# DAME


***D**evelopment, Validation and **A**pplication of an agent based **M**odeling Approach for optimal Integration of **E**lectromobility in Electricity Distribution Grids*

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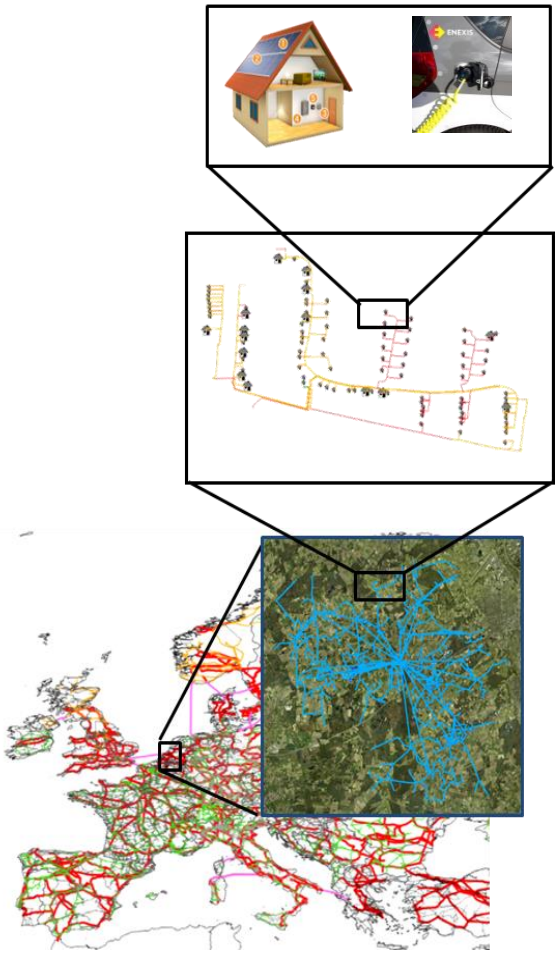
Electromobility+ Mid-term event, Copenhagen 2014

# Motivation and project goal

- E-mobility as a new (politically facilitated) form of future transportation
- Distribution System Operator perspective
  - **Long asset life cycles** and planning phases in today‘s power grids
  - Tomorrow‘s challenges need to be considered today
- Electric vehicles as mobile storages and with specific challenges
  - **Temporally and spatially highly fluctuating load**
  - Cause **additional local load peaks** on top of the conventional loads
  - Depending on the **deployment of charging infrastructure**

➢ Aim of the project: Development of a new grid planning process to integrate future electric vehicle fleets into the electrical grid



# Key Questions


- How can **load profiles of electric vehicles** be modeled?
- What is the expected **impact** of electric vehicles **on distribution networks**?
- What is the **effect of** different **charging strategies**?
- How can electromobility be **integrated in today's grid planning process**?

# Methodology

## Overview

Analysis of current and future operational situations

### E-Mobility

- Bottom-up modeling of the driving behavior
- Agent-based modeling of electric vehicles with individual characteristics validated on statistical data
- Implementation of different charging strategies

### Conventional loads and generators

- Households
- Industry and agriculture
- Increasing share of distributed generation such as PV systems or heat pumps

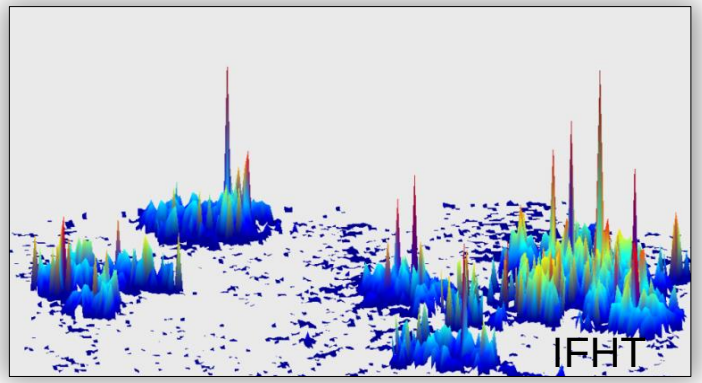
Analysis of the impact on the distribution grid

**Basis for the development of new grid planning methods**

# E-Mobility

## Generation of load profiles of electric vehicles

- Agent-based modeling approach
  - Individual modeling of each electric vehicle and its technical parameters
  - Individual driving behavior and charging preferences
  - Parameterized/ validated with extensive statistical data
- Adapted gravity model
  - “Attractiveness” of destinations modifies the probability of a trip to their locations



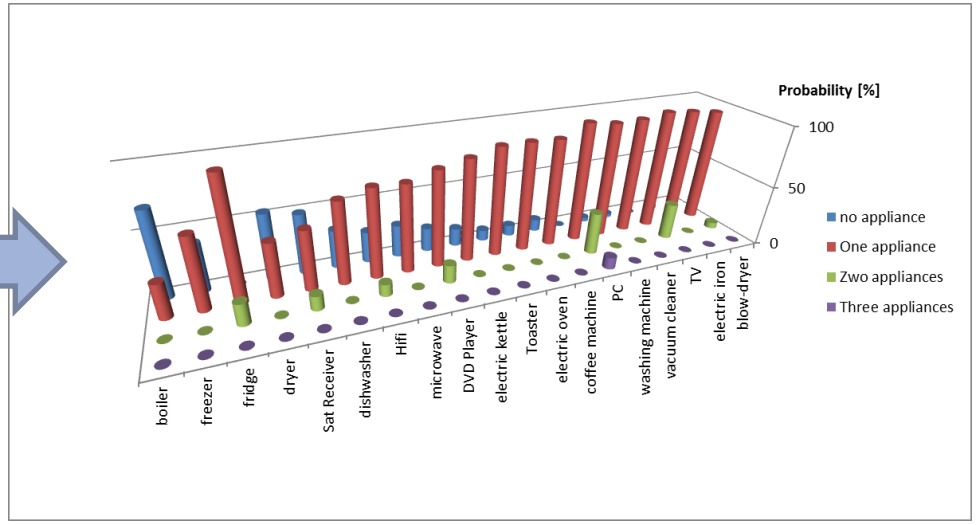

No destination Max. destinations

- Generation of load profiles
  - Charging strategy: Maximize the economic benefit of an EV fleet through participation in electricity and balancing markets
  - Deployment of charging stations

➢ Probabilistic profile for each electric vehicle

# Conventional loads and generators

## Modeling



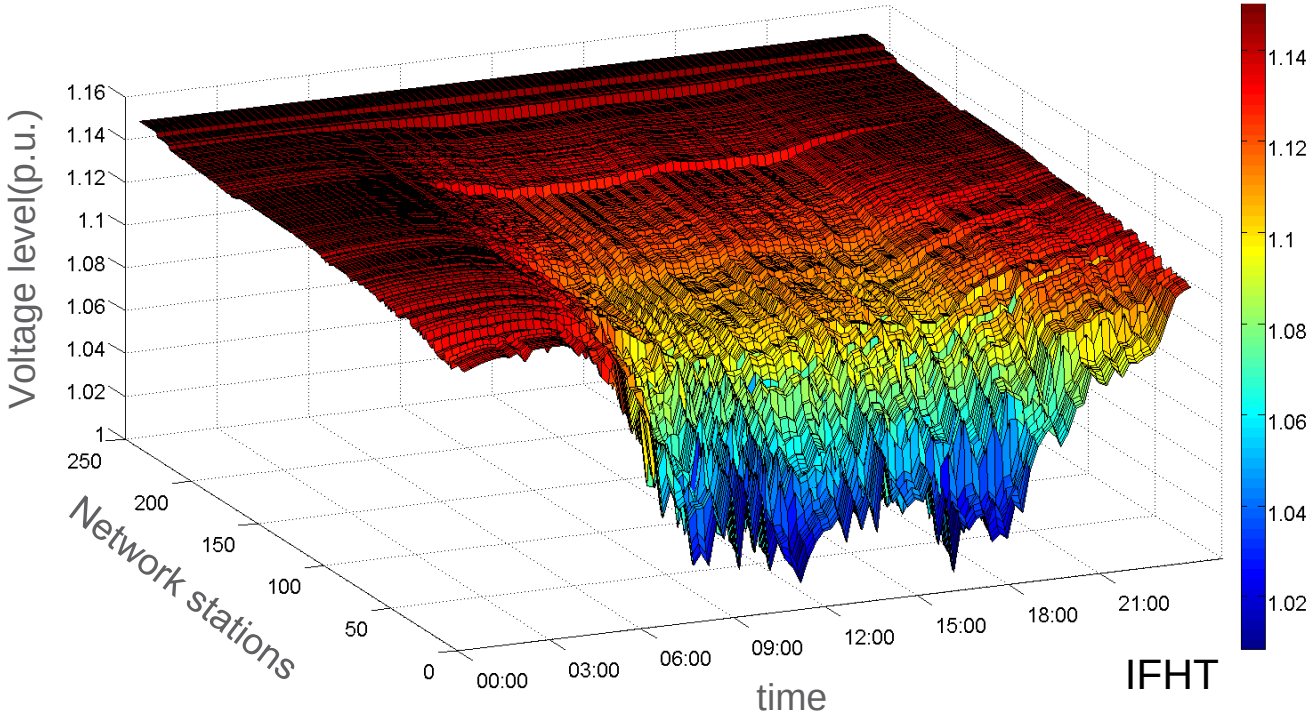

- Statistic modeling of each household to generate a range of different load profiles
  - Considering probability of ownership, usage frequency and duration …. of a household appliance
- Generation of load profiles with and without distributed energy resources (DER)

➢ Probabilistic profile for each household and for each DER

# Preliminary results

## Influence of electric vehicles on distribution networks

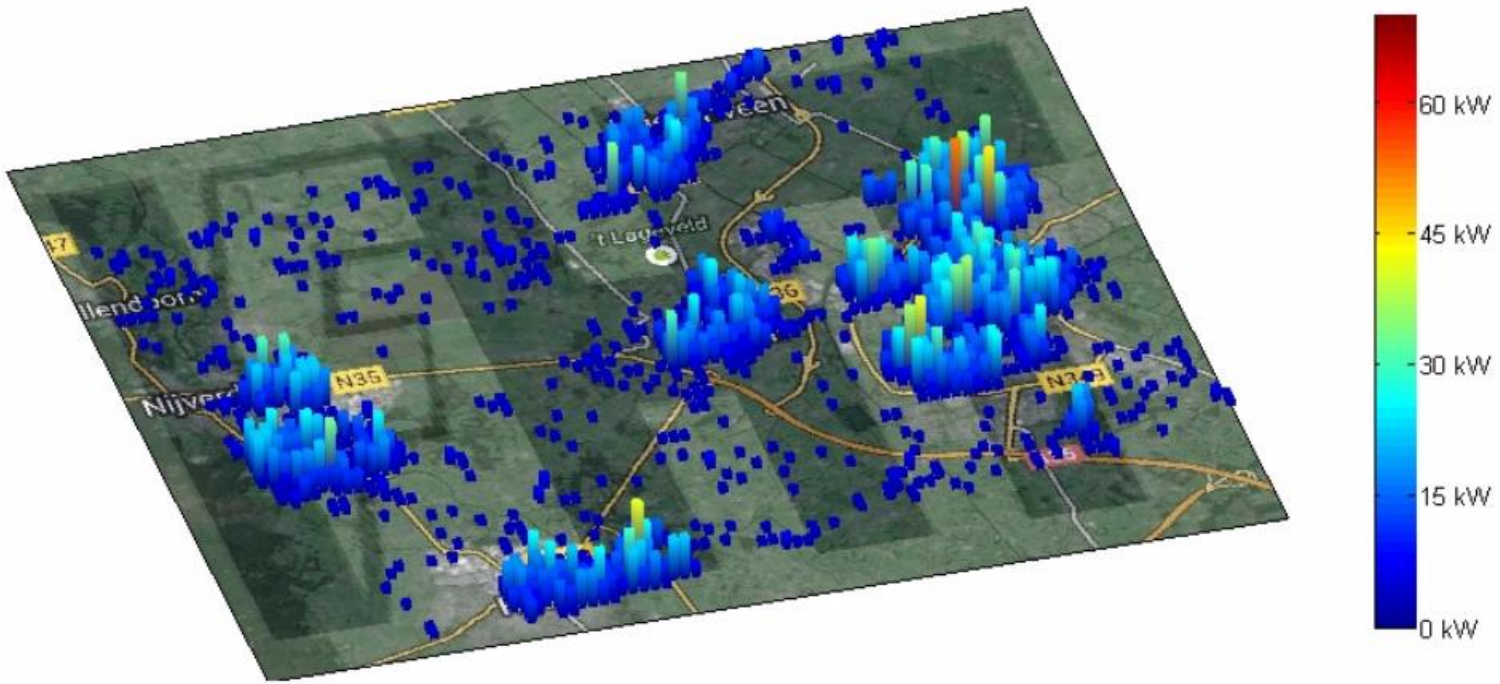
- Example scenario
  - ➔ 50% market penetration of electric vehicles
  - ➔ Charging at home and at selected public charging stations
  - ➔ Charging power between 3.7 and 22 kW
- Worst case of voltage level* by local network stations and time
- ➢ Identification of critical parts of the distribution gird




*local operational voltage without electric vehicle influence is 1,15 pu

# Generation of load profiles

## Exemplary load distribution of electric vehicles

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High peak loads possible, particularly in inner cities with high charging demand and existing public charging infrastructure

# Preliminary results

- The impact of electric vehicle charging on the distribution grid can be analyzed with the developed models
- The charging at **public charging stations** can be more critical than charging at home
- **Placement of public charging infrastructure** has a significant impact on the utilization of resources in distribution networks

# Next Steps

- **Validate** the models on a significant number of medium voltage grids
- **Reduce the complexity and calculation time** of the models for a better integration into the grid planning processes
- Derive improved methods and operational procedures for distribution **grid planning processes**

*Thank you for your attention*

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