2023 Strategic Forecasting Annual Report

November 2023

START >

Part of Energy Queensland

Executive summary

The purpose of this document is to summarise the key forecasts. The report will be published on the Energex and Ergon Energy websites as part of the Queensland Government's Open Data policy.

Growth in Maximum Demand and the expansion of the network into new areas are key drivers of investment decisions leading to augmentation of the network. Electrical demand forecasts are not only undertaken at the system level but are also calculated for all zone substations and distribution feeders for a period of 10 years.

Energex system Maximum Demand growth remains relatively low (see Table 1 below), despite growth in customer numbers and commercial building activity. Annual average growth of system Maximum Demand (base case at 50 PoE level) is around 0.6% over the 2024 to 2033 period in the latest forecast model. Ergon Energy annual average growth of system Maximum Demand (base case at 50 PoE level) is expected to be approximately 0.9% over the 2024 to 2033 period in the latest forecast model.

Energy Queensland's forecasts for rooftop Solar Photovoltaic (PV), electric vehicles, battery storage systems, as well as minimum demand from the system level to distribution feeders, are summarised in Table 1. The growth and scale of solar PV installations is changing the shape of the load profile. While it is reducing maximum demand in some areas, it is having a more significant impact in reducing the minimum demand. The strong growth in distribution connected solar PV is greater in scale than growth in native demand – including Electric Vehicle charging load which is expected to grow strongly but from a low base. The forecasts incorporate an initial assessment of the possible impacts of the recent *Queensland Energy and Jobs Plan* but not the possible impacts of future tariff reform.

A ten-year energy and customer number forecasts are prepared at a system level, at customer category levels and for certain individual network tariffs. Energy forecasts are used to determine annual network losses and establish network tariff prices. The impact of Consumer Energy Resources is significant here as well, with solar PV reducing growth in the medium term before being offset by electric vehicle charging over the longer term.

System Maximum Demand (MW)

5,221
March 2023
ENERGEX

2,637
February 2023
ERGON NETWORK

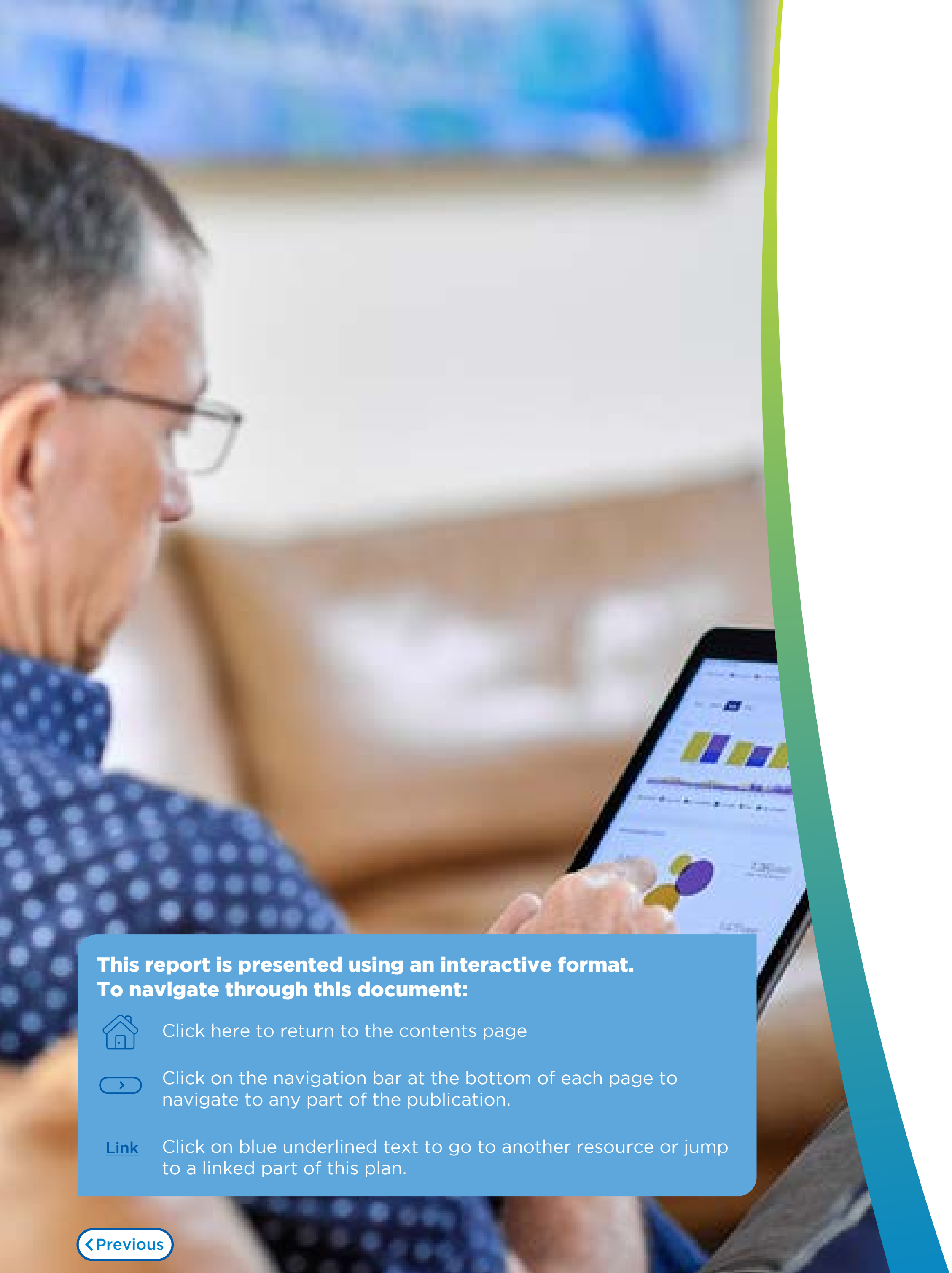
System Minimum Demand (MW)

283
April 2023
ENERGEX

799
May 2023
ERGON NETWORK

		System Maximum Demand (MW)	Energy Delivered (GWh)	Customer Numbers	Rooftop Solar PV (Inverter kVA)	Electric Vehicles (count)	Battery Storage Systems (units)	Minimum Demand (MW)
Actual	**Energex**	5,221 (March 2023)	21,708	1,566,217	3,113,071	25,554	10,352	283 (April 2023)
	Ergon Energy	2,637 (February 2023)	13,646	760,861	1,369,750	3,181	5,130	799 (May 2023)
Average annual growth forecast	**Energex 2024-33**	0.6%	0.6%	1.3%	9.6%	44.5%	14.3%	-336 MW/yr (Base Case)
	Ergon Energy 2024-33	0.9%	0.0%	0.8%	7.5%	43.7%	11.1%	-95 MW/yr (Base Case)

Table 1 Strategic forecasts summary. *Data sources: Energy Queensland internal data, Battery and Rooftop Solar PV – Distributed Energy Resource (DER) Register, Electric Vehicle – Department of Transport and Main Road*



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1. Context and challenges

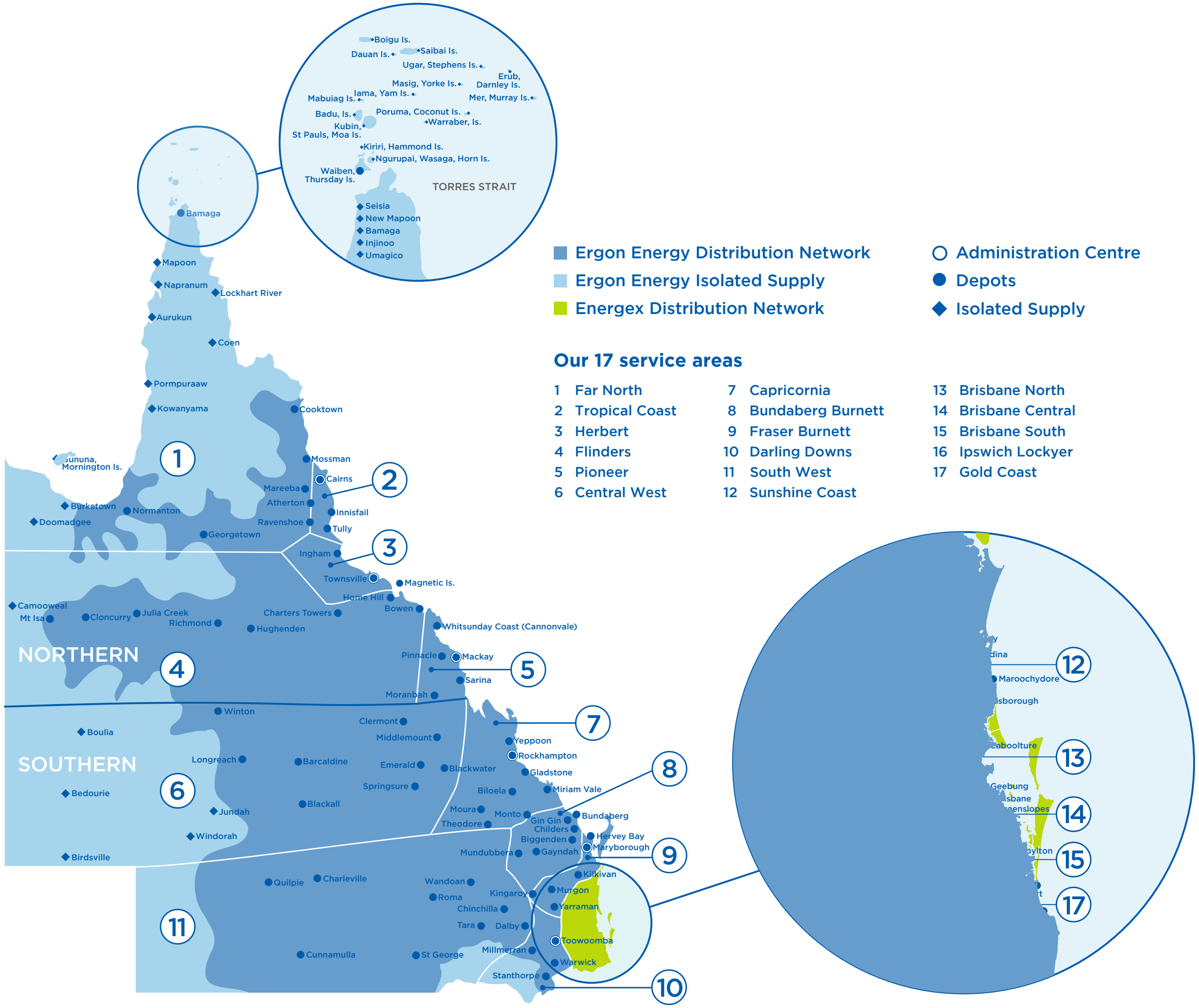
Who we are

Energy Queensland is Australia's largest, wholly government-owned electricity company.

Our 'poles and wires' businesses, Ergon Energy and Energex deliver electricity across Queensland. We supply more than five million Queenslanders through more than 200,000 kilometres of electricity networks, and 33 isolated systems. We energise Queensland communities from Tweed River to Torres Strait and from Brisbane across to Birdsville.

Around seventy per cent of Ergon Energy's network distribution is in rural Queensland. It is the largest distribution network in the National Electricity Market (NEM) and has the second lowest customer density per network kilometre. It has a proportionately high investment in sub-transmission assets, compared to the more urban distribution networks, and has one of the largest Single Wire Earth Return networks in the world.

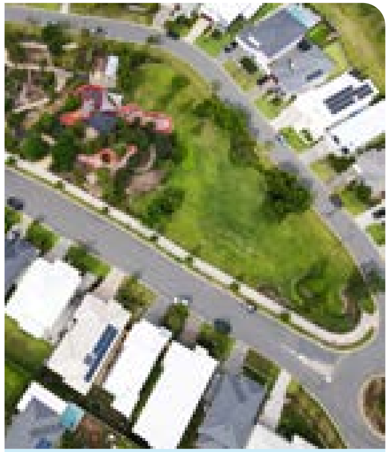
Energex's distribution network supplies electricity to Southeast Queensland, servicing high density population areas, including Brisbane Central Business District, the Gold Coast and Sunshine Coast areas, as well as the South East's extensive urban and rural areas.



- Ergon Energy Distribution Network
- Ergon Energy Isolated Supply
- Energex Distribution Network
- Administration Centre
- Depots
- Isolated Supply

Our 17 service areas

1	Far North	7	Capricornia	13	Brisbane North
2	Tropical Coast	8	Bundaberg Burnett	14	Brisbane Central
3	Herbert	9	Fraser Burnett	15	Brisbane South
4	Flinders	10	Darling Downs	16	Ipswich Lockyer
5	Pioneer	11	South West	17	Gold Coast
6	Central West	12	Sunshine Coast		



Population growth

Queensland continues to see the largest net interstate migration – currently just over 31 000 people per year. It is expected that the Brisbane 2032 Olympics may also boost the population growth towards the end of the forecast horizon with construction and other facilitation jobs in the lead up to the games.

2030 Emissions reduction and clean energy targets

The Queensland Government published the *Queensland Energy and Jobs Plan* in September 2022, setting renewable energy targets to 50 per cent 2028, 70 per cent by 2032 and 80 per cent by 2035. The emissions target forms the basis of our inputs into the maximum and minimum demand forecast.

Electrification

As more people adopt electric vehicles, we'll see an increase in the demand for charging services, which may put some extra strain on the distribution network. The anticipated shift away from gas fueled household appliances, together with industry increasingly moving toward electrification of everything for their business operations, will increase electricity's share of the total energy consumption.

Inflation

According to *Deloitte Access Economics, Business Outlook, September 2023*, the recent inflation and materials shortage headwinds have largely subsided, and they project that headline inflation will return to the Reserve Bank of Australia's 2-3 per cent target band by December 2024. Deloitte's also expects that the interest rate increases to combat inflation are close to an end, if they haven't peaked already.

Minimum Demand

The continued growth of Solar PV installations is changing the shape of the network load profile. Solar PV is in some areas, having a far greater impact in terms of reducing the minimum demand – which requires initiatives to manage stability at the network level and creates reverse flow issues at lower levels of the network. Understanding and predicting Minimum Demand presents different challenges to those experienced in the past with modelling Maximum Demand.

2. Forecast drivers

The main forecasts of Maximum Demand, energy, and customer numbers are built using projections from key drivers such as customer behaviour, economic growth, and the uptake of Consumer Energy Resources (CER – Electric Vehicles, Solar photovoltaic (PV) and Battery Energy Storage Systems). As a result, these projections are equally as important as the forecasts they are used to create.

Economic Growth

The level of economic activity is a major influence on many aspects of the electrical industry, and as a result, the Gross State Product (GSP) projections are a key driver in many of our forecasting models. In alignment with the Australian Electricity Market Operator, Energy Queensland utilises 10-year economic forecasts from *Deloitte Access Economics, Business Outlook* report.

Energy Queensland's use of those forecasts is also based on the following assumptions:

- GSP measures the aggregate economic activities throughout the whole rather than parts of Queensland.
- While GSP directly affects businesses, its influence on ordinary households is limited because electricity is a necessary service. The majority of households, regardless of their income levels, will use more electricity in the peak period of a hot day (for air conditioning), but won't use an unnecessary extra amount if temperatures are mild.

For further details on the Queensland economic environment consult the Queensland Treasury website.

Population Growth

Population growth is another indicative driver of electricity demand and can be used as a proxy for electrical appliances drivers. Queensland's population growth started to slow down in 2020, due to the initial adverse impacts of COVID-19 on the Net Overseas Migration (NOM), with the Net Interstate Migration (NIM) providing some offset. However, more recently Queensland has attracted interstate migrants - supporting overall population growth and activity. The majority of the Queensland population growth will occur in Southeast Queensland (SEQ).

Consumer Energy Resources

Solar PV, Electric Vehicles (EV), and Battery Energy Storage Systems (BESS) are being collectively referred to as "Consumer Energy Resources", to better reflect their characteristics. The current forecast incorporates the initial assessment of the possible impact the Queensland Energy and Jobs Plan released in September 2022 will have on the expected uptake of CER.

Electric Vehicles

Mainstream adoption of EVs and Plug in Hybrid Electric Vehicles (PHEVs) have the potential to increase energy and demand forecasts in the future. Currently, the uptake rate of EVs and PHEVs has not been high due to a combination of factors including the high initial cost and low availability of various vehicle types. However, it is anticipated that EV uptake is likely to have a significant increase through time as a greater variety of vehicle types are on offer in the market and the cost of EV move closer to price parity with its Internal Combustible Engine (ICE) counterpart. Therefore, the impact factored into the forecasts is low initially but increases over time with the growing population of vehicles. It is expected that most of the EV growth will be in the South east Queensland. However, EVs are not expected to provide much offset for Minimum Demand due to the differences in timing between vehicle charging and peak Solar PV generation.

Solar PV

The impact of Solar PV is based on profiles which have been constructed to predict generation (and export) for rooftop systems under the fast, base and slow scenarios. This approach enables forecasts to be produced for energy, Maximum Demand, and the native load profile.

Battery Energy Storage Systems

Customer interest in Battery Energy Storage Systems (BESS) is increasing with the number of known energy storage systems estimated to be 10,250 and 5,118 for Energex and Ergon Energy respectively, as of the end of June 2023. Forecasting the impact of batteries can prove difficult as the impact of energy storage on customer energy consumption cannot be directly metered, and there has been little high-quality data surrounding the number and size of batteries being installed. The quality of the installation data has improved with the Australian Energy Market Operator's establishing the "Distributed Energy Resources (DER) Register" (a database dedicated to the collection and sharing of PV and BESS information), although larger systems (>30 MW) still lack a centralised register.

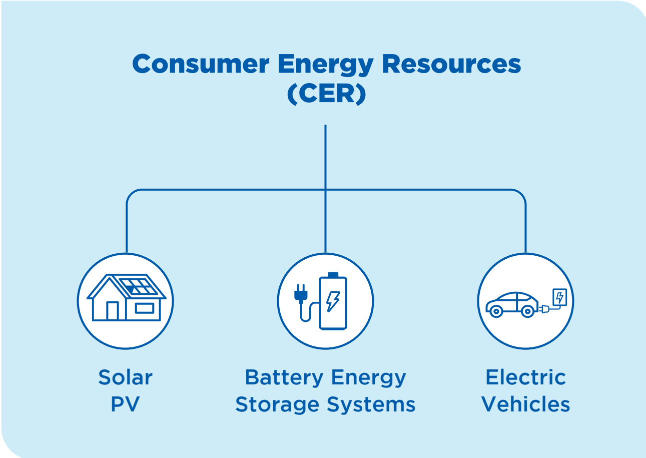
3. Forecast inputs and linkages

- The forecasts of Queensland's Economic Growth are produced by Deloitte Access Economics and are used projecting the customer numbers, Electricity Delivered and Maximum Demand forecasts.
- This year's CER forecasts were produced by Blunomy Consulting (previously known as ENEA Consulting). These forecasts were used in the Electricity Delivered, system Maximum Demand, Minimum Demand, and zone substation Maximum Demand forecasts.
- The Electricity Delivered forecasts uses the economic growth and customer number forecasts and are used as benchmark for native profile growth in the system Minimum Demand forecasts.
- The system Maximum Demand forecasts use the economic growth forecasts and are used as a reconciliation benchmark for the zone substation maximum demand forecasts.

4. Consumer Energy Resources forecasts

The amount of Consumer Energy Resources (CER – Solar PV, EVs and BESS) in the network is growing rapidly and is changing the way customers use electricity. Energy Queensland engaged Blunomy Consulting to develop a CER forecast for both networks, along with background information on the inputs, methodology, assumptions, and key changes from previous forecasts. The forecasts presented here are those available as of May 2023. Further details of the methodology can be found in the Appendix.

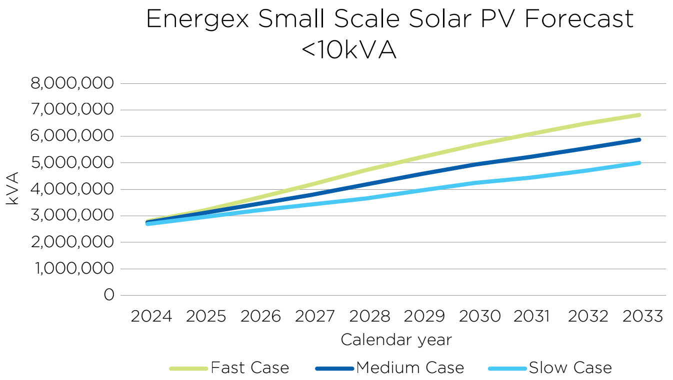
The current CER forecast aligns with the *Queensland Energy and Jobs Plan* (QEJP) to achieve its 70 per cent renewable energy target by 2032, Queensland's *Zero Emission Vehicle Strategy 2022-32* to reach a zero net emissions by 2050, and target to having 50 per cent of new passenger vehicle sales to be zero emission by 2030 and 100 per cent by 2036.



Solar PV forecast

Solar PV forecasts are important for energy forecasting and network planning.

Figure 1 demonstrates the scenario-based forecast for Solar PV panel capacity (systems with inverter size <=10kVA).



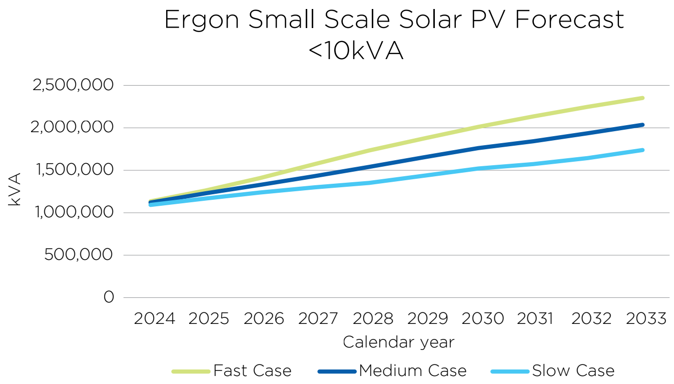


Figure 1: Solar PV forecasts by network and scenario. *Data sources: Energy Queensland internal data, Blunomy.*

Battery Energy Storage Systems forecast

BESS forecasts are important for predicting changes in the load profile at a local level. Figure 2 demonstrates the latest Energy Queensland non-network BESS forecast.

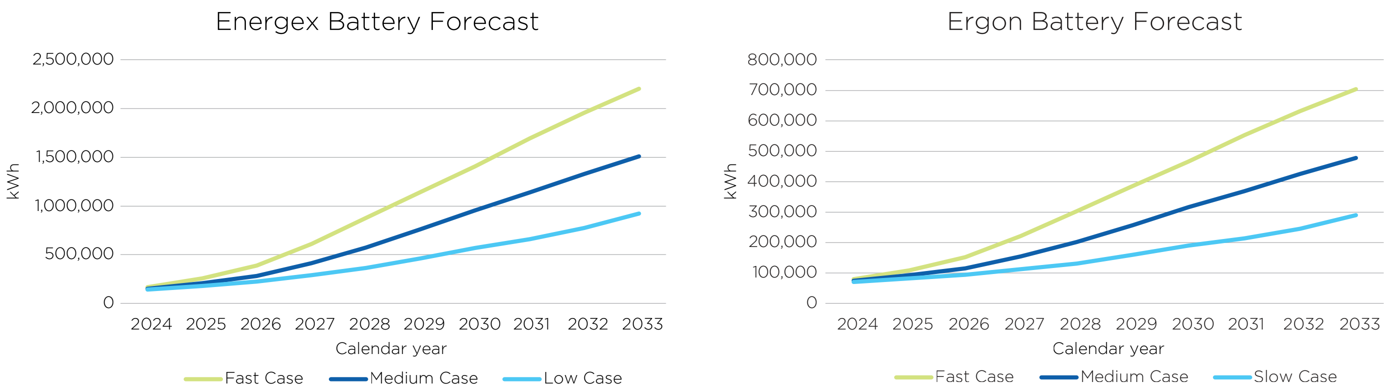


Figure 2: Battery Energy Storage Systems forecasts by network and scenario. *Data sources: Energy Queensland internal data, Blunomy.*

Electric Vehicles

EV forecasts are important for energy and Maximum Demand forecasts, as well as predicting changes in the load profile. EVs are expected to have significant growth over the next 10 years albeit from a low base – see Figure 3 below.

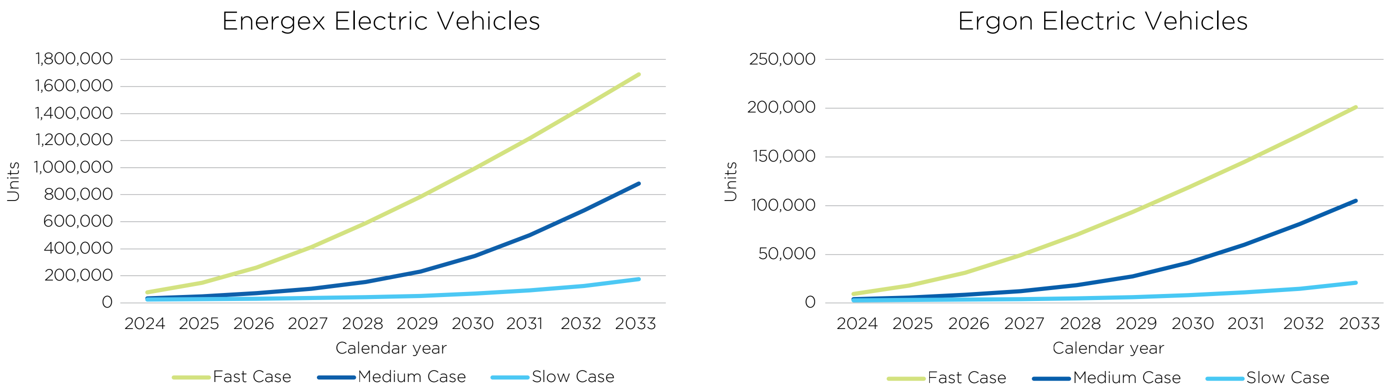


Figure 3: Electric vehicle forecasts by network and scenario. *Data sources: Energy Queensland internal data, Blunomy.*

5. Electricity Delivered forecast

Electricity Delivered is that component which is distributed via the grid and excludes sources like in-home Solar PV consumption. They are important for determining revenue and future prices. Further details of the methodology can be found in the Appendix.

Figure 4 below presents the Energex and Ergon Energy Delivered Energy scenarios over the forecast horizon.

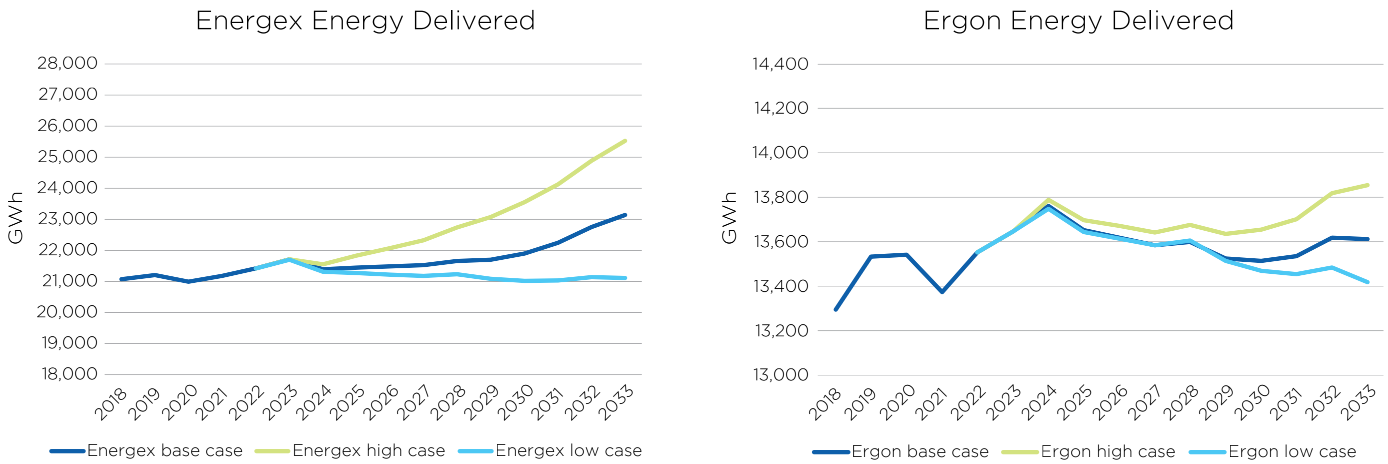


Figure 4: Energex and Ergon Energy Delivered Scenarios. *Data sources: Energy Queensland internal data, Blunomy.*

6. Customer number forecast

Customer number forecasts are a key component of the Electricity Delivered forecasts. Further details of the methodology can be found in the Appendix.

Figure 5 below presents the Energex and Ergon Energy delivered customer number forecasts by scenario over the forecast horizon.

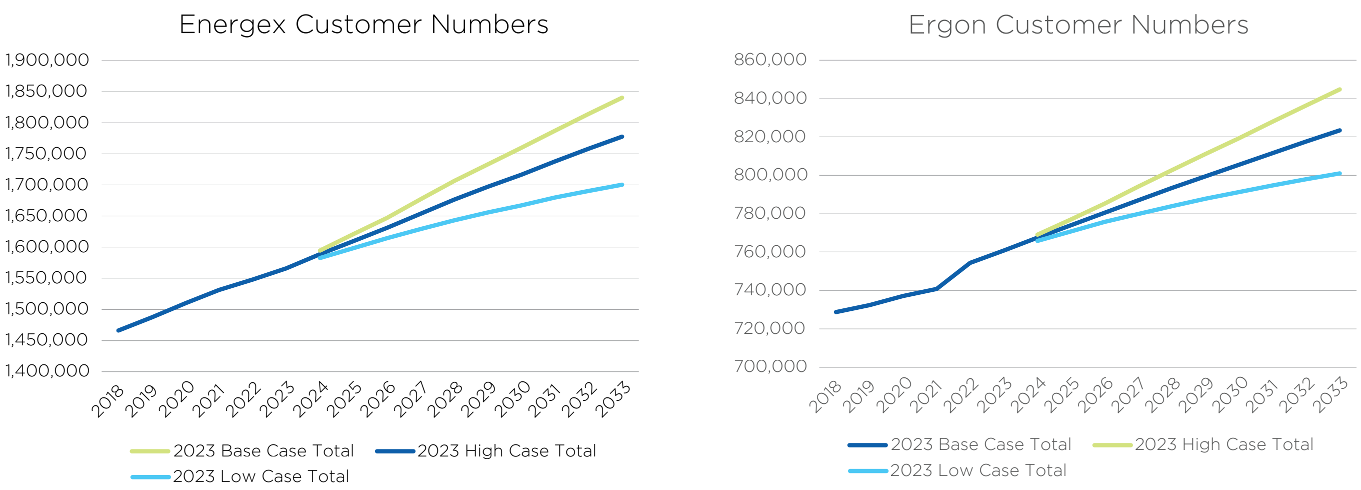


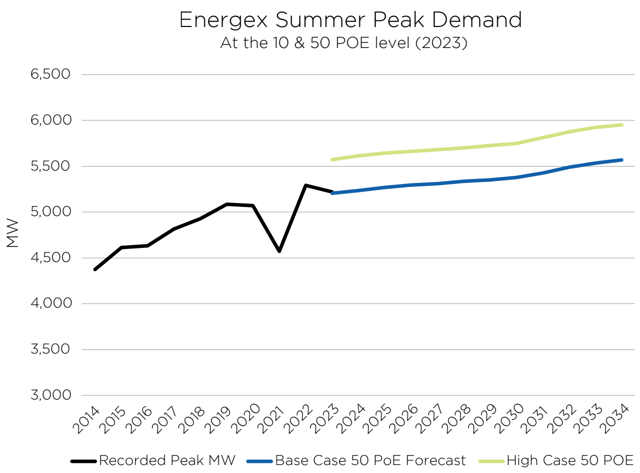
Figure 5: Energex and Ergon customer number counts. *Data sources: Energy Queensland internal data.*

7. System Maximum Demand forecast

Energex's summer system maximum of 5,221 MW occurred between 5:00 pm and 5:30 pm on 17 March 2023 as the temperature at Amberley hit a maximum of 37.5 degrees Celsius. Ergon Energy's summer system maximum of 2,637 MW occurred between 6:30 pm and 7:00 pm on the 13th of February 2023.

System maximum demand forecasts provide a measure of the overall growth of load on the network and are a key component of the zone substation demand forecasts. Further details of the methodology, and the Energex and Ergon Energy Maximum Demand days for 2023, can be found in the Appendix.

The Energex recorded Peak Demand was slightly lower than that of the previous year. Ergon Energy recorded Peak Demand was slightly higher than the previous year, with the consistency of the system peak masking areas of localised growth (See Figure 6 below).



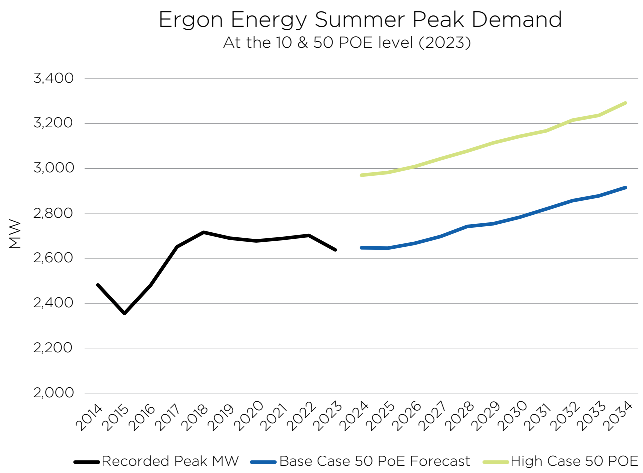


Figure 6: Energex and Ergon Energy summer Maximum Demand forecasts. *Data sources: Energy Queensland internal data.*

8. Zone substation and feeder forecasts

Zone substation and feeder Maximum Demand forecasts are used to identify emerging network limitations in the sub transmission and distribution networks, with subsequent investigations to identify the most cost-effective solution which may include increased capacity, load transfers or demand management alternatives. Further details of the methodology can be found in the Appendix.

While Maximum Demand growth at a system level is low, there is significant growth at a localised substation level (see Figure 7).

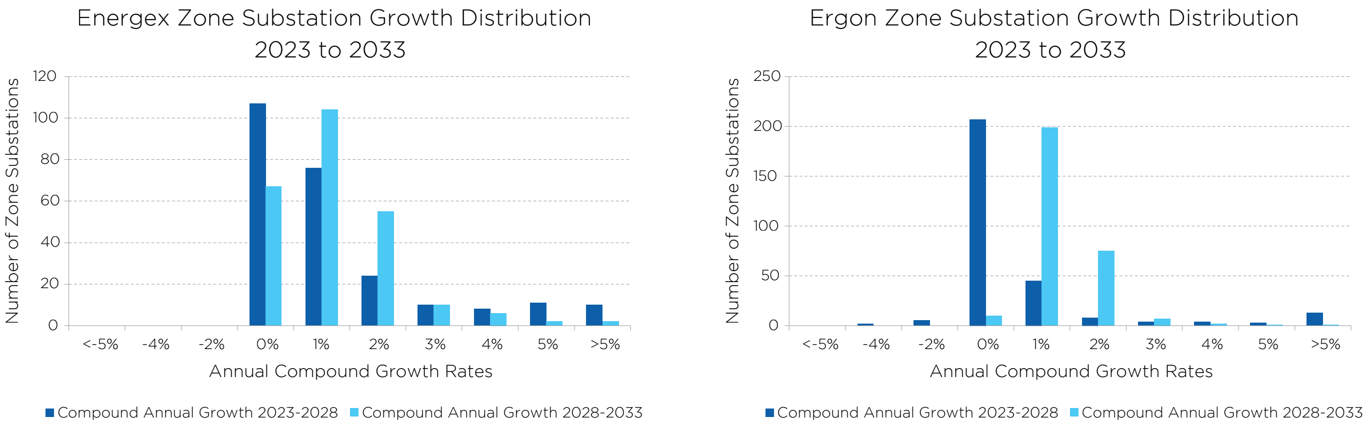


Figure 7: Energex and Ergon Energy zone substation growth distribution. *Data sources: Energy Queensland internal data.*

9. System Minimum Demand forecasts

At the time of publication, the lowest recent recorded demands for Energex and Ergon were 240 MW on 1 Oct 2023 and 692 MW on 19 August 2023 respectively – both occurring during the incomplete 2023/24 financial year. The analysis below is based on the data up to the end of the 2022/23 financial year. The sizable scale and rapid growth of Solar PV installations is changing the shape of the load profile, resulting in a significant trend decay in Minimum Demand. Minimum demand forecasts provide timely insights to ensure system stability. Further details of the methodology can be found in the Appendix section.

Energex and Ergon Energy's preliminary Minimum Demand forecasts are presented below.

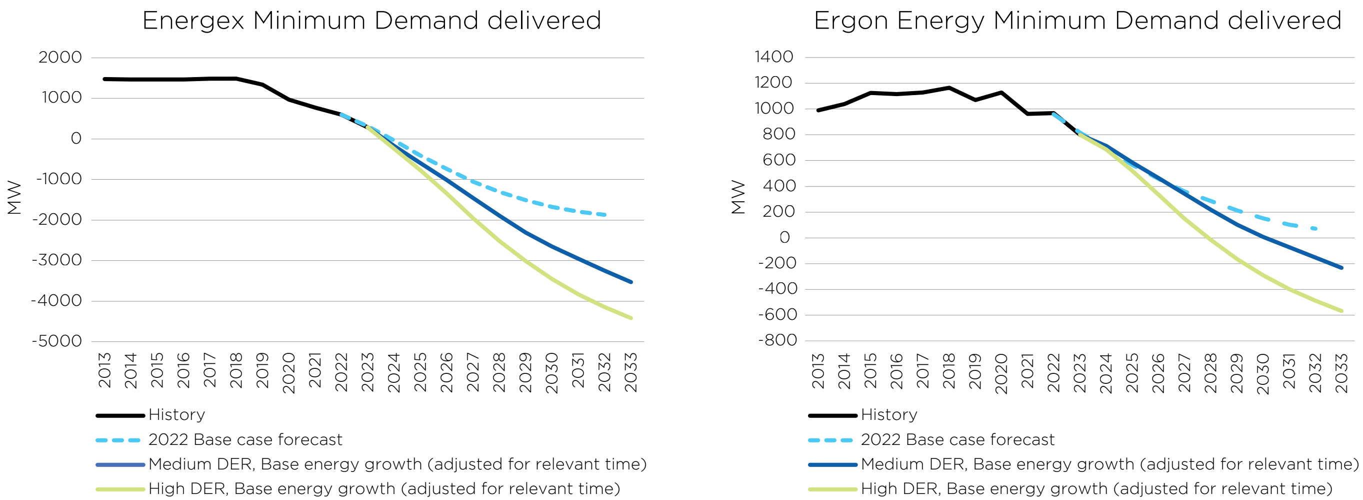


Figure 8: Energex and Ergon Energy Minimum Demand delivered. *Data sources: Energy Queensland internal data.*

In the early years of Solar PV, substantial growth in Solar PV capacity had little impact on the network, as the scale of demand was in orders of magnitude greater than the Solar PV generation. While variations in demand growth still have an impact on the Minimum Demand, the scale of Solar PV generation has made it the major influence on Minimum Demand. The declining trend for Minimum Demand is the net result of the interaction between the forecast growth in Solar PV capacity and the underlying forecast growth in demand.

10. Appendix – forecast methodology & commentary

Definitions

Battery Energy Storage System (BESS)

Electrical Battery Energy Storage Systems. It is assumed that battery storage will primarily be charged by Solar PV and discharged over the late afternoon and early evening period between 4pm and 8pm.

Consumer Energy Resources (CER) / Distributed Energy Resources (DER)

Consumer Energy Resources / Distributed Energy Resources is the name given to a wide range of technologies commonly located at houses or businesses – such as rooftop Solar PV, battery storage, thermal energy storage, Electric Vehicles and chargers, and home energy management technologies

Electricity / Energy Delivered

Within the electricity industry, "Electricity" Delivered/ consumed is frequently referred to as simply "Energy" Delivered/consumed. Electricity/Energy delivered in this report refers to the component in which is distributed via the grid and excludes sources like in-home Solar PV consumption.

Electric Vehicle (EV)

Electric Vehicles are battery electric and Plug in Hybrid Vehicles.

Maximum Demand / Peak Demand

The terms can be used interchangeably. Peak Demand occurs when the community's electricity use is at its highest. This usually happens between 4pm – 8pm on our hottest, summer days.

Minimum Demand / Negative Peak Demand

Negative Peak Demand or Minimum Demand happens when energy flows away from customers are greater than energy flowing towards them. This is typically caused when rooftop solar and storage matches or exceeds demand on the network. This usually happens between 10am and 2pm on clear, sunny days during spring and autumn, particularly on weekends or public holidays. For further information see AEMO factsheet.

Probability of Exceedance (POE)

"Probability of Exceedance" is a measure for the natural variation in Maximum Demand due to factors like (but not limited to) weather. The 10 POE value is the extreme season benchmark where maximum demand is high and could only be expected to equal or exceed that level with a 10 per cent probability. A 50 POE is an average season benchmark, with a 50 per cent chance that the season's Maximum Demand will equal or exceed that mark.

Solar Photovoltaic (PV)

Generally, analysis of solar PV excludes the large-scale solar farms, which are treated as embedded generators.

Abbreviations

ABS	Australian Bureau of Statistics
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
BEV	Battery Electric Vehicle
BOM	Bureau of Meteorology
CER	Consumer Energy Resource
DER	Distributed Energy Resource
DM	Demand Management
DNSP	Distribution Network Service Provider
EV	Electric Vehicle
GSP	Gross State Product
HV	High Voltage
ICE	Internal Combustion Engine
kVA	Kilovolt ampere
MW	Megawatt
PHEV	Plug in Hybrid Electric Vehicle
POE	Probability of Exceedance
PV	Photo-voltaic
QEJP	Queensland Energy and Jobs Plan
SA2	Statistical Area 2 – medium sized general purpose areas representing a community that interacts together socially and economically
SCADA	Supervisory Control and Data Acquisition

Consumer Energy Resource (CER)

The forecasts produced by Blunomy utilise a combination of input scenarios and are detailed below.

CER/DER Scenario	Population and Economic Growth	Household Income Growth (applies to small customers only)	Energy Prices	Technology Cost Decline	Guiding Themes
Slow	Slow	Slow	Higher	Slow	Slow change, with delayed net zero.
Medium	Central	Central	Central	Central	70% Renewable energy by 2032. Net zero by 2050, in line with existing federal and state policies.
Fast	Fast	Fast	Lower	Fast	Accelerated decarbonisation bring net zero achievements forwards, with potential step change in technology.

Table 2: Blunomy scenarios

The CER forecast is based on the assumptions are set out below.

Assumptions	
Customers	• Customers are grouped into residential and small and large business by their tariffs using data coming from our network billing system.

Solar PV	• Solar PV update is primarily driven by technology costs, income and population.
	• CSIRO GenCost 2021-22 for small-scale rooftop solar PV price forecast; Solar Choice Solar Price Index March 2023 for historical solar PV cost data.
	• Household Income obtained from Australian Bureau of Statistics 2019 and uplifted by economic growth projections from *Deloitte Access Economics, Business Outlook, December 2022*.
	• Energy Queensland DER Register historical data for installations.
	• 0.5 per cent per-annum degradation factor is used for solar PV systems.
	• Categories were segmented by size
	  • Small residential <=10kVA, >10 & <=30kVA, >30kVA & <= 1.5MVA;
	  • Small business <= 10kVA, >10 & <=30kVA, >30kVA & <= 1.5MVA;
	  • Large business <= 10kVA, >10 & <=30kVA, >30kVA & <= 1.5MVA; and
	  • Industrial segments were aggregated due to small sample sizes.

BESS (behind the meter)	• Batteries will only be installed with new Solar PV systems, or as a retrofit to an existing Solar PV system. • Battery uptake is forecast as a function of Solar PV uptake. • BESS technology costs from CSIRO Small-scale Solar and Battery projections 2022 and Solar Choice. • Historical energy prices obtained from AER and forecast based on AEMO ESOO 2022. • VPP benefits assume upfront subsidy of $1250, payback of $200 per year and FIT of 9.8c/kWh. • Network batteries have been excluded. • Energy Queensland DER Register historical data for installations. • A 2 per cent per-annum degradation factor is used for Battery Energy Storage System charging capacity. • 6 per cent of EV batteries will be recycled, 50 per cent of which will be repurposed as BESS based on 10-year lifespan
EV	• Electric Vehicle forecast includes: Battery Electric (BEV), Plug-in Hybrid (PHEV) and Electric Motorbikes. • EV technology costs from CSIRO EV projections 2021 and 2022, Budget Direct cost of owning a motorcycle. • Population as per Solar PV assumptions. • Residential customers will only own motorcycles, passenger vehicles, and light commercial vehicles/vans (which include utility vehicles, or utes). Business customers could also own trucks and buses. • Electric Vehicles will account for 50 per cent of all new vehicle sales once price parity is achieved. After price parity, EV sales will continue to grow in market share as uptake progresses along the technology adoption curve and the number of ICE vehicles available on the market decreases. • The forecast distribution of Electric Vehicle uptake is based on historical EV stock at the suburb level. • No change in propensity to own a vehicle over time.

Table 3: Assumptions used for the CER forecast

The CER Forecasts used for the system and substation forecasts for Energex and Ergon Energy are detailed respectively below.

Energex Distributed Energy Resources forecasts by scenario										
Energex Medium Scenario										
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Battery (kWh)	151,582	208,363	283,255	412,723	575,063	760,308	955,540	1,138,036	1,329,286	1,508,380
Electric Vehicle (count)	33,462	48,986	72,163	105,140	154,357	231,490	347,732	501,868	683,357	883,694
Solar PV Inverter (kVA)	3,434,442	3,920,319	4,398,894	4,883,781	5,409,355	5,921,873	6,396,982	6,766,128	7,152,388	7,549,723
Energex Fast Scenario										
Battery (kWh)	165,448	256,680	389,357	610,469	876,518	1,143,993	1,408,120	1,695,222	1,955,303	2,205,267
Electric Vehicle (count)	77,823	150,752	263,259	413,076	589,573	785,395	995,793	1,217,786	1,449,379	1,689,373
Solar PV Inverter (kVA)	3,489,252	4,055,897	4,710,627	5,429,358	6,145,305	6,780,421	7,368,793	7,890,824	8,353,602	8,760,746
Energex Slow Scenario										
Battery (kWh)	140,495	178,990	224,185	290,648	361,718	463,953	569,076	660,896	773,908	923,134
Electric Vehicle (count)	23,921	27,616	31,295	36,186	43,060	53,369	69,236	92,705	126,636	176,871
Solar PV Inverter (kVA)	3,336,761	3,700,593	4,049,038	4,373,619	4,665,914	5,076,545	5,456,601	5,706,722	6,023,803	6,396,414

Note – There are minor variations between the charts and the table data due differences in the method aggregation.

Table 4: Energex CER forecasts by scenario. *Data sources: Energy Queensland internal data, Blunomy.*

Ergon Energy Distributed Energy Resources forecasts by scenario										
Ergon Energy Medium Scenario										
	2024	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**
Battery (kWh)	75,065	92,944	115,372	154,133	202,352	257,607	315,759	368,936	425,256	478,193
Electric Vehicle (count)	3,852	5,684	8,439	12,387	18,280	27,499	41,348	59,683	81,268	105,104
Solar PV Inverter (kVA)	1,474,034	1,634,910	1,784,875	1,933,052	2,095,364	2,252,515	2,397,029	2,505,644	2,624,230	2,749,901
Ergon Energy Fast Scenario										
Battery (kWh)	79,988	109,377	151,481	221,314	303,805	385,641	466,086	553,299	631,679	703,550
Electric Vehicle (count)	9,190	17,887	31,271	49,076	70,065	93,361	118,400	144,827	172,400	200,974
Solar PV Inverter (kVA)	1,495,848	1,688,268	1,907,139	2,143,654	2,373,885	2,571,596	2,752,963	2,913,044	3,055,484	3,181,565
Ergon Energy Slow Scenario										
Battery (kWh)	70,824	82,032	94,444	112,333	130,688	159,748	189,686	214,284	245,916	290,249
Electric Vehicle (count)	2,702	3,106	3,524	4,086	4,886	6,100	7,988	10,792	14,855	20,870
Solar PV Inverter (kVA)	1,433,019	1,543,449	1,642,623	1,730,580	1,806,944	1,930,590	2,044,309	2,113,196	2,210,027	2,329,579

Note – There are minor variations between the charts and the table data due differences in the method aggregation.

Table 5: Ergon Energy CER forecasts by scenario. *Data sources: Energy Queensland internal data, Blunomy.*

Customer number forecast

Energex

Annual new customer connections, predominantly driven by domestic customers, grew by 1.4 per cent per annum over the 2018–2021 period, helped by the increased long term overseas arrivals and the increased construction of new houses and apartments. The number of new connections slowed over 2021/22 & 2022/23, with 1.1 per cent & 1.2 per cent growth respectively – which can be attributed to adverse COVID-19 impacts compounded by the slowing construction of housing and apartments. However, as the COVID-19 impacts diminish, new connections are expected to recuperate to 1.4 per cent in 2023/24 and stabilise around 1.3 per cent per annum over the subsequent years to 2032/33. The increase will be driven by continued buoyant overseas immigration, the upward housing market and growth in GSP.

Ergon Energy

Within the Ergon Energy network, annual new customer connections averaged 0.6 per cent from 2018 to 2021. Like Energex, COVID-19 had some impacts but anecdotally, it appears that the increased ability to work remotely is creating more opportunities in regional areas – supporting customer retention/growth – but more time is needed before any longer-term trend differences can be determined. The annual growth rate in new connections is forecast to hover around 0.8 per cent over the forecast horizon out to 2033.

Electricity delivered forecast

Energex

Energex Low, Base, and High case electricity delivered forecasts are presented in Table 6 below.

Scenario	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Low (GWh)	21708	21312	21268	21225	21184	21230	21084	21018	21036	21145	21119
Base (GWh)	21708	21393	21453	21487	21525	21661	21701	21903	22247	22755	23148
High (GWh)	21708	21554	21839	22070	22329	22743	23081	23560	24133	24890	25530

Table 6: Energex's Base, High and Low case Electricity Delivered Forecasts (GWh). *Data sources: Energy Queensland internal data, Blunomy.*

Ergon Energy

Ergon Energy's Low, Base, and High case electricity delivered forecasts are presented in Table 7 below.

Scenario	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Low (GWh)	13646	13748	13643	13613	13584	13605	13513	13469	13455	13485	13419
Base (GWh)	13646	13760	13652	13618	13585	13599	13525	13513	13536	13618	13612
High (GWh)	13646	13788	13698	13670	13642	13676	13634	13654	13702	13819	13854

Table 7: Ergon's Base, High and Low case Electricity Delivered Forecasts (GWh). *Data sources: Energy Queensland internal data, Blunomy.*

System Maximum Demand forecast

Energy Queensland reviews and updates its ten-year 50 PoE and 10 PoE system summer and winter Maximum Demand forecasts after each summer season. Each new forecast is used to identify emerging network limitations in the sub-transmission and distribution networks via the substation Maximum Demand forecast reconciliation process.

The system Maximum Demand forecast model uses the latest data (and forecasts where relevant) for:

- weather data (source: Bureau of Meteorology).
- population (source: Deloitte Access Economics).
- economic activity via Gross State Product Forecast (source: Australian Bureau of Statistics and *Deloitte Access Economics, Business Outlook, March 2023*.
- Consumer Energy Resources (Solar PV, EV and BESS – via customer installation data and Blunomy. Source: *Energy Queensland, Distributed Energy Resource Register, Blunomy*).
- historical electrical load data (Source: Corporate SCADA/Metering database).

Hot weather remains one of the main drivers of load variation within a season due to temperature sensitive loads such as air-conditioning and refrigeration. Weather patterns have moved from extreme drought in 2009, to flooding and heavy rain, to extended hot conditions, and most recently La Nina coinciding with the impact of COVID-19.

Historically, temperature was the major variable on peak demand (after systematic factors such as time of day and day of year). However, the scale of solar PV generation means that cloud cover can create variations in generation output (thereby changing the source of supply to Powerlink) greater than what would be seen from temperature changes.

The summer and winter 50% PoE values have been calculated to illustrate the underlying network growth. It should be noted that these figures are derived from each year's model, as such, yearly comparisons of the temperature corrected demands should only be made using a series of numbers from the same model.

Energex

Summer Maximum Demands over the 2022/23 – 2032/33 period are forecast to increase with an annual average growth rate of 0.6 per cent, reaching 5,535 MW in 2032/33.

Table 8 below lists the Maximum Demand forecasts over the next ten years.

Base Scenario Forecast	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33
Summer (50% PoE) (MW)	5,235	5,269	5,295	5,311	5,335	5,350	5,377	5,427	5,491	5,535
Growth (%)		0.7%	0.5%	0.3%	0.4%	0.3%	0.5%	0.9%	1.2%	0.8%
Summer (10% PoE) (MW)	5,614	5,642	5,661	5,681	5,699	5,724	5,749	5,813	5,875	5,924
Growth (%)		0.5%	0.3%	0.4%	0.3%	0.4%	0.4%	1.1%	1.1%	0.8%
Base Scenario Forecast	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**	**2030-31**	**2031-32**	**2032-33**
Winter (50% PoE) (MW)	4,246	4,316	4,398	4,460	4,513	4,562	4,616	4,683	4,760	4,851
Growth (%)		1.6%	1.9%	1.4%	1.2%	1.1%	1.2%	1.5%	1.6%	1.9%
Winter (10% PoE) (MW)	4,106	4,161	4,229	4,291	4,333	4,379	4,432	4,489	4,559	4,640
Growth (%)		1.3%	1.7%	1.5%	1.0%	1.1%	1.2%	1.3%	1.6%	1.8%

Table 8: Energex Maximum Demand forecasts (MW). *Data sources: Energy Queensland internal data.*

The 2022-23 Energex summer system maximum of 5,221 MW occurred between 5:00 pm and 5:30 pm on 17 March 2023 as the temperature at Amberley hit a maximum of 37.5 degrees celsius (see Figure 9). There was a slight decrease over last year's peak. Figure 9 demonstrates how the maximum would have been 548 MW higher without PV generation.

Ergon Energy

Summer maximum demands over the 2022/23 – 2032/33 period are forecast to increase with an annual average growth rate of 0.9 per cent, reaching 2,877 MW in 2032/33 summarises the Maximum Demand forecasts over the next ten years for the 50 PoE and 10 PoE cases.

Table 9 below lists the Maximum Demand forecasts over the next ten years.

Base Scenario Forecast	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33
Summer (50% PoE) (MW)	2647	2645	2667	2698	2741	2754	2783	2819	2856	2877
Growth (%)		-0.1%	0.8%	1.2%	1.6%	0.5%	1.1%	1.3%	1.3%	0.7%
Summer (10% PoE) (MW)	2970	2982	3008	3043	3077	3114	3143	3167	3215	3236
Growth (%)		0.4%	0.9%	1.2%	1.1%	1.2%	1.0%	0.8%	1.5%	0.6%
Base Scenario Forecast	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**	**2030-31**	**2031-32**	**2032-33**
Winter (50% PoE) (MW)	2251	2257	2272	2290	2316	2336	2371	2392	2422	2451
Growth (%)		0.3%	0.7%	0.8%	1.1%	0.9%	1.5%	0.9%	1.2%	1.2%
Winter (10% PoE) (MW)	2575	2580	2598	2617	2653	2682	2716	2736	2762	2800
Growth (%)		0.2%	0.7%	0.7%	1.4%	1.1%	1.3%	0.7%	0.9%	1.4%

Table 9: Ergon Energy Maximum Demand forecasts (MW). Data sources: Energy Queensland internal data.

The 2022-23 Ergon Energy summer system maximum of 2,637 MW between 6:30 pm and 7:00 pm on the 13th of February 2023. Figure 9 demonstrates how the maximum would have been 23 MW higher without PV generation.

CER Impact

While the growth of Solar PV generation has reduced the midday network load, the peak is relatively unimpacted as it occurs close to sundown. Looking forward, system Maximum Demands are expected to occur outside of the Solar PV generation times, and as a result the continued growth of Solar PV will not have any real effect on the annual peaks in future years.

CER is also having a growing influence and the tables below detail the anticipated impacts that have been incorporated into Energex's and Ergon Energy's summer Maximum Demand forecasts.

Forecast CER impact on Energex maximum demand	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Solar PV Capacity impact on System Maximum Demand (MW)	-628	-715	-261	-289	-320	-350	-377	-398	-421	-444
Electric Vehicle Load impact on System Maximum Demand (MW)	7	11	19	28	41	62	94	135	183	233
Battery Energy Storage Systems Load impact on System Maximum Demand (MW)	-7	-9	-12	-13	-16	-19	-23	-26	-30	-33

Table 10: Energex Solar PV, Electric Vehicles and Battery contribution to summer Maximum Demand. *Data sources: Energy Queensland internal data.*

Forecast CER impact on Ergon Energy maximum demand	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Solar PV Capacity impact on System Maximum Demand (MW)	-9	-	-7	-	-	-	-39	-18	-	-13
Electric Vehicle Load impact on System Maximum Demand (MW)	1	1	2	2	4	4	6	9	16	16
Battery Energy Storage Systems Load impact on System Maximum Demand (MW)	-3	-4	-3	-4	-3	-5	-6	-6	-6	-7

Table 11: Ergon Energy Solar PV, Electric Vehicles and Battery contribution to summer Maximum Demand. *Data sources: Energy Queensland internal data.*

As battery energy storage becomes more affordable and therefore more widely used, daily peaks may revert to mid-to-late afternoons, as less PV generation is exported in preference for re-charging storage batteries.

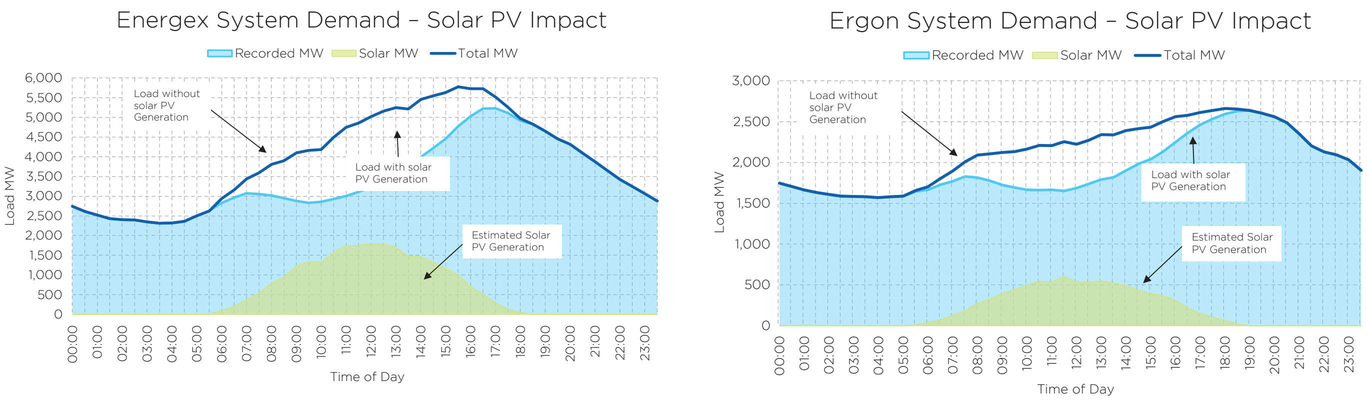


Figure 9: Energex and Ergon Energy system demands - Solar PV impact. *Data sources: Energy Queensland internal data, Distributed Energy Resource Register, Weatherzone.*

The cumulative PV generating capacity has resulted in daily load profiles that exhibit a 'hollowed out' pattern, and reduced afternoon Maximum Demand in several areas. While Battery Energy Storage could offset this trend, the scale of Solar PV generation connected to the network is orders of magnitude greater than the available storage.

A complex relationship exists between increases in PV generation capacity and the need for network augmentation expenditure. Solar PV may reduce Maximum Demand in some areas but not in others, depending on the shape of the load profile. For example, Lota zone substation is located east of Brisbane and has predominately residential customers (evening peaking profiles). In this case, the maximum is unaffected by Solar PV despite it reducing afternoon load – see Figure 10 below.

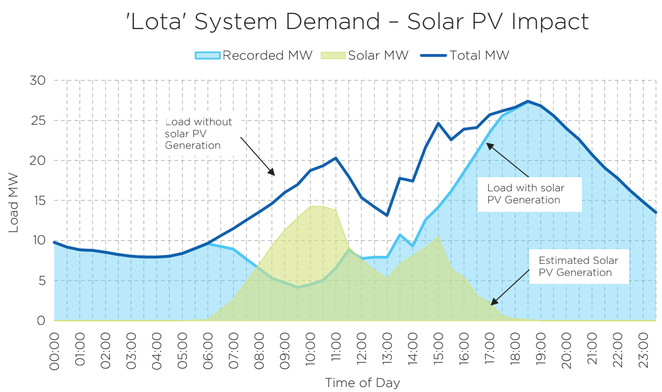


Figure 10: Lota without Solar PV Maximum Demand impact. *Data sources: Energy Queensland internal data, Distributed Energy Resource Register, Weatherzone.*

System Minimum Demand forecast

The sizable scale and rapid growth of Solar PV installations is changing the shape of the load profile (see the Energex system profile in Figure 11 for an example) and reducing Minimum (delivered) Demand.

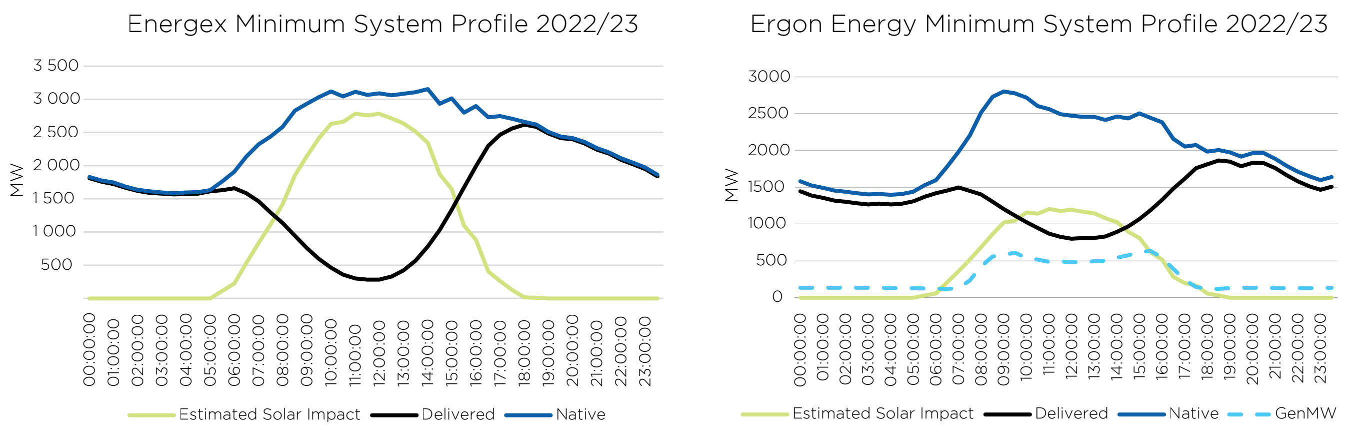


Figure 11: Energex and Ergon Energy minimum system profiles for 2022/23. Data sources: Energy Queensland internal data, Distributed Energy Resource Register

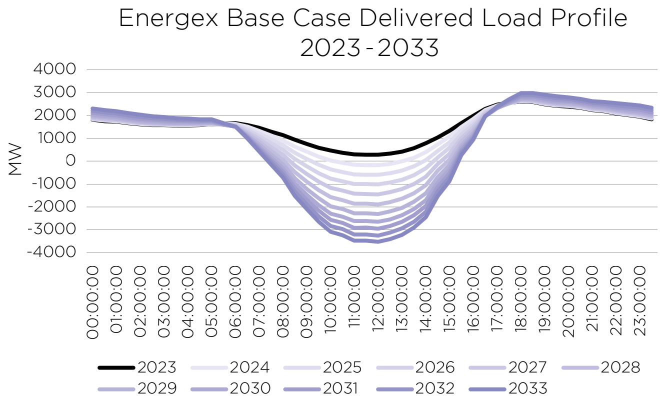
The impact affects the distribution network at multiple levels, all of which affect CAPEX expenditure:

- Market/system level – can cause oversupply during the middle of the day.
- Zone Substation level – cyclic issues due to reverse flow may reduce the life of zone substation transformers.
- At a feeder level, stability of individual feeders could be impacted by voltage fluctuations which, in turn, impact protection settings at a feeder level.

The forecasts highlight the decline in Minimum delivered Demand, suggesting that even in the base case Energex and Ergon Energy could hit a negative demand by 2023/24 and 2030/31 respectively (See Figure 8). This reduction is due to the forecast growth in distribution connected Solar PV, overshadowing the ongoing growth in native demand (including EV charging load), at the time of Minimum Demand, over the forecast horizon. The scale of connected Solar PV also increases the "ramp rate", a separate challenge created where cloud cover rapidly reduces Solar PV generation and increases the need for demand from traditional synchronous generators on days of possible high loads.

The growth in distribution connected Solar PV is overshadowing the ongoing growth in native demand including EV charging load causing a decline in Delivered Energy (on the Minimum Demand days) – see Figure 12 below.

The methodology used to calculate Minimum Demands at the system, transmission connection point, bulk supply point, zone substation and distribution feeder level is different to that used to calculate Maximum Demand forecasts, in that it is calculated without temperature correction and the minimums calculated at lower levels of the network are not reconciled to a system minimum forecast.



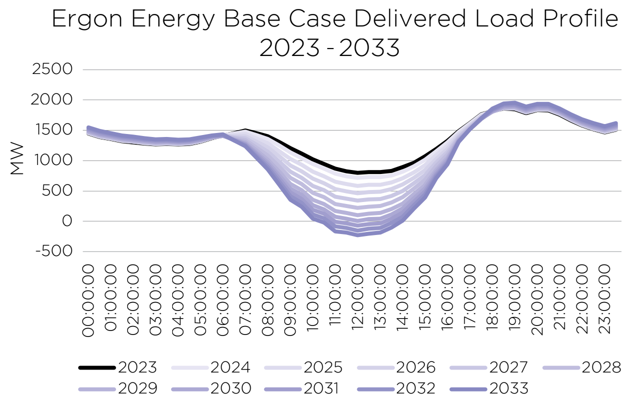


Figure 12: Energex and Ergon Energy impacts of CER on Delivered Energy. *Data source: Energy Queensland internal data, Consumer Energy Resource Blunomy*

Zone substation and feeder forecasts

Maximum Demand

The ten-year substation Maximum Demand forecasts for summer and winter are prepared at the end of summer and are modelled for both existing and proposed substations.

The forecasts are based upon several inputs, including:

- Historical electrical load data *(Source: Energy Queensland)*
- Weather data from 5 sites in Energex and 42 for Ergon Energy *(Source: Bureau of Meteorology)*
- Proposed future developments (new major customers, network augmentation, etc.) *(Source: Energy Queensland)*
- Consumer Energy Resources uptake (Solar PV, EV and BESS) *(Source: Distributed Energy Resource Register, Blunomy)*
- Demand Management initiatives *(Source: Energy Queensland)*
- Network topology *(Source: Energy Queensland)*
- Forecast growth rates for zone substation demand organic growth *(Source: Energy Queensland)*
- System Maximum Demand forecasts (at the zone substation level) *(Source: Energy Queensland)*.

The growth rates are derived from the aggregation of profiles for residential, non-residential and Consumer Energy Resources (Solar PV, EV, and BESS). CER profile growth rates are based on growth in the uptake of CER.

Residential growth rates are based on ABS population growth forecasts at the SA2 level. With each zone substation's growth weighted according to its share of the relevant SA2 areas that it supplies and recent historical growth at the zone substation. So for a SA2 level with growth, it is assumed the growth will continue at zone substations already seeing growth at greater rate than zone substations with stagnate growth. Non-residential growth does not follow residential's growth pattern, as a result, population forecasts are not a good predictor of non-residential growth as non-residential load is not closely related to an area's population growth and the load associated with new non-residential customers tends not to be closely related to the area's existing customers' load.

Most recently a more sophisticated forecasting process was developed for those substations which do not have a significant temperature/demand relationship (e.g. industrial/rural). This is key to determining the probability of significant loads on shared assets.

The bottom-up zone substation Maximum Demand forecast is reconciled with the system level Maximum Demand forecast, after allowances for network losses and diversity of maximum loads. This process accounts for drivers which only become significant at the higher points of aggregation (e.g., economics and demographic factors), while also enabling investment decisions to be based on local factors.

The latest forecasts have predicted a range of demand growth rates, with many established areas remaining static while other areas like the northern Gold Coast, and the southern Sunshine Coast growing strongly.

Within the Energex distribution network over the 2023-28 period, the percentage compound growth rates at the zone substation level were:

43% of substations have an annual compound growth rate at or below 0 per cent

41% have an average annual compound growth rate between 0 per cent and 2 per cent

12% have an average annual compound growth rate between 2 per cent and 5 per cent

4% of zone substations have an annual compound growth rate exceeding 5 per cent.

Within the Ergon Energy distribution network over the 2023-28 period, the percentage compound growth rates at the zone substation level were:

74% of substations have an annual compound growth rate at or below 0 per cent

18% have an average annual compound growth rate between 0 per cent and 2 per cent

4% have an average annual compound growth rate between 2 per cent and 5 per cent

4% of zone substations have an annual compound growth rate exceeding 5 per cent.

Minimum Demand

The Minimum Demand forecast is used to predict the annual decay rate of the loads at each of the Transmission Connection Points, Bulk Supply, Zone Substation and Distribution Feeders across the network.

The key drivers for Minimum Demand forecasts are:

- Customer numbers
- Solar PV capacity
- Battery storage capacity
- Electric Vehicle count

Historical load analysis is done to detect and filter outliers and faulty load data, with the automated segmentation detecting unplanned load switch or load transfers. Many of the distribution feeders do not record direction of the power flow, so reverse power flows are detected with a machine learning model.

The load profile of the minimum recorded day is used as the base profile to construct the Minimum Demand forecast. Future profiles are predicted from the aggregation of profiles for residential, non-residential and the uptake of CER within the base, high and low case scenarios.

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