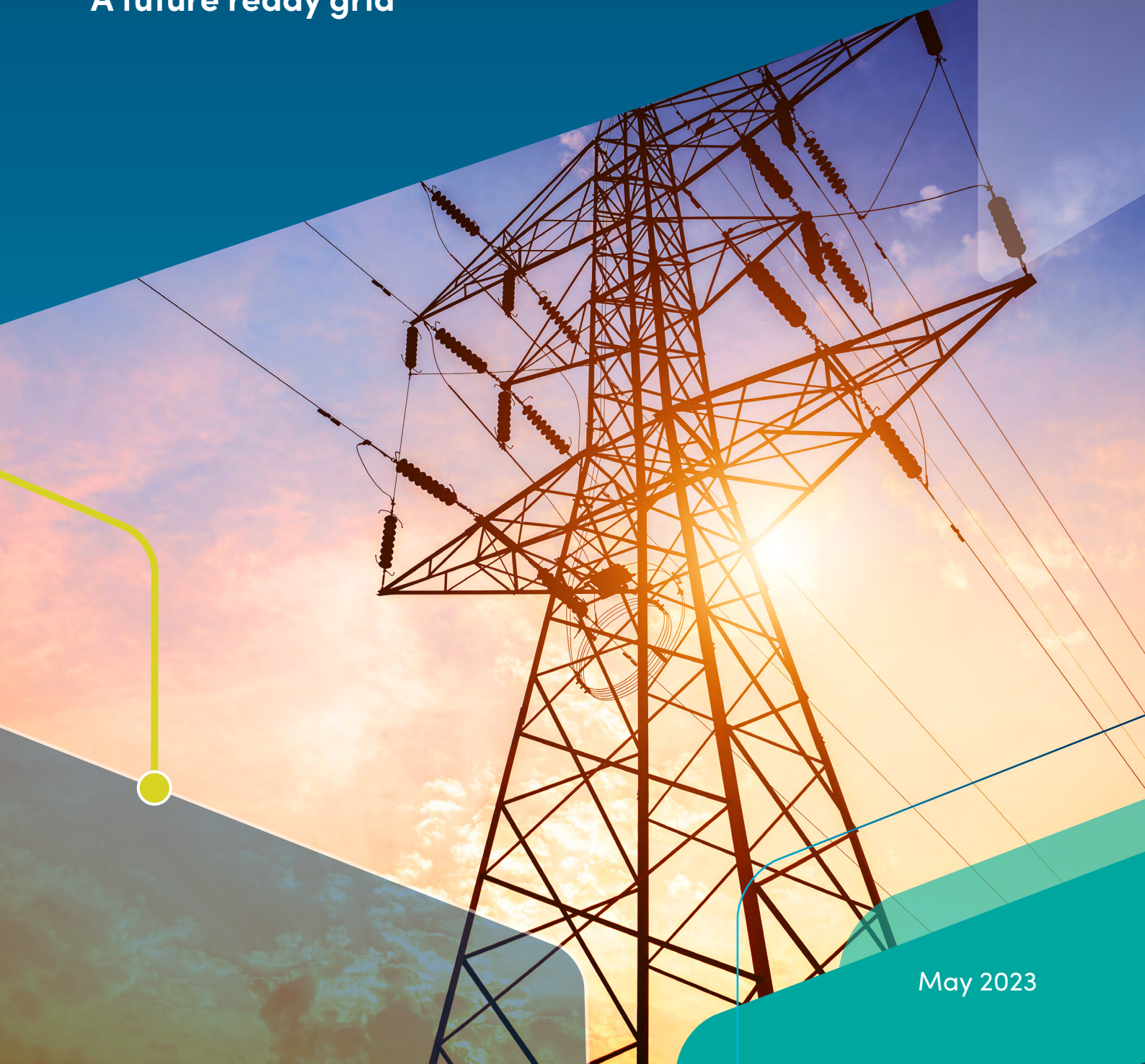
GOVERNMENT OF
WESTERN AUSTRALIA

SWIS Demand Assessment 2023 to 2042

A future ready grid



May 2023

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Foreword from the Minister for Energy

Western Australia is leading the way towards a low carbon future. As part of our commitment to achieving net zero greenhouse gas emissions by 2050, the McGowan Government is driving changes to our energy markets, investing in critical mineral discoveries and facilitating the uptake of renewable generation, energy storage and distributed energy resources including electric vehicles.

These initiatives will play a major role in helping industry, government and the community achieve decarbonisation. Central to their success is the electricity transmission network.

Electrification of industries, transport and homes is key to reducing greenhouse gas emissions. Western Australia has some of the best and most reliable renewable energy resources on the planet. But having world-leading renewable energy is only one piece of the puzzle - it needs to be connected to where it will be used.

The State-owned Western Power network is vast, secure, reliable and remains the lowest cost way of transporting electricity. The major powerlines that span from Geraldton to Albany and east to Kalgoorlie are the backbone of our economy in the South West and will continue to be for decades to come. However, the powerlines need to reach the locations where wind blows the strongest and sun shines the brightest. Similarly, the network must expand to new locations to cater for emerging industries such as hydrogen production and lithium mining, while also meeting the demands of existing industrial power users looking to expand and decarbonise rapidly.

This South West Interconnected System (SWIS) Demand Assessment shows how much the transmission network will need to transform to meet industrial demand for green electrons over the next 20 years. Industry stakeholders have shared their expansion and electrification plans with us to build a picture of future load growth and overall electricity demand in the SWIS. Using this information, we have modelled the optimal mix of renewable generation and storage required to meet this anticipated demand, and identified the network augmentations necessary to transport that electricity.

This modelling builds on the 2020 Whole of System Plan, the next iteration of which was due to be delivered at the end of 2023. However, recognising the urgency of action on climate change, the State Government brought forward this SWIS Demand Assessment to gain earlier insights.

Since the first Whole of System Plan was delivered at the end of 2020, the world has changed. Industry decarbonisation ambitions have strengthened and accelerated, governments around the world have set ambitious greenhouse gas reduction targets, and concepts around establishing new green industries such as renewable hydrogen are translating into policies and action. The SWIS Demand Assessment revisits the infrastructure needs of the SWIS in relation to renewable generation, storage and network requirements to support this transition.

The resulting picture is exciting, with huge potential to connect new renewable generation and storage projects that will support new and existing industries and create new jobs.

But the SWIS Demand Assessment is only the first step in the journey towards transformation of the grid. Government is committed to working with industry to confirm their network capacity needs, with a focus on minimising the cost of new network build being passed onto households. However, to ensure these assets are delivered in a timely manner, the Government has already committed Western Power to undertake early planning works in the northern, central and eastern areas of the network.

The McGowan Government looks forward to working with industry to build on the SWIS Demand Assessment, supporting their decarbonisation efforts and helping Western Australia transition to a low carbon future.

Hon. Bill Johnston

Minister for Mines and Petroleum; Energy; Corrective Services; Industrial Relations

Overview

The SWIS Demand Assessment is an initial assessment of potential future electricity demand required over the next 20 years to meet industry and Government commitments of achieving net zero greenhouse gas emissions by 2050. A Treasury-led Taskforce, with support from Department of the Premier and Cabinet, Energy Policy WA, Western Power, the Department of Jobs, Tourism, Science and Innovation, and the Department of Water and Environmental Regulation, oversaw the delivery of the SWIS Demand Assessment.

The SWIS Demand Assessment complements the 2020 Whole of System Plan by looking at the future growth of electricity demand that is largely driven by industry action on climate change. Since 2020, commitments to reduce greenhouse gas emissions at global and national levels have strengthened, along with introduction of legislation to underpin these commitments. The McGowan Government has announced the retirement of the State-owned coal generation fleet by 2030 and plans to introduce climate change legislation. All of these factors are driving acceleration of the decarbonisation plans of the State's major industries.

Using renewable electricity is one of the most cost effective ways of moving to a net zero future. Through consultation with existing and potential new industry stakeholders, a range of potential demand scenarios were considered. Under all scenarios Western Australia's main transmission network would need to grow significantly to meet industrial demand.

The 'Future Ready' scenario shows peak demand would almost triple by 2042. This would require almost 10 times the current amount of generation and storage capacity, and over 4,000 km of new transmission lines to transport that energy from where it is produced to where it is used.

Replacing thermal generation with zero emissions electricity requires substantially more renewable generation and energy storage capacity. This is because the amount of electricity wind and solar generators can produce varies significantly with the wind and sun resources available at any time.

The modelling shows new renewable generation will need to be installed across the SWIS, as well as in areas with high quality renewable resources outside the existing SWIS footprint. The model identifies that the most cost effective way of accessing these areas is by establishing renewable generation hubs. This could be a new concept for the SWIS where clusters of renewable generation would be located in places where the wind and/or sun resources complement the connection of other renewable generation across the grid and support a constant supply of renewable electricity.

The SWIS Demand Assessment includes a three-stage network augmentation vision, which shows what investment would be required under the Future Ready scenario. In recognition of the need to get started, Western Power has commenced early works and planning for Stage 1 investments. As with all network investment, network augmentations will be subject to business cases, and plans may be adjusted over time as demand eventuates.

The Government will also help expedite the required works by addressing challenges including improving the network connection process and establishing a new 'Priority Projects' mechanism.

Assessment approach

A highly consultative approach was used to inform expectations of the use of the SWIS in a decarbonised future.

More than 50 meetings with existing and new mining, critical minerals and processing industries, potential hydrogen producers, and renewable energy project developers were held. These major electricity users provided details of their electrification plans, emissions targets, and expectations of network supply over the coming decades.

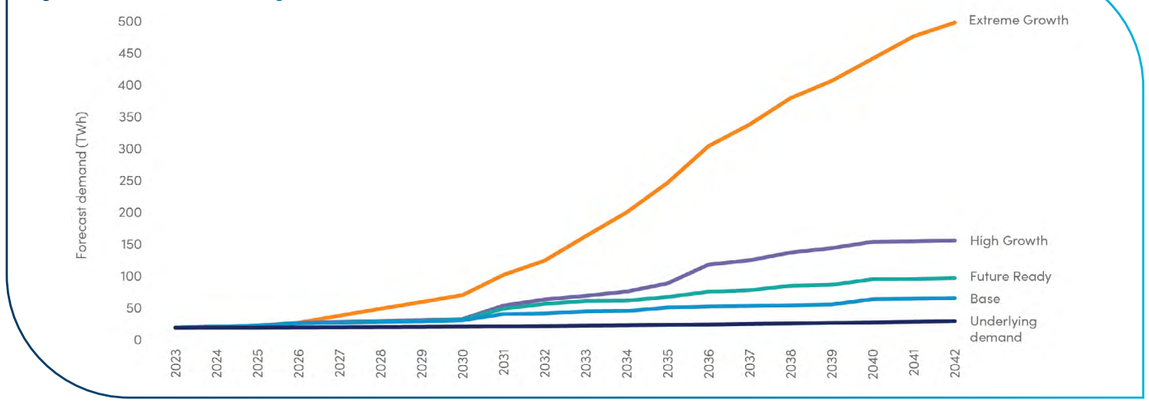
With this information, four demand scenarios were developed, each reflecting different outlooks for major loads connecting to Western Power's transmission network over the next 20 years:

1. **Extreme Growth:** All load growth put forward by proponents occurs, applying the highest load and most ambitious timing assumptions.
2. **High Growth:** All expansion and electrification of existing and new connections put forward by proponents occurs, including rapid connection of hydrogen production loads.
3. **Future Ready:** Includes expansion and electrification of existing connections plus a more conservative estimate of hydrogen loads connecting during the 2030s (assumes additional growth in hydrogen production is not SWIS-connected).
4. **Base:** Load growth is limited to expansion of existing loads and electrification of existing connections.

Each scenario was constructed by adding the different outlooks for major load growth to a forecast of the underlying demand in the SWIS based on the 'Expected' scenario in the Australian Energy Market Operator's (AEMO) 2022 Electricity Statement of Opportunities. This work builds on the modelling framework developed through engagement with energy sector stakeholders to deliver the 2020 Whole of System Plan, with additional network nodes introduced. The SWIS Demand Assessment also considers additional wind resource data, including in areas beyond the existing SWIS footprint, as well as a more refined analysis of land availability.

Figure 1 shows the demand under each of the four scenarios. The generation and storage capacity required to meet demand in each of the scenarios across 14 different nodes in the SWIS was modelled, including the optimal locations for generation and storage. Taking into consideration the load estimates provided by stakeholders, and the outputs of the scenario modelling, the Future Ready scenario was selected as the basis for developing a network vision for the coming decades. From there, Western Power worked to identify the transmission network augmentation required to transport the necessary volumes of electricity around the SWIS if the Future Ready scenario eventuated.

Figure 1: Modelled demand growth scenarios



Load, generation, and storage forecast

There is a need to plan for a future where existing and new industries can continue to grow in a low carbon environment. Industry consultation suggests electricity demand could increase by more than 7 GW, requiring investment in over 50 GW of new renewable generation and firming capacity across the network.

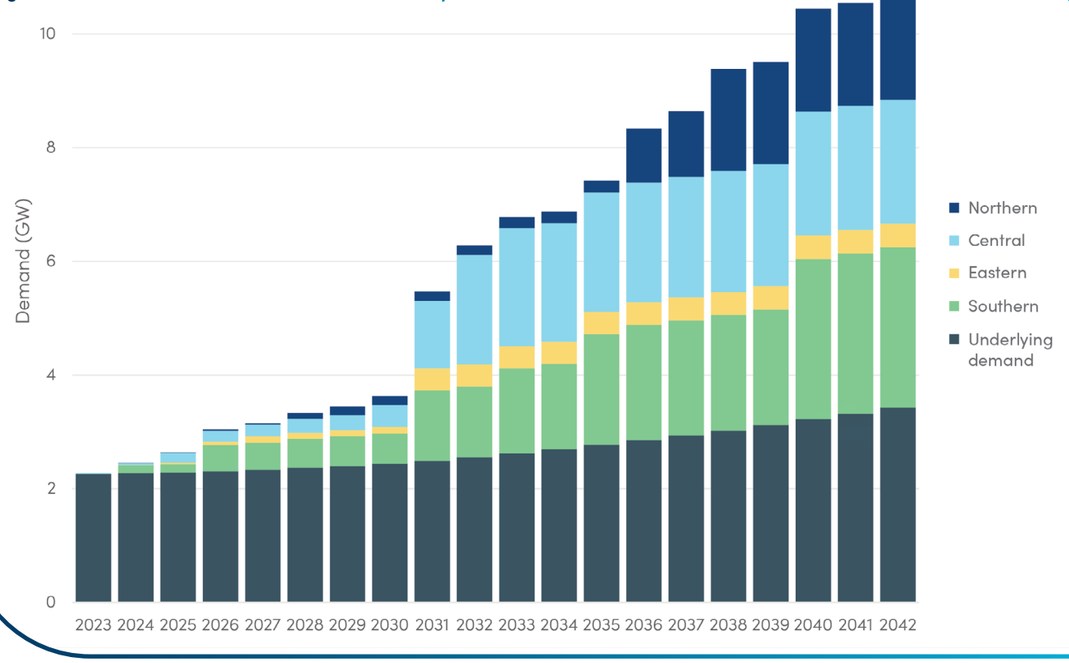
The Future Ready load growth scenario was selected for further development, as it provides a balance between short-term needs and long-term network options. Future Ready reflects a credible representation of SWIS demand through to 2042, as it:

- is based on the expansion and electrification plans of existing connected industrial customers;
- reflects conservative assumptions of SWIS connected growth in new and emerging industries;
- aligns with Government policies and direction with regard to emerging industries (such as hydrogen, green steel, and critical minerals) while balancing uncertainty about the timing and scale of the associated future demand growth; and
- allows for scalability in network capacity if/when significant demand eventuates.

Figure 2 below and the map on page 9 provide a geographic representation of the 7.2 GW of new large customer loads (electricity demand) that would occur in the SWIS by 2042 under the Future Ready scenario. More than half of the growth (3.7 GW) would materialise by 2032. A key driver of this is the Commonwealth Government's Safeguard Mechanism, which is expected to increase demand on the network as major industrial customers seek to reduce emissions from mid-2023.

The key load areas, growth drivers, and potential generation and storage requirements are summarised in the following section.

Figure 2: New load size and location - Future Ready



Key load areas: Future Ready

South West

Load growth is anticipated to be strongest in the South West node, with approximately 2.8 GW of new electricity demand expected to connect to the network at load centres between Pinjarra and Bridgetown. The bulk of the increase in the South West is driven by electrification of established minerals and metals industries, particularly alumina.

Central

The estimated 2.2 GW of demand growth in the Central area of the SWIS (from Kwinana to Alkimos) would be largely based around the Kwinana Industrial Area (2.0 GW). Industries in the Kwinana region are seeking to decarbonise, with many signalling their intent to electrify operations via a grid connection.

The pace and extent of grid connection remains uncertain, as the options for decarbonisation are limited by current technology. Major electricity users in the region are exploring options involving low emissions electricity combined with renewable hydrogen technology which, while not yet commercially viable, has potential to evolve over the coming decades. Any new generation and/or energy intensive processes adopted in the heavily industrialised Kwinana region will require substantial network upgrades.

North

Demand growth in the northern parts of the SWIS (from Moora to Oakajee) would be driven primarily by plans to produce renewable hydrogen, with a view to exporting it globally. Government plans to accelerate development of the Mid West Clean Hydrogen Hub in the Oakajee Strategic Industrial Area are attracting significant interest and investment.

Approximately 1.7 GW of the expected 1.8 GW increase in load in the region is linked to production of hydrogen. However, it is uncertain what the impact on SWIS demand might be in terms of timeframe, given the need to develop additional infrastructure such as export facilities to realise this industry.

Eastern Goldfields

Identified load growth in the Eastern Goldfields is shown to be lower than in other parts of the SWIS, and challenging to estimate given the range of variabilities around industry growth and network requirements in the region. In addition to feedback from existing major network users, the Eastern Goldfields load growth assessment considered the potential demand impact should greater network capacity become available, enabling currently off-grid loads to move away from diesel and gas and electrify their operations.

For the purposes of the demand projections, a 50 km buffer was imagined around the SWIS, with potential loads drawn from within that boundary. This means that the potential electrification needs of off-grid mines further outside the existing SWIS footprint were not captured for this exercise.

Generation and storage: Future Ready

Supply mix

Under the Future Ready scenario, more than 50 GW of new generation and storage capacity would be required to supply load growth in the SWIS by 2042.

The overwhelming majority of this new generation capacity is large-scale wind and solar (41.8 GW) as these are the most commercially viable technologies.

By comparison, total utility-scale generation capacity in the SWIS in 2022 was 5.9 GW, with approximately 1.2 GW of this being large-scale wind and solar, and 3.1 GW being gas-fired generation.

The modelling shows large-scale solar paired with long duration energy storage (LDES) as the most cost efficient form of firmed renewable generation. This combination is expected to be built across the SWIS.

The strongest solar resources are generally in the northern and eastern parts of the SWIS. However, the availability of land and reliable sunshine in the south suggests that up to 11.1GW of solar could also be installed there. Modelling indicates that wind generation build should occur across the SWIS to access diverse wind profiles over the day and year to maximise the availability of renewable generation at any one time.

Due to the intermittency of wind and solar resources, energy storage capacity would be essential to enable excess generation to be stored for when it is needed. The modelling considers two, four and eight-hour duration lithium-ion batteries, and a

10-hour LDES option from 2030.

The LDES option is based on pumped hydro, which is the most mature and widely deployed storage option available to date. Pumped hydro is challenging in the SWIS given the topography and drying climate. However, early exploration in options for pumped hydro is currently underway by Government. Other technologies are emerging, but these technologies are not yet commercially viable or ready to be deployed at scale. If these technologies do not eventuate, larger quantities of shorter duration storage technologies such as batteries may be required.

Under Future Ready, new renewable generation would be supported by an additional 3.9 GW of new flexible gas generation capacity using reciprocating gas engines. This is a modular, comparatively efficient form of gas generation technology, with a fast response capability. It is a relatively low cost option to provide essential system services and supplement energy storage in firming the intermittent renewable fleet.

Renewable generation hubs

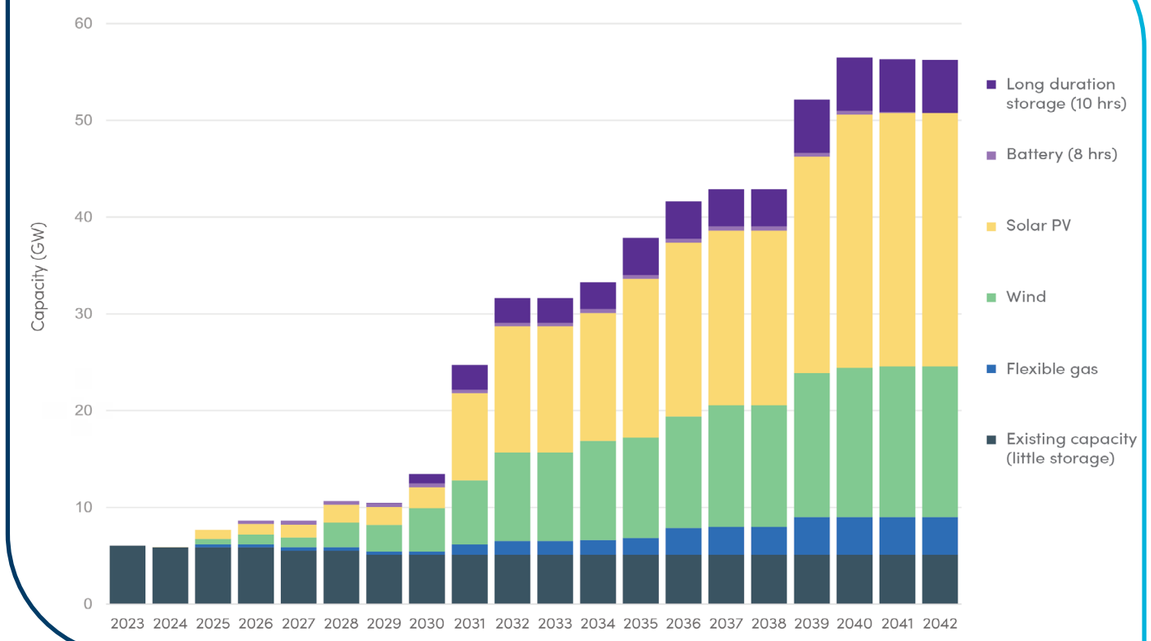
Since the 2020 Whole of System plan modelling was conducted, the scale of the potential renewable energy requirements has shifted. The industry-wide focus on decarbonisation is driving a substantial increase in demand for renewable generation.

Some of Western Australia's best solar and wind resources are located outside the reaches of the existing transmission network. There is potential to establish renewable generation hubs outside the current SWIS footprint, complementing renewable capacity elsewhere in the SWIS.

The modelling suggests developing new renewable generation hubs in the north, east and south of the SWIS could be part of a least-cost system future as these hubs either:

- achieve a significantly higher capacity factor than other areas; or
- have wind output that is relatively uncorrelated with wind output in other areas (it generally blows at different times of day/year to other parts of the SWIS).

Figure 3: New capacity type



Network augmentation

A future ready transmission network is critical to deliver Western Australia's world-class wind and solar resources to major loads. The location of world-class renewable resources at the fringe of the grid, coupled with the huge footprint of the SWIS, means more than 4,000 km of new high capacity transmission lines could be needed over the next 20 years to meet industry's demand for greener energy.

The scale of work required is unprecedented, reflecting the nature of how electricity will be generated in a clean energy future. Given the magnitude and urgency of the task, planning for those network investments that would be required under all demand scenarios will commence immediately through Western Power.

The electricity network is critical to help decarbonise Western Australia's existing industries, as well as develop potential new industries aligned with a clean energy future.

The existing transmission network will need to be reinforced to meet the additional demand from those looking to decarbonise. It will also need to be expanded to reach new sources of renewable energy and connect new industry areas to the power system.

The modelling suggests significant investments in the transmission network are required in all directions.

Through the consultation period, multiple stakeholders expressed the view that the northern corridor is an early priority as it will unlock existing renewable (wind) generation, and improve the connection between the primary load centre (the Perth Metropolitan Area and South West) and some of the areas with the highest wind capacity factors. This view was corroborated by the modelling.

Additional network capacity in the southern corridor allows access to a different wind profile than in the north. This diversity of supply, facilitated by the network, helps keep the electricity system secure as well as playing a critical role in supplying demand around the South West and major industry around the Kwinana area.

Upgrades through the eastern corridor are required to provide the region with more reliable access to low emissions grid-connected energy, supporting decarbonisation of the mining, metals and minerals processing loads in the Goldfields.

The lead times to plan and construct transmission infrastructure can be significant, and the modelling shows that each of the existing SWIS corridors require major upgrades to support the net zero future.

As part of this SWIS Demand Assessment, Western Power has developed a high-level vision for turning this modelling into reality. This includes consideration of the commonality, timing, priority, scalability, optionality and deliverability of each key augmentation.

An overview of the potential stages of augmentation is provided in the map opposite and in the following sections. Work identified in stages two and three of the network plan are indicative only. They are based on current understanding of the load and generation that may eventuate, and the corresponding network use.

Stage 1

This stage would unlock existing renewable generation capacity, and allow the addition of new renewables to facilitate the orderly retirement of coal-fired generation. Stage 1 represents network build that would be required under all scenarios. Works have already started on a number of investments, and will continue until 2027.

Stage 1 includes:

- Upgrading the northern corridor, building a new line from the metropolitan area to Neerabup, and converting the existing line between Neerabup and Mid West from 132 kV to 330 kV.
- Undertaking critical conversion and reinforcement works in Kwinana and Metro North to support near term load growth.
- Building two new lines from the South East to South West to enable the initial connection of around 1.3 GW of new renewables. This will facilitate further work in Stages 2 and 3 to enable the connection of a further 5.9 GW of new renewables through a generation hub in the south.

SWIS nodal map

Potential network augmentation to 2042

Notes on network build

Network augmentation may include network conversion and intranodal reinforcement.

Stage 1 north country works involve upgrading existing transmission line. New line route not required.

Modelling assumes any new transmission lines would be 500 kV, energised to 330 kV in first instance. Actual network build to be determined.

Line routes are indicative only.

Suggested location of potential renewable generation hubs is for illustrative purposes only. Precise locations are to be determined.

Legend

- Transmission network node
- Current nodal connection (simple representation)
- Stage 1 augmentations (~2023 to 2027)
- Stage 2 augmentations (~2027 to 2034)
- Stage 3 augmentations (~2034 to 2042)
- Stage 1 intranodal reinforcement and upgrades

NC = North Country
MW = Mid West
CM = Central Midlands
NB = Neerabup
MC = Metro Central
MN = Metro North
EC = East Country
MS = Metro South
KW = Kwinana
ME = Mid East
EG = Eastern Goldfields
SW = South West
SE = South East
GS = Great Southern

- Works to enhance the rating of the existing 220 kV line between the South West and Eastern Goldfields.

Each of the new transmission lines would be 500 kV, high capacity, double circuit transmission lines, initially energised to 330 kV. This will provide scalability should the network need be greater than modelled.

Stage 2

To facilitate decarbonisation of the modelled load and generation, the following projects are expected to be required to be undertaken prior to 2034:

- Building two new lines from Metro North to North Country.
- Building a new line from Kwinana to Metro North.
- Building a new line between Kwinana and the South West.
- Building two new lines to connect a renewable generation hub in the south.
- Building new lines connecting the Eastern Goldfields to the South West, and extending the network to facilitate the connection of a renewable generation hub in the Northern Goldfields.

More detailed planning to confirm Stage 2 investments will be developed with industry input as part of Stage 1.

Stage 3

Works from 2034 onward would need to include the following projects:

- Building a new line to connect the renewable generation hub in the Northern Goldfields to the North Country.
- Building a second line connecting Kwinana and Metro North.
- Building a second line between Kwinana and the South West.
- Building two new lines to expand the southern renewable generation hub.

More detailed planning to confirm Stage 3 investments will be developed with industry input.

Like all modelling, this SWIS Demand Assessment is not a prediction of the future. The SWIS Demand Assessment is based on current industry feedback, modelling and network capability. These will necessarily develop and change over time.

As the network owner and operator, Western Power will continue to develop detailed network plans which will evolve as the future use of the network by industry is confirmed.

Potential network augmentation to 2042

by SWIS region and node

		Stage 1 ~2023 to 2027	Stage 2 ~2027 to 2034	Stage 3 ~2034 to 2042
North	Metro North - Neerabup			
	Neerabup - Central Mid			
	Central Mid - Mid West			
	Mid West - North Country			
	Estimated network build	30 km	930 km	590 km
Central	Kwinana - Metro North			
	Metro North - Metro Central			
	Kwinana - Metro South			
	South West - Kwinana			
	Estimated network build		190 km	190 km
South	South East - South West			
	Great Southern - South East			
	Estimated network build	180 km	280 km	630 km
East	Eastern Goldfields - Mid East			
	Mid East - South West			
	East Country - Metro North			
	Estimated network build		980 km	

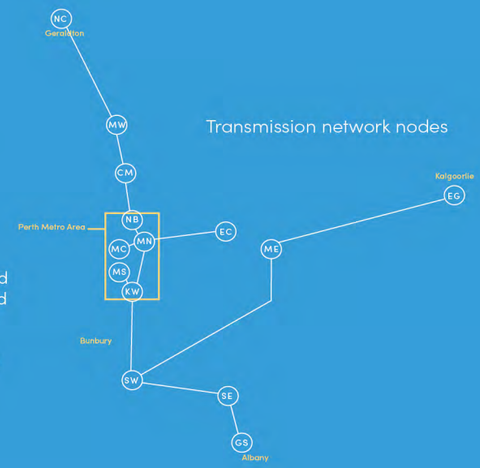
Legend & notes

High capacity 500 kV double circuit line across nodal boundary, energised to 330 kV in first instance. Line length in km may vary based on final line route.

Network upgrade & intranodal work.

The proposed works program is indicative only, and is based on network load growth indications proved by major customers in late 2022, and the modelled generation capacity requirements to meet that load.

The actual work program will vary, and will be developed following detailed network studies and contemporary load forecasts.



Where we are heading

Increasing the capacity of the transmission network is critical to the electrification and decarbonisation of the SWIS. However, it is only one piece of the puzzle. The McGowan Government has invested more than $120 million to kickstart early network planning in the SWIS and complement other initiatives across government to drive a low emissions future.

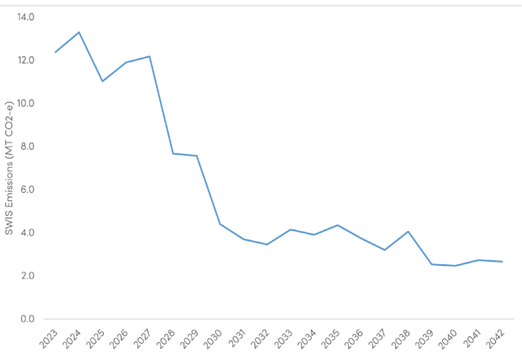
Reducing emissions

Investment in the transmission network is essential to enable the supply of low emissions electricity to meet demand from all SWIS customers. It is integral to achieving a Government-wide emission reduction of 80 per cent by 2030, and to help the whole economy move towards the net zero emissions by 2050 target.

Figure 4 shows the likely impact of facilitating the entry of over 50 GW of renewable capacity over the study period. The modelling shows 96 per cent of electricity produced in the SWIS comes from renewable energy by 2042.

Work will also continue with industry to progress the Sectoral Emissions Reduction Strategies, due to be released by the end of 2023, which will deliver robust and credible pathways to reduce emissions in key sectors of the Western Australian economy.

Figure 4: Emissions reduction - Future Ready



Delivering stage 1 network investments

The McGowan Government has committed more than $120 million of additional funding for Western Power to commence delivery of the first stage of network investments identified in the SWIS Demand Assessment.

Western Power will be able to start detailed planning and scoping for works required in the next five years, and reviewing the network connection processes.

It will also allow procurement of some long lead-time assets, and commencement of critical conversion and reinforcement works across the network.

Energy Policy WA will help expedite the Stage 1 works and other critical transformational network augmentation projects by progressing regulatory changes. This will include developing a new 'Priority Projects' mechanism.

As with all network investment, Western Power will develop business cases supporting all investment decisions to ensure each project is in the long-term interests of energy consumers.

Connecting more renewable generation

The South West is home to some of the best renewable energy resources in the world. Some of these resources are connected or close to the existing SWIS, while others are further beyond its current reach.

The SWIS Demand Assessment indicates that establishing renewable generation hubs in areas extending beyond the existing SWIS footprint could be a cost effective way of maximising the amount of renewable electricity generated to meet industrial customers' demand for a reliable, low emissions electricity supply.

Further work is required to investigate the legal, commercial and regulatory implications associated with establishing hubs by co-locating generation

and network, particularly given the vast and isolated nature of the SWIS and the unique market in which it operates.

The McGowan Government is committed to working with industrial users to explore investment approaches in the State-owned network, to minimise the cost of new network builds being passed on to household energy consumers. With the SWIS Demand Assessment complete, consultation with existing and new industrial users will now progress to inform a network investment strategy, including mechanisms for industry contributions and third party investments.

Coordinating investments

The infrastructure build contemplated through the SWIS Demand Assessment is significant, and an order of magnitude larger than previous energy projects undertaken on the SWIS. The focus of the SWIS Demand Assessment is to provide a view of the work required in the transmission network. However, significant investment from across the entire energy sector is required.

A coordinated approach is necessary to ensure that, as a state, Western Australia's low emissions goals are achieved in the swiftest, and most efficient way. The State Government is in the best position to facilitate this, and will consider possible structures for a new specialised facilitation body responsible for:

- overseeing the coordinated deployment of electrification projects in Western Australia;
- assisting with critical issues such as supply chain blockages;
- ensuring consideration of critical factors such as community support, environmental conservation and Aboriginal cultural heritage; and
- ensuring the Western Australian community is brought along on the decarbonisation journey.

Working together

With the pace of change in all areas affecting Western Australia's energy transition, from new technologies to industry and business plans, it has never been more important to start planning and acting for the future, while remaining flexible.

The work discussed in the SWIS Demand Assessment is only part of Western Australia's transition to a low emissions future. The network vision and work driven by the SWIS Demand Assessment will, of course, be undertaken in conjunction with decarbonisation work already underway.

Engagement with industry will continue in order to progress thinking on the future of the SWIS, and build on the work done through the SWIS Demand Assessment in upcoming forecasts and plans including Western Power's updated Transmission System Plan, AEMO's next Electricity Statement of Opportunities, and the next Whole of System Plan.

Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**
Energy Policy WA

Energy Policy WA
Level 1, 66 St Georges Terrace
Perth WA 6000

Locked Bag 100 East Perth WA 6892

Telephone: 08 6551 4600

www.energy.wa.gov.au

ABN 84 730 831 715

Enquiries about this report should be directed to:
EPWA-info@dmirs.wa.gov.au