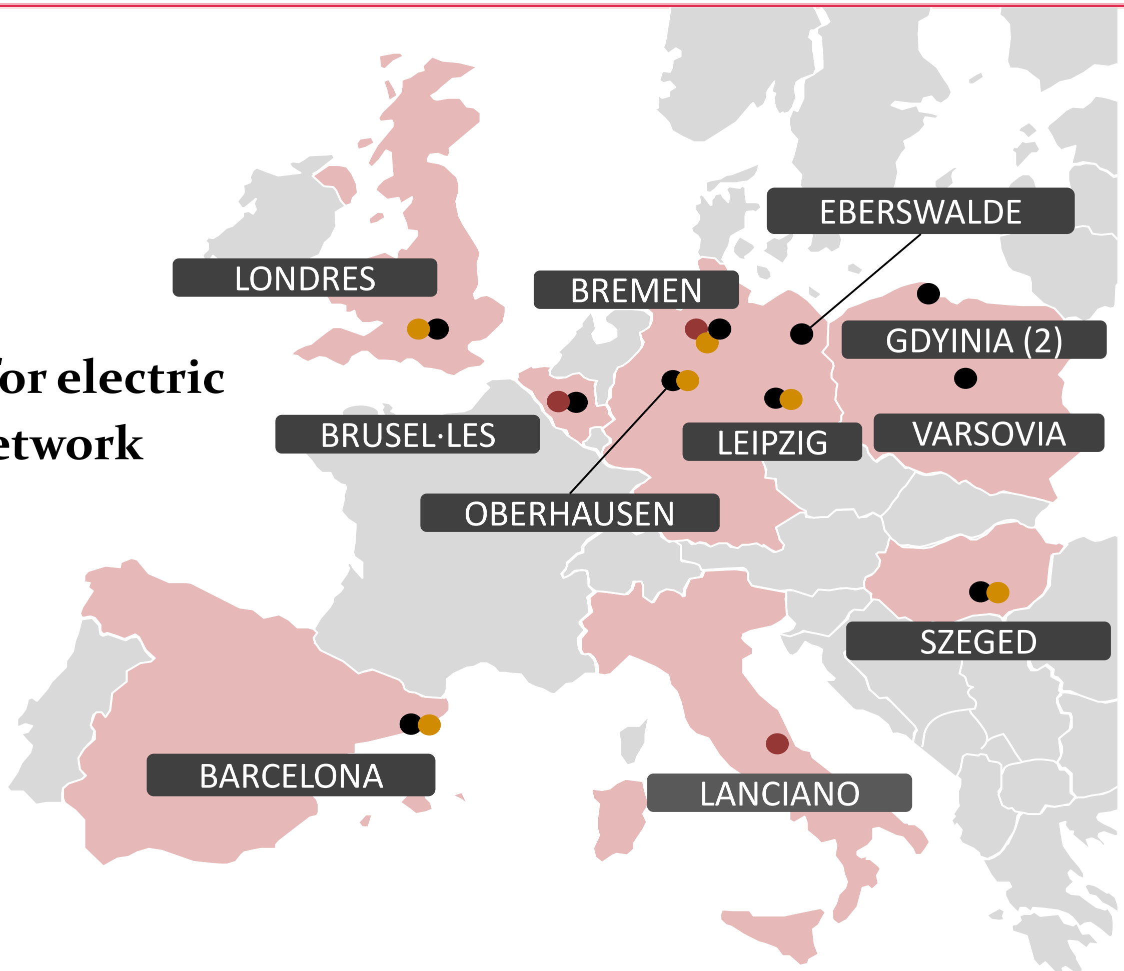
ELIPTIC



Planning a charging infrastructure for electric vehicles using Barcelona's rail network

Eliptic Project

April 9 2018

ELIPTIC – Electrification of public transport in cities

ELIPTIC expects that the future of the electric mobility can be reinforced integrating them in the existing electric public transport infrastructure

Pillar A

Secure integration of e–buses into the existing electric public transport infrastructure

Pillar B

Actualization or regeneration of the public electric transport to improve the operative efficiency

Pillar C

Multiple use of the electric public transport infrastructure

33 partners in 8 countries

Research and Innovation project Horizon 2020

36 months duration: 01.06.2015 - 30.05.2018

Budget: 5,9 Million EUR

Why ELIPTIC for Barcelona?

- Contribution to create a more sustainable city, decreasing the greenhouse gases and noise pollution to improve the citizens quality of life.

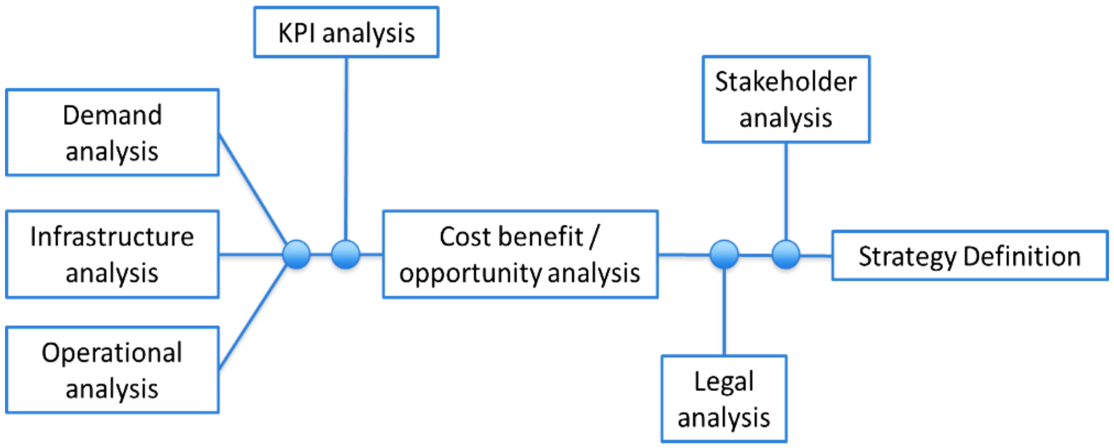
- Increase the resilience of the city optimizing the energy use between the railway operator and B:SM car parks for charging purposes.

- B:SM wants to supply the electric charging service for the citizens in an efficient and effective way.

ELIPTIC. Pillar C – B:SM

Eliptic Pillar C Barcelona has the objective to carry out a viability study to prove the convenience of the electric car charging network implementation in B:SM car parks connected to the railway electric infrastructure.

INFRASTRUCTURAL	**Analysis of the necessary elements for the connection with the electrical Railway network, capacity and demand**
OPERATIONAL	***Analysis of the infrastructural business model and resolution of barriers (operative and legal)***
STRATEGICAL	***Strategic Implementation plan linked with the skateholders***



Planning the distribution of charging points in the city

Steps followed:

1. Analyse the requirements to connect charging points to the railway grid

2. Analyse all parking areas of the city
   - Taxi parking areas (taxi stops)
   - Areas for loading/unloading of goods for urban freight vehicles
   - Regulated Surface parking areas (resident and non-resident areas)
   - BSM underground parkings (both season holder and pay per use)

3. Analyse the *use (occupation)* of the different areas

4. Distribute the forecasted charging points needed taking into consideration:

- The demand of each parking area
- The spatial coverage of the city
- The proximity to railway lines in order to connect them to their grid

Requirements to connect charging points to the railway grid

Area in which a charging station could be connected to the railway grid

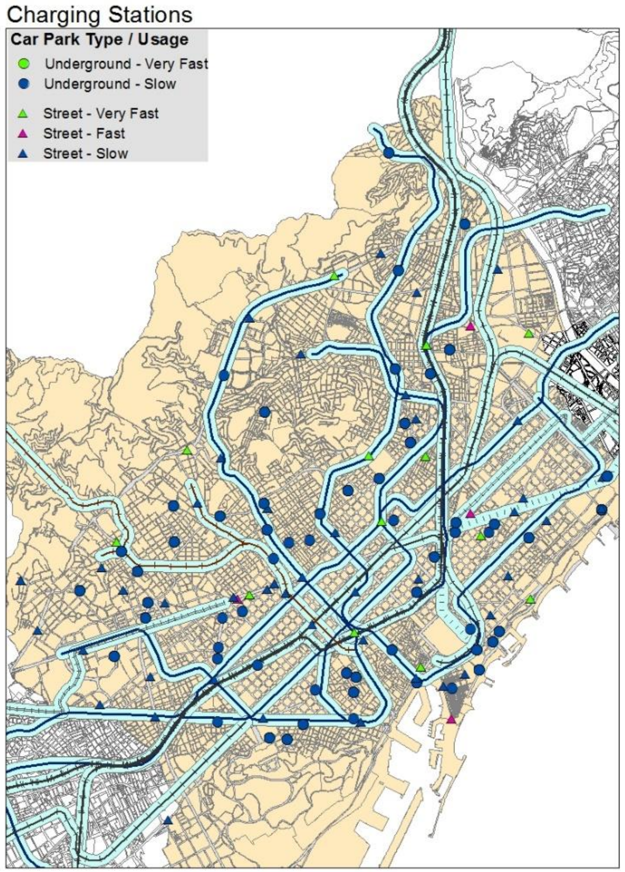
As an approximation, the area to which the charging points could be potentially connected has been calculated taking into account the cost of installation of the cable, both on-street and in gallery (undergrounded) looking for the minimum distance between a feeder substation and recharging points.

Current number of charging points in the vicinity of railway lines

The map shows the current railway lines and the existing charging points for different segments of users:

- Underground fast chargers
- On-street fast charge
- On-street motorbike
- On-street freight vehicles
- On-street taxis

Currently (may 2017), **42** out of **125 charging stations** fall in the area of influence of railway lines (metro, tram, railway).

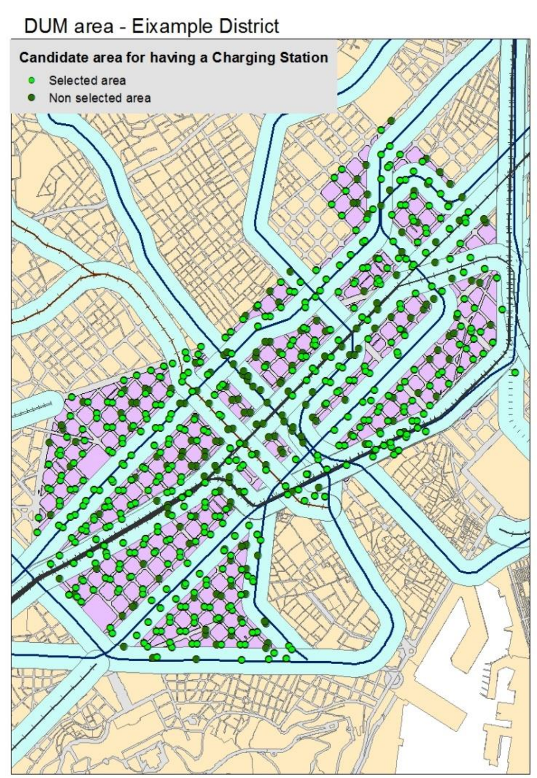


Distribution of the forecasted charging stations in the city

To distribute the charging stations in the different parking areas several requirements have been considered:

- **Uniformity** in the urban areas
- **Density** of the different parking areas
- **High use** of the parking areas
- **Distance** to the railway grid

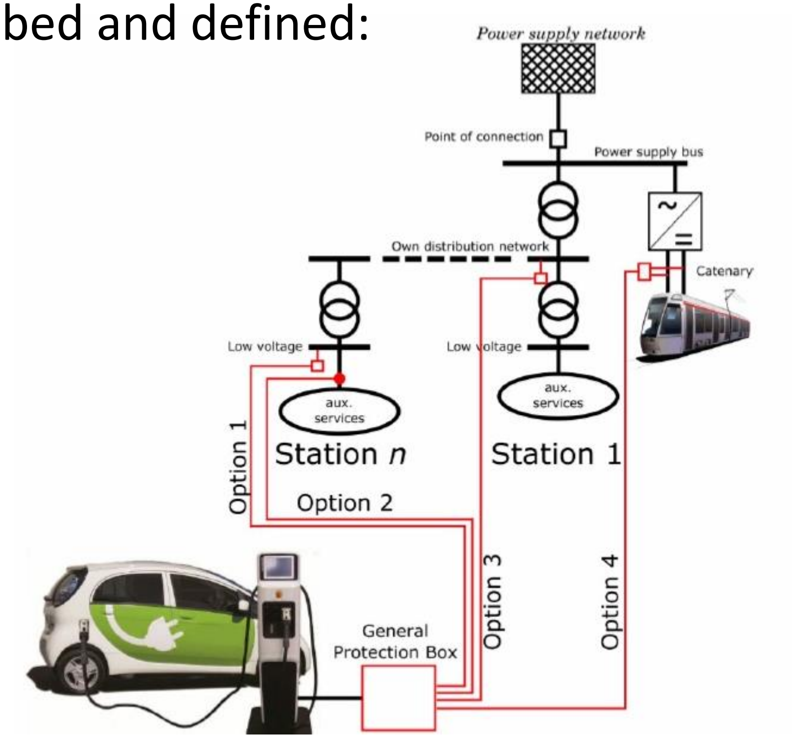
The figures obtained allow that in a second stage, city council technicians decide in detail the exact location of the charging stations considering further requirements as well as ensuring a high use of them.



ELIPTIC. Pillar C – Infrastructure analysis

Four connection modes have been technically identified, described and defined:

1. Connecting AC to the station 420 V on transformer bars.
2. Connecting AC 420 V on the station auxiliary services line.
3. Connecting AC 420 V on the substation transformer bars.
4. Connecting DC 750-1500V directly from the catenary.



The investment and maintenance cost has been described through cost drivers based on basic units of cost (distance from the tunnel, devices needed…).

The connection chosen due to functional and economical feasibility has been the option 3.

ELIPTIC. Pillar C – Infrastructure growth

ELECTRIC CHARGER TYPES

- Slow and fast charging points, to provide a flexible service (on-street)
- Slow charging points, which are the only ones currently used at B:SM car parks (off-street)

EXPANSION OF THE PARKING NETWORK NEED

It includes the current parking lots, the off-street growth and the on and off-street growth

MANAGEMENT MODEL

- Agreement between rail operator and B:SM management
- Exclusive Railway Operator management
- Exclusive B:SM management or allowing the utility to be the network operator.

RAILWAY NETWORK POWER USAGE

- BSM will use its parking lot energy supply constantly or dynamically.

ELIPTIC. PILLAR C – Operational analysis

Alternative scenarios

USE	1 electricity sale	2 electricity sales
Public	**Scenario 1** B:SM pays the Railway Operator for the electricity. B:SM charge its own public fleet.	**Scenario 3** B:SM pays the Railway Operator for the electricity. Public fleets pay B:SM for charging their fleets.
Private	**Scenario 2** Final client pays the Railway Operator for the charge. Final client pays B:SM for the parking slot.	**Scenario 4** B:SM pays the Railway Operator for the electricity. Final private client pays B:SM.

ELIPTIC. PILLAR C – VIABILITY

USE	1 electricity sale	2 electricity sales
Public	**Scenario 1** Legal Viability ✓ Infrastructural* Viability ✓ Operational Viability ✓	**Scenario 3** Legal Viability ✗ Infrastructural* Viability ✓ Operational Viability ✓
Private	**Scenario 2** Legal Viability ✓ Infrastructural* Viability ✓ Operational Viability ✓	**Scenario 4** Legal Viability ✗ Infrastructural* Viability ✓ Operational Viability ✓

** It depends on the location of the railway substations. If it is closer than 300m to the car park then it's viable if it's further it is not viable.*

SWOT Analysis

Strength	Weakness	Opportunity	Threat
• **Technology concept is available on the market, sufficiently standardized and ready for full commercial application** • **Charging points supplied by the railway power grid have energy efficiency advantages compared to charging points supplied by the public distribution grid** • **Dual function of the metro power grid, specifically, leads to a higher utilization rate (more efficient use of excess energy), especially due to complementary power demand patterns of metro service (morning and afternoon) and electric vehicle charging (night)** • **Future extension of the municipal electric cycling, taxi and bus fleet**	• **Slow chargers (3,6 kW output power, AC)** are currently **considered as the solution** in this context, semi-fast chargers are planned in the near-term in the car parks • **Energy supply for charging points** is **second priority** within the railway power grid, which **causes power availability issues** (time and location specific) • **Planning and implementation effort** for connecting to metro substations is **higher** compared to connecting to the public distribution grid • **Poor communication between local and national subsidies and the citizens in the sense of choosing between an electric car or a power fueled vehicle**	• **Operational availability can be increased by using smart meters to constantly monitor the metro power grid and to control the power supply in consecuence with the demand** • **Combination of park & ride strategies with electric charging points supplied by the railway grid have the potential to increase coverage of railway service** • **(Local) politics and authorities are supporters, having a high influence on the implementation (for example municipal electric fleets, constant e-mobility projects participation and so)** • **European and regional funding are promoting the e-mobility in Catalonia** • **Taxes and restrictions of the diesel vehicles when pollution episodes happen will influence positively in**	• By **offering a free charging service** the technology concept may **foster the substitution of the collective public service by individual electric vehicles not solving the public space occupation** in the main areas of the city. Traffic jams and parking queues will continue same way than currently • **Funding** is **partly available and not fully secure from the national government** it can constitute a **substantial barrier** for the concept feasibility • Barcelona has **a low number of electric vehicles** and the charging infrastructure may be unused due to the commercialization of e-vehicles is not the expected • **High legal barriers** from Spanish national regulations that are unfavorable for the implementation and operation concerning mostly energy and

FEASABILITY ANALYSIS CONCLUSIONS

Infrastructure design and installation report

- 300 meters is the maximum recommended distance between the rail network and the recharging point. Each point should have its own study.
- Recommended AC 420 V connection on the substation transformers bars.
- Plan a scalable network growth involving the main stakeholders considering the impact in the social cost and plan the usage of an alternative power source when PT peak time through a competitive management model

Demand analysis report

- Key variables to locate of resilient or non-resilient charging points: uniformity of supply, density and occupation of car parks. The charging point nominal power depends on the users and areas of the city, on-street and off-street should be differentiated.
- Due to EV growth, by 2020, the total number of charging points needed to supply the demand will be 331 charging points.

Operational model definition report

- Power usage during daytime could be a combination of the maximum PT excess energy and other sources. During night-time, the charging system could benefit completely from PT due to rail services schedule.
- The charging manager is the only part able to sell energy. This role can be done by the PTO or by the car park manager, this is not only important in financial terms but also has consequences on the maintenance responsibilities.

Legal report

- Actual Spanish decrees and regulations have been taken into account, looks likely they're going to be more open, so there will be more opportunities.
- Currently the most likely scenarios to be approved are the ones when there is only one charging manager (PTO to car park manager) and the end user is related to the public administration

ELIPTIC. PILLAR C – B:SM CHARGING MANAGER STRATEGY

Ensure the infrastructure **legalization** following the Art. 1 Real Decret 647/2011, May 9th

Introduce improvements in the **regulatory framework** and in the public politics to boost the e-mobility

Motivate public social services to use **a 100% electric fleet**. Make the demand increase.

Give value to the infrastructure and setting up a price for the charge

Line-up with the principal players in the electro mobility area

Work for the sustainable network growth based on the **urban resilience** and the search of alternative energy distribution network.

Thank you for your attention