Battery training

Size 1: Setting the vehicle targets

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 875041

Agenda

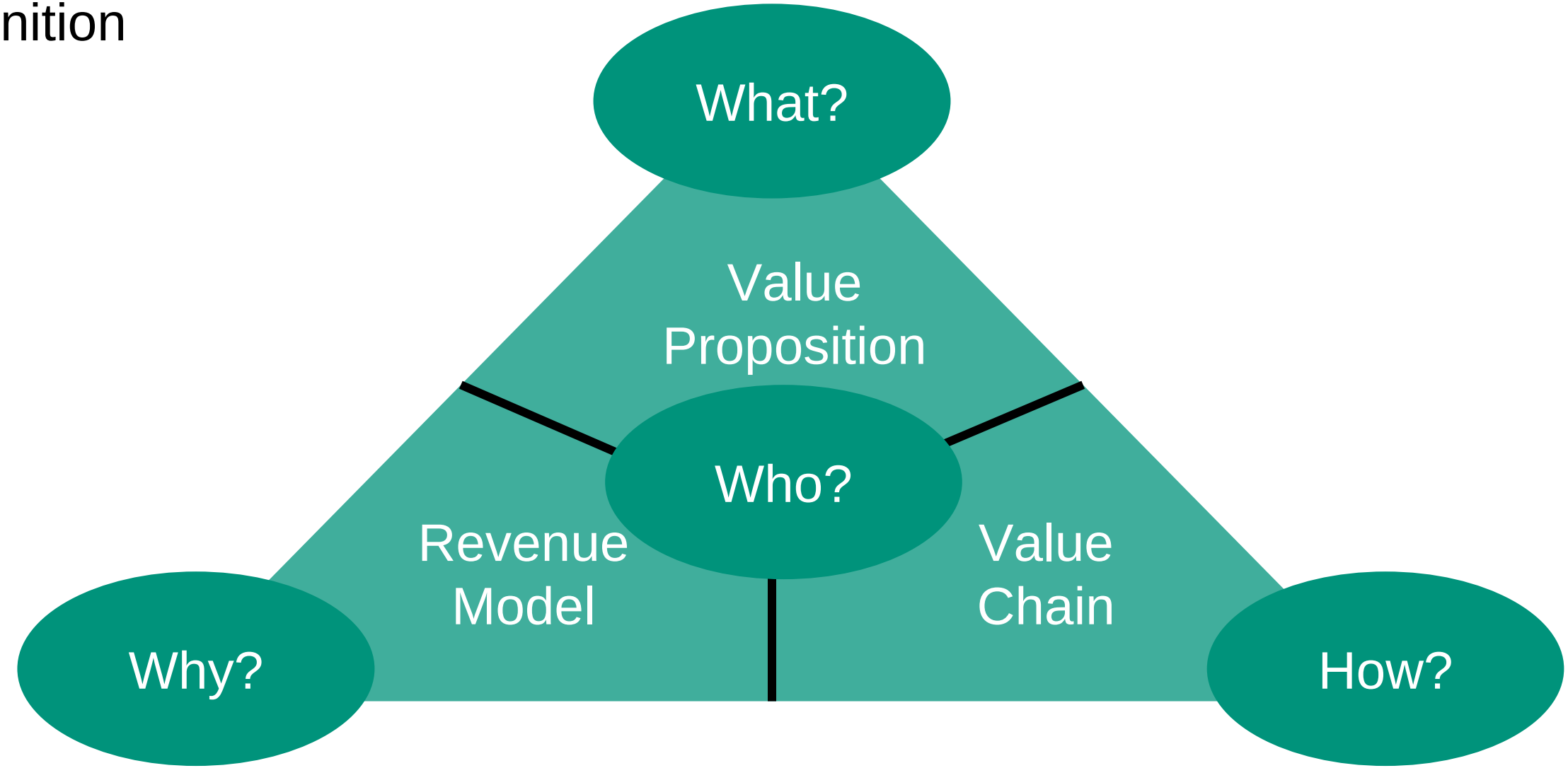
1. Business model impact on target setting
   - 1.1 Business model. Decision Support Tool
2. **Use case identification and data acquisition**
   - 2.1 Use case analysis. Barcelona line electrification
3. **Definition of vehicle targets**
4. **Competitors benchmarking**
5. **Vehicle targets. Barcelona urban bus feasibility**

Business model impact on target setting

@ Chandelier photo created by wirestock

Business model

Definition



Business model

First steps

What..?

- Kind of service
- Propose of the service
- What type of vehicle

Who…?

- Clients
- Providers

⇒ **Target Setting**

Business model

@ Mobile user photo created by katemangostar

First steps

Why…?

- Why is important

  - Reason, needs…

How…?

- Implementation
  - Time, infrastructure, people
- Revenue

Business model

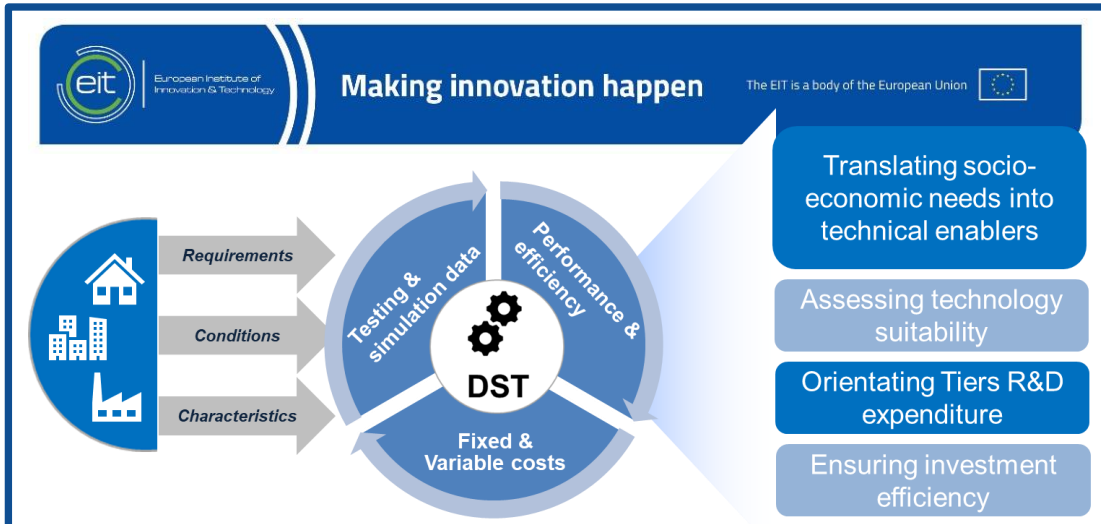
Target setting considerations for transport electrification

Economic

- Right-sizing future-proof charging infrastructure
- Balancing social Benefit and expenditure (capital and operating)

Technical

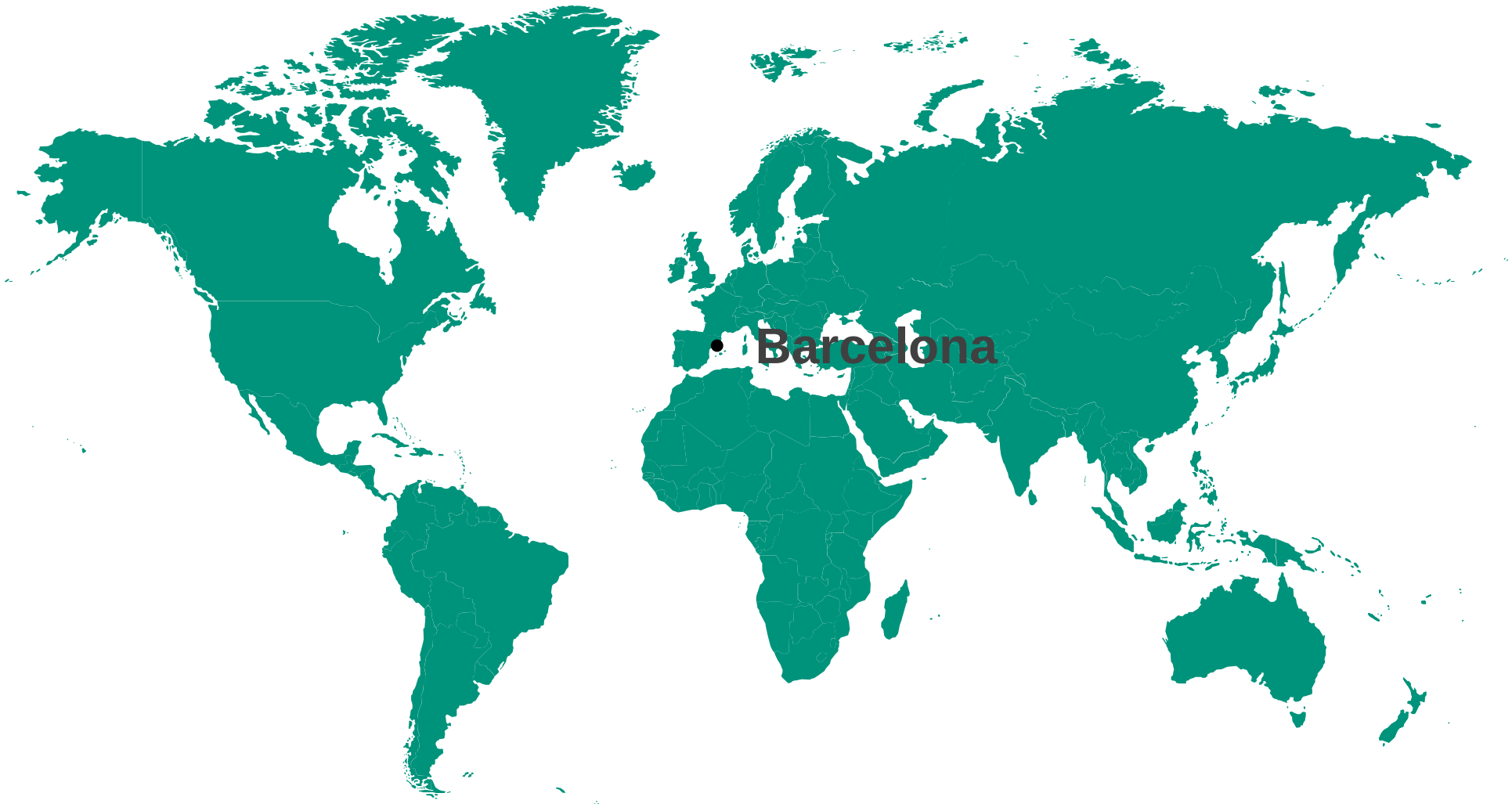
- Vehicle specs definition
- Safety
- Reliability



Business model. Decision Support Tool example

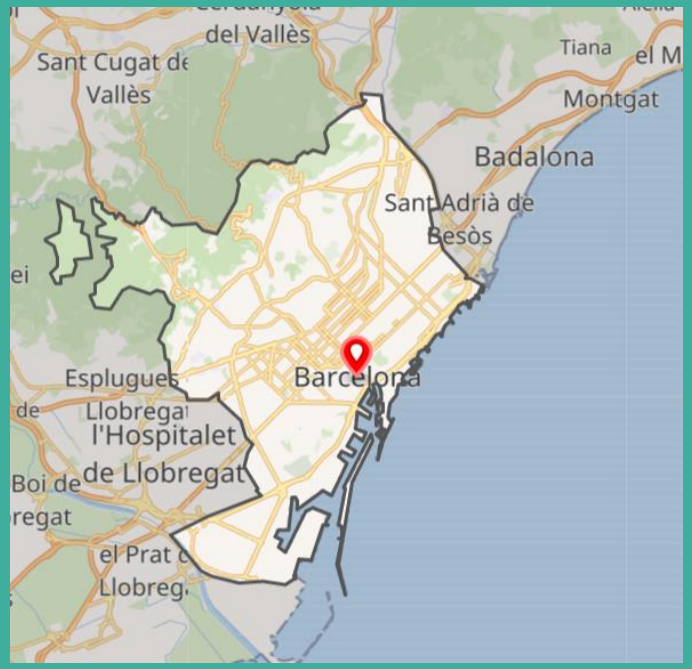
Business model

World

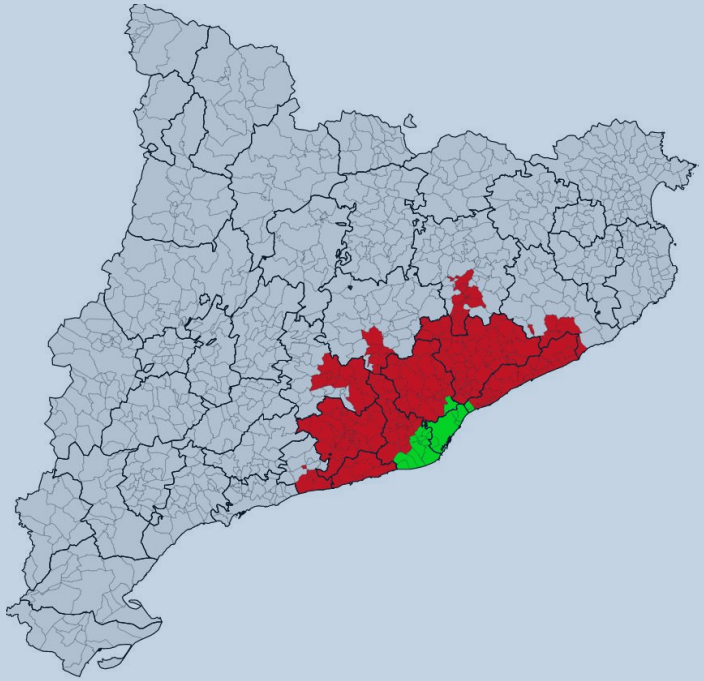


Business model

Barcelona as a city hub



- Barcelona city population: 1,6 M people (2021)
- Area 101,3 km^2



- Barcelona city population: 3,2M people (2012)
- Area 636 km^2

A lot potential people to go to Barcelona for different reasons

Business model

How to get to Barcelona?

By land

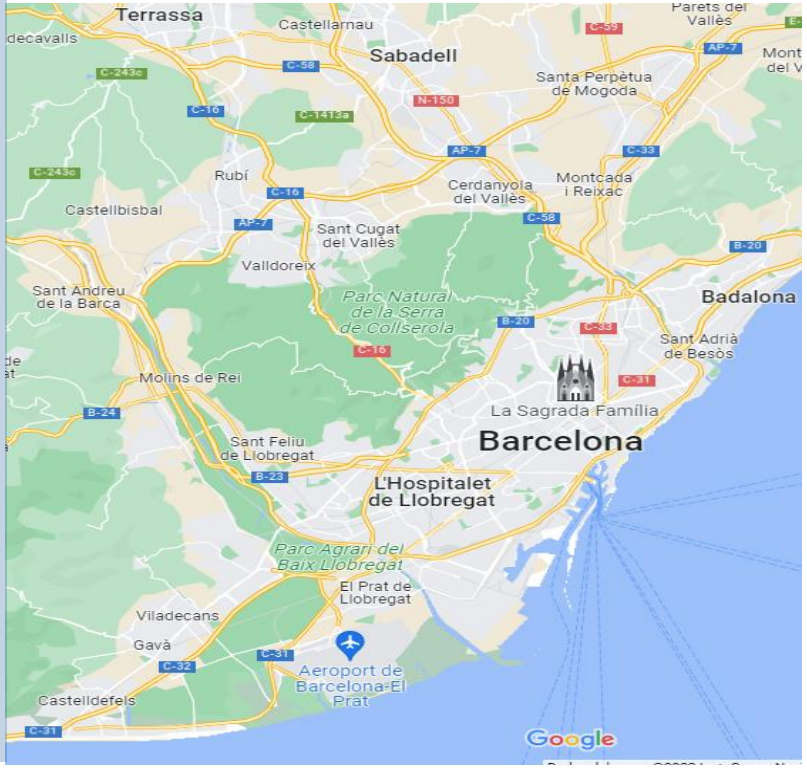
- Private vehicle
- Bus
- Train

By sea

- Cruise
- Yacht
- Sailboat

By air

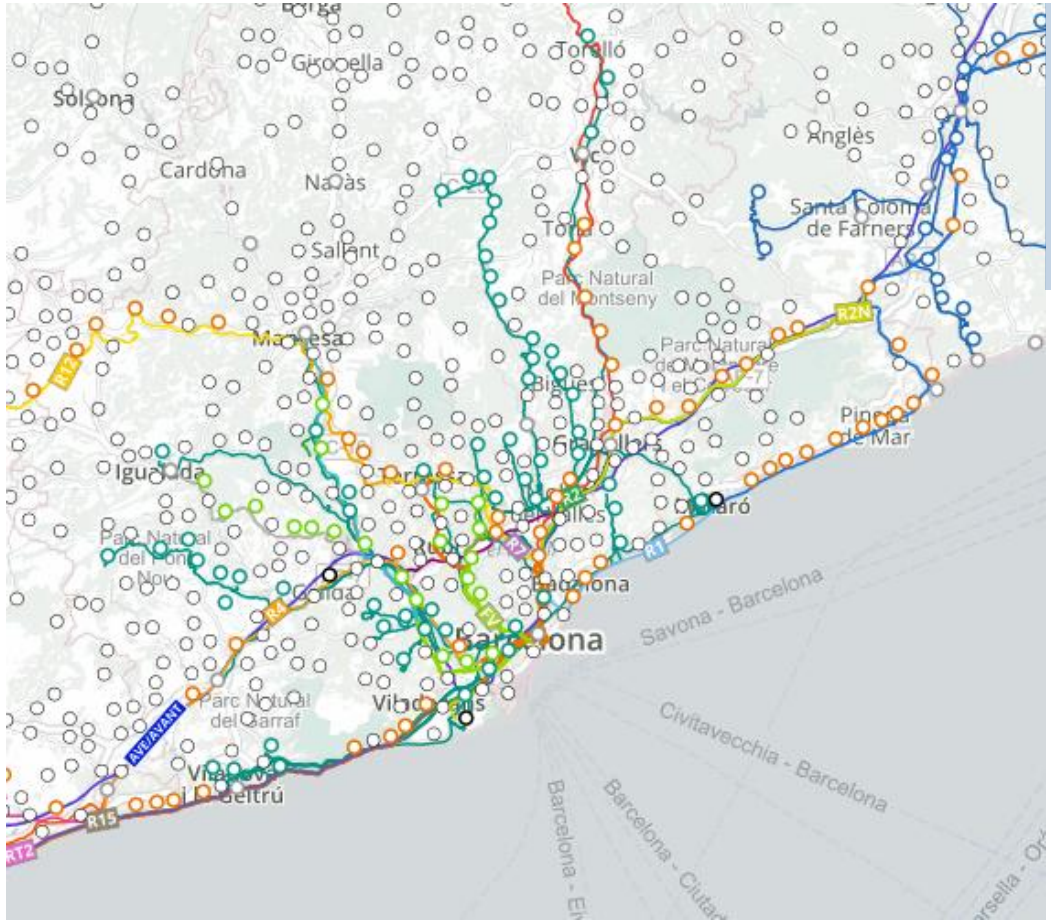
- Passenger airliners
- Prinvet jets
- Light aircrafts



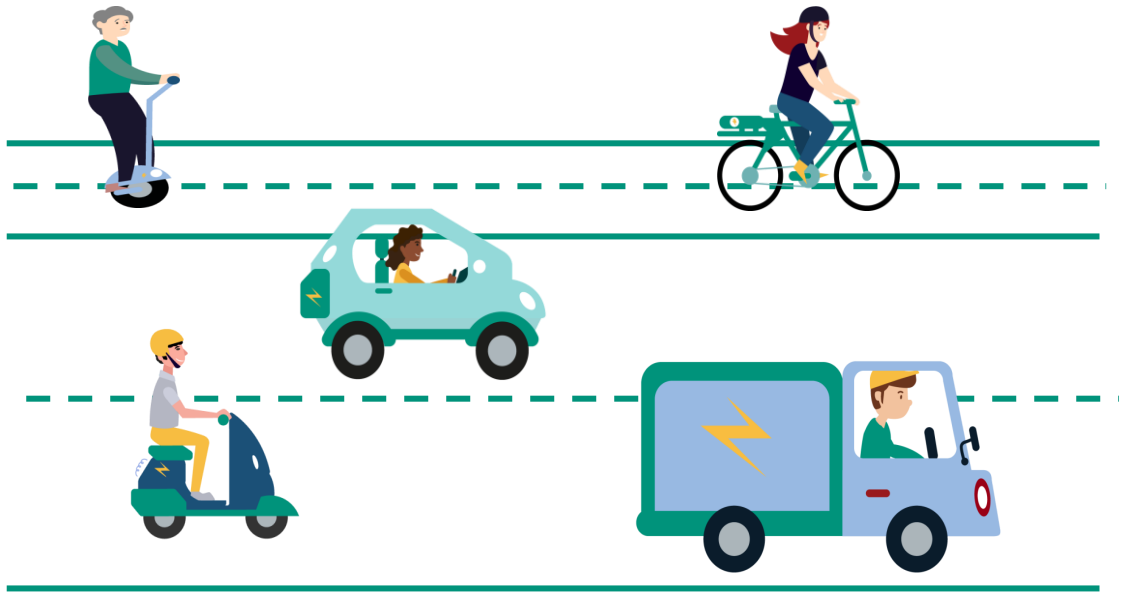
Mobility example

Business model

Problematic: Public transport and private transport



How we can move inside the city?



Business model

Move by public transport: Underground/trolley

Remarks:

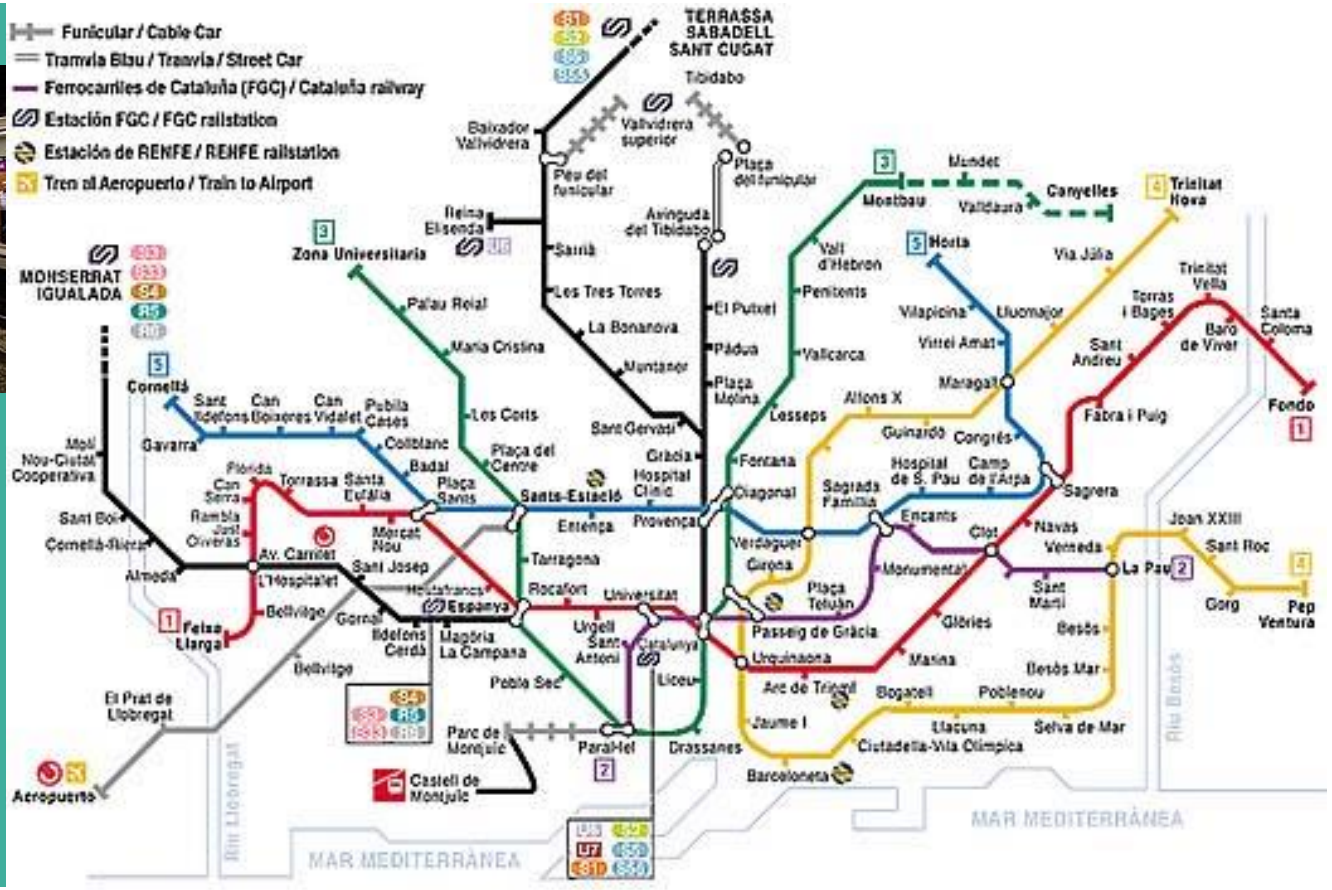
Underground

- 8 lines
- 165 station
- 162 vehicles

Remarks:

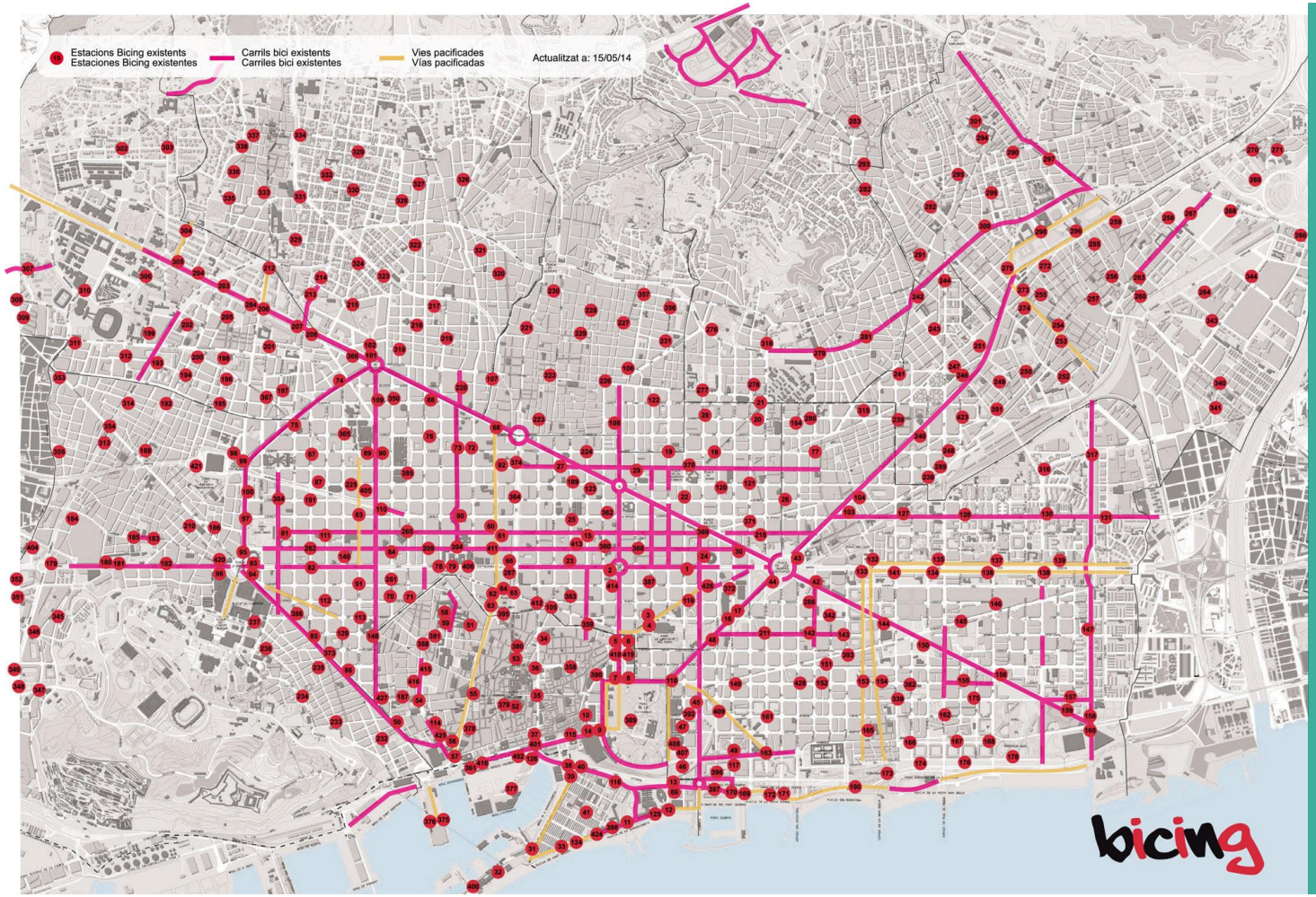
Trolley

- 6 lines
- 55 station
- 42 vehicles



Business model

Move by public transport: CO2 free ride



Remarks:

- 130300 clients
- 7000 bikes
- 519 Service points

Source: https://www.bicing.barcelona/es

Business model

Move by public transport: urban bus line

833 km, 219 km of bus line
+ 100 lines

115 millions of passengers (2020)
209 millions of passengers (2019)

Business model

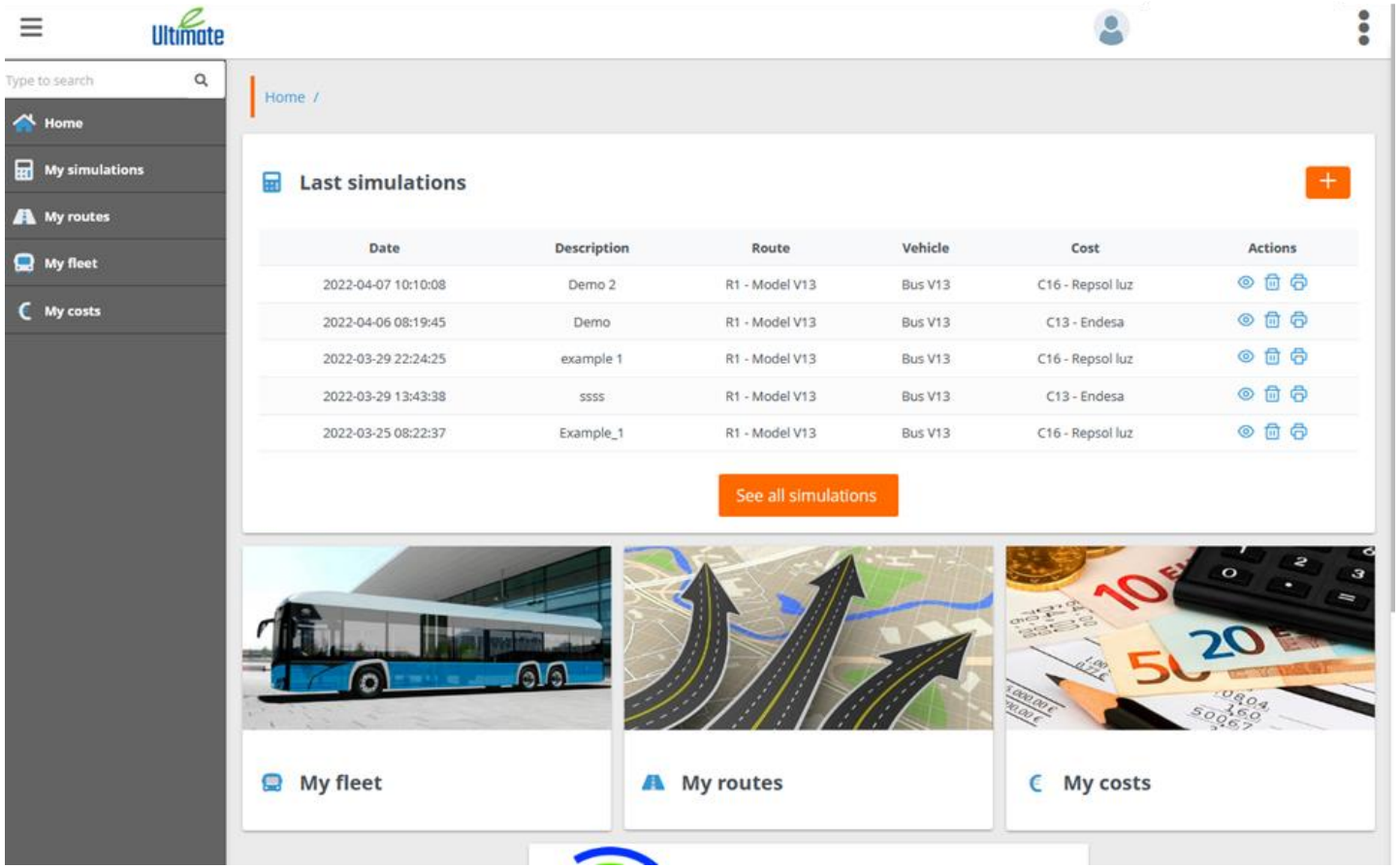
Bus line planification:
How to electrify new lines?

Question:

- How many vehicles I need
- Electrification of new line
- New line definition
- Charging schema?
- How many charger I need
- Invesment?
- …

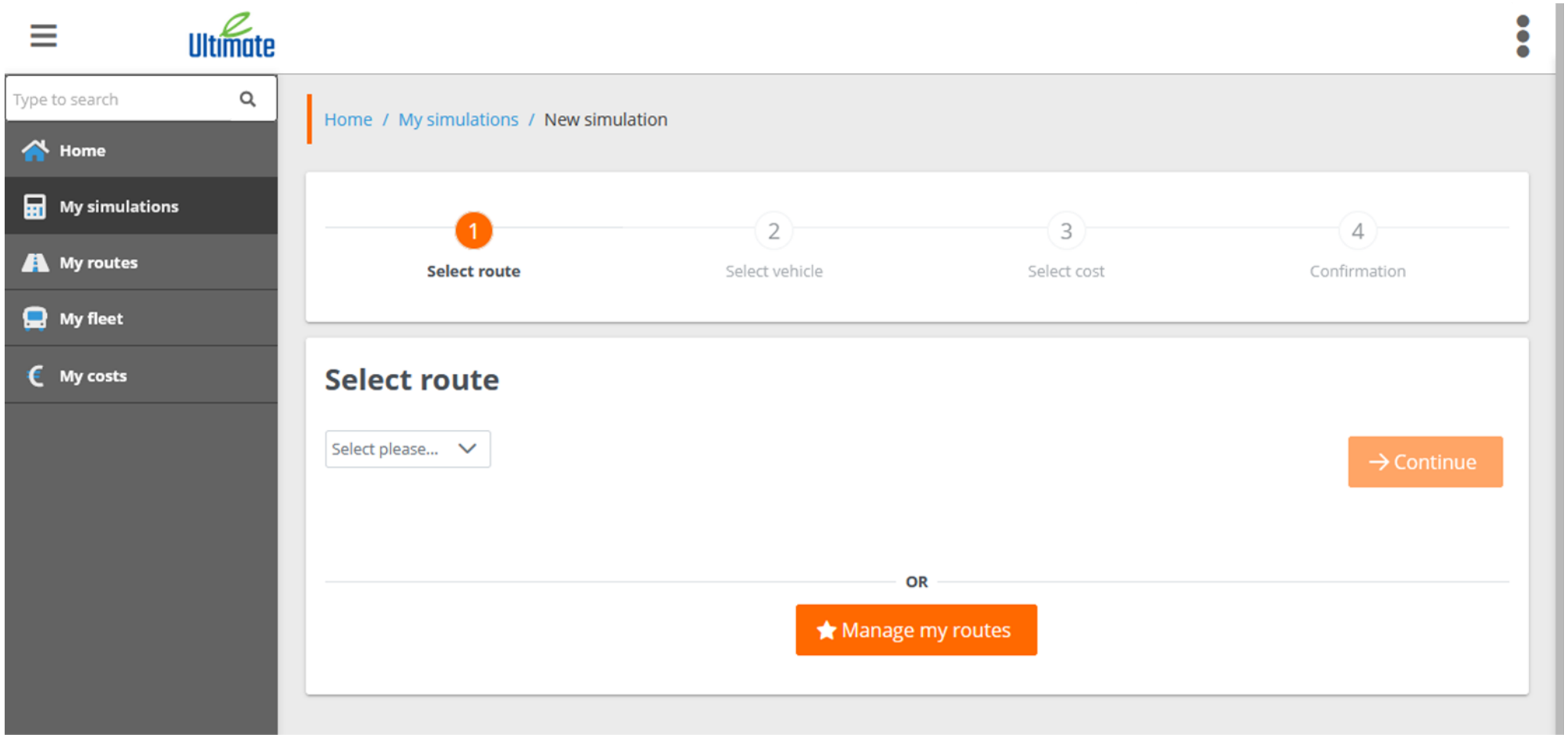
Business model

Bus line planification:
How to electrify new lines? Decision Support Tool



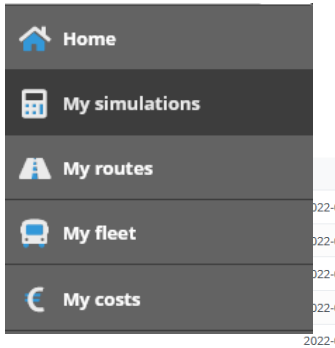
Business model

Decision Support Tool

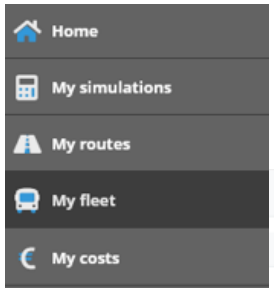


Business model

Decision Support Tool

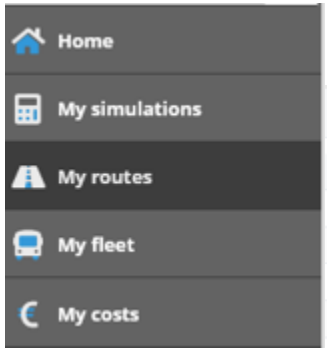


Date	Description	Route	Vehicle	Cost	Actions
022-04-07 10:10:08	Demo 2	R1 - Model V13	Bus V13	C16 - Repsol luz	
022-04-06 08:19:45	Demo	R1 - Model V13	Bus V13	C13 - Endesa	
022-03-29 22:24:25	example 1	R1 - Model V13	Bus V13	C16 - Repsol luz	
022-03-29 13:43:38	ssss	R1 - Model V13	Bus V13	C13 - Endesa	
2022-03-25 08:22:37	Example_1	R1 - Model V13	Bus V13	C16 - Repsol luz	
2022-03-25 07:35:32	Simulation H16	R2 - Model H16	Bus H16	C13 - Endesa	
2022-03-24 17:21:23	simulacion nº3	R2 - Model H16	Bus H16	C16 - Repsol luz	
2022-03-24 16:59:56	Simulacion nº2	R1 - Model V13	Bus V13	C13 - Endesa	
2022-03-24 16:22:05	R1 V13 Mod13	R1-Model V13	V13	Mod 13	



My fleet

Name	Creation date	Actions
Bus H16	2022-03-29	
Bus V13	2022-03-24	
Default 12m eBus	2022-03-24	
Default 15m eBus	2022-03-24	
Default 18m eBus	2022-03-24	
Default 8m eBus	2022-03-24	
IDIADA_eBus	2022-03-25	
V2 - Irizar i2e	2022-03-22	



My routes

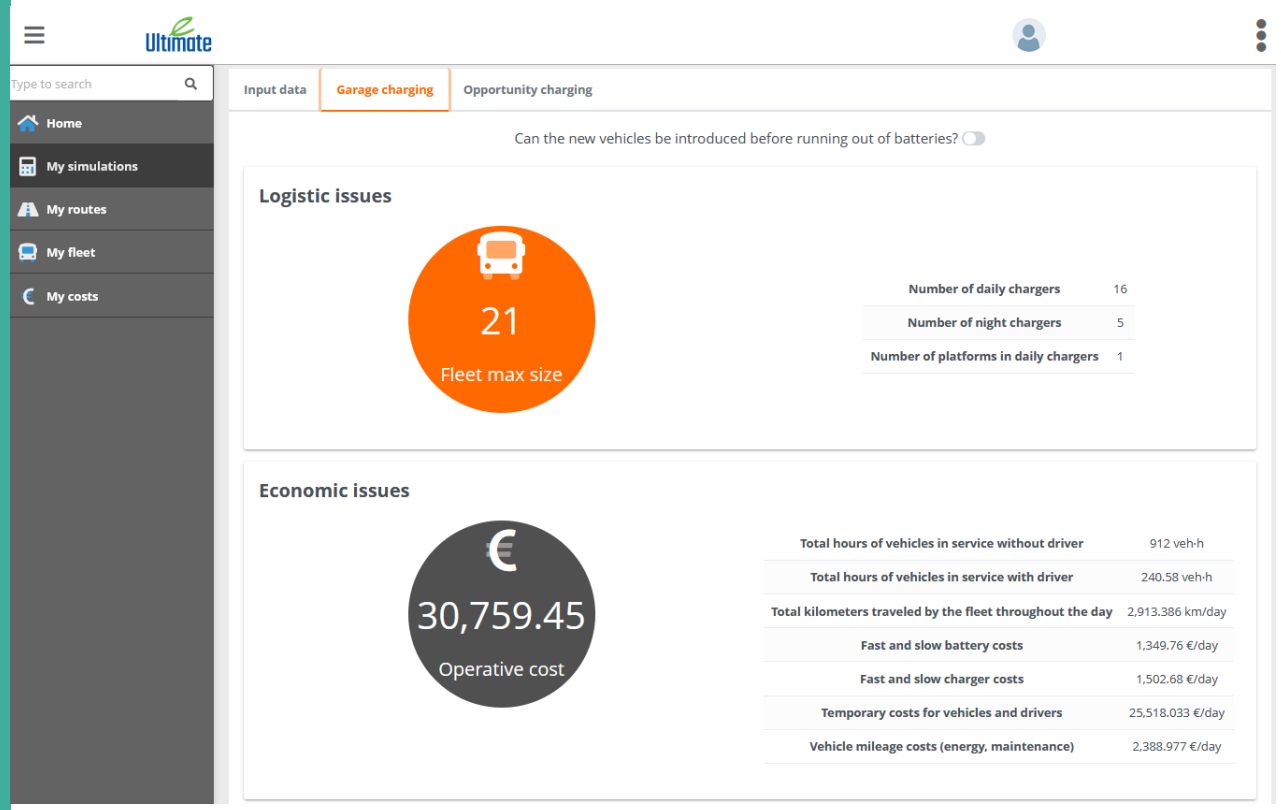
Name	Creation date	Actions
IDIADA_RT1	2022-03-25	
R1 - Model V13	2022-03-31	
R2 - Model H16	2022-03-29	
R2 - Terminal 2	2022-03-22	
Route M33 Barcelona	2022-03-24	
Ruta #44	2022-03-29	

Business model

Decision Support Tool

Summary:

- This tool help fleet operators to:
  - How many vehicles I need
  - How much chargers I need
  - How much it will cost



Use case identification and data acquisition

Use case identification

Define use case.

Steps:

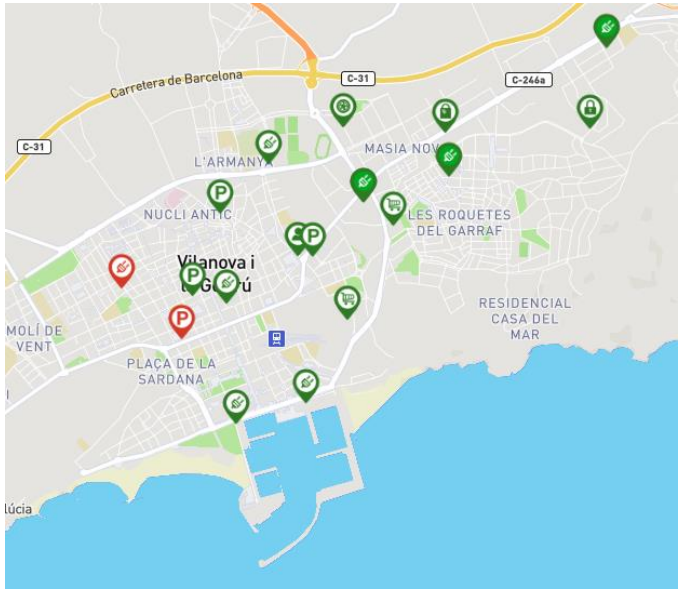
- Product definition
- Propose definition
- Area of service or route definition

Use case identification

Define use case. Electrical vehicle environment example

Parameters:

- Electric vehicle car sharing energy charger
- Define a charger network
- Define charger
- What type of connector I need?



Use case identification

Route parameters

Urban
- Low speed

Extra urban
- High speed

Rural
- Irregular road

Offroad
- High slope

Use case identification

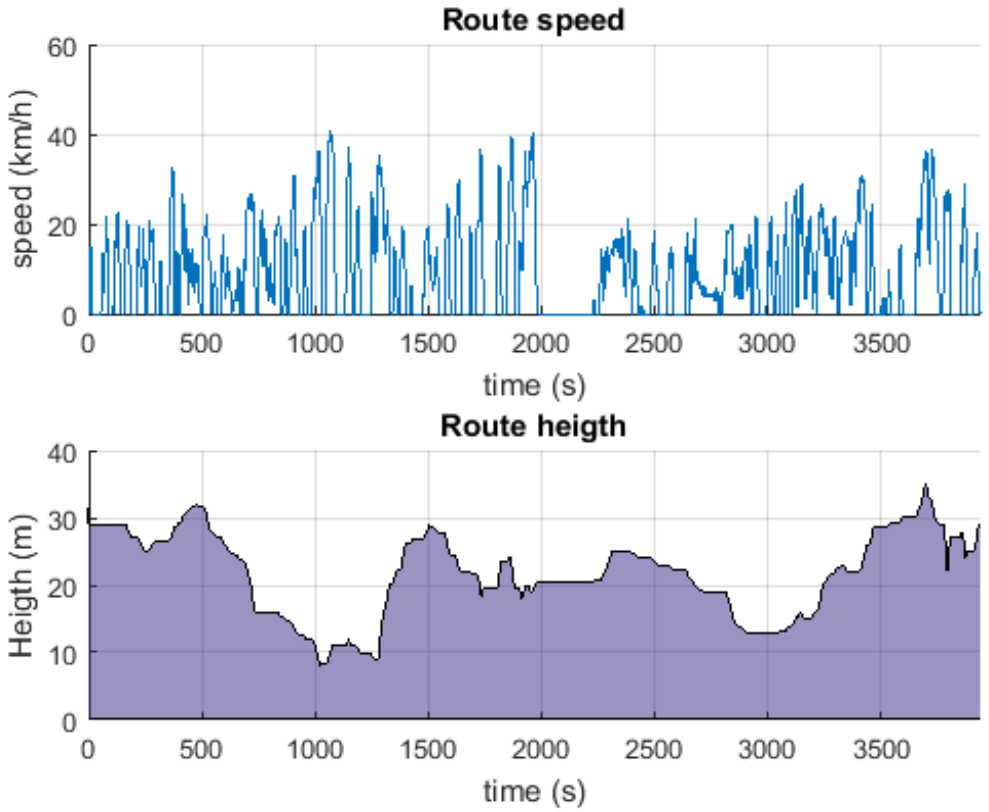
Define use case. Profile analisis

Desired route

Route acquisition

- GPS
- Mobile app

Route analysis



- Maximum speed/Mean speed
- Length
- Slope

Use case identification

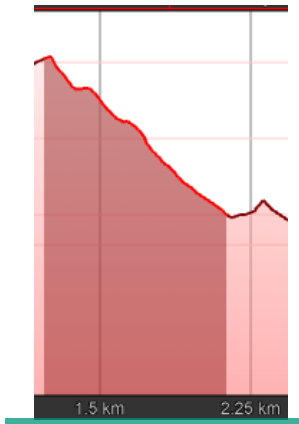
Define use case. Example

Use case example. Barcelona bus line electrification

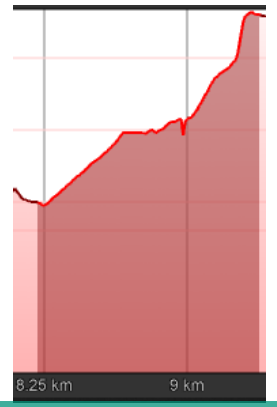
Use case example

Line caracterització

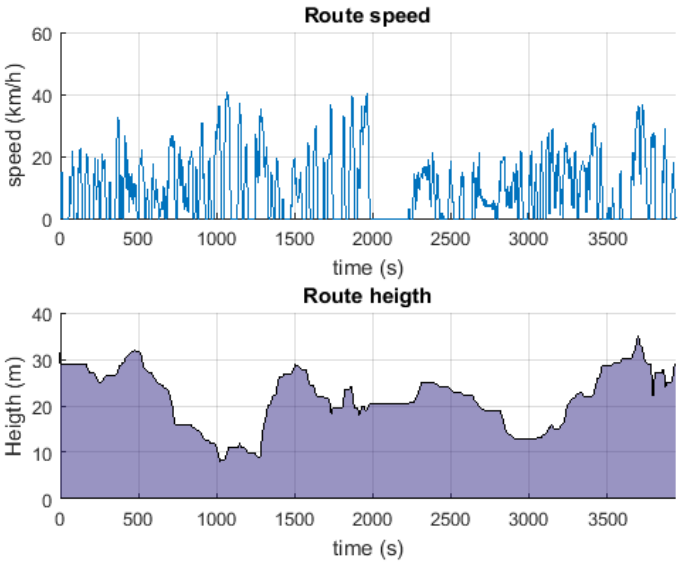
L120



Slope:-2.4%



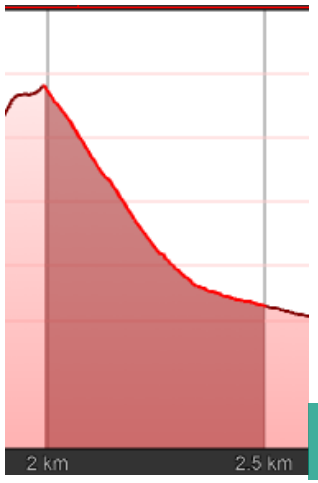
Slope: 6.5%



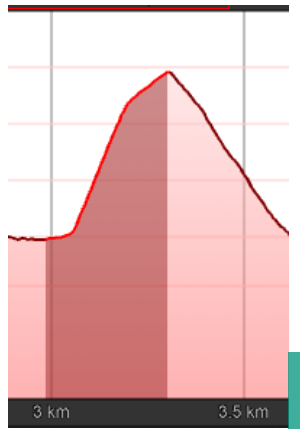
Use case example

Line caracterització

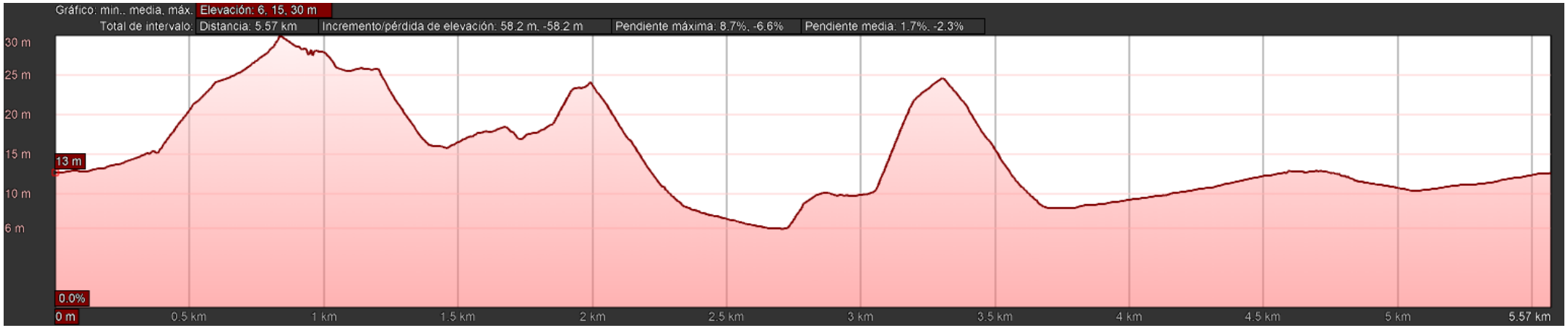
L121



Slope:-5.7%



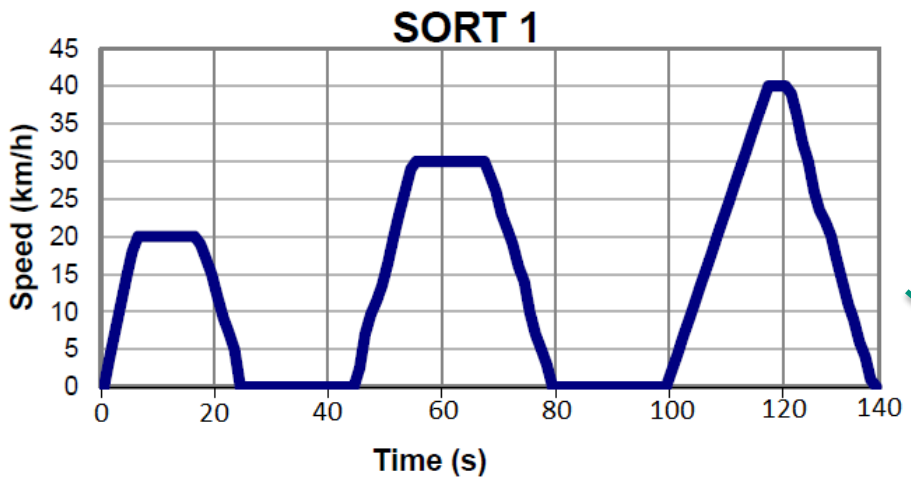
Slope:-4.7%



Use case example

Consumption validation on PG

A) Standard reference cycle:

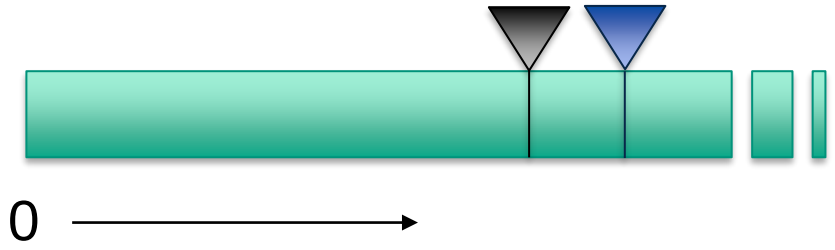


More aggresive than real use but lower impact of auxiliaries consumption per kilometer

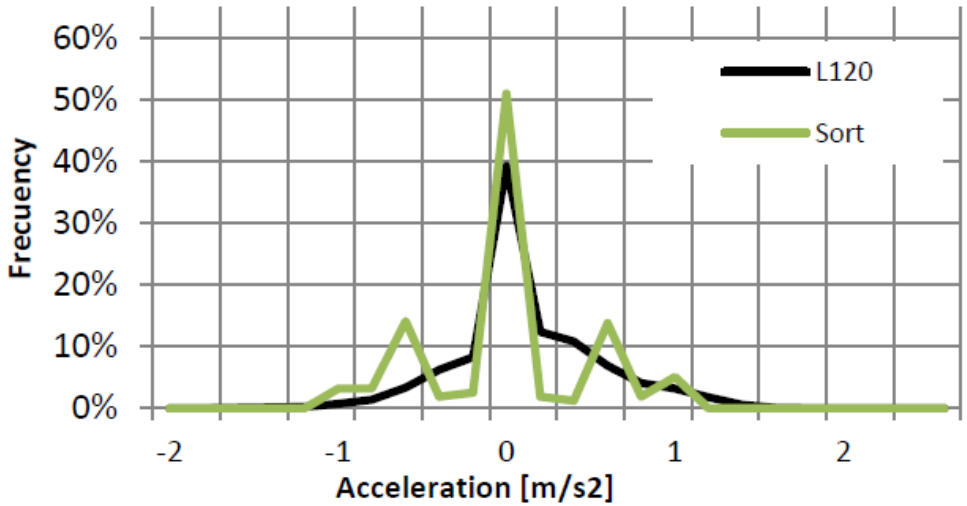
Average speed

Real 10,2 km/h

SORT 12 km/h



Acc comparison



***Development of an advanced and sustainable vehicle for optimal transportation of people in urban environments (M.Roche, P.Maroto, M. Mammetti, C.Moure, D.Sabrià, A.Freixas and C.de Mello)*

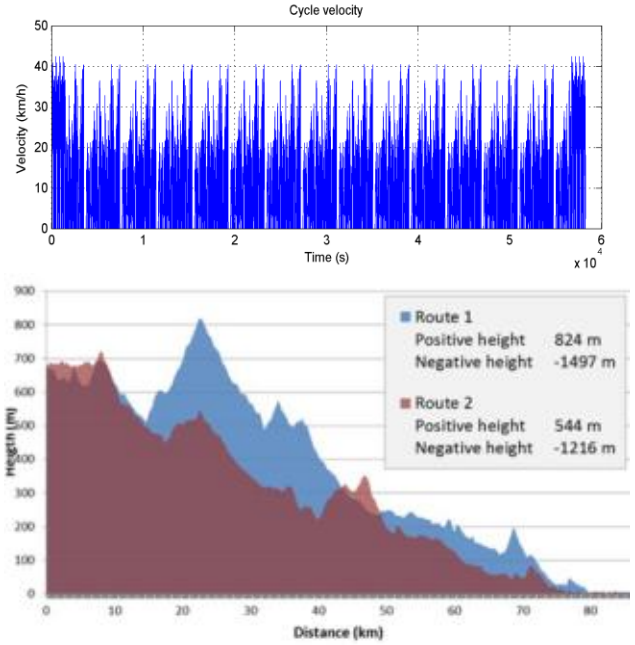
Use case example

Synthetic cycle generation

Purpose: Define a reduced cycle to reproduce the real duty cycle consumption

Real Cycle

RLDA (several hours)

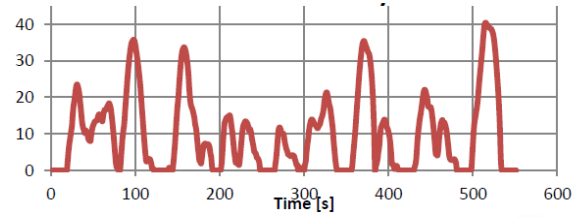


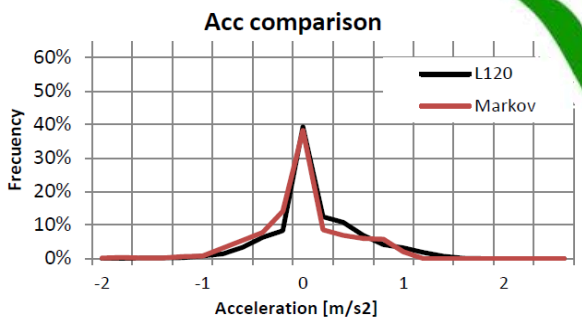
Stochastic model

Markov method

Reduced Cycle generation

New cycle generation & KPI validation

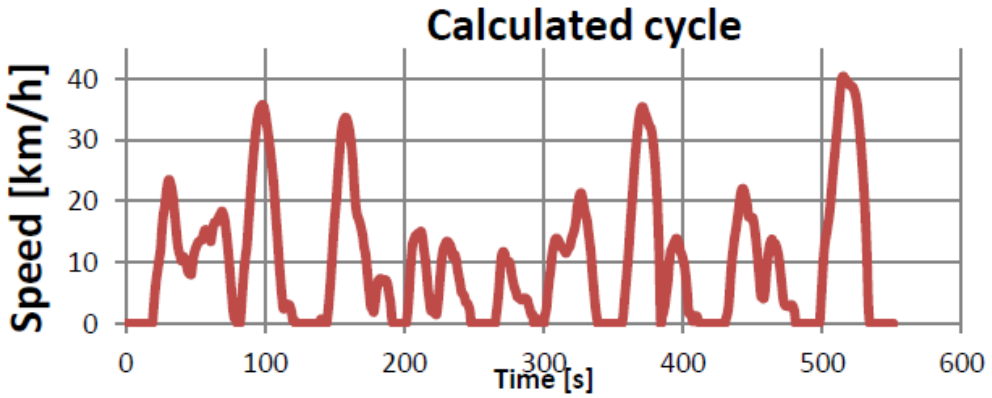




Use case example

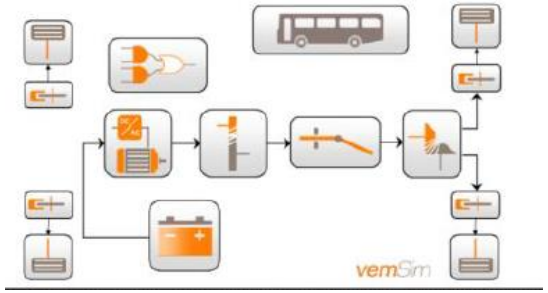
Consumption validation on PG

B) Synthetic representative cycle:

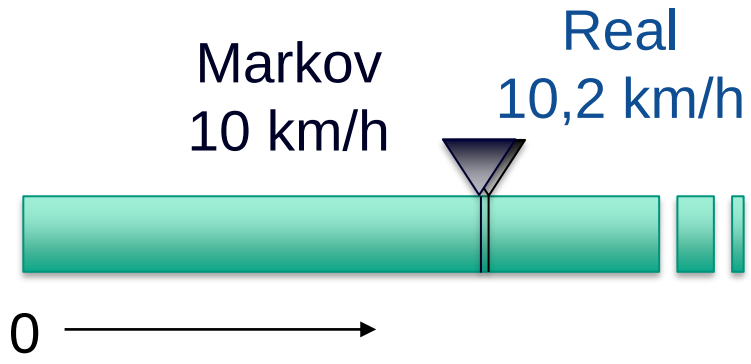


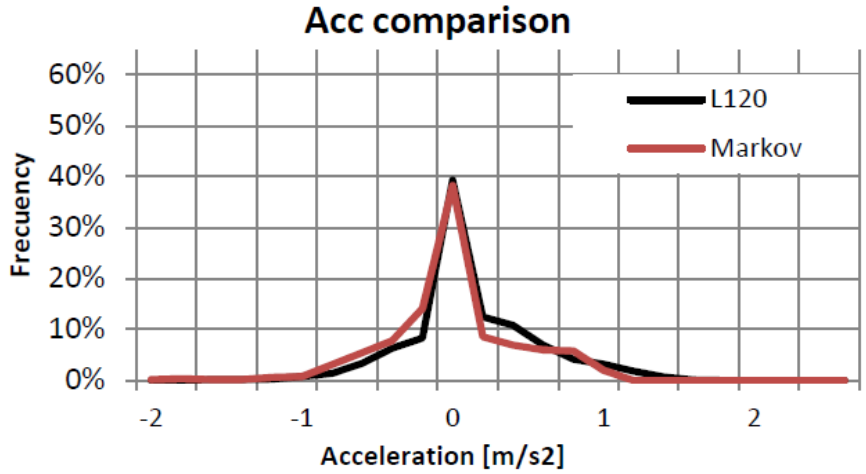
Cycle length: 1.8 km

Validated with simulation:



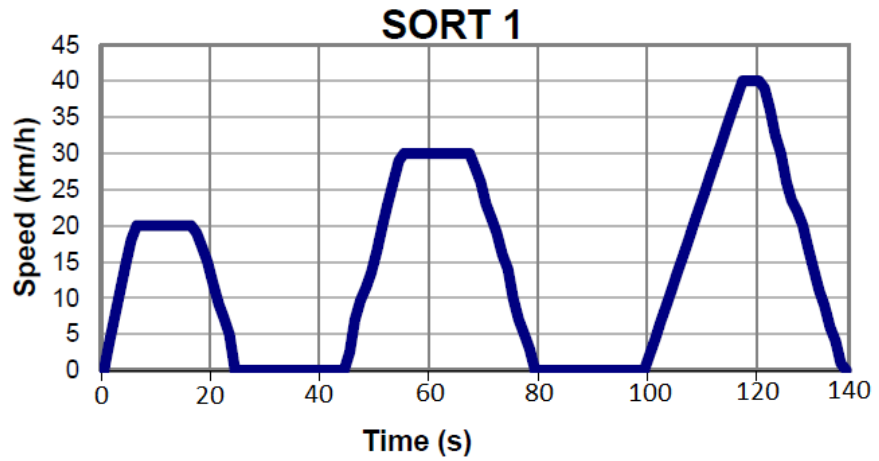
Average speed





Use case example

Consumption cycles comparison

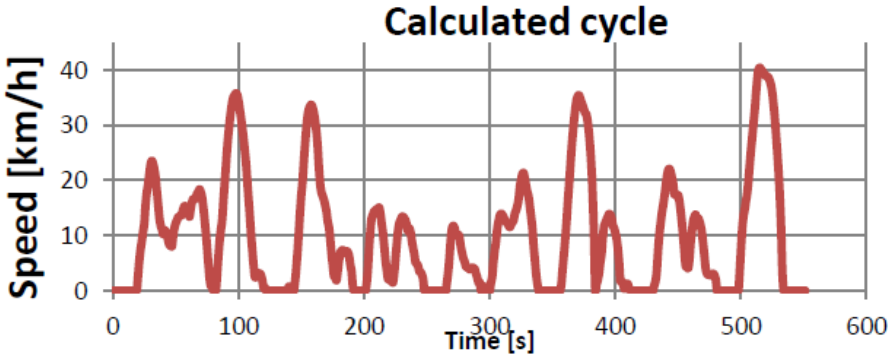


Average consumption (auxiliaries included)
0,672 kWh/km

Average consumption (acceleration)
0,998 kWh/km

Average consumption (deceleration)
-0,311 kWh/km

Average consumption/hour
8,372 kWh/h



Average consumption (auxiliaries included)
0,649 kWh/km

Average consumption (acceleration)
0,856 kWh/km

Average consumption (deceleration)
-0,206 kWh/km

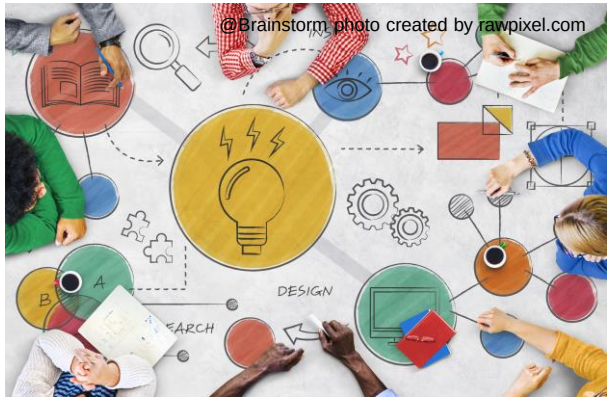
Average consumption/hour
6,507 kWh/h

Definition of vehicle targets

Definition of vehicle targets

Vehicle specification

- Service definition
- Use case definition
- Vehicle definition ?



Definition of vehicle targets

Electric bike. Desired targets

Battery?

Gear?

Traction system?

Connectivity?

Wheel size?

Others?

Design?

Definition of vehicle targets

Electric bike. Desired targets. Use case

Urban:

- Slope
- Low range
- Not experienced user

Rural:

- Slope
- Performance
- Not/Experienced user

Extra urban:

- Slope
- High range
- Experienced user

Off road:

- High slope
- High Performance
- Not/Experienced user

Definition of vehicle targets

Desired targets

Important targets:

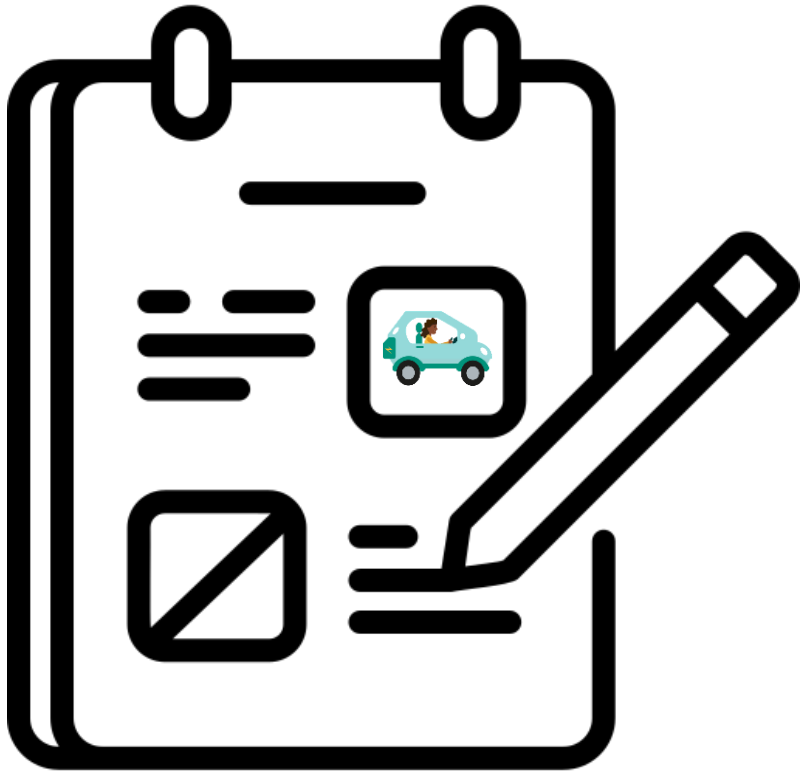
- Vehicle range (urban)
- Maximum speed (high/low)
- Slope (near sea/top mountain)
- Connectivity

Important targets:

- Vehicle range (urban/extra urban)
- Cargo capacity (last mile/parcel)
- Slope
- Special auxiliaries (climatic cargo)

Definition of vehicle targets

Desired targets



Important targets to think:

- Vehicle propose!
- Vehicle capacity (people/goods)
- Vehicle range → distance without charging (km)
- Vehicle performance:
  - Maximum speed (km/h)
  - Acceleration time from null to 100km/h (or less)
  - Climbability (if required) in %
- Electrical auxiliaries

Competitors benchmarking

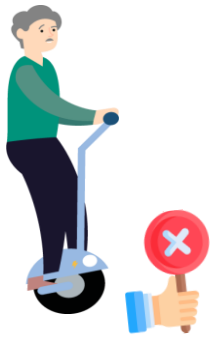
Competitors benchmarking

Market analysis

- Identification of clue parameters
- Product difference
- Improvement

Competitors benchmarking

Market analysis. Electric bike



Definition of vehicle targets

Desired targets

Citroën C-Zero

Important targets:

- Vehicle range (urban)
- Maximum speed (high/low)
- Slope (near sea/top mountain)
- Connectivity

Piaaggio Porter

Important targets:

- Vehicle range (urban/extra urban)
- Cargo capacity (last mile/parcel)
- Slope
- Special auxiliaries (climatic cargo)

Vehicle targets. Barcelona urban bus feasibility

Vehicle targets

Vehicle requirements

Fleet operator desired requirements:

- Guarantee 2 shifts
- Maximum gradeability: 18%
- Minimum maximum speed: 55km/h
- Acceleration 0-55km/h: 16s
- Low entry for disable people

Let’s start to calculate!

Vehicle targets

Competitors

Battery capacity (kWh): 100

Wolta 100% electric	
Long/Amp/Alt (mm)	6000/2100/2980
Weight (kg)	7400
Range (km)	160
Speed (km/h)	50
Slope (%)	16

Battery capacity (kWh): 61.4

XES EV Minibus	
Long/Amp/Alt (mm)	6010/1880/2320
Weight (kg)	-
Range (km)	220
Speed (km/h)	100
Slope (%)	-

Battery capacity (kWh): 52

CM Mission 150E	
Long/Amp/Alt (mm)	7500/2200/2690
Weight (kg)	5000
Range (km)	160
Speed (km/h)	100
Slope (%)	-

Battery capacity (kWh): 84

IVECO daily electric	
Long/Amp/Alt (mm)	7120/-/-
Weight (kg)	5600
Range (km)	160
Speed (km/h)	80
Slope (%)	-

Vehicle targets

Vehicle requirements related to battery consumption

What is 2 shifts?

From depot

N x routes (~16h)*

To depot

time

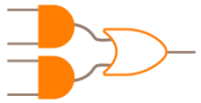
* No opportunity charging

Vehicle targets

Vehicle requirements related to battery consumption

What is worst case?

22 people, 2000 kg



3,2 kW DC consumption:

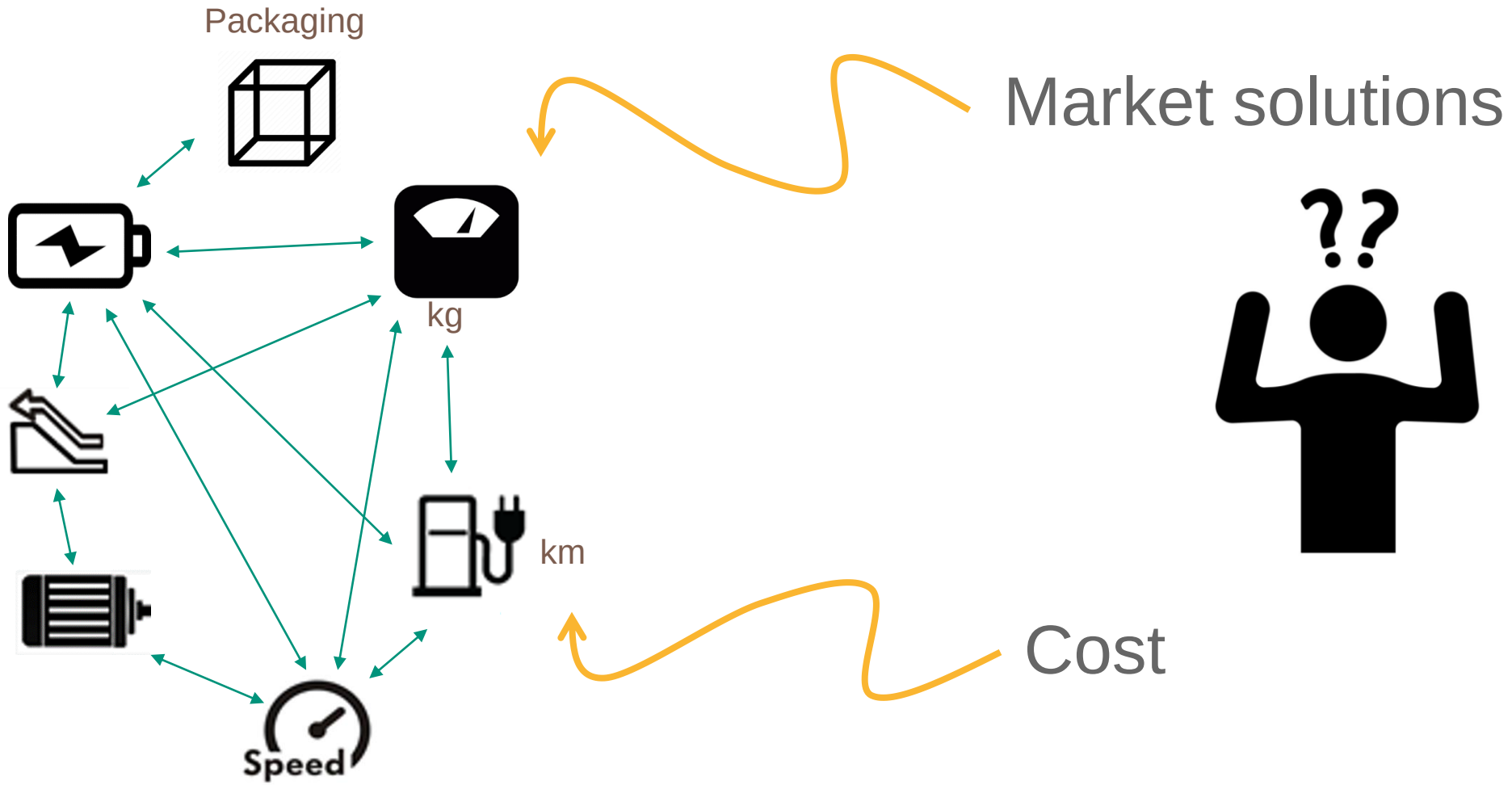
- Cooling
- HVAC
- Pneumatic system
- Wheel chair ramp
- Other auxiliaries

} 53 kWh

Vehicle targets

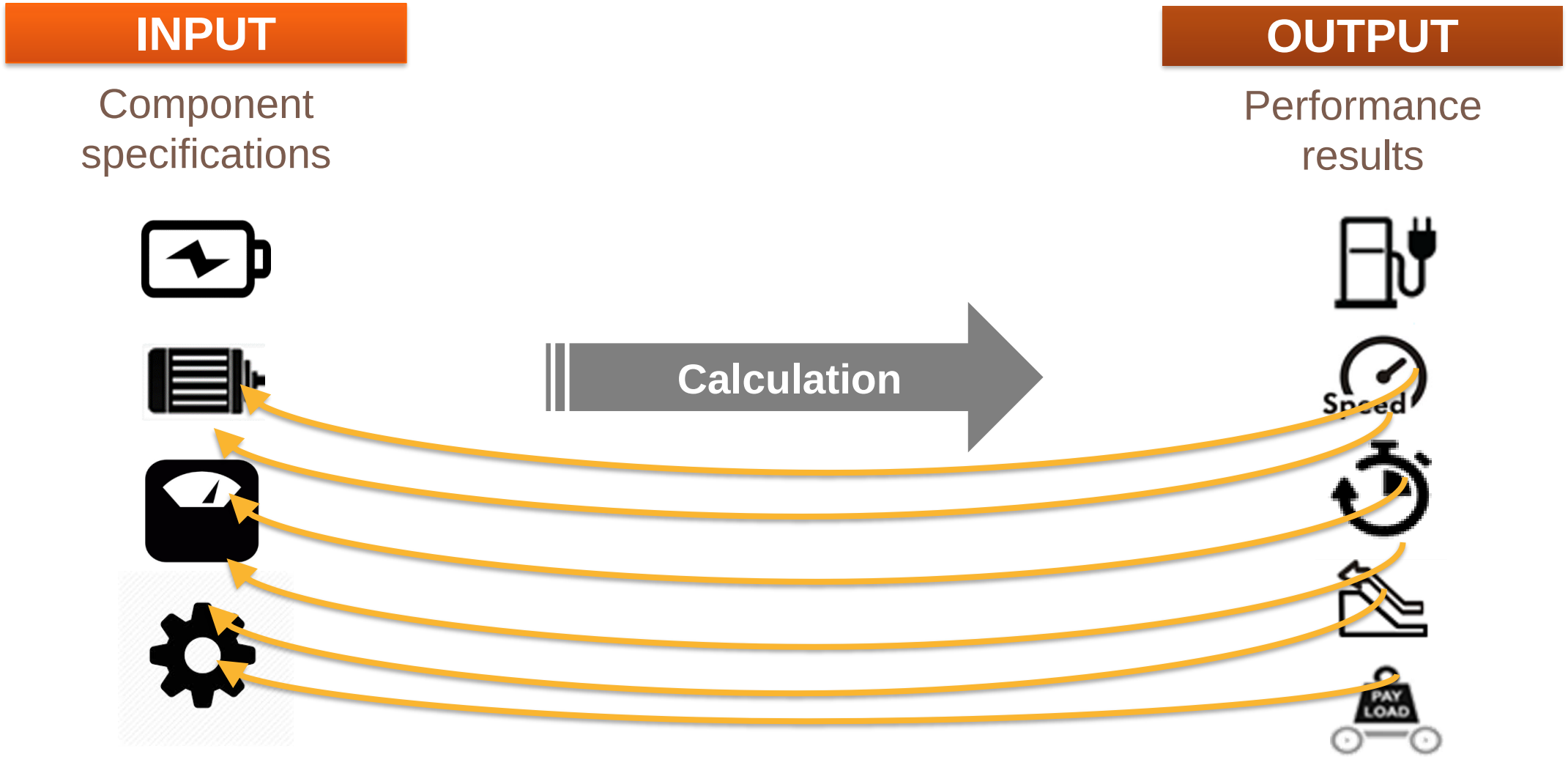
Vehicle requirements related to battery consumption

Powertrain Pre-Sizing problem



Vehicle targets

Vehicle requirements related to battery consumption



Vehicle targets

Vehicle requirements related to battery consumption

INPUT

Component specifications

Calculation

OUTPUT

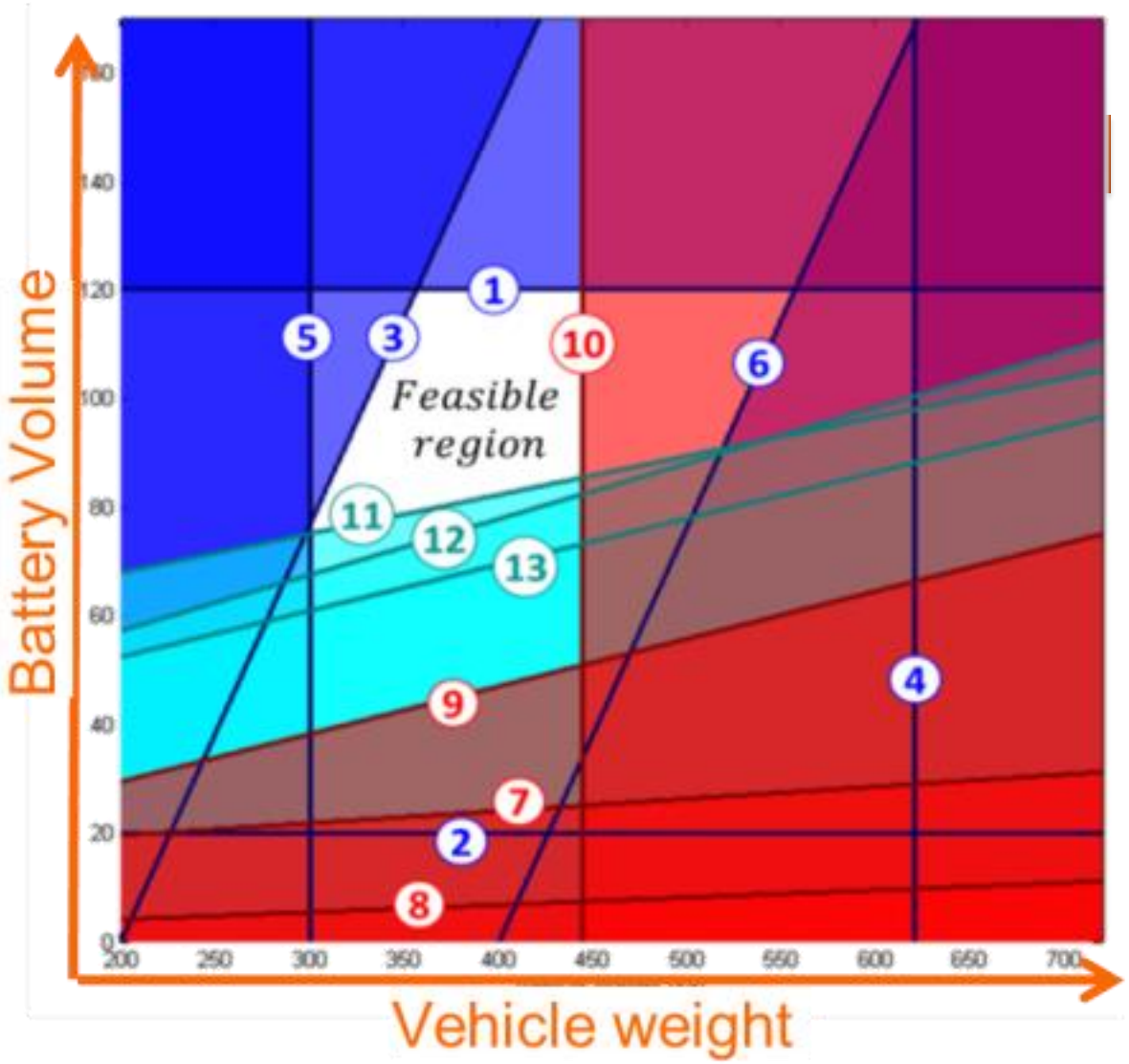
Performance results

Vehicle targets

Pre-design tool

INPUT

Performance results



*Roche, M., Sabrià, D., Mammetti, M., "An Accesible Predesign Calculation Tool to Support the EV Components Definition", EVS28 Technical Paper

Vehicle targets

Pre-design tool

INPUT

Performance results

164 km user cycle

55 km/h

16 s

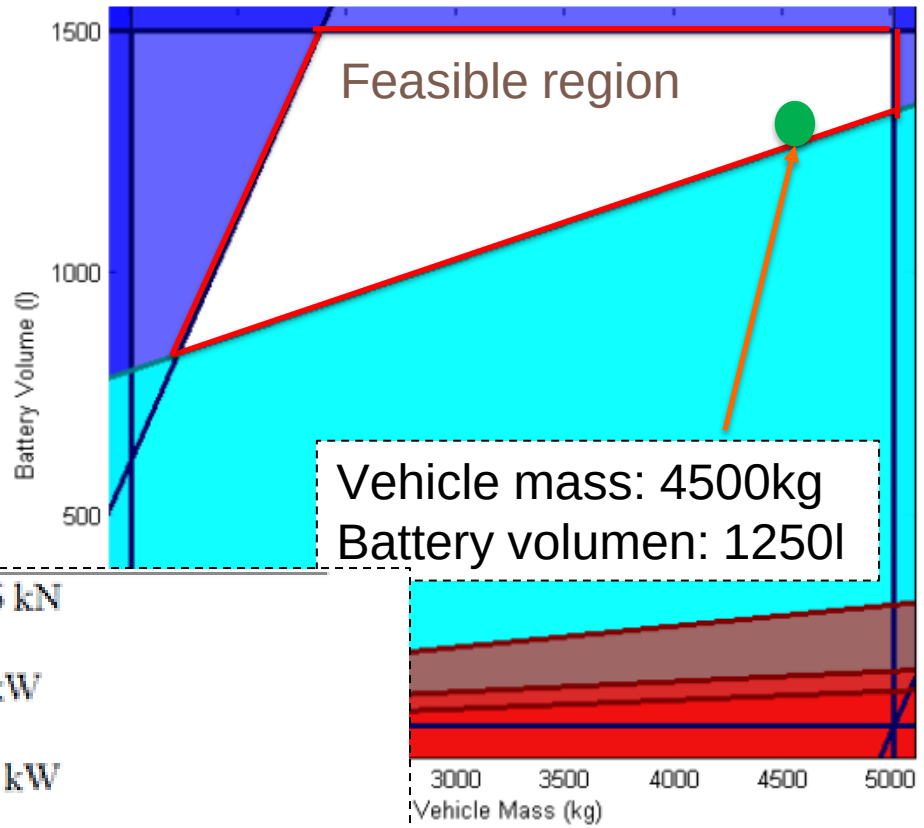
18%

2000 kg

Wheel force	>13,6 kN
Motor continuous power	>70 kW
Motor corner power	>230 kW
Battery capacity	>125 kWh

OUTPUT

Possible solutions



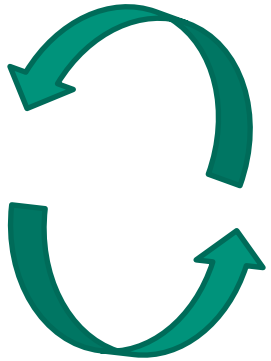
Summary

Business model

- Use case definition
- Vehicle targets

Use case definition

- Deep study of the use case
- Route analysis
- Vehicle requirements



Target setting

- From business model
- From use case analysis
- Desired perfomance

Benchmarking

- Competitors product
- Strengths and waeknesses
- Final decision

Handout work

Handout work tasks:

- Think in about an electrical vehicle that you would build.

Can you define the following desired targets?

Use case

- Define route
  - Length
  - One way/circular
- How to record the route

Vehicle targets

- Range (km)
- Maximum gradeability (%)
- Maximum speed (km/h)
- Acceleration 0-XXkm/h: (s)
- Think about auxiliaries consumption(kW)

References

References list:

- *Virtual modelling of real-driving conditions for early evaluation and validation of vehicle design (D.Sabria, F.Díaz, R.Salat, P.Cano, M. Roche, X. Bertolí)*
- *Development of an advanced and sustainable vehicle for optimal transportation of people in urban environments (M.Roche, P.Maroto, M. Mammetti, C.Moure, D.Sabrià, A.Freixas and C.de Mello)*
- *Accesible Pre-Design calculation tool to support the definition of EV Components (M. Roche*, D. Sabrià and M. Mammeti)*
- *Modern Electric, Hybrid Electric, and Fuel Cell Vehicles Fundamentals, Theory, and Design (M. Ehsani, Y. Gao, S. E. Gay, A. Emadi)*

Thank you for your kind attention!