



SIMB!



Electric Mobility Needs Smart Infrastructures

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Introduction

- Sustainable communities – including sustainable mobility?
- Most promising option:
 - Electric vehicles (EVs) and
 - plug-in hybrid electric vehicles (PHEVs)
- Are they clean and sustainable, and will they be affordable?
- **Yes, if...**
 - 1. EVs smartly integrated into grid**
 - 2. charging infrastructure available and smart**
 - 3. urban and environmental impact balanced**
 - 4. e-mobility value network in place**



*An interim status of the Tekes Sustainable Community project
SIMBe: Smart Infrastructures for Electric Mobility in Built Environments*

Thousands of Buffer Batteries

- Disruptive paradigm change: **cars can provide clean energy**
 - Grid becomes smart – and electric vehicles play active role
 - electrical, renewable energy can be **buffered**
 - thus local and distributed energy production is **welcome at any time**



Clean energy in
when available



Clean energy out
when needed



- Smart grid project examples
 - International: Pecan Street Project (<http://pecanstreetproject.org>)
 - Helsinki: Kalasatama (https://www.helen.fi/pdf/Suvi10_hyvarinen.pdf)

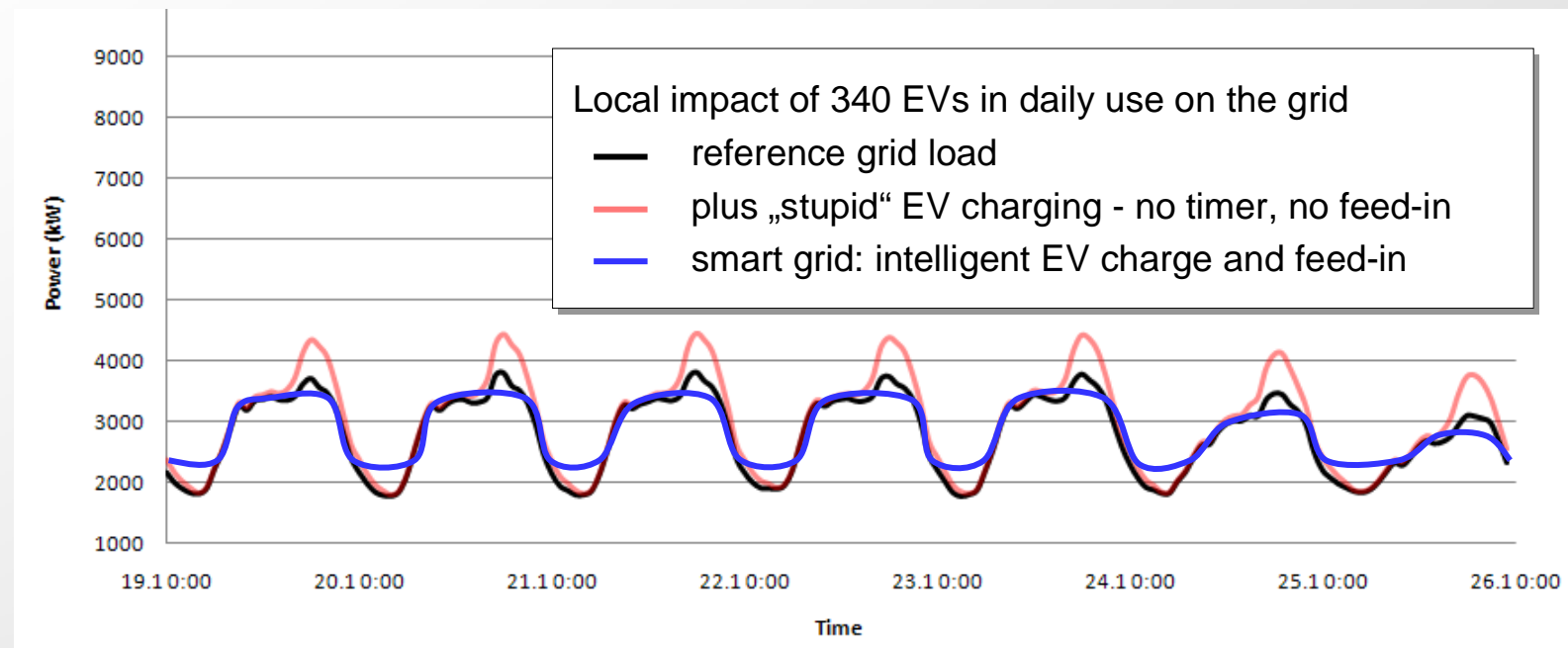
Less Peaks and Cleaner

Target

- Reduce peak loads: less CO₂ emission
- Use **renewable** energy when available
- Consume unused energy: especially nuclear power

Study impact on power supply grid

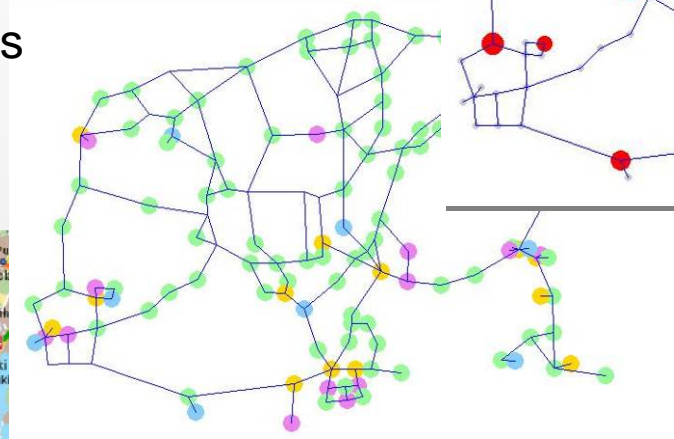
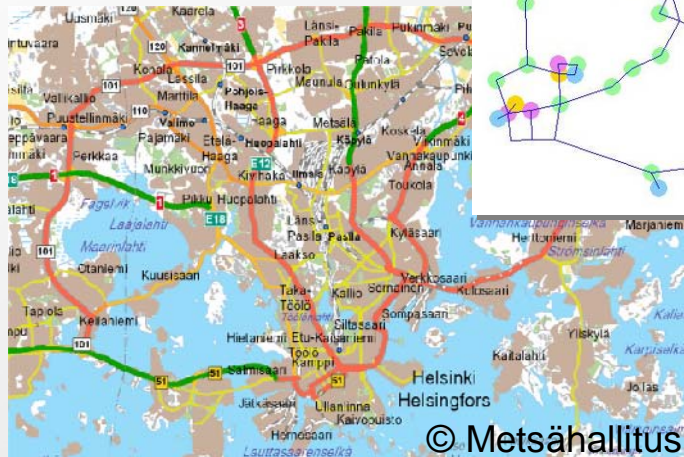
- Suburban areas (individual view and medium voltage feeder)
- Downtown areas



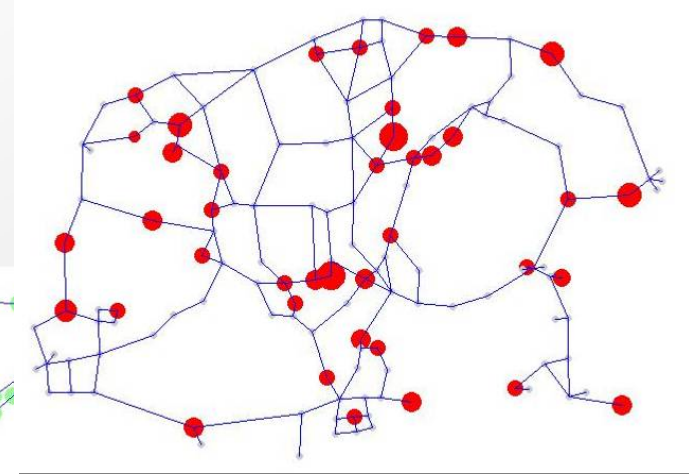
Helsinki Simulations

Research dimensions

- EV population/battery density
- Charging distribution
- EV charging loads
- Feed-in



Charging types



Charging loads

Charging Infrastructure

Research on individual EVs

- Slow/fast charging and its effects on grid & battery
- Charging in garages, parking lots, park-and-ride, **kerbside**, home and work
- Billing and metering and means of payment
- **Smart charging and feed-in** rewards

Research on public and delivery transport

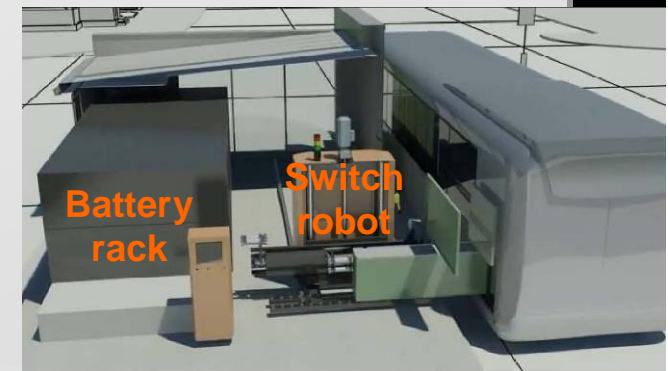
- Trolley and battery (combined) buses
- Battery powered delivery vehicles

Battery switching

- Benefit: recharging time = today's refueling time
- Attractive for large EVs with batteries >100kWh
- "Battery rack" allows fast charging for standard EVs
- Car manufacturers show **little interest** in switching

IEC 61851-1 charging modes

1.	230-400V	16A	3.7-11kW
2.	400V	32A	13-22kW
3.	690V	32-250A	22-300kW
4.	1000V DC	400A	400kW



Power Source Evaluation

Reference = Diesel bus (4.5-5kWh/km), 250-300k€	Transport fuel/power source versus Diesel alternative		
	Overhead (trolley)	Hydrogen	Battery
Energy balance (consumption in kWh/km)	++ (1.8-2.5)	-- (3.9-6.4 - fuel cell)	++ (1.0-1.2)
Volumetric storage density	++ (no special storage needed)	+	--
Technological availability	o	-	-
Range	++ (unlimited; restricted routes)	o (similar distances to diesel)	-- (very limited)
Additional infrastructure	- (overhead lines etc.)	- (storage; dispensing)	- (recharging; battery swapping)
Unit costs (x1000€)	- 450-750	-- 805-2 410	- 383 (hybrid)
Working as power resource	Not possible	Not considered	+ (supporting smart grid)
Comfort and attractiveness			
Environmental issues			

-- Major disadvantage; - Disadvantage; o Neutral; + Advantage; ++ Major advantage

Urban and Environmental Impact

Research on future urban mobility

- Why do humans yearn for mobility?
- Future role of the (individual) car?
- Emerging EVs and concepts?
- E-mobility effects on people's mobility...
- ...and on selection of transport means?

Environmental assessment

- over whole EV life cycle, including
- emission view on electric energy creation

Research on traffic and transport integration

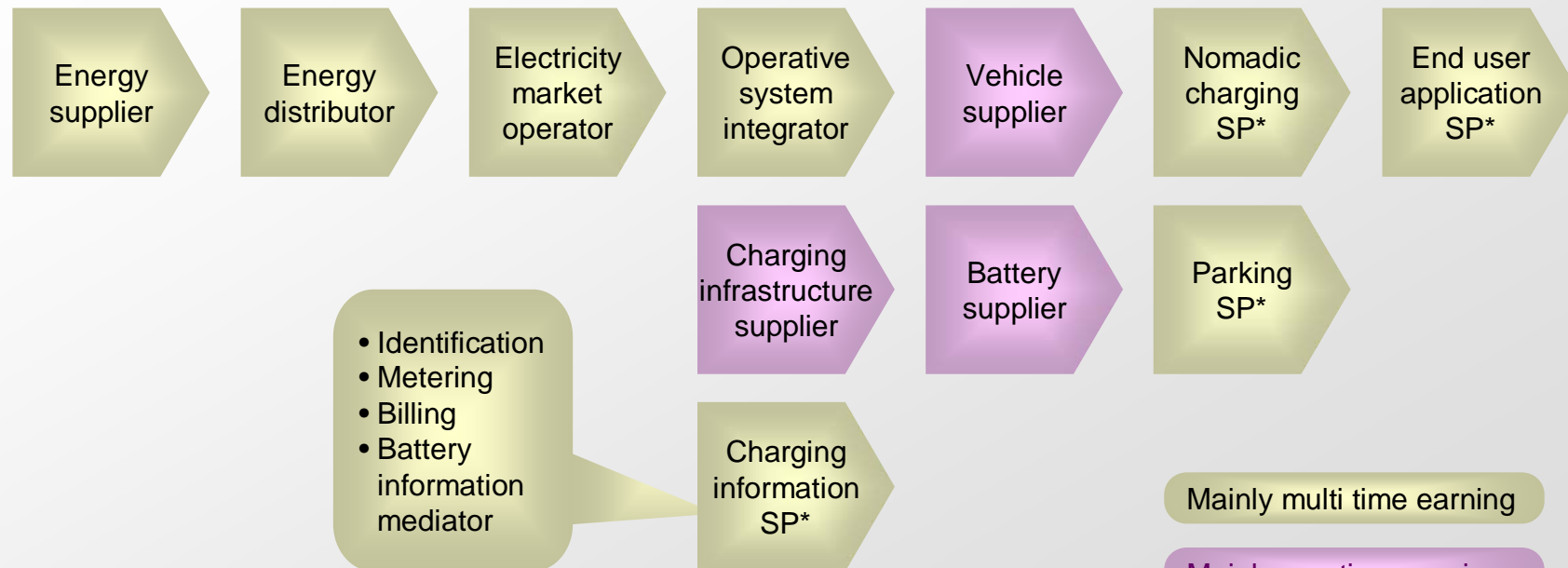
- Urban traffic flows and travelling behaviour
- Data from Helsinki metropolitan area traffic survey
- Various scenarios for penetration speed of EVs
- Output: blueprint for local charging network



Industrial e-Mobility Value Chain



Maintenance
and Life Cycle Services








Mainly multi time earning

Mainly one time earning

*: SP = Service Provider

Ideal EV Management System*

Context	System level	Optimisation aim	Number of EVs
 Regional power system	Layer IV	Support Frequency Stability	Millions
 Distribution system	Layer III	Avoid peak loads	Thousands
 Local power system	Layer II	Support local power generation	Hundreds
 Fast charging station	Layer I	Provide safe and reliable charging	Tens
 User	Smart Control Terminal	Optimize charge and discharge schedule	One

*: In agreement with CEPRI Electrical Engineering and New Material Department

Selected Business Opportunities

In the mid term, market will become end-user driven

- end-users ask for clean and smart mobility,
- and they will be ready to pay

Nomadic charging service provider

- fuel station network
- supermarkets, shopping centres

Parking service provider

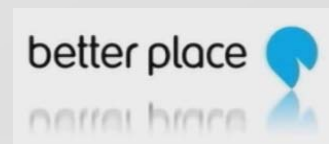
- today's slow charging can be extended in volume and speed

End user application service provider

- EVs most suitable for urban traffic (0 emissions)
- ideal for urban car sharing clubs and car rental agencies
- hotels and further real estate and utility providers will follow
- EVs ideal feeders for railway stations

Operative system integrator

- combines potentially strongest opportunities and risks



Conclusion: e-Mobility Needs Smart Infrastructures

EV batteries offer opportunities for grid and sustainable mobility

- with **intelligent, smart charging** solutions,
- sufficient charging and **feed-in** possibilities,
- also in work places and especially on **kerbsides**.
- Battery racks should be multi-use and multi-feed.



Opportunities for real estate, construction and facilities management industry

- urban car sharing clubs and rental agencies
- hotels and railway station operators
- most interesting: **operative system integrator**

When linking EVs to sustainable communities and building

- Think holistic and allow complexity
- Think big and international
- Listen to stakeholders
- Find the business perspective: visit www.SIMBe.fi

A! Aalto University
School of Business
and Technology

SIMBe!

Sustainable community

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Background

SIMBe: Smart Infrastructures for Electric Mobility in Built Environments
An Aalto University project funded by the **Takes Sustainable Community programme**

Electric cars, hybrids, batteries and development seem to appear on a daily basis. Did you know that you can do more than drive an electric car? What are the barriers to launch such large amounts of electric vehicles into Finnish streets?

Aalto University researchers have a first class in the business. Or more precisely, to accelerate the introduction of sustainable electric mobility in Finland and to explore the associated business opportunities and related social services. The barrier there will be some, certainly but some business opportunities will be created: energy sales and parking, provision of vehicles and mobility services, as well as provision of a fleet of vehicles to shared customers.

Partnering up with the car manufacturers and companies active in intelligent energy, a social, smart management networks as well as the Finnish energy class, European authorities and other electric car service providers are for Aalto University department. This includes the **MIT Research Center**, the **Howe Energy Technology** group, the **Transportation Management** and the **Department of Electrical Engineering, Research Center for Intelligent**.

SIMBe has set up in January 2010 a first stakeholder in analysis, working together public authorities and end users of the concept, working and elaborate phase market. There are technology assessments as well as new and existing services will be integrated into concepts for strategic business models and energy cycle. [Read more about our work](http://www.aalto.fi/simbe) <http://www.aalto.fi/simbe>

Further updates in 2011: receive an introduction to project as well as guidelines for market analysis, uncertainty management and other the market. <http://www.aalto.fi/simbe>

THINKcity

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