Introduction

Nearly a quarter of direct CO2 emissions from global fuel combustion can be attributed to the transport sector [1]. Electrification of transportation has the potential to reduce greenhouse gas (GHG) emissions through the use of electric vehicles (EVs) [2, 3]. As an alternative to conventional fossil fuelled internal combustion engines (ICEs), EVs can be utilised to decarbonise the transport sector depending on the sources of electricity generation [4-6]. However, the uptake rate of EV technology has been hindered by concerns regarding range, high upfront costs and availability of charging infrastructure [7-9]. Whilst some barriers for EV adoption can be overcome by policy incentives, several issues relating to charging have yet to be addressed [10, 11].

Charging infrastructure refers to electric vehicle supply equipment (EVSE) which can be categorised according to --Paragraph on EV charging levels (including table)--

Whilst there is growing interest in EVs, electric cars only accounted for 2.6% of global car sales in 2019 [12]. Due to the low market share of EVs, academic literature regarding consumer interaction with EV charging infrastructure on a large-scale has been scarce. The importance of home, work and public chargers vary according to consumer access. Home charging has been identified as the primary source of recharging EVs and the most crucial element of charging infrastructure required for widespread EV adoption [13, 14]. The second most frequent charging location after home charging is the workplace. This is in line with daily human mobility patterns derived from surveys and mobile phone data where the most common behaviour consists of travel between two locations [15]. Commuters with no access to home charging will require a regular workplace charger as an alternative option. Public charging stations serve a similar role for substituting home charging for those with limited availability, whilst also being the least frequently used location for charging [16]. The charging behaviour observed from early trial projects indicate that consumers are motivated by convenience [17]. However, these trials involved a small sample size of EVs and financial incentives such as free charging. The transition from early adopters to widespread EV users will likely change the interdependency of home and workplace charging infrastructure.

---Section 2: Related Work--- (Optional break)

The long-term financial viability of workplace charging will depend on numerous variables. Upfront capital expenditure will be required for the initial installation of workplace charging infrastructure. This can include the costs associated with design, site provisions, hardware components and cost of labour. Moreover, variation in expenditure is expected depending on the power level and number of chargers installed [18]. Ongoing costs will also be incurred for electricity usage, network charges and maintenance. Electricity utility charge can be associated with either peak continuous power used (kW) or amount of energy used (kWh). In the latter case, the metered total consumption will be based on the amount of energy required by employees. This amount an EV requires is inherently linked with the distance commuted by the user. Subsequently, the employer is subjected to uncertainties associated with utilisation of workplace chargers which serves as a method for cost recovery. As such, there are several works on the economic feasibility of workplace charging. An optimisation framework for workplace charging strategies was proposed where average national data was used to demonstrate the applicability and generality of the methodology [19]. Workplace charging lifetime costs were minimised whilst all charging demand of EVs were satisfied by the strategy provided by the general decision-making framework. Whilst the energy needs of employees were met, competition introduced by alternative sources of charging were not included. Electricity mark-up was the main focus of another study which included the consumer perspective where electricity prices were compared to gasoline prices [20]. This included benchmarks comparing different proposed pricing structures with varying degrees of cost recovery in addition to a break-even pricing scenario. A sensitivity analysis was included to account for fluctuations in the cost of electricity, but similarly did not include the possibility of access to alternative charging sources such as home or public charging. Conversely, a comprehensive model which included both the employer’s and employee’s perspectives was presented in another study [21]. Several workplace charging contract schemes were proposed with different utility focuses, including a joint perspective scenario. Whilst numerous parameters were included to reduce the number of uncertainties involved, the possibility of employees having access to a residential photovoltaic (PV) array installed along with their home charger was not included. In recent years, the cost of PV systems have reduced significantly [22]. Consequently, increased rooftop PV installations has resulted in Australia having the highest uptake globally [23]. The inclusion of residential rooftop PV at an employee’s home charger will subsequently introduce uncertainties to workplace charger utilisation where employers will be subjected to the risk associated with this variable.

Related work: Consumer preferences + PV self-consumption 🡪 Introduction of risk aspect

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