



Achieving net-zero-energy-demand buildings

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Outline

Introduction
Net-zero-energy-demand buildings
Solar photovoltaic (PV) opportunities
Space heating and cooling for Melbourne
Potential wind and solar energy availability
Discussion and summary

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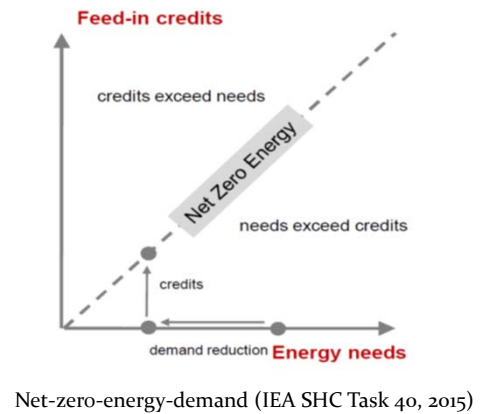


Net-zero-energy-demand buildings

“Zero Net Energy Buildings are buildings that over a year are neutral, meaning that they deliver as much energy to the supply grids as they use from the grids” (Laustsen, 2008)

Considerations in this investigation

- Metric: final energy demand and supply
- Balance boundary: operational energy
- Balance period: operation year



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Zero

0

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Net-zero

– ? +

Demand > Production

Demand = Production

Demand < Production

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The tallest, largest, and smartest net-zero-energy building in the world

<https://youtu.be/utoQzjNbZFo> (00:02:33)



http://static.gulfnews.com/polopoly_fs/1.19069051/image/2854196310.jpg_gen/derivatives/box_620347/2854196310.jpg
<http://gulfnews.com/news/uae/environment/dewa-unveils-fully-solar-powered-headquarters-1.1906908>

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Questions?

Can I make my home net-zero-energy-demand house?

- Pascoe Vale (37.7260°S 144.9265°E)
- Three bed rooms, four occupants
- Land size: 600 m², Floor area: 130 m²

How much would it cost?

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Annual energy demand from networks

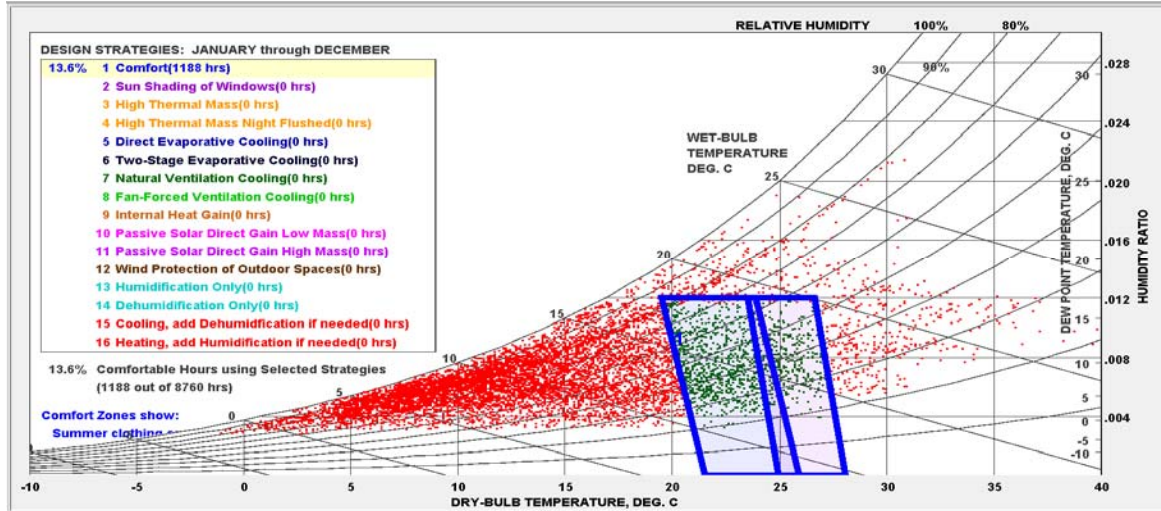
Electricity: 2,291 kWh_e → 17.6 kWh_e m⁻² floor area

Gas: 47,664 MJ = 13,240 kWh_g → 101.8 kWh_g m⁻² floor area
(Cooking, hot water, and space heating)

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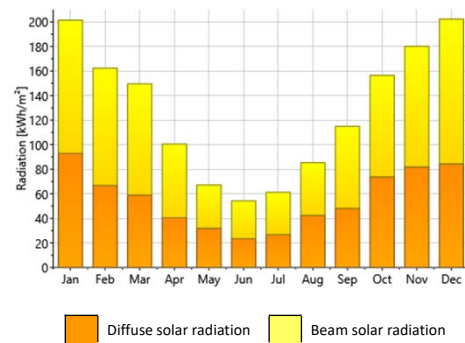
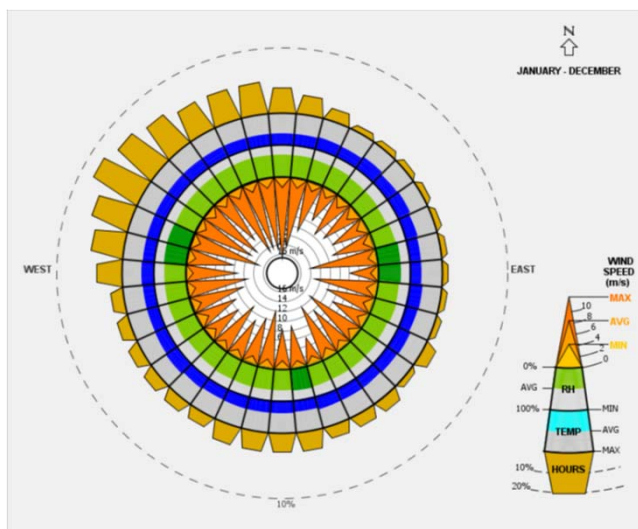
Outdoor air, Pascoe Vale



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Potential wind and solar, Pascoe Vale



Wind < 10% of time
Annual solar: 1,542 kWh m⁻²

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PV system for electricity

Electricity usage may be covered by PV
(system efficiency ~10%) →

PV array area required = $2291 / (0.1 \times 1542)$
= ~15 m²

PV capacity = 1.5 kW_p + 30% considering
uncertainty = ~2 kW_p → \$ 3,420

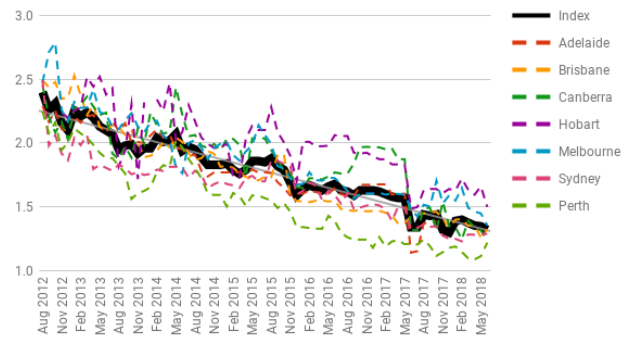
Medium system price = ~\$ 1.72 per W_p

Note: 2 kW_p system would need 20 m²

Do I have the roof with solar access? **Yes!**

Do I have spare money? May be ;>).

Solar PV Price Index (\$/W - All cities, all sizes)



<https://www.solarchoice.net.au/home-solar-system-prices>

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What about hot water?

4 people (150 litres per day)

High efficient heat pump water heater annual electricity usage

= 910 kWh_e (additional ~40% more electricity required)

(<https://www.sustainability.vic.gov.au/You-and-Your-Home/Save-energy/Hot-water/Hot-water-running-costs>)

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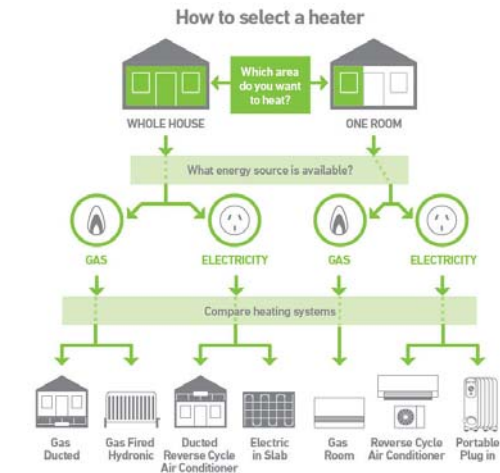


What about space heating?

Small house (floor area 100 m², excluding laundry and bathroom)

Ducted reverse-circuit heat pump, annual electricity usage

= 2,132 kWh_e (additional ~100% more electricity required)



<https://www.sustainability.vic.gov.au/You-and-Your-Home/Save-energy/Heating/Choose-energy-efficient-heating>



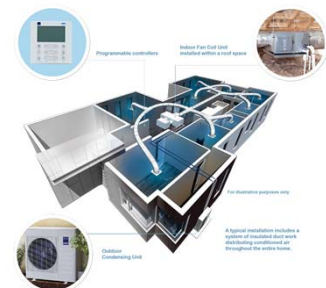
Roof top PV, HP water heater, Ducted reverse-circuit heat pump



<https://images.theconversation.com/files/116828/original/image-20160330-28455-1n8yykr.jpg?ixlib=rb-1.1.0&q=45&auto=format&w=496&fit=clip>



<https://2ecff01e1ab3e9383f0-07db7b9624bdf022e3b5395236d5cf8.ssl.cf4.rackcdn.com/Product-1600x1600/fcdda669-e1a4-4953-800e-d51cfe9aee5.jpg>



<http://www.brivis.com.au/wp-content/uploads/2017/02/How-economical-is-ducted-reverse-cycle.png>



Conservative numbers

Electricity consumption	kWh _e	kW _p	Area (m ²)
Electricity (Current appliances + central heating fan)	2,291	2	20
Hot water (Heat pump water heater)	910	1	10
Space heating (Ducted reverse-circuit heat pump)	2,132	2	20
Total	5,333	5	50

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Costs

Item	Cost	Source
PV system (5 kW _p)	\$ 5,080	https://www.solarchoice.net.au/home-solar-system-prices
Heat pump water heater (280 L) + installation	\$ 2,595	https://www.bunnings.com.au/chromagen-midea-electric-heat-pump-water-heater-280l_p5102893
Ducted reverse-circuit heat pump (~14 kW _h) supply and install	\$ 8,000	https://hipages.com.au/article/ducted-air-conditioning-prices
Total	\$ 15,675	

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Answers to the questions

Can I make my home net-zero-energy-demand house?

• Pascoe Vale (37.7260°S 144.9265°E)

Yes! Technically doable.

How much would it cost?

~ \$ 16k

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Downsides and upsides

Costs

Benefits

Added values

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