Electric vehicles – new trends in mobility

The Enabling Role of ICT for Fully Electric Vehicles

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Electric Vehicles

- The differences between the 2nd and 3rd generation Smart electric drive are manifold
  - LED daytime running lights
  - state of charge/power usage in place of the tachometer
  - **the ability to program the car through an iPhone app**
- The third generation and its new electric motor bumps the horsepower count to 74
- The increased urgency delivered by the new powertrain chops the run to the metric ton to 11.5 seconds

EV impact on Power Grid

- EV could play a central role in decarbonising road transport
- But, EV could have a much bigger impact on peak load as motorists seek to recharge their batteries during the evening.
- Electricity suppliers will need to anticipate the long-term investments that will be needed to respond to this emerging trend
- Smart-grid technology can enable EV-charging (grid-to-vehicle, or G2V) load to be shifted to off-peak periods, thereby flattening the daily load curve and significantly reducing both generation and network investment needs.

Smart Grid impact on EV

- ICT is a significant enabler of smart grids
  - through meter communications, data collection and analysis, billing, etc
- Smart grids and meters also raise the prospect of home energy management systems, where consumer gadgets and devices can be controlled remotely, via internet and smartphone, further helping to save energy
- Wind and solar power generation is variable, but smart grids have the potential to match demand with supply through a dynamic pricing structure. Electric vehicles have an important part to play in the future, sucking up the energy when prices are low and effectively acting as storage devices for grid power.

Implications of electric vehicles for load management using smart-grid technologies

- The World Energy Outlook, produced by the International Energy Agency (IEA), projects that the total EV fleet will reach 1.6 million in 2020 and 31 million in 2035
  - Israel - the additional electricity needs for EVs would amount to about half of the country's electricity use based on current mobility levels and electricity use
  - On the most optimistic assumptions about the commercialization of EVs, in which EVs displace virtually all conventional vehicles in the global fleet by 2050, EVs could add over 20% to global electricity demand.
- Commuters will typically want to recharge the battery on returning home in the evening, coinciding with the normal daily peak in load
  - unless they have a financial incentive and the means to schedule charging during the night, when overall system load is much lower

Possible solutions

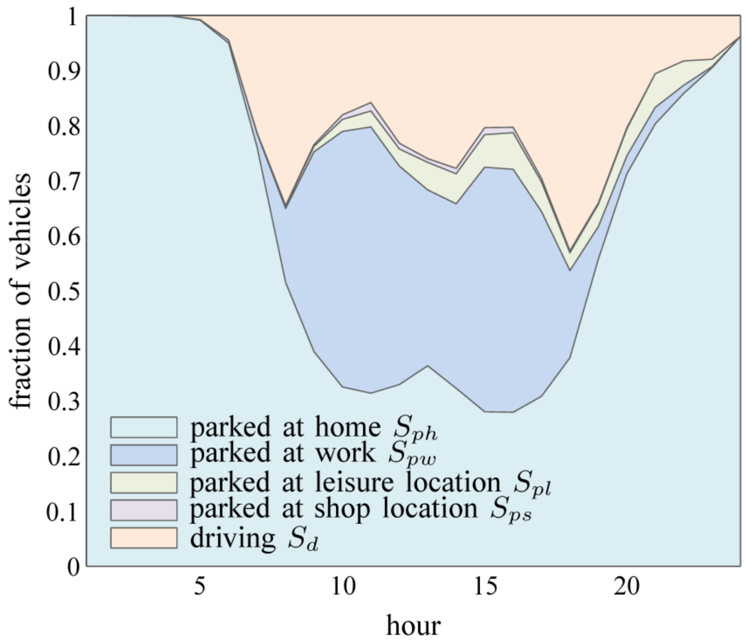
- Smart Charging of plug-in Vehicles under Driving Behavior Uncertainty
  - Probabilistic traffic model
- Integration of Electric Vehicles in Smart Homes

Probabilistic traffic model

- The goal of the probabilistic traffic model is to create possible realizations of mobility patterns out of particular exemplary realizations
- Mobility patterns are the set of trips performed with a vehicle as well as the timing, duration, energy consumption, destination location and purpose of these trips
- To model individual driving behavior, there can be defined different states: a driving state and parking states (parked at work, at home, for leisure or at a shopping location)
- Defining different parked states allows the setting of some parameters conditional on the state (e.g. only home charging is possible or a higher charging rated power is available at commercial locations than at home).

Probabilistic traffic model

- Based on these states and possible state transitions driving patterns can be modeled as a continuous-time non-Markov chain.
- With this framework, a Monte Carlo simulation which leads to different samples of mobility patterns for each vehicle will be performed.
- Based on these, the demand profile of the vehicles can be optimized



Integration of Electric Vehicles in Smart Homes

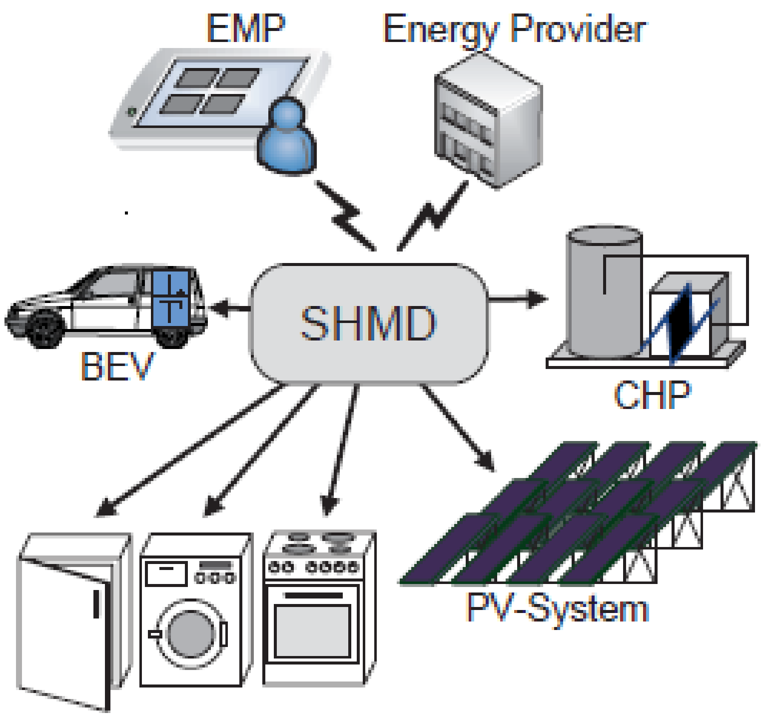


Fig. 2. The smart home energy management setup

- CHP – Combined Heat and Power
- SHMD – Smart Home Management Device
- EMP - Energy Management Panel

Integration of Electric Vehicles in Smart Homes

- The resident can:
  - monitor the current state of charge (SoC) given as the approximated range
  - monitor the current charging or discharging power
  - check the time when the EV will be fully charged, and
  - check and change the configured departure time (here the same as “end of charge”).
- The integration of a BEV will allow for bi-directional charging
  - The BEV either can be used as an additional load or as an energy storage system able to feed back energy when needed

Smart phone applications

- EVs really do need apps, because they'll be highly interactive with the grid.
- The cars can't possibly work if they're dumb appliances that all plug in when their owners return from work at 6 p.m
- Charging has to be spaced out, and done mostly at night.
- Since you're not going to want to get up at midnight to plug the car in, electronics have to handle the work
- Your car will "talk" to the utility, which will start a charging session at the optimal after-hours time
- And you'll be able to use your cell phone to initiate sessions

Our phone will take control

- We'll be chatting in a restaurant, get a ping and discover that the car we left outside is now fully charged
- Take it with you, and it can provide information on your battery car's state of charge, expected completion time, and location of charging stations

Conclusions

- Ferdinand Porsche (VW beetle)
  - Electric car using wheel motors and an 80Ah lead acid battery providing 50km range
- Software is now one of the major driving factors behind the automotive innovations
- Today, 80% of innovations in cars are a direct product of the technology transfer from the domain of computer systems
- **Future**
  - Energy- / Cost-Efficiency (Optimization at system level, Intelligent predictive control manager)
  - Zero Accidents (Pro-active safety functions)
  - Seamless Connectivity (Integration and interaction with CE devices, Interaction with cloud possible, Software updates over the air)