EV business models- Participation of EVs in control energy markets and the second life potential

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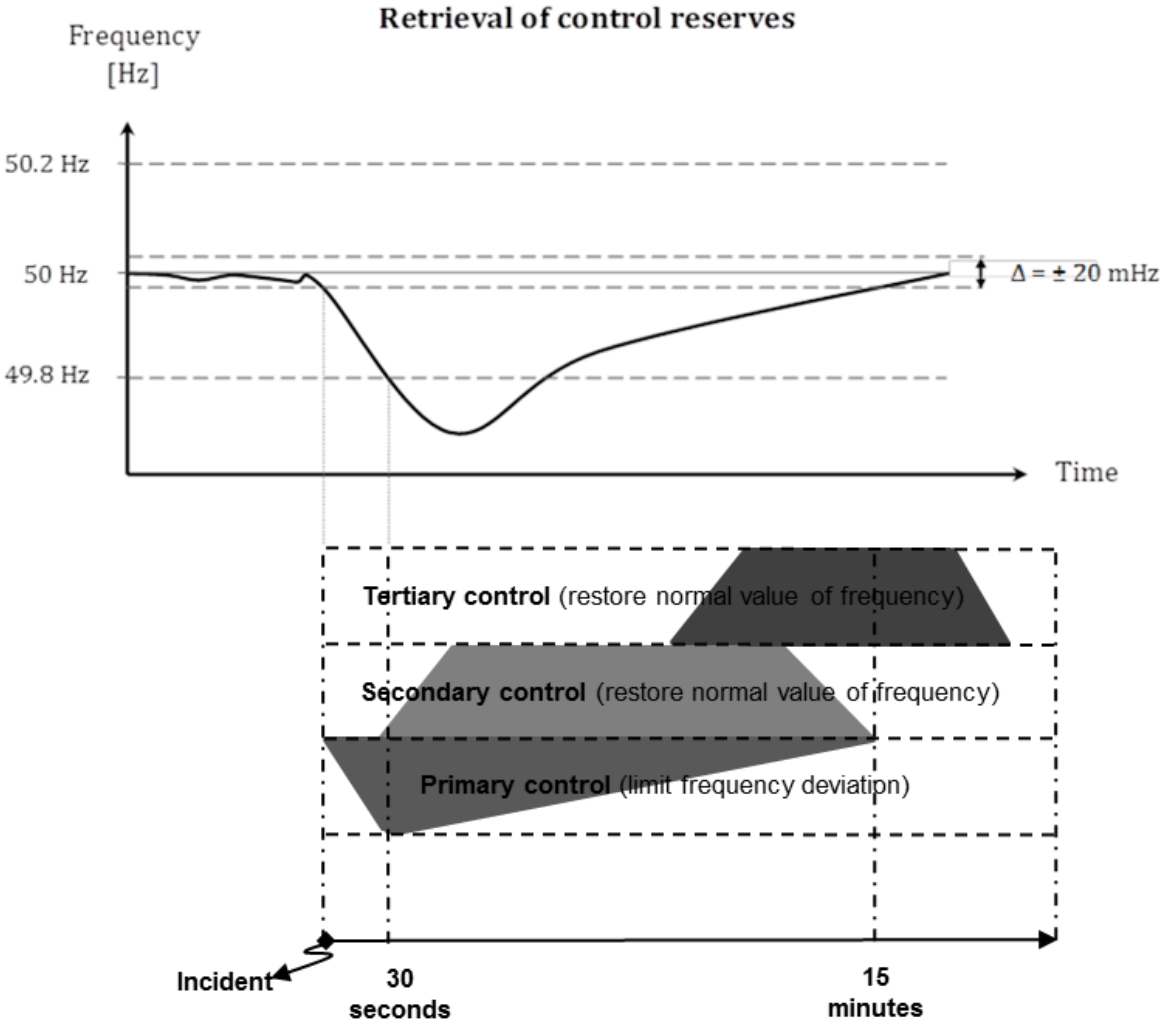
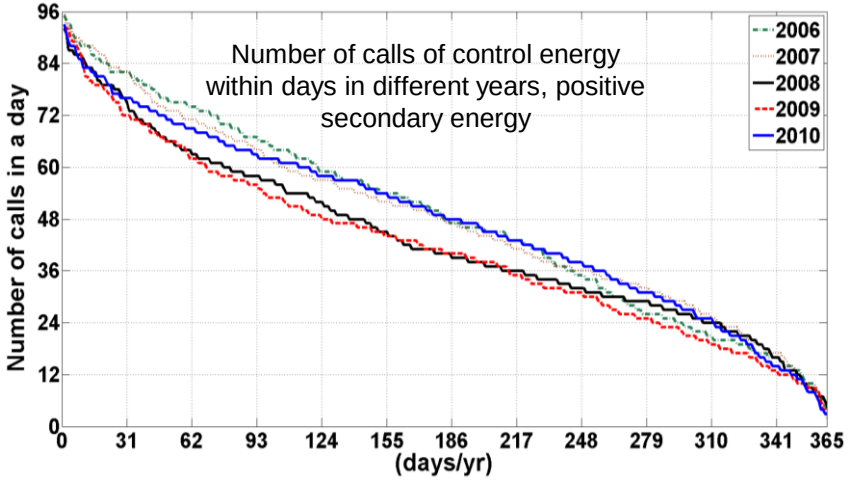
1. Introduction

- Control energy (retrieval of control reserve)



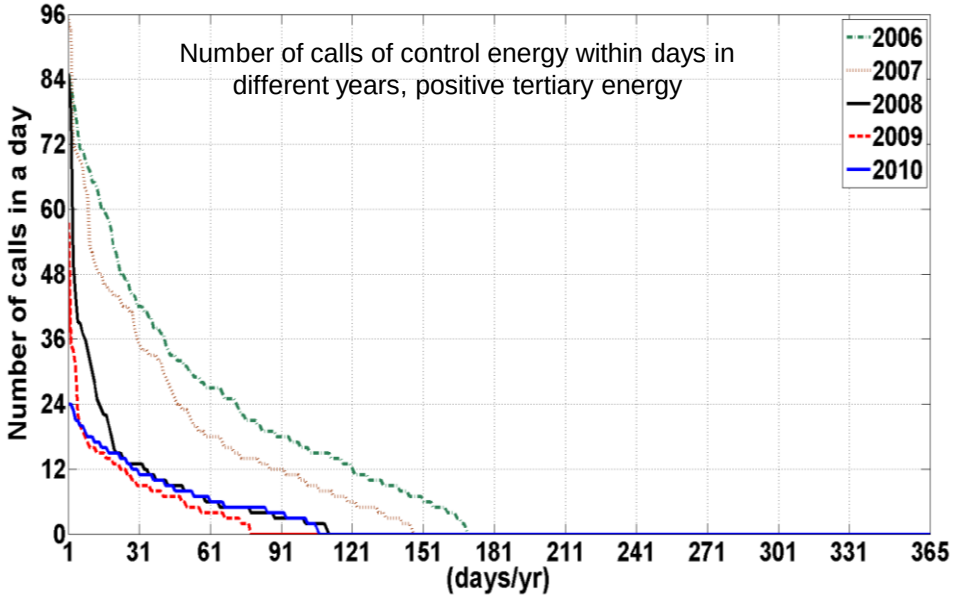
1. Introduction

- Control energy markets in Austria
  - Primary control market
    - Volume of power: +/-71 MW in the year 2012.
    - The minimum bid is +/-2 MW. The tendering period always extends from Monday 00:00 to Sunday 24:00.
  - Secondary control market
    - Volume of power: +/-200 MW.
    - The minimum bid is 5 MW.
    - Tendering period: One or four week products.
      - The products are broken into three time slots:
        - Peak week Monday to Friday from 8:00 to 20:00
        - Off peak week
          Monday to Friday from 0:00 to 8:00 and from 20:00 to 24:00
        - Weekend Saturday to Sunday from 0:00 to 24:00.



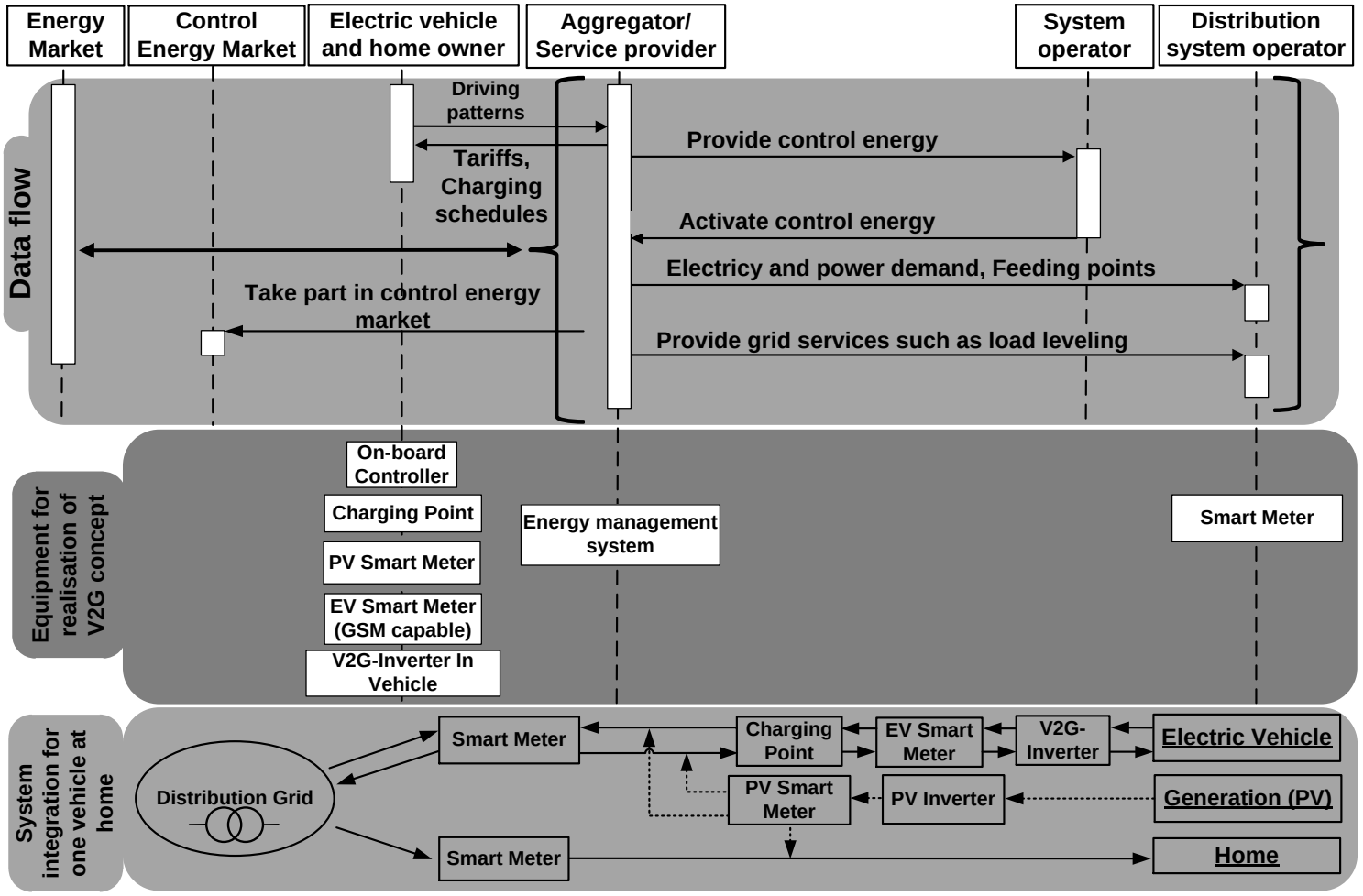
1. Introduction

- Control energy markets in Austria
- Tertiary control market
  - Volume of power: +280 MW /-125 MW
  - Bid: One block between 10 and 50 MW
  - A tender is carried out for the coming weekend (Saturday and Sunday) as well as – separately – for the following week from Monday to Friday. These tendering periods embrace 6 different product time slots, (0:00-4:00, 4:00-8:00, 8:00-12:00, 12:00-16:00, 16:00-20:00, 20:00-24:00)



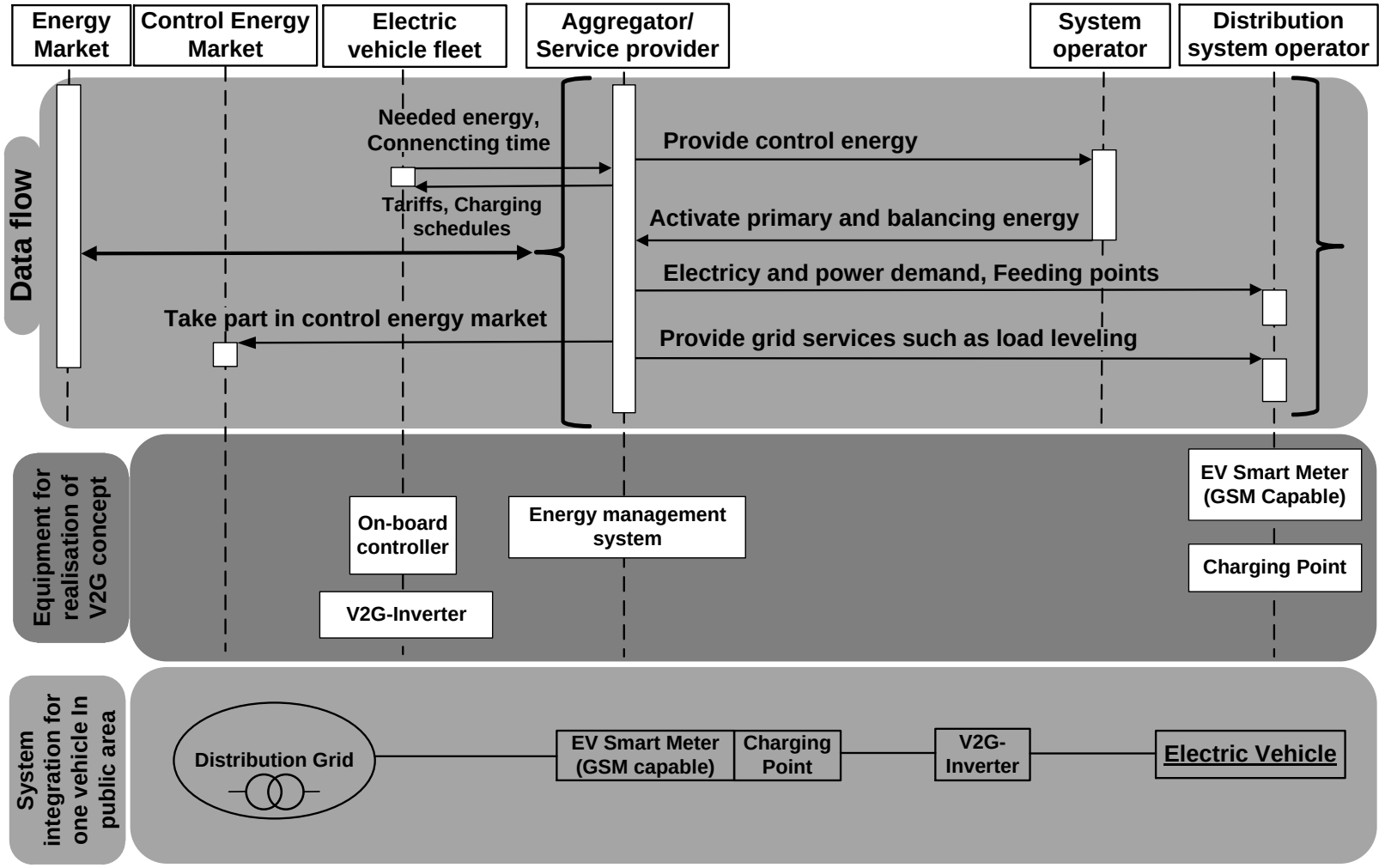
2. Business models

- V2G/ G2V use cases: Participation of Electric Vehicles at control energy markets: Private charging station (home, office, company)



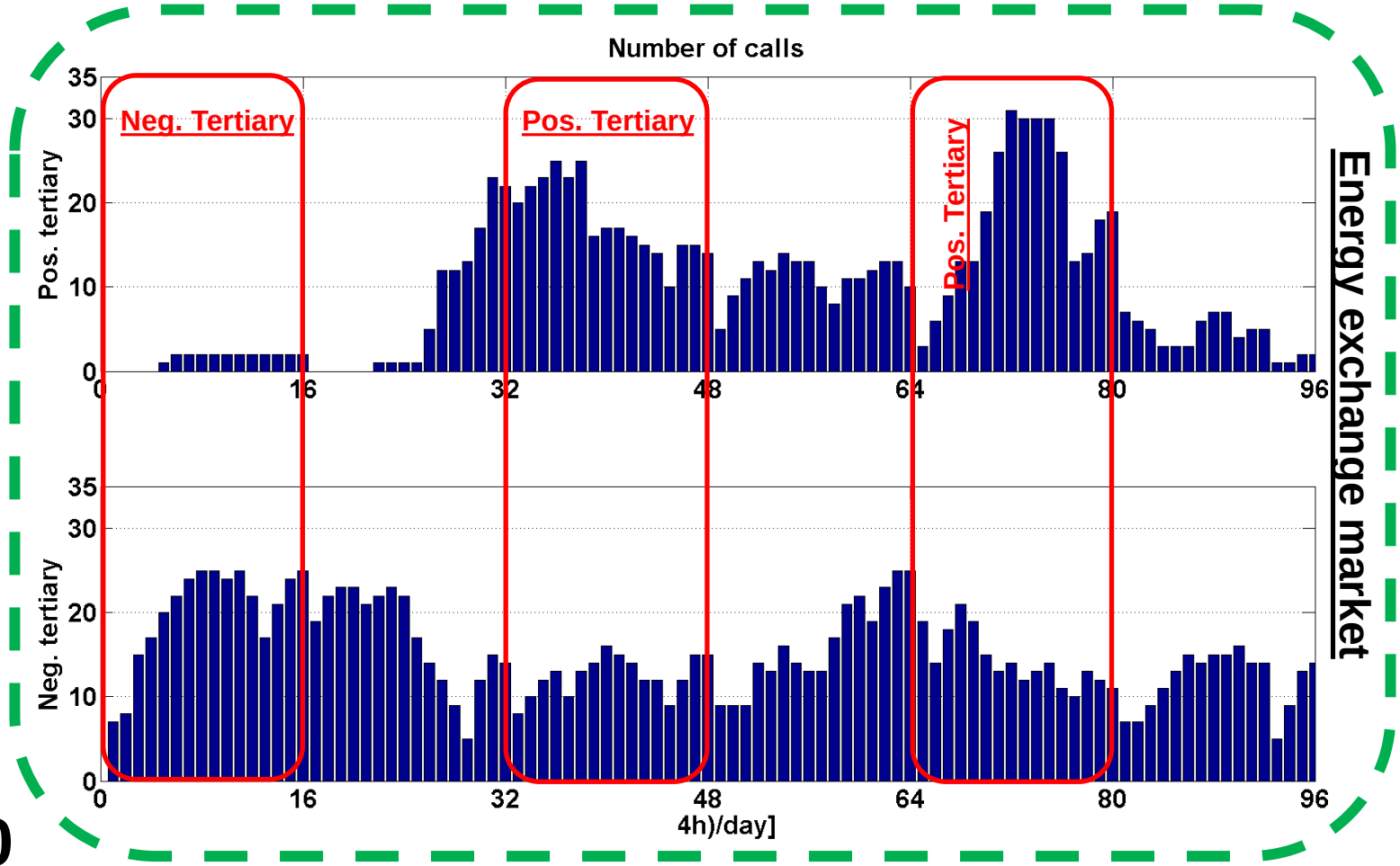
2. Business models

- V2G/ G2V use cases: Participation of Electric Vehicles at control energy markets: Public charging stations



2. Business models

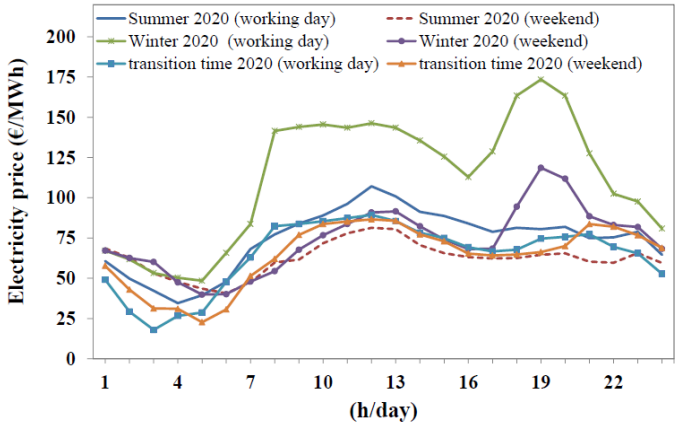
- **2nd life application (use case):** Simultaneous participation of stationary battery on the energy exchange and control energy markets (hourly sequentially linear optimization model, Matlab)



2010

3. Related data

- Driving patterns of vehicle owners [1]
- Battery characteristics
  - Degradation due to discharging and the associated costs [2]
  - Efficiency from grid to the battery and vice versa [3]
  - Charging properties, P_{charge} = f(SOC) [4]
- Simulation of called control energy in Austrian power grid
- Assumed electricity prices for 2020, based on typical price curves in 2009



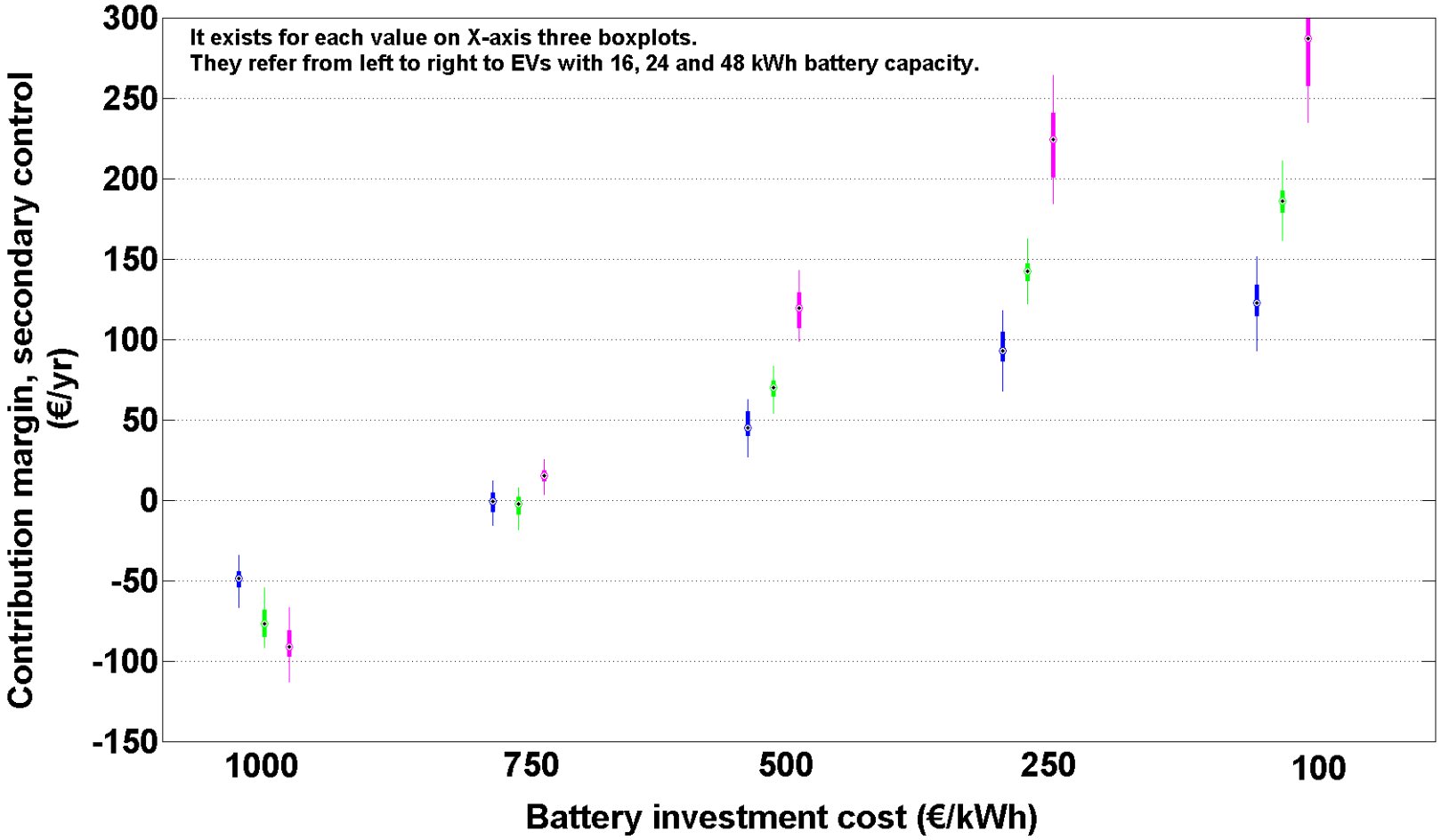
- Average calculated and assumed value of energy and power price for Austrian control market in 2020

	Positive (V2G)		Negative (G2V)	
	Power price €/MW/h	Energy price €/MWh	Power price €/MW/h	Energy price €/MWh
Primary control	53.6		53.6	
Secondary control	26	116.90	26	73.1
Tertiary control	2	176.75	10	73.1

[1] M. Litzlbauer: Grid integration of electric vehicles considering the mobility needs, paper in EVS26, Institute of Energy Systems and Electrical Drives, Vienna University of Technology, Los Angeles, 6-9 May, 2012 (accepted)
[2] Peterson, S. B., Apt, J., Whitacre, J.F. (2009): Lithium-ion battery cell degradation resulting from realistic vehicle and vehicle-to-grid utilization, Journal of power sources, doi:10.1016/j.jpowsour.2009.20.010
[3] T. L. Gibson, N. A. Kelly: Solar photovoltaic charging of lithium-ion batteries, paper in Journal of Power Sources, doi:10.1016/j.powsour.2009.12.082, 2009
[4] A. Schuster (2008): Batterie- bzw. Wasserstoffspeicher bei elektrischen Fahrzeugen_ English: battery and hydrogen storage for electric drive vehicles, Master thesis, Institute of Energy Systems and Electrical Drives, Vienna University of Technology 2008

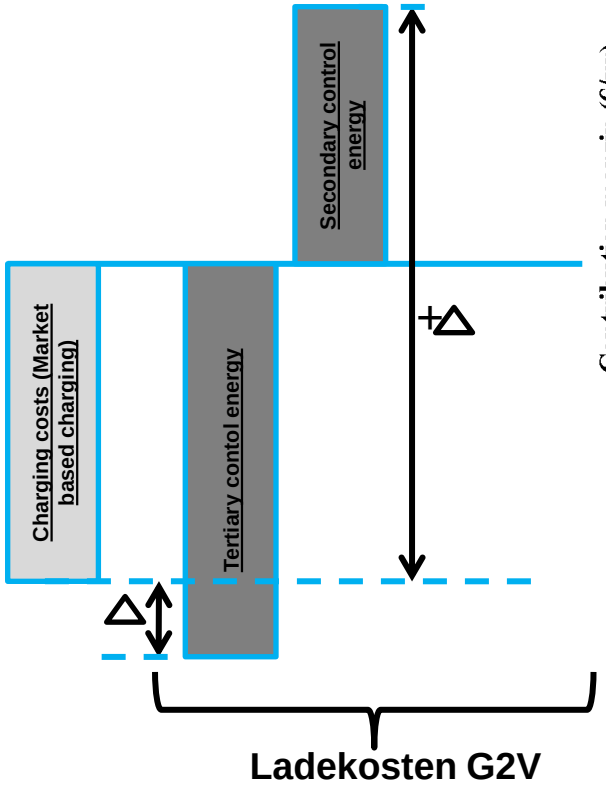
4. Results

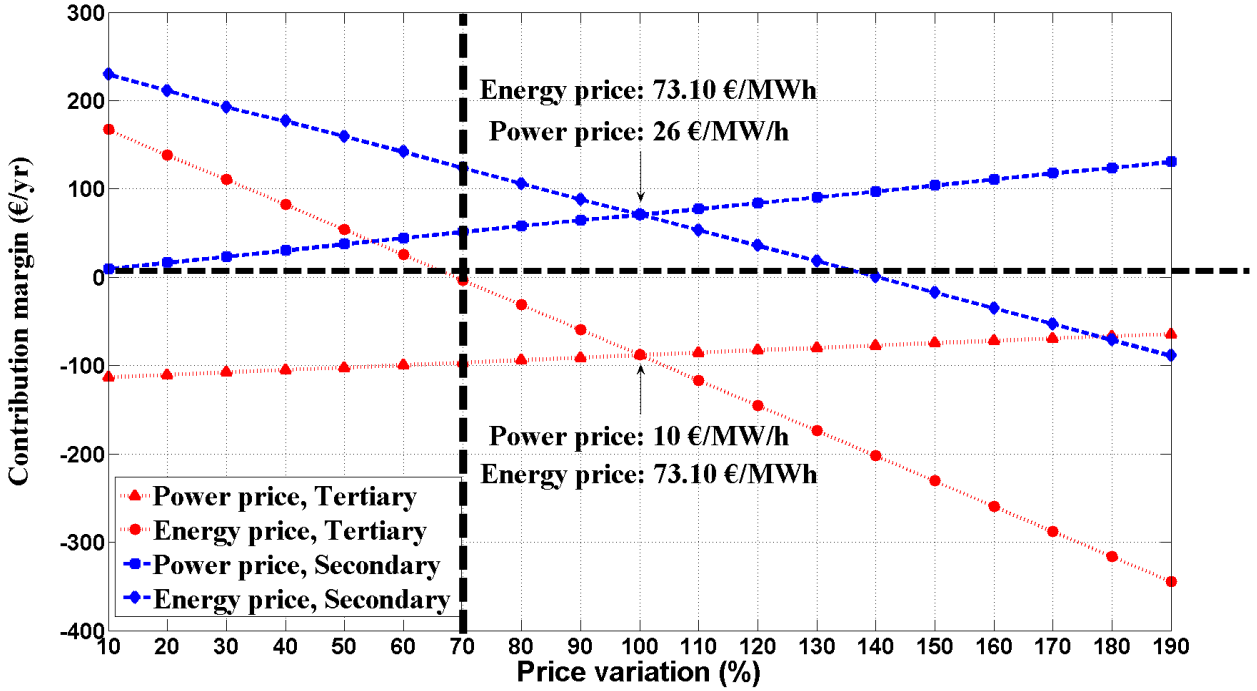
- Provision of positive control energy (V2G)
- Secondary



4. Results

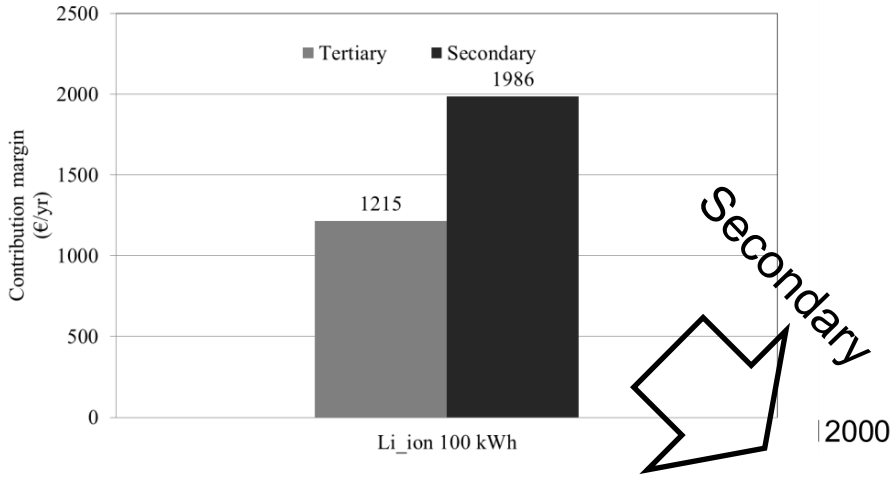
- Provision of negative control energy (G2V)
- Tertiary and secondary



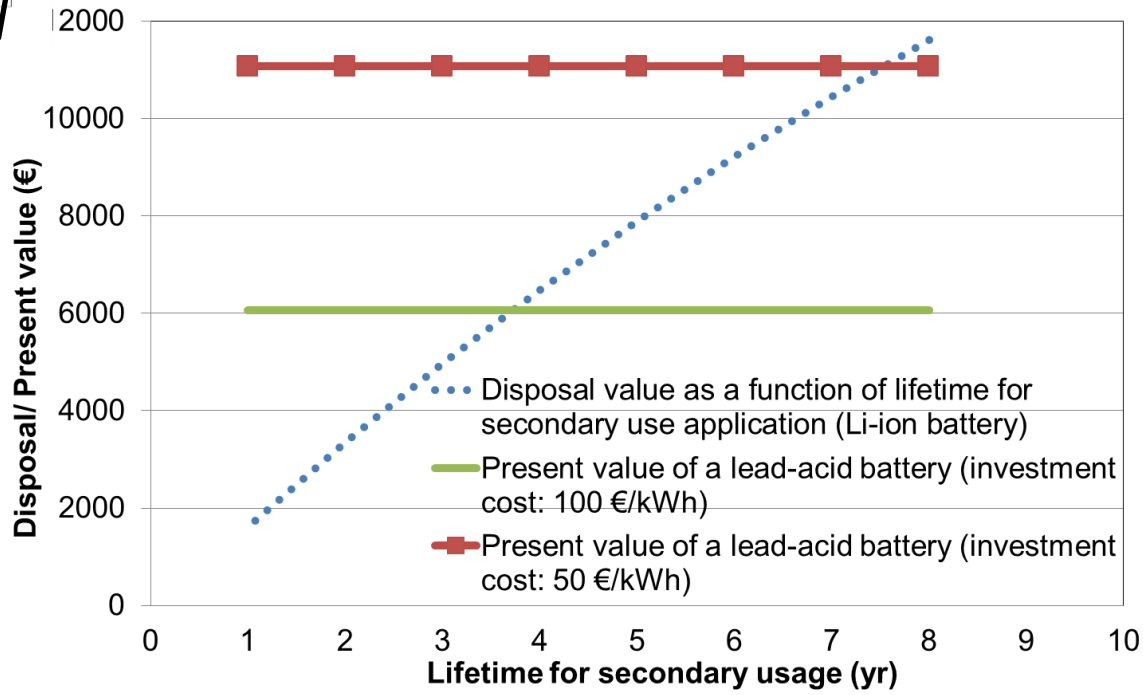


4. Results

- 2nd life application



Secondary

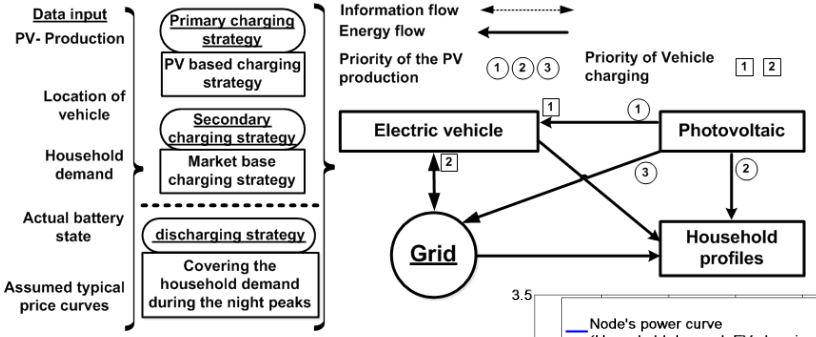


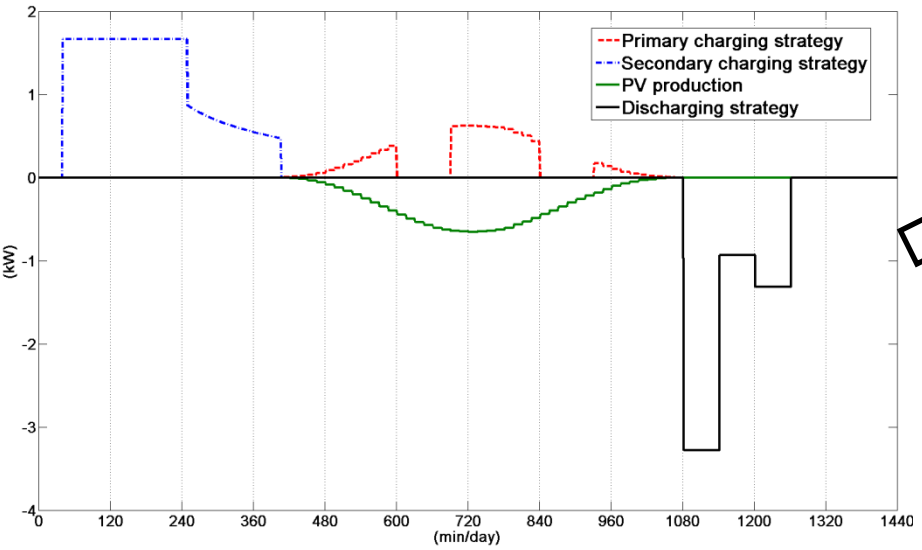
5. Conclusion

- Participation of Evs in Austrian control energy markets
  - The calculation of G2V and V2G contribution margins doesn't consider the main costs like communication infrastructure, aggregator's energy management system and V2G inverter. Therefore, an economic realization of V2G (G2V) concepts (participation on the control energy market in Austria) with a maximum margin from -7.32 to 63.94 €/vehicle/month cannot be recommended.
  - The G2V application for participation on the negative secondary control market has a better economic potential compared to the V2G application. The reasons lie in a higher number of control energy calls and non-existing battery degradation costs.
- Reusing of battery after it's automotive retirement
  - A reuse of EV batteries after their automotive lifetime for participation on the energy exchange and control energy markets thus can be recommended as a successful BM, if 2nd lifetimes higher than 4 years can be achieved. The reason lies in a positive and higher net present value of the reused batteries compared to new ones (same performance of lead acid batteries as those of reused batteries).

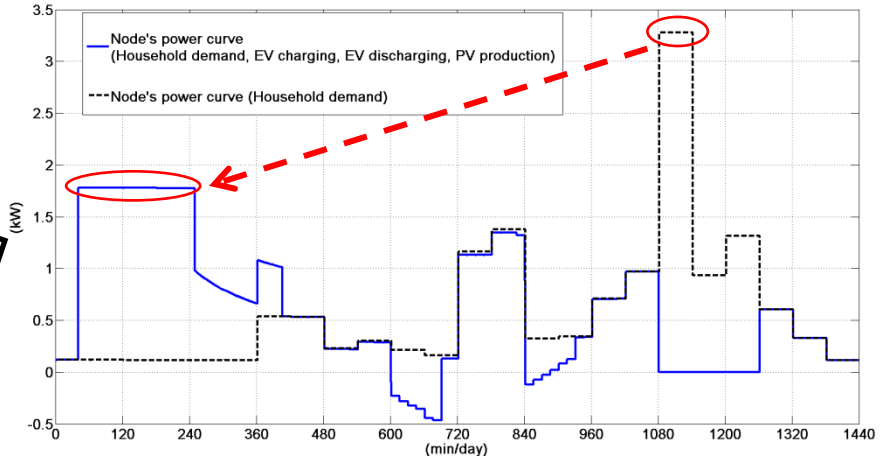
6. Outlook

Use Case: PV-based charging strategy





Charging and discharging strategies



Impact on power node‘s power curve

How high would be the saved load at
the local power transformer for a selected Low voltage grid?

Economic potential

The work is supported by the “Austrian Climate and Energy fund” and is part of the program “NEUE ENERGIEN 2020”.

Thank you for your attention

Partners: Salzburg Netz, AIT Austrian Institute of Technology

http://www.smartgridssalzburg.at/

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