FULL ELECTRIC AND PLUG-IN HYBRID ELECTRIC VEHICLES FROM THE POWER SYSTEM PERSPECTIVE

Task XVII, IEA Demand Side Management Programme
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ABOUT THE REPORT

Greetings from Juha:

- The report is still very much a draft – unfortunately there was not enough time at hand when writing it.
- Technical aspects of electric vehicles are not my field, so it would be especially helpful to get comments on that section.
- There are not too many references and there are too many opinions.
  - I’ll try to improve that.
  - References and corrections are very welcome.
- What is missing that would be important?
- Are there sections that are too difficult to understand?
ABOUT THE PRESENTATION

- Reviews the main points in the report
  - Technical aspects
  - EV penetration scenarios
  - Charging opportunities
  - Electricity consumption
  - Revenues for EVs
MAIN COMPONENTS OF ELECTRIC VEHICLES

- EV power train is different
- PHEVs need most from both worlds

- EV component status
- Product development for use in EVs
  - Electric motor/generator
  - AC/DC Charger
  - Controller
  - DC/AC Converter

- Major R&D
  - Batteries (main barrier)
  - Battery and thermal management systems
KEY ISSUES AFFECTING THE COMPETITIVENESS OF ELECTRIC VEHICLES

- BATTERIES
  - Cost
    - Lifetime (calendar and cycling)
    - Safety
    - Performance (acceleration etc)
    - Behavior in harsh conditions (heat and cold)
  - Cost of using internal combustion engines (or regular hybrids)
    - Fuel costs (fossil or renewable based)
    - External costs (CO₂ and air quality)
EXAMPLE OF BREAK-EVEN BATTERY COSTS COMPARED TO GASOLINE COST

FEV
Consumption: 0.2 kWh/km
Electricity: 0.1 €/kWh
40 kWh batteries
Interest rate 10%
Amortization: 10 years
Cost: ICEV cost -2000 €
(without battery costs)

ICEV
Consumption: 5 l/100km
VEHICLE PENETRATION SCENARIOS FROM IEA

VEHICLE SALES IN THE BLUE MAP SCENARIO

Electric vehicles too!

IEA BlueMap, EV sales

Extrapolated EV sales based on national targets

CHARGING OPPORTUNITIES

- Home
  - Usually one-phase available, three-phase will add to costs
  - Charging on one-phase can take long, if battery is near empty
    - Usually batteries are not near empty: average daily driving distance around 50 km → 10 kWh (at 0.2 kWh/km)
- Work place
  - Could halve the necessary battery size for the daily commute (important for PHEVs)
- Public parking
  - Wirings usually not existing
  - If it costs more than home charging, will it be used?
- Fast charging
  - Can enable long-distance trips for FEVs
  - Charging stations will be relatively expensive to build
VEHICLE DEPARTURES AND ARRIVALS BASED ON FINNISH TRAVEL SURVEY

No. of trips

Hour of the day

From home
From work
To home
To work

VEHICLE DEPARTURES AND ARRIVALS BASED ON FINNISH TRAVEL SURVEY

No. of trips

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Share of EVs plugged in

Charging room in the batteries arriving to the grid

Charging pattern of immediate charging EVs

Charging pattern of smart charging EVs
SMALLER COSTS OR EXTRA REVENUES FOR EVs

- Smart charging:
  - Charging during low-cost hours
  - Change of charging schedule based on intra-day markets or balancing markets
  - Participation in reserves (stop charging if system needs positive reserves)
  - Charging time based on distribution network congestions

- Vehicle-to-grid
  - Costs from additional equipment
  - Benefits have to be larger than losses and battery degradation
  - Revenue from discharging possible based on market and reserve needs
  - PHEVs could even act as emergency power plants (if not in garage)
INTERPLAY BETWEEN EVs AND REST OF THE POWER SYSTEM

- Likely changes in the power generation will increase the need for flexibility
  - More wind power and PV in the system (variability and prediction errors increase)
- Smart electric vehicles will face competition
  - Conventional power plants likely to be more flexible and more efficient at part load
  - Other demand side management options can provide similar services as EVs typically at low marginal cost
  - Lot of smart EVs can also reduce prices of ancillary services
  - Dedicated electricity storage?
- Bottlenecks in the grid: especially distribution grids or connections to apartment houses; locational marginal pricing can also create opportunities in congested grids
VTT creates business from technology