure 4: Average daily spot price and operational demand in Queensland across FY20 (Source: AEMO data, accessed via the Hub market platform)

2.2.3 Evaluation Part 3: Functionality

Feedback from the market has been that the Super Peak product provides buyers an effective risk management tool for the most volatile periods of the day. Previously, a full day contract (either baseload 24/7, or peak 7am-10pm futures) would be purchased with the intention of covering the morning and/or evening peak. Now

participants have the flexibility of being able to hedge themselves against the most expensive part of the day, which is usually the evening peak.

Participants currently utilising the Super Peak product have spoken of risk management as the main benefit of the contract rather than arbitrage opportunities. The introduction of a standardised product which allows greater price transparency has created more liquidity in the market. In turn, retailers have been willing to buy Super Peak contracts as they can manage a larger short position in the middle of the day when demand and/or prices are low.

2.2.4 Evaluation Part 4: Transition-proof/Enabling

The Super Peak product has been well received by the market. Buyers noted that the product offered a way to standardise contracts, making them more transparent which ultimately made it easier to trade and use. Their utility seemed to suit those generators who could ramp up quickly such as pumped hydro.

Super Peak contracts seem well suited to the market going forward, particularly as the Five-Minute Settlement rule is introduced in Q3 2021. The current model based on settlement averaged over 30 min intervals suits gas peaking plants, however going forward asset classes that can ramp-up at 5 minutes stand to benefit. Early indications suggest that this may reduce the demand for cap products, which again may increase the popularity of Super Peak swap contracts linked to asset types such as pumped hydro and batteries.

2.3 Market Narrative and Insights

The market (particularly on the buy side) has been extremely receptive to the Super Peak contract as it offers a hedge against the most expensive periods of the day. A Retailer with no-generation capacity noted the difficulty of previously contracting around these periods, however standardising around a transparent product opens the market, creates more liquidity and makes it easier for them to manage/hedge these periods.

Buyers see demand in the middle of the day falling at increasing rates (driven by a proliferation in DERs, particularly rooftop PV) with demand increasing at peak usage times in morning and evening. A Super Peak product hedges against these large peaks and potentially reduces the need for further hedges.

3 Solar Shape Contract

3.1 Product Overview

The Solar Shape and Inverse Solar swap products are the first of their type tailored to the specific profile of solar generators. There are two products within the Solar Shape offering:

1. **Solar Shape Swap:** a swap contract covering those hours relevant to a generic solar generation profile. It provides a firm shape and fixed price against the solar profile which is consistent across all NEM regions, with the shape varying by month.

And

2. **Inverse Solar Shape:** operating inverse to the Solar Shape Swap, this product is a sculpted swap contract with the profile representing the energy required to firm the Solar Shape contract to a flat swap. It allows buyers to access fixed volume and prices during in the periods generally not covered by solar generation.

3.1.1 Solar Shape Swap

The Solar Shape Swap is a sculpted swap contract designed to reflect the profile of a solar farm at half hour intervals for the relevant contract period (see [Figure 5](#)). It covers only those hours relevant to a generic solar generation profile, unlike a standard baseload or “flat” contract which cover buyers and sellers for a fixed MW volume, 24 hours/day.

While the peak volume of the contract is constant, the shape of the contract does change monthly to account for seasonal changes in irradiance. The profile is also consistent across all NEM Regions with this consistency facilitating improved liquidity.

Solar Shape Swap settlement calculation per trading period for the buyer:

$$\text{Settlement} = X \text{ multiplied by } (RRP - SS)$$

Where:

X = Contract Volume (MW)

RRP = Regional Reference Price (\$/MWh)

SS = Solar Shaped Swap Contract Price (\$/MWh)

Table 6: Solar Shape settlement calculation.

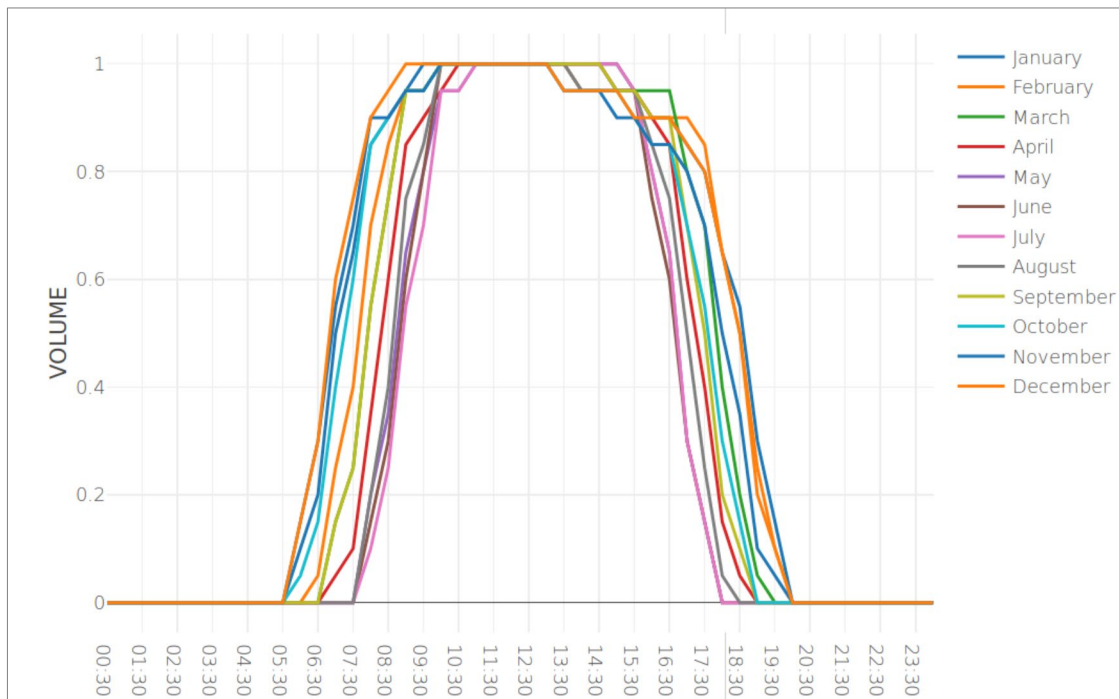


Figure 5: RENEWABLE ENERGY HUB SOLAR SHAPE SWAP CONTRACT VOLUMETRIC PROFILES (1 MW peak profile across 48 half hour trading periods)

3.1.2 Inverse Solar Shape

The Inverse Solar (IS) Swap contract operates in inverse to the Solar Shape Swap product - see [Figure 6](#). It operates as a firming product representing the sum of energy required to make a Solar Shape Swap equivalent to a flat or base swap.

While the peak volume of the contract is constant, the shape of the contract does change on a monthly basis to account for seasonal changes in irradiance. The profile is also consistent across all NEM Regions with this consistency facilitating improved liquidity.

Inverse solar shape settlement calculation per trading period for the buyer:

$$\text{Settlement} = X \text{ multiplied by } (\text{RRP} - \text{IS})$$

Where:

X = Contract Volume (MW)

RRP = Regional Reference Price (\$/MWh)

IS = Inverse Solar Swap Contract Price (\$/MWh)

Table 7: Inverse Solar Shape settlement calculation.

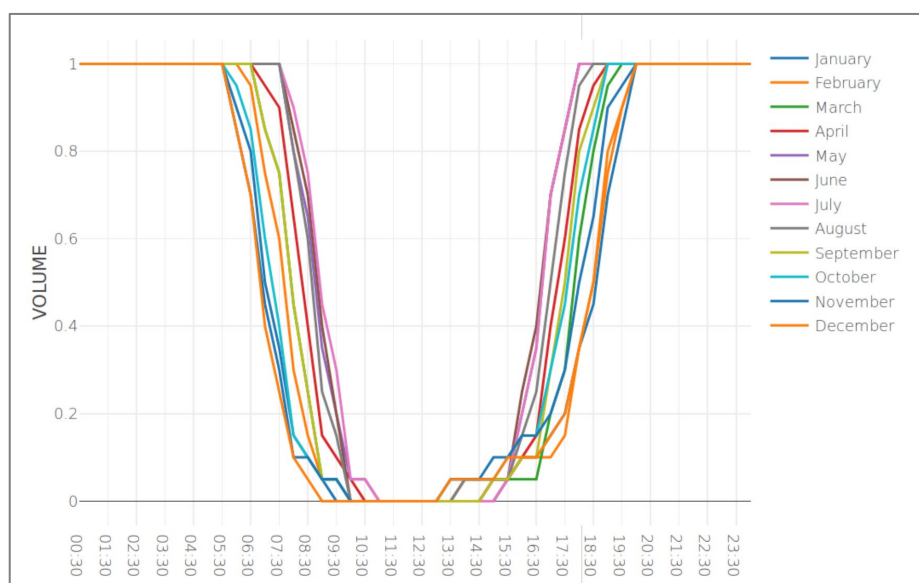


Figure 6: RENEWABLE ENERGY HUB INVERSE SOLAR SWAP CONTRACT VOLUMETRIC PROFILES (1 MW peak profile across 48 half hour trading periods)

3.2 Products Evaluation

3.2.1 Evaluation Part 1: Financial Performance

Volume Weighted Average Prices

The Monthly Volume Weighted Average Price (VWAP) for both Solar Shape Swap and Inverse Solar Shape products are shown below in [Figure 7](#) and [Figure 8](#), respectively.

These monthly average values reflect the overall decline in spot prices driven by record deployment of rooftop and utility scale solar and associated price cannibalisation during the periods covered by the Solar Shape. This was most acute in South Australia (the red line on [Figure 7](#)) where in September of this year values strayed into negative average monthly prices.

These low market prices are likely below the Levelised Cost of Energy (LCOE) of most solar projects, meaning solar generators are unable to contract at such low prices. Retailers also have less need to hedge during low price periods, compounding reduced demand for the product.

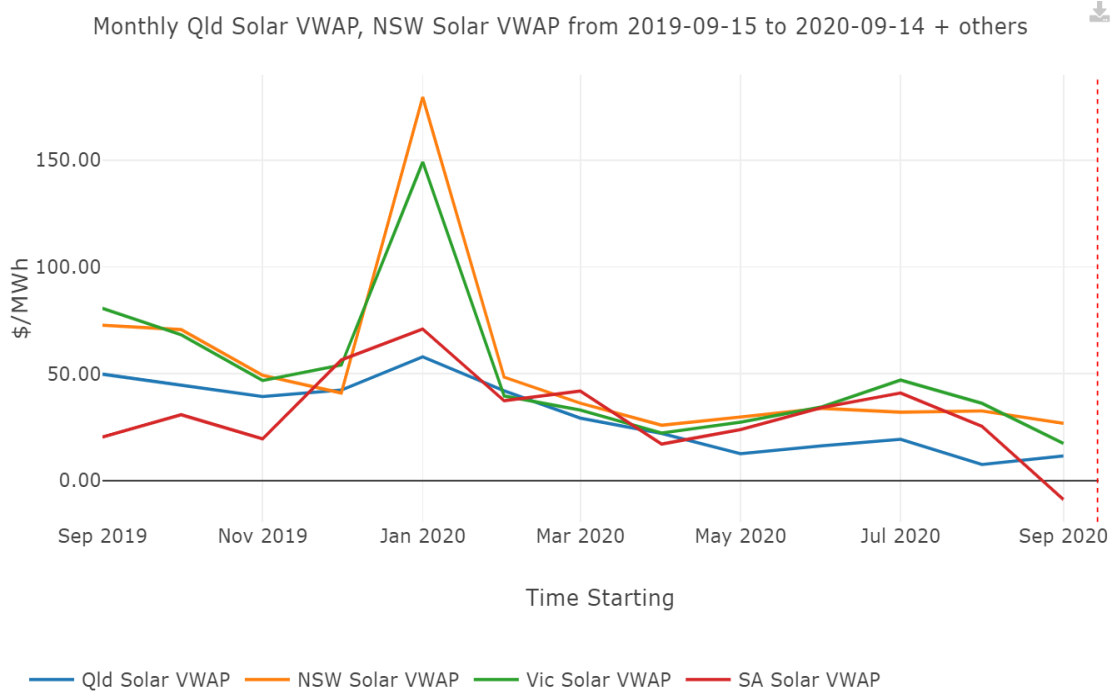


Figure 7: SOLAR SHAPE SWAP: Monthly Volume Weighted Average Price (Sept 2019 - Sept 2020)

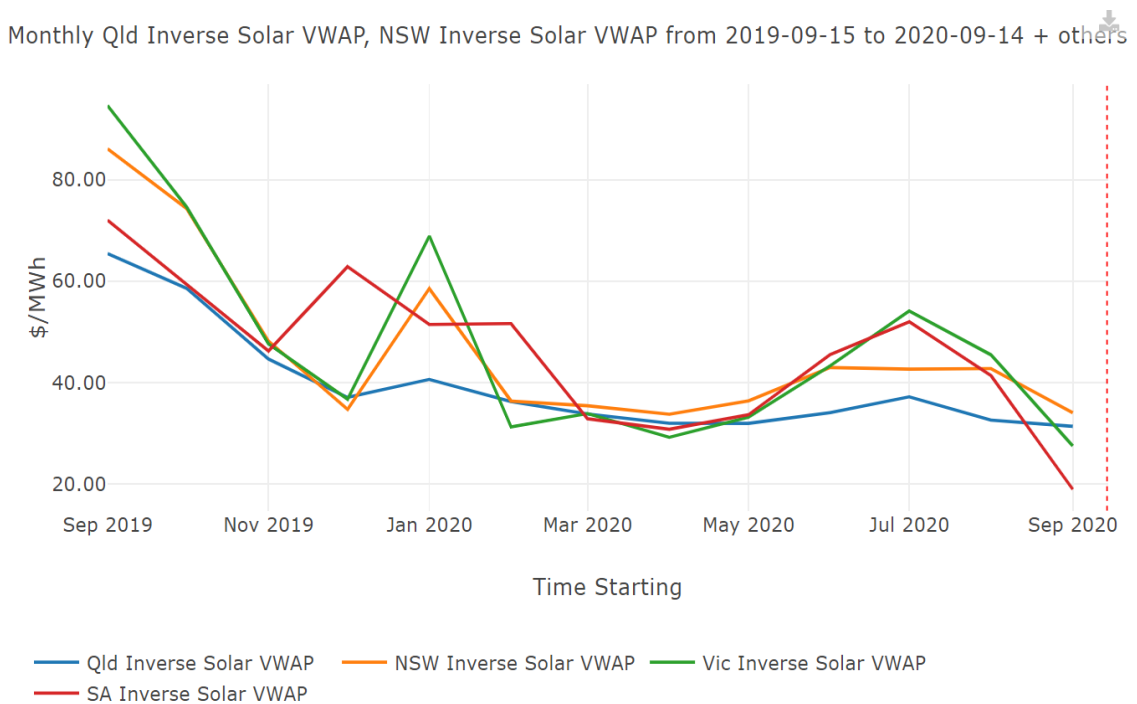


Figure 8: INVERSE SOLAR SHAPE: Monthly Volume Weighted Average Price (Sept 2019 - Sept 2020)

Financial performance relative to baseload futures

The most recent trade in the Solar Shape (15/07/2020) was for the Q420 NSW contract which traded at \$47.75. This price represents 98% of the value of the baseload contract on the same day (see [Figure 9](#) below).

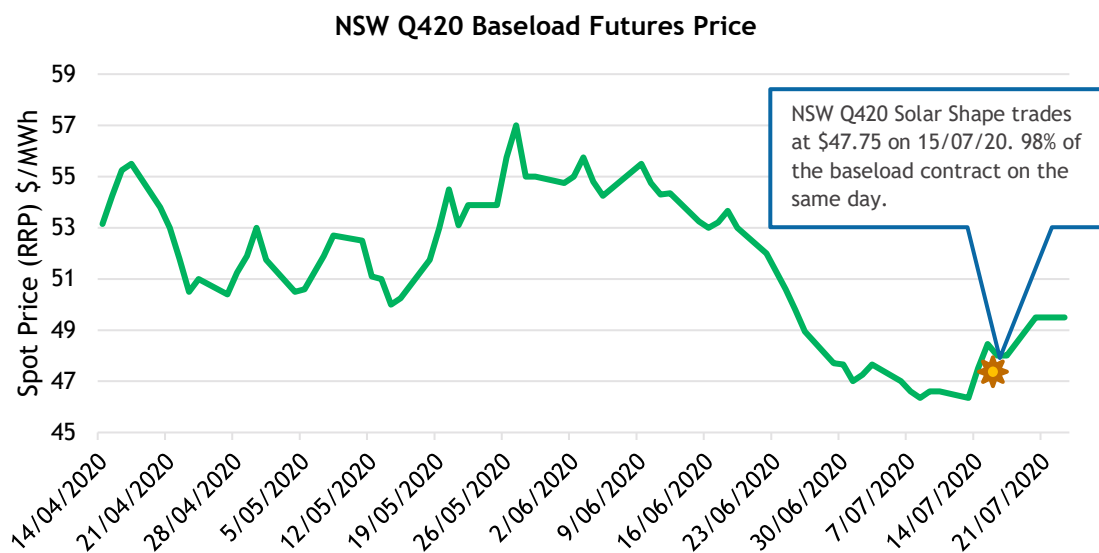


Figure 9: Q4 2020 NSW BASELOAD FUTURES CONTRACT SETTLE PRICES VS SOLAR SHAPE (Sources: ASX Energy, TFS Australia, Renewable Energy Hub)

Prices at this level reflect the seasonal variations in value captured by the Solar Shape contract. [Figure 10](#) below provides an historical view of the average quarterly value of the Solar Shape contract based on spot price outcomes using a 'volume weighted average price' calculation. We observe that in Q4 2019 the Solar Shape in NSW (orange line) was valued at approximately 95% of all spot prices, showing again the relative value of Solar Shape against the baseload profile. This historical value is well aligned with the traded price for Q4 2020 futures discussed above.

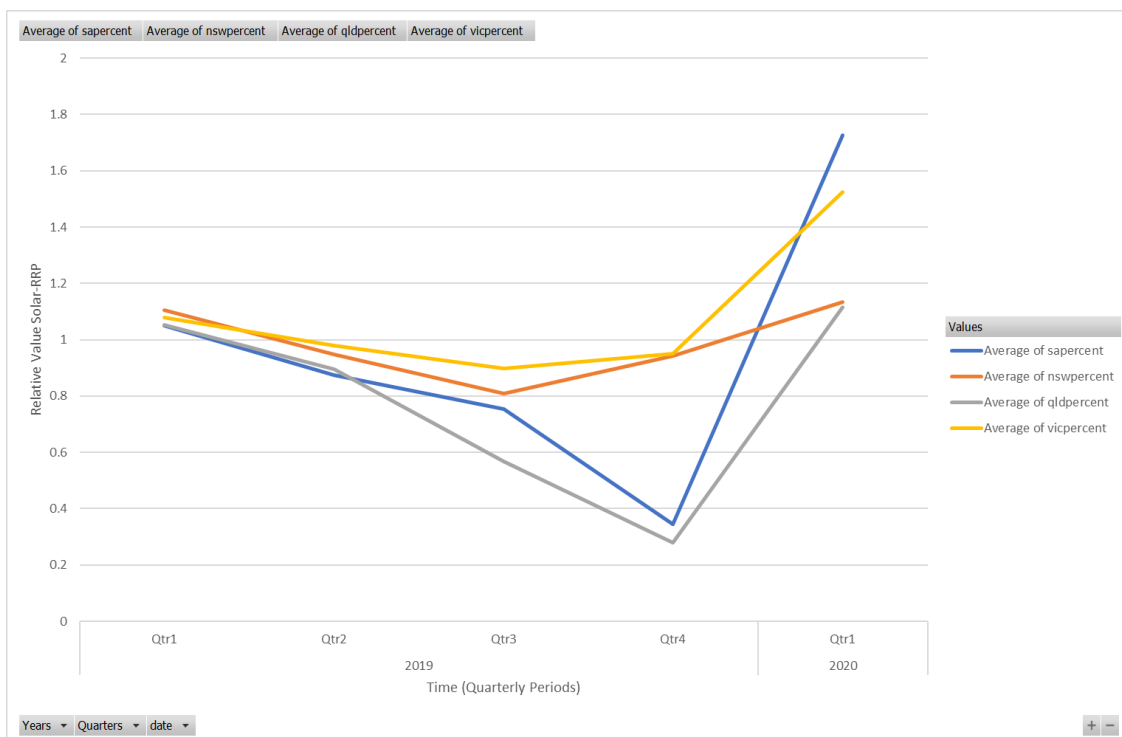


Figure 10: RELATIVE VALUE OF SOLAR SHAPE VS SPOT PRICE - based on quarterly average relative value of the daily volume weighted average price of solar shape vs spot price (RRP) in all NEM states

3.2.2 Evaluation Part 2: Utilisation

Markets for Solar Shape contracts have been subdued over Q2 of 2020. The decline in spot prices during the day driven by the ongoing record deployment of solar (both utility scale and rooftop) and resulting price cannibalisation has dampened interest in hedging forward this contract shape for many participants.

Trade volumes since the start of 2019 are shown in [Table 8](#)

Total MW	542
Total trades	89
Total counterparties	15

Table 8: Solar Shape trading volumes (since start 2019)

Figure 11 following shows that the Solar Shape contract has attracted higher volumes than the Inverse Solar contract to date. Most volume has also been traded in Victoria.

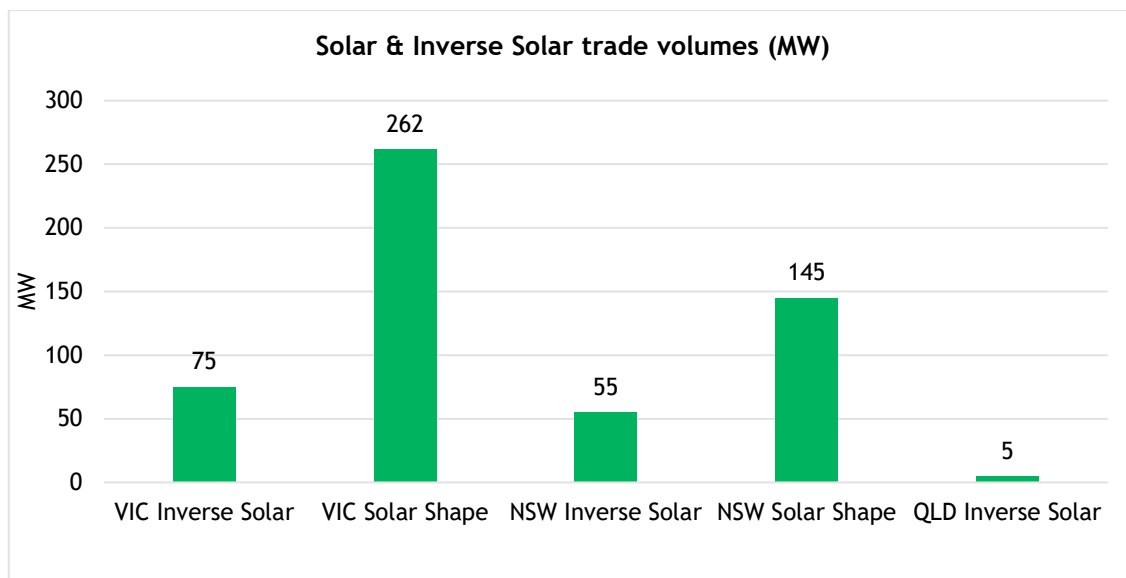


Figure 11: Solar Shape trading volumes (MW) by state and product type.

Demand and supply of this contract has fluctuated substantially since the end of calendar 2019. In Q2 2020, volumes fell and prices were extremely low, making it difficult for the natural sellers of such contracts. Many participants commented on the abnormal circumstances currently being experienced in the market, i.e. with general demand falling due to mild seasonal temperatures and the impact of COVID-19 on top of the increasing growth of Distributed Energy Resources (DERs).

Not unsurprisingly the Solar Shape has yet to trade in Queensland or South Australia. While South Australia has historically suffered from a lack of liquidity across all contract markets⁴, Queensland's rapidly changing intra-day price profile (the 'duck curve' phenomenon noted above) provides little incentive to buyers to hedge this profile. This contrasts with the high level of activity in the Super Peak contract witnessed in the Queensland market.

3.2.3 Evaluation Part 3: Functionality

Feedback from the market suggest that participants are using the Solar Shape products to support enhanced risk management within their portfolios. To date participants have not taken a speculative position or seen any benefits around arbitrage opportunities from the Solar Shape products.

Participants have noted that the benefits of the Solar Shape products include:

⁴ ACCC, Retail Electricity Pricing Inquiry, Preliminary report, 22 September 2017
<https://www.accc.gov.au/system/files/Retail%20Electricity%20Inquiry%20-%20Preliminary%20report%20-%202013%20November%202017.pdf>

- The shape of the product provides a point of difference to a flat swap contract that **brings retailers value in hedging low prices** in the middle of the day. Solar shape provides a more sophisticated tailored product that can manage the intermittency as solar generation output changes with time of the day (sun irradiance) and weather conditions (e.g. cloud cover). Participants who have traded with Solar Shape have commented that there is a clear market trend towards more flexible contracts such as the Solar Shape.
- **Enhanced liquidity** over traditional PPAs. Retailers (particularly those without generation capacity) have noted that it is a product that can bring liquidity to the market for renewable energy backed contracts. This feedback is particularly important, and points to the value of standardisation of renewable energy backed hedge contracts over traditional PPAs. Counterparties are able to easily trade into and out of contract positions using the Solar Shape and Inverse Solar contracts to manage their exposures to solar generation.
- **More transparent pricing and less contract overheads** in comparison to traditional PPAs. Further to the above point, the standardisation and associated liquidity also drives price transparency. Market participants have noted that traditional PPAs may require up to 12 months of negotiations, and significant information asymmetry. By contrast, the Renewable Energy Hub contracts provide visibility of market valuations and straight forward contracting mechanics⁵.

3.2.4 Evaluation Part 4: Transition-proof/Enabling

Feedback from MAG participants is that the Solar Shape products will enable increased solar generation projects to enter the market particularly by unlocking developers or relatively immature generators who are not established and do not have strong credit lines to trade in these products. These participants would likely have previously engaged in either merchant revenues strategies or PPAs. Drawing more sellers into the market also creates additional liquidity - a benefit to all participants.

Retailers who have utilised the Solar Shape product see an opportunity for the product to be expanded from one standard shape across NEM states to a custom shape for each state to reflect different irradiance throughout the NEM. While noting this feedback from some participants, REH have been reluctant to introduce multiple versions of the Solar Shape product; balancing the need for building liquidity around a limited number of products, with the differing physical characteristics of solar generation in different regions. Participants noted that REH's approach in carefully launching select products and then slowly learning and adapting them is well suited to the evolution of this product.

⁵ Renewable Energy Hub has prepared a separate guide to legal aspects of the wholesale contracts market available through our project page on the [ARENA website](#).

3.3 Market Narrative and Insights

The Solar Shape products provide a level of contract flexibility to manage the intermittency of renewable generation. It is expected that the Solar Shape products will be best suited to support solar generators looking to minimise their merchant exposure, providing them coverage against prolonged periods of low prices. As the market for solar energy matures these contracts provide an alternative approach to managing project revenues, complementing more traditional run of meter PPAs and/or merchant exposure.

Market feedback to date is that while there was significant support for the contracts in 2019, in current market conditions there is not significant value on these products due to suppressed prices in the middle of the day. However, participants also noted that future circumstances such as coal retirements may mean retailers will be more inclined to hedge prices in the middle of the day necessitating a swing back to solar products. Products such as Solar Shape are therefore expected to have an ongoing role in the market despite current conditions limiting liquidity.

To date participants have used the Solar Shape products to provide hedging. They have not seen arbitrage opportunities from the products.

The Solar Shape products may also evolve to account for regional differences. At present the product is quite simple with the same shape for every NEM state, however there is potential to customise the shape to differences in irradiance between states and regions.

Note on the design of the Solar Shape products

REH has been challenged by divergent views in contract valuation by market participants. This divergence results in wide 'spreads' between bids (buyers) and offers (sellers). Throughout a trading day these spreads may stay as wide as \$10.

A key driver of these wide spreads is a divergence in views between buyers and sellers as to the 'cap value' captured by the solar products. That is, the likelihood that the periods of the day covered by the Solar Shape or Inverse Solar products will align with trading periods where prices exceed \$300 (which corresponds to the price trigger on standard cap contracts sold in the NEM).

If sellers expect there will be many high price periods (>\$300) during the contract tenor this will be reflected in higher strike prices to ensure that they lose less of the 'upside' in their contract position. However, buyers have suggested that rather than paying a higher strike price for the solar swap products, it would instead be more cost effective to buy caps to protect themselves from high price events. Having done that, they do not wish to pay for any 'cap value' in the swap contract strike price.

In response to this feedback, Renewable Energy Hub created the Solar Shape and Inverse Solar <\$300 products.

These product iterations utilise the same generic solar profile as the current products but cover only prices below \$300, thereby excluding any cap value. The contract design will make it easier for market participants to close the often-large bid/offer spreads in the market for the solar products.

Buyers of the Solar Shape that also require hedge cover for prices >\$300/MWh within the Solar Shape profile retain a number of options:

- Purchase the current Solar Shape product (all prices);
- Purchase flat electricity cap products (subject to shape requirements); or
- Purchase the Solar Shape (all prices) and sell the Solar Shape (prices < \$300/MWh), leaving the net Bought position as the Solar Shape (prices > \$300/MWh).

Sellers of the Solar Shape product that wish to also sell for prices >\$300/MWh within the Solar Shape profile also retain a number of options:

- Sell the current Solar Shape product (all prices);
- Sell flat electricity cap products (subject to shape requirements); or
- Sell the Solar Shape (all prices) and buy the Solar Shape (prices < \$300/MWh), leaving the net Sold position as Solar Shape (prices > \$300/MWh).

Renewable Energy Hub continues to engage with the market on potential pilot trades in these alternative versions of the Solar Shape products.

4 Virtual Storage Contract

4.1 Product Overview

Virtual Storage is the most recent product developed through the Project, and is designed for buyers and sellers of battery storage energy. The objective of the product is for participants to agree upon a set spread between the ‘charge’ and ‘discharge’ price paid for energy by battery operators. This will enable merchant battery operators to de-risk their energy arbitrage revenue, and for retailers to better manage their long (e.g. overnight or middle of the day) and short (early evening) periods.

The virtual battery swap contract will operate as follows:

- Buyer of the Virtual Storage simultaneously sells a fixed MW block of low-priced energy “charge” and buys a block of higher priced energy “discharge”.
- The product is energy-neutral (charge/discharge legs are the same MWhs), and the transaction price is the agreed price spread between bought and sold legs (i.e. the energy arbitrage value).
- Settlement is calculated daily.

As noted, the product is in its infancy and some changes in its design have taken place.

- Name changed from Virtual Battery to Virtual Storage contract to ensure the product is sufficiently attractive to all forms of energy storage technology.
- Creation of two versions, with both short (2 hours) and long (8 hours) under consideration by the market.
- Settlement calculations use a “heads and tails” methodology (described below).

Note on the design of the Virtual Storage Product - Heads & Tails

Previous iterations of the product design utilised fixed time periods for the charge and discharge legs of the product, however, market feedback suggested that this method meant that there was insufficient difference between the low (charge) and high (discharge) price periods. As a result REH changed the settlement approach to a ‘Heads & Tails’ method, common in financial markets.

The Heads & Tails settlement methodology for the Virtual Storage contract is set out below using the short duration (2 hour) contract as an example:

- The seller of the Virtual Storage contract buys energy at the lowest four 30min Trading Interval prices of the day and sells energy back at the highest four Trading Interval prices of the day (note these do not have to be contiguous).
- The seller of the contract does not know ahead of time which hours to charge/discharge their storage technology to physically defend the contract. In this way these contracts carry greater uncertainty (which may be priced-

in to the transaction) but will ensure the greatest arbitrage spread is captured each day for the purposes of contract settlement.

4.1.1 Utilisation

REH is in active discussions with several counterparties regarding an initial transaction(s) in the Virtual Storage contract. We are currently discussing transactions in both the short (2 hours) and long (8 hours) duration versions of the product. As grid scale battery technology and additional pumped hydro energy storage assets becomes more prevalent in the NEM, the Virtual Storage product is expected to gain more attention. It is anticipated that battery operators will be the main participants utilising the short duration Virtual Storage product, while hydro and pumped hydro are best suited to the long duration version.

4.1.2 Transition-proof/Enabling

We anticipate that the Virtual Storage product will become a much more utilised product when the market moves to Five-minute settlement in 2021. Volatility within the market will be more noticeable as prices will not be averaged over a 30-minute trading interval. As a result, this will lead to increased risk to merchant assets that will need to be managed by products that can replicate the quick response rate of a battery.

The current business model for batteries in the NEM is largely driven by participation in FCAS markets. Market participants have confirmed with REH that 50-75% of project revenues are assumed to be derived from the eight regulation and contingency FCAS markets, with energy arbitrage being only a relatively small component of project income. Participants have also noted that the size of the FCAS opportunity for battery projects is likely to change as new batteries enter the market and increased competition in relatively shallow FCAS market volumes lead to reduced prices.

In addition, the ongoing deployment of renewables creates greater need for load shifting and/or firming. Both of these drivers (the potential saturation of FCAS markets and dampening of revenues, and the need for load shifting capacity) will create increased demand for hedging of market arbitrage revenues. We believe the Virtual Storage product will play an important role in enabling this in the market.

4.2 Market Narrative and Insights

The development of a new hedge contract for storage technologies has progressed well, to the point where REH have commenced initial discussions with potential counterparties for pilot transaction opportunities.

Over Q3 and Q4 of 2020 we will continue to progress and refine the product design as well as initiate our first transactions in the product. Stakeholders interested in participating in trades or with feedback on the product itself can contact us: hello@renewableenergyhub.com.au

5 Digital Market Platform

Renewable Energy Hub is progressing the development of the digital market platform.

The platform will facilitate price discovery, evaluation of market opportunities and ultimately liquidity in the new hedge contracts developed during the project. The target market for the platform is wholesale market contract traders (existing 'gentailers', retailers, banks & funds), renewable energy project developers and asset owners, and large energy users.

Prior to the public launch of the Hub, REH is continuing to engage with market participants - energy retailers, project developers, large customers, and government agencies - to provide product demonstrations. These sessions continue to provide the Project team with the ongoing opportunity to refine our product roadmap and ensure core features and functionality are well aligned with market requirements.

The public release of the Hub was delayed from July to October primarily due to the disruption to working arrangements caused by COVID-19. These delays are due to the challenges of working remotely (Renewable Energy Hub is a Victorian based business); managing a team of software developers who are constructing a brand new product, while developing new systems and approaches for collaborating resulted in some tasks being initially more time consuming than forecast. In addition, the disruptions delayed our hiring of a new Product and Development Operations Manager, however, this role is now in place and has been successfully onboarded into the team despite the ongoing remote working arrangements.

However, despite these disruptions, our software team continues to build features in line with our roadmap, and we are in the process of onboarding our initial users onto the platform.

Those interested in accessing the Hub platform should register their interest through our website: <https://www.renewableenergyhub.com.au/marketplace>

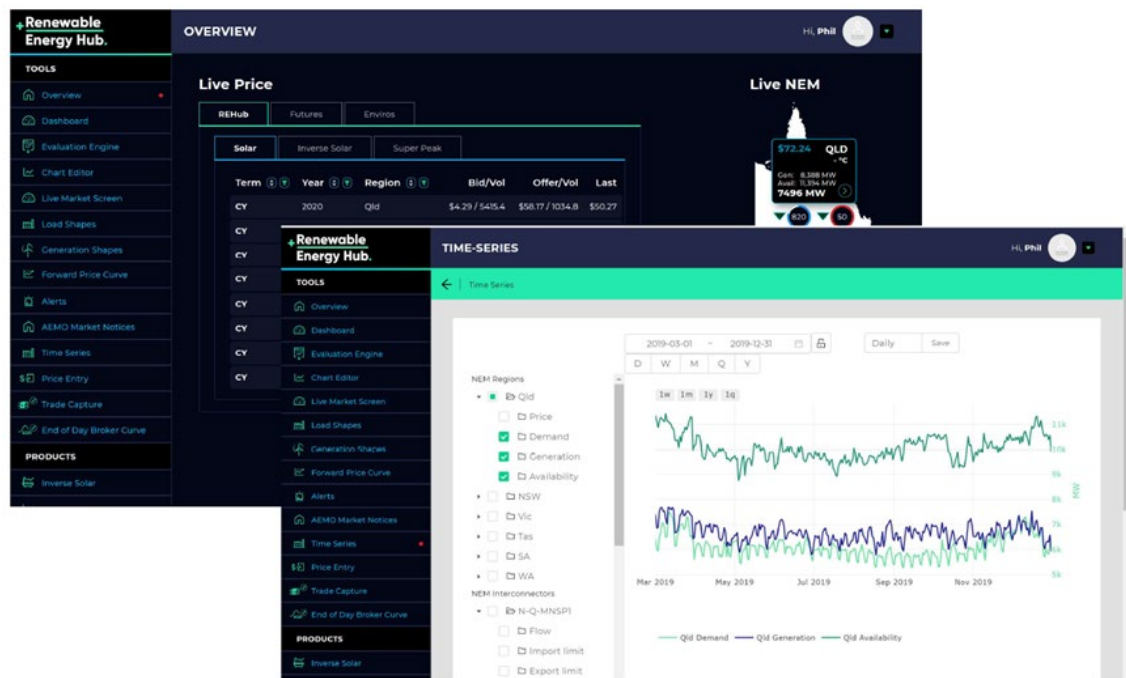


Figure 12: Screenshots of the 'Hub' digital market platform.

6 Further Information

For additional information regarding Renewable Energy Hub's unique firming contracts and the Hub digital marketplace, we have prepared a range of reports and supporting materials. Please visit our ARENA [project page](#) to review Knowledge Sharing materials including the Hub Platform Launch report, Legal Overview Report and Lessons Learned Reports. These documents provide detailed analysis and guidance on the legal structure and requirements of the hedge contracts, recent transaction details and further detail on the operation of the digital platform.

If you wish to access the Hub platform, please register on our website - <https://www.renewableenergyhub.com.au/marketplace>