Közlekedési informatika – BMEKOKKM223

Dr. Csiszár Csaba – Csonka Bálint – Földes Dávid: Innovative Passenger Transportation Systems (printed book) 2018.

Dr. Csiszár Csaba – Sándor Zsolt: Közlekedési informatika (jegyzet) 2014.

Tantárgyfelelős oktató: Dr. Csiszár Csaba egyetemi docens
csiszar.csaba@mail.bme.hu, 0036 1 4631978, St. 403

Tanszéki honlap: www.kukg.bme.hu letölthető tananyagok + eredmények

Órarend, névsor, a tantárgy lényege, előzményei, mi a képzés célja?

Tantárgyi egymásra épülés:

BSc képzésben:

Közlekedési információs rendszerek I. és II. + alágazati információs rendszerek

MSc képzésben:

Intelligens közlekedési rendszerek (ITS) + választható tárgyak (pl. Személyközlekedés)

Záróvizsga tételek (honlap)

Characteristic of electric vehicles and the model of electromobility system

- Why do we need change?
- Short history of electric cars
- Technology aspects
- Environmental aspects
- Cost aspects
- Electric car sales numbers and incentives

Charging network of road vehicles

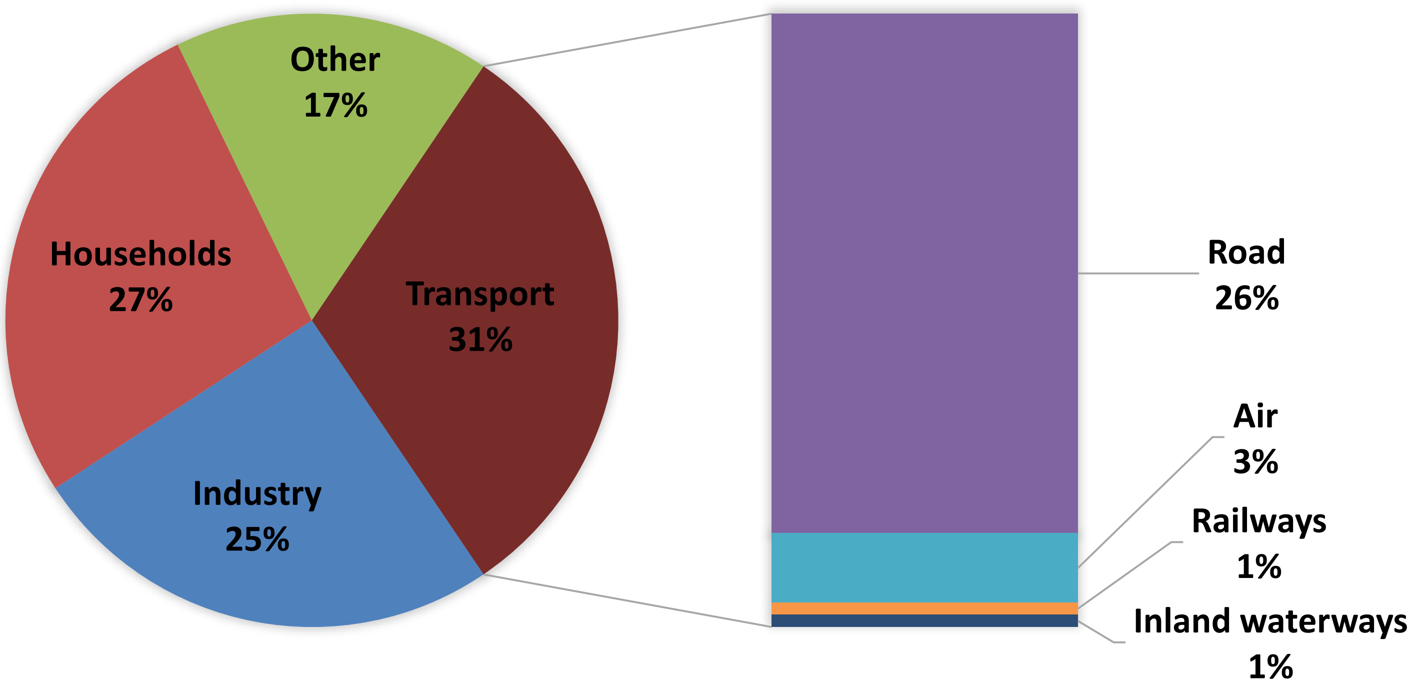
- Current state
- Charging demand
- Inter-city method
- Intra-city method

Characteristic of electric vehicles and the model of electromobility system

Why do we need change?

- Limited oil resources, energy demand: 90% of oil is imported in EU
- Global and local impacts of environmental pollution
- 2030: reduce CO_2 emission by 40% compared to the basis year of 1990
- 2050: reduce CO_2 emission by 60% compared to the basis year of 1990

FINAL ENERGY CONSUMPTION BY SECTOR EU28, 2013 (EUROSTAT)

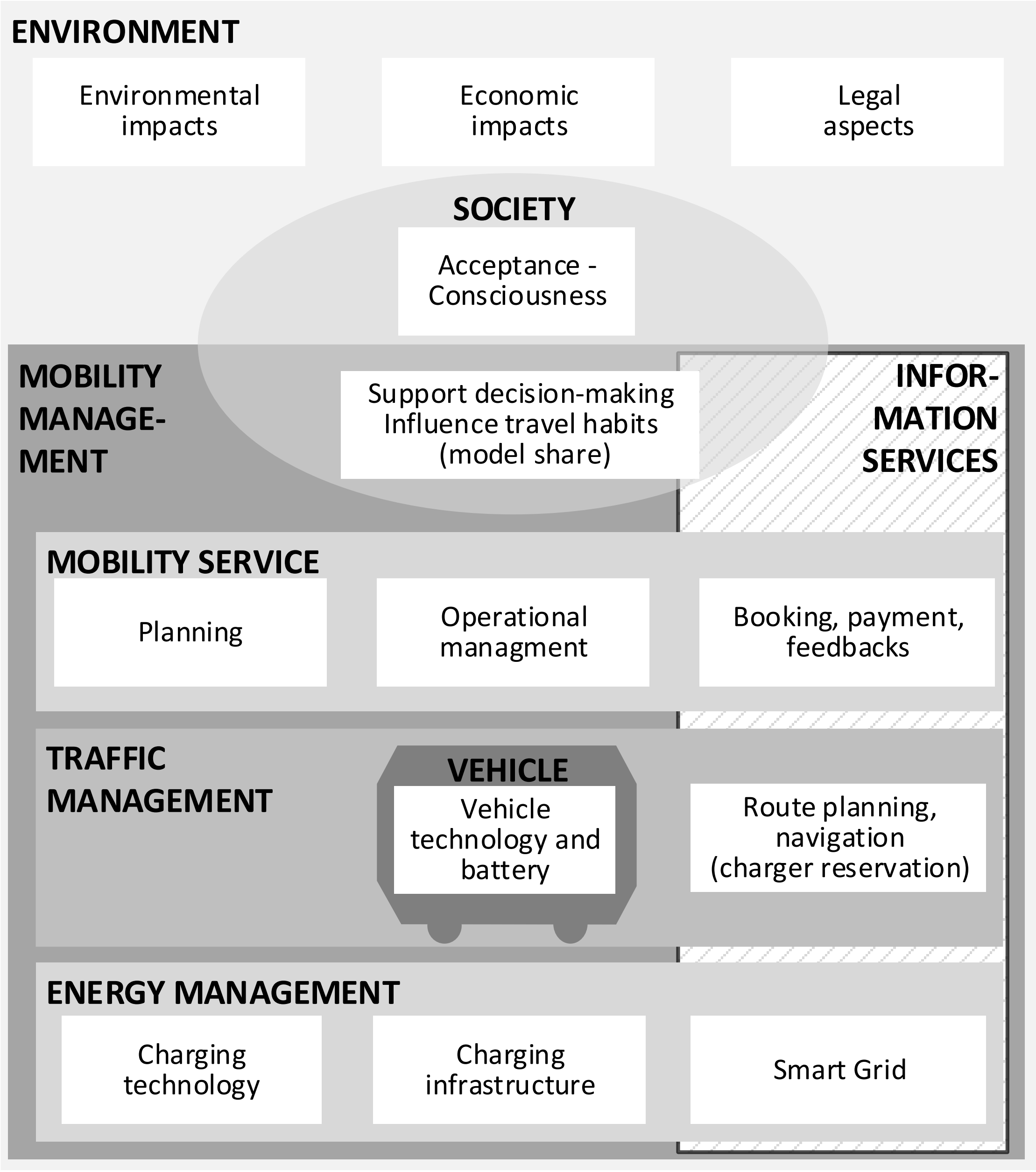


Short history of electric cars

When was the first electric car released for public?

1894

Operational aspects

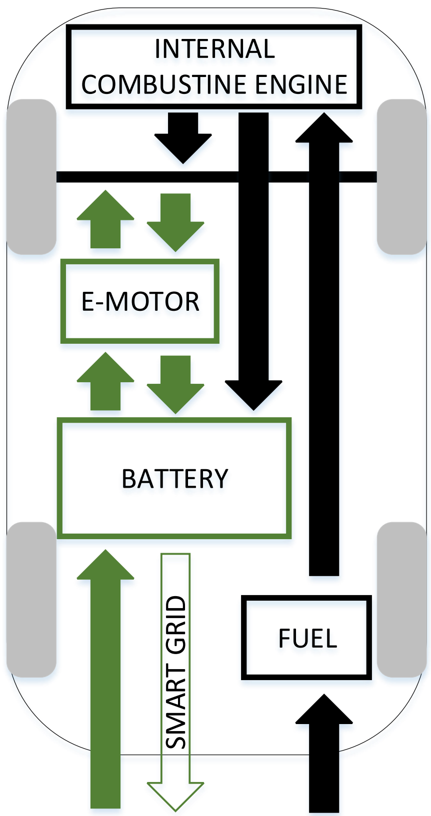


An electric vehicle is a part of a complex system

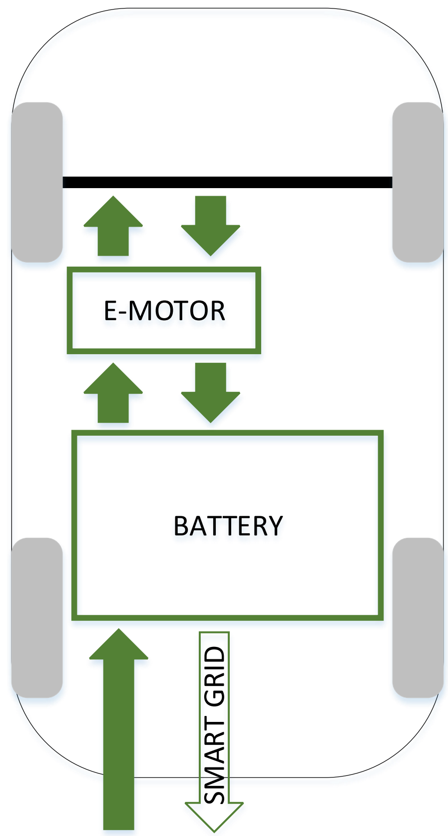
Technology aspects

ELECTROMOBILITY:

- The use of electric drive in road vehicles
- Infrastructure to serve electric cars (e.g. charging network)
- Communication technologies: between traveller, vehicle and infrastructure



Plug-in hybrid electric vehicle (PHEV)



Battery electric vehicle (BEV)

✓ Simple and reliable technology
✓ High efficiency
✓ Zero local emission
✓ Smart Grid

– Low range
– Expensive battery
– Long charging time

Technology aspects

conventional drive | hybrid | plug-in hybrid | battery electric

Energy efficiency

Transitional technologies
The battery capacity is increasing

1.1

Technology aspects

Main attributes	Conductive		Inductive	
	Stationary	In movement	Stationary	In movement
Efficiency	High (~90%)		High (~90%)	Average (85-90%)
Cost	Low	Expensive	Moderate	Extremely expensive
Comfort	Wire needed	No interaction	Wire optional	No interaction
Safety	Safe	Safe	Safe	Not clear
Accessories	Wire	Arm or pantograph	Magnetic coil	Magnetic coil

The selection of the charging technology depends on the characteristic of the demand

Technology aspects

Main attributes	Power [kW]	Charging time	Connector
Super	>42	30 min (80%)	CHAdeMO, CCS, Type2
Fast	22-42	2-3 hours	Type2, CCS
Normal	<22	4-8 hours	Type1, Type2
Home	3.6	8 hours	Type1, Type2

The connector may differ for several car types
The charging time depends on the power and the battery capacity

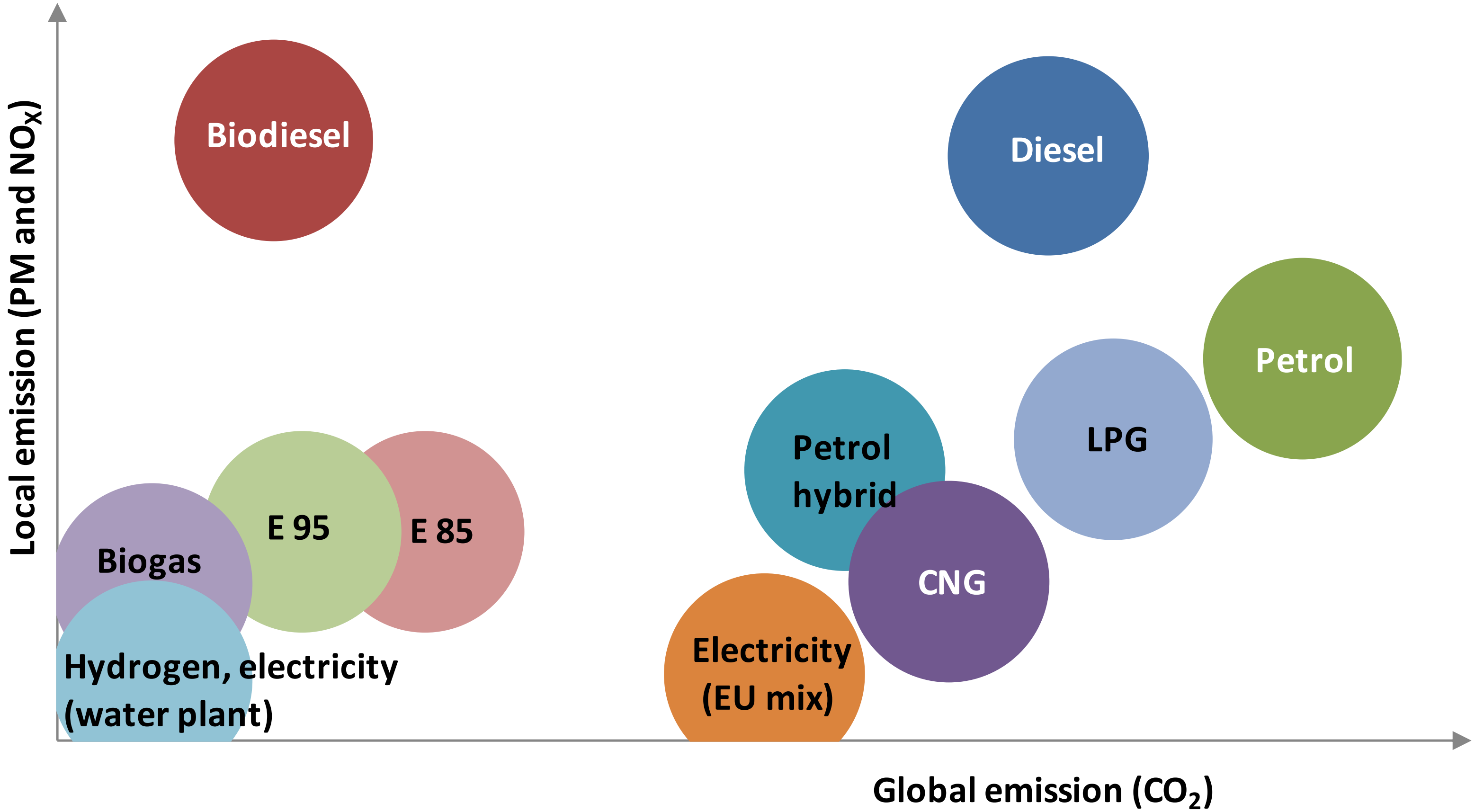
Environmental aspects

Which vehicle is more environment friendly, if both EV and ICE vehicle are charged in Hungary?

(or less CO_2 emission)

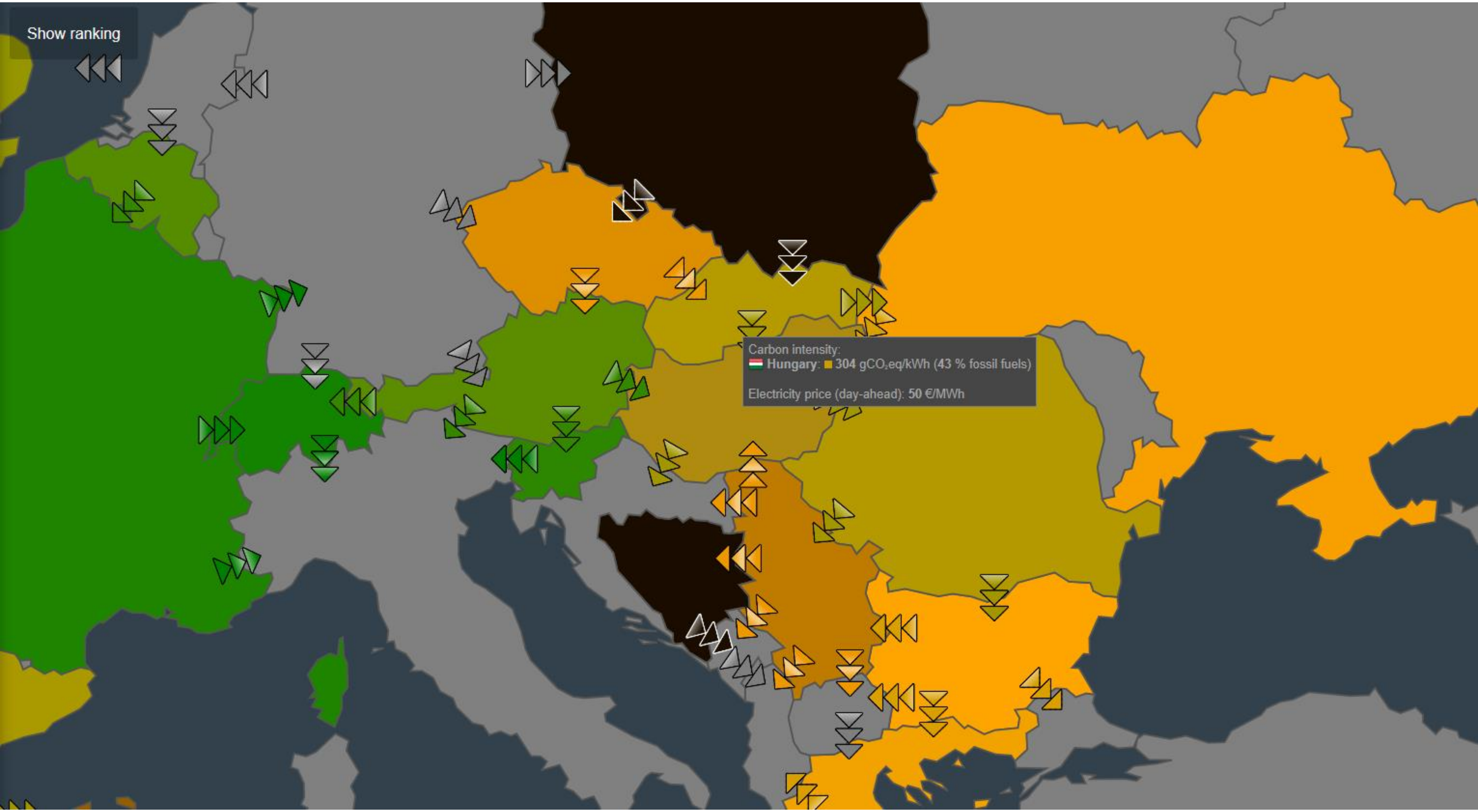
1.2

Environmental aspects

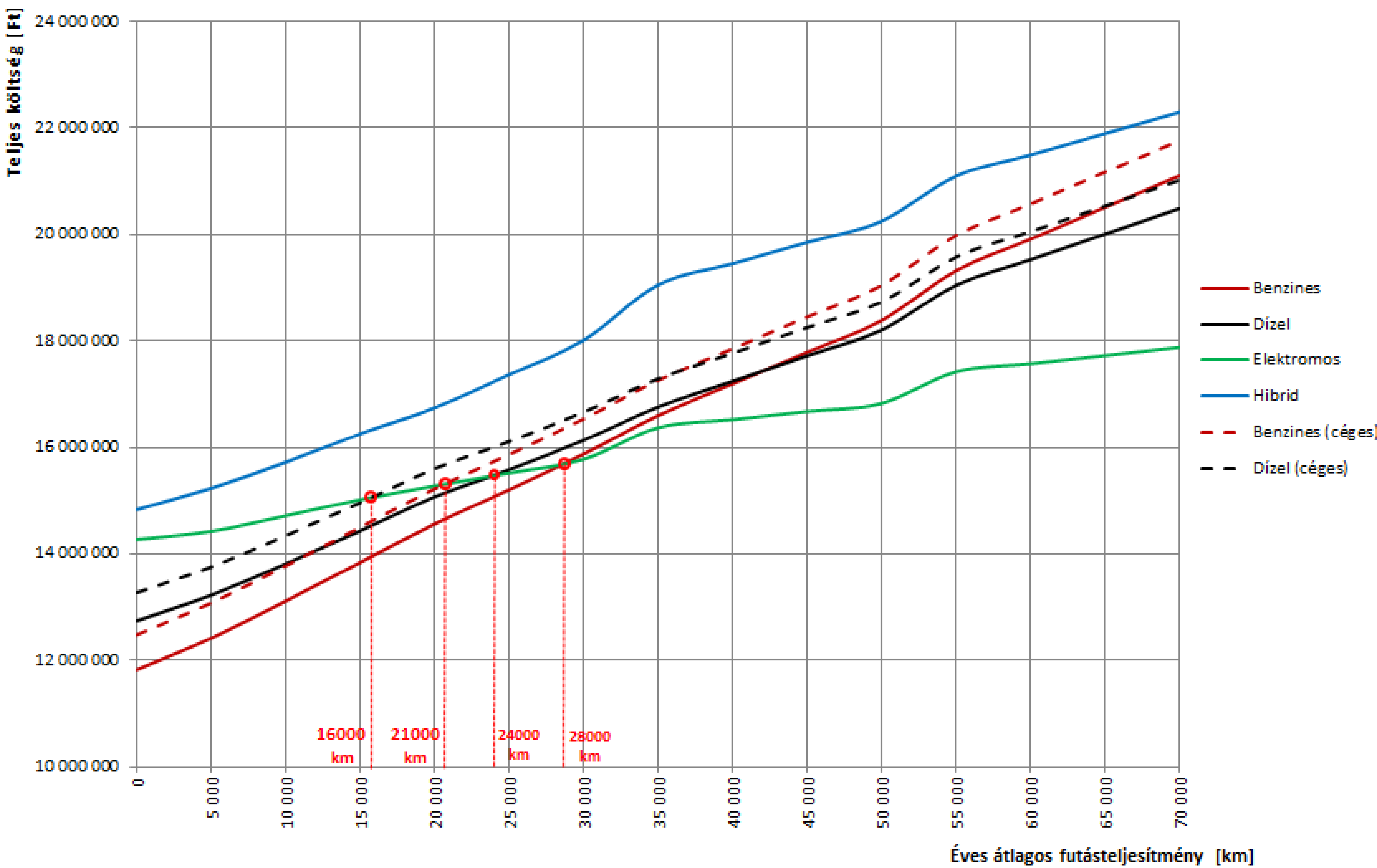


The answer depends on how the electricity is made

Environmental aspects

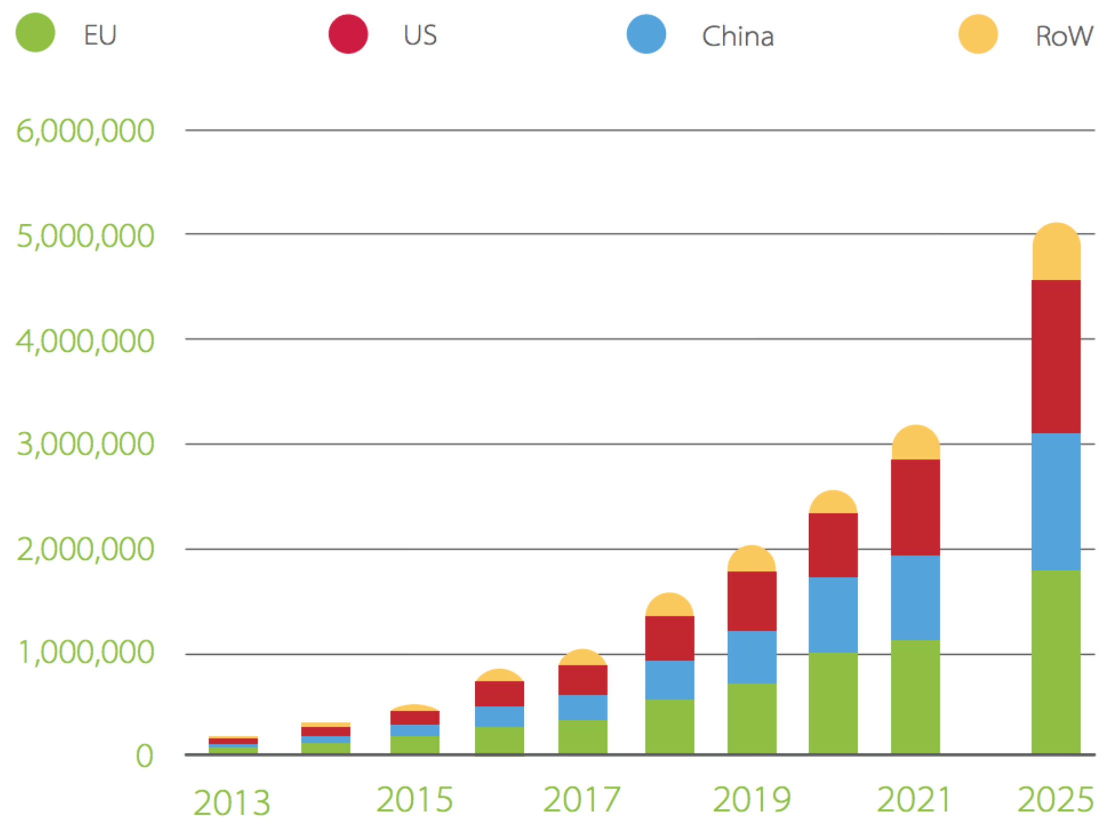


Cost aspects – total cost of ownership



High purchase price– lower operational cost

Electric car sales numbers and incentives



https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3986/plug-in-vehicle-infrastructure-strategy.pdf

pod POINT
Charging your Electric Car

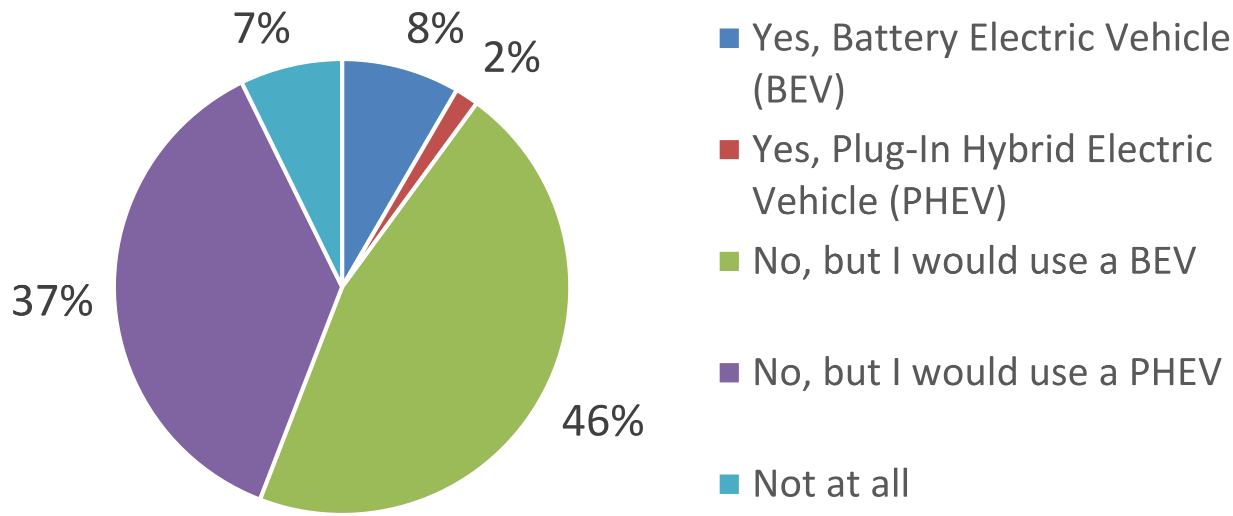
The number of sales follows an ‚*S*' curve, we are still in the accelerating state

Expected:

- Purchase price difference vanishes by **2022**
- More EV sold than conventional vehicle in a year by **2038**

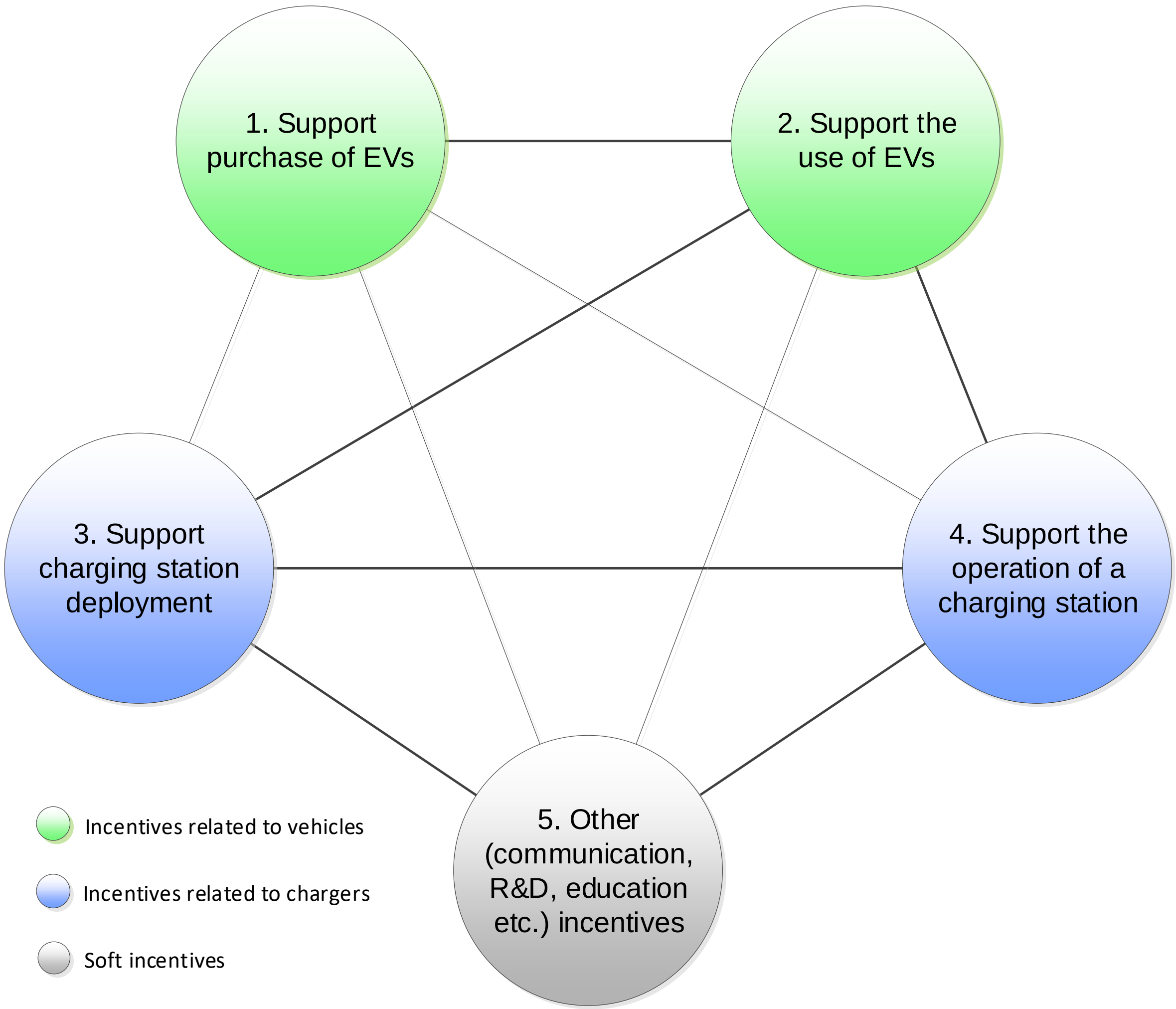
Electric car sales numbers and incentives

Do you use an electric vehicle?



Number of electric vehicles (HU) **(estimating method)**	
2016	1600
2017	*3480*
2020	*16760*
2025	*60080*
2030	*120800*

Electric car sales numbers and incentives



The use of incentives in a conjoint manner increase its efficiency

Electric car sales numbers and incentives

New vehicle purchase

- Non-refundable subsidies
- Tax benefit
- Green plate numbers: bus lane use, parking discount, traffic zone discount, etc.
- Free charging
- Replace old vehicles

Expand the charging network

- Simplify the terms and conditions of a new charging station installation
- Charging network develepoment with system approach
- Unify connectors
- Control of charging station use and operation
- Development of integrated information system/ service (find and book charging station, easy-to-pay)

Development of public transportation

- Carsharing, bikesharing, taxi, electric buses
- It influence the travellers and raise the awareness

Governmental fleets

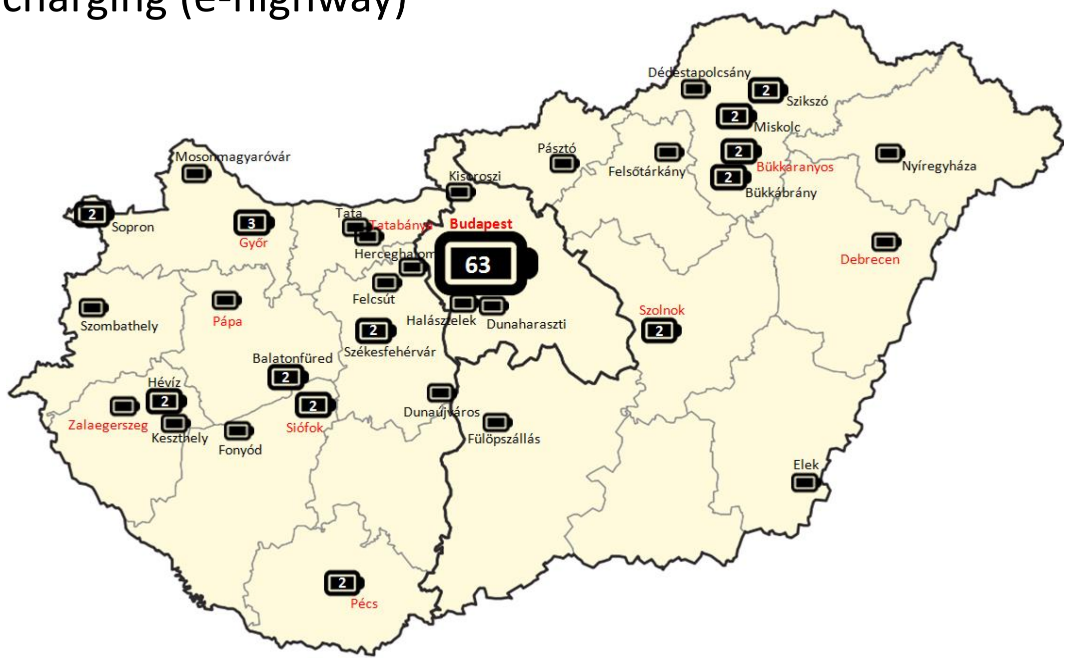
Education, research and development

- Reduce the fear of unknown
- Implementation of novel solutions

Charging network of road vehicles

Current state

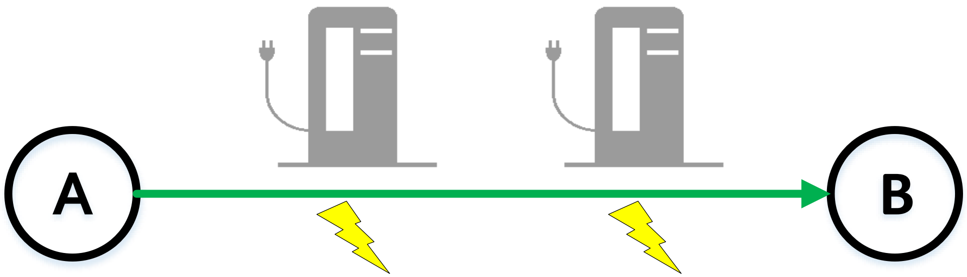
- Frequent charging demand: the average range of an EV today is 150 km
- Different connectors and charging power
- Point and line charging (e-highway)



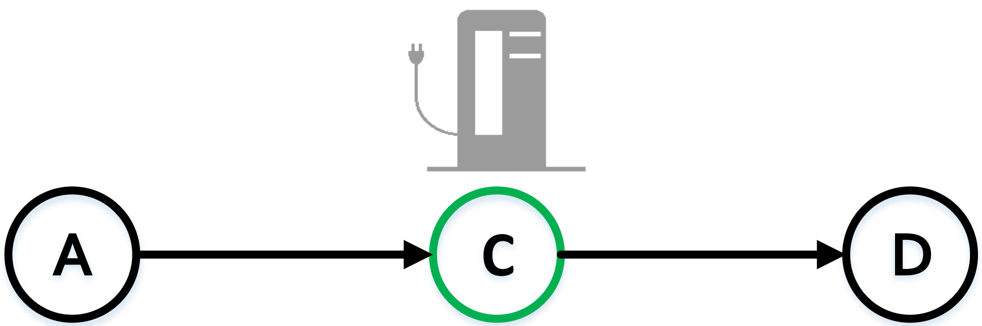
1.3

Lack of integration end interoperability. Separated charging station deployment.

Charging demands



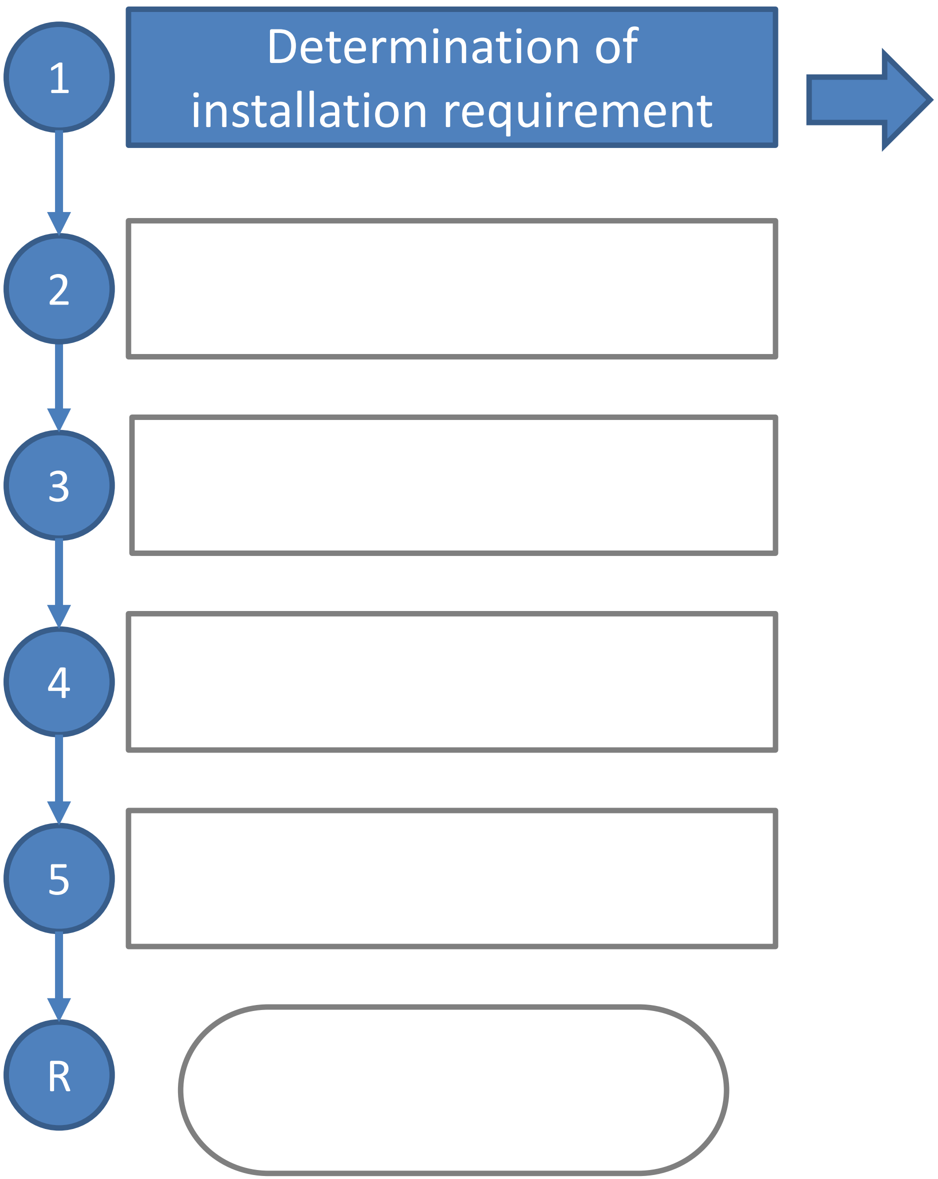
Inter-city charging demand



Intra-city charging demand

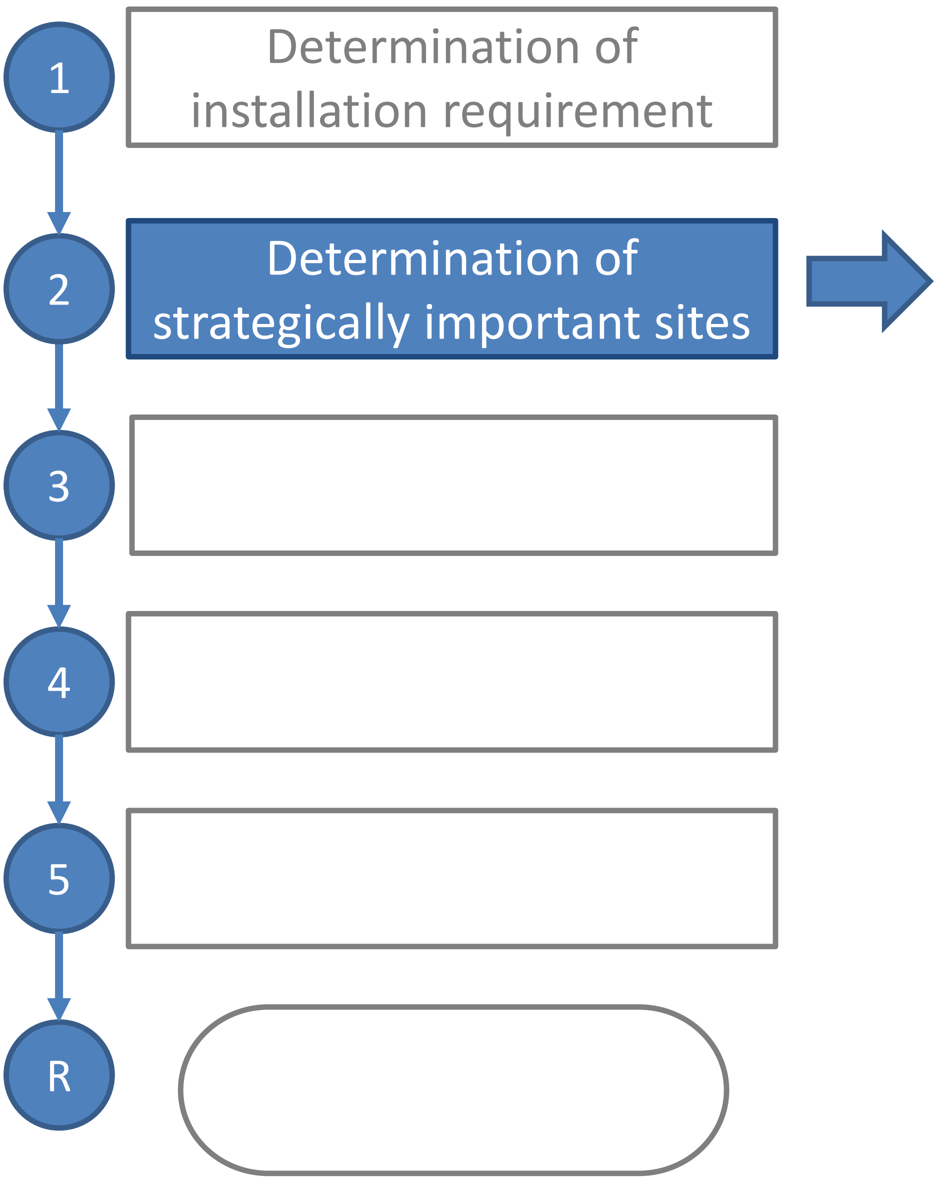
MOT!VATION

Inter-city method



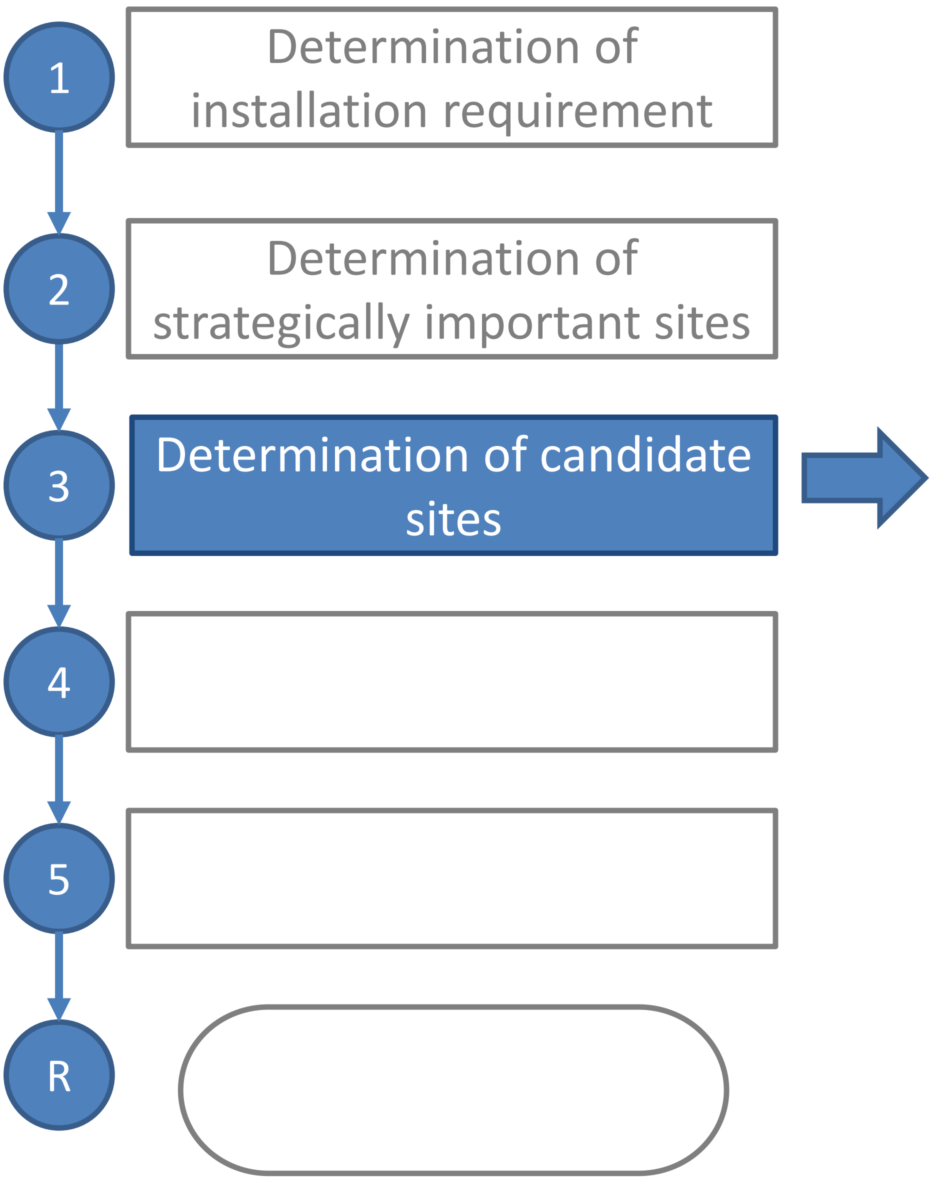
- Charging stations are to be deployed until requirement is fulfilled
- E.g. rate of coverage, number of carging stations

Inter-city method

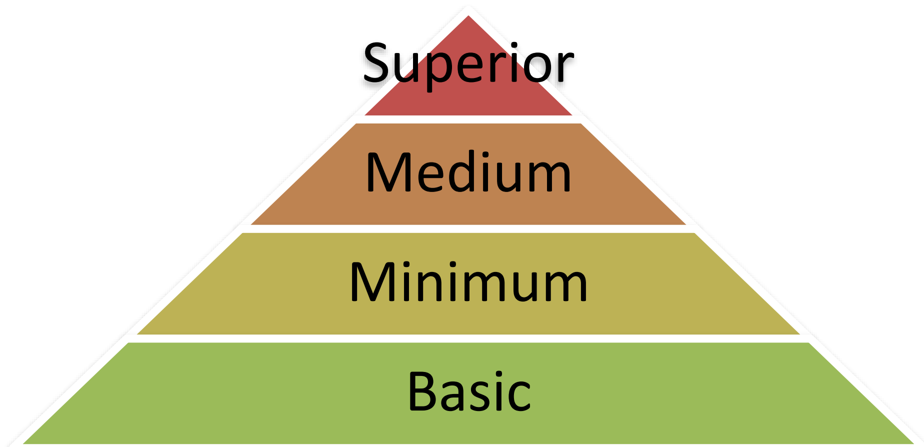


- Sites where charging station deployment is justified
- Benefit from local knowledge

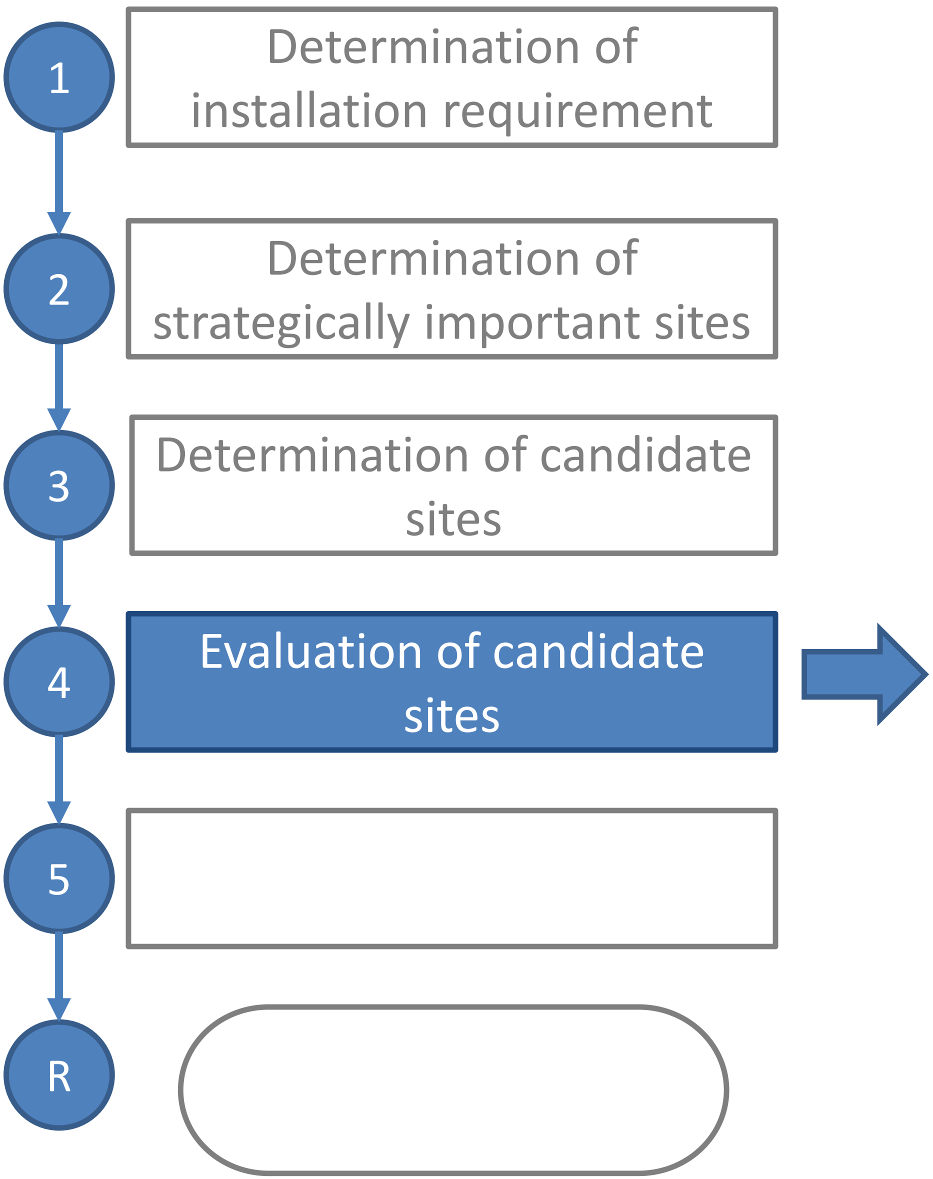
Inter-city method



- Rest-areas not farther than 250 m
- Reduce installation cost
- 4 categories



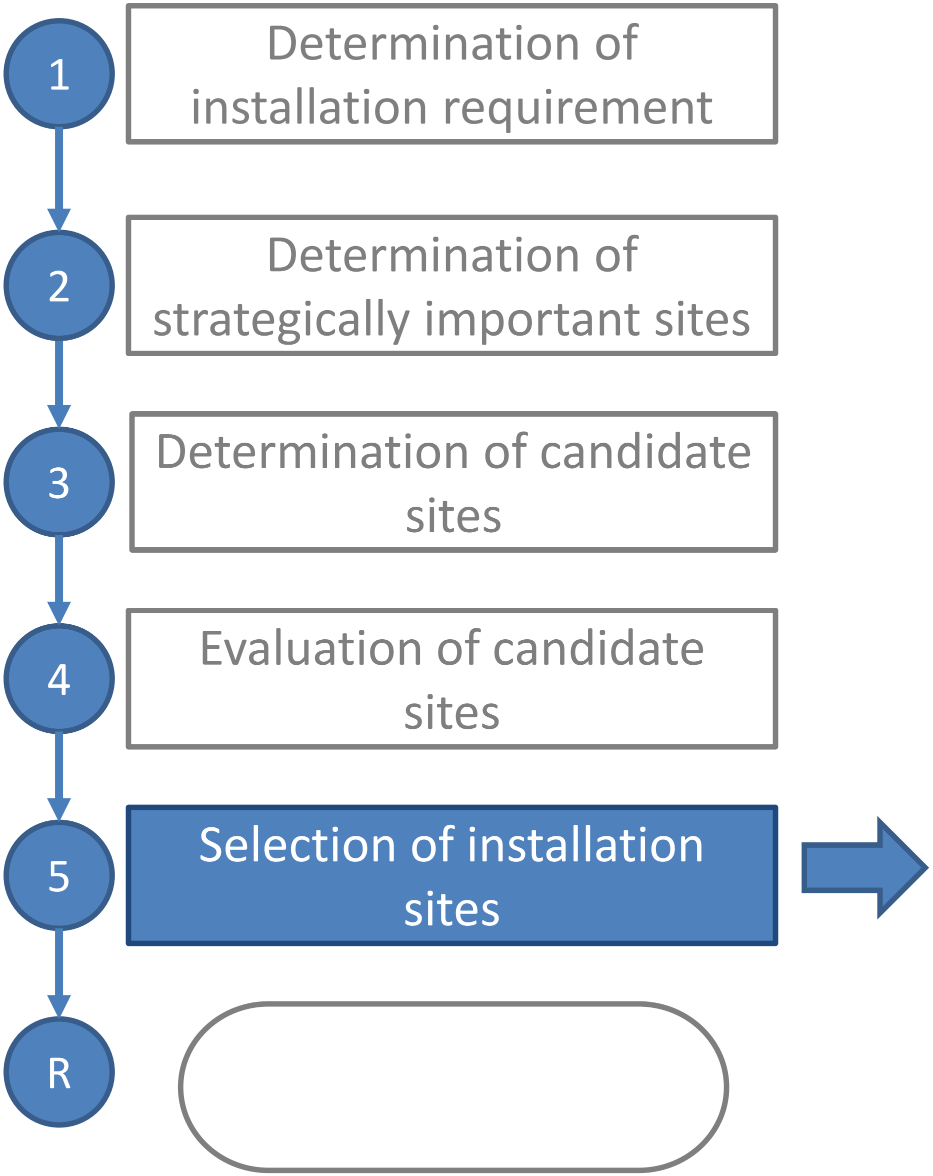
Inter-city method



- Traffic volume (x_{11})
- Road category (x_{12})
- Nearby settlements population (x_2)
- Service level of candidate site (x_3)
- Negative effect of the nearest fast charging station (x_4)
- Weights ($a_1..a_4$) are derived from the development plan

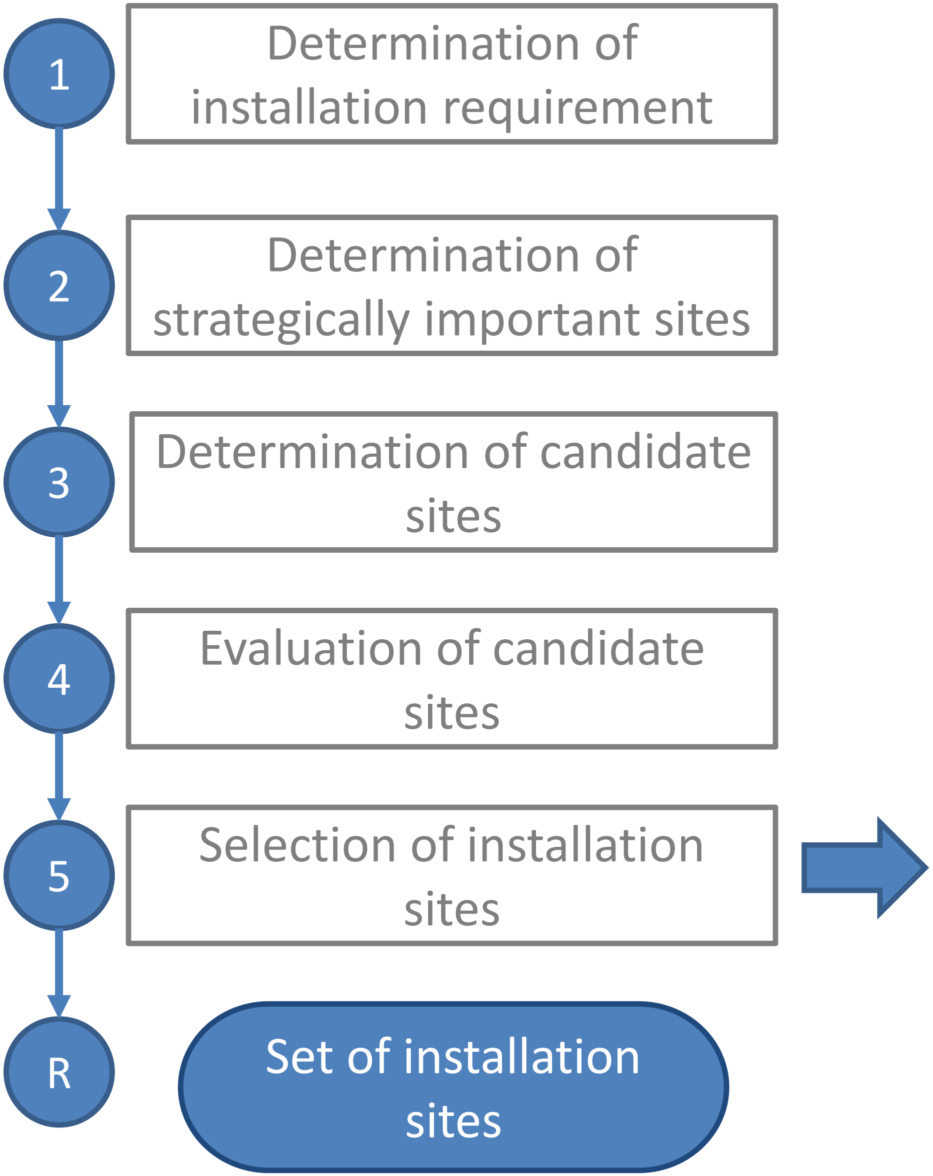
$$IP_j = a_1 \cdot (x_{11,j} + x_{12,j}) + a_2 \cdot x_{2,j} + a_3 \cdot x_{3,j} - a_4 \cdot x_{4,j}$$

Inter-city method



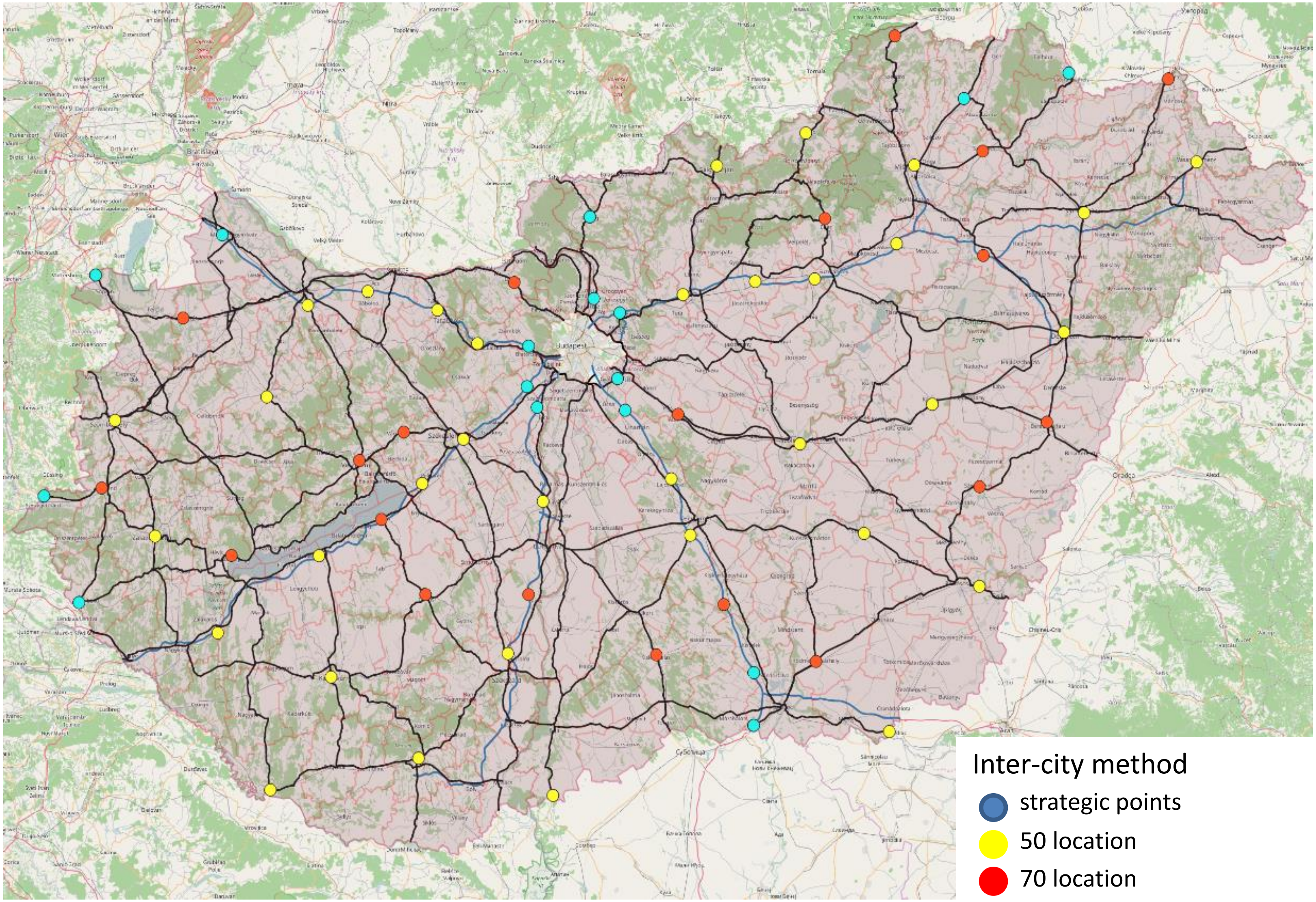
- Select the highest IP
- Deployment requirement:
  - Specific number of charging stations, or
  - the maximum distance between neighboring charging station

Inter-city method



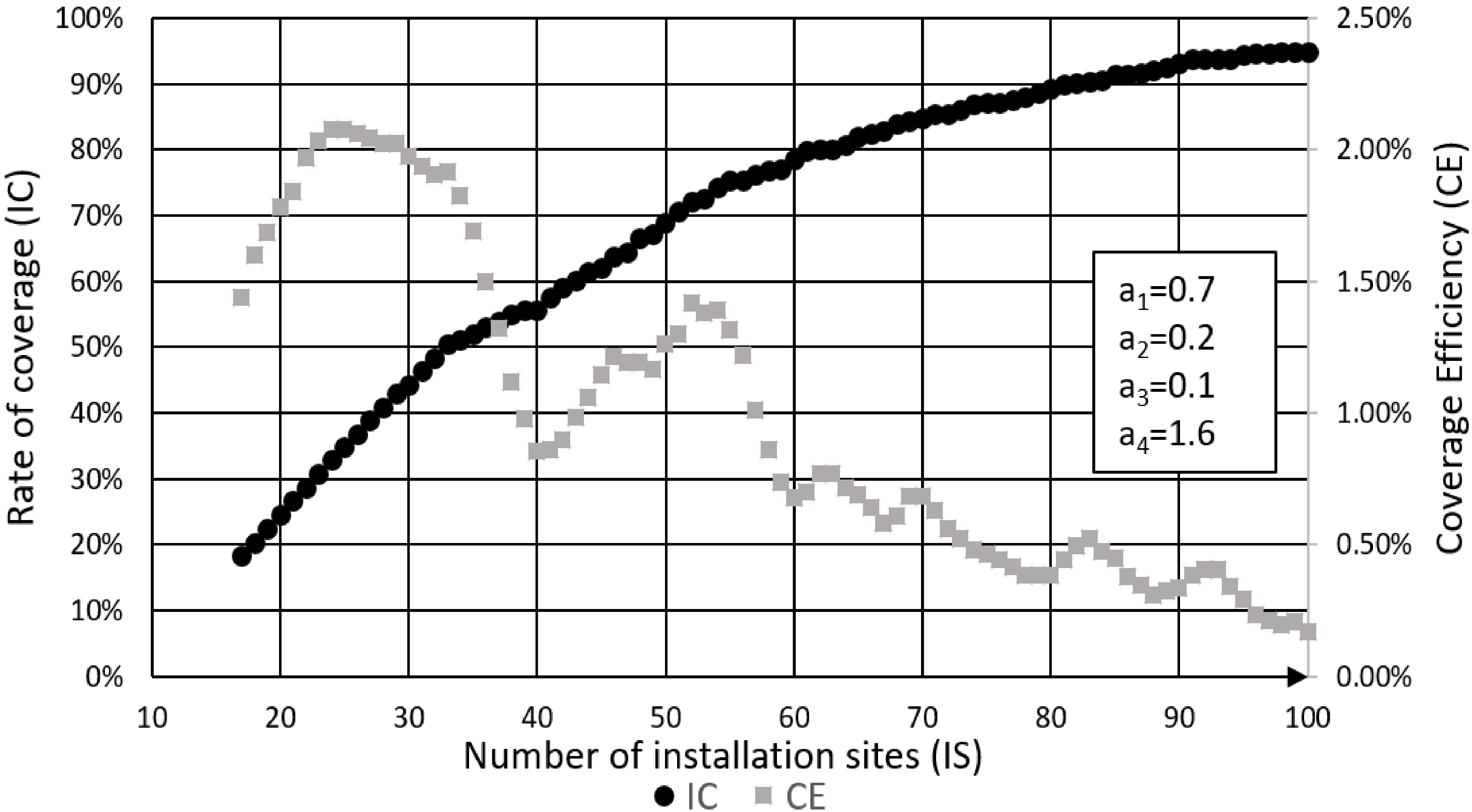
- Support long journeys

Inter-city method

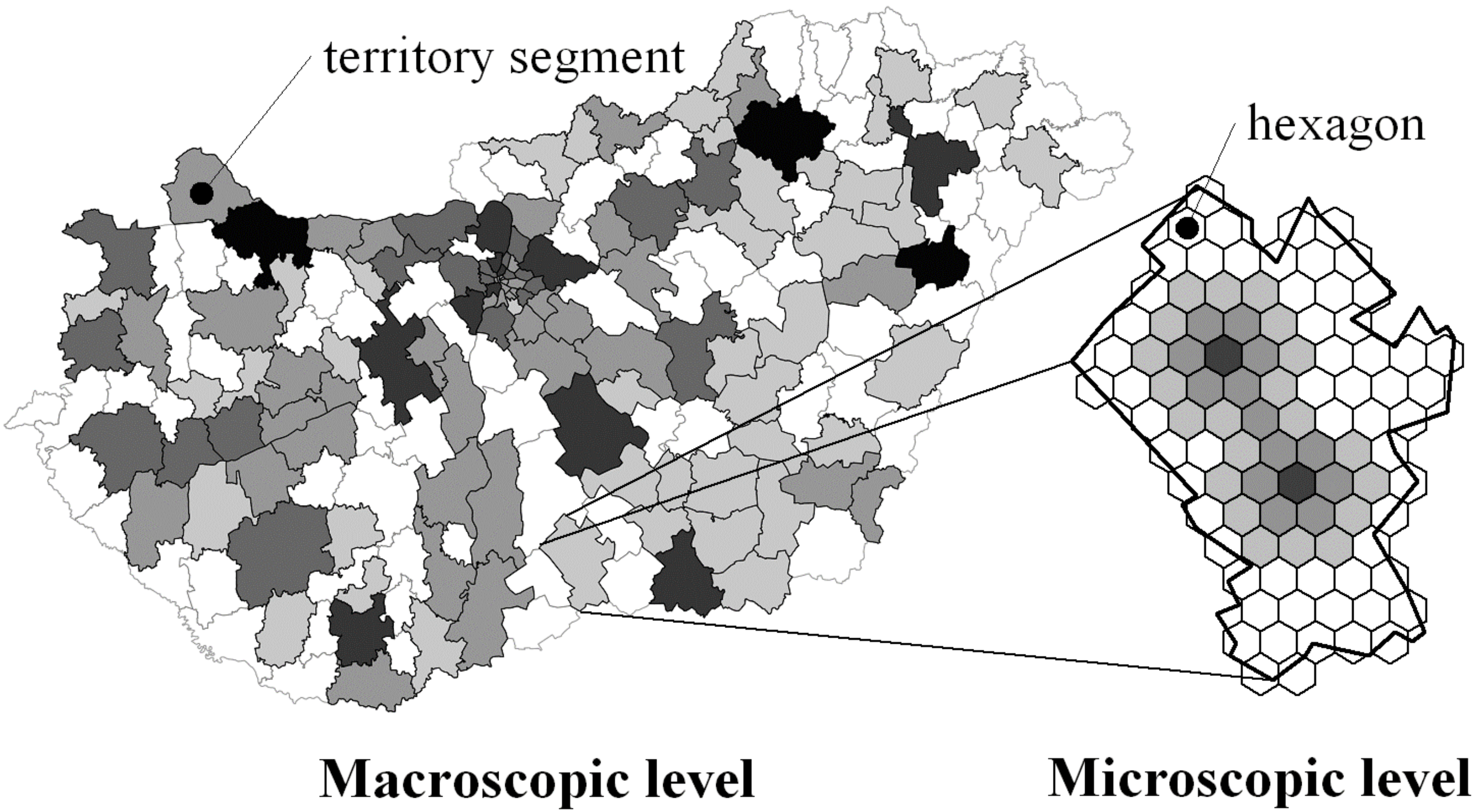


Support long-distance journeys, charging stations at gas stations. Determination of charging points based on traffic volume.

Inter-city method



Intra-city method

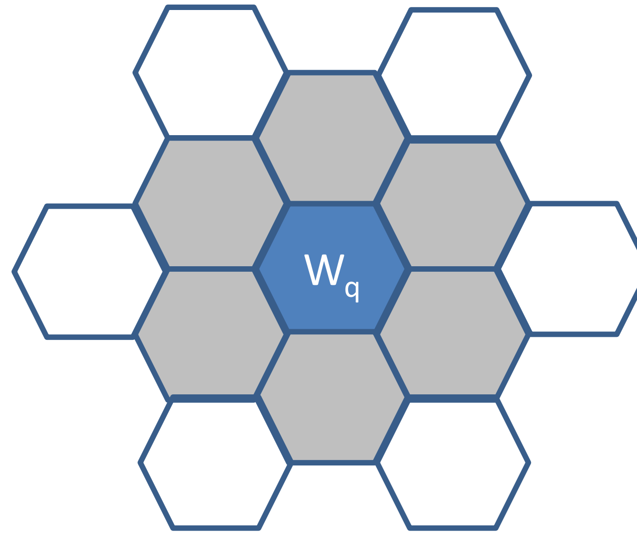


Macro-level: attributes that affect the total electric miles
Micro-level: attributes that are in correlation with parking demand

Intra-city method

PARK!NG

Daytime parking – services (S)
Nighttime parking - population (P)
Near charging stations (v_q)



Parcel the area to hexagons
Evaluate hexagons

$$V_q = c_1 \cdot \frac{S_q}{MAX(S_q)} \cdot 5 + c_2 \cdot \frac{P_q}{MAX(P_q)} \cdot 5$$

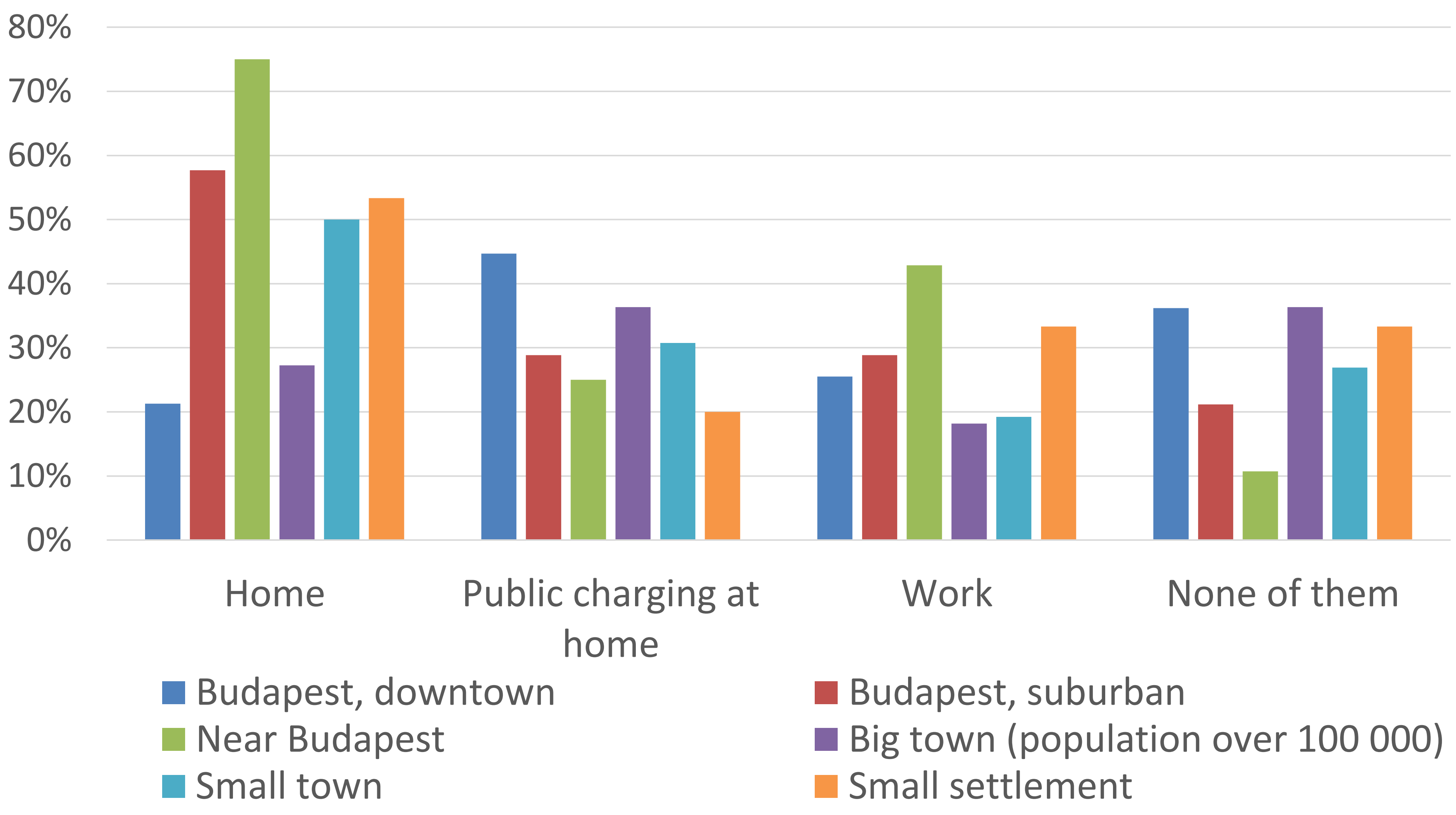
$$W_q = b_1 \cdot V_q + b_2 \cdot \overline{V_q^n} - b_3 \cdot \sum v_q$$

Intra-city method

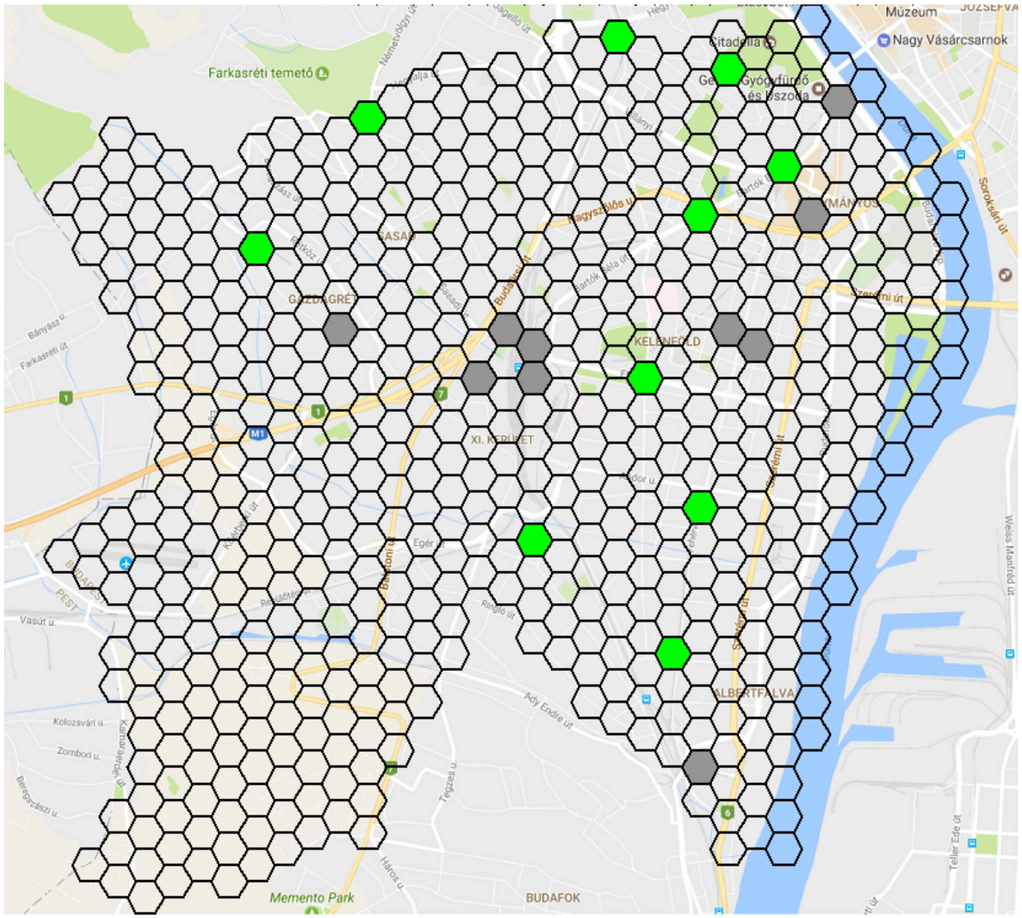
Location	Frequency of charging [charging/day/vehicle]	Charging time [hh:mm]
Home	**0,72**	**5:58**
Public charging at home	0,27	1:50
Work	**0,59**	**4:44**
Shops and markets	0,18	0:43
Bank, post office	0,09	0:21
P+R parking lot	0,15	2:09
Bus and railway station	0,08	1:21
Gas station	**0,25**	**0:21**
Tourist destination, museums, sport and recreation facilities	0,12	1:15

Intra-city method

Where could you charge your vehicle now?



Application of intra-city method



Legend: Proposed hexagon for charging station
Existing or in development charging station

- New charging stations close to services and high density areas

Conclusion

- Simple technology, expensive battery
- An EV is as environment friendly as the technology how the electricity was made
- The use of electric vehicles in public service raise awareness and lot of people can benefit from the advantages
- Two types of chargind demand, different motivations:
    - Super chargers at gas stations along highways: long-distany journeys
    - Normal or fast chargers in urban areas close to services and in high density areas: short-distance trips in the city