A winning formula: high-performance house plus EV

Despite the upfront cost premium, opting for a highly efficient, all-electric home with an EV can offer significant economic and environmental benefits. We analyse one example.

Near Cape Paterson on Victoria's south-east coast, Joe and Jo Spano live at an eco-development known as The Cape. They recently built a highly efficient, all-electric home with 6 kW of solar PV and 4.8 kWh of energy storage. And they are about to take possession of one of the next generation of long-range electric vehicles.

To understand the economic and environmental value of the Spanos' home and car choices, the energy analysts at Renew compared them with two alternative scenarios: an average existing (2 Star) or minimum-standard (6 Star) new build, "dual-fuel" Victorian home, along with the purchase of a comparable internal combustion engine (ICE) vehicle.

For this analysis, we asked the following questions:

- What if the Spanos had built a typical 6 Star, dual-fuel Victorian home and bought an ICE vehicle?
- How does the Spanos' all-electric solar home compare to a typical existing, 2 Star Victorian dual-fuel home?
- What are the costs, savings and environmental benefits of each approach?

Image: John Thompson, courtesy Beaumont Concepts

The Spanos' 8.3 Star home at The Cape is all-electric, with 6 kW of solar PV and 4.8 kWh of energy storage. A Hyundai Kona electric vehicle is due to be delivered any day.

The home

The Spanos' new home is a three-bedroom, 153 m^2 dwelling that has been rated at 8.3 Stars. It is connected to the electricity grid, and uses a combination of direct solar electricity, stored solar electricity and the mains grid to power the home. The home is not connected to the mains gas network and does not use either bottled gas or wood for fuel.

The home consumes an average of 2 kWh of electricity from the grid per day—or around 700 kWh per year. This is about 1/20th of the energy grid usage of an average Victorian home, which consumes around 4400 kWh per year along with 40 gigajoules (approx 11,100 kWh) of mains gas (bit.ly/vuchs).

Based on their current retail tariff (peak $0.32/kWh, off peak $0.13/kWh for 100% GreenPower; $1.15/day supply charge), the Cape Paterson home will pay stationary electricity bills of approximately $123 per year, with no gas bills.

The car

The Spanos have recently purchased a Hyundai Kona Hylander electric vehicle (EV), a model that is offered in both EV and ICE formats. See Figure 1 for their specifications.

As former residents of Melbourne, the Spanos plan to make twice weekly trips to the city (300 km roundtrip) to see friends and family. As new residents of the Bass Coast, they are keen to explore the region and estimate travelling approximately 400 km once a month.

Aside from that, local trips are likely to incur another 150 km per week of local driving. It has been assumed that the couple will take four weeks of holidays per year, where EV driving won't be required.

Based on this, the Spanos' total driving distance per year has been estimated at 40,400 km.

	Kona Hylander EV	Kona Hylander ICE
Price	$72,000	$40,000
Range	449 km	714 km
Storage	64 kWh	50 litres
Consumption	16 kWh/100 km	7.2 litres/100 km
Maintenance	$165/year	$279/year
Warranty	Car—5 years, unlimited kms Battery—8 years, unlimited kms	5 years, unlimited kms

Figure 1. Key specifications of the Kona Hylander EV and ICE versions.

	The Spanos' home (8.3 Star, all-electric)	6 Star, dual-fuel home	2 Star, dual-fuel home
Cost premium	$13,465	$0	$0
Electricity usage per year	3763 kWh	2580 kWh	4380 kWh
Gas usage per year	0	22,396 MJ	40,000 MJ
Electricity cost per year	$123	$1522	$1497
Gas cost per year	$0	$908	$1390
Stationary energy cost per year	$123	$2430	$2887
Annual emissions (tonnes CO_2e)	0	4.38	7.56

Figure 2. Energy costs and emissions for the three modelled homes. Annual emissions calculated using electricity emission factor for Vic (2018) of 1.16 kg CO_2e/kWh and LNG emission factor of 61.85 kg CO_2e/GJ (bit.ly/DOEE-NGAF)

	Kona Hylander EV	Kona Hylander ICE
Cost premium	$32,000	$0
Travel distance per year	40,400 km	40,400 km
Energy/fuel usage per year	6456 kWh	2909 litres
Energy/fuel unit price	$0.2818/kWh	$1.60/litre
Energy/fuel cost per year	$1819	$4654
Servicing cost per year	$165	$279
Transport cost per year	$1984	$4933
Annual emissions (tonnes CO_2e)	0	6.83

Figure 3. Running costs and emissions of the two modelled vehicles. Annual emissions for the ICE are based on 169 g/km tailpipe emissions.

The comparison

We modelled the upfront and running costs of each vehicle, and the stationary (i.e. non-transport) energy usage and bills of all three house scenarios (assuming gas heating, hot water and cooking for the dual-fuel homes).

The energy costs and carbon footprint of the three modelled homes is laid out in Figure 2. (The annual electricity cost of $1522 for the 6 Star dual-fuel home does not include solar PV. Were 6 kW of solar PV installed on this home, it would reduce that home's electricity bill to -$206 per year.)

Figure 3 shows the running costs and carbon footprint of the two modelled vehicles. The energy price for the EV is for the non-solar (i.e. grid) component of the EV charging, which equates to approximately 75% of the annual energy required for EV charging.

Synthesis

The analysis above results in upfront and running costs and annual emissions for the three different home and vehicle combinations as outlined in Figure 4.

Key appliances in the Spanos' all-electric home

- A single, high efficiency (COP 5.81) 2.5/3.6 kW Daikin Ururu Sarara (US7) reverse-cycle air conditioner, in the living space only
- A high efficiency (COP 5.96) 0.84 kW input, Sanden heat pump hot water system
- Ceiling fans in the living spaces and bedrooms
- LED lighting throughout
- An induction cooktop
- Relatively new and efficient whitegoods

As compared with the dual-fuel homes, the 8.3 Star solar all-electric home and EV combination offers significant benefits

The additional cost to the Spanos of their efficient home and EV was just over $45,000, and the running cost is just over $2100 per year. This is a saving of over $5200 per year compared with the new 6 Star dual-fuel home, and over $5700 per year compared with an existing 2 Star dual-fuel home.

Compared with the new 6 Star dual-fuel home and ICE car combination, the additional cost of the Spanos' home and EV has a simple payback time of 8.65 years, provides an annual investment return of 11.6% and sees the Spanos over $21,000 better off after 15 years, as compared with if they had invested the cost premium of $45,465 directly into their household mortgage.

From an environmental perspective, the 8.3 Star, solar all-electric home and EV reduces annual emissions by more than 11 tonnes (as compared with its 6 Star and ICE equivalent) and more than 14 tonnes (as compared with its 2 Star and ICE equivalent).

Discussion

This case study puts into a broader perspective the current costs and benefits of both all-electric homes and EVs.

While the significant benefits of solar PV are well known, and those of all-electric homes are increasingly understood (see Renew's latest research into the economics of household fuel choice: bit.ly/EvsG_report), the economic and environmental benefits of EVs, and of all-electric homes with EVs, are poorly understood at this point in time.

	All-electric home & EV	6 Star dual-fuel home & ICE vehicle	2 Star dual-fuel home & ICE vehicle
Cost premium	$45,465	$0	$0
Running costs per year	$2107	$7363	$7820
Annual emissions (tonnes CO_2e)	0	11.21	14.38

Figure 4. Costs and emissions for the three home and vehicle combinations modelled

EVs in Australia in 2019 remain expensive in terms of upfront costs, as compared with similar ICE vehicles in the market. And while they are on a downward price trajectory, EVs may remain more expensive to purchase than equivalent ICE vehicles for some years to come.

However, when considering the full upfront and ongoing costs and benefits, and in the context of an all-electric home with regard to both stationary and transport energy, all-electric homes and EVs present a very strong economic case, as compared with typical Victorian dual-fuel homes and ICE vehicles.

In addition, the environmental benefit (by way of lower greenhouse gas emissions) of solar all-electric homes coupled with EVs is becoming clear. Indeed, EVs on their own are able to be lower emissions than comparable ICE vehicles, even in Victoria—with the highest emissions factor for electricity use in the country. Even without direct charging from on-site solar PV, the emissions intensity of EVs will improve over time as the emissions intensity of the national electricity market continues to reduce. Understanding the costs and benefits and environmental value of higher efficiency, solar all-electric homes and EVs in this way is relatively new and much more analysis needs to be done to develop a deeper understanding of opportunities and constraints for Australian households.

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