From:
To:
Subject:
Date:
Attachments:

Dear Anthony

Please forgive my delay in thanking you, Angeline and Tina for all your help on Monday 18 November. It was very much appreciated and I got to my AGM and presentation in time.

I have now read the transcript of the evidence I gave. I have a few minor corrections and ask how best they should be handled?

I promised two 'on notice' answers; the first on batteries and EVs, the second on comparative wholesale electricity prices world wide. For the first question I attach the ATSE 'Focus' article to which I referred, both the original .docx file and the actual Focus magazine .pdf file. However I should note that in response to a recent question to my co-author, Dr John Baxter FTSE, he advises as follows:

"V2G is waiting for a uniform industry standard to evolve, probably eventually from an industry body with "grunt" such as SAE. EV manufacturers don't like to have their batteries depleted by an unknown load, at unknown & unpredictable timing, with an unknown data interchange protocol. Car makers, like most other "product" manufacturers, like to sell you, and of course provide you a warranty for, a "black box" and try to avoid the risks involved with their "product" forming part of a much larger system (i.e. the grid)."

This response may be helpful to the committee.

Turning to the question of wholesale electricity prices, I have yet to locate the file to which I referred. Meantime I offer the website below which emphasises the point I made, but requires some investment to access the data! I will leave that one to you but will continue my search for the file(s) on international wholesale prices that I had in mind.

With kind regards,

Martin

https://www.globalpetrolprices.com/electricity_prices/

Electricity prices

Electricity prices, March 2019: The chart shows the price of electricity for households and businesses in over 100 countries. The prices are per kWh and include all items in the electricity bill such as the distribution and energy cost, various environmental and fuel cost charges and taxes. The world average price is 0.14 U.S. Dollar per kWh for household users and 0.12 U.S. Dollar per kWh for business users. The prices for **households** are calculated using the average annual household electricity consumption per year and for **businesses**, we use 1,000,000 kWh consumption per year. We do, however, calculate several data points at different levels of consumption for both households and businesses. The methodology of price collection is described on the about page.

The latest business and household electricity price data from September 2019 are available for download

Electricity prices for households, March 2019

(kWh, U.S. Dollar)

ATSE IN ACTION

Can EV batteries drive rooftop PV uptake?


By John Baxter and Martin Thomas
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This article was prepared by the authors as a summary of Appendix 2 of the ATSE Submission to the Energy White Paper Issues Paper, the contributors to which were the authors together with ATSE Fellows Dr Alan Finkel, Dr Graeme Pearman, Dr David Rand, Dr John Sligar and Dr Brian Spies.

The world is entering an era of unprecedented development of electric vehicles (EVs) driven by rapid advances in the reliability, performance and durability of Lithium-ion batteries. Over the past 10 years the specific energy (kWh/kg) and cycle-life of such batteries have risen dramatically while manufacturing costs continue to fall.

Roof-top photo-voltaic (PV) cell systems are now installed on close to one in 10 Australian homes and provide an attractive low-emissions-intensity means of slow-charging 'plug-in' EVs.

But are there other more significant synergies between these two technologies?

EV production worldwide, while growing rapidly, is still minute compared with the 63 million conventional cars manufactured annually with internal combustion (IC) engines. Only two Battery Electric Vehicle (BEV) models (Nissan Leaf and Mitsubishi i-MiEV) and one parallel-hybrid Plug-in Hybrid Electric Vehicle (PHEV) model (GM Volt) are currently imported into Australia. However, a far wider range of BEVs and PHEVs are expected to reach our market over the next five years – with the corresponding increase in annual world production volumes of EVs and battery systems inevitably reducing prices.

BEVs use a highly efficient electric motor to power the drive-train. Energy stored in an on-board battery is initially supplied from the grid. PHEVs also have an electric motor but add an IC engine able to drive the wheels either directly via the drive-train or indirectly via a generator.

Thus the battery, with two reliable sources of supply, offers significantly enhanced vehicle range. PHEVs are further classified as 'series hybrid', where the engine powers only the generator to charge the battery, or 'parallel hybrid' where it is also either continuously or intermittently connected mechanically to the drive-train, optimising the drive cycle through improved acceleration and reduced emissions at higher loads.

Plug-in EVs, once sufficiently adopted in the marketplace, can bring huge benefits to the electricity grid. EV batteries offer significant storage capacity and an essentially off-peak load – typically 10 to 20 kWh for PHEVs and 20 to 50 kWh for BEVs. Such potential load-levelling capacity enables a truly 'intelligent grid' with substantial distributed storage embedded in the low-voltage (LV) layer of the system, inter alia enabling the further expansion of rooftop PV systems on Australia's homes, factories and public buildings.

With an appropriate enabling regulatory and economic framework (including intelligent metering, time-of-use pricing and connection standards), possibly coupled with economic incentives, at least initially, much of this new generation and storage capacity would be funded privately by business and individuals, reducing new funding for conventional generation. 'Plan-based' business models could develop, similar to mobile phone markets, to permit alternative ownership and payment schemes and so encourage PV generation.

In addition, the more challenging option of 'vehicle-to-grid' (V2G) resupply of electricity back to the grid at times of high demand (and thus premium price) could become attractive, depending on the individual usage profiles and system management. EV owners could be enabled, and indeed be economically motivated, to arbitrage the buying and selling of electricity based on tariffs and time-of-use spot prices available over the daily system supply-demand cycle. Economic benefits could accrue both to EV owners and supply utilities, although much remains to be done to bring V2G to commercial reality.

Optimal integration of the vehicle and the grid requires EVs to communicate intelligently with the grid to sell demand-response services. Most private vehicles are parked more than 95 per cent of the time. System architecture must be configured to allow electricity flow from grid to vehicle (G2V) during charging and from vehicle to grid (V2G) under controlled battery state-of-charge conditions – consistent, of course, with owners' needs.

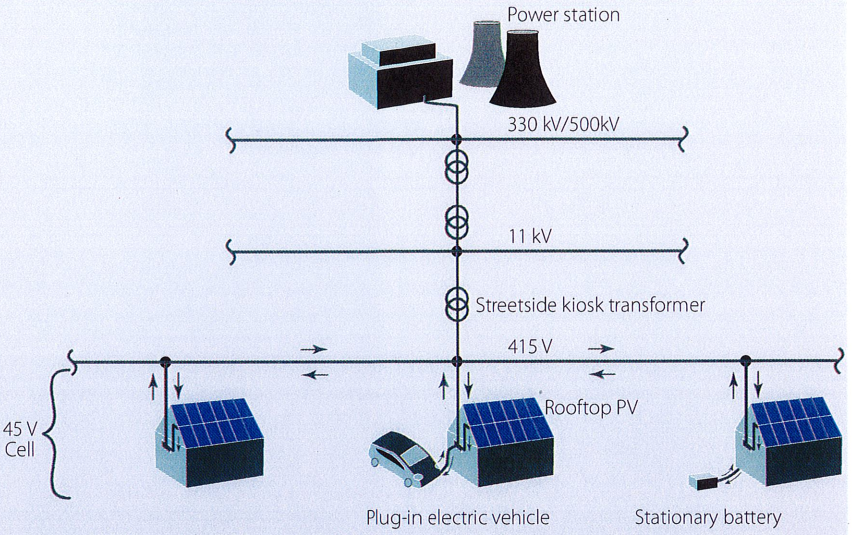
Thus V2G-enabled vehicles could, if permitted by their owners, assist in grid load-balancing by accepting charge at night (when demand and prices are low) and selling power back in day peaks (when demand and prices are high). While special technologies are needed to control supply quality, such arrangements can provide supply utilities with access to effective 'spinning reserve' to meet sudden ramp demands for power as well as maintaining high-quality voltage and frequency regulation.

V2G-enabled vehicles, in sufficient quantity on the system, could also help buffer the supply variability of PV arrays and wind turbines by storing energy during high insolation and strong winds and returning it at times of high demand or reduced renewable supplies. PV and wind resource value can thus be significantly enhanced by economically driven time-of-use pricing.

Notwithstanding these attributes V2G architectures remain embryonic. Pacific Gas and Electric and Xcel in the US are converting conventional PHEVs to V2G configuration to trial grid interfacing. The University of

ATSE IN ACTION

Figure 1 Low voltage exchange network comprising multiple 415V cells, each supplied by a streetside kiosk transformer.



Delaware is studying the technical and economic modelling of direct battery to grid (B2G) technology. A consortium of IBM, Siemens, EURISCO, Dong Energy, Østkraft, the Technical University of Denmark and the Danish Energy Association is using B2G technology to study how best to balance intermittent supplies from Denmark's extensive wind farms, which deliver 20 per cent of its electricity.

Domestic PV supply is typically provided via DC to AC inverters at low-voltage (from 200V to 400V DC to 240V AC). Supply is intermittent due to solar radiation variability dictated by weather conditions, shading and geographical location. In mid-latitude Australian metropolitan cities such as Sydney or Melbourne, a relatively large (20 square metre) PV installation will, on a sunny day, deliver around 4 kW over an average of 12 daylight hours, producing around 15 kWh. An average Australian household uses about 18 kWh per day, although a typical representative range is 10 to 40 kWh depending on family size, their house, its location and its insulation.

The storage and re-supply capability of EV batteries is highly variable at the vehicle level and dictated by owner needs. Not all EVs are plugged in at the same time – some will be fully charged, some owners may not wish to permit any discharge, no matter how attractive arbitrage may be, while yet others will be happy to maximise arbitrage income and accept the risk of a lower driving range. Experience and a clear understanding of the advantages – and disadvantages – of home-based charge-discharge cycles will establish reliable evidence of the quantum and value of benefits to EV owners and system operators.

Even if PV intermittency issues are ameliorated through customer averaging, structural problems with EV charging and grid architectures remain to be resolved to achieve true 'smart grid' architecture. Current physical and electrical EV charging standards do not yet provide for V2G. North American automotive standard SAE J1772 and the European standard VDE-AR-E-2623-2-2 are designed only for AC or DC charging, not for discharging, effectively precluding V2G.

Until EV electrical interface standards evolve under market pressure to permit V2G, at least one alternative solution is available: the use of stationary batteries. Household lithium-ion packages are offered by companies such as SolarCity in the US, using modules manufactured by Tesla on its Californian production line. Other stationary battery concepts include recycled and repackaged performance-degraded EV batteries of various different battery technologies.

A current Australian restraint is that capital city low voltage (LV) infrastructure may have insufficient capacity for significant energy transfer between sources (such as PV cells) and storages (such as EVs and stationary batteries) for which it was not designed. Substantial PV capacity addition could overload LV systems causing unacceptably high voltage and phase swings, excessive harmonics and unacceptable neutral voltage drift. Likewise, large-scale EV adoption could in some circumstances overload local LV systems.

The Australian grid has traditionally been designed 'top-down' from the power station through the grid via a network of step-down transformers from 500 kV or 330 kV, down through 33 kV, 11 kV and ultimately the 415 V level of suburban distribution. Suburban LV grid 'cells' are typically served by a single 1 to 2 MW street-level kiosk or pole-mounted 11 kV transformer delivering a 415 V 3-phase 50 Hz AC supply with floating neutral. Normally each third property taps off one of the three phases and the neutral to provide the conventional 240 V single-phase domestic supply. Such cells typically supply 50 or so properties in one or two suburban streets.

Australian LV architecture provides only for electricity flow in one direction – from supplier to customer – with protection arrangements at transformers to prevent reverse flow. With enhanced EV and rooftop PV penetration significant benefits can be gained by permitting surplus electricity feed-back to the 11 kV network layer, thereby enabling overall network load averaging to be achieved much more broadly than is currently possible.

In order to maximise the potential benefits, Australia must prepare intelligently for the widespread adoption of EVs.

The LV grid layer will need to evolve to what is becoming termed a 'low voltage exchange network', analogous to LANs in computer communications. As cities grow they will demand more electricity.

Provided LV system constraints are removed to enable the grid to become a true exchange network, albeit requiring

CONTINUED ON PAGE 26

ATSE IN ACTION

Antarctic science needs Australian support

Australian scientists working in the Antarctic.

The Federal Government must provide resources and long-term funding for scientific activities in the Antarctic if Australia is to maintain a long-term presence in the region – and it must ensure sufficient supply of trained and/or qualified researchers to meet research needs.

Increasing support for Antarctic research is crucial to Australia's ability to respond to emerging challenges in the region, such as biodiversity conservation and a growing interest in the exploration of the Antarctic's living and non-living resources.

These are two key recommendations in the Academy's submission to the Australian Government's *20-Year Australian Antarctic Strategic Plan*, which notes that Australia has strong strategic national interests in the Antarctic, including a large territorial claim.

It says the Australian Government must ensure there is adequate resourcing of Australia's activities in the Antarctic to enable Australia to deliver viable research programs, strengthen its science capability and support in the region and maintain an effective air and sea transport system between Australia and Antarctica.

"The credibility of our claim to the Australian Antarctic Territory (AAT) is underpinned by our presence across the region through scientific activities. These activities also have direct national benefits through improving our understanding of the region and of the potential impacts resulting from increased human activity in the region," it says.

"Australia has a strong geopolitical interest in ensuring that Antarctica is used for peaceful purposes and that the Antarctic Treaty is upheld. It is also imperative for Australia to be well informed on the activities of other countries in this important region.

"Australia depends on the Antarctic for a range of environmental and economic benefits. The Antarctic provides a range of important ecosystem services and is an important area for fisheries management and biodiversity conservation.

"A key element of our science activity across the region is sustained monitoring and surveying of the Antarctic environment and its natural resources," the submission says.

It suggests improved national coordination could be achieved through:

- ensuring that funding mechanisms have sufficient scope for Australia's long-term strategic Antarctic research needs (including long-term monitoring activities); and
- the establishment of a continuing high-level coordination mechanism that includes all agencies with science and policy interests in Antarctica.

National and international collaboration would enable Australia to leverage its investment in research in Antarctica. A flexible strategy for occupying the AAT, including collaboration with international partners, should assist in supporting logistically demanding science programs.

It notes that Tasmania plays an important role as an Antarctic gateway and urges Government support for research facilities in Tasmania these facilities be maintained or increased. It suggests Australia could explore the effects of tourism in the Antarctic – seeking to become a world-leader in best-practice approaches to minimising environmental harm from tourism activities in the region.

The full submission is on the ATSE website at Publications/Submissions/2014.

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significant engineering design and capital investment, it is not unrealistic to expect that enhanced domestic and commercial PV capacity associated with storage offered by EVs could contribute substantially to meeting urban electrical load growth while reducing the need for new capacity simply to meet system peaks.

DR JOHN BAXTER FTSE was previously joint Managing Director of Bishop Innovation, involved in automotive steering product and process R&D, IP management and international IP licensing. He was inventor or co-inventor for many of Bishop's patents families and has authored and co-authored numerous published technical papers on automotive steering and related vehicle dynamics. In 2009 he joined Baxter IP Patent and Trade Mark Attorneys where he is now a consultant specialising in IP commercialisation, particularly the the structuring of patents and licence agreements to maximise the commercial value of IP.

MR MARTIN THOMAS AM FTSE was a Principal of consulting engineers Sinclair Knight Merz, responsible for the engineering power and energy projects in Australia and overseas, particularly specialising in industrial energy efficiency. Outside the firm he served as President of the Institution of Engineers Australia and the Australian Institute of Energy, the NSW Electricity Council, the export agency Austenergy and the 2000 Olympic Energy Panel. Following retirement he was Managing Director of the Australian CRC for Renewable Energy. He is a past Vice President of ATSE and immediate past Chairman of the ATSE Energy Forum.

From: Martin Thomas
To: State Development
Subject: Re: Inquiry into the Uranium Mining and Nuclear Facilities (Prohibitions) Repeal Bill 2019 - Post hearing responses - 18 November 2019 - Email 3
Date: Tuesday, 17 December 2019 5:14:49 PM

Dear Anthony

In this Email 3 I refer to documentation in support of i) answers to questions on notice and ii) additional information I would like to provide to the committee in support of the written and oral evidence I presented.

I trust this data is of assistance to the committee, and I appreciate the opportunity to have made a contribution.

With kind regards

Martin

Question on notice re international power costs (ref Page 29)
I have not been able to locate the specific table I had in mid giving wholesale power costs in the OECD countries. However the following documentation is relevant to and supportive of the point I was making, essentially on Australia's loss of competitiveness through rising wholesale power prices:

- ***International Energy Agency (IEA) - World Energy Prices 2019: An Overview.*** Reference https://webstore.iea.org/world-energy-prices-2019-an-overview (and attached PDF file). This authoritative IEA report (see particularly Fig 7 - Residential electricity prices in selected economies - 2017) shows that German electricity prices are amongst the world's highest with Australia, with fast growing renewables penetration, now close behind. Countries with nuclear in their generation mix (eg Russia, S Korea, France and Canada) are nearer mid-range prices; *inter alia* also having lower per capita carbon emissions. Some 50 years ago Australia had amongst the world's lowest electricity prices based on high quality coal, consequently attracting resource and manufacturing industries, much of which has now closed or left Australia's shores.

- ***World Nuclear Association (WNA) - Germany's 'Energiewende'.*** Reference https://www.world-nuclear.org/information-library/energy-and-the-environment/energiewende.aspx. This comprehensive WNA paper comments on Germany's policy shift from essentially coal and nuclear based generation, with moderate renewables penetration, to increasingly high renewables penetration combined with the closure of operating nuclear power reactors. The unintended consequences have been and continue to be massive subsidies for renewables (solar and wind), massive investment in enhanced HV transmission from Germany's windy north to its industrialised south, a significant increase in wholesale electricity prices and, astonishingly, renewed investment in brown coal power generation. Germany is fortunate to be able to import electricity from other European nations; some, like France, being able to offer cross-border nuclear generated power.

- ***Australian Energy Council (AEC) - Worldwide Electricity Prices: How does Australia compare?*** Reference https://www.energycouncil.com.au/analysis/worldwide-electricity-prices-how-does-australia-compare/. This instructive paper (see particularly Fig 1 - OECD household electricity prices, PPP measure - 2014) shows that in 2014 Australian prices were in the lower half, next to France and just over half Germany. The substantial price increases since then, taking Australia close to Germany at the top of the table, are in part due to necessary investment in ‘poles and wires’, noting however that some of this investment was required to connect remote renewables and to manage more localised congestion. Further renewables penetration will require significant new transmission and distribution infrastructure. If nuclear power plant were to be deployed at or near the sites of to be decommissioned coal fired plant, it is postulated that much of the established infrastructure could be repurposed. Moreover established regional employment capabilities could readily be re-engaged.

- ***Statista - Global Electricity Prices in 2018, by select country.*** Reference https://www.statista.com/statistics/263492/electricity-prices-in-selected-countries/. This up to date document reinforces the points made in the foregoing data sets. Note that renewables rich Germany at 0.33c/kWh is approaching double the price of nuclear rich France at 0.19c/kWh. Other countries with significant nuclear capacity appear in the lower half of the graph.