Energy Green Paper 2014

Submission on Chapter 4 in relation to the issue:

“Secure and reliable energy supplies”

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Electric vehicles. The world is entering an era of unprecedented development and take-up of battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). This expansion is primarily driven by rapid advances in the reliability, performance and durability of Li-ion batteries, as well as control systems and regenerative braking, that optimise the conversion of electrical energy to vehicle motion. Over the last ten years the specific energy (kWh/kg) and cycle-life of Li-ion batteries have risen dramatically. At the same time manufacturing costs continue to fall. Currently EV production worldwide is distributed over approximately 40 passenger car BEV and PHEV models, a small figure compared to the many hundreds of models making up the 63 million “conventional cars” manufactured annually that use only the internal combustion (IC) engine as their power source. However almost all automotive manufacturers currently have EV models in production, or at least in their 5-year development cycle pipeline. The massive increase in annual world production volumes of EVs and the adoption of true mass production techniques for Li-Ion battery systems over the next 10 – 15 years will inevitably significantly reduce prices to the point where the amortised cost of purchasing and running small EVs will be lower than the equivalent gasoline or diesel powered cars. Hence a far wider range of EVs, and at much lower prices, is expected to progressively penetrate the Australian passenger car market over this period.

The Australian population is highly urbanised by world standards, hence EV adoption will be greatest in large capital cities where the more limited range of most EVs better suits the daily commuting environment, and many families already own a second “conventional car” which can be used for country driving and holidays.

This EV adoption scenario will gradually but inexorably influence Australian electrical energy demand, since EVs will need to be charged from the low voltage electricity grid at home or at work. In parallel to this, the widespread adoption of EV technology in large Australian cities over the next 10 – 15 years will see a gradual shift in the “energy usage mix” from use of gasoline/diesel in IC engines to EVs being charged with electrical energy from the grid, which is generated by burning thermal coal or natural gas, or obtained from renewable sources as such as solar PV, wind and hydro.

Despite the big impact that EV adoption will undoubtedly have in Australia, and in particular on the architecture and capacity of the electricity grid, it was a surprise that <u>only 11 lines in the 94-page Energy Green Paper 2014 is devoted to EV technology</u>. Even then, the report is dismissive of the EV technological revolution in road transportation on the basis of it having

***"several disadvantages with the current fleet, including high vehicle prices, unsophisticated sale and maintenance networks, limited recharging infrastructure, and motorists' concerns. The consumer concerns holding back growth include range anxiety (and limited recharging choices), vehicle performance and higher up-front costs"* (p 53). As stated above, all these stated "disadvantages" are based on dated, historical information, and do not reflect the technological advances and huge development funding being devoted to EV and Li-Ion battery technologies by the international automotive industry, and the massive expansion of EV manufacturing volumes over the next 10 – 15 years projected by automotive manufacturers and their Tier-1 & Tier-2 component suppliers.**

Synergies with the grid. In parallel to this anticipated increase in penetration of EVs in the Australian market, the use of rooftop solar photo-voltaic (PV) systems is expanding, and such systems are currently installed on over 1 million Australian homes. With the worldwide mass production of solar PV cell systems *"the LCOE of solar PV is expected to become lower than the non-renewables from mid-2030 onwards"* (Energy Green Paper 2014, p 57).

Of course solar PV provides an attractive low-emissions-intensity means of slow-charging EVs but there are other even more significant synergies between these two technologies.

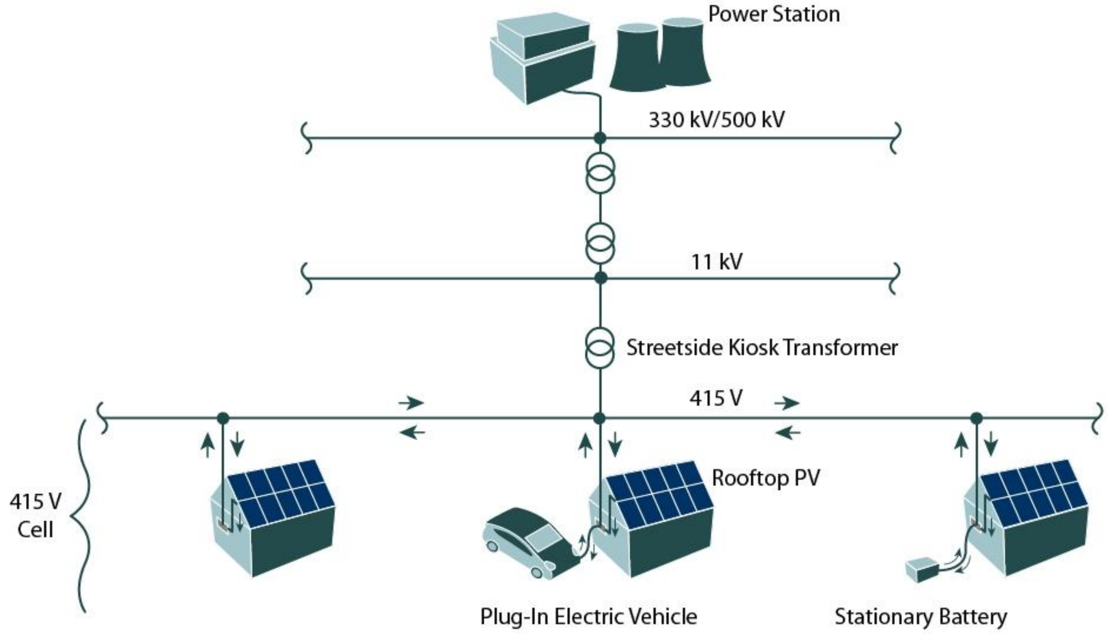
EV adoption can bring huge benefits to the electricity grid. EV batteries have significant electrical storage capacity and are an essentially off-peak load - typically 10–20 kWh for PHEVs and 20–50 kWh for BEVs. Such potential load-levelling capacity of EV batteries, and also stationary Li-Ion battery packs (in some cases manufactured for "end-of-life" EV batteries), enables a truly "intelligent grid" architecture to be attained, with substantial distributed storage embedded in the low-voltage layer of the system, *inter alia* enabling the further expansion of rooftop solar PV systems on Australia's homes, factories and public buildings. The huge investment in the mass production of EV Li-Ion batteries worldwide (e.g. the planned Tesla/Panasonic "gigafactory" in Nevada, USA) will doubtless have flow-on effects on the affordability and installation of domestic and commercial off-grid storage, thus accelerating the transition to this intelligent grid architecture.

With an appropriate enabling regulatory and economic framework, including intelligent metering, time-of-use pricing and connection standards, much of this new generation and storage capacity will be funded privately by business and individuals, reducing the need for new funding for conventional electricity 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 to both to EV owners and supply utilities, although much remains to be done to bring V2G to commercial reality.

The synergies between widespread EV, solar PV, and stationary/vehicle-based battery storage adoption in Australian cities is elaborated on in Appendix 2 of the submission made by the Australian Academy of Technological Sciences and Engineering (ATSE) to the Energy White Paper (Issues Paper) entitled *"The Low Voltage Exchange Network: Can electric vehicle energy storage improve the effectiveness and uptake of rooftop solar PV?"*. Unfortunately again, none of these potential synergies are referred to in the Energy Green Paper 2014.

Recommendations. The final Energy White Paper should incorporate a thorough analysis of the potential future penetration of EVs into the Australian city automotive market, a discussion of the resulting flow-on effects on the architecture and capacity of the metropolitan low-voltage electricity grid, and a recognition of synergies that EV, solar PV and stationary/vehicle-based electric storage technologies will have in this new energy generation and distribution environment.



Low Voltage Exchange Network comprising multiple 415V Cells, each supplied by a streetside kiosk transformer

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Short Bio:

Dr John Baxter is a fellow of the Australian Academy of Technological Science and Engineering (ATSE), Engineers Australia, and the Society of Automotive Engineers Australasia (SAEA). He spent most of his professional career at Bishop Technology Group Limited, where he was 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 1997 he was appointed Joint Managing Director of Bishop Innovation Limited. After retirement from Bishop in 2009, he joined Baxter IP Patent and Trade Mark Attorneys as a consultant where he is now specialises in client IP commercialisation and, in particular, the structuring of patents and licence agreements to maximize the commercial value of IP.

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Short Bio:

Brian Spies has held senior research and management roles in the mining, petroleum and environmental sectors in Australia and the USA, with positions in industry, academia and government. In Australia his positions includes Chief Research Scientist in CSIRO's Exploration and Mining and Director of Physics at ANSTO. Brian has a degree in physics and geology from the UNSW and a PhD in geophysics from Macquarie University. He is a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE) and in 2003 was awarded the Australian Centenary Medal for his services to Australian geosciences. His current research interests include the interface between water, energy, climate change and the Australian economy. He was lead author of the 2012 ATSE report *Sustainable water management: Securing Australia's future in a green economy*, and has recently contributed to the NSW Chief Scientist and Engineer's *Independent Review of Coal Seam Gas Activities in New South Wales*.