

# **Reversible substations in Spanish conventional-DC lines**

*Energy Area*

*Strategy Directorate*

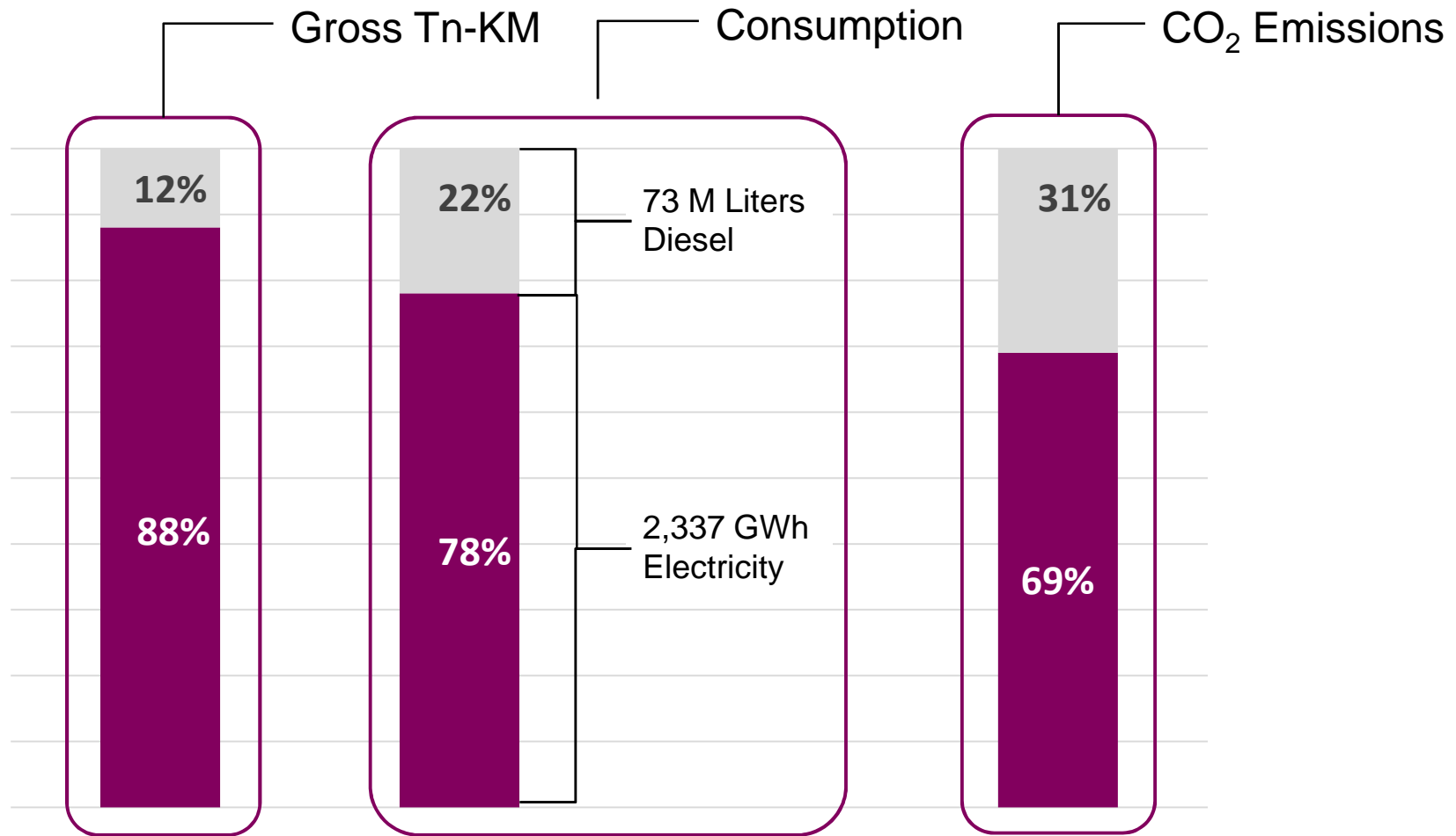
*Renfe*

Rome, Oct 4th, 2017



# Context

## Main Traction Energy Figures



**1% of the total national electricity consumption**

## Context

### Electrified Lines

Types of lines				
Type		Km		Consumption
<b>Non electrified</b>				Diesel expressed in GWh
			6,051.6 (40%)	731.8 GWh (24%)
<b>Electrified</b>				
DC	3Kv	6,423.6 (42%)		1,353.4 GWh (44%)
	1,5Kv	346 (2%)		21.6 GWh (1%)
AC	25Kv	2,474.1 (16%)		962.2 GWh (31%)
<b>Total</b>		<b>15,295.3</b>		<b>3,069 GWh</b>

- 10% Diesel consumptions in electrified lines
- Conventional Lines: DC
- High Speed Lines : AC

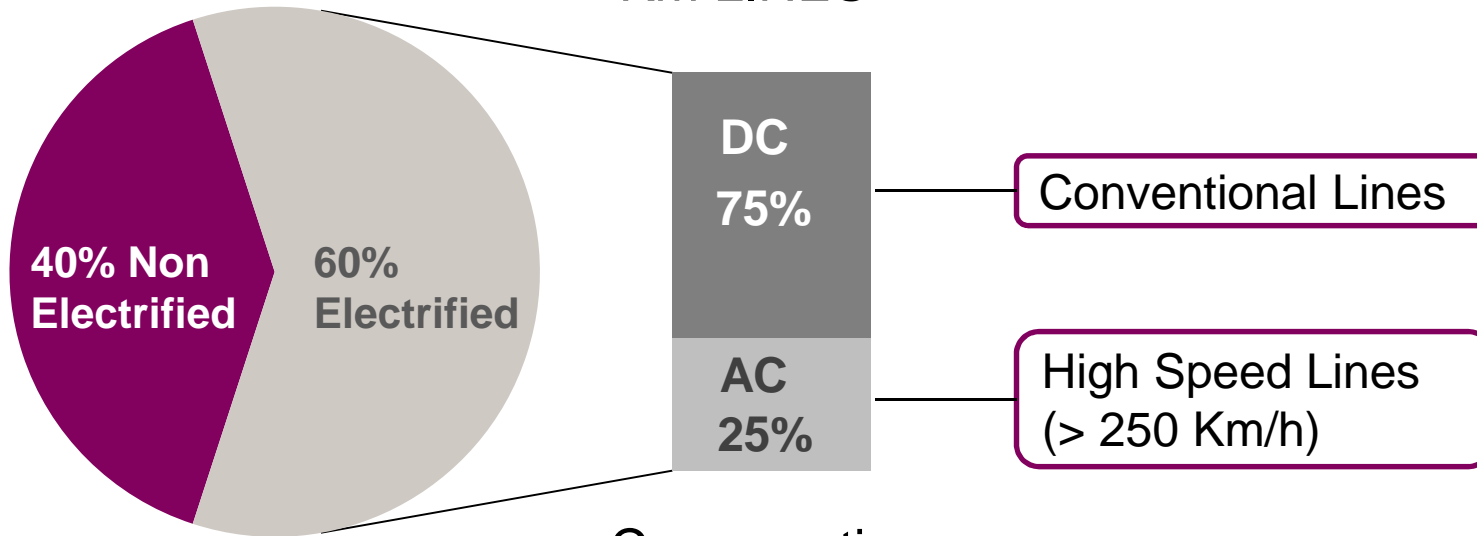
**DC represents 45 % of total energy and  
59 % of electricity consumption**

# Context

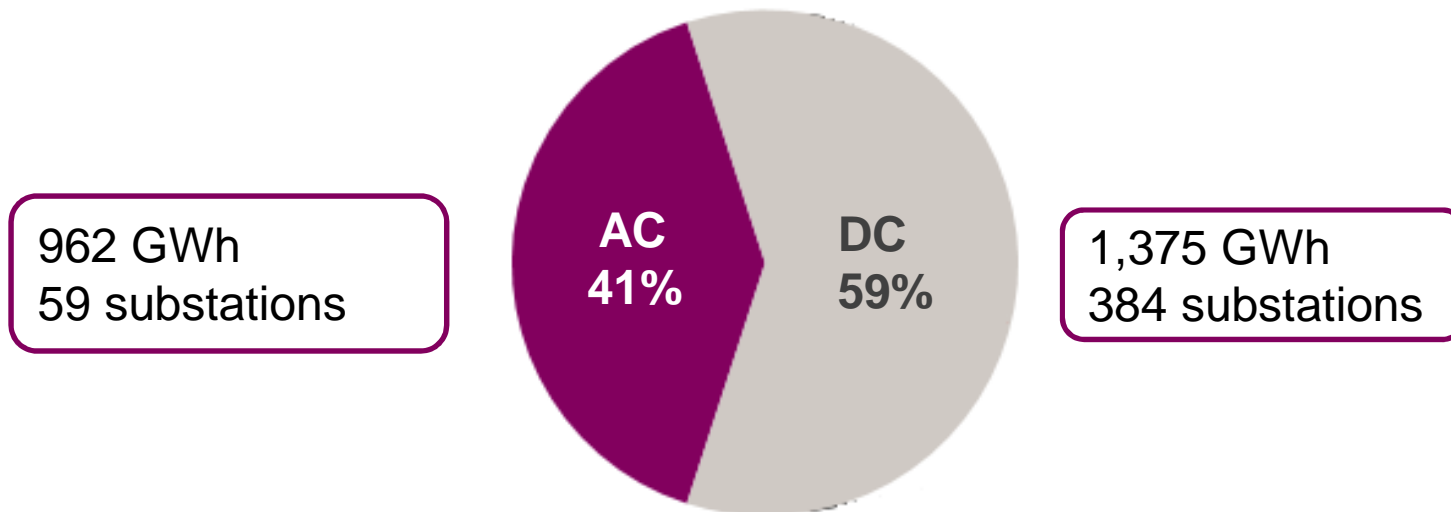
## Electrified Lines

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### Km LINES



### Consumption



## Alternating current (AC))

### Energy Recovery

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- 73.5 GWh sold back a year to electricity supplier
- 7% Total AC lines Consumption
- 5 € Million saved (a year)

▪ **> 21,000 electric housing consumptions**

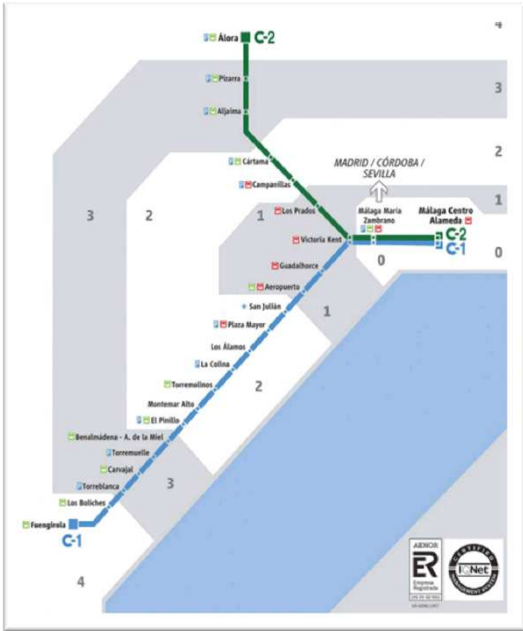


# Direct current: First Experience Substation 'La Comba' (Málaga)

## Context

- Merlin Project
- Commuter Service
- Frequency: 1 train/20 min.
- 18 stations
- 3 substations
- 31.35 Km

- Fleet: EMU, 4 coaches
- Trains 464 series CAF
- 3 Kv – DC Headline



## Direct current: First Experience Substation 'La Comba' (Málaga)

### Outcomes

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#### Total consumption

8.6 GWh/year (all line)  
2.6 GWh/year (La Comba)

#### Total energy sold back to the grid

1 GWh/year (La Comba)  
(11.6% line – 38.5% Substation)

#### Total cost savings

65 K € /year

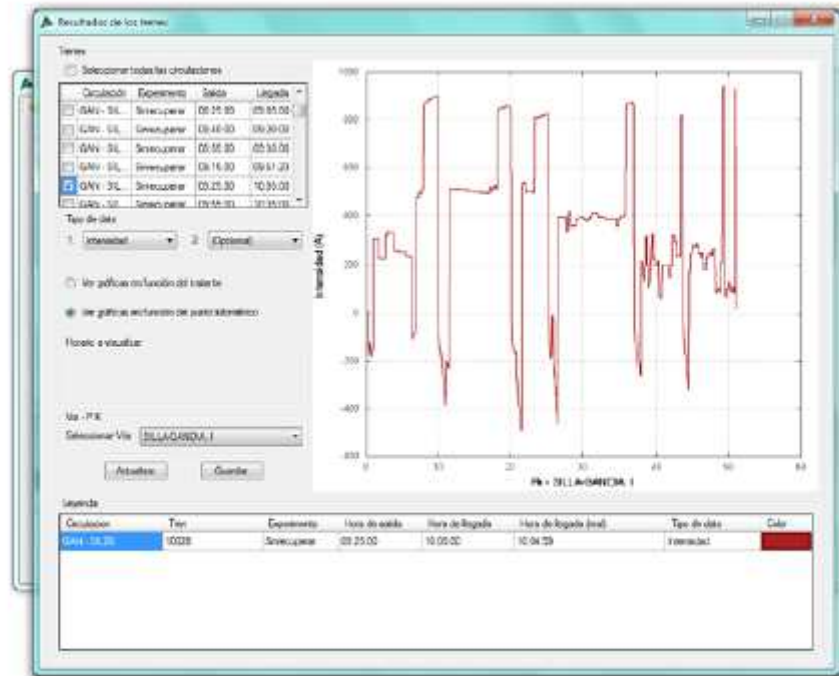
#### Pay back period

12 years

## Next steps

### Simulation and decision making Process

#### SYCE



Profitable if  
> 1 Gwh/year of  
estimated energy  
recovered

#### TAKEN INTO ACCOUNT:

##### ROLLING STOCK

- Timetables
- Type of Rolling Stock
- Recovery capacity of the train
- Ancillary services consumption
- ....

##### POWER SYSTEM

- Electric demand profile
- Overhead line wearing
- Ancillary services consumption
- Inverter performance
- Transformer performance
- Rectifier performance
- .....

##### OTHERS

- Energy cost
- Market Regulation
- ....



## Next steps

6 new substations (bidding process)

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Substation	Energy recovered (GWh-year)	Cost saved (€ year)	Pay-back period* (year)
Alcorcón (Madrid)	2.7	162,000	3.4
Getafe (Madrid)	1.5	90,000	6.2
Olabeaga (Bilbao)	1.5	90,000	6.2
Guarnizo (Santander)	1.1	66,000	8.4
Areyns (Barcelona)	1.9	114,000	4.9
Martorell (Barcelona)	1.3	78,000	7
	<b>10</b>	<b>600,000</b>	<b>5.6</b>

Total investment: 4.8 € M \*(3.4 € M with public grants)

Investment supported by Renfe

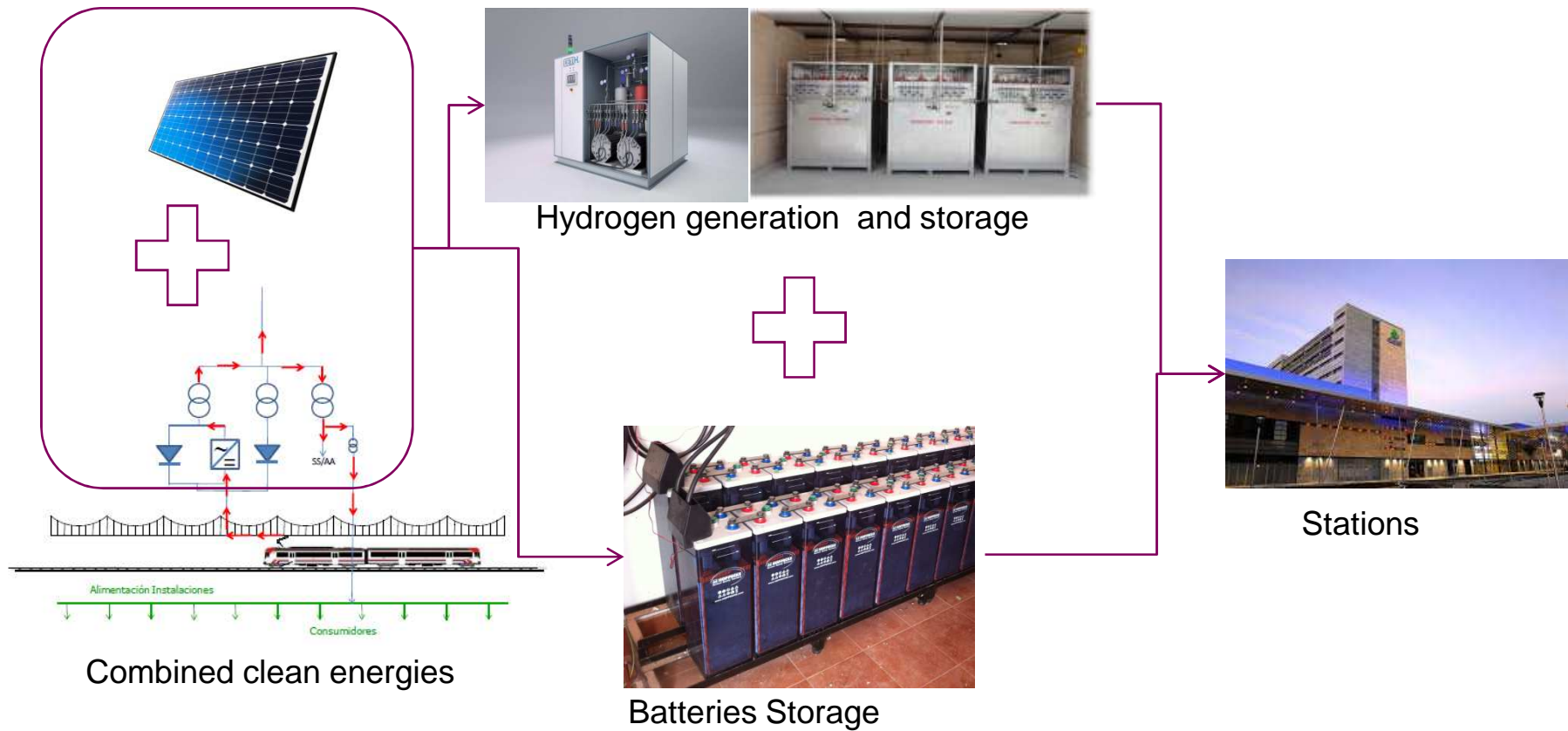
Total CO<sub>2</sub> saved emissions: 1,74 Tons

# Next steps

## Self consumption

Cost energy purchased: 100 € MWh (>40% taxes)

Cost sold back energy : 60 € MWh



# Thank you

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