Victorian electricity sector renewable energy transition

Economic impacts modelling

A report for the Victorian Department of Environment, Land, Water and Planning

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Disclaimer

Executive summary

Victoria's renewable energy transition is well underway and its pace has exceeded expectations.

The percentage of energy generated from renewable resources in Victoria has increased from about 12% in 2013/14 to 34% in 2021/22, comfortably beating the Government's first renewable energy target of 25% by 2020.

In recognition that the pace of Victoria's electricity market transformation has exceeded expectations, the Victorian Government has announced an increased renewable energy target of 65% by 2030 and a new renewable energy target of 95% by 2035.

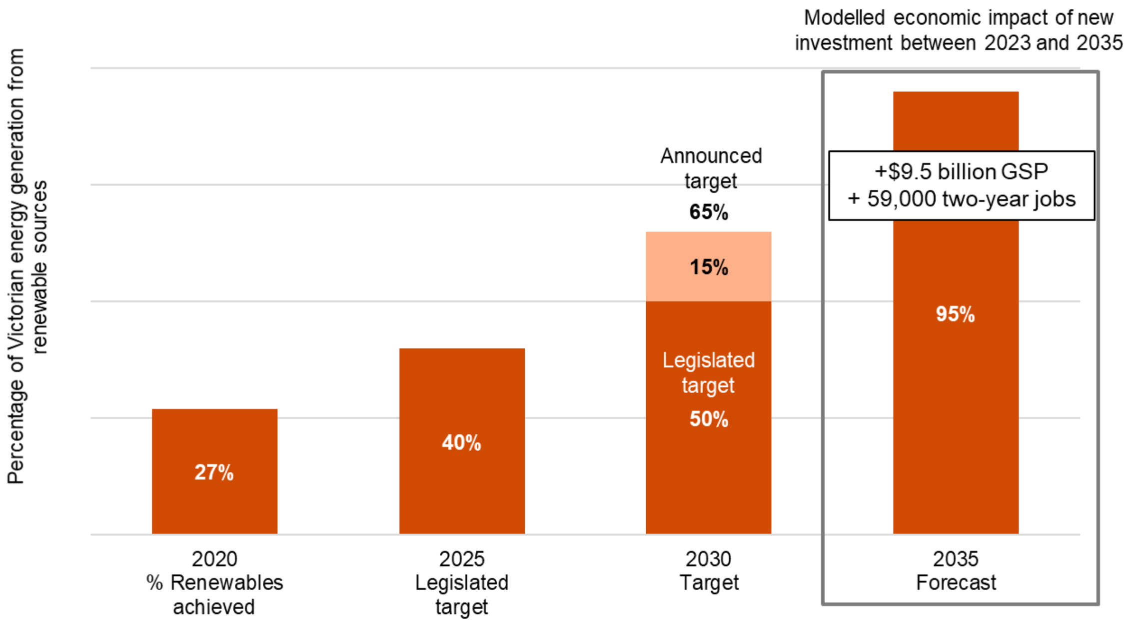
PwC was engaged by the Department of Environment, Land, Water and Planning to assess the potential economic impact of a more rapid transition to renewable energy generation going forward.

Our analysis, using input-output modelling (I-O), found that accelerating the energy transition to achieve 95% renewable energy supply in Victoria by 2035 would add about **$9.5 billion to GSP on a gross basis and generate an additional 59,214 jobs over that horizon**[1] as shown in Figure 1.

With the energy sector accounting for 70% of Victoria's total greenhouse gas emissions in 2019, the transition to 95% renewable energy is essential in order for Victoria to achieve its legislated target of net zero emissions by 2050.

Our analysis shows this transition will also generate significant economic activity through the delivery of major renewable energy generation and storage infrastructure.

Figure 1 Estimated economic impact of new investment in renewable energy and storage between 2023 to 2035 [2]



The analysis utilises energy market modelling by Jacobs Australia and DELWP, which considered the new renewable energy and energy storage needed to achieve 95% renewable energy in Victoria. This energy market modelling shows Victoria can achieve an accelerated renewable energy transition that maintains supply reliability and energy affordability in line with average prices since 2018. Victoria's recently announced energy storage targets support an optimal transition

1 These are two-year FTE equivalent jobs.

2 The I-O modelling methodology considers the direct and gross economic impact of new and additional renewable energy generation and storage. The analysis has not incorporated the potential cost of the investment and is not a cost-benefit analysis

pathway for the state by supporting timely investment in renewable generation, firm capacity and emerging dispatchable technologies such as hydrogen based generation. Greater transmission interconnection as well as household solar, batteries and electric vehicles will complement this new build and play key roles in facilitating this transition. This report analyses this transition in economic terms, including the contribution that this new generation and storage build could make to economic activity and jobs in Victoria in the coming years.

Contents

1 Introduction

In 2017, the Victorian Government legislated Victorian Renewable Energy Targets (VRET) of 25 per cent renewable electricity generation by 2020 and 40 per cent by 2025. In 2019, Victoria legislated a VRET target of 50 per cent renewable electricity generation by 2030. As renewable energy sources generated more than 26 per cent of Victoria's electricity in 2020, Victoria has successfully met its first VRET target and continues to look forward, ensuring it remains on track towards its future VRET targets.

It is recognised that Victoria's electricity market is changing more rapidly than expected when the VRET targets were set. In light of this, DELWP commissioned PwC to undertake input-output (I-O) modelling to estimate the economic impacts of new electricity generation and capacity in Victoria on jobs (i.e. employment) and economic activity (i.e. gross valued added (GVA)) in Victoria's energy sector over the period to 2040. The analysis is based on a more rapid electricity sector transition towards 95% renewable electricity generation by mid-2035 (based on the AEMO Step Change modelling incorporating some Victorian Government programs).

In this report, the methodology and assumptions adopted for the I-O modelling have been detailed in chapter 2, followed by the modelling results in chapter 3.

2 Methodology and assumptions

This chapter provides an overview of the modelling approach employed and the key assumptions which have been adopted in undertaking the analysis.

2.1 The Modelling Approach

I-O modelling is a quantitative economic modelling tool which uses interactions between sectors of the economy to estimate the multiplier effects of interventions on the economy. It relies upon detailed records of the supply and use of products in each industry in Australia (known as 'input-output' tables) produced by the Australian Bureau of Statistics (ABS). The tables used in the analysis adopted within this report were for the 2018-19 financial year (ABS cat no. 5209.0.55.001).

2.1.1 I-O model

The model includes a detailed breakdown of labour, gross operating surplus, taxes and imports for all 114 industries. It contains a detailed breakdown of the intermediate inputs used by each industry: the way that an industry uses all other commodities in the economy to produce its outputs. The model also includes all the categories of final demand: household consumption; government consumption; fixed capital creation by private enterprises, public enterprises, and general government; inventory accumulation; and exports. All of this information can be used to calculate both direct and indirect employment and economic activity (gross value add) impacts.

Based on these tables, input-output multipliers are derived to establish how changes to a given part of the economy can impact the economy as a whole. This is achieved by quantifying the potential impacts on jobs and investment outcomes in Victoria, based on the transition of Victoria's electricity sector to renewable technologies.

2.1.2 Impacts considered

The I-O modelling is split into two phases:

- the construction phase – inputs within this phase include the sum of capital expenditure across all technologies being modelled
- the operational phase – inputs within this phase include the sum of operating expenditure arising across all technologies within Victoria being modelled over a 20-year period.

We have then considered economic impacts in terms of three key variables:

- output – the total value of goods/services produced in/by that sector
- value-added – the value contribution made by the sector (i.e. the amount by which the value of goods/services exceeds the value of intermediate inputs to that sector)
- employment – the total number of jobs (direct and indirect) created.

2.1.3 Limitations of I-O modelling

I-O modelling is a useful tool for understanding the contribution a sector can make to the economy, however, there are some important limitations arising from I-O models, predominantly caused by the assumptions on which they are based.

These assumptions include:

- They assume that the economy can expand in proportion to its current make-up, increasing all inputs in fixed proportions to their initial level. This means that if an industry expands by some percentage, then all costs of the industry (labour, capital, intermediate inputs) will expand by the same percentage. In the real economy, capacity constraints (particularly on labour) may mean that costs are likely to increase by more than the output increase or efficiencies in scale may mean costs increase by less than output increases.

- They also assume that the prices of sales and intermediate inputs are unchanged by the level of activity. As output increases in the real economy for example, businesses may have to lower their prices to increase the volume that they sell.
- They do not include substitution possibilities between inputs. Businesses are assumed to maintain the input mix that the I-O tables contain. As a result, there will not be substitution in favour of inputs that are more readily available.
- Household spending is assumed to be tied to labour payments, with an unchanging rate of consumption per dollar earned. This means that all consumers in the region will continue to use the same proportion of their income for consumption as the economy expands and will continue to buy the exact same mix of goods (therefore excluding any price substitution).

2.2 Assumptions

The analysis builds on previous energy market modelling completed by DELWP and Jacobs Australia. It is based on the **AEMO Step Change scenario and Victorian Government programs** which details Victoria's electricity generation and capacity on the basis that all brown coal plants are closed by the mid-2035, the upgrade of the Kerang Link interconnector occurs in mid-2031, completion of Marinus Link interconnector occurs in mid-2033 (stage 1) and mid-2035 (stage 2), and Victorian offshore wind targets of 4 GW by 2035 and 9 GW by 2040 are achieved.

Key assumptions which have been adopted in the I-O modelling for the purpose of the analysis are summarised in Table 1.

Table 1 Key Assumptions adopted within I-O model

#	Renewable Technology	Assumption adopted
1	Battery storage	For the purposes of collating inputs for battery storage systems, inputs relating to 2hr and 4hr storage capacity have been adopted and averaged to calculate the relevant capital and operating costs. This approach has been adopted based on DELWP's instruction.
2		The capacity split relating to utility scale battery storage and household battery storage was provided by DELWP based on energy market modelling.
3		Costs relating to both utility scale and household battery storage batteries have been adopted within the inputs.
4	Wind (offshore)	Victorian offshore wind targets of 4 GW by 2035 and 9 GW by 2040.
5	Rooftop solar	Rooftop solar PV capital costs have been adjusted to align with a 6.6kW system size given the increasing popularity of this system size.
6		We have assumed operating costs do not arise for rooftop solar systems. This approach has been accepted and confirmed by DELWP.
7	PVNSG	We have assumed the operating costs for the PVNSG technology are the same on a per MW basis as for large-scale solar PV systems.
8	Traditional hydro	No new traditional hydroelectricity capacity was added into the system over the time period being considered in the energy modelling provided by DELWP.

#	Renewable Technology	Assumption adopted
9	Pumped hydro	As agreed with DELWP, we have assumed pumped hydro systems have 8 to 48 hours storage capacity.
9	All	Fuel costs have not been captured within the I-O modelling.

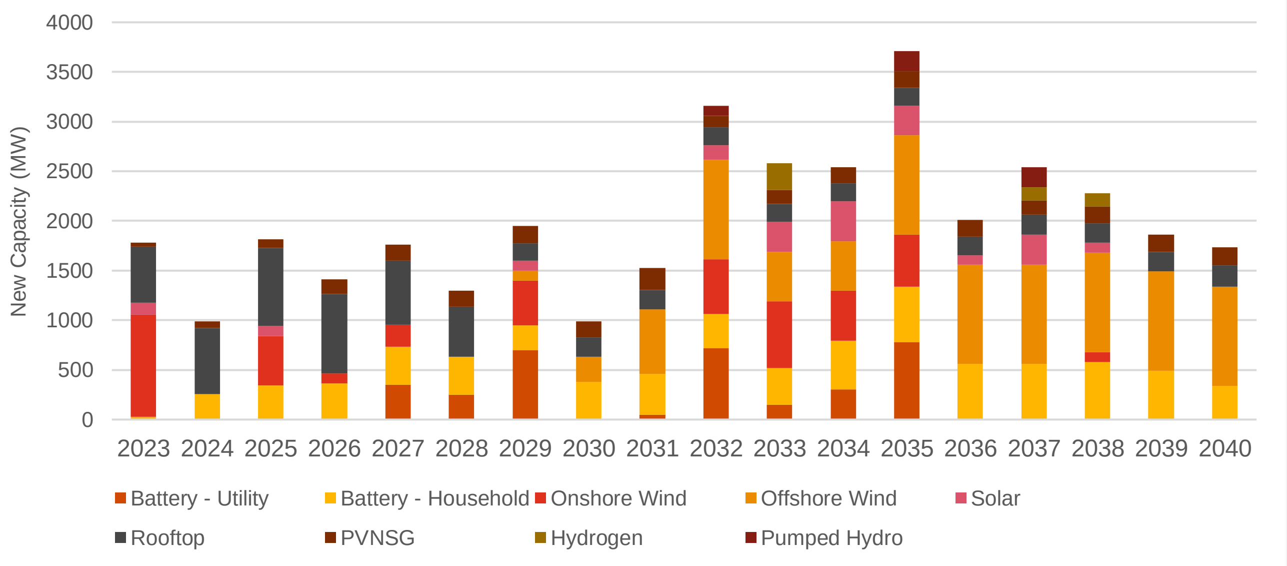
2.3 Modelling inputs

Earlier this year, the Department commissioned energy market modelling detailing how Victoria's energy market may transition over a period to 2040. The following outputs based on that modelling have been provided by the Department to be captured within the I-O modelling undertaken in this exercise.

2.3.1 Projected investment

The projected investment in new energy generation and storage capacity in Victoria to 2040 is presented in Figure 2.

Figure 2 Projected investment in new renewable generation and energy storage in Victoria to 2040



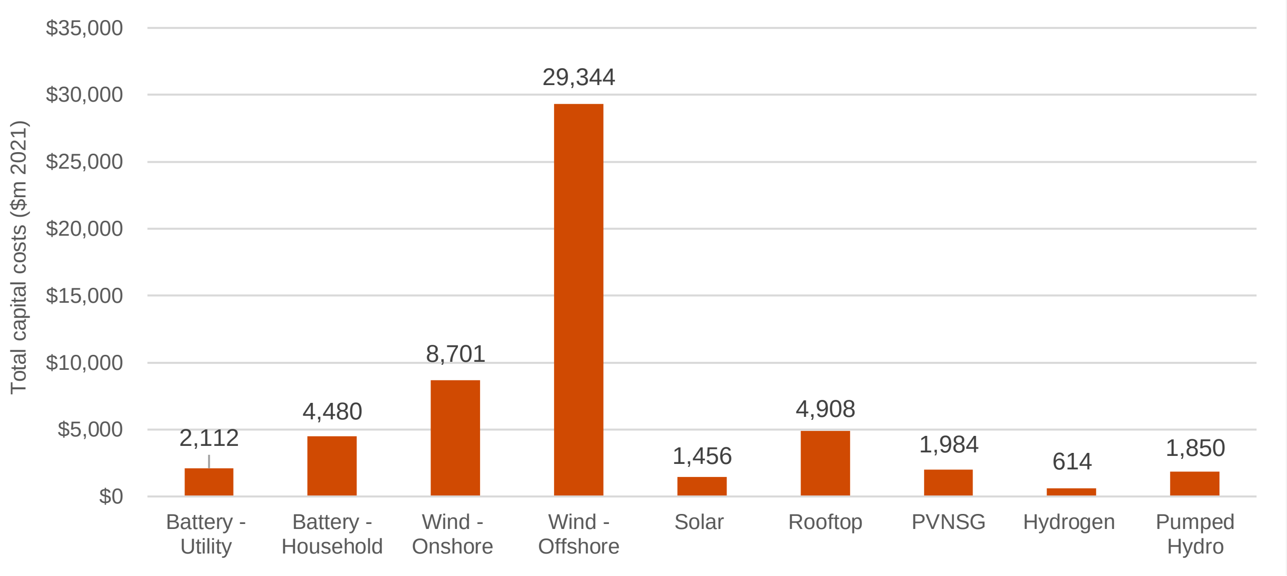
Source: Analysis by DELWP and Jacobs Australia

As outlined within Table 1, no new traditional hydroelectricity capacity is added to Victoria's energy mix over the period to 2040.

2.3.2 Capital costs

The capital costs across each technology were provided by DELWP. The total relative costs of each of the renewable technologies are provided in Figure 3. Capital costs were provided for all technologies except for traditional hydro.

Figure 3 Total undiscounted capital costs in Victoria by technology (2023 – 2040)

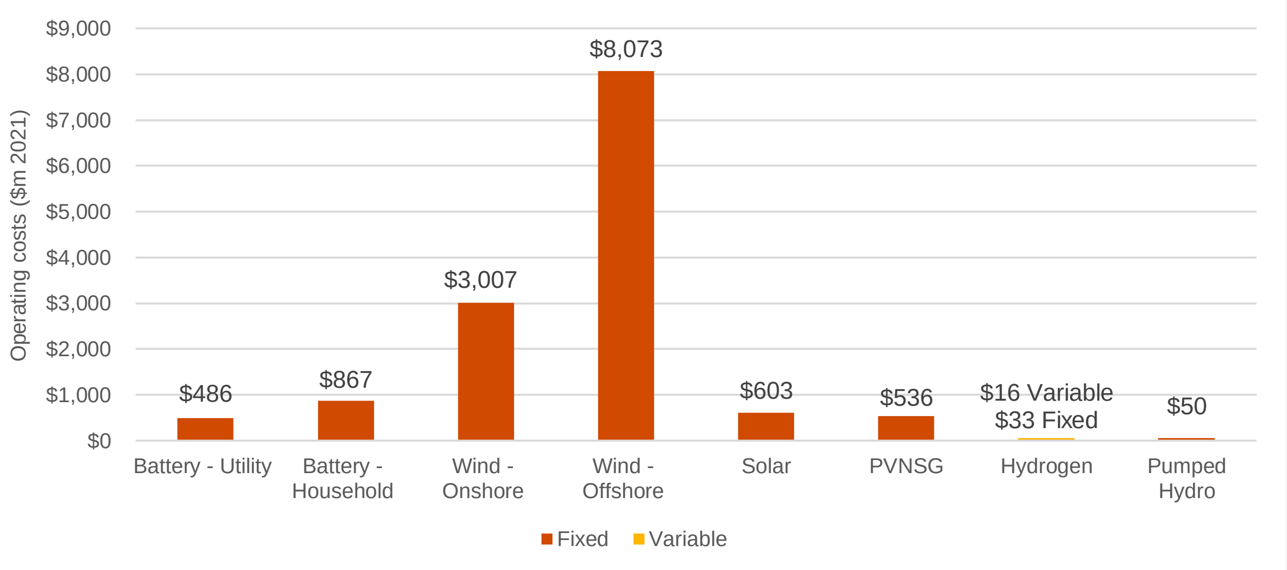


Source: PwC analysis based on Department's modelling

2.3.3 Operating costs

Operating costs across each technology were provided by DELWP. No traditional hydro operating costs have been captured, based on the data provided by DELWP. Additionally, no rooftop solar operating costs have been assumed, based on the data provided by DELWP, and the nature of the technology (i.e. generally no operating costs arise once rooftop solar panels are installed). Further, operating costs across each technology have generally been fixed in nature, except for hydrogen.

Figure 4 Total undiscounted operating costs in Victoria by technology to (2023 – 2040)



Source: PwC analysis based on DELWP modelling

2.4 Results

Based on the inputs adopted in the I-O model, the results, relevant to Victoria, are presented in terms of:

- **Direct impact**: The economic activity generated directly by Victoria's energy sector transitioning to renewable energy over the period to 2040.
- **Indirect impact:** The additional economic activity stimulated in the supply chain supporting Victoria's transition to renewable energy.
- **Induced impact:** The additional economic activity stimulated due to higher consumption generated from investment and employment impacts.

Results have been presented in aggregate, recognising that multiple aspects of Victorian and national energy transition interplay into these results.

Results have been presented as total impacts throughout, which refers to the direct, indirect and induced impacts (unless where induced impacts are specifically referred to). Results have been presented in this way to be consistent with previous economic impact analysis of the VRET. [3]

The results are presented in nominal terms, as well as in net present value (NPV) terms using a 7 per cent discount rate.

[3] ACIL Allen Consulting (2019), Victorian Renewable Energy Transition Economic Impacts Modelling.

3 Results

Chapter 3 summarises the results of the I-O modelling undertaken over the period from 2023 to 2040. The total impact is summarised in Section 3.1, while a breakdown of GVA and employment impacts are detailed in sections 3.2 and 3.3 respectively. As outlined in section 2.4, total impacts include direct, indirect and induced impacts (unless where we make specific reference to indirect and induced impacts).

3.1 Total economic contribution

In Table 2 we detail the total economic contribution expected to be realised by the Victorian economy, based on the level of electricity generation and storage projected between 2023 and 2035. Approximately $9.5 billion in GSP and 59,214 two-year jobs are expected to arise over the period from 2023 to 2035. Further details around these impacts are discussed in Sections 3.2 and 3.3.

Table 2 Total economic contribution in Victoria (2023 – 2035)

		2023 – 2030		2023 – 2035	
		GVA (NPV 7%, $ million)	Employment (Two-year FTE jobs)	GVA (NPV 7%, $ million)	Employment (Two-year FTE jobs)
Construction phase	Direct	$2,102	13,998	$3,419	28,549
	Indirect	$1,216	6,802	$1,978	13,873
	Induced	$1,090	5,196	$1,773	10,597
	Total	**$4,408**	**25,996**	**$7,170**	**53,019**
Operation phase	Direct	$344	290	$857	961
	Indirect	$450	984	$1,122	3,254
	Induced	$117	598	$291	1,980
	Total	**$911**	**1,872**	**$2,270**	**6,195**
	Total	**$5,319**	**27,869**	**$9,440**	**59,214**

Source: PwC modelling

3.2 GVA impacts

The GVA impacts resulting from new renewable generation capacity are summarised in Table 3.

We anticipate that approximately $9.5 billion of additional investment will arise in the Victorian economy over the period to 2035 ($7.1 billion relating to construction and $2.3 billion relating to operation). The direct impact resulting from the construction phase contributes largely to the results summarised, given the capacity increase expected in offshore wind in later years considered (2031 onwards).[4]

Table 3 Total GVA impacts by technology in Victoria from 2023 to 2030 and 2023 to 2035 ($ millions) – 7 per cent discount rate

		2023-2030	2023-2035
Construction phase	Battery – Utility	$202	$379
	Battery – Household	$447	$644
	Wind – Onshore	$1,414	$2,142
	Wind - Offshore	$64	$819

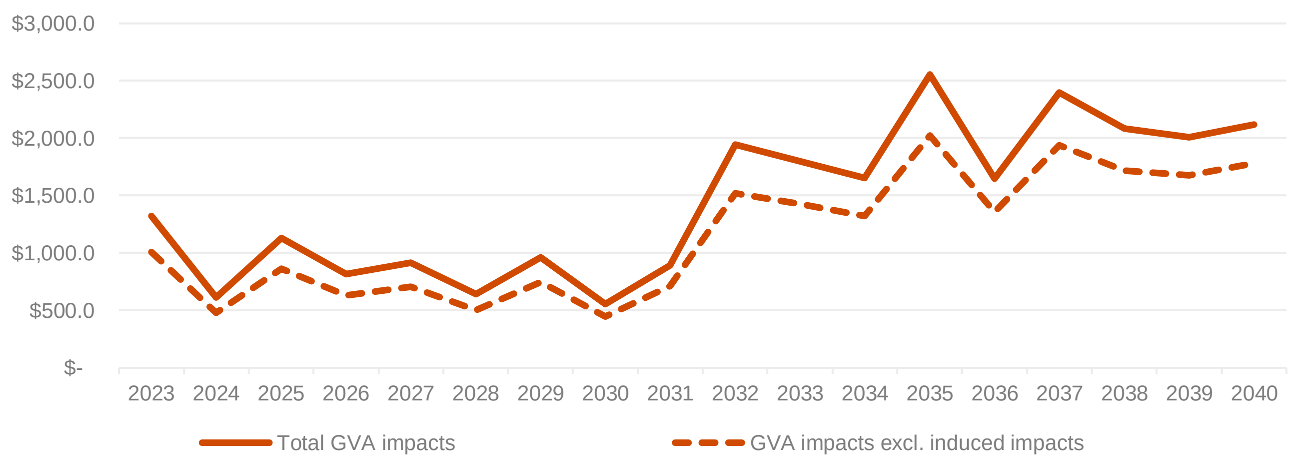
[4] While what is driving the I-O results reported has been identified and reported, it is important to note that multiple aspects of Victorian and national energy transition interplay into these results, and the outcomes cannot solely be attributed to a single policy measure or technology.

	Solar	$103	$271
	Rooftop	$1,911	$2,119
	PVNSG	$266	$393
	Hydrogen	$0	$92
	Pumped Hydro	$0	$311
	Total	**$4,408**	**$7,170**
Operation phase	Battery – Utility	$33	$95
	Battery – Household	$77	$174
	Wind – Onshore	$600	$926
	Wind – Offshore	$35	$779
	Solar	$101	$160
	Rooftop	$0	$0
	PVNSG	$66	$128
	Hydrogen	$0	$4
	Pumped Hydro	$0	$4
	Total	**$911**	**$2,270**
Total	Battery – Utility	$235	$474
	Battery – Household	$524	$818
	Wind – Onshore	$2,015	$3,068
	Wind – Offshore	$99	$1,598
	Solar	$204	$431
	Rooftop	$1,911	$2,119
	PVNSG	$332	$521
	Hydrogen	$0	$96
	Pumped Hydro	$0	$314
	Total	**$5,319**	**$9,440**

Source: PwC modelling

Figure 5 reflects the GVA impacts on the Victorian economy of the investment in new renewable generation and energy storage. In illustrating these impacts, both the total impacts and total impacts (excluding induced) are summarised in the figure below.

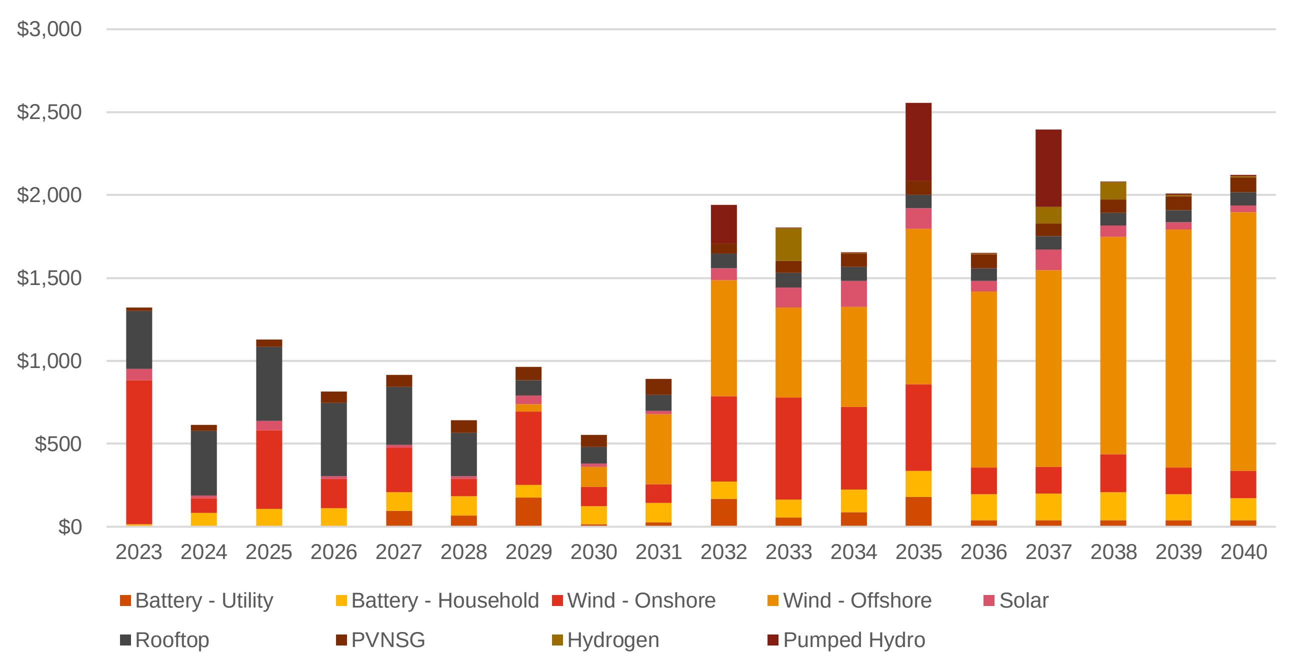
Figure 5 GVA impacts in Victoria over time ($ million)



Source: PwC modelling

Figure 6 illustrates the total (direct, indirect and induced) GVA impacts on the Victorian economy of the investment in new renewable generation and energy storage capacity by technology. The modelling results suggest that the investment in wind and rooftop PV may have a relatively significant contribution to the Victorian economy throughout the period.[5]

Figure 6 Total GVA impacts in Victoria over time by technology ($ million)



Source: PwC modelling

3.3 Employment impacts

The employment impacts resulting from new renewable generation and energy storage capacity are summarised in Table 4 by technology as two-year FTE jobs and illustrated per year within Figure 8. The number of two-year jobs arising has been quantified by dividing the total number of FTEs over the period considered by two.

It is anticipated that an additional 27,869 two-year jobs will arise by 2030 and 59,214 by 2035.

Table 4 Total employment impacts (two-year jobs) in Victoria by technology from 2023 to 2030 and 2023 to 2035

Period	2023 – 2030	2023 – 2035
Construction		
Battery – Utility	1,407	3,155
Battery – Household	2,800	4,713
Wind – Onshore	7,871	15,061
Wind - Offshore	495	7,726
Solar	582	2,269
Rooftop	11,132	13,115
PVNSG	1,709	2,915
Hydrogen	0	882
Pumped Hydro	0	3,184

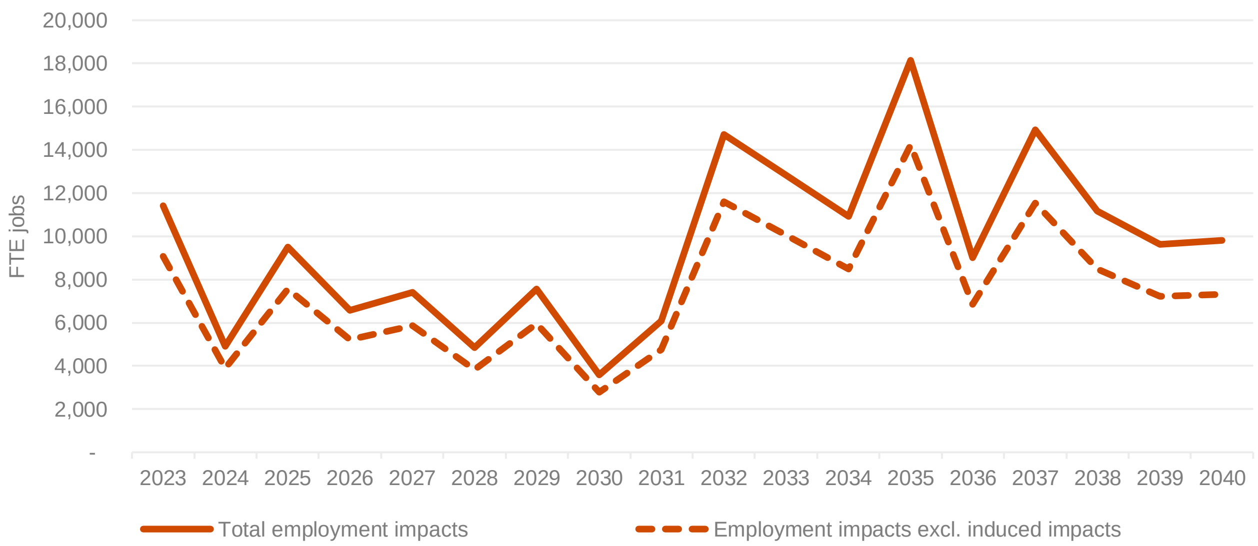
[5] While what is driving the I-O results reported has been identified and reported, it is important to note that multiple aspects of Victorian and national energy transition interplay into these results, and the outcomes cannot solely be attributed to a single policy measure or technology.

Operation		
Battery – Utility	75	272
Battery – Household	168	472
Wind – Onshore	1,204	2,224
Wind - Offshore	86	2,480
Solar	201	390
Rooftop	0	0
PVNSG	139	332
Hydrogen	0	13
Pumped Hydro	0	12
Total		
Battery – Utility	1,481	3,427
Battery – Household	2,969	5,185
Wind – Onshore	9,075	17,285
Wind - Offshore	581	10,205
Solar	782	2,659
Rooftop	11,132	13,115
PVNSG	1,848	3,247
Hydrogen	0	895
Pumped Hydro	0	3,195

Source: PwC modelling

Figure 7 reflects the employment impacts on the Victorian economy resulting from jobs being created by new renewable generation and energy storage capacity. In illustrating these impacts, both the total impacts and total impacts (excluding induced) are summarised in the figure below.

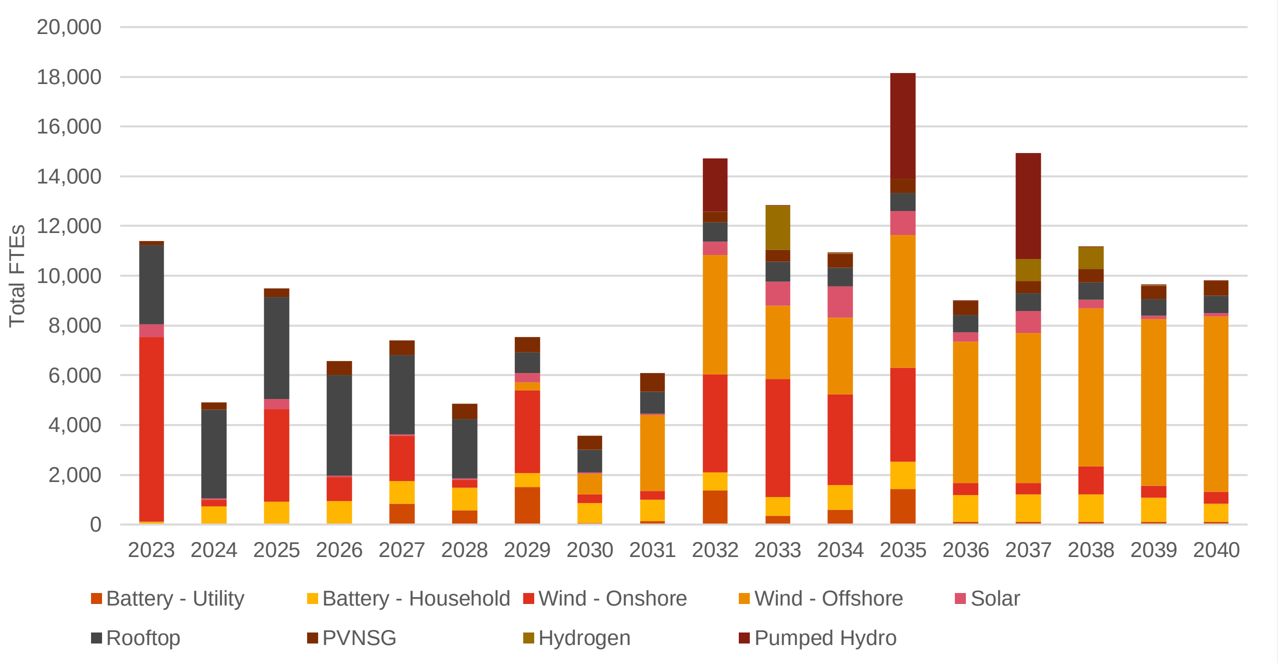
Figure 7 Employment impacts in Victoria over time



Source: PwC modelling

Figure 8 illustrates the contribution to Victorian employment of the investment in new renewable generation and energy storage capacity by technology. The modelling results suggest that the investment in wind and rooftop PV makes a relatively significant contribution to Victorian employment throughout the period.[6]

Figure 8 Total employment impact in Victoria over 2023 - 40 by technology



Source: PwC modelling

[6] While what is driving the I-O results reported has been identified and reported, it is important to note that multiple aspects of Victorian and national energy transition interplay into these results, and the outcomes cannot solely be attributed to a single policy measure or technology.

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