

# Pathways for triple zero housing in Australia

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# Outlines

1. Background
2. Methodology
3. Results and discussions
4. Conclusions

# Project background

- In 2019, Energy Ministers agreed the Trajectory for Low Energy Buildings  
The Trajectory aims to:
  - a) Set a trajectory towards zero energy (and carbon) ready buildings;
  - b) Implement cost-effective increases to the energy efficiency provisions in NCC 2022; and
  - c) Expand NatHERS to offer nationally accredited WoH tools to enable verification requirements in the NCC
- CSIRO was commissioned by the NatHERS Administrators to develop benchmark WoH tools for house design and retrofitting
- AccuRate Home for new housing was released to the public June 2023 and beta version for existing housing was delivered to industry for evaluation in Nov 2022

# Building simulation tools developed by CSIRO



Thermal Hot Water Lighting HVAC Appliances Occupancy Water PV/battery

AccuRate



AusZEH Design

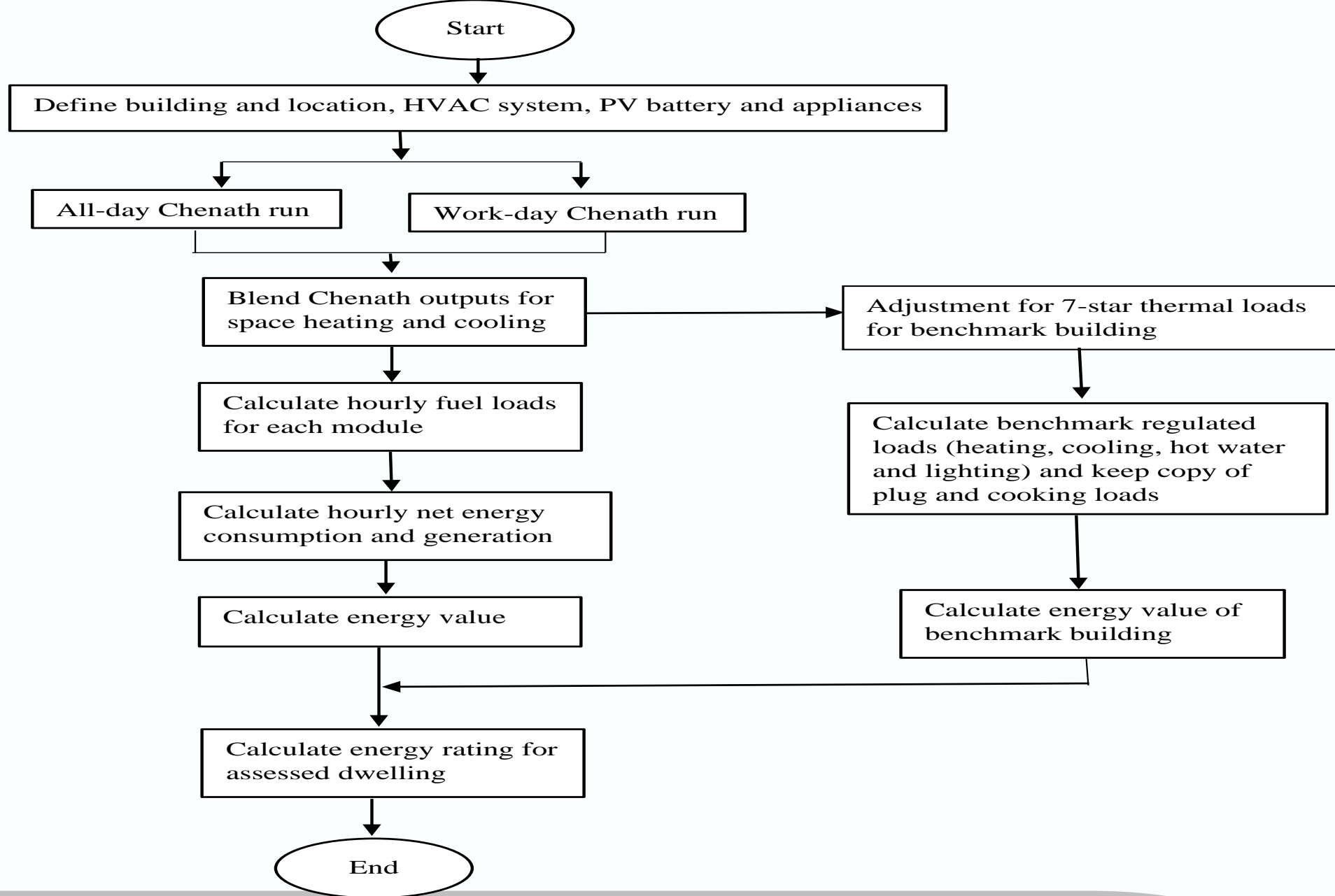


WoH Tool new housing



WoH Tool existing housing





Databook (Base Design)

Project | Constructions | Zones | Shading | Elements | Ventilation | Lighting | Hotwater | Cooling | Heating | Swimming Pool | Plug Loads and Cooking | Solar PV | Summary

### Annual Summary

#### Assessment Building Energy Consumption

	Lighting	Hotwater	Cooling	Heating	Swimming Pool	Plug Loads	Cook Top	Oven		Total Demand	Imported Energy	Energy Costs(\$)			
Electricity	<b>513.2</b>	<b>0.0</b>	<b>317.0</b>	<b>241.3</b>	<b>1559.2</b>	<b>2361.6</b>	<b>304.8</b>	<b>250.8</b>	kWh/yr	<b>5548.0</b>	kWh/yr	<b>3274.1</b>	kWh/yr	PV Export	231.30
Gas		<b>16069.8</b>		<b>0.0</b>	<b>0.0</b>		<b>0</b>	<b>0.0</b>	MJ/yr	<b>16069.8</b>	MJ/yr			Grid Import	1058.66
Others		<b>0.0</b>		<b>0.0</b>	<b>0.0</b>				MJ/yr	<b>0.0</b>	MJ/yr			Gas	556.02
														Wood	0.00
														Net Energy Value	1383.38

	Solar PV	
Electricity Generation	<b>4568.7</b>	kWh/yr
Export to Grid	<b>2294.6</b>	kWh/yr

WoH				
	Cooling	Electricity	Heating Gas	Others
All day	<b>376.61</b>	<b>268.68</b>	<b>0.00</b>	<b>0.00</b>
Work day	<b>227.67</b>	<b>200.19</b>	<b>0.00</b>	<b>0.00</b>

#### Reference Building Energy Consumption

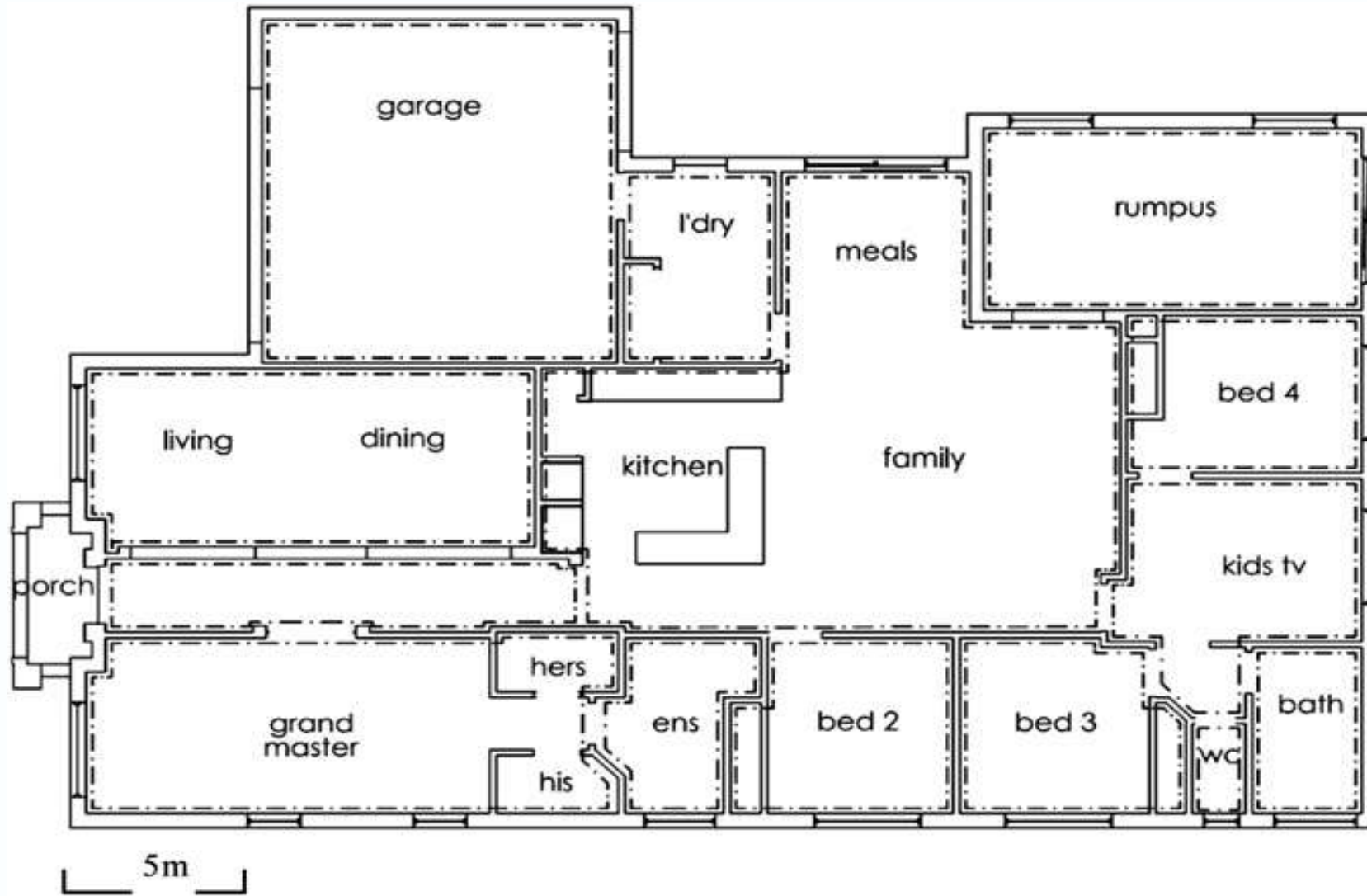
Period	Combined Heating_Cooling Load MJ	Percentage(%)	Floor Area (Square Metres)	175.76	Thermal Adjustment Factor	1.1867	Energy Value (\$)
Peak	3657.04	47.57	Occupant Number	3.35	Energy consumption for space heating and cooling (kWh)	470.4312	147.42
Shoulder	2346.09	30.52	Annual Plug Loads (Electric, kWh)	2361.64	Lighting (kWh)	410.5753	131.70
Off-Peak	1684.12	21.91	Annual Oven Load (Electric, MJ)	902.99	Water Heating Auxiliary (kWh)	38.76	11.28
Total	7687.25	100.00	Annual Electric Cooktop (Electric, MJ)	1097.23	Water heating (MJ)	13267.95	459.07
					Plug-load (kWh)	2361.64	670.76
					Cooktop (kWh)	304.79	104.55
					Oven (kWh)	250.83	86.04
					Total (E.V50)		1610.83
					E.V60		1385.99
					E.V0		3566.20

# Whole-of-home rating

## Energy Value (Societal Cost) of Fuel for NatHERS Assessments

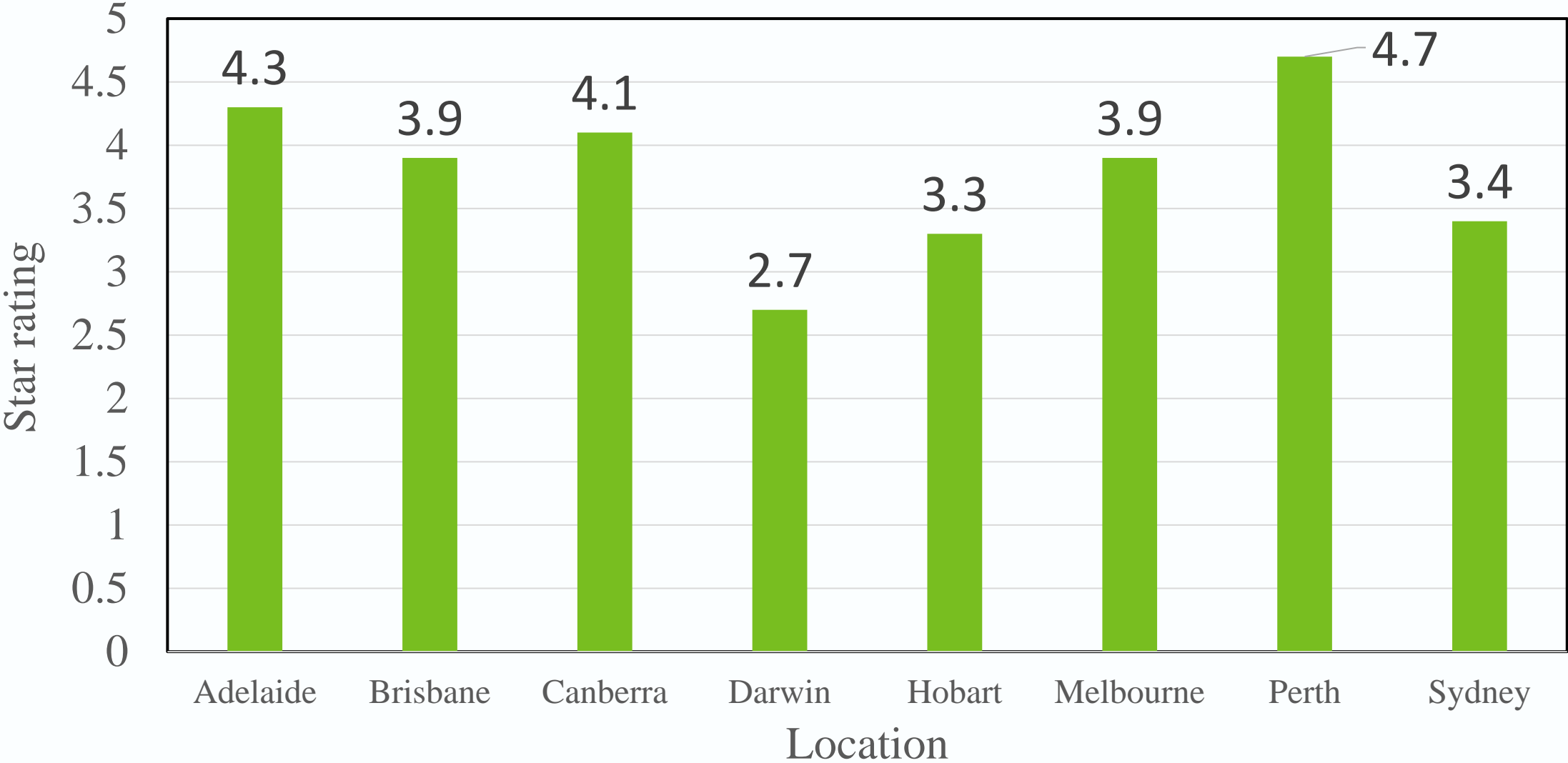
Parameters	Societal energy costs for calculations							
	NSW	Vic	QLD	SA	WA	TAS	NT	ACT
Electricity - peak (c/kWh)	39.80	38.41	33.46	51.29	41.24	29.96	37.32	33.88
Electricity - shoulder (c/kWh)	25.97	25.17	21.91	33.20	26.83	19.34	24.30	21.86
Electricity - off-peak (c/kWh)	20.44	19.88	17.29	25.97	21.06	15.09	19.09	17.05
Electricity - controlled load (c/kWh)	14.07	20.61	16.74	20.43	12.73	13.50	26.90	14.83
PV Export (c/kWh)	10.08	13.34	11.11	11.64	7.89	9.71	26.85	9.21
Natural gas (c/MJ)	3.46	2.43	4.95	4.30	4.08	3.74	3.74	3.64
LPG (c/MJ)	5.58	5.58	5.58	5.58	5.58	5.58	5.58	5.58
Wood (c/MJ)	1.86	1.86	1.86	1.86	1.86	1.86	1.86	1.86

# Case study

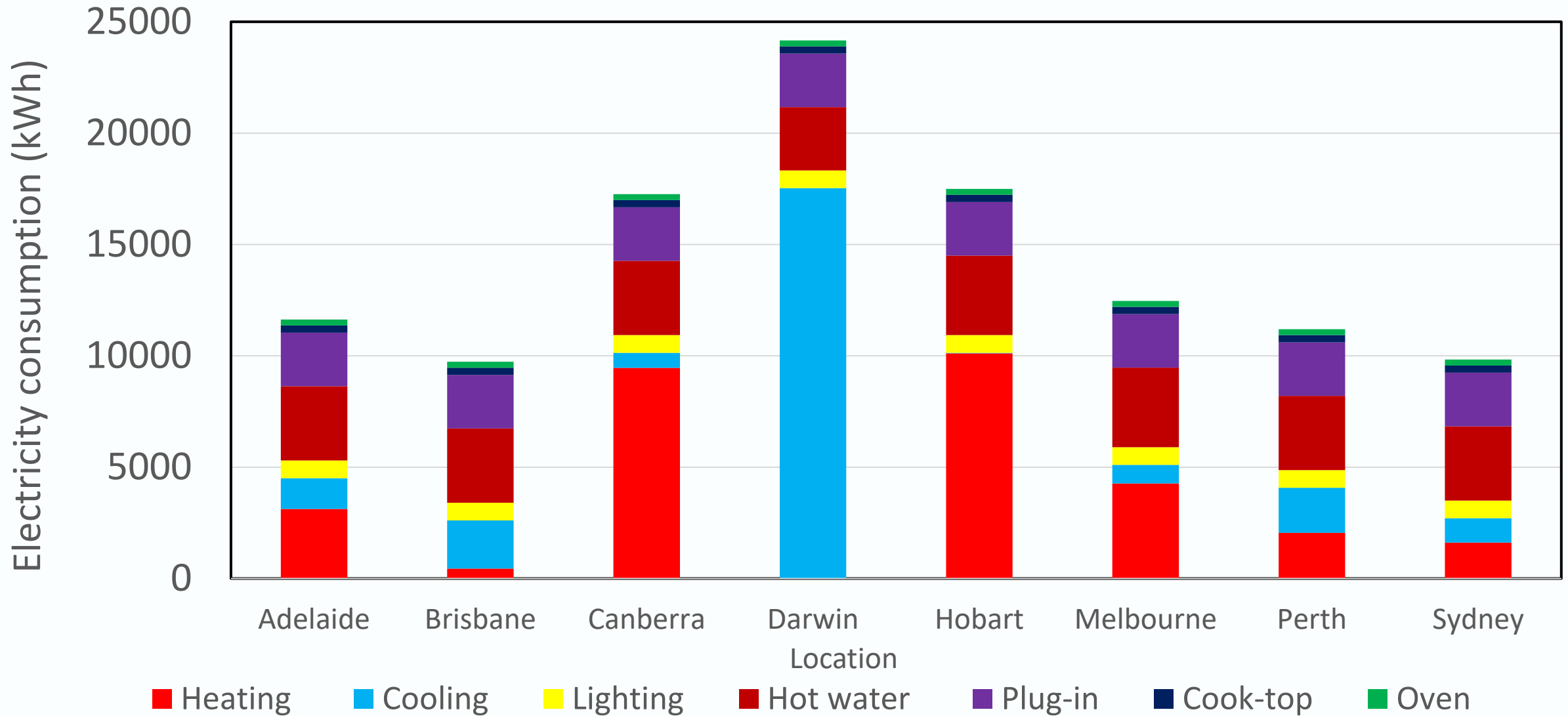




# Energy star rating before retrofitting



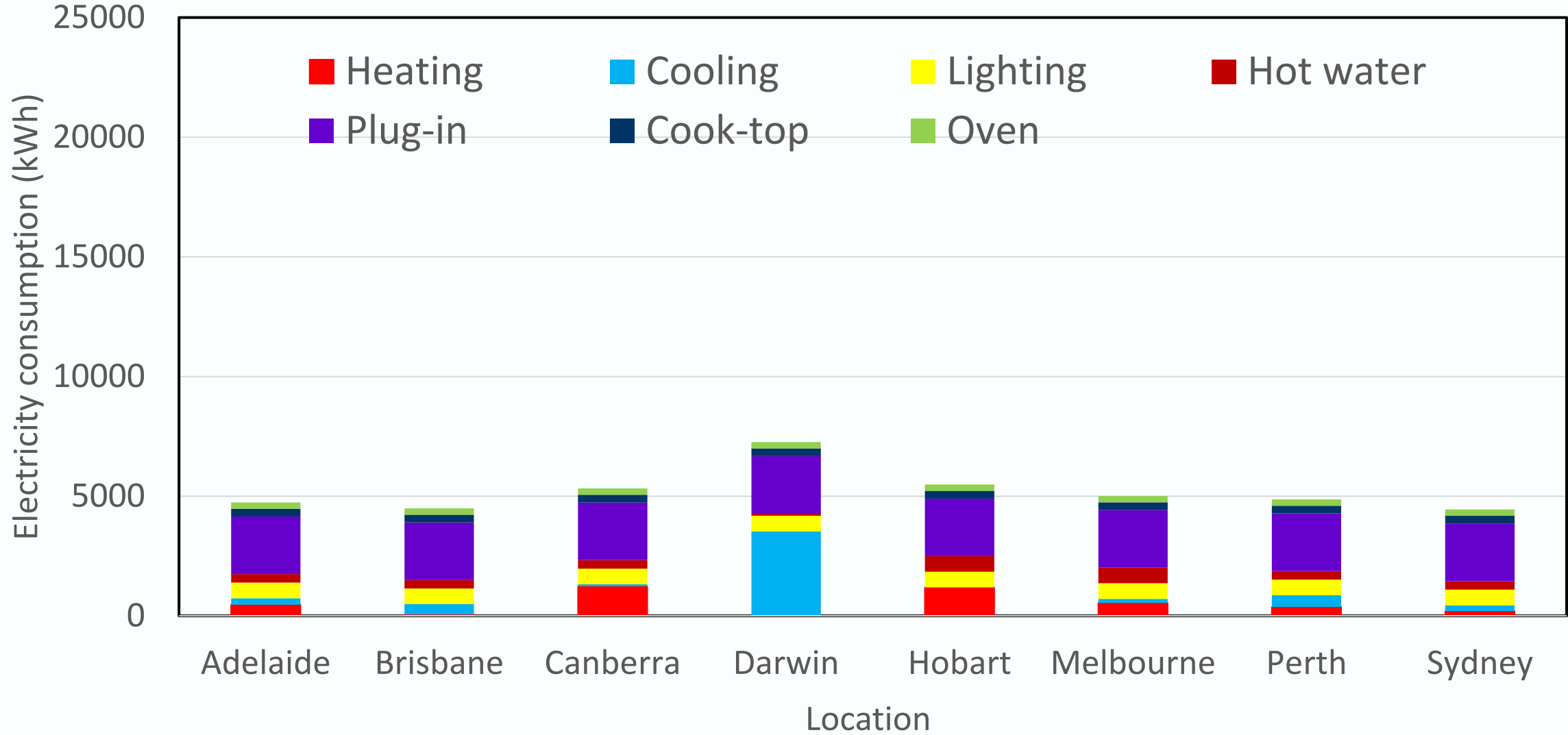
# Electricity consumption before retrofitting



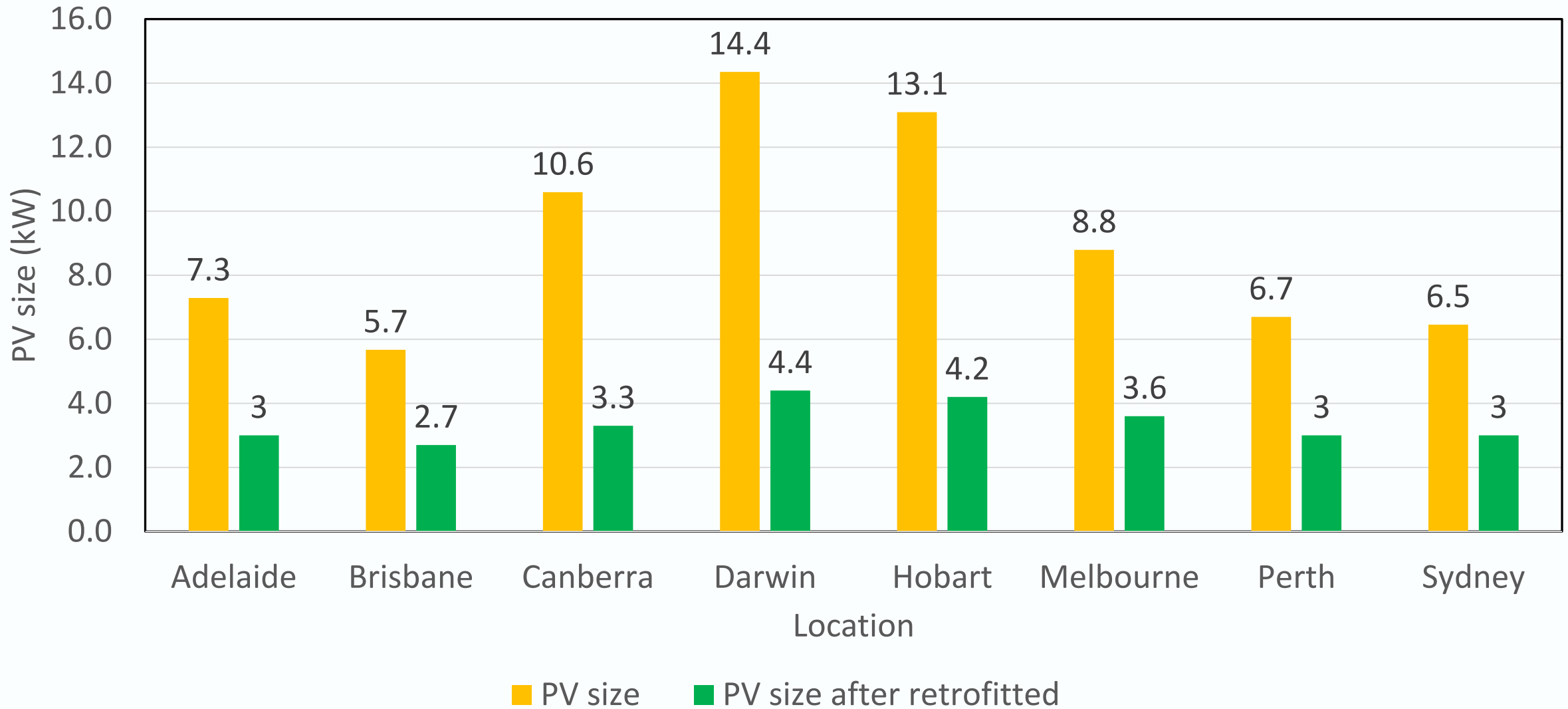
# Measures for retrofitting the houses

1. Upgraded to 7 stars (sealing the houses, replacing the windows with high performance double glazing windows, insulations to roof space and external wall)
2. Electric-boosted solar hot water with 45 STCs
3. 4-star non-ducted heat pump for space heating and cooling
4. LED lighting
5. No swimming pool/spa

# Electricity consumption after retrofitting



# PV size for zero energy/emission housing before/after



# PV systems for zero energy (emissions) housing

Location	PV size	Imported	Exported	Net Energy value	Rating
Adelaide	3	2981.4	3024.6	819.4	83
Brisbane	2.7	2762.6	2902.3	398.6	89
Canberra	3.3	3454.3	3507.9	576.7	85
Darwin	4.4	4696.6	4841.3	-9.1	100
Hobart	4.2	3576.1	3699.6	466.6	87
Melbourne	3.6	3135.9	3231.4	498.4	86
Perth	3	3033.8	3179.5	716.5	83
Sydney	3	2761.1	2881.2	560.4	85

# PV battery systems for triple zero housing

Location	PV size	Battery size	Solar PV generation (kWh)	Imported	Exported	Net Energy value	Rating
Adelaide	5	4.5	7975.1	1511.1	4507.4	-28.1	100
Brisbane	4	2.5	6864.5	1904.3	4140.2	-17	100
Canberra	5	5	8148.7	1841.8	4404	7.4	99
Darwin	4.4	0	7409.1	4696.6	4841.3	-9.1	100
Hobart	6	6	8010.2	1838.6	4072.5	-7.7	100
Melbourne	5	4	7087.3	1860.8	3736	-14	100
Perth	5	5	8356.6	1399.9	4621.8	-1	100
Sydney	5	3	7614.5	1703.2	4708.9	-27.19	100

# Conclusions

1. With the benchmark tool used for calculating whole-of-home energy consumption and energy value for existing housing in Australia, the results show when electricity supply is available only, Darwin has the highest electricity use (24,165 kWh) and Brisbane has the lowest (9734 kWh)
2. To operate the demo house, Darwin is the most expensive city (near A\$7000), Brisbane is the cheapest (A\$2641). The energy rating scale is 0 in Canberra, Darwin, Hobart and Melbourne
3. With the house being updated high energy efficient building envelop, equipment and appliances, more than half energy was saved



## Conclusions-cont.

4. To achieve zero energy (carbon) housing, installation of 4.4 kW solar PV is required in Darwin and 4.2 kW in Hobart, around 3.5 kW in Melbourne and Canberra, 3.0 kW in Adelaide, Sydney, Brisbane and Perth
5. Except in Darwin, it needs several hundred Australia dollars to operate the retrofitted house even it was achieved zero energy (or exported energy is greater than imported)
6. With the highest electricity exported tariff, Darwin is the cheapest city to achieve triple zero housing (4.4 kW PV only), Hobart needs the largest PV and battery system (6 kW PV and 6 kWh battery)

# References

1. Ren Z., Jian A., Law A., Godhani A. and Chen D. Development of a benchmark tool for whole of home energy rating for Australian new housing, *Energy & Buildings* 285 (2023), 112921.
2. Ren Z., Jian A. and Chen D. Development of an energy rating tool for Australian existing housing, *Energies* 16 (2023), 7368.

*Thank You!*

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