

The Queensland Conservation Council Vision To Power Up Queensland with 100% Clean Energy

Introduction

Queensland is the Sunshine State – and yet we are currently more reliant on coal than any other state or territory in Australia. We are also the country's biggest carbon polluter.

In 2007-2008, coal accounted for approximately 88% of the state's electricity generation and renewables only 2%, with gas making up the remaining 10% of supply. Since then, the government has begun working towards a target of 50% renewable energy by 2030 and we're now on-track for 20% of the state's electricity consumption to come from renewable energy sources by the end of 2020.

According to The Australia Institute, renewables are "cheaper to build, even with six hours of backup storage tacked on to it — it's cheaper to build than coal by about 30 per cent."

"Renewable energy is a revolution. It is providing jobs and investment opportunities. It is lowering the power prices for Queensland families." - former Qld Energy Minister Anthony Lynham

So there has been progress, but it's not fast enough. Queensland is still in the early stages of shifting from the old polluting power of the past toward a new clean energy system.

A report by the leading experts Climate Analytics found Queensland should stop burning coal for power by 2030 to play our part in keeping global heating to 1.5 Celsius under the UN's Paris Agreement targets and that a rise of more than 1.5C would "virtually guarantee the extinction of most of the Great Barrier Reef".

With Queensland's plans for three Renewable Energy Zones and a Renewable Energy Fund for publicly owned renewables, the future is coming into view. But we need to drive this transition in a fast and fair way.

However, there is still currently no plan in place to phase-out the state's coal fired stations and make the essential transition over to renewable energy.

The Power Up Queensland Vision

To investigate what this transition could look like, QCC asked two Australian energy system experts to provide us with possible scenarios for 100% renewable energy in Queensland.

"Queensland actually has a multitude of options for how it might achieve 100% renewable and reliable and affordable electricity supply." - *Tristan Edis, Green Energy Markets*

The Power Up Queensland Vision draws on these expert reports to present one possible way for us to power our state with clean energy through a reliable, affordable power system.

Four essential ingredients

There are four essential ingredients required to run a reliable electricity system that meets all the needs of Queensland homes, businesses and heavy industry. A well-designed renewable energy system can deliver all these things:

1. Plenty of electricity
2. At the right time
3. In the right place
4. Getting the technical stuff right

A Powerful Recipe

1. Plenty of clean electricity

In an average year, Queensland uses about 57.6 terra-watt hours of electricity. The state's abundant sunshine and wind resources can easily supply that quantity of electricity - in fact we have enough wind and sunshine to provide many times that amount. This opens up new opportunities for clean energy exports - but that's another story. For now, the Power Up Queensland Vision puts forward a plan to provide all Queensland's *domestic* electricity needs with renewables.

2. At the right time

The amount of electricity Queensland consumes varies throughout the day, and at different times of year. Generally, the greatest demand for electricity occurs in the morning and the evening, when more people are home with the lights on and appliances running. The greatest seasonal demand occurs on hot summer days when everyone cranks up their air-conditioners and fridges have to work harder to stay cool.

You've probably heard people ask "but how will we keep the lights on when the sun's not shining and the wind doesn't blow?" The abundant electricity generated by wind and solar can be stored in various ways to deliver a reliable supply of electricity that can be dispatched at short notice to meet peaks in demand or drops in supply. By combining a mix of technologies that can deliver dispatchable clean energy whenever required, we can make sure that electricity is always available when we need it. All these technologies are already in use commercially around the world.

- **Hydro power and pumped-hydro energy storage:** Hydroelectric power has been around for decades, it uses water flowing from a dam to drive a turbine and generate electricity. Pumped hydro involves pumping water from one reservoir uphill to a second reservoir, then circulating it around to drive a turbine. Wind or solar power can be used when it's available to pump the water uphill, then the water can be released to generate electricity whenever it's needed.
- We don't support building new dams for hydroelectric power. New dams damage our river systems, and they are incredibly expensive. There are much cheaper and less damaging ways to provide dispatchable clean energy.
- **Solar Thermal:** This process uses mirrors to concentrate the sun's energy into a narrow beam to heat a fluid to several hundred degrees centigrade. This fluid is then stored in heavily insulated tanks to be used when needed to drive a steam turbine to generate power, even in the middle of the night.
- **Battery storage:** Batteries use chemicals (usually Lithium-ion) to absorb energy and release it on demand. Batteries allow renewable energy to be stored during times of low demand and released when demand is high. The Queensland system would integrate both large-scale and household/commercial batteries to store energy.
- **Green-hydrogen gas:** Hydrogen gas is produced by using an electrical current to split water into hydrogen and oxygen. By using electricity from a solar or wind farm to manufacture hydrogen, we can produce zero-emissions gas that can then be used to run gas turbines to generate clean, dispatchable electricity. The CSIRO recently produced a clean Hydrogen Roadmap for Australia.
- **Bio-energy:** Bioenergy uses organic materials (known as biomass) to produce heat, electricity, biogas or liquid fuels. Many Queensland sugar-mills generate electricity from sugar-cane waste. At landfill sites (garbage-dumps) the methane-rich gas produced from decomposing natural materials like food scraps can be captured and used to generate electricity.

“The cost of electricity from dispatchable renewable generation is comparable with estimates for new build gas while avoiding the associated fuel and carbon price risks.”- ARENA report 2018

3. In the right place

Queensland's electricity transmission network was built to transport electricity from a few big coal and gas plants (located mainly in the south-east) and deliver it to homes and businesses across the state. This existing network of poles and wires wasn't designed to connect our cities and towns to the parts of Queensland that have the best solar and wind resources. So some parts of the state with lots of wind and sun don't have any power lines at all, or the existing lines can only handle small amounts of electricity.

That means we need to supplement Queensland's existing electricity network with new transmission lines (and upgrade some existing lines) to get all that clean renewable energy to where it's needed in our cities, towns and industrial centres. In particular, new transmission lines are required to connect the world-class wind and solar resources in north and north-west Queensland, and parts of central Queensland to our national electricity grid.

4. Getting the technical stuff right

Electricity can be complicated and tricky for most of us to understand. There's a bunch of technical issues like voltage and frequency control that have to be right to make our electricity system work. Until recently, coal and gas generators have been carefully managed to make sure the technical requirements of the electricity system stay in balance. You might hear this referred to as the "ancillary services" provided by coal power plants.

Thankfully, engineers have worked out how to adapt this for a renewable-energy powered electricity grid. Not only can this be done, the system is already adapting effectively.

Solar thermal plants and green-gas turbines can provide some of these technical services, using renewable energy sources to create heat and power turbines that behave in similar ways to the heat-powered turbines in a fossil fuel plant.

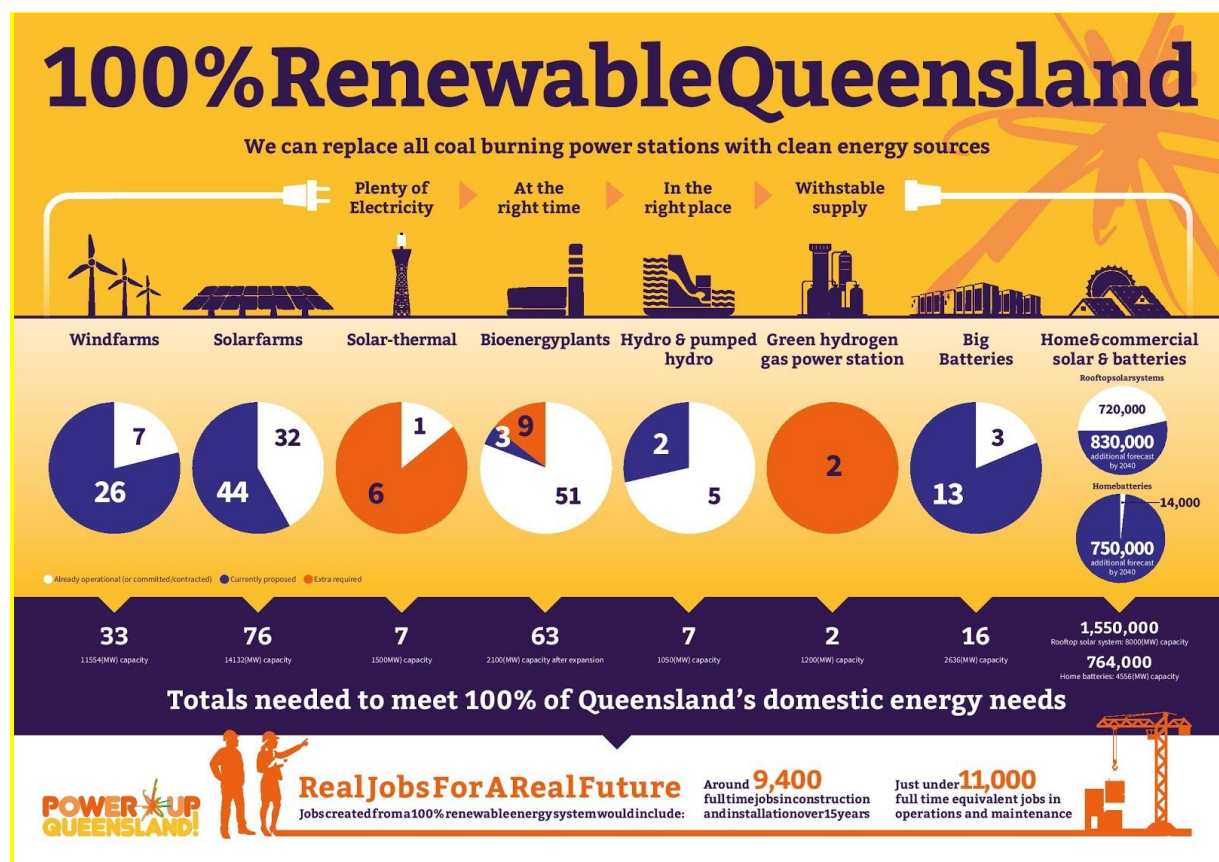
However, to keep the grid in balance and working smoothly with 100% renewable energy, we will also need a few extra bits of technology:

- **Synchronous condensers:** a rotational machine that behaves like conventional turbines to resist changes in voltage and frequency. Synchronous condensers have been around for decades, but are finding new uses in the renewable energy system.
- **Grid-forming inverters:** installed alongside a big-battery, grid-forming inverters can automatically moderate the output of the battery to resist changes in power system frequency. For example, the Tesla Big Battery in South Australia is already providing some of these essential technical services.

STATEWIDE SUMMARY

The expert reports behind the Power Up Queensland Vision both recommend a mix of renewable energy generation and storage systems to deliver the electricity Queensland needs, at the right times, in the right places, in a way that's both reliable and affordable. Building on findings from both of these reports, QCC has developed its own combination of renewable energy technologies - distributed in regions right across the state – which could provide all Queensland's domestic electricity needs.

- 33 wind farms
- 76 solar farms
- 7 concentrated solar thermal plants
- 63 bio-energy plants
- 7 hydro or pumped-hydro power stations
- 2 green hydrogen gas power-station
- 26 big-batteries
- 1.5 million rooftop solar systems
- 764,000 batteries in homes and businesses



We are already on the path to building a clean energy system that the next generation can rely on to give them affordable, reliable clean energy for many decades to come. The table below shows that most of the large-scale renewable energy projects Queensland needs are either already up and running, contracted for construction or currently proposed by energy companies as potential future projects. What's more, thanks to the falling cost of rooftop solar and home batteries, current trends suggest we're well on track to hit the targets needed for these home-energy systems to play a growing role in supporting the state's energy grid.

Extra planning and investment will be needed to deliver some of the large-scale dispatchable clean energy Queensland will need once we start phasing out our old coal power plants, in particular upgrading our bioenergy plants, building solar thermal plants like those seen overseas, and progressing the production of green hydrogen. All these things are achievable, and affordable, with the right forward planning and community backing.

Table 1: The mix of large-scale renewable energy technologies included in the Power Up Queensland Vision. This table shows how many of the projects are already operational or committed; currently proposed, or extra requirements to meet 100% of the state's domestic electricity needs.

		Already operational (or committed/ contracted)	Currently proposed	Extra required	Total
Wind farms	Projects	7	26	nil	33
	Capacity (MW)	2226	9328		11554
Solar farms	Projects	32	44	nil	76
	Capacity (MW)	1947	12185		14132
Solar-Thermal	Projects	1	nil	6	7

	Capacity (MW)	50		1450	1500
Bioenergy plants	Projects	51	3	9	63
	Current capacity (MW)	505	98		603
	Capacity after proposed expansion (MW)	1500	300	300	2100
Hydro & pumped hydro	Projects	5	2	nil	7
	Capacity (MW)	980	70		1050
Green hydrogen gas power station	Projects	nil	nil	2	2
	Capacity (MW)			1200	1200
Big Batteries	Projects	3	13	nil	16
	Capacity (MW)	103	2533	nil	2636

Table 2: Home and commercial-scale solar & batteries included in the Power Up Queensland Vision

		Already Operating	Additional Forecast by 2040	Total
Rooftop solar systems	Number ¹	720,000	830,000	1,550,000
	Capacity (MW) ²	3,000	5,000	8,000
Home batteries	Number ¹	14,000	750,000	764,000

	Capacity* (MW) ²	56	4,500	4556
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Notes: (1) Number of solar rooftops & batteries estimated by QCC (2) Megawatts of capacity based on projections prepared by Green Energy Markets.

A few important details

In the Power Up Queensland Vision, most of the electricity generated by the wind farms and solar farms will be delivered straight into the grid and used directly to power homes and businesses. The rest will be converted to dispatchable on-demand electricity supplies by storing it in big batteries; using it to produce green-hydrogen; or running pumped-hydro power stations. That way the power of the wind and sun are available at the flick of a switch.

We'll also need some synchronous condensers and grid-forming inverters fitted to some of the big-batteries, to manage frequency and voltage issues. The PUQ vision includes upgrading many of our existing small-scale bio-energy plants to use waste products from agriculture to generate a much greater volume of electricity.

To make this vision possible, Queensland will need to build new transmission lines (and upgrade some existing lines) in strategic locations to transport the renewable energy to where it's needed.

The Power Up Queensland Vision is grounded in scientific studies, real-world research and expert calculations, so we know that it's really possible. However, this is just one scenario for how we could provide all our energy needs from renewables. There are many other combinations of these and other renewable energy technologies that could deliver the pollution-free power we need.

Ensuring a just-transition

With good planning, we can support local workers and communities *and* replace all coal-burning power stations with clean energy sources. We need real engagement and accountability in the planning process to ensure no-one is left behind as our energy system transforms.

Real Jobs For A Real Future

Based on data from Green Energy Markets, we estimate that the employment that would be supported by the shift to this 100% renewable energy system would include around 9,400 full-time jobs in construction and installation activity if this transition was undertaken over a 15 year period.

The ongoing full-time equivalent jobs in operating and maintaining the renewable energy facilities and batteries is estimated to be just under 11,000.

Table 2-1 Employment supported from establishing 100% renewable energy system by region

Region	Construction (job-years)	Ongoing operations (FTE)
Central Queensland	13,783	952
Darling Downs - Condamine	17,733	2,473
Far North Queensland	5,038	1,293
Mackay-Whitsunday	21,465	1,373
South East Queensland	7,652	1,728
Townsville - Dry Tropics	11,021	1,381
Western Queensland	349	69
Wide-Bay Burnett	9,358	1,666
All regions (small solar and batteries)	54,340	0
TOTAL	140,739	10,935

THREE KEY REGIONS

The focus areas for this vision are the three areas which will be the location for the recently announced Renewable Energy Zones:-

Townsville, Dry Tropics and the Far North

Green Energy Markets estimates that, based on projects already in place or proposed, the Townsville Dry Tropics region would be expected to host 4,868 MW of capacity, while the Far North region is estimated to host 1,990MW.

This area has added over 500MW of solar farm capacity and 340MW of wind farm capacity in the past 4 years and currently has 6,687MW of project proposals.

While there are currently no coal power stations in operation here, a company called Shine Energy, has received money from the Federal Government for a feasibility study into building a new coal power plant in Collinsville – half way between Townsville and Mackay.

There is very little detail available about the design of the proposed coal power station, but based on the historical performance of the last coal plant constructed in Queensland (Kogan Creek), the facility could be expected to produce around 7000GWh of electricity per annum - which is about half the amount of energy that the 100% renewables mix of projects in this region would be capable of producing.

Renewable energy projects established in the region are already capable of generating more power than local demand. In order for these two regions to exploit their full potential of projects, investment will be required in new transmission and also voltage support.

Central Queensland and the Mackay-Whitsunday Regions

Based on projects already in place or proposed the Central Queensland region would be expected to host 5,667 MW of capacity, while the Mackay-Whitsunday region to the north is estimated to host 6,733MW. To date most of the renewable energy project activity has been in the Mackay-Whitsunday area. But each of these regions have thousands of megawatts of wind and solar projects proposed for development.

The coal power stations currently operating in Central Queensland are Gladstone (privately owned), Stanwell (State government owned/controlled), Callide B (State government owned/controlled) and Callide C (½ State government and ½ private ownership). They have a combined generating capacity of 4,740MW and average annual generation of around 27,000GWh. The oldest of these – Gladstone – has been operating well below its rated capacity in recent times and is already being steadily displaced by the expanding use of renewable energy.

The potential renewable energy projects for the region would be capable of producing almost the same amount of electricity per annum that currently comes from the coal power stations in this region.

Darling Downs-Condamine

Based on projects already in place or proposed, the Darling Downs-Condamine region would be expected to host 8,823 MW of capacity.

This would come from solar projects, wind farms and bioenergy (with plants located close to existing biofuels).

The existing coal power stations in this region are Millmerran (privately owned) and Kogan Creek, Tarong A and Tarong B (all State government owned/controlled). They have a combined generating capacity of 3,450MW and average annual generation of around 23,500GWh.

The renewable energy projects identified for this region would be capable of producing around 84% of the electricity that currently comes from the coal power stations. The remaining power to replace the electricity from these coal generators would then come from other regions in Queensland.

Behind the Vision- how the figures were developed

To investigate what this transition could look like, QCC asked two Australian energy system experts to provide us with possible scenarios for 100% renewable energy in Queensland:

- Dr Ben Elliston - used powerful computer models and detailed weather maps to develop a 'desk-top' scenario of what is possible. This study found that the state could achieve a highly reliable supply of electricity based entirely on renewable energy sources within its own state, plus a modest amount of imports from NSW.
- Tristan Edis from Green Energy Markets compared Dr Elliston's model to what's already happening on the ground, plus real proposals being developed forward by clean energy companies. He essentially "ground-truthed" Dr Elliston's model to develop a more detailed scenario, based on how the energy transition is already unfolding.

Queensland Conservation Council took the information from these two reports to develop the Power Up Queensland Vision for Queensland's clean energy future.

The scenario is grounded in scientific studies, real-world research and expert calculations, so we know that it's really possible. In fact, parts of it are already happening.

No one has a crystal ball - this is just one scenario for how we could provide all our energy needs from renewables. There are many combinations of wind/solar/batteries etc that could deliver the power we need. The most important thing is to get moving and get it done, as fast as we can, to cut climate pollution, phase out dirty old coal generators and create sustainable new jobs.

Conclusion

As Edis says in his report - “We don’t have to reach a landing right now on what is the precise mix of technologies that need to be in place in ten to twenty years’ time. In many cases we can wait and see and let businesses battle it out amongst themselves as to which are the most competitive options.

But there are some decisions that need to be made sooner rather than later. The most important is that Governments need to back their grand talk and promises of addressing climate change with laws that turn these words into action.”

So now we know what's possible, how do we make it happen? It just needs political will to get on with the job, and that's where we come in! Join QCC's campaign, to [Power Up Queensland](#), make your voice heard and tell our politicians to get on board before it's too late and make a plan to phase out polluting coal power.

QCC acknowledges the traditional owners of this land and pays our respects to elders past, present and emerging.

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Further reading

[The projects that can power Queensland to a zero pollution future](#)

[Preliminary questions about 100% renewable energy in Queensland](#)

[Repower Australia Plan](#)

[Beyond Zero Emissions, Million Jobs Plan](#)