A Framework for Maximising the Economic Value of Electric Vehicle Integration into the Australian NEM

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Background

- **Electric Vehicles (EV) represent more than simply a future additional load for the electricity industry**
- **From the perspective of the electricity industry, EV integration may result in economic costs and/or benefits:**
  - ⇒ Potential benefits arise from charging flexibility and battery storage leading to improved industry asset utilization
  - ⇒ Potential costs are associated with the correlation between EV charging and existing load peaks resulting in increases in industry operational and investment costs
- **The full range of economic costs and benefits are yet to be characterized in the Australian electricity market (NEM) context.**
- **A framework for understanding, characterizing, and assessing the economic value of EV integration in the Australian NEM is presented in this paper.**

EV Integration Challenge

- **An optimal set of electricity industry arrangements are those that maximize overall societal value. Societal value will be maximized in a market environment when commercial signals lead to decision making which reflect underlying economic value.**
- **The electricity industry is a socio-technical system which includes decision making at physical, commercial, and governance levels. EV integration requires appropriate arrangements at each of these three levels.**
- **Aspects of technical decision making (e.g. charging algorithms) have been extensively studied.**
- **Consideration of commercial and governance arrangements/ decision making is also necessary to maximize economic value.**

NEM Decision Making Regimes

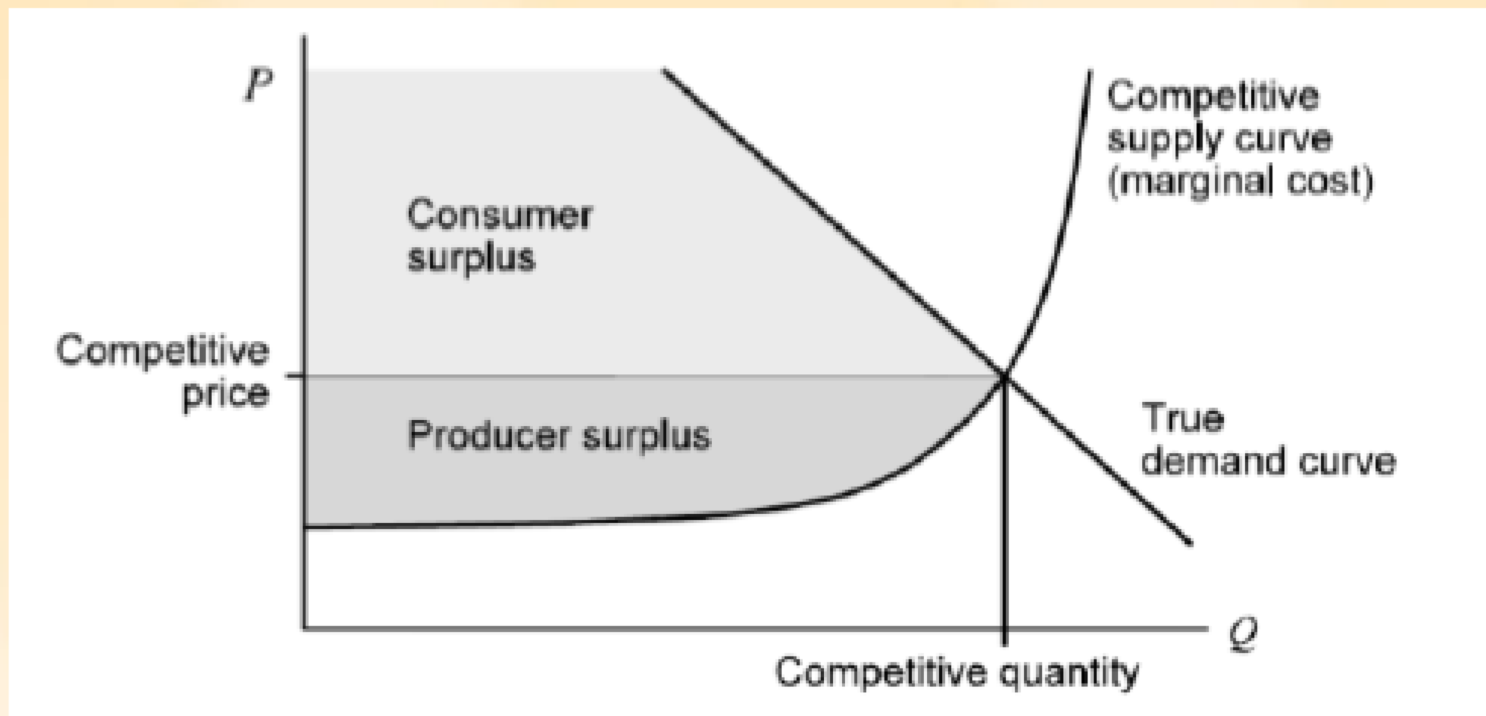
	Role [1]	Identified Issues/Barriers
Governance Regime	*-The set of formal institutions, legislation and policies that underpin the decision making framework in which a competitive electricity industry operates.*	*- Price regulation for small users will remain under state jurisdictional control even as retail market regulatory functions transition to the AER under the Chapter 5A of the NER.* *- Regulatory arrangements with respect to connection charging and network access for EV connections remain unclear under the new proposed Chapter 5A of the NER.*
Security / Commercial Regime	*-The commercial arrangements for the competitive electricity industry.* *-The task, assigned to one or more system operators, of maintaining the integrity of a local or industry-wide core of an electricity industry in the face of threats posed by plausible large disturbances.*	*- Barriers in wholesale bidding rules (NER 3.8.3b) prevent aggregation of loads in energy market bidding. Such rules prevent EV load aggregation participating directly in electricity market dispatch.* *- Market settlement (Financially Responsible Market Participant) rules create an effective monopoly for incumbent retailers and act as a barrier for the entry of 3rd party EV service providers.* *- Retail market arrangements, remain significantly state based with price regulation limiting scope for efficient price signals to drive decision making w.r.t. EV charging*
Technical Regime	*- The integrated rules for component and system design and system operation that allow the various components of an electricity industry, when connected together, to function effectively as a single machine.*	*- Lack of clarity with respect to metering roles and responsibilities for sub metering in embedded networks. Such lack of clarity in metering arrangements may limit the ability for competitive pressures to drive disaggregation of EV charging load for the purpose of load control.*

[1] Outhred, H.; Thorncraft, S.; , "Integrating Non-Storable Renewable Energy into the Australian Electricity Industry," System Sciences (HICSS), 2010 43rd Hawaii International Conference on , vol., no., pp.1-10, 5-8 Jan. 2010 doi: 10.1109/

Assessing Economic Value

- **Quantifying economic value outcomes requires an assessment of underlying economics (as opposed to financial/commercial transfers) including externalities**
- **Identifying gaps between optimal economic value outcomes and likely outcomes under existing commercial arrangements can be of useful for policy makers evaluating options for electricity market reform**
- **Economic welfare assessments can be used to evaluate economic value outcomes in an electricity market context by evaluating changes in:**
  - ⇒ ΔCS - Consumer Surplus, ΔPS - Producer Surplus, ΔV_{ext} - Value of Externalities, ΔV_{losses} - Value of Losses.
- **The impact of short-run (operational) and long-run (investment) decision making needs to be considered.**

$$V = \Delta CS + \Delta PS + \Delta V_{Ext} + \Delta V_{Losses}$$



Sources of Economic Value

- **EV integration can result in economic value outcomes across a range of electricity industry areas including:**
  - ⇒ Energy/Ancillary Services value
  - ⇒ Capacity value
  - ⇒ Loss reduction value
  - ⇒ Avoided CO_2 emission value
  - ⇒ Avoided/deferred network investment value
  - ⇒ Renewable energy integration value
  - ⇒ Security of supply value
- **Future studies will establish the economic value proposition for EV integration in each of these areas**

Proposed Modelling Approach

- **In order to establish the economic value of EV integration in each of the above categories an integrated modeling approach is proposed including:**
  - ⇒ State based modeling of electric vehicle charging behavior integrating un-managed, managed, and V2G/V2H
  - ⇒ Electricity system operational impacts through dispatch/unit commitment modeling
  - ⇒ Electricity system investment requirement modeling

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