Equilibrium Modeling between the Energy and Transportation Industries

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Abstract-The transportation and the electric power sectors occupy a central role in our nation`s energy industry, together making up to 65% of primary energy consumption. The overwhelming dependence on environmentally detrimental fossilized fuel sources has paved way for the establishment of federally mandated regulations on emissions and foreign oil imports to make the energy industry more sustainable. Between 2010 and 2011, internal combustion engine (ICE) vehicle fuel consumption reduced by 3480 thousand gasoline equivalent gallons (GeG), whereas fuel consumption by plug-in electric vehicles (PEVs) , and natural gas vehicles (NGVs), increased by 28500 thousand GeG . Advantageous environmental implications of large-scale adoption of PEVs and NGVs arise from their ability displace gasoline consumption and overall improvement in drivetrain efficiency compared to ICE based vehicles. The CO_2 emission reduction from PEVs and NGVs ranges anywhere between 10% and 40% on a per mile basis. From an investment perspective, the system levelized cost per kWh of an on-shore wind, offshore wind, hydro and solar plants are $0.086, $0.22, $0.09 and $0.14 over a 30-year cost recovery period respectively. Whereas a similar investment into a PEV charging station and compressed natural gas fuel station are $0.007 and $0.027 respectively, with cost recovery period less than the average vehicle lifetime of 10 years.

The aforementioned discussion highlights the potential of the large scale PEV and NGV penetration in acting as a catalyst in transitioning towards sustainable infrastructures in the electric power and the transportation sectors. Such a transition would gradually result in lesser dependence on foreign oil, promote energy security and enhance the resilience of the energy industry, which is one of the most important critical infrastructures. The key to achieving such a transition is to provide consumers with easy access to fueling stations and make PEVs and NGVs more cost friendly in comparison to ICE vehicles through host of incentives (monetary and non-monetary) and favorable policies to achieve the same . Thus, the need for a suite of optimization models that simultaneously considers the impact of NGVs, PEVs on both the energy and transportation infrastructure is very evident. It is this multi- disciplinary area that the proposed research intends to model as a mathematical program with equilibrium constraints (MPECs), to understand the influence of environmental initiatives on the joint U.S. energy-transportation infrastructure.

Index Terms-MPEC, Natural gas vehicles, Plug-in electric vehicles