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B. Gaton, 2022.

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A-Class electrician & Registered Electrical Contractor

(Former!) ICE to EV converter and repairer

Member - Renew

Why EV?

Healesville CoRE, 19.2.22

WHAT's different about EVs compared to ICE? (Terminology, technology)

WHAT's available (In Australia and elsewhere)

WHY are they better?

WHEN to consider making the move

Why EV?

EV Transition is coming in ALL forms:

- Trucks
- Bicycles
- motorbikes
- Planes
- 'Flying cars'
- Autonomous forms
- Busses
- Ferries



Transitions often happen faster than you expect ...



New York: 5th Avenue

April 1900

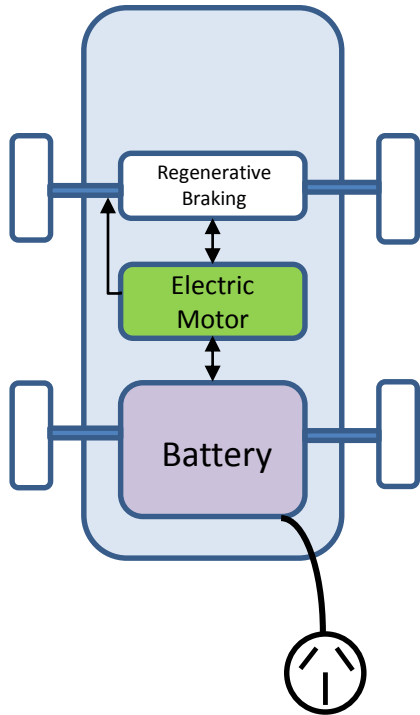
Source: US national archives/Wikipedia

Easter 1913

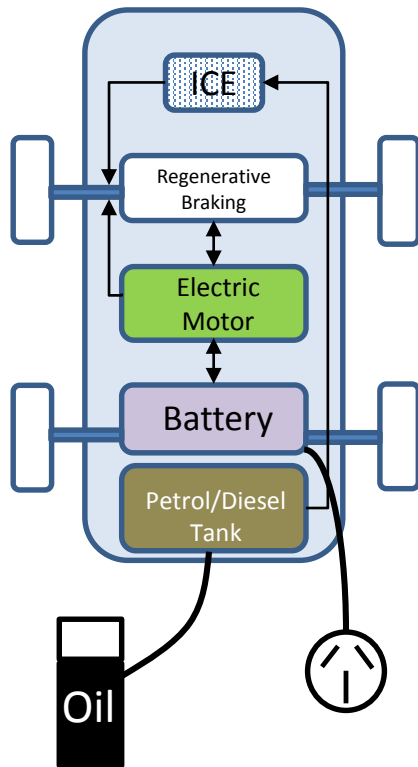
Source: George Bantham Bain Collection

PEV
Plug-in Electric Vehicle

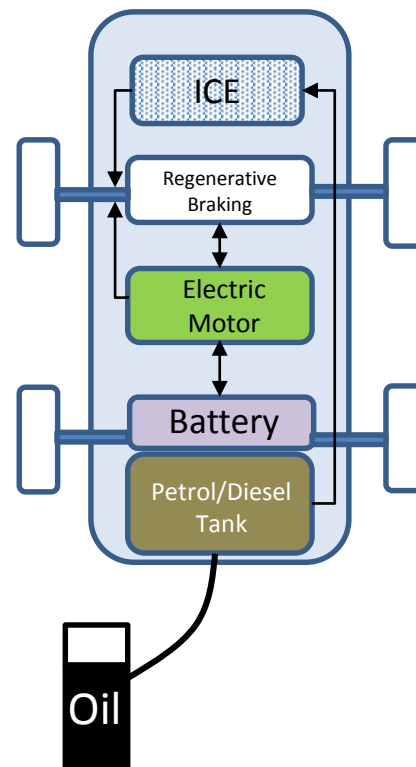
BEV
Battery Electric Vehicle



PHEV
Plug-in Hybrid Electric Vehicle

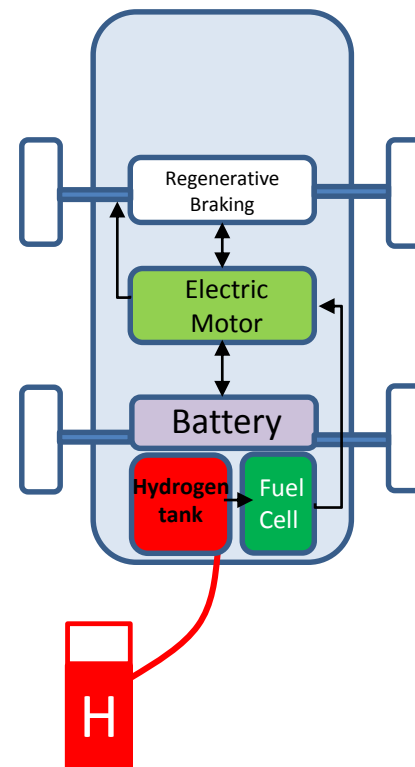


HEV
Hybrid Electric Vehicle

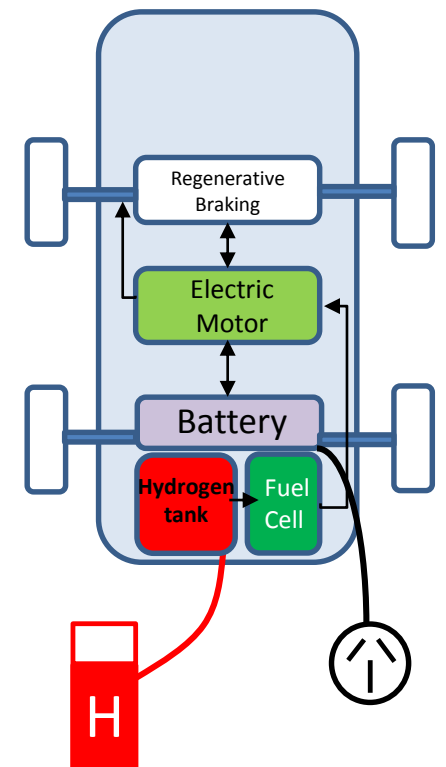


Alternative name:
'the hydrogen car'

FCEV
Fuel Cell Electric Vehicle



PFEV?
Plug-in Fuel Cell Electric Vehicle
(Some experimental EV trucks)



What is an EVSE?

EVSE = Electric Vehicle Supply Equipment. (= Car charger)

AC types:

DC (fast-charge):



Image: EVolution



Image: JetCharge



Image: Tesla



Image: Tritium



Image: ABB

What is V2X?

V2L = Vehicle to Load (appliances only)

V2H = Vehicle to Home (behind the meter)

V2G = Vehicle to Grid (feeds to grid as well)

V2X = general term for all

Currently:

- a) Only CHAdeMO does V2H or V2G
- b) CHAdeMO lost the Plug War: CCS now the dominant DC connector
- c) Only one unit approved for use with CHAdeMO (**as of last week**)
- d) CCS is being developed to do V2X (Now does V2L)
- e) Likely 2025 before CCS V2X systems and hardware approved and widely available here



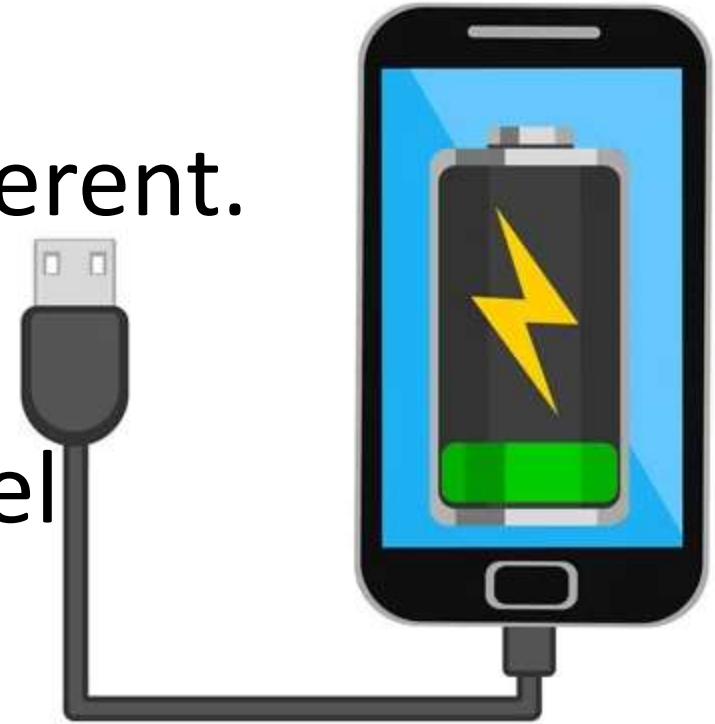
How do I charge?

Key point: EV 'refuelling' paradigm is different.

Think plug-n-ignore 'mobile phone' model

NOT

find, stop, and act as a
'fuel pump attendant'








How fast can I charge?

Provisos:

- 1. Charge times shown are estimates only and are not endorsed by the manufacturer.
- 2. Please refer to official specifications when purchasing an electric vehicle.

Notes to table:

- a. Assuming 15kWh/100km efficiency.
- b. Ioniq 5 has a max. 11kW (16A x 3 phase) charger.
- c. Ioniq 5 maximum DC rate is 220kW
- d. Gives 100km charged in under 5 min!

Typical outlet example	AC supply Amps	DC kW	Hyundai Ioniq 5	
			max. km charged/hr ^a	Hours to 100%
	10	2.4	15	31
	15	3.6	24	20
	32	7.2	45	10
	32 3 phase	22	67	6.1
DC Chargers:	AC supply Amps	DC kW	max. km charged/hr ^{a,d}	Time to 80%
	75 3 phase	50	383	56.5 m
	525 3 phase	350	1250 ^c	17.25 m ^d

How fast do I NEED to charge at home?

1. Less than 200km in a day



- Overnight charge @ 10A/2.4kW will have you recharged in less than 8hrs
- Cost: approx. \$500 installed. BTW: don't use a power point as your sole home charging method ...



2. Within range of one car charge/day (Kona = 400+km)

- Overnight charge @ 32A/7.2kW = full charge in 9hrs
- Cost: \$1500 up installed.



How far can I go on a charge? (Range estimates)

Beware: one of three test standards may have been used.

1. NEDC = Old European standard/still regularly quoted here.

Commonly around 30% too high.

2. WLTP = New European standard (since 2017).


Very close to mainly city/middle to outer suburban use.

3. US EPA = United States Environmental Protection Agency

Very close to mainly middle/outer suburban and regional driving.

- For more info on range: see Renew magazine edition 155. (Apr – Jun 2021)

	NEDC	WLTP	US EPA
Vehicle	Range estimates in kilometres (km)		
Nissan Leaf 40kWh	315	285	243
Hyundai Kona 64kWh	557	484	413
BMW i3 42kWh	359	310	245
Renault Zoe	403	300	Not sold in US

- 
1. Are EVs overall more polluting? **NO**
 2. Can the grid handle the extra load? **YES**
 3. Can EV batteries be recycled? **YES**
 4. Do EV batteries last? **YES**
 5. Do EV batteries cost more than the car? **NO**
 6. Are EVs made with polluting minerals mined by children? **Not just an EV issue**
 7. Can I charge away from home? **Yes (and improving-see next slides)**
 8. Can BEVs tow? **If rated for it**
 9. Do EVs catch fire a lot? **NO**

Details: <https://thedriven.io/2021/11/03/top-10-urban-myths-about-electric-vehicles-that-deserve-to-die/>

10. Does an EV go the distance?

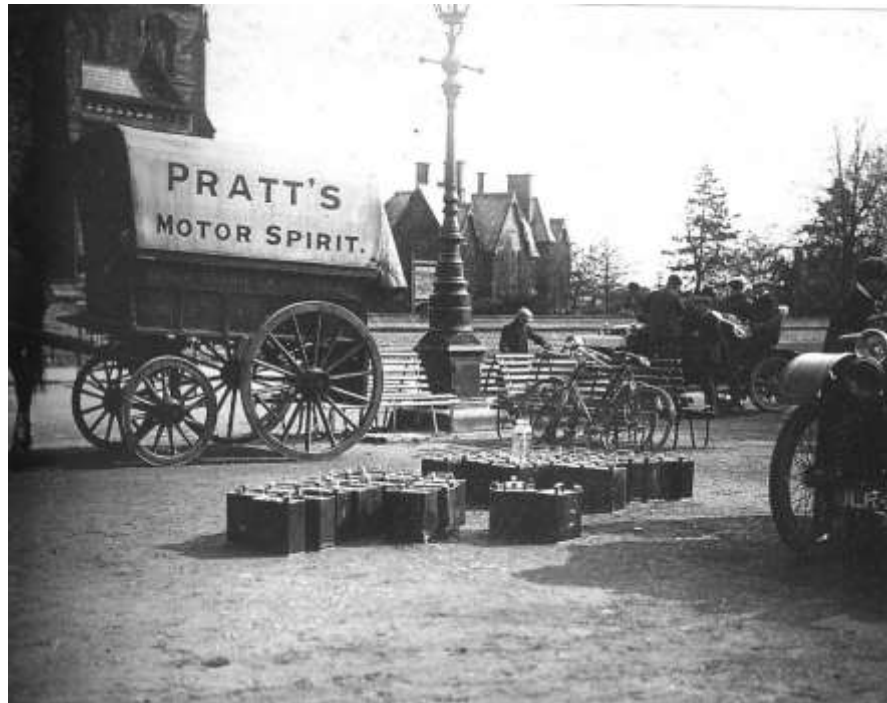
Early days?

The first petrol pumps were introduced just after WW1:

- This was 25 years after the first ICE vehicles

Before that ...

... were only 2 gallon tins:

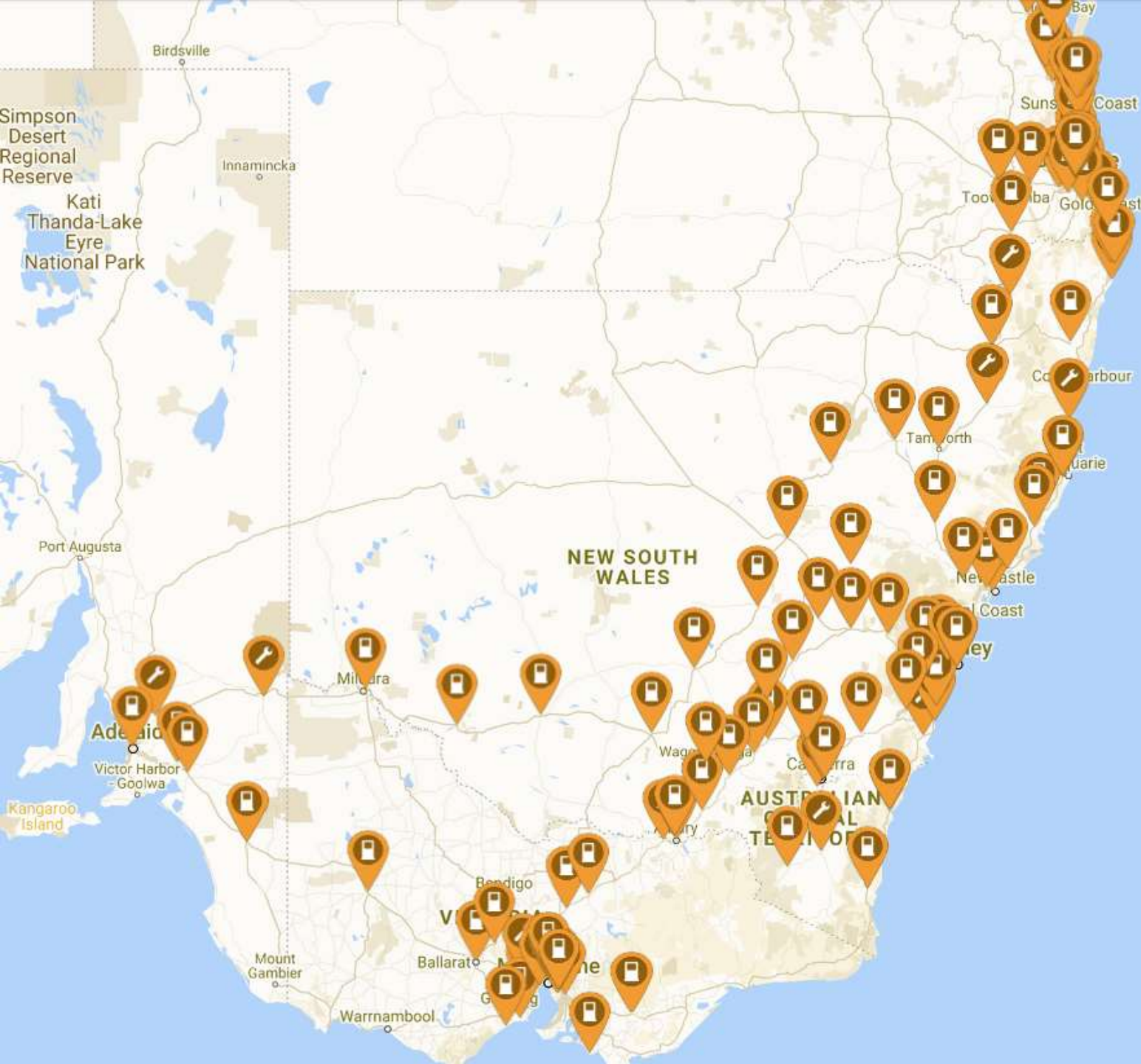


Victoria

The map displays the state of Victoria, Australia, with its borders with New South Wales (NSW) to the north and South Australia (SA) to the west. Major cities and towns are marked, including Melbourne, Geelong, Bendigo, Ballarat, and Hamilton. The ECOSSE tour route is highlighted in black, starting at Melbourne and ending at Ballarat. Key stops are marked with numbered circles: Stop 2 (near Wangaratta), Stop 3 (near Kerang), Stop 4 (near Mildura), Stop 5 (near Horsham), and Stop 7 (near Ballarat). A legend in the top right corner identifies road types: C 234 (C Roads), B 400 (B Roads), A 79 (A Highways), M 79 (M Freeways), and A 8 (National Highways). A north arrow is located in the top right corner. The text 'End: ECOSSE' is placed near Melbourne, and 'Night 1' is indicated near Ballarat.

Now...

<https://www.plugshare.com/>



The future:



WHAT is available: World – lots of BEV cars coming!



BEVs currently available in Australia:



Tesla Model S: **\$170,000**
Unavailable till Dec 2022



Tesla Model X: **\$197,000**
Unavailable till Dec 2022



Tesla Model 3: **\$67,500**



Renault Kangoo ZE: **\$53,000**



Mini Cooper SE electric: **\$62,000**



Hyundai Ioniq EV: **\$54,000**



Hyundai Ioniq 5: **\$77,300**



Hyundai Kona EV: **\$64,000**



BMW i4: **\$111,000**



BMW iX3: **\$129,000**



BMW iX Drive40 **111,000**



BMW iX Drive50: **\$182,500**

BEVs currently available in Australia:



Volvo XC40 Recharge: **\$84,000**



Mazda MX-30 E35: **\$69,000**



MG ZS EV: **\$44,000**



Jaguar I-Pace: **\$140,000**



ZE1 Nissan Leaf: **\$53,000**



Mercedes EQA: **\$85,500**



Mercedes EQC: **\$151,500**



Porsche Taycan: **\$218,000**



Polestar 2: **\$66,387**



Audi e-tron: **\$144,000**



Kia EV6: **\$75,000 TBC**



Kia e-Niro: **\$67,500**

BEVs likely coming soon to Australia:



Tesla Model Y: H1 2022??
From \$75,000? (exc ORCs)



Tesla Roadster 2.0: H1 2023?
From \$250,000? (exc ORCs)



SEA E4B Commuter Bus. Soon.
\$TBC



EV Auto EC11 1.75t van: Q1 2022
\$89,000 (inc ORCs)



Porsche Taycan Cross: H1 2022
Price: > \$230k



Toyota bZ4X (Q4 2022)
From \$80,000? (inc ORCs)



Genesis GV60: H1 2022
\$75k TBC (exc ORCs)



Ora Good Cat (Q4 2022?)
From \$40k (exc ORCs)



Cupra Born: Q4 2022 (VW ID.3 based)
Price: \$70k? TBC

Mercedes:

EQS: H1, 2022. **Price: > \$250k**

EQB: H2 2022. **Price TBC**

EQV: H2 2022. **Price TBC**

Genesis:

GV70: H1, 2022. **Price: TBC**

G80: H1 2022. **Price TBC**



BYD: Wait and see.
From \$45,000??

BEV utes are coming (But few to Australia ... yet)



GM Hummer electric
US release: Q2 2022
Not confirmed for Australia



Rivian RT1
Released: Q4 2021
Confirmed for Australia in 2023?



Ford F150 Lightning.
US release: April 2022
Not confirmed for Australia



GM Chevrolet Silverado
US release: 2024
Not confirmed for Australia



Tesla Cybertruck
US release Q1 2023?
Confirmed for Australia



Mercedes EQG concept
2024?

Electric ute features over ICE:

- AC power outlets to run tools on remote sites
- Extra space for loads (eg Rivian gear tunnel)
- Whisper quiet travel in the bush
- Full electric camp kitchen options: Rivian, Tesla



FCEVs?



- Toyota Mirai, Hyundai Nexo, Honda Clarity, Renault Master FCEV, etc.
- Beyond 2022 to buy. (Currently lease-only for Nexo here).
- Negligible refuelling capacity. (3 or 4 in Australia, one public).
- High electrical energy requirement to generate H_2
= 3 to 5 times that of a BEV doing the same distance.
- Hyundai, Honda have recently ended developing passenger FCEVs.

WHAT is available in Australia:

Second-hand EV offerings

Tesla Model S

- 2013 – current
- \$65K up.
- Range still close to new: batteries holding up well



Tesla Roadster

- 2010 – 2012
- \$100K up? Rare to get hold of.
- Batteries holding up well; Tesla also offer upgrades



Tesla Model X

- 2017 – current
- \$135K up.
- Range/battery issues: As per Model S



Nissan Leaf (Australian delivered)

- 2012 (A few 2011 ex Vic EV trial)
- \$10 – 20k
- Range:
 - ❖ Gen 1 (24kWh): 130 - 140 km (new)
 - ❖ Now: approx 70 - 110 km
 - ❖ NB: Some Gen 1 batteries (2011 to 2013) not holding up.



2011 – 2013 Mitsubishi iMiEV

- \$10 – 15k
- Range:
 - ❖ New 120 km;
 - ❖ now approx. 70 – 100 (depending on battery ageing)



2015 – current BMW i3

- \$35K up
- Note larger & smaller batteries, some REx petrol
- Range (BEV only):
 - ❖ Older: 130km (22kWh), newer: 184km (33kWh); Latest: 40kWh, no REx
 - ❖ No reported battery issues, range holding so far
 - ❖ Early (up to 2018) have CCS1 DC charge port.



Renault Zoe

- 2017-2019
- 40kWh battery
- Up to 22kW AC charging
- No DC charging option
 - ❖ Range: 240 winter/280-300 summer



2018-2019 Ioniq

- \$38 up
- 28kWh battery (38kWh from mid 2019)
- Range:
 - ❖ 28kWh: 200km;
 - ❖ 38kWh: 270km

WHAT is available in Australia:

Private imports/mass conversions

Note: Grey imports can seem cheap, but check warranty & dealer support

MiEV minicab (Grey import)

- 2011 – 2015
- \$15 – 22K
- Private importer in Qld
- Mechanically an iMiEV
- 10.5 & 16kWh battery sizes



Nissan Leaf (Grey import)

- 2012 - 2020
- \$18 – 50k (generally 30 & 40kWh, some 63kWh)
- Private importers in Qld and Vic
- GoodCarCo doing bulk-buys
- Range:
 - ❖ Gen 1 (24kWh): 100 - 120 km
 - ❖ Gen 1a (30kWh) 160km
 - ❖ ZE1: (40kWh) 220km
 - ❖ ZE1 e+ : (63kWh) 364km



Nissan E-NV200 van/wagon (Grey import)

- 2014 – 2017
- \$23-28K
- Private importer in Qld. Good Car Co too?
- Mechanically a 24kWh Leaf, but many have battery cooling. (Unlike the Leaf).



Blade Electron (Converted Hyundai Getz)

- 2007 - 2011
- \$500 – 12,000 (depending if going or not)
- Range: 40 – 150km depending on version and battery age (originally quoted as 100 – 200km)
- Approximately 50 built: NOT for the faint-hearted, technical and build quality issues abound!



WHY EVs benefit the environment (and you)



1. The environment:

- No tailpipe pollution
- Reduced overall emissions (see also next slide)
- Negligible emissions if using solar and/or GreenPower
- Reduction in waste coolants, oils, brake pads, plugs, & filters
- Some issues re ethical sourcing of some battery minerals – but this applies equally to many other products too. ☹️

2. You:

- Vehicle service costs much reduced
- Electricity is much cheaper than petrol
- On the right tariff – fuel may effectively be ‘free’!

WHY EVs benefit the environment (and you):

What are my savings?

Assumptions:

- Renault Zoe EV (133Wh/km, Australian Green Vehicle Guide)
- 10,000 km/yr
- charge overnight only, off-peak tariff of 20c/kWh
- ICE at 10L/100km using 98 RON premium fuel



EV: at 13.3kWh/100km & 20c/kW (off peak) = **\$266**

ICE: at 10L/100km & 1.50/L (premium fuel) = **\$1500**

Fuel saving: \$1500 - \$266 = \$1234

PLUS: Service savings: estimate \$250/yr

Total saving using EV/10,000km (approx.): **\$1500/10,000km**



WHEN to consider a currently available new EV (usage):

Created and written by:
Bryce Gatton
Contact:
Bryce@evchoice.com.au

EV FACT SHEET
NEW BEV models currently
(or soon to be) available in Australia

For latest list: <https://www.aeva.asn.au/battery-electric-vehicle-models-bevs/>

Feb 2022



Criteria:	For data - see EV Fact Sheet 'BEV Summary' at: www.aeva.asn.au		
	Model choice 1 Kona EV	Model choice 2 Ioniq 5	Model choice 3 MG ZE EV
Do you travel ≤ 50 km/day? (Av. daily <u>Melb</u> commute = 30km)	✓	✓	✓
Do you travel ≤ 140 km/day?	✓	✓	✓
Do you travel ≤ 200 km/day?	✓	✓	✓
Do you travel ≤ 300 km/day?	✓	? ¹	?
Do you travel ≤ 400 km/day?	✓	✓	??
Your long distance travel follows a Tesla interstate Supercharger route?	X	X	X
Do you need a car for towing?	X	✓	X
Have a approx. budget of \$60,000	✓	X	✓✓

Battery Electric Passenger Vehicles – available now						
make/model	WLTP range ¹ km	Size class ¹¹	Battery size/s: kWh	Max charge rates in kW AC/DC ⁷	Tow rating in kg unbraked/braked	Price ⁴
Audi e-tron 50	336	L SUV	71	11/150	750/1800	\$148,000
Audi e-tron 55	417	L SUV	95	11/150	750/1800	\$165,699
Hyundai Kona electric-SR	305	S SUV	39	7.2/44	X	\$59,000
Hyundai Kona electric-LR	484	S SUV	64	7.2/70	X	\$64,000
Hyundai Ioniq electric	311	S Pass	38	7.2/44	X	\$54,000
Hyundai Ioniq 5	451	M SUV	73	11/220	750/1600 ⁹	\$77,300
BMW i4 eDrive40	590	L SUV	81	11/200	TBC:750/1600	\$111,000
BMW iX3	460	M SUV	80	11/155	750	\$129,000
BMW iX Drive40	420	L SUV	75	11/150	750/2500	\$150,000
BMW iX Drive50	620	L SUV	110	11/200	750/2500	\$182,500
Jaguar I-Pace	470	L SUV	90	11/100	750/750	\$127,990
Kia e-Niro	455	S SUV	64	7.2/70	300/300	\$67,500
Mazda MX-30 E3S Astina	200	S SUV	35.5	6.6/50	X	\$69,000
Mercedes EQA	426	S SUV	66.5	11/100	X	\$83,000
Mercedes EQC	400	M SUV	80	7.4/110	X	\$151,500
MG ZS EV	263	S SUV	44.5	7/50	X	\$45,000
Mini Cooper SE	232	Li Pass	32.6	11/50	X	\$62,000
Nissan Leaf ZE1	270	S Pass	40	6.6/50	X	\$53,785
Nissan Leaf ZE1 e+	385	S Pass	62	6.6/100	X	\$65,000
Polestar 2 std. range (2WD)	440	M Pass	69	11/130	750/1500	\$66,387
Polestar 2 long range (AWD)	540	M Pass	78	11/155	750/1500	\$77,067
Porsche Taycan 4S	431	L Pass	79/93 ⁸	11/270	X	\$218,224
Tesla Model 3 Std Range 2WD	491	M Pass	50	11/100	750/910	\$67,485
Tesla Model 3 L Range AWD	614	M Pass	75	11/250	750/910	\$79,047
Volvo XC40 Recharge	400 TBC	S SUV	78	11/150	750/1500	\$84,000

Battery Electric Light Commercial Vans – available now						
make/model	WLTP range ¹ km	Load capacity: kg	Battery size/s: kWh	Max charge rates in kW AC/DC ⁷	Tow rating in kg unbraked/braked	Price ⁴
Renault Kangoo ZE van	270 ¹ /160 ²	650	33	7.2(NA)	322/322	\$53,000

Article: <https://thedriven.io/2021/06/13/the-what-why-when-guide-to-buying-an-electric-vehicle-in-australia/>

WHEN to consider a used EV (usage):

Criteria:	2 nd hand							
	24kWh Leaf	30kWh Leaf ³	Mitsubishi iMiEV	BMW i3 22kWh	BMW i3 33kWh	Mitsubishi MiEV van ³	Nissan E-NV200 ³	Renault Zoe
Do you travel ≤ 50 km/day? (Av. daily Melb commute = 30km)	✓	✓	✓	✓	✓	✓	✓	✓
Do you travel ≤ 140 km/day?	? ¹	✓	? ¹	? ^{1,2}	✓	? ¹	? ¹	✓
Do you travel ≤ 200 km/day?	X	? ¹	X	? ^{1,2}	? ^{1,2}	X	? ¹	✓
Do you travel ≤ 300 km/day?	X	X	X	X	? ^{1,2}	X	X	✓
Do you travel ≤ 400 km/day?	X	X	X	X	X	X	X	? ¹
Does your long distance travel follow a Tesla interstate Supercharger route?	X	X	X	X	X	X	X	X
Do you need a car for towing?	X	X	X	X	X	X	X	X
Have a maximum budget of \$30,000	✓	✓	✓	?	X	✓	✓	✓

Notes:

1. Can make these ranges if topping up during day or use DC fast-charge option.
2. No DC fast-charge (or 3 phase AC charge) for pre-2018 BMW i3. Note: some may have CCS1 DC port, but this needs to be changed to CCS2 to be useful (easy, but costly).
3. Second-hand, 'Grey Import' Japanese Mitsubishi MiEV vans, 30kWh Nissan Leafs and Nissan E-NV200 vans now being imported by several vehicle businesses.

WHEN to consider an EV (practicalities):

Other considerations:

- Current switchboard and street supply cable needs to be up to providing the increased electrical load.
 - See ReNew magazine, edition 143.
- Do you have somewhere to charge off-street? (lead safety, strata title homes).
 - See Renew magazine edition 145.
- Need to carefully select an appropriate electricity tariff.
 - See ReNew magazine, edition 144.
- Choice of EVSE capacities (PV sensing, load managing, price)
 - See Renew Magazine edition 156 (July – Sept 2021)
- You may need to buy extra adaptors/leads to use public EVSEs.
- Useful to carry a higher power EVSE for travelling.



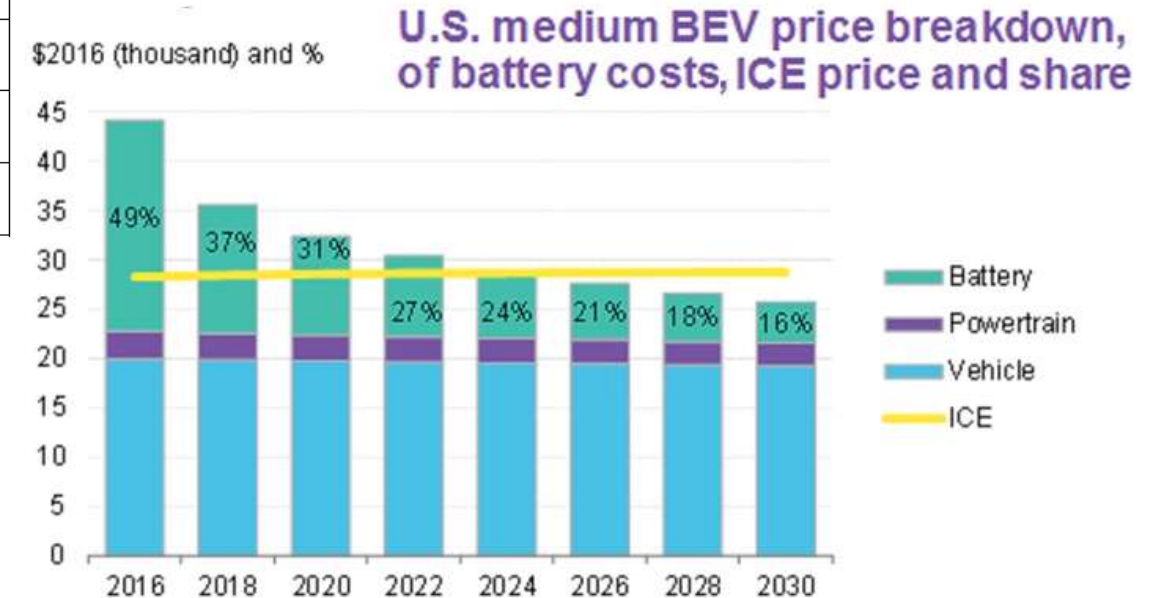
When can I afford one?

First vehicle segment BEV prices predicted to reach ICE price parity by 2024, fall below ICE thereafter:

Year of EV up-front price parity with ICE vehicles in selected markets

Segment	US	EU	China	Japan
Small	2027	2028	2030	2040
Medium	2025	2024	2024	2029
Large	2026	2025	2029	2027
SUV	2024	2026	2040	2025

Source: Senate enquiry into Electric Vehicles report, 2019



Source: Bloomberg New Energy Finance, EPA, ICCT, FEV, ONRL, IDL. Note: Estimated pre-tax retail prices

WHEN will there be only EVs to buy?

Countries with legislated bans on new ICE vehicle sales:

Country	ICE sales end date
Costa Rica	2021
Norway	2025 (2040 for short-haul flight)
Denmark	2030
India	2030
Ireland	2030
Israel	2030
Netherlands	2030
Sweden	2030
UK: Scotland	2032
China	2040
France	2040
UK: England Wales N. Ireland	✗ ✗ ✗



More should be done to encourage the transition to electrified vehicles, according to Victorians, despite proposed taxes.



2030?

To find out more:



<https://renew.org.au/>

Edition 156: (July – Sept 2021)

- EVSE buyer's guide
- EV conversion electrical work safety

Edition 157: (Oct – Dec 2021)

- EV Buyer's Guide
- EV market Update

Edition 158: (Jan – Mar 2022)

- How to check a second-hand EV



Site: (for membership)

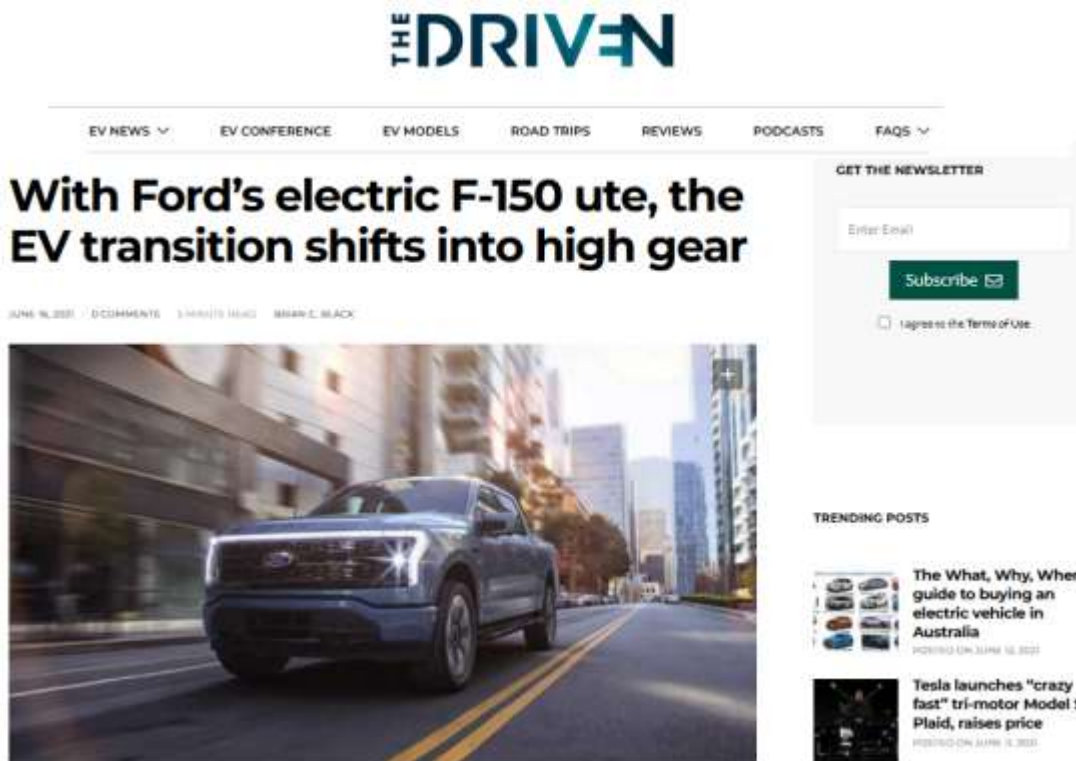
<https://www.aeva.asn.au>

Discussion forum: (free to join)

<http://forums.aeva.asn.au/>

Australian EV news and information websites:

- TheDriven: <https://thedriven.io/>
- Electric Vehicle Council: <https://electricvehiclecouncil.com.au/>



Summing up:

- ✓ The EV transition is about more than just cars.
- ✓ BEVs in Australia DO reduce carbon emissions, even if using grid power.
- ✓ BEV CO₂-e reduces to zero with a green grid. ICE cannot.
- ✗ FCEV will reach zero emissions a very long time after BEV.
- ✓ BEVs remove exhaust emissions from built-up areas.
- ✓ BEVs WILL do the distance – city AND country.
- ✓ BEVs are cheaper to run, both for service and ‘fuel’ costs.
- ✓ BEVs are better to drive (instant acceleration, no vibration, no fumes, quiet).
- ✓ BEVs are getting cheaper all the time, price parity begins 2024, all by 2028-ish.
- ✓ BEVs becoming available in ever more vehicle segments (including utes).
- ✓ EVs (particularly BEV) will soon become the ONLY option.

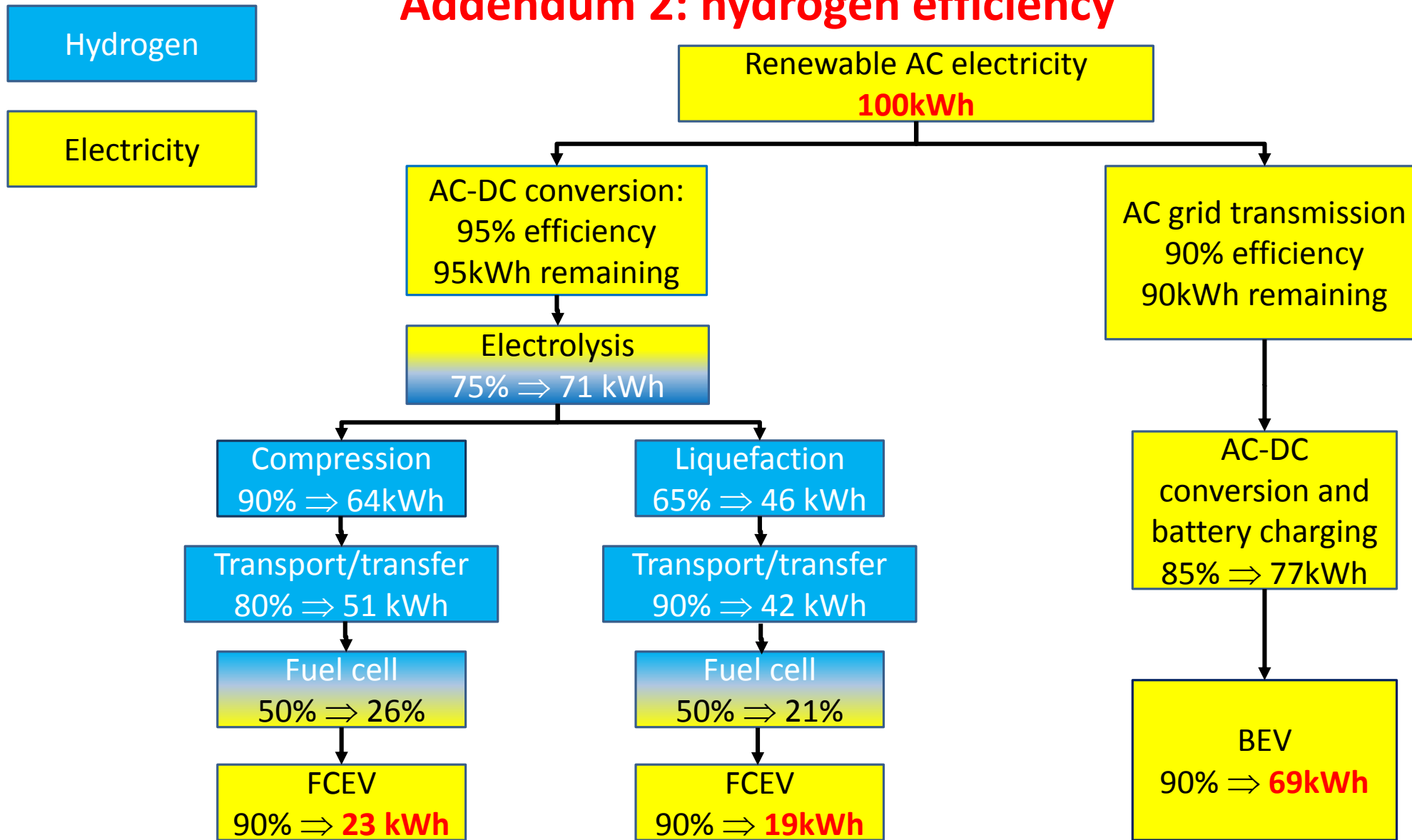
Any burning questions?

Want a copy of these slides: EVNews@bigpond.com

Addendum 1. Further reading:

- European air quality standards:
<https://ec.europa.eu/environment/air/quality/standards.htm>
- EV Council report (Australia): State of Electric Vehicles, August 2019.
<https://electricvehiclecouncil.com.au/wp-content/uploads/2019/09/State-of-EVs-in-Australia-2019.pdf>
- Smit, Whitehead and Washington, 2018. Where are we heading with electric vehicles, *Air Quality and Climate Change*, V52, No.3, September 2018, 18 – 27.
- Climate Council report: Waiting for the Green Light: Transport Solutions to Climate Change. 2018. <https://www.climatecouncil.org.au/resources/transport-climate-change/>
- Australian Vehicle Emission Standards:
<https://www.infrastructure.gov.au/vehicles/environment/emission/index.aspx>
- Senate Select Committee Report on Electric Vehicles:
https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Electric_Vehicles
- Union of Concerned Scientists: Top Five Reasons to Choose an Electric Car
<https://www.ucsusa.org/resources/top-five-reasons-choose-electric-car>

Addendum 2: hydrogen efficiency

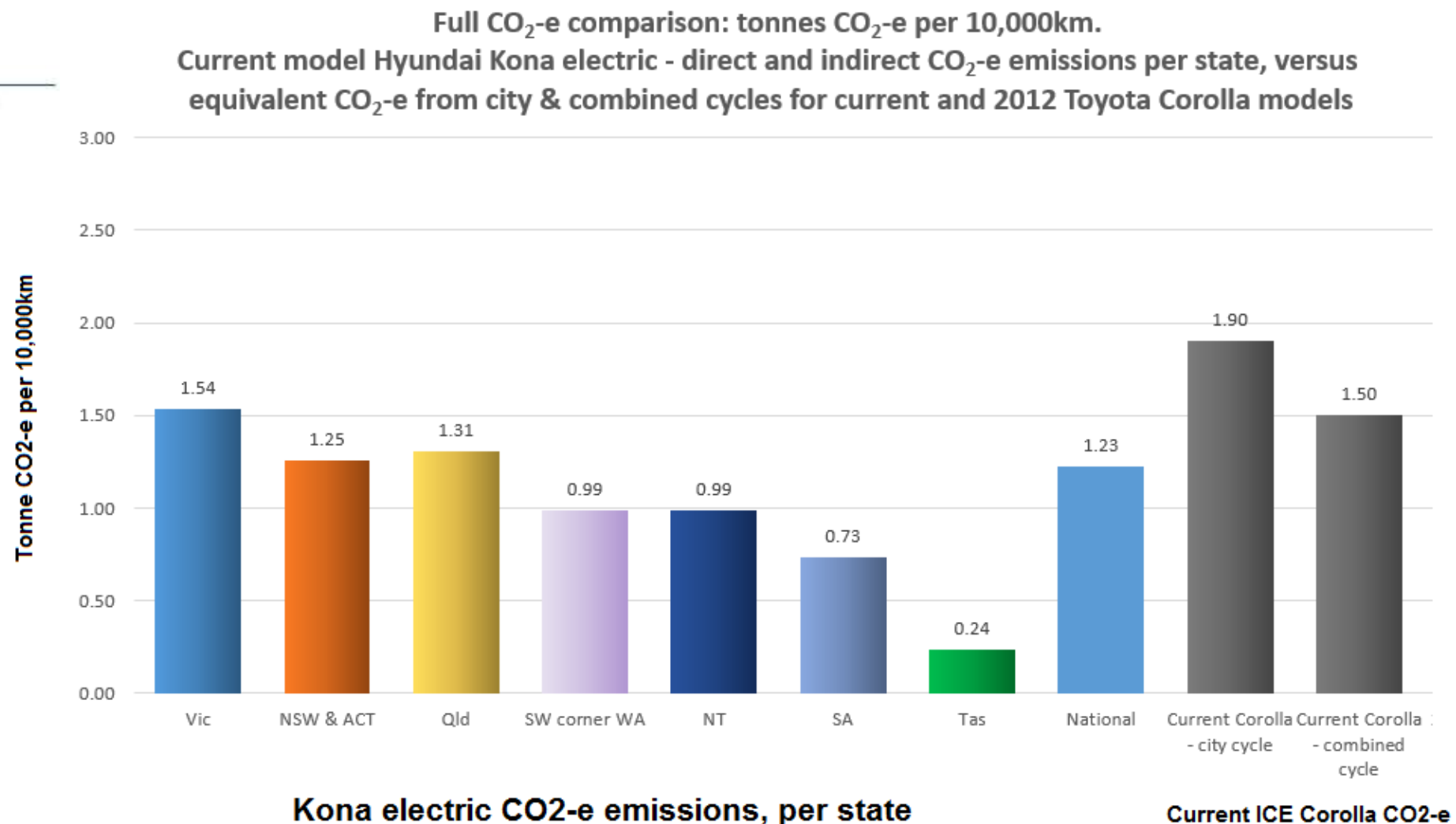


Source: "Does a Hydrogen Economy Make Sense?" *Proceedings of the IEEE*. Vol. 94, No. 10, October 2006.

Addendum 3: Australian grids and EV emissions

National Greenhouse
Accounts Factors

Australian National Greenhouse Accounts



*Calculations done to Department of the Environment and Energy National Greenhouse Accounting methodology using the 2020 NGA Factors data. For full (2017 data) article: see ReNew 143, April-June 2018. New 2020 data summary article at TheDriven.io).

Addendum 4: ICE vs EV resource use and payback periods

Currently:

- Average EV in Europe produces 50% less life-cycle CO₂-e over the first 150,000 km.
- EV manufacturing-phase emissions paid back in 2 years of driving using European av. grid elec.

Reference: Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions. <https://theicct.org>

UK predictions to 2050:

