Vehicle to Grid and Crisis Management:

Potential of V2G for smart city Power grids in Norway

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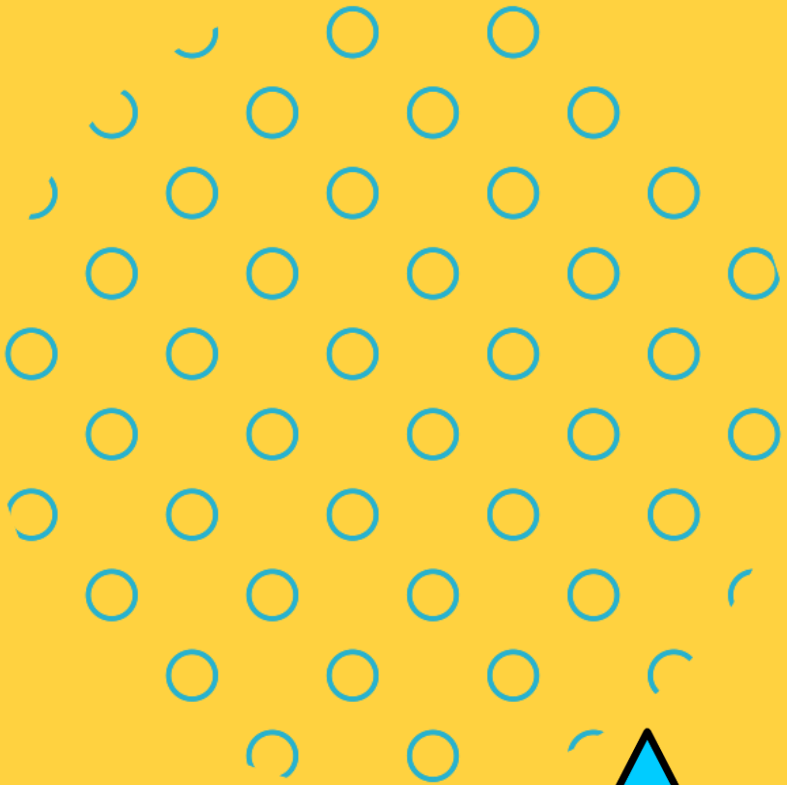

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About myself

- Associate Professor in Information Systems
- Research on digital government and participation since 2009
- Head of Management Information Systems research group since 2018
- Teaching Digitalization and society, digitalization for sustainable development & project management

Research group interests

- We currently have projects running in the following areas:
  - Smart Cities and smart business models
  - Analytics, IoT, social media
  - E-learning
  - E-health
  - Extended reality
  - Electronic participation

Summary of paper

- We examine the potential of vehicle to grid (V2G) from a crisis management perspective, using norway as case
- Approach:
  - calculcate available power from electric vehicles (Evs), and compare to demand on national and city level.
  - Examine possible incentives for EV owners to make their cars available as backup power source
  - Examine technical and social barriers

Introduction and motivation

- V2G: Reversing the flow of energy between Evs and the home/power grid
- Means EVs can act as a balancing mechanism for the grid, saving money during peak hours and more importantly also be a backup in case of power failure
- We examine the potential of V2G to act as a backup source of electricity

Introduction and motivation

- As the green transition continues, we are becoming ever more reliant on electricity, and the consequences of even a short time power grid failure can become quite serious, hence the link with crisis management.

- We only focus on households, as critical infrastructure such as hospitals already have solutions in place. However, there are often driven by fossil fuels, so one should also look into this area

Research approach

1. Using data from statistics Norway and the national EV survey, we:
   - Calculate daily energy needs nationally and for a mid-sized city
   - Calculate potential number of EV's in 2025 and 2030
   - Estimate available battery capacity in 2025 and 2030
   - Estimate available power available, taking use into account
     - Detailed description is in the paper

2. Using literature, we examine technical and social barriers for V2G

Findings - energy demand

TABLE I. DAILY ENERGY DEMAND, HOUSEHOLDS

	National demand	City demand
Summer	70,5 GWh	1 GWh
Winter	140 GWh	2 GWh

- Due to temperate summers and cold winters, demand is about twice as high in winter

Findings – available energy from EVs

TABLE II. ESTIMATED NUMBER OF EV'S

	Nationally	Mid-sized city
2025	900.000	11.000
2030	1.700.000	18.000

Estimate based on reaching the goal of only selling Evs from 2025

Battery capacity is a guesstimate based on current and announced models. Number is per car

TABLE III. AVAILABLE ENERGY IN THE MORNING AND EVENING, AVG/CAR

	Morning	Evening
2025	30 kWh	20 kWh
2030	40 kWh	30 kWh

Findings – available energy as percentage of demand

TABLE IV. POTENTIALLY AVAILABLE ENERGY IN EVS, 2025. SUMMER AND WINTER, AS A PERCENTAGE OF AVERAGE HOUSEHOLD DEMAND

2025	Nation, morning	Nation, evening	City, morning	City, evening
Available energy	28 GWh	18.7 GWh	0.3 GWh	0.21 GWh
Summer, percentage of demand	40%	27%	30%	21%
Winter, percentage of demand	20%	13%	15%	10%

TABLE V. POTENTIALLY AVAILABLE ENERGY IN EVS, 2030. SUMMER AND WINTER, AS A PERCENTAGE OF AVERAGE HOUSEHOLD DEMAND

2030	Nation, morning	Nation, evening	City, morning	City, evening
Available energy	67 GWh	42 GWh	0,72 GWh	0,45 GWh
Summer, percentage of demand	95%	60%	72%	45%
Winter, percentage of demand	48%	30%	36%	23%

In our scenario, energy stored in Evs can potentially cover 48% of the national demand a typical winter morning, and 30% in the evening when we reach 2030.

Summary of findings

- In our scenario, we find that IF all vehicles and homes are equipped with V2G technology, Evs can store a significant amount of power when we reach the year 2030. Perhaps not enough to avoid blackouts, but certainly enough for ***vehicle to home*** emergency power.

- Relying on Evs to cover the entire grid's demand does not seem likely, unless a lot of households switch off non-essential appliances during a blackout

Mediating factors – technical challenges

- As EVs cannot necessarily cover all of the demand in an emergency, grid balancing and demand needs to be carefully managed, most likely using automated algorithms and requiring smart hubs installed in homes with the ability to control household energy use.

- Few homes have the technology to reverse the current and draw power from EV batteries, or to deliver this from home to grid.

- These challenges are technically possible to overcome, but so far, households have few incentives to install expensive equipment

Mediating factors – social challenges

- «what's in it for me» is a major challenge. Smart technology is expensive, so households need incentives to invest

- For V2G to be an option in a crisis, plans need to be developed, including how to get households to switch off non-essential appliances during a power outage.

- Plans for V2G in crisis management also needs to include prioritization. Some elderly live at home, and are reliant on various medical equipment. Families with small children might be dependant on power to feed babies etc.

Summary

EVs have the potential to become a significant part of energy crisis management, but in order to make this feasible, numerous challenges need to be overcome in the coming years.

As we are still in the early days of smart grids/meters/hubs/homes, we have the opportunity to plan for these things now in order to make the energy system more robust in the future.

Future research

- One possible research approach could be to examine "neighborhood grids", attempting to balance supply and demand within, for example, the grid served by one transformer.
- There is need for research on incentives for households to invest in the necessary technology, and for research on new business models allowing a more flexible use of the power grid
- For crisis management, we suggest there is a need to draw up detailed plans and scenarios for how to apply limited EV power in a blackout. The details of such a plan require more research.
- Overall, we suggest a socio-technical approach combining the technical requirements, necessary plans and how to get the public invested.