



Universiteit Utrecht

LomboXnet



Copernicus Institute of
Sustainable Development

Smart Solar Charging: the role of photovoltaics in the sharing economy

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thanks to Marte Gerritsma, Robin Berg, Carolien van Hemel,
and the SSC consortium

EUPVSEC33, 25-29 September 2017



Hier wordt geïnvesteerd in uw toekomst. Dit project wordt mede mogelijk
gemaakt door het Europees Fonds voor Regionale Ontwikkeling.



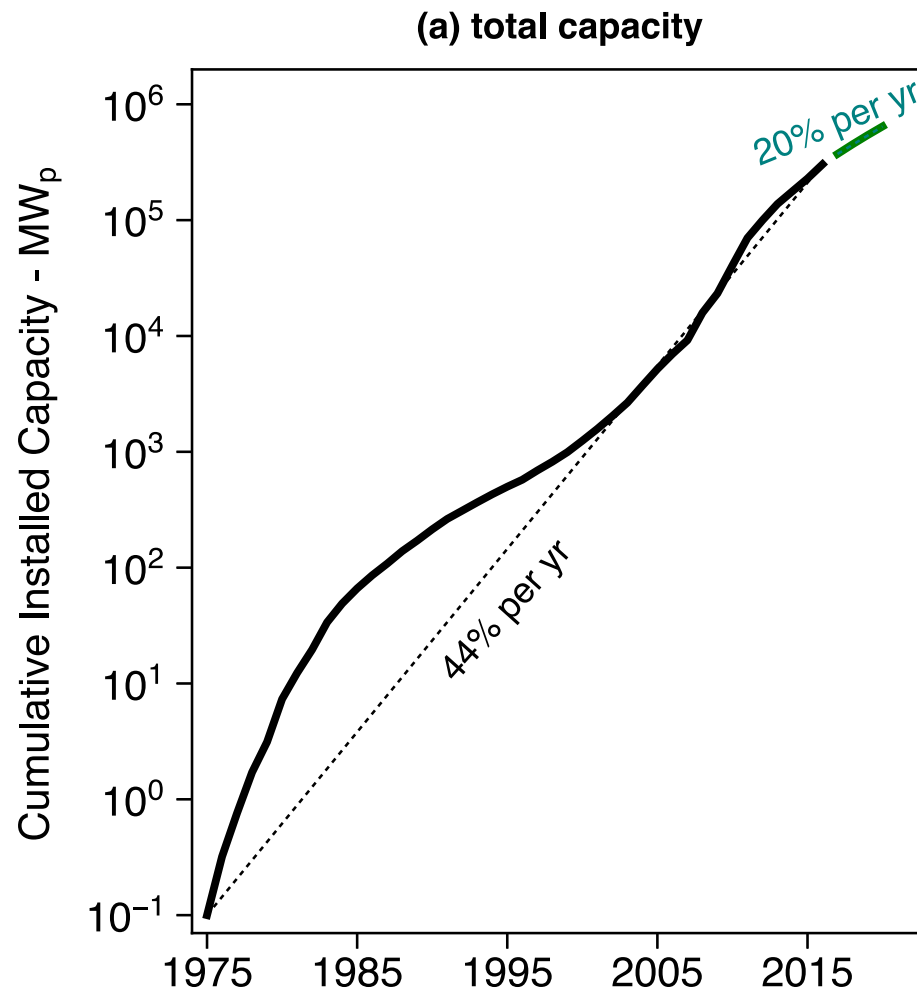


Motivation - 1

- Fast increasing amount of photovoltaic solar energy installations due to decreasing prices
now 303 GWp (~1.3 billion solar panels)
- Consumers: grid parity
- Commercial: feasible only with subsidy
>15 kWp, SDE+, NL
- However, multi-MW:
PPC of 3-4 c\$/kWh in Chile, Abu Dhabi



Strong growth of PV



6 orders of magnitude in 40 years

5 TWp in 2030, with 20% growth per year
[Haegel, Science, 2017]

~30% global electricity

(Louwen et al. 2016, updated)



Motivation - 2

- More photovoltaic solar energy installations due to decreasing prices (303 GWp globally)
 - Consumers: grid parity
- Increased amount of electric mobility
- Hybrid, plug-in hybrid, full electric

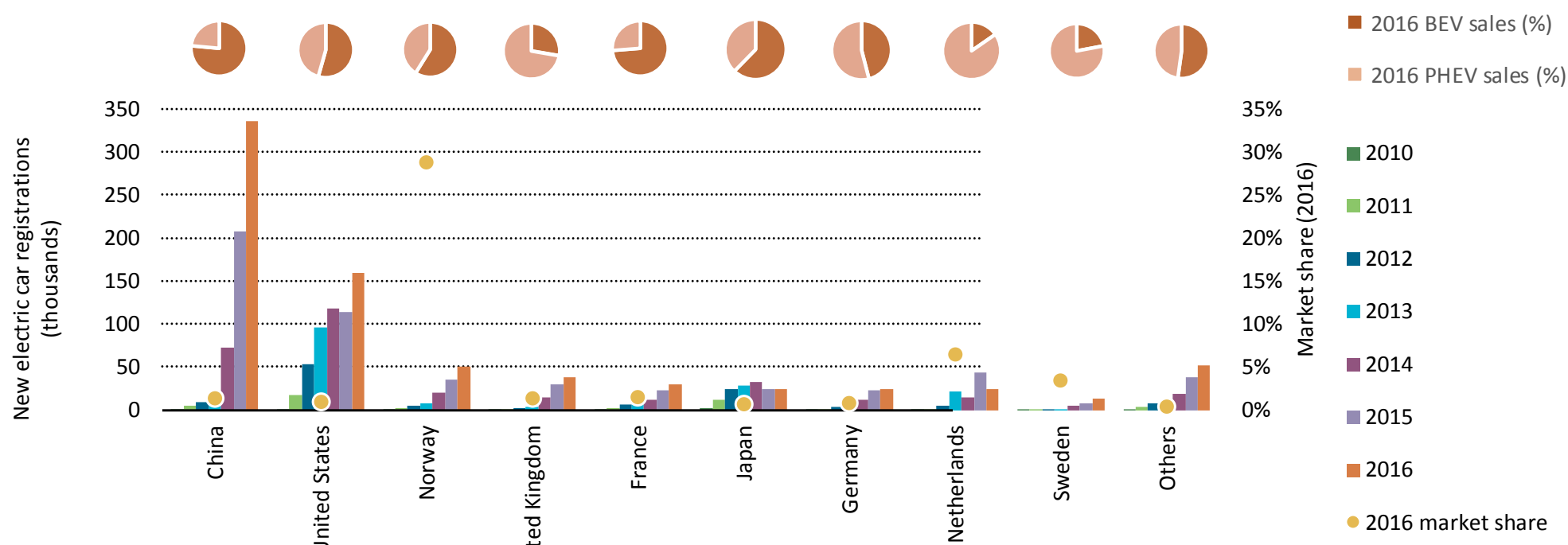


Renault ZOE, 300 km range



Tesla Model 3, 345 km range

Electric vehicles market growth



China+US ~ 500,000 EVs
 NL, Norway: high market share

(IEA, 2017)



Concerns EV

- Will the local grid be able to handle increased amount of EVs?
- Charging peak coincides with peak demand (6-9PM)
- Charging behaviour
 - Uncontrolled
 - Controlled (and, who is controlling)



Motivation - 3

- More photovoltaic solar energy installations due to decreasing prices (303 GWp globally)
 - Consumers: grid parity
- Increased amount of electric mobility
- **Can we link PV and EV development?**
 - Business case: charge EV with solar
→ Smart Solar Charging
 - Include vehicle-to-grid
 - Distribution grid level





Sharing cars

- Solar charged EVs
 - Much better air quality
- Reduce number of cars in district
 - More space for children, trees, ...
- Sharing
 - Increased social cohesion





Development of Smart Solar Charging

- Pilot
 - Defining the business case
 - Project “Smart Grids – Benefit for all”
- Demonstration, experimentation
 - Realization, organize car sharing and measure what happens
 - Project “Smart Solar Charging”
- Roll-out the business
 - “Piece-of-cake”



Rendement smartgrid voor iedereen!

Projectpartners

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sustainable energy for everyone

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Smart Grid – Value4All

2012-2015

**Creating business
by developing smart energy services**



Pilot Lombok: E-car4all en Storage4all

Objective

Develop and evaluate **algorithms** for a smart grid system that can **increase self-consumption** of PV-power by storing electricity in EVs in the residential sector while **meeting the demands** by the use of the **EVs**





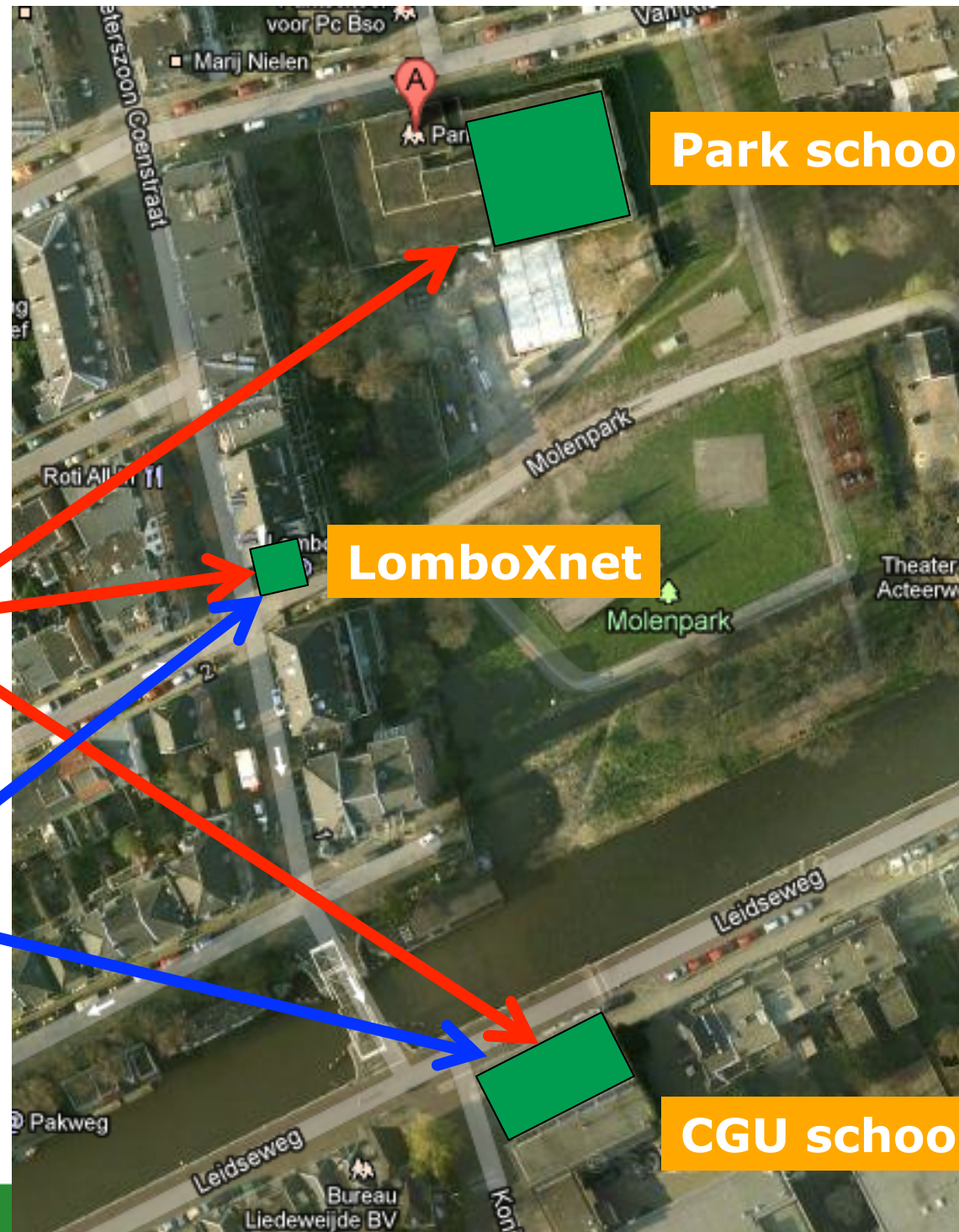


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PV panels

E-car
chargers



Park school

Lomboxnet

CGU school



LomboXnet

Park school

CGU school



Utrecht, Lombok

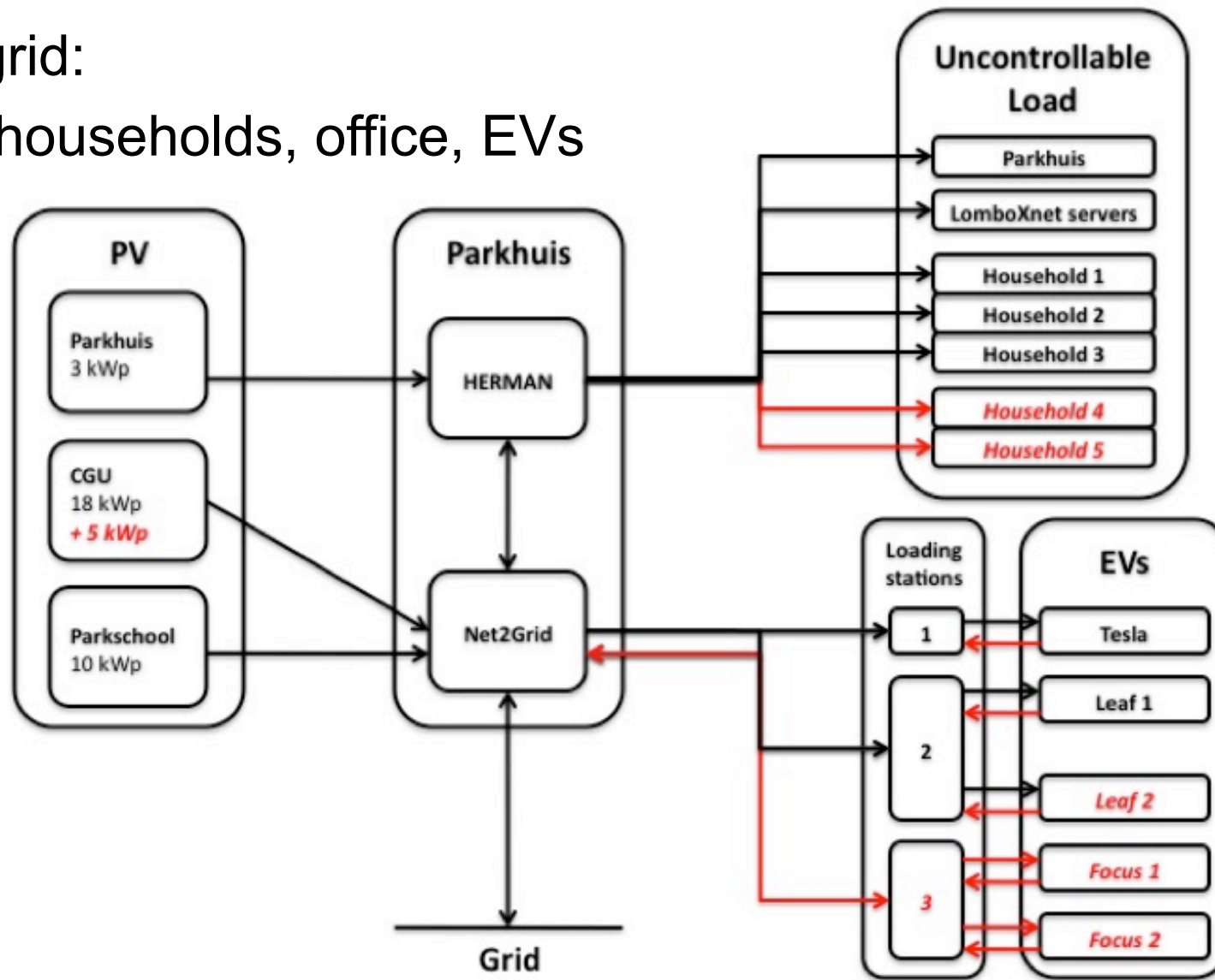




Model development

Microgrid:

- PV, households, office, EVs



Van der Kam, 2015

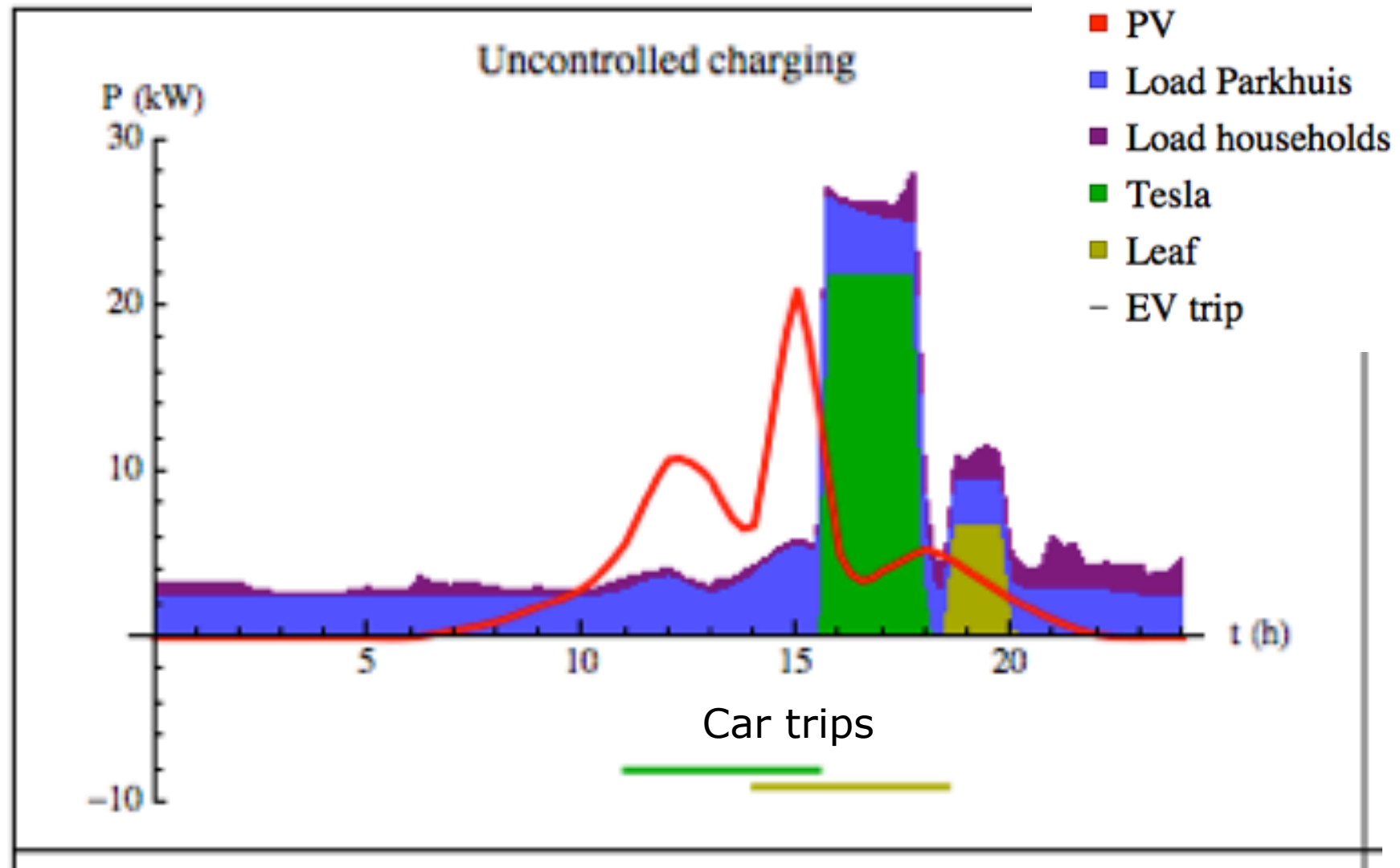


Strategies EV-charging

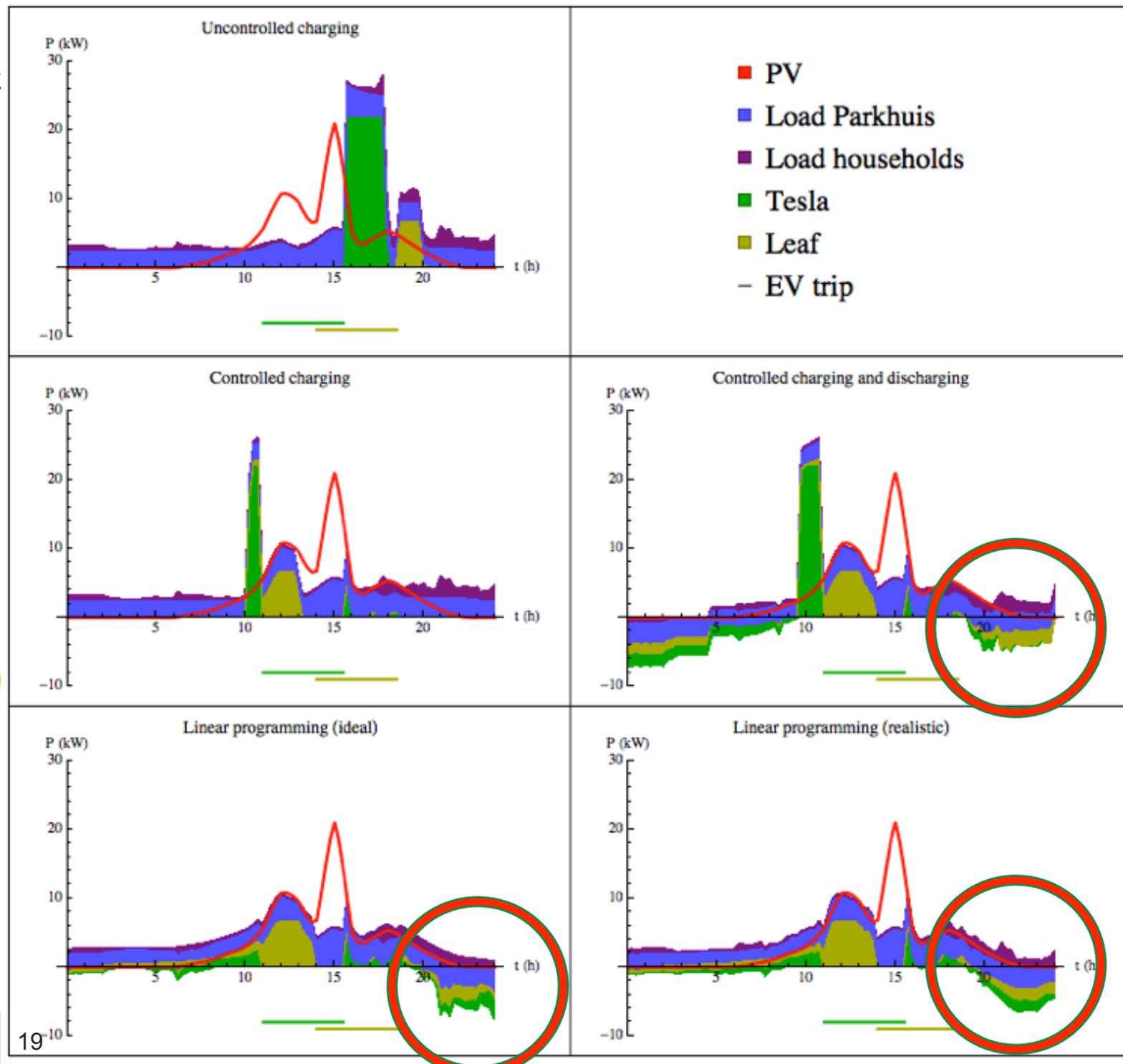
- Uncontrolled charging: “plug&charge”
- Controlled charging
- Controlled charging and discharging (V2G)
- Linear optimization
 - (Dis-)charging profile established through mathematical optimisation
 - Good predictions for PV and demand necessary
 - Evaluation with and without perfect information (ideal vs. realistic)



Results: uncontrolled charging



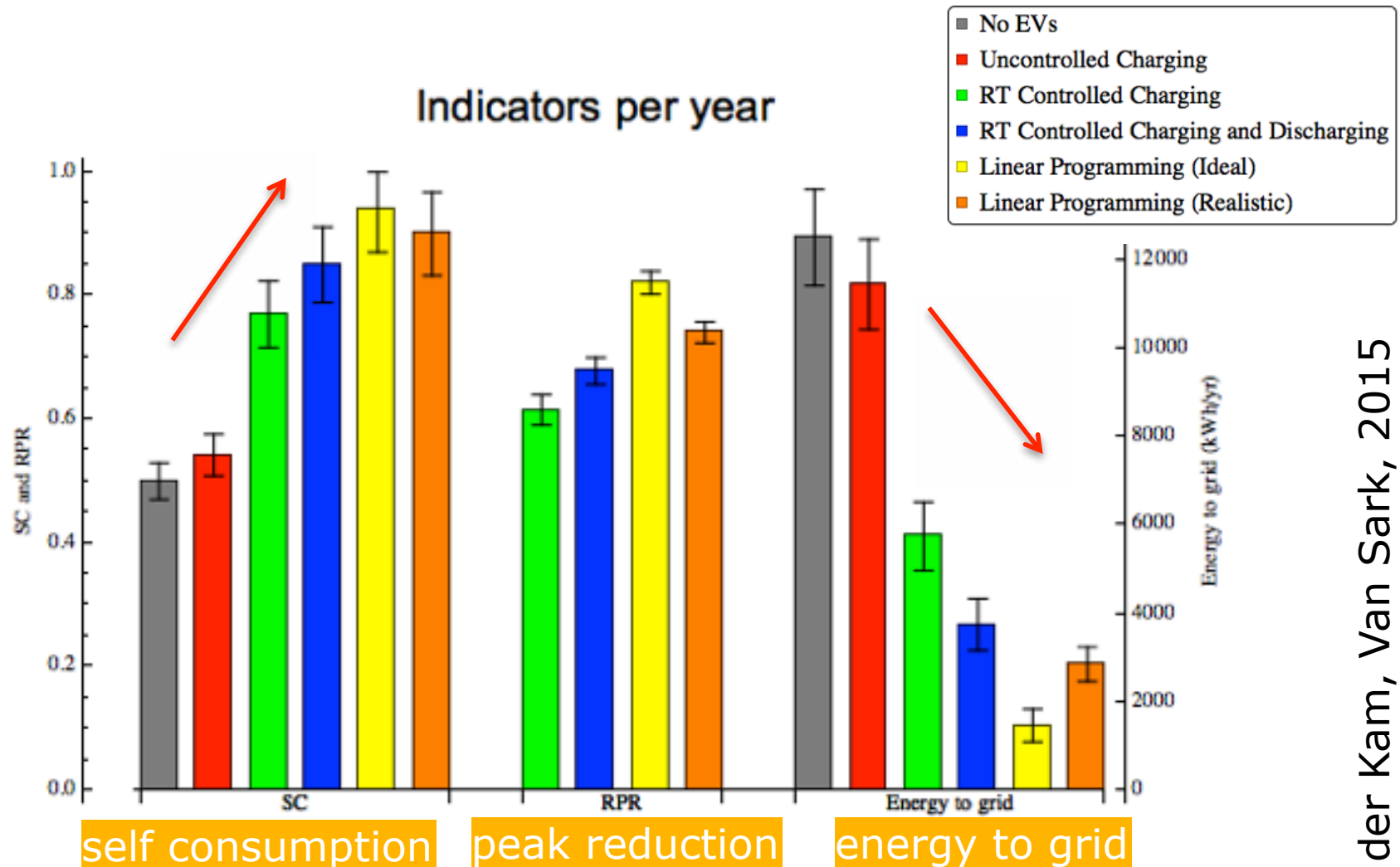
Van der Kam, Van Sark, 2015



Van der Kam, Van Sark, 2015



Results: self consumption, peak reduction, energy to grid



Van der Kam, Van Sark, 2015



Summary results

- Smart grid **control algorithms** for managing the (dis)charging profile of multiple EVs, either in real-time or using linear optimization with **predictions** for PV-power and electricity demand (**car agenda**)
- Results show that **smart storage of (solar) electricity in EVs** can increase self-consumption with 23% to 38%, reduce energy sent to the main grid with 3 to 9 MWh per year and reduce peaks with 27% to 67% (in this case study)
- Requires Vehicle-to-Grid!



First bidirectional charging station in Europe



June 9th 2015: live demonstration during international V2G-meeting Nissan



Summary

NOW: time for experimental data (bidirectional chargers)



- Scale-up
- Other districts, with different population, usage profile (office area, university campus)
- Company: **WE DRIVE SOLAR**

WE DRIVE SOLAR



MOBILITY HEROES



JEDLIX



RENAULT Z.E.



UTRECHT I/O



LomboXnet



last mile <> solutions®

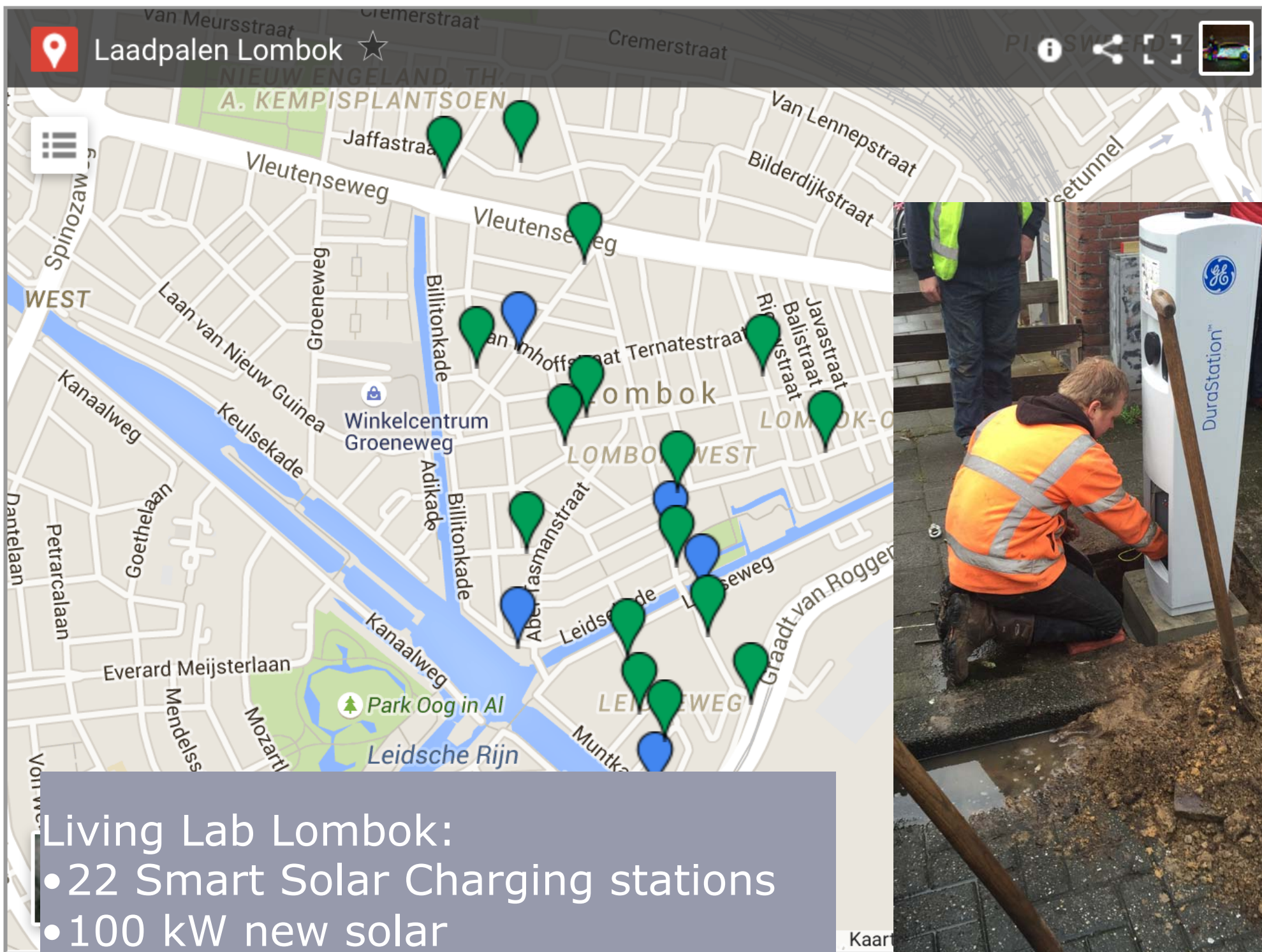


DirectLease

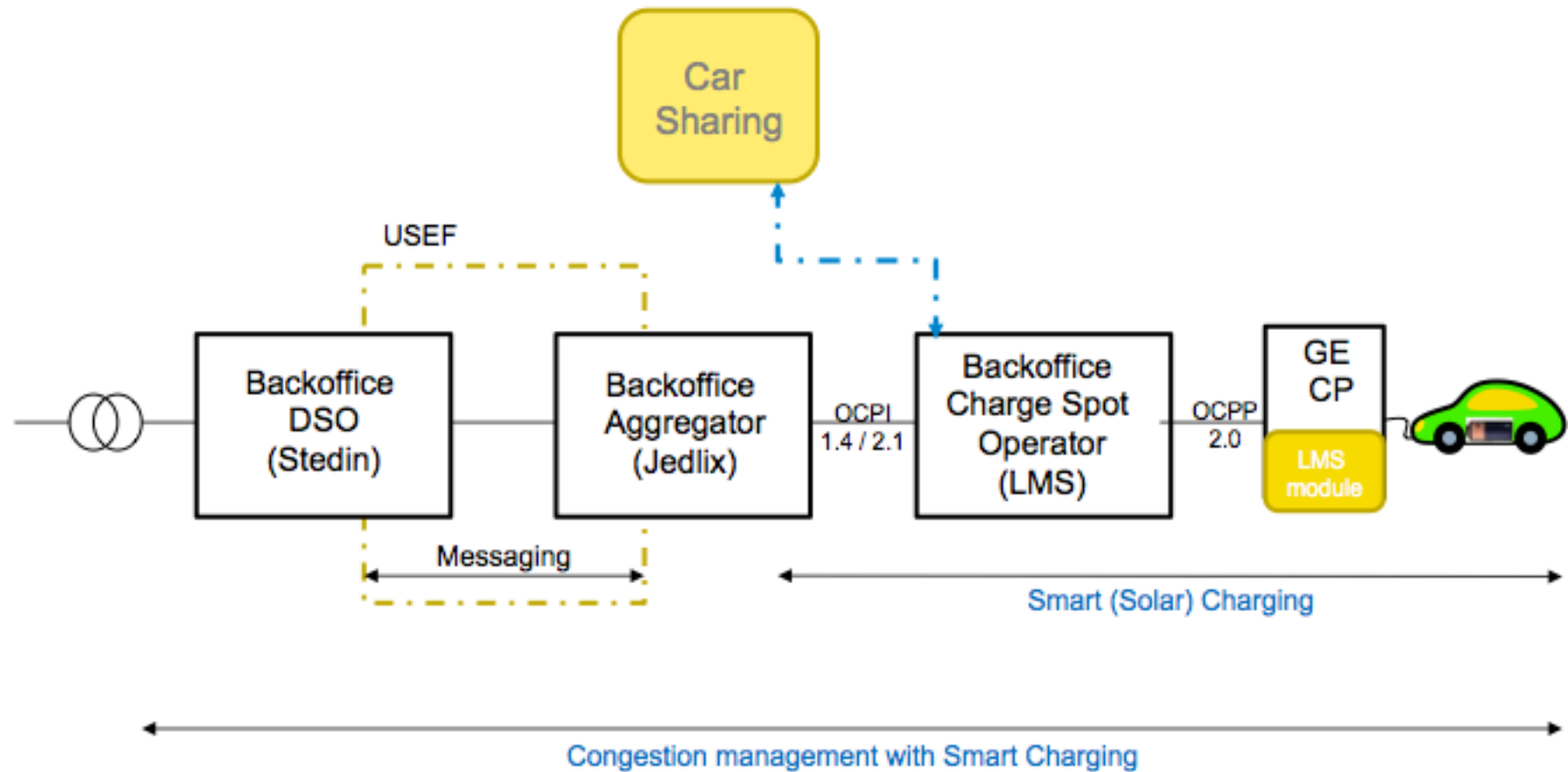
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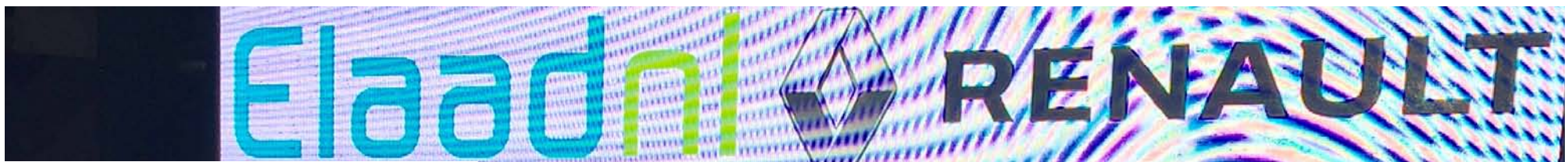


provincie :: Utrecht



Organize the business case





rganize the cars



Paris March 11 2016, Dutch royal visit to France
150 Renault ZOE's, 300 km range, bidirectional

The background image shows a sunny day on a Dutch street. A large, leafy tree on the left has the sun shining through its branches, creating a lens flare. In the background, a traditional Dutch windmill with a thatched roof and wooden structure is visible. A white car is blurred in motion on a cobblestone road in the foreground. A bicycle is parked on the left side of the road. The sky is clear and blue.

WE **DRIVE** SO

Entry price € 99,-/month [**6 participants CAR SHARING**

Includes km and insurance

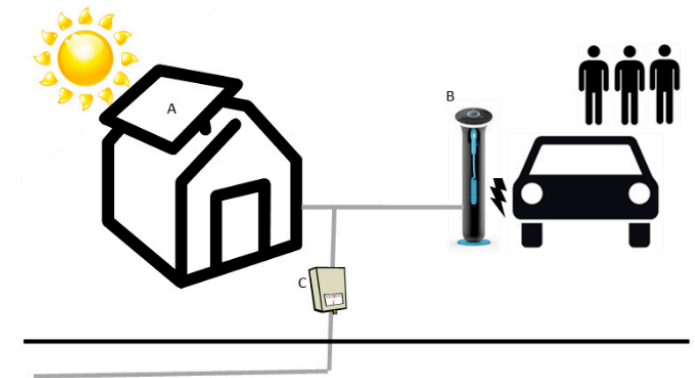
Licence plate based parking lot with Smart Solar Charging

App for reservation and opening

300 km range

The team





Future work: sharing

- Organize groups of 3-6 drivers (families) per car
 - Based on typical driving behaviour

BETTER?

- Organize pool of drivers for a fleet (5-10) of cars
- Study car sharing behaviour in relation to power flows → attempt to forecast charging needs
- Link to local, short-term solar forecast
- Determine optimal self-sufficiency level



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Ambition Utrecht Region 2018/2019

1.000 solar chargers, 1.000 shared EV's, 10.000 new solar panels, 100.000 users

First region in Europe with clean energy- and mobility system based on solar





HOT NEWS:

- EU Horizon 2020 Lighthouse project granted



IRIS

Integrated and Replicable Solutions
for Co-Creation in Sustainable Cities

- Utrecht (NL), Nice (FR), Gothenburg (SE), and 4 follower cities
- Contains smart solar charging in combination with deep renovation of social housing



Summary

- Photovoltaics and electric mobility are increasing simultaneously
- At district level, PV+EV can be combined using “Smart Solar Charging” concept
 - Smart grid energy management
 - Defer grid investments
 - **Business case car sharing**
 - Potential benefit from balancing
- Ingredient for Smart Sustainable Cities

THANK YOU FOR YOUR ATTENTION



Smart Solar Charging

A sustainable energy system at district level. Locally produced solar energy is stored in (pool) cars. This energy can be released to the district at a later time, via a smart charging station.

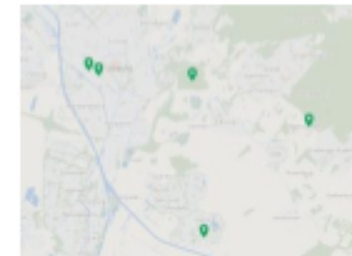
[Read more](#)



The project

The experiences in Lombok will be developed further and tested over the next four years in five linked pilot areas in the Utrecht region. This will result in marketable product-service combinations for various types of areas.

[Read more](#)



Five pilot areas in the Utrecht region

All areas combine the production of renewable energy with Vehicle2Grid-charging points and car sharing systems. Each pilot area has its own user profile, type of customer and specific market.

[Read more](#)