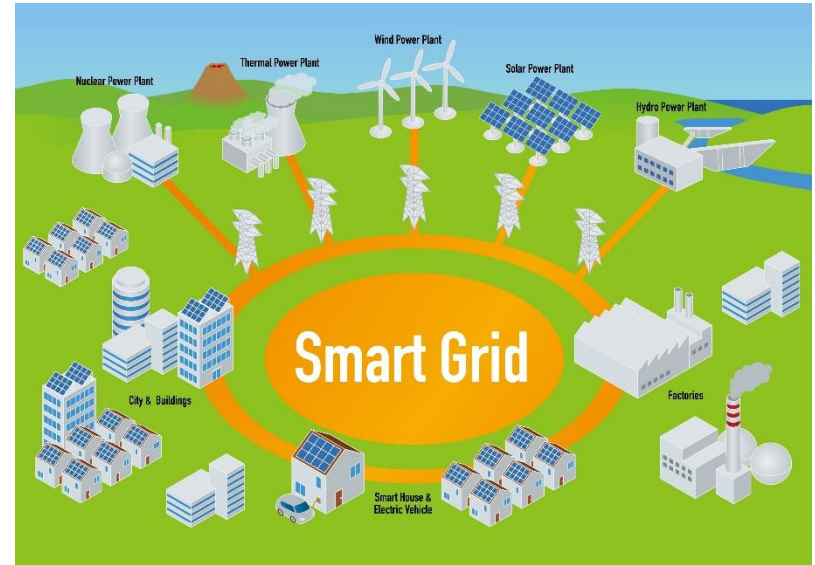## Management of charging demand on smart grid

- Smart grid
- Grid load
- Charging demand management
- Charging planning method
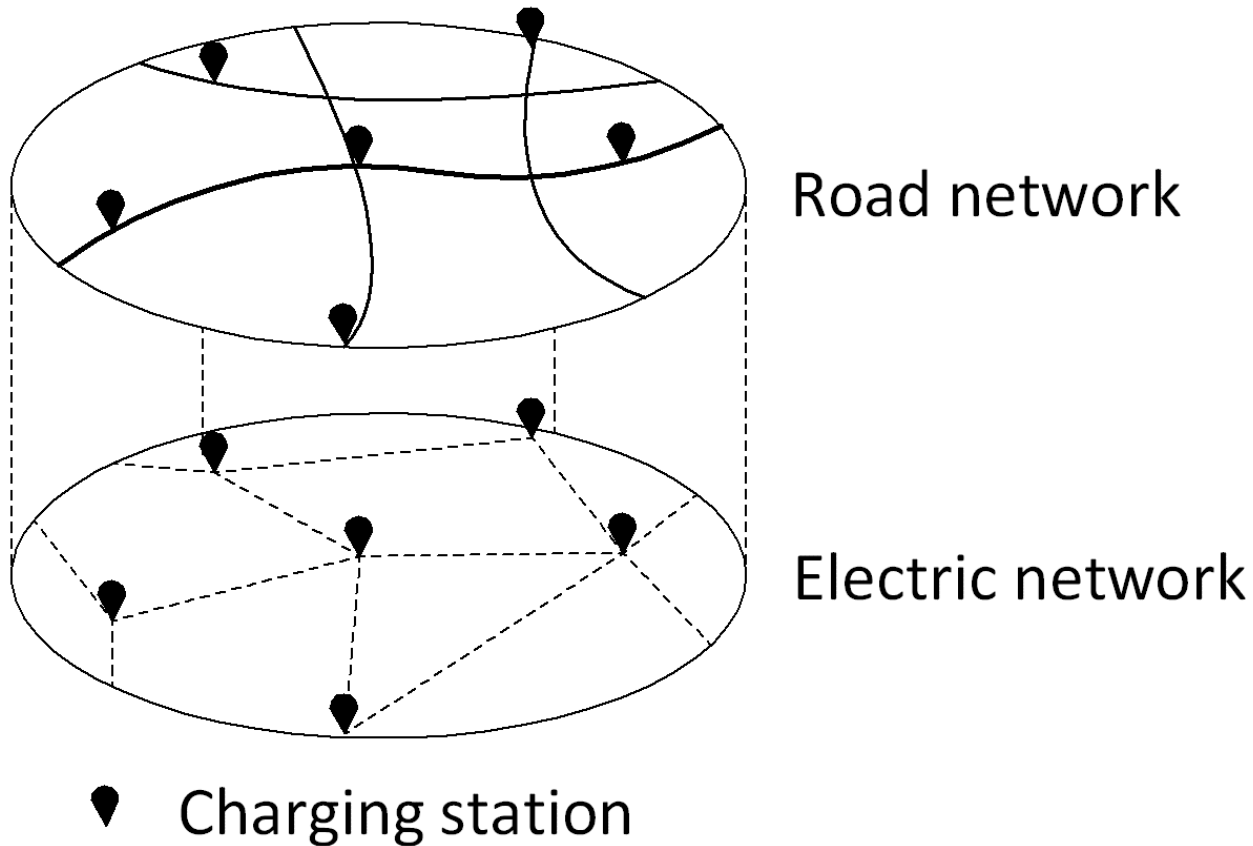

Information system of electromobility and services
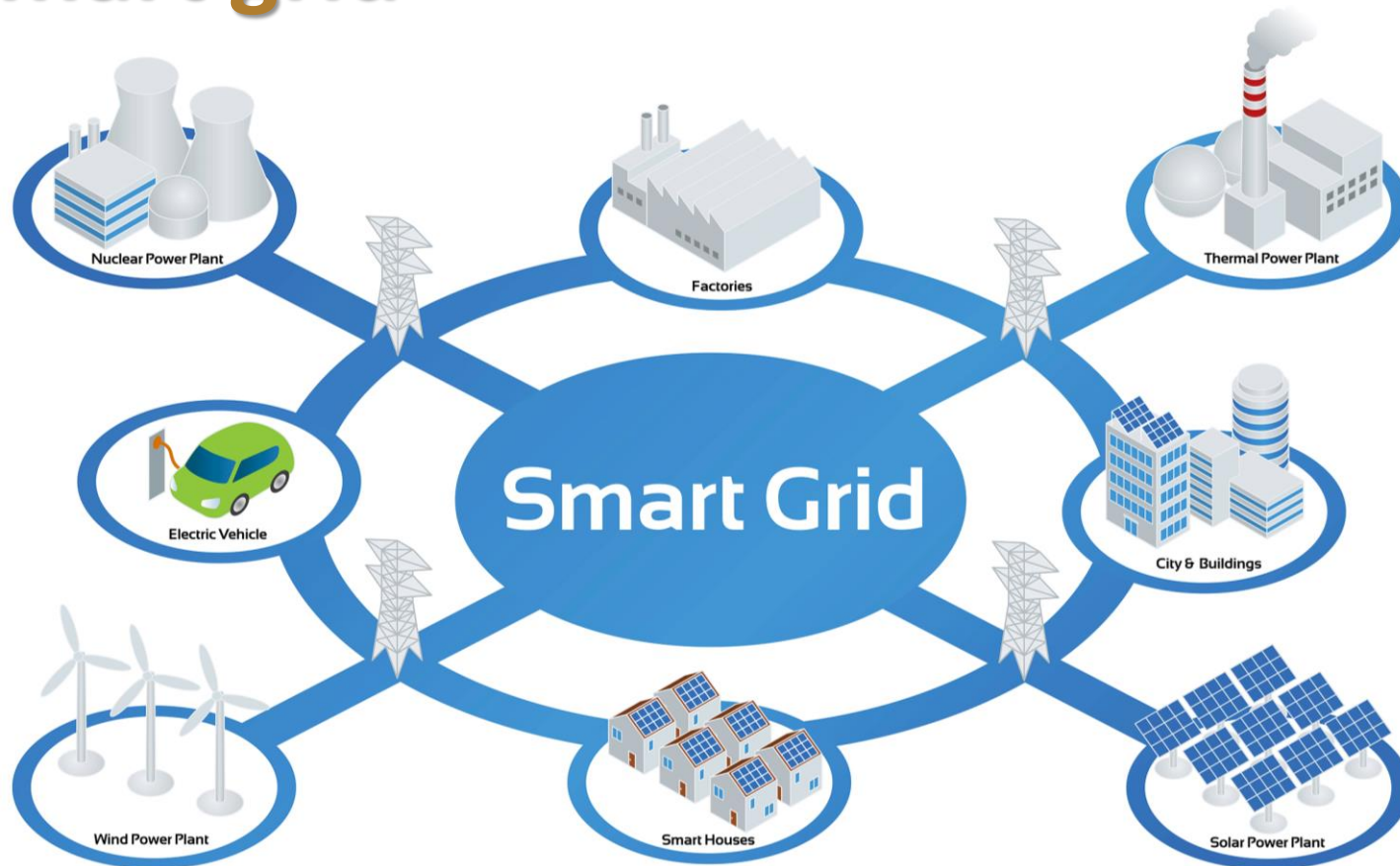
- Information system of electromobility
- Novel services

Management of charging demand on smart grid

Road network
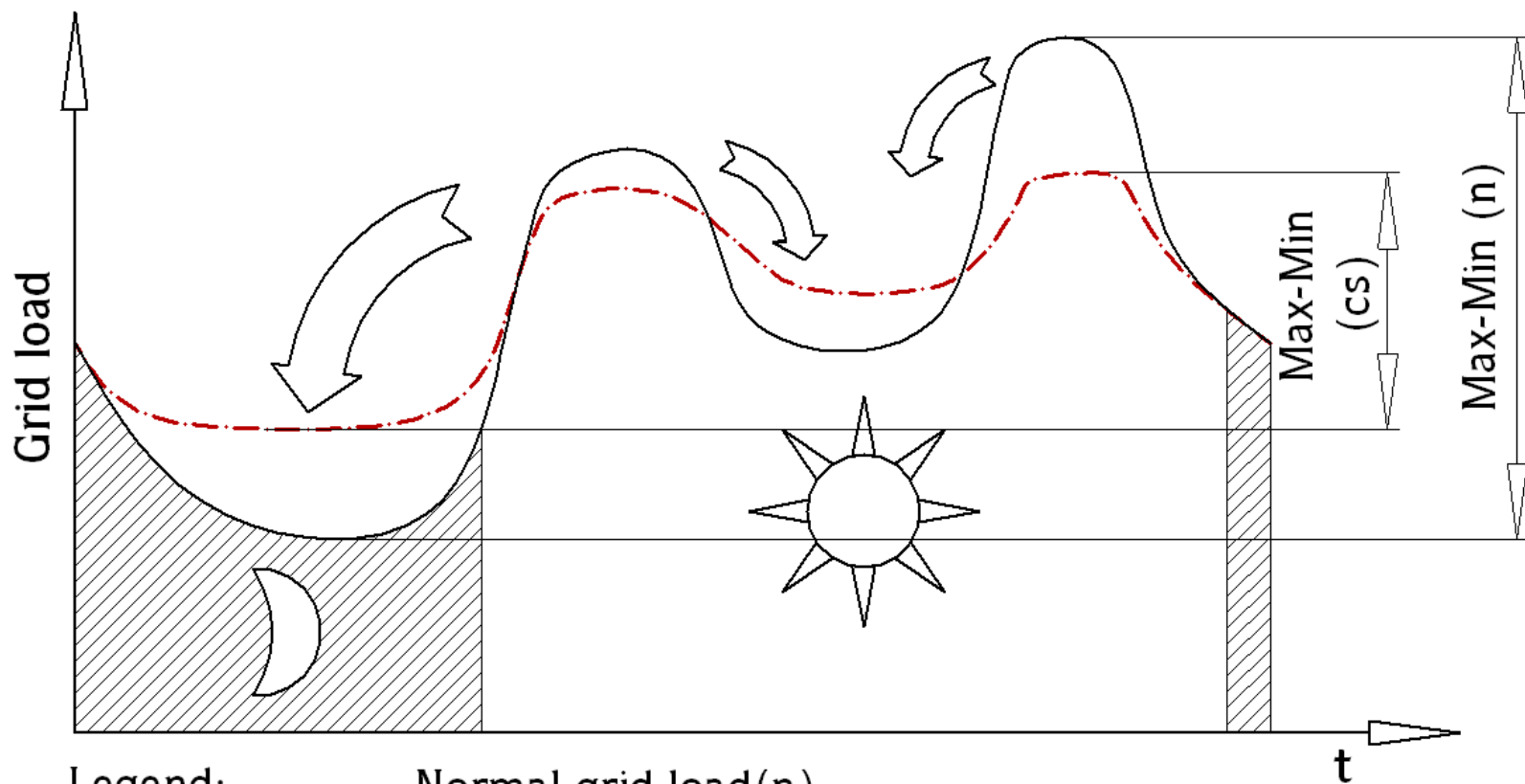
Electric network

♦ Charging station

The electric vehicle is in relationship with both the road network and electric network

Smart grid

2.1

Smart grid combines the latest developments in energy, communication and information technology

Grid load

Legend: ——— Normal grid load(n)

—·——·— Grid load with charging scheduling (cs)

Daytime charging raise the fluctuation of grid load
Intelligent charging management decrease the
fluctuation of grid load
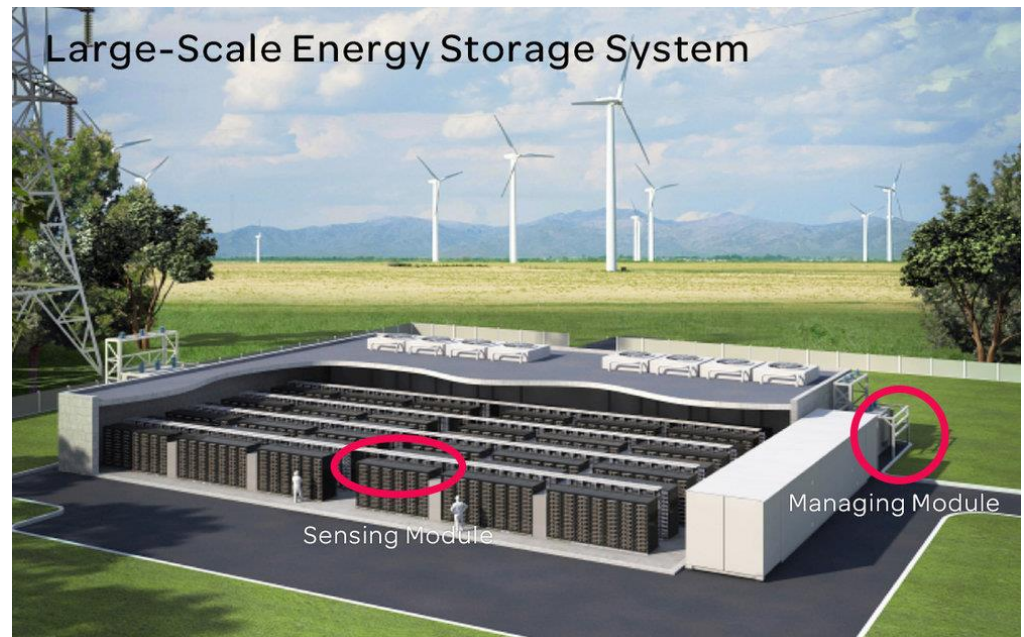
Charging demand management

Optimums:
- Global optimum: the aim is to minimize the fluctuation of load on the grid. Minimize the cost of the network operator.
- User optimum: the aim is to minimize the cost of charging. The cost may include the charging time also.

There are several methods using ITS support the management of travel demand on road network → adapt technologies with modifications

Tool of demand management:
External energy storage:
charged during valley period,
recharge during peak hours

2.2

Large-Scale Energy Storage System

Sensing Module

Managing Module

Charging demand management

**Each battery in the electric vehicles is an energy storage**

- Usually a significant rate of the total battery capacity is not used during an average day
- Recharging reduces battery life time and availability of the vehicle

The key: influence charging behaviour

Variable fee

Electric network operator

Electric vehicle user

Charging behaviour
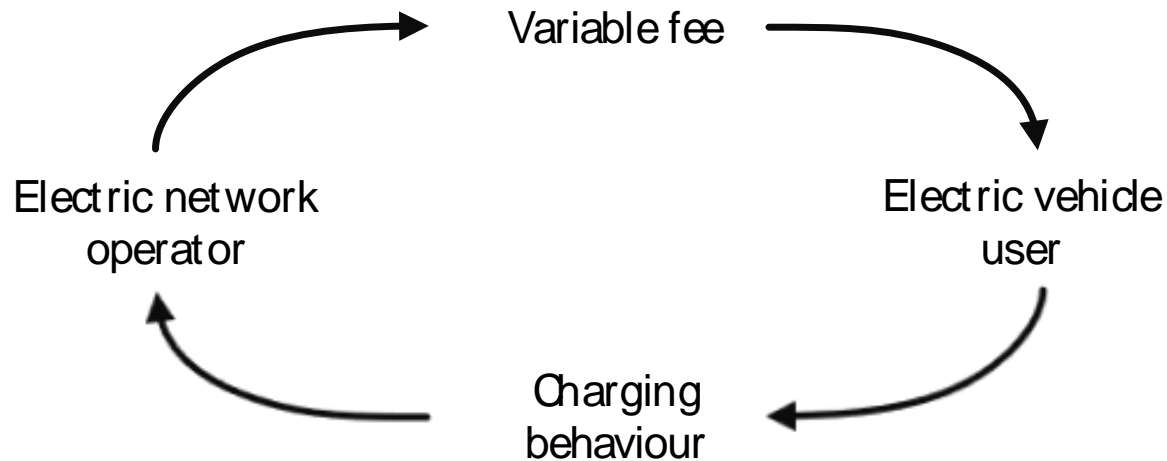
Variable fee is necessary to gain EV users' interest in demand management
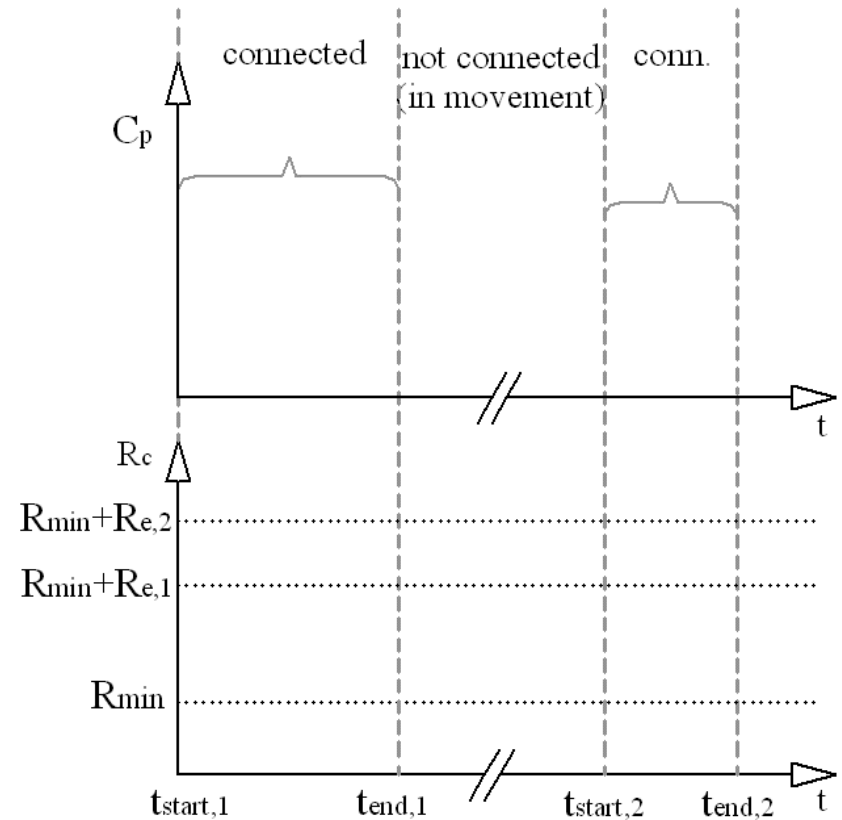
Charging planning method
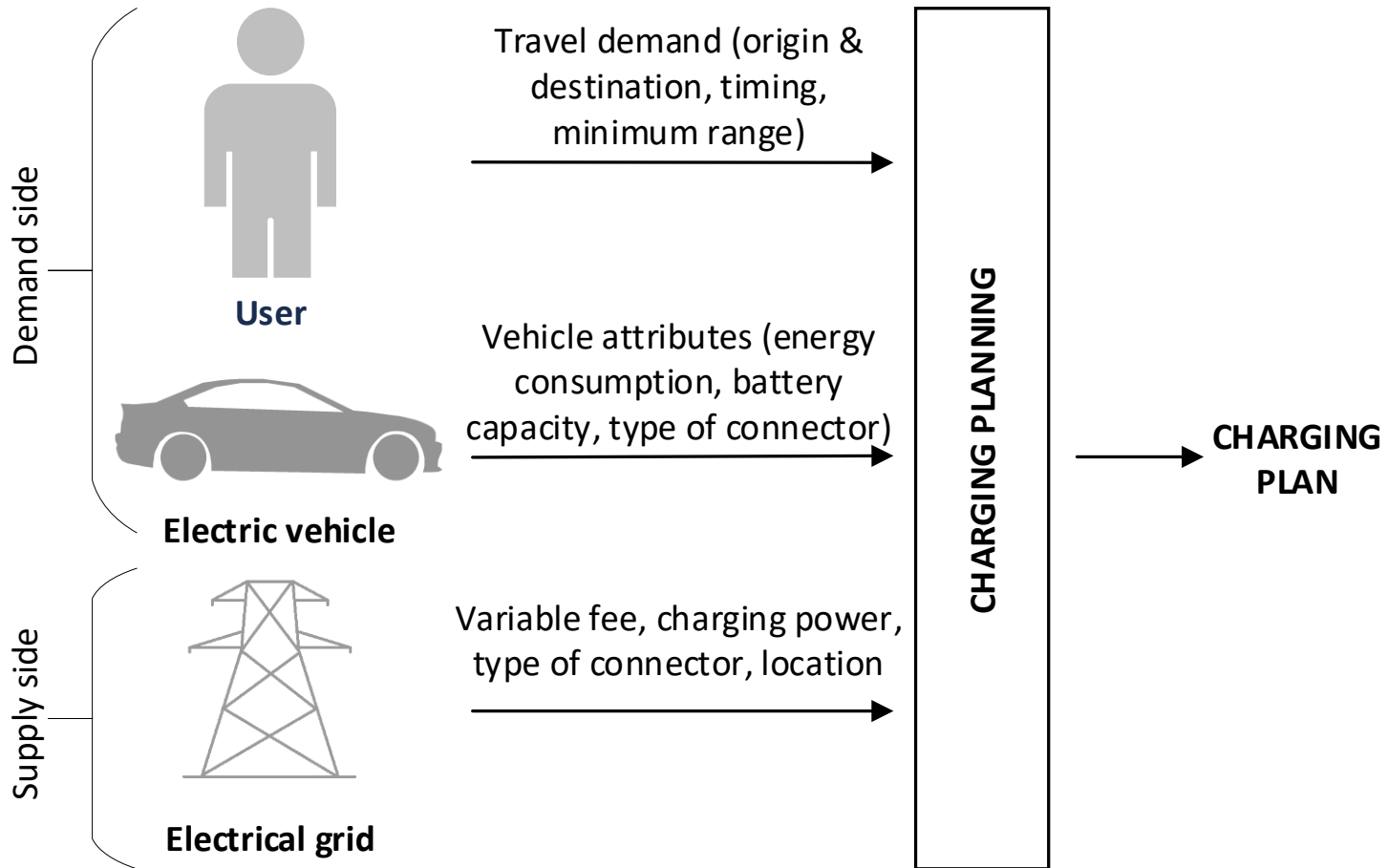
The planning method focuses on the user optimum; however, the electricity network operator asserts its aims with variable electricity rates

Charging planning method
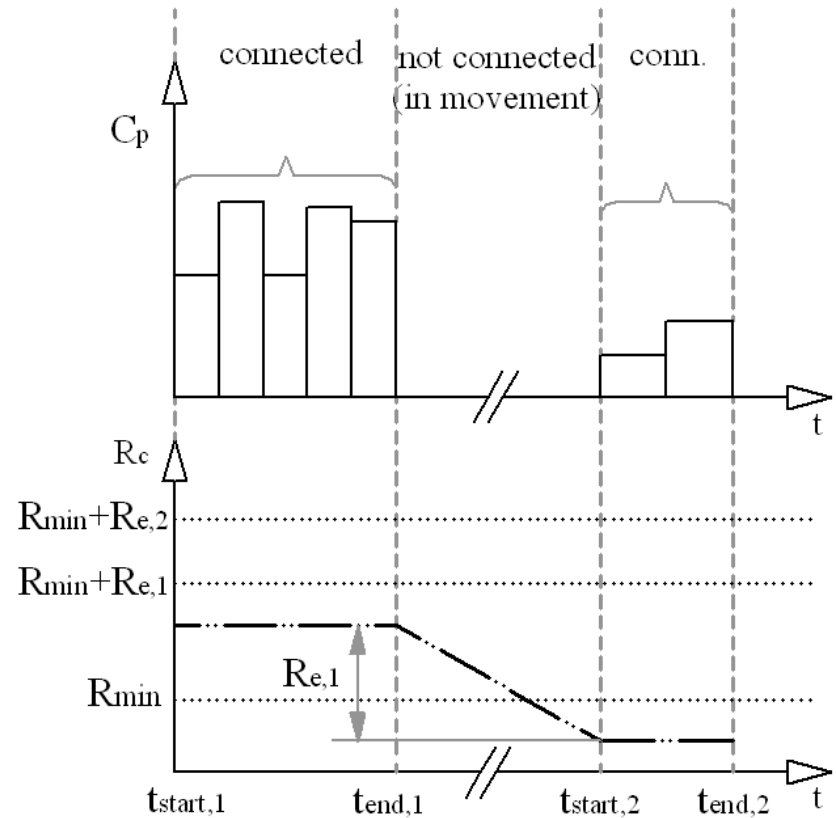
Steps of the method

1. The user needs are modelled (connected – not connected, range requirement)

Charging planning method

Steps of the method

1. The user needs are modelled (connected – not connected, range requirement)
2. The charging session is divided into shorter periods, energy consumption is calculated

Charging planning method

Steps of the method
1. The user needs are modelled (connected – not connected, range requirement)
2. The charging session is divided into shorter periods, energy consumption is calculated
3. Periods are selected by using greedy algorithm (lowest cost) to fulfill 1. range requirement…

Greedy algorithm: the best option is selected in each step. It reaches global optimum if the elements are independent.

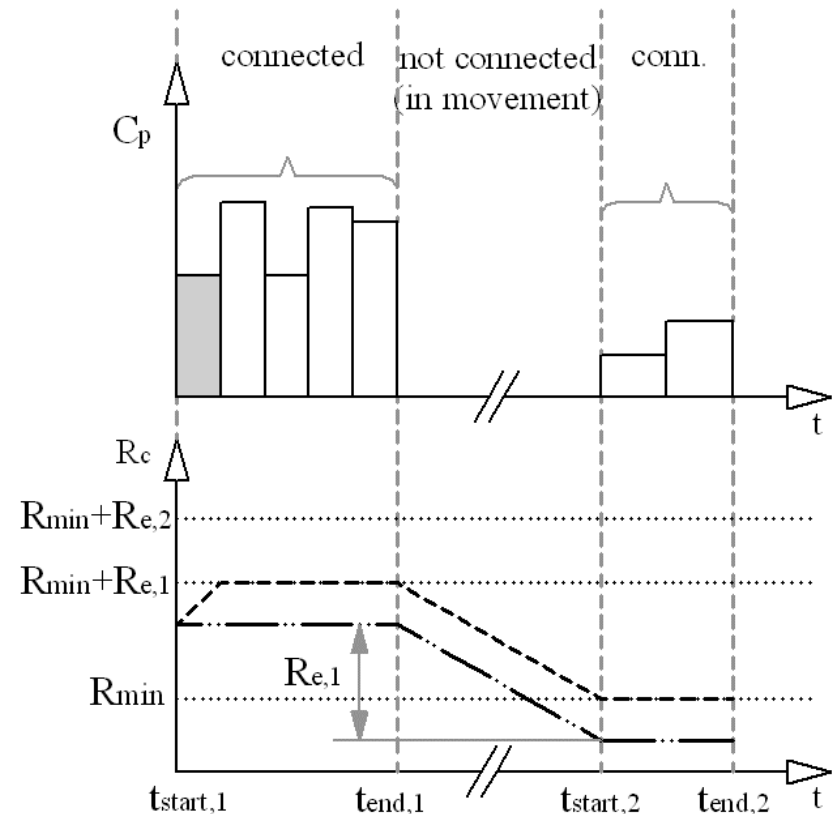# Charging planning method

Steps of the method

1. The user needs are modelled (connected – not connected, range requirement)
2. The charging session is divided into shorter periods, energy consumption is calculated
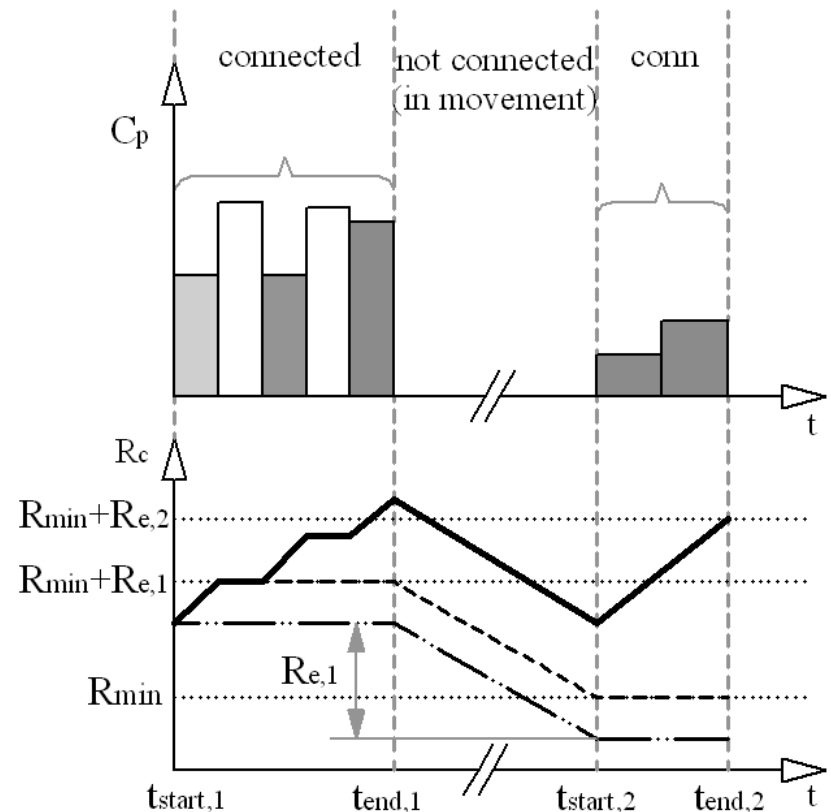3. Periods are selected by using greedy algorithm (lowest cost) to fulfill 1. range requirement…
4. And 2. range requirement

•   The recharging periods are selected similarly

Benefit

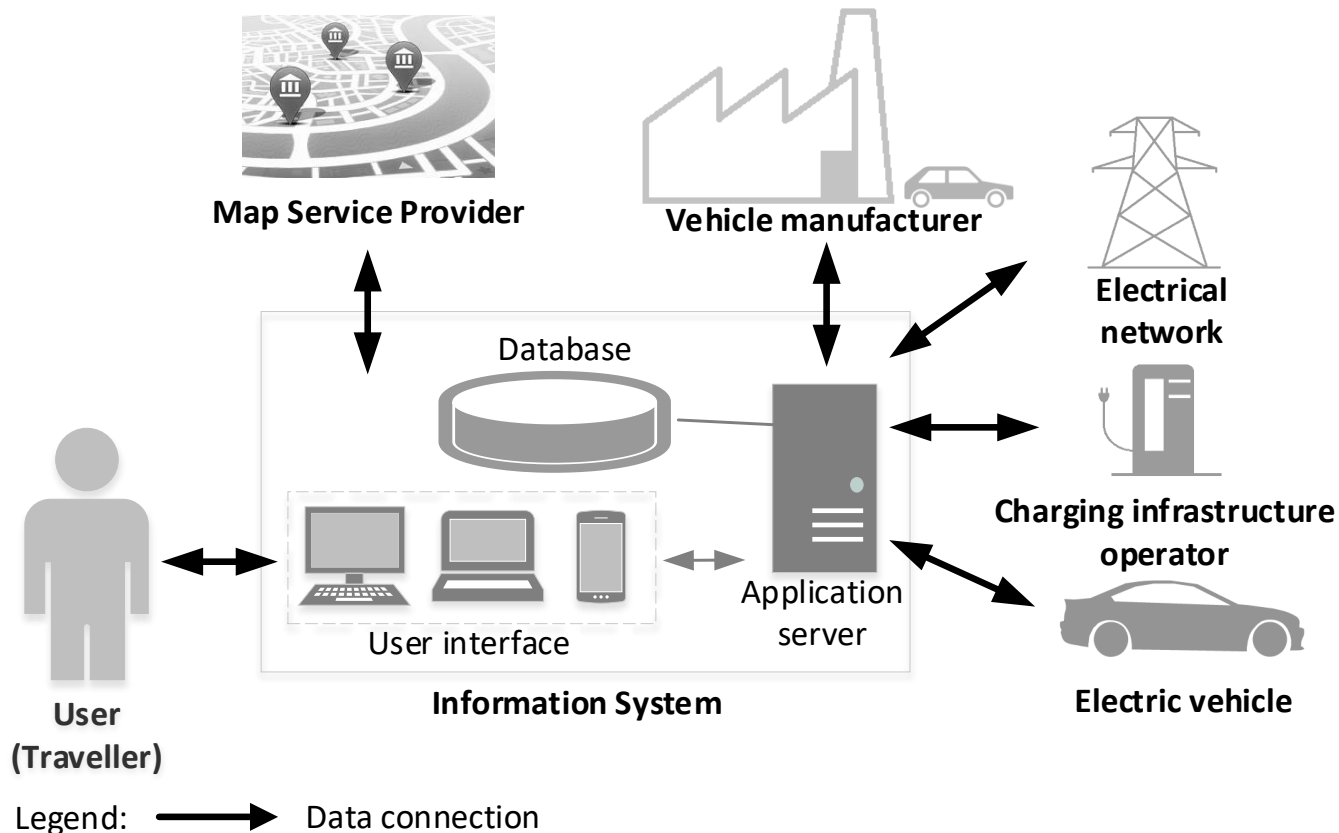•   EV user's charging cost decreases (even by 40%)

Information system of electromobility and services

Information system of electromobility

Motivation

- Information provision is a soft way to influence the user behaviour
- The existing information services lack the integration of the stake holders

The value of provided information and the recognition of the relationships are the key of success.

Map Service Provider

Vehicle manufacturer

Electrical network

Database

Charging infrastructure operator

Application server

User interface

Information System

Electric vehicle

User (Traveller)

Legend: ──▶ Data connection

Information system of electromobility
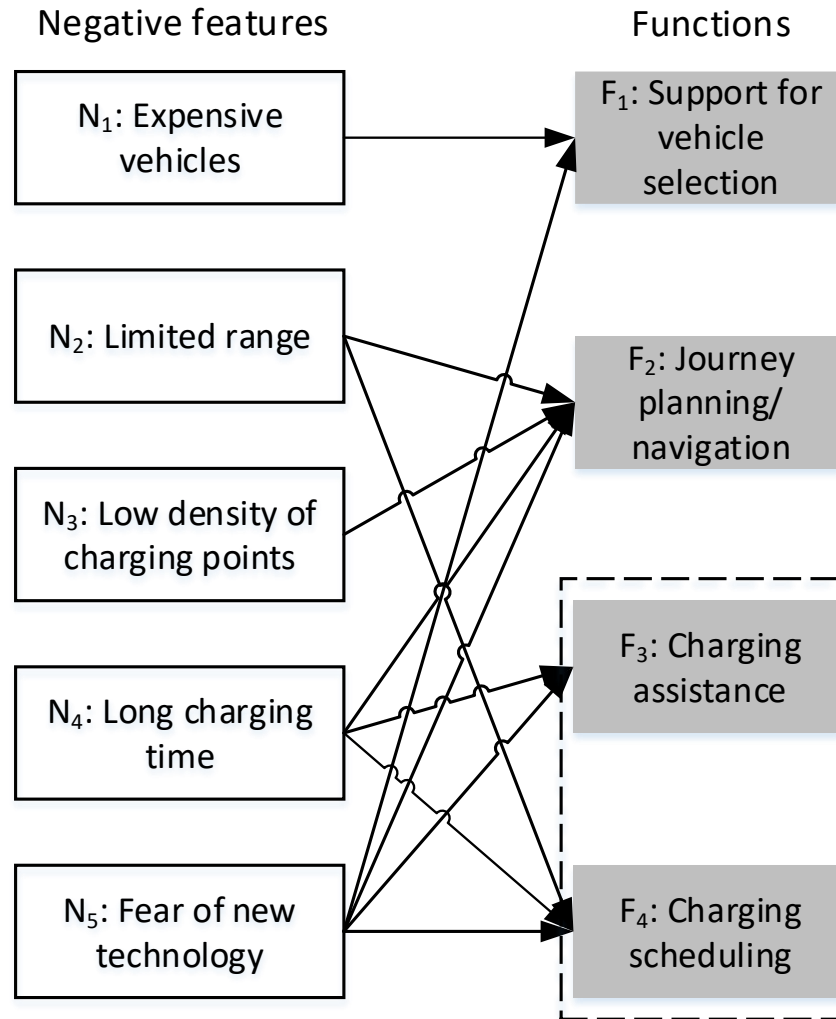
The key functions are derived from the negative features

Information system of electromobility

Support for vehicle selection
- Provide information on available electric vehicles
- Support decision on the base of the user needs and vehicle cahracteristc
- The first impression of a new technology is determinative

Journey planning/ navigation
- Customized and 'vehiclized' journey plan
- Considered aspects:
  - Driving behaviour
  - Vehicle characteristic (type of connector, range, energy consumption)
  - State of charging infrastructure
  - Transportation network parameters
- Travel demand planning (locations are given) or activity demand planning (locations are not given, but activities)

Charging assistance
- Provide information on the state of charging (cost, transmitted energy, state of charge etc.)
- Support payments

Novel electromobility services

e-Car-sharing
- Registration required, short period car rentals
- Crowded and high density areas
- Part of the transportatin system. Together with other transportation modes are an alternative of private car use

2.3

e-Bike-sharing
- Similar to carsharing, but bikes
- Short trips, flat areas

2.4

e-Fleet and e-Bus:
- It is advised to replace the frequently used internal combustine engine vehicles with electric vehicles at first.
- Vehicles in public service are available for a wide range of travellers

e-Highway
- Trolley cables over the highway