The road toward electric vehicles as flexibility providers for distribution systems. A techno-economic review.

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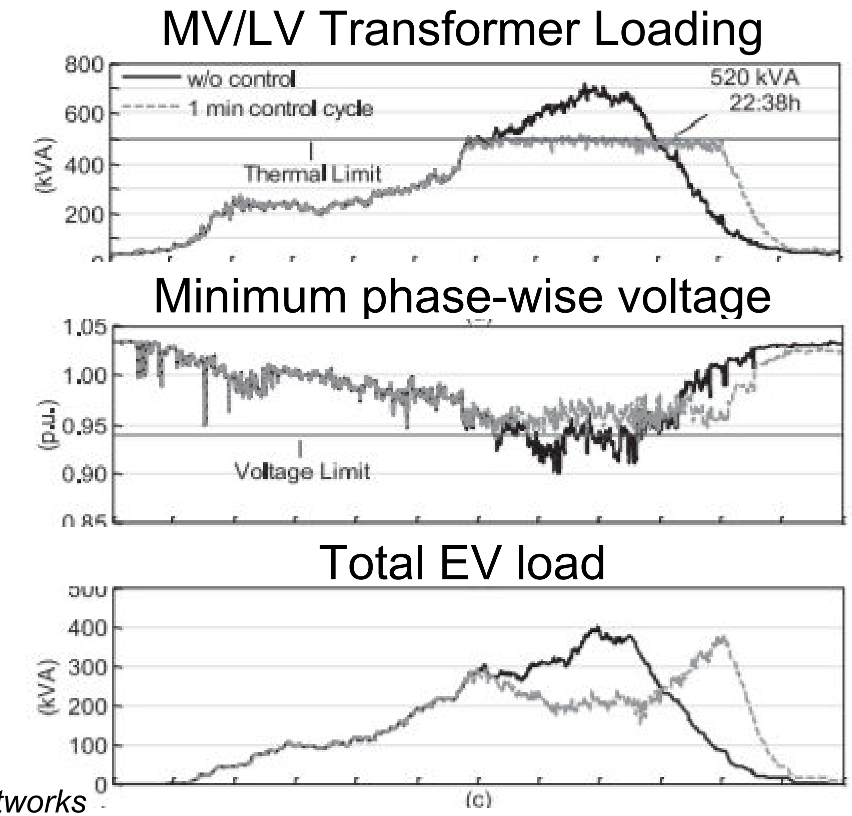
Outline

- Motivation
- Objectives and Framework
- Technical and Economic Barriers
- Conclusions

Motivation

- Massive grid integration of EVs can pose serious challenges
  - Specially to distribution grids (local level)

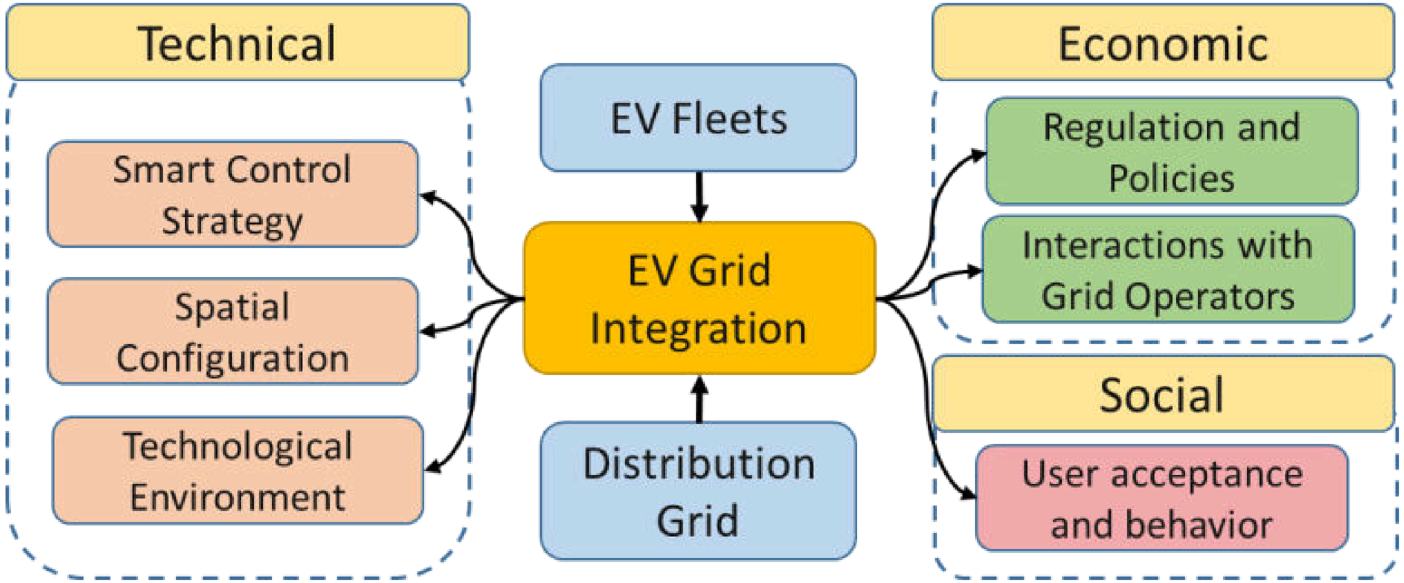
- And also opportunities for optimized use of assets
  - Smart charging and V2G
  - Can defer or avoid costly reinforcements
  - Increase EV hosting capacity (+50-60%)*



[*] OFGEM, 2018, *Future Insight Series. Implications of the transition to Electric Vehicles*,
Source: Quiros-Tortos et al, 2016, *Control of EV Charging Points for Thermal and Voltage Management of LV Networks*

Objectives & framework

- **How can we exploit this flexibility?**
- Identify main technical and economic barriers for EV to provide flexibility at the distribution level



InterFLEX INVADE EMPOWER evolvDSO SmartNet IDEAL ideal grid for all ACES Flexpower Amsterdam parker gridmotion MY ELECTRIC AVENUE

Technical Aspects

- Variety of proposed services at differents levels of the grid.

Level	Customer	Service
Behind-the-meter	End-user/Building	Optimizing Electricity Bill Subscribed Power V2H/V2B/V2X
Local	**DSO**	**Local Congestion** **Voltage regulation** Phase-unbalances (LV) Load shaping
System-wide	TSO/BRP	Frequency Regulation Portfolio Optimization

- At distribution level, main value of flexibility lies on investment deferral

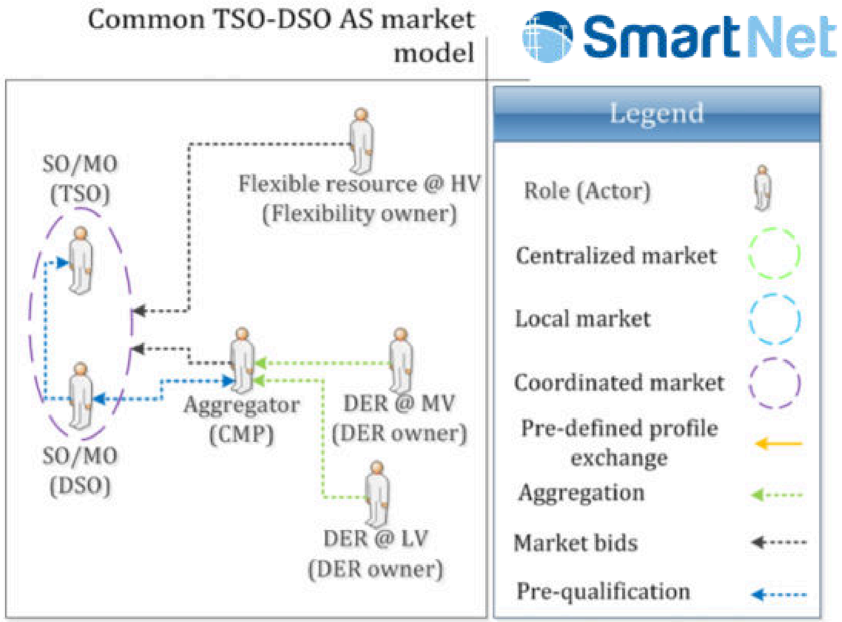
Technical flexibility, proven but needs improvements

- Technical flexibility has been proven practically
  - Frequency Regulation
  - Energy portfolio management
- Technological improvements are required, mainly for V2G-based services
  - Bidirectional chargers are not a mature technology
  - Battery degradation still an issue (though studies indicate grid services have minor effects)
  - ICTs standards are evolving (ex. ISO 15118) allowing for effective control of the charging process
  - Increased observability in distribution systems

NUVVE
JEDLIX
eMotorWerks
parker
gridmotion

Economic/Institutional Aspects

- Uncertain value of EV flexibility at distribution level
- Modernization of DSO’s roles and responsibilities
  - From Fit-and-forget to **active management** of the network
    - To value flexibility instead of investing in infrastructure
    - Role of DSO as a market facilitator
  - Increased interaction between TSO-DSO



Economic Aspects

- Lack of DSO frameworks to procure flexibility (EU perspective)

Framework	Valorization	Example	Benefits	Risks
Rules-based	**No value**	*Reactive Power Provision*	Useful when no market solution	Technology bias Inefficiency
Network tariffs	**Indirect**	*Time-of-Use/CPP* *Dynamic Pricing* *Distribution Congestion Pricing*	Incentive for all users	Don't solve local issues Equalization principle Tariffs not set by DSO
Smart Connection Arrangements	**Direct**	*Variable Capacity Connection* Flexpower Amsterdam	Fast connection process Low connection costs	May preclude access to flex markets
Market based		*Bilateral Contracts* *Local flexibility market platforms* *Local Energy Markets (P2P)*	Preferred by regulators Competitve and transparent Foster innovation	Reduced size of local markets (competition, transaction costs)

Based on CEER, 2018

… and advances

- Increasing interest by regulators for DSOs to use flexibility instead of costly reinforcements
    - European Commission Clean Energy Act 2016

- DSO active approach
    - UK: UKPN (London Area DNO)
        - Flexibility Tenders for investment deferral
    - Netherlands: Several DSO-led projects studying local flexibilities by EVs (ElaadNL)
    - And others initiatives (demo projects, testing local market solutions)
        - NODES (Norway, Germany), GOPACS (NL), Enera (Germany)

Conclusions

Conclusions

- EVs grid integration present risks but also opportunities (active grid management)

- Technically, EVs should capable of providing DSO services

- Main barriers for DSO services are economic/institutional, not technical
  - Uncertain value of DSO services
  - DSO’s role towards active management of the grid
  - Lack of frameworks to value flexibility (though they are emerging)

The road ahead

- Multiple solutions for flexibility coexisting
  - Smart network tariffs to incentivize EV demand response
  - Smart connection agreements to reduce and expedite investments
  - Local flexibility markets for investment deferral (aggregators)

- One solution does not solve all problems !
  - Each framework has pros and cons
  - Diversity of problems, grids and users

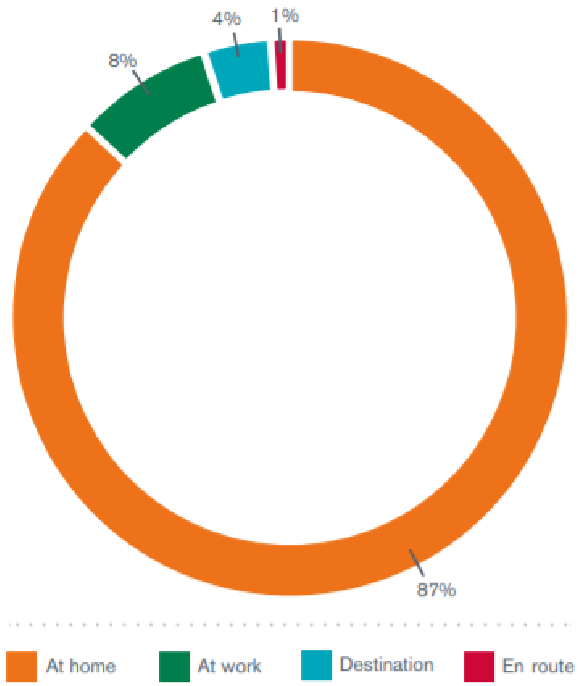
Thanks !
Questions?

Open questions – Future work

- Will EVs be able to participate in new DSO services (ex. Flex tenders)?
- What value for DSO services? And of V2G?
- TSO-DSO coordination. Stacking of DSO-TSO services ?
- How to use flexibility at low voltage grids? Markets might not be suited for it.
- How to achieve end-user acceptability?

Social aspects

- Flexibility strongly dependend user driving and charging behavior
  - Dependent on several factors
    - EVSE availability, workplace charging
    - Rural or urban
    - Private / company fleets
  - How will these behaviors evolve ?
- Demonstrator projects are a great source for understanding user behavior
  - SwitchEV, My Electric Avenue (UK).
- Consumer acceptance and engagement:
  - How to achieve it ?



Where EV users currently charge (UK) ?
Source: OFGEM, 2018 (from Regen)

Use cases

- Several use cases where EV flexibility can provide value for distribution grids
  - Investment deferral
  - Maintenance
  - Curtailment reduction / RES coupling
  - Unplanned