



Municipal Transport Company of Madrid - EMT Madrid

October, 20th 2022



EMT Madrid

- ✓ **Strategic Framework 2021-2025**
 - Bus Service Transformation
 - Digital Transformation
 - Infrastructure Transformation

Gonzalo Fernández Sánchez
Infrastructure's Director
EMT Madrid

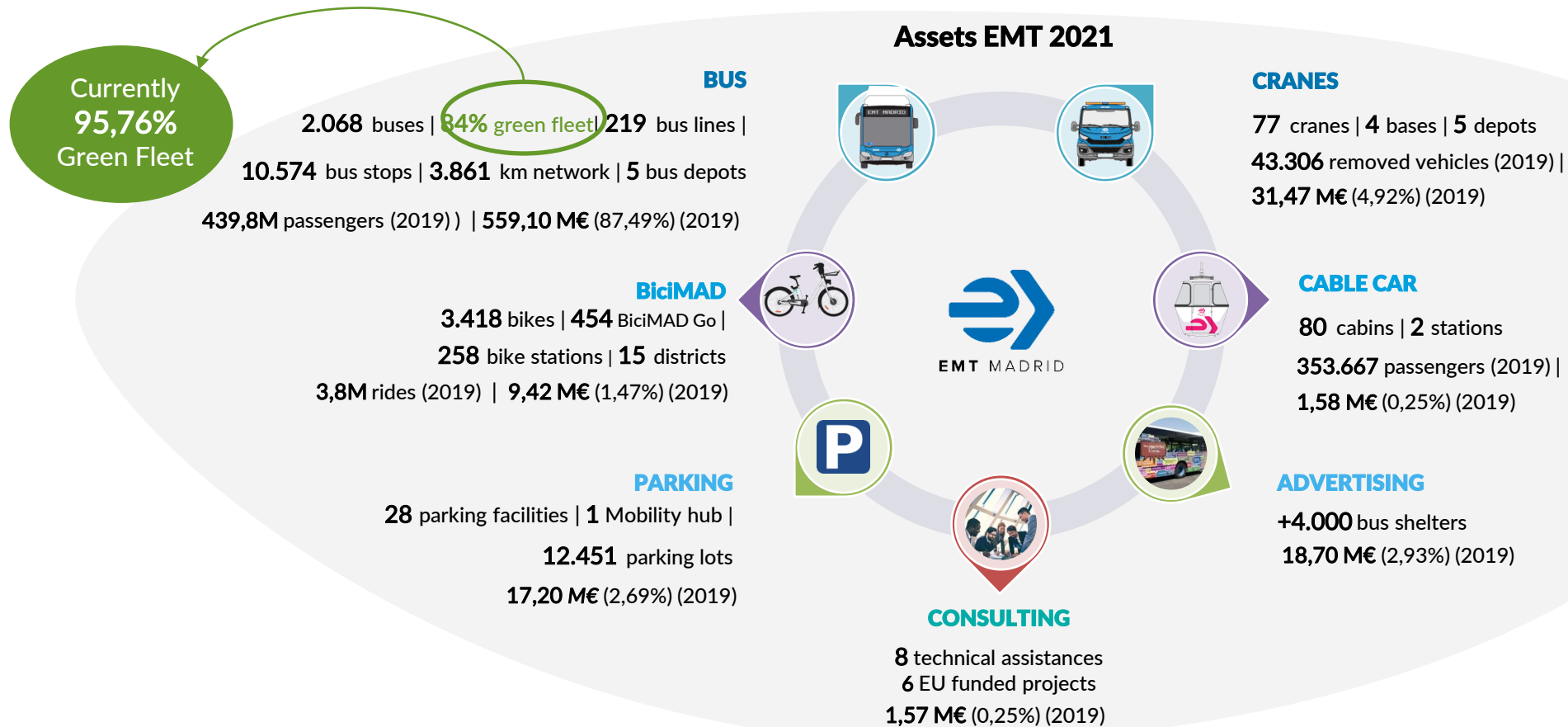


Strategic Framework 2021-2025

EMT Madrid

Main figures

EMT is the **reference of surface mobility** in the city of Madrid. It counts with 9.816 workers, 7 business lines and 5 Bus Depots that enable the company to provide integrated and client-oriented services that foster a **sustainable and efficient mobility**.



Strategic Framework for EMT

International roadmap transferred to the local level

Sustainable Development Goals (SDG)



European Green Deal



Next Generation Funds



MADRID 360 Sustainability Strategy



Sustainability Strategy Madrid 360 reflects Madrid's commitment to:

- the SDGs and the decarbonisation objectives of the European Green Deal, and
- the reduction of carbon dioxide emissions in the city by 6.5% is marked as a key objective.

EMT Madrid Strategic Plan 2021-2025



EMT Strategic Plan 2021-2025 aims to reinforce the Company as:

- the reference of sustainable mobility in the city,
- 100% free of diesel and with clear progress in the decarbonisation of the fleet.

Strategic Framework for EMT Madrid

Strategic Plan EMT 2021-2025

Corporate Goals

The corporate objectives characterize the general purpose in **transversal objectives** for the entire company, focused on **sustainability**, the **client**, **economic profitability** and **digital transformation**.



Move towards a **green, decarbonised company** that takes advantage of the benefits of the **circular economy**



Strengthen customer orientation with an **excellent** service of general interest



Guarantee **financial sustainability and business growth** through **new businesses and services**

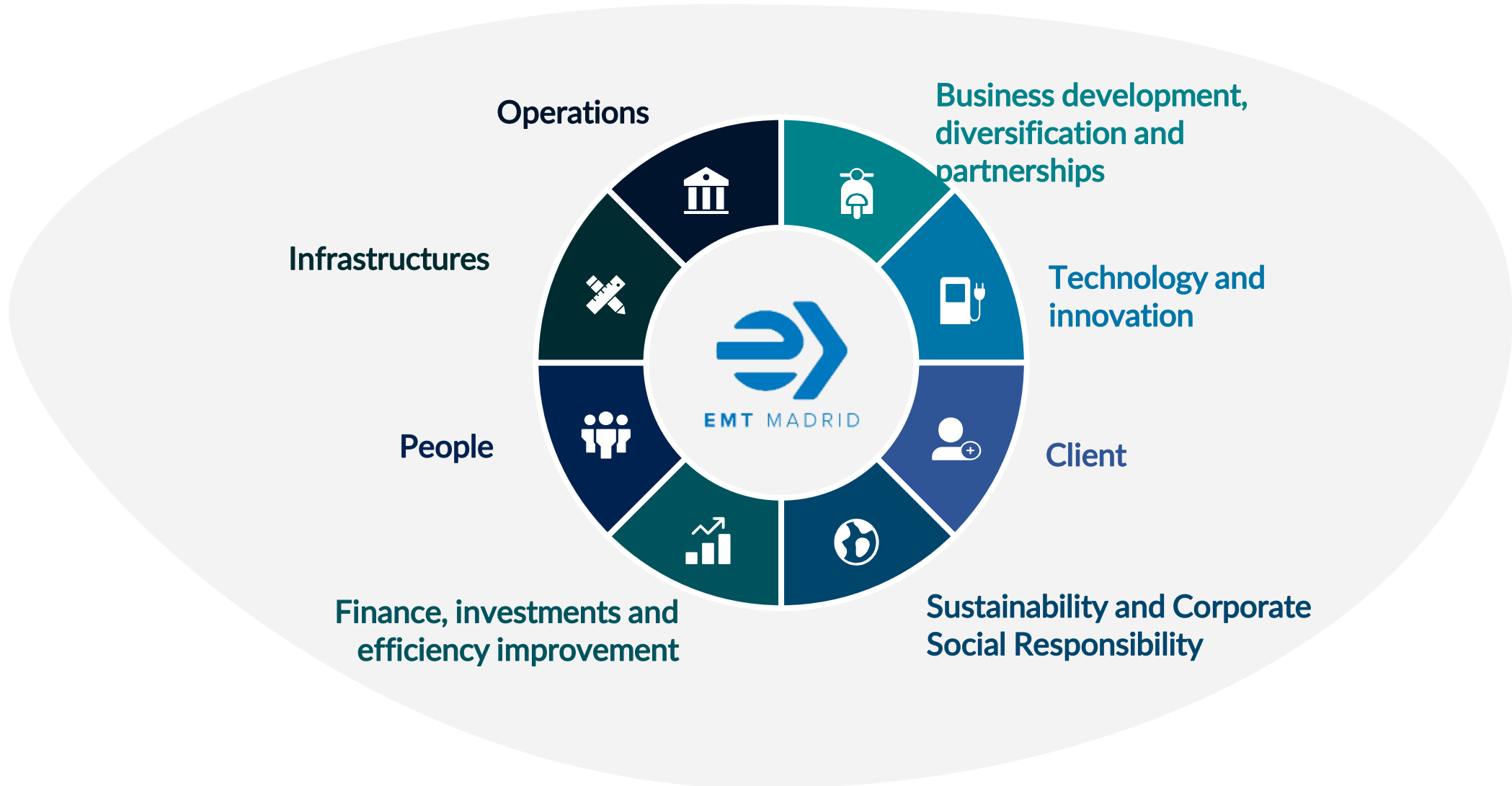


Promote the **digital transformation** of EMT and the improvement of **efficiency** in the provision of mobility services



Strategic Framework for EMT Madrid

Strategic Axes



Strategic Framework for EMT Madrid

Main Strategic Projects



Operations



2030 Bus Development

Design of the new **bus model, with technological improvements** deployed on board to improve the quality, efficiency and safety of the service.



On-demand bus pilots and autonomous driving

Prospecting and development of pilots to **promote innovation and international positioning** of the company, offering new services to users.



Infrastructures



Bus Depots of the future: La Elipa and Las Tablas

Design and construction of the Bus Depots of the future to **optimize the operation of current services** and enable the provision of new services.



Parking lots as mobility infrastructures

Transformation of infrastructures to support the **sustainable mobility of the future**, promoting EMT Madrid's role as a mobility agent.



Photovoltaic panels installation

Installation of more than **40,000 m² of photovoltaic panels** to improve infrastructure sustainability and facilitate the **transition to a decarbonized and efficient EMT**.

Strategic Framework for EMT Madrid

Main Strategic Projects



Financing, investments and efficiency improvement



Gas commercialization

EMT Madrid positioning as a **gas supplier**, in a vertical integration of energy supplies to improve economic and financial efficiency.



European Funds

Attracting and managing European Next Gen funds and other instruments (e.g. ERDF) to accelerate the company's transformation.



Sustainability and Corporate Social Responsibility



Fleet Electrification

Transition to a sustainable bus fleet, moving from 179 electric buses in 2021 to **729 electric buses** in 2027.



Hydrogen Station

Construction of a hydrogen station producing up to **440 kg/day of green hydrogen** for a **supply capacity of up to 20 buses**, as part of a circular economy strategy.

Strategic Framework for EMT Madrid

Main Strategic Projects

Client



Transforming the **customer experience**

Identifying and **analyzing customer needs** and improving their experience in all services, **developing new digital relationship models**



Technology and innovation



EMT Labs

Lab creation to practically and directly foster both internal and open **innovation in the field of mobility**



Business development, diversification and partnerships



New mobility services prospection

Prospecting and deployment of initiatives that develop new transportation and mobility businesses, such as **motosharing or electric scooters**



BiciMAD expansion

Technological transformation of the current BiciMAD system through an expansion to **new areas, customers and sectors**



Madrid Mobility 360 development as a business line

Establishment of a Madrid Mobility 360 business line to provide **new integrated digital mobility services** for customers and enhance **EMT's leadership**

Strategic Framework for EMT

Strategic Plan EMT 2025

Investment planned: € 1.000M for the next 5 years



534M €
Buses Acquisition



131M €
Construction



158M €
Installations



177M €
Other investments

€	2021	2022	2023	2024	2025	TOTAL
Buses acquisition	112.132.900	108.584.200	81.403.900	116.284.200	116.284.200	534.689.400
Constructions	200.000	17.692.900	45.155.800	52.655.800	16.050.000	131.754.500
Installations	4.124.744	29.523.188	50.675.800	55.255.800	18.650.000	158.229.532
Other investments	25.362.310	59.719.861	45.038.420	23.000.495	24.064.208	177.185.292
TOTAL INVESTMENT	141.819.954	215.520.148	222.273.920	247.196.295	175.048.408	1.001.858.724

Strategic Framework for EMT

Main Reference Indicators

Sustainability and city structuring



% Electric Fleet

8.5%  25.2%

Buses (2021)

Buses (2025)

Which represents an increase of 477%



Reduction in tons of NOx emitted

200  40

Tn NOx (2021)

Tn NOx (2025)

Which represents a reduction of 80%



m2 of solar panels installed

1,430  42,220

m2 (2021)

m2 (2025)

With an installed capacity equivalent to 1,000 single-family homes*



Millions of travellers

440M  463M

(2019)

(2025, optimistic scenario)

Which represents an increase of 2.7%



Total investment

+1,000 M€

(2021-2025)

534M € Buses Acquisition

290M € Constructions and installations

177M € Other investments

Note: Assuming an average contracted power of 6.6KW, IDAE.



EMT Madrid

- Strategic Framework 2021-2025
- ✓ **Bus Service Transformation**
- ✓ **Digital Transformation**
- Infrastructure Transformation

Carlos Sierra Martín-Serrano
Transport Director
EMT Madrid



Bus Service Transformation

Bus Service Transformation

Fleet Transformation

EMT Madrid was the first public transport company using CNG (1994)

From CNG...

- **Fleet evolution:**
 - ✓ One of the most important fleets using CNG.
 - ✓ Acquisition of hybrid CNG buses.
- **2010:**
 - ✓ First **100% CNG Bus Depot:** located in **Sanchinarro**.
- **Main Characteristics:**
 - ✓ Reductions in air pollution emissions + Increase in CO2 emissions
 - ✓ However, it results in local air quality improvement benefits.
- Helping the City Council to achieve air quality targets.
- **2020:** Last CNG buses tendered.



...to electrification



Currently,
95,76% Green Fleet

Bus Service Transformation

Electrification Strategy

City Strategies

A Sustainable Mobility Ordinance of the City of Madrid :

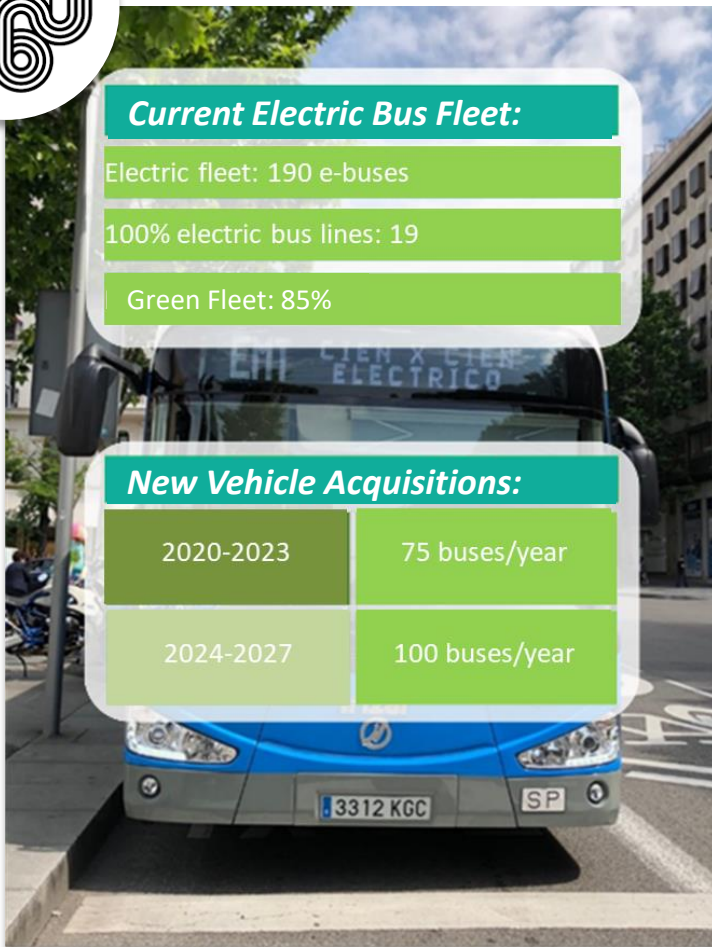
- Measure: Establishment of 3 Low Emission Zones.

B Madrid 360 - Environmental Sustainability Strategy:

- Meets EU air quality objectives.
- Measure: Zero Lines: zero cost, no emissions, only electric vehicles.



Bus Service Transformation



Fleet Transformation

Evolution of the EMT Madrid fleet: Forecast by fuel type

Fuel	2020	2021	2022	2023	2024	2025	2026	2027
Diesel	388	196						
NGC	1.552	1.678	1.829	1.744	1.661	1.561	1.451	1.351
Hybrid	47	47	17	17				
Hydrogen				10	10	10	20	20
Electric	81	179	254	329	429	529	629	729
Total	2.068	2.100	2.100	2.100	2.100	2.100	2.100	2.100
% Electric fleet	3,9%	8,5%	12,1%	15,7%	20,4%	25,2%	30,0%	34,7%

Evolution of the composition of the EMT bus fleet at the end of the year (units).

Bus Service Transformation

Challenges



Electrification Challenges

- Autonomy
- Charging systems
- Associated facilities
- Costs
- Workforce



Operation Parameters

Parameters to be considered for line electrification:

- Kilometers of the line
- Commercial speed
- Line timetable
- Distance Headers - Depot
- Line orography
- Line programming

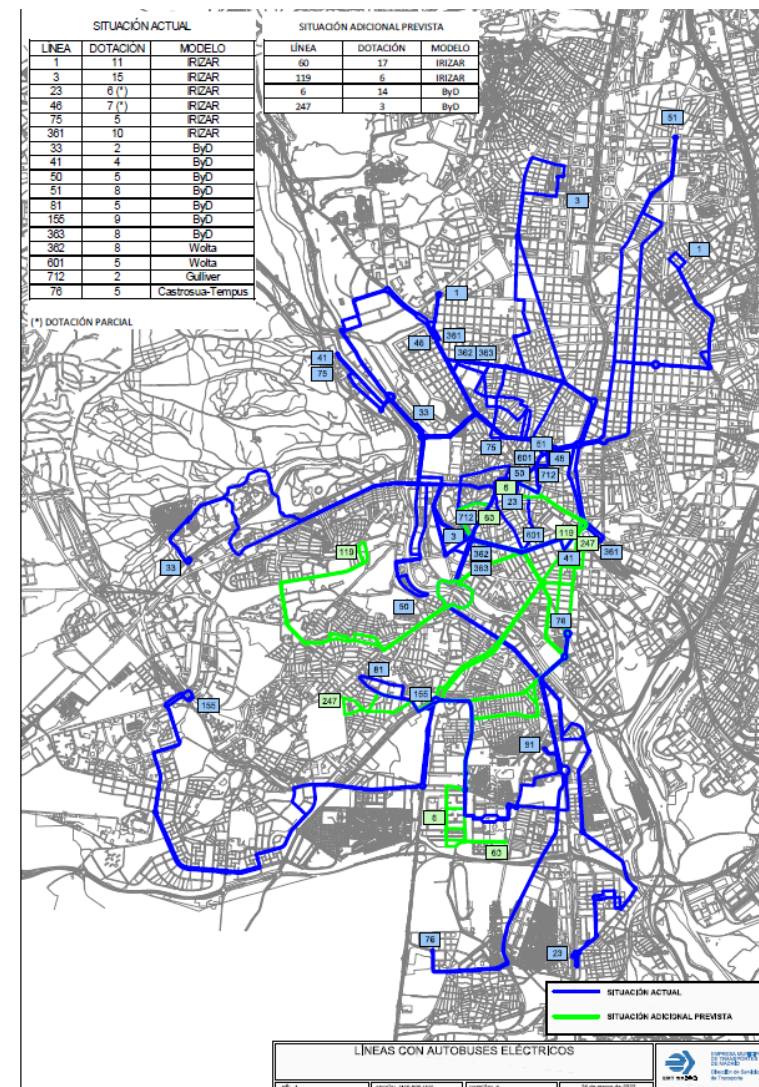
100% electric EMT lines	
Currently	17 Lines
December 2022 forecast	21 Lines

Parameters to be considered for the choice of rolling stock:

- Length: 6m, 10m, 12m, 18m....
- Autonomy
- Demand of each line.
- Estimated maximum consumption in the most unfavorable period (air conditioning and end of battery life).

Period	Manufacturer	Total Km	Cons/100Km
01/01/2021 a 01/31/2021	BYD	33.305,667	112,22
02/01/2021 a 02/28/2021	BYD	49.661,195	108,38
03/01/2021 a 03/31/2021	BYD	52.251,964	107,57

Example Influence of consumption according to period.



Bus Service Transformation

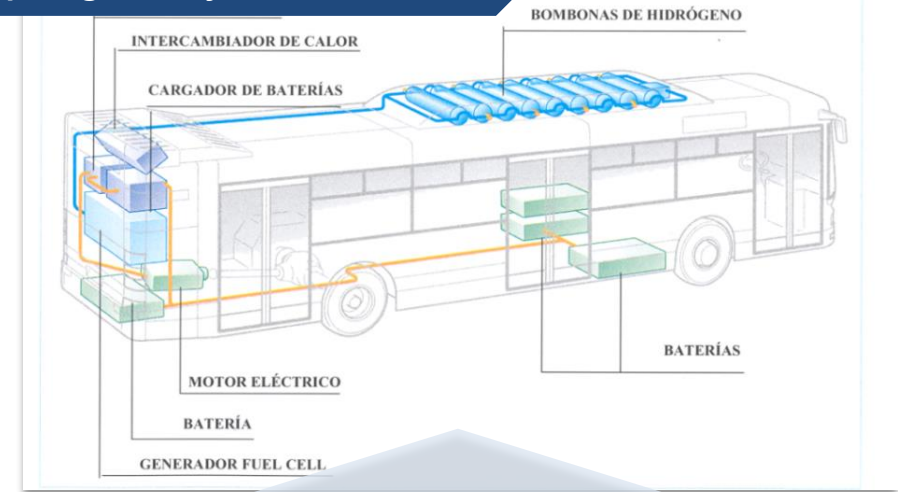
Exploring Renewable Alternatives

Biogas Project



- **Circular Economy Project:** biogas produced by food waste from Madrid City (Agreement EMT - Valdemingómez Technology Park)
 - EMT Madrid acquires renewable gas (biomethane)
 - 6 GWh of biomethane per year for EMT's CNG fleet.
 - Supply equivalent to the consumption of line C1 (20 buses / 1 million kilometers traveled / 4.43 million passengers transported in 2021).
- **Initial term:** until December 31, 2023 (annual extensions)

Hydrogen Project



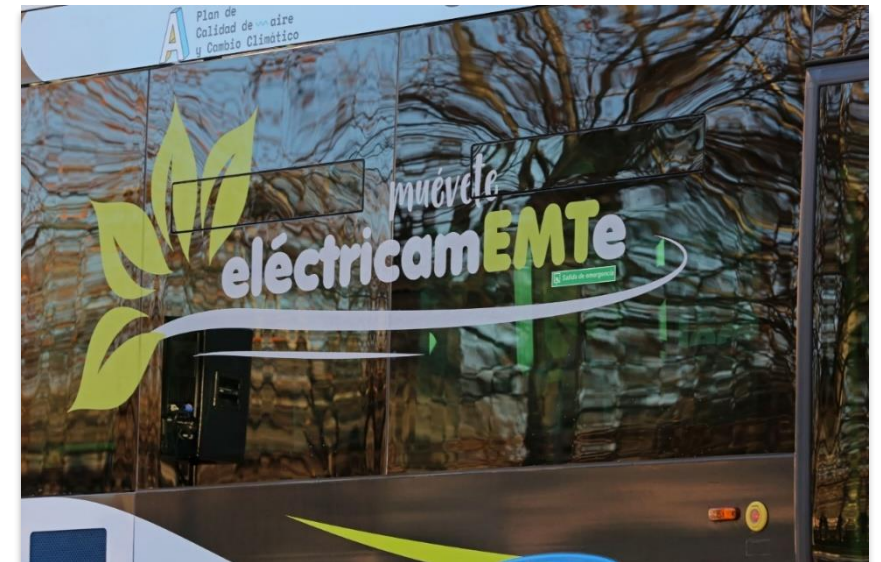
- ✓ Acquisition and commissioning of **10 Fuel Cell buses** in the EMT operation
- ✓ **€7,74 million Investment** (Next Gen funding of €2,7 million under evaluation)
- ✓ Tender in process, planned acquisition: December 2023

Conclusions



- Electrification according to the network **characteristics**.
- **Choice of optimal charging model**.
- **Bus depots design and adaptation** to guarantee energy availability.
- **Bus charging must be guaranteed in an efficient and reliable manner**: A very high electrical power is required, but by planning the recharging, the electrification of the fleet can be assumed.
- **Public-private collaboration**: Operator, Administration and energy suppliers.

Electrification is the best solution for sustainable public transportation

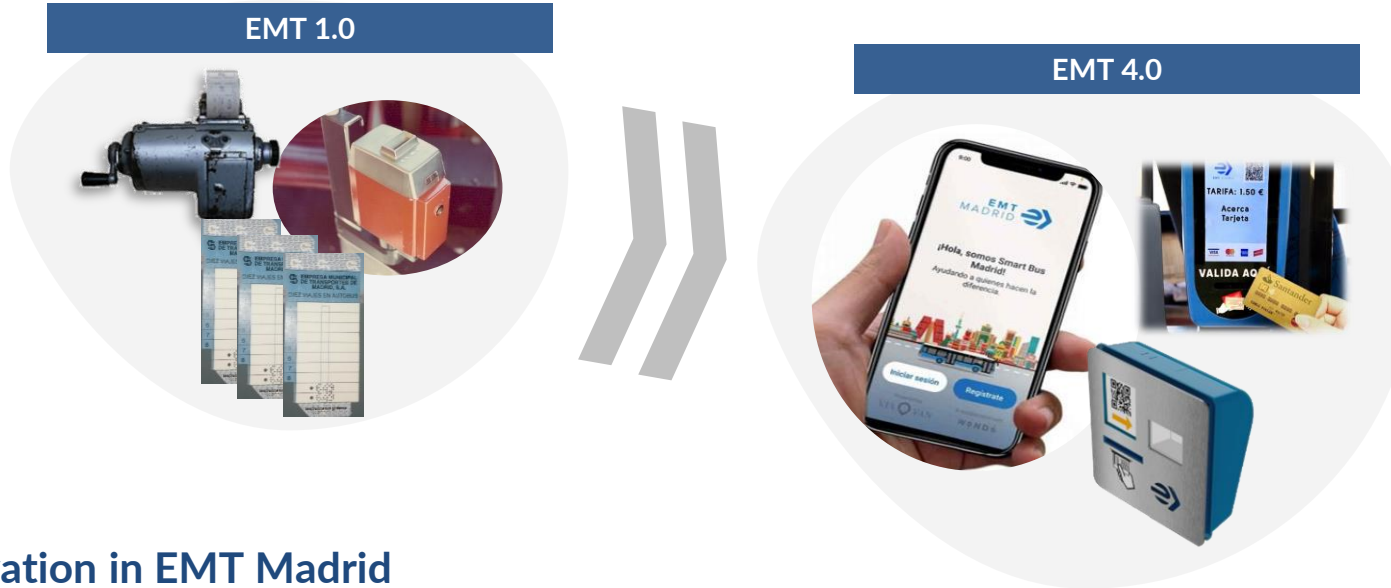




Digital Transformation

Digital Transformation

Digital Transformation



Technology and Innovation in EMT Madrid



Payment Systems

- EMV/QR Payment
- Payment Platform
- **POSTPAYMENT** or flat rate
- Access integration/Identities Payment



Information Systems

- IoT, IA, BigData
- Opendata
- **Multimedia Screens**
- Bus on Demand
- Occupancy rate



Multimodal System

- Calculation of multimodal routes for public and private operators -> MM360
- **Dissuasive Parking lots**



Sustainability

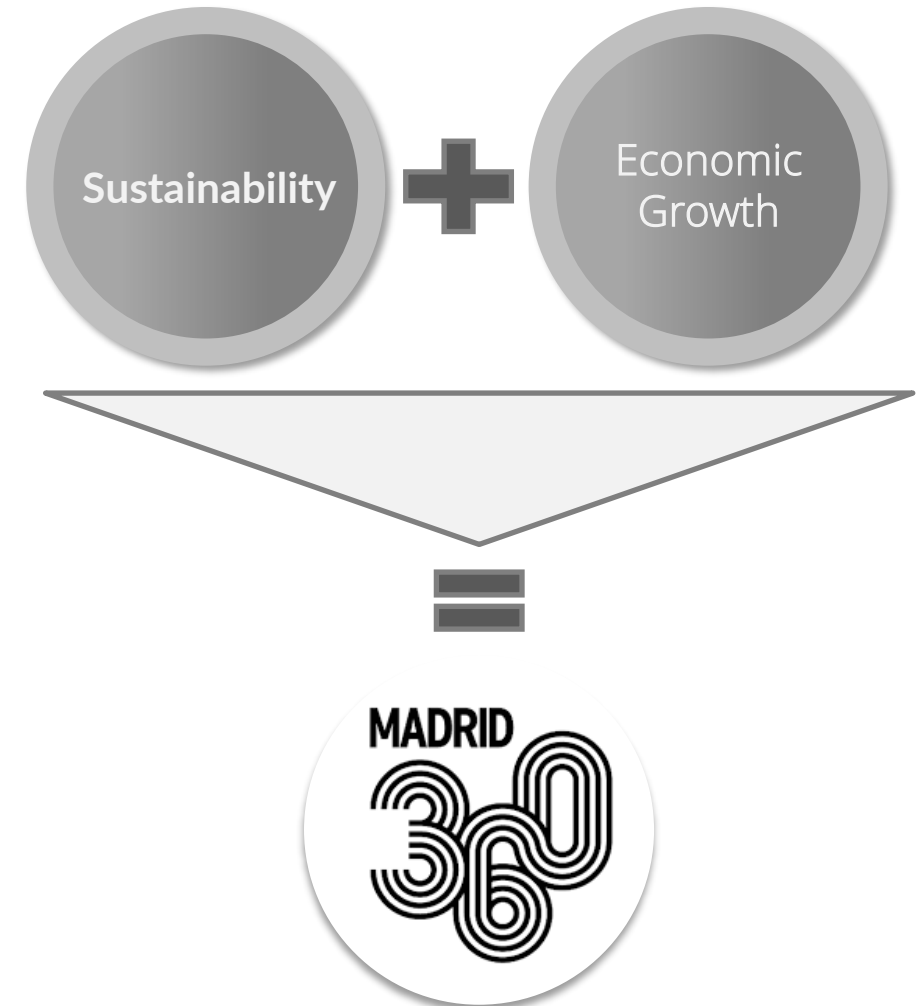
- Eco driving
- MM360
- **Electric Vehicle**
- Electric Bicycle

Digital Transformation

Transformation Framework – Commitment to the city

Madrid's Low-Emission Zone

- Madrid 360 includes the creation of **Low Emission Zones (LEZ)** to improve environmental protection in Madrid's 21 districts.
- Madrid 360 includes the transition to **efficient air conditioning systems, fleet renewal, promotion of public transport, integration of all modes of transport, reinforcement of road safety and innovation.**
- EMT Madrid is prioritizing the **electrification of lines in low-emission zones.**



Digital Transformation

Concept Bus – Commitment with the citizens

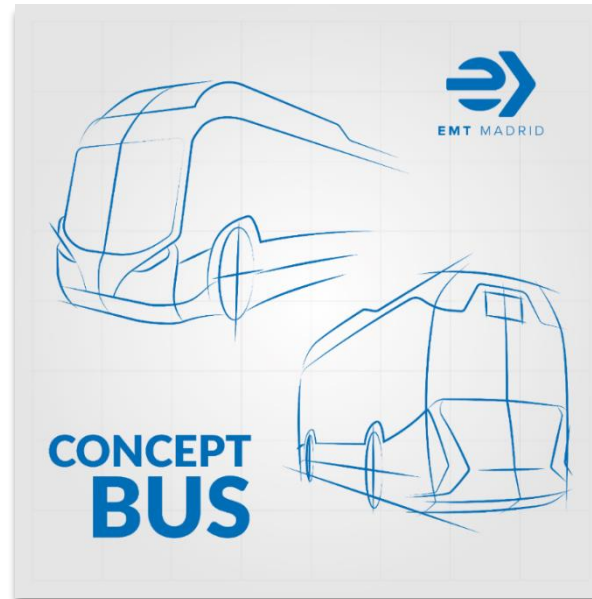
Concept Bus

- The Concept Bus is an **open competition of ideas** that seeks to design the **bus of the future**.
- It is a **design-driven initiative**, launched on September 27th 2022.
- A full-scale prototype will be placed in Madrid's streets in order to gather **inputs and engagement from the citizens** and serve as a test-bed of innovation and maturity of the solution.

New-generation buses

Deadline: December 2022

*We encourage you
to participate!*



Autonomous Bus



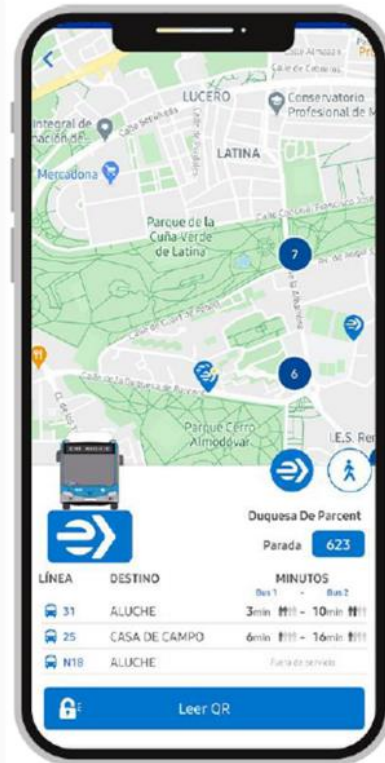
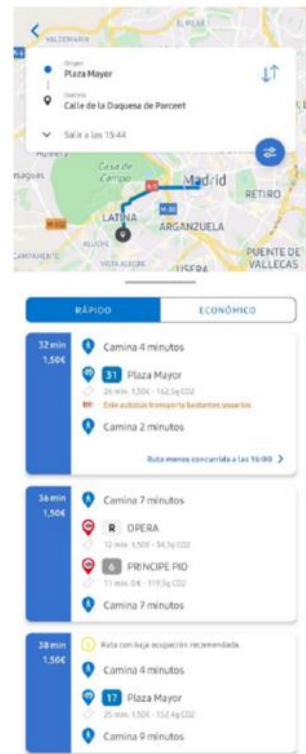
**Public transport as an
image-booster for cities**

Digital Transformation

Holistic Transformation

Services integration: Mobility as a Service (MaaS)

Digital Platform





EMT Madrid

- Strategic Framework 2021-2025
- Bus Service Transformation
- Digital Transformation
- ✓ **Infrastructure Transformation**

Gonzalo Fernández Sánchez
Infrastructure's Director
EMT Madrid



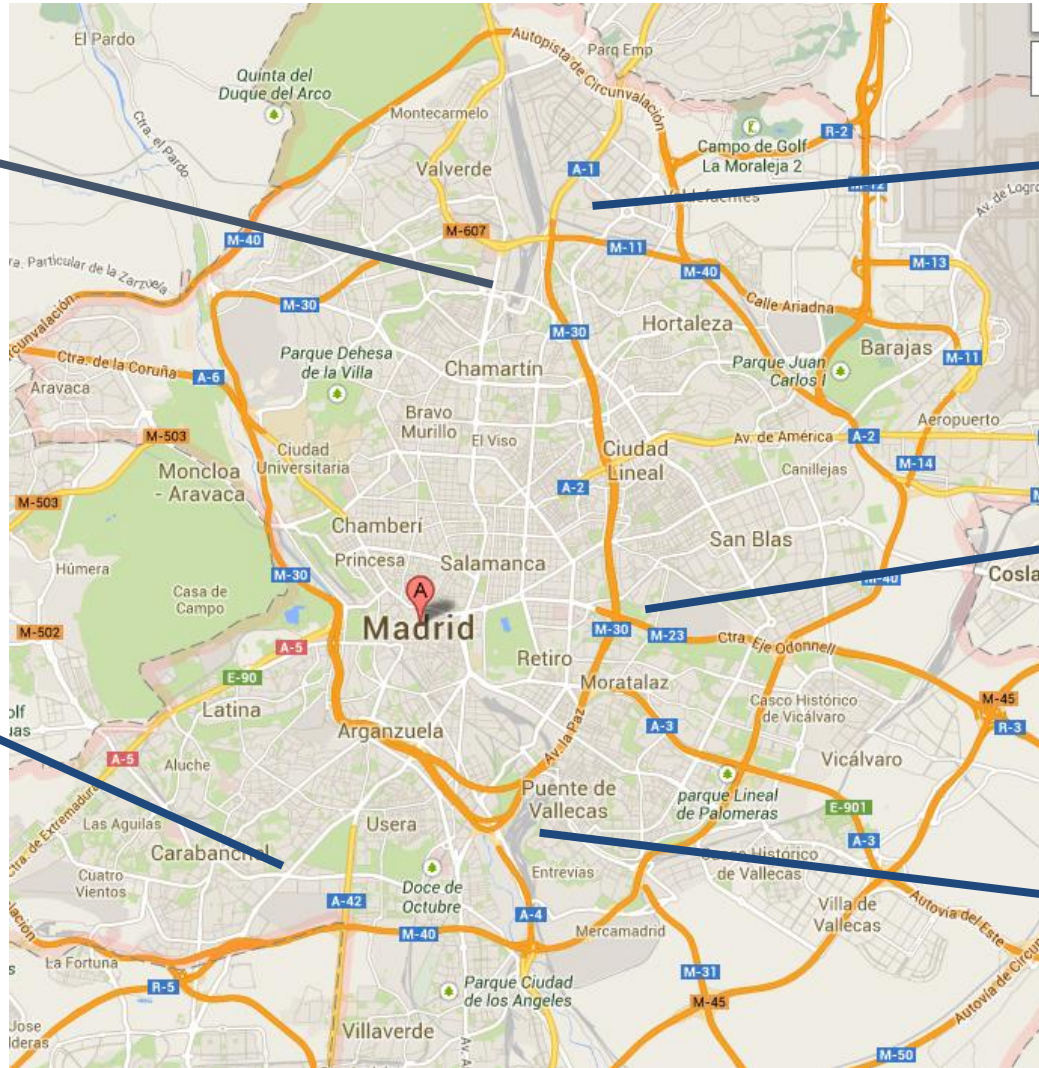
Infrastructure's Transformation

Infrastructure's Transformation

EMT Bus Depots



Fuencarral Bus Depot



Sanchinarro Bus Depot



Carabanchel Bus Depot



La Elipa Bus Depot



Entrevías Bus Depot

Infrastructure's Transformation

EMT Bus Depots

Sanchinarro Bus Depot



- **Newest Depot (2010)**
- **1st Depot 100% CNG**
- **Transition from Diesel to CNG started in 1994 and is ending 2022!**

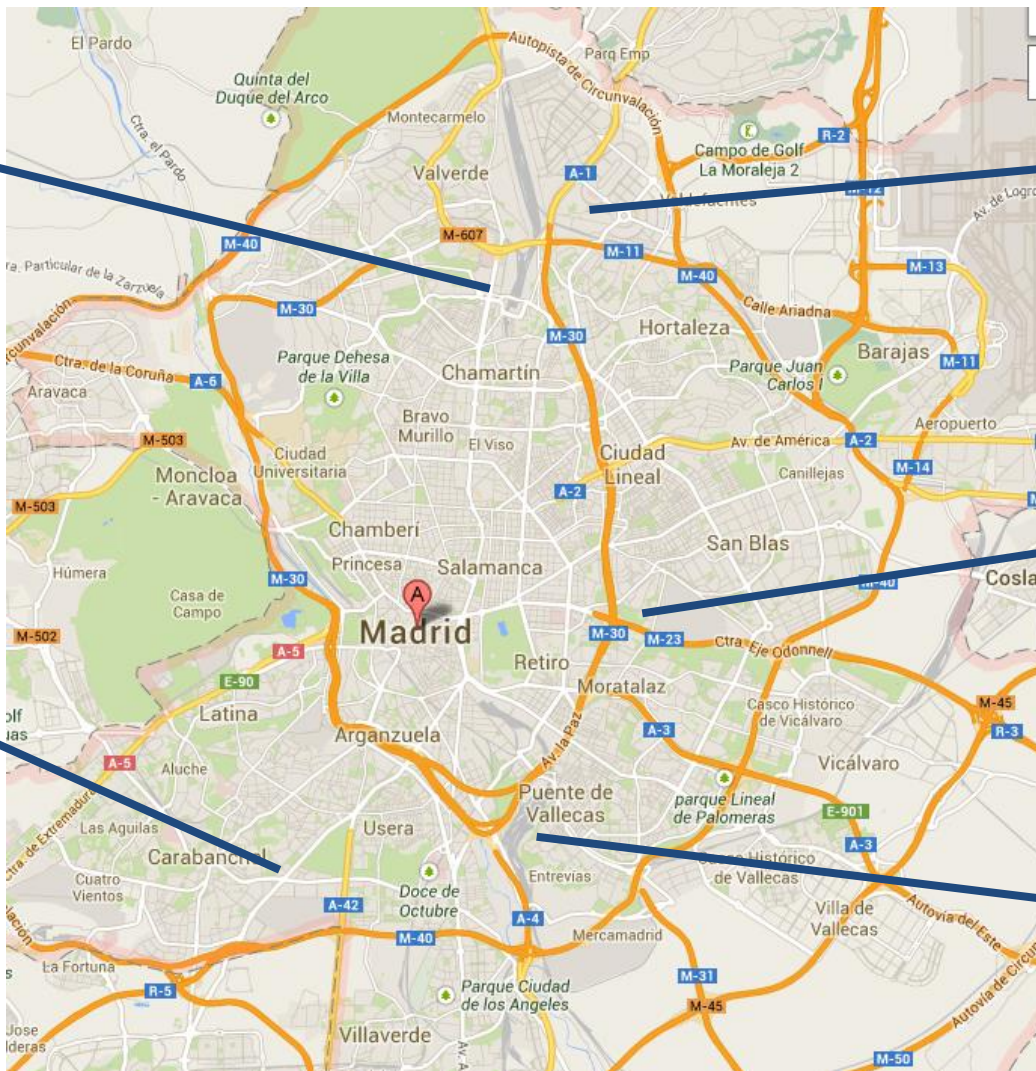


Infrastructure's Transformation

EMT Bus Depots



Fuencarral Bus Depot



Sanchinarro Bus Depot



La Elipa Bus Depot



Carabanchel Bus Depot



Entrevías Bus Depot

Infrastructure's Transformation

EMT Bus Depots

Fuencarral Bus Depot



- eBuses:
 - 2018 (15 buses)
 - 2019 (35 buses)
- Charging infrastructure: 50 buses

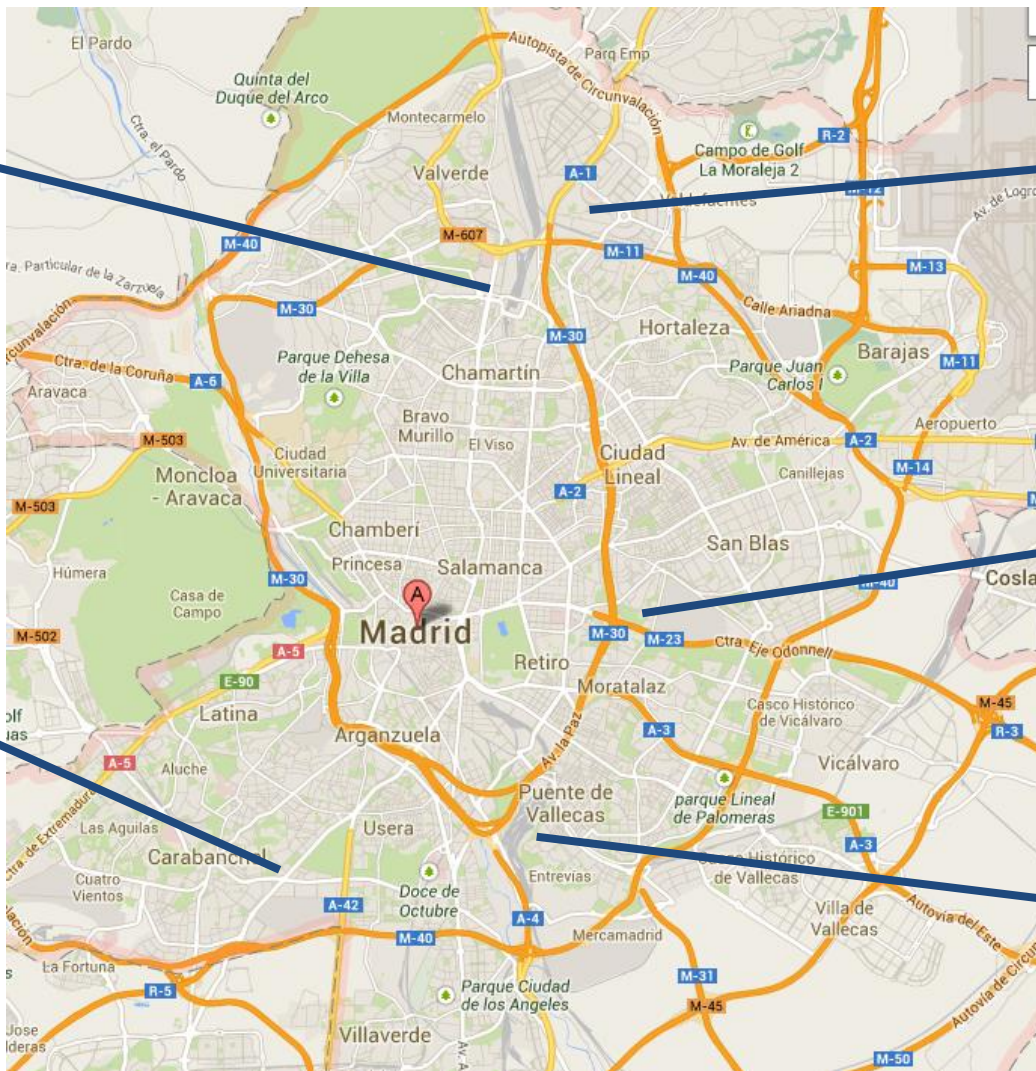


Infrastructure's Transformation

EMT Bus Depots



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Infrastructure's Transformation

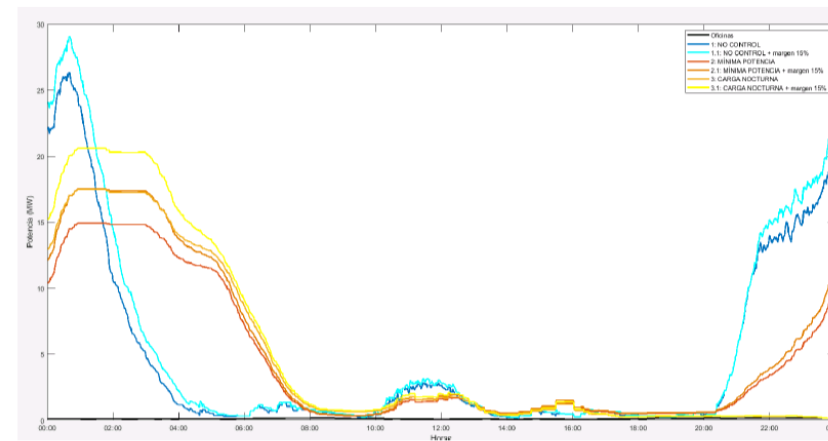
EMT Bus Depots

La Elipa NEW Bus Depot



- ✓ 318 buses parking area
- ✓ 100% electric fleet
- ✓ Covered Depot, with photovoltaic installations
- ✓ Bus e-charging system through inverted pantographs.
- ✓ Execution in 2 years
- ✓ €127 million investment

Gestión de carga: 100% Eléctrico



Estimación de diferentes perfiles de consumo de la instalación final.

1. No control



2. Mínima potencia



3. Carga nocturna



Infrastructure's Transformation

EMT Bus Depots

La Elipa NEW Bus Depot



Infrastructure's Transformation

EMT Bus Depots

La Elipa NEW Bus Depot

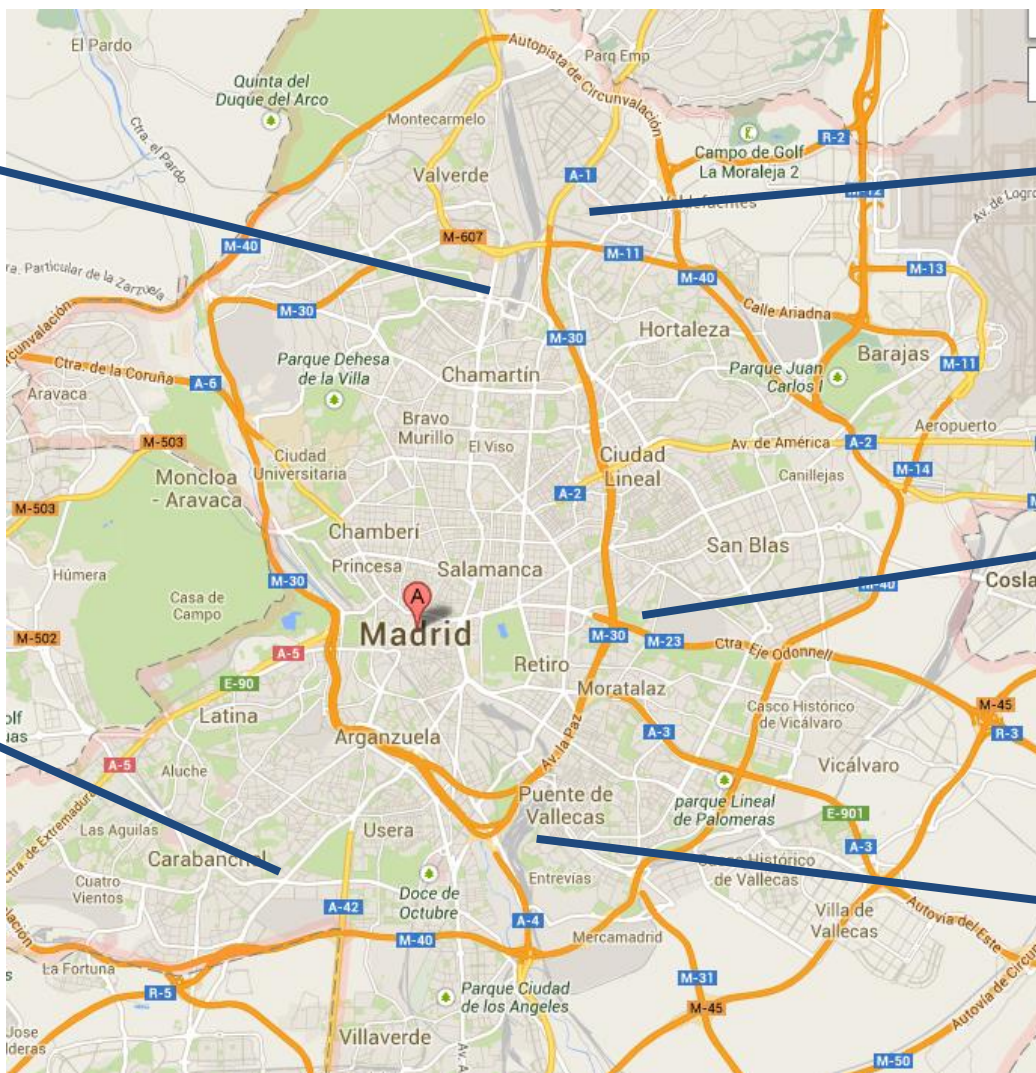


Infrastructure's Transformation

EMT Bus Depots



Fuencarral Bus Depot



Sanchinarro Bus Depot



Carabanchel Bus Depot



La Elipa Bus Depot



Entrevías Bus Depot



Carabanchel Bus Depot

Carabanchel Bus Depot Electrification 2021-2023



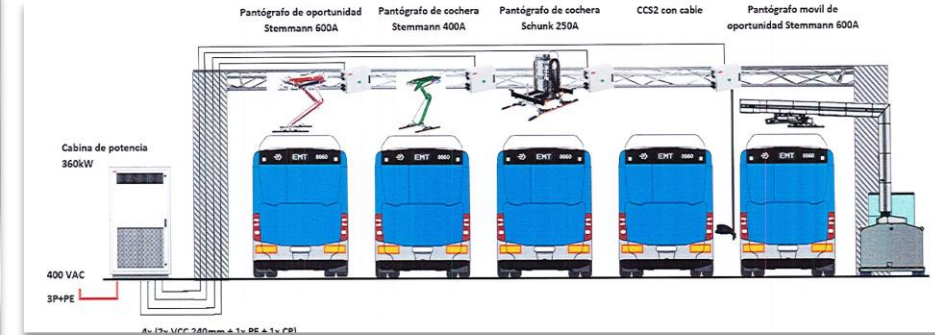
Imagen del C.O. Carabanchel. Descripción de fases

- Phase 0: 5 Pilot pantograph chargers
- Phase 0: 25 chargers for electric minibuses
- Phase 1: 63 standard chargers + 15 MW of new service connection (FEDER)
- Phases 2 & 3: 172 chargers for inverted pantograph (NextGen)

Infrastructure's Transformation



Carabanchel Bus Depot

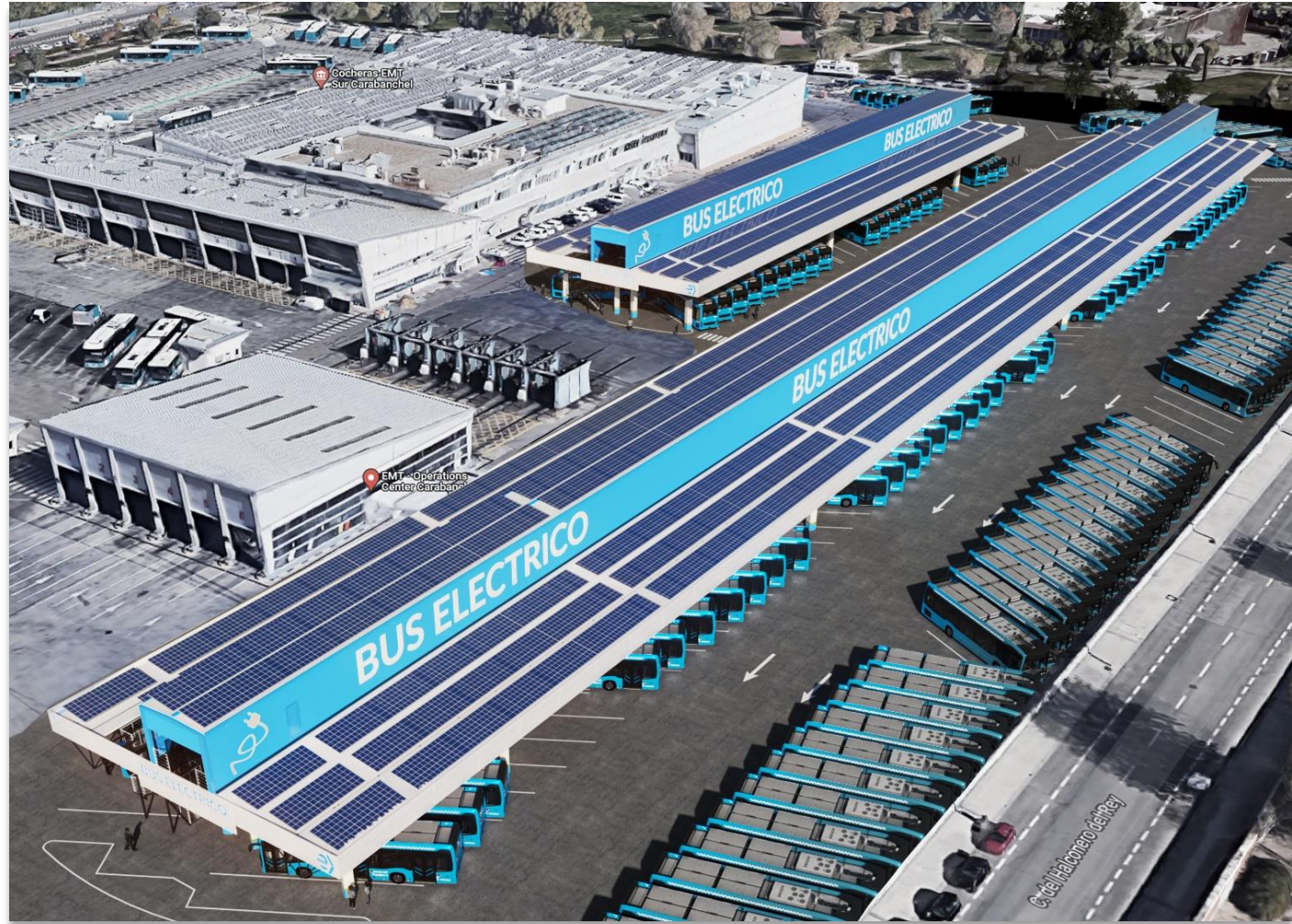


- ✓ Acquisition and Infrastructure for 172 pantographs
- ✓ Infrastructure and acquisition for cable charging points
- ✓ Smart charging system
- ✓ Total investment > €20.5 million

Infrastructure's Transformation



Carabanchel Depot electrification





Carabanchel Depot electrification



Article

Different Approaches for a Goal: The Electrical Bus-EMT Madrid as a Successful Case Study

Iván López ¹, Pedro Luis Calvo ¹, Gonzalo Fernández-Sánchez ^{1,*}, Carlos Sierra ¹, Roberto Corchero ¹, Cesar Omar Chacón ¹, Carlos de Juan ², Daniel Rosas ² and Francisco Burgos ²

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Abstract: A deep review of the state of the electromobility in urban public transport by bus was conducted from all different charging strategies, types of chargers, and e-buses with a general overview and SWOT analysis. A review of five case studies worldwide was also conducted and a real case study with real data was shown in depth: EMT Madrid, where all chargers and charging systems were developed in a single operation center. Total Cost of Ownership (TCO) from the literature and from the case study for e-buses were shown as compared with different bus technologies.

Keywords: TCO; e-buses; electromobility; electrical infrastructures; bus public transport

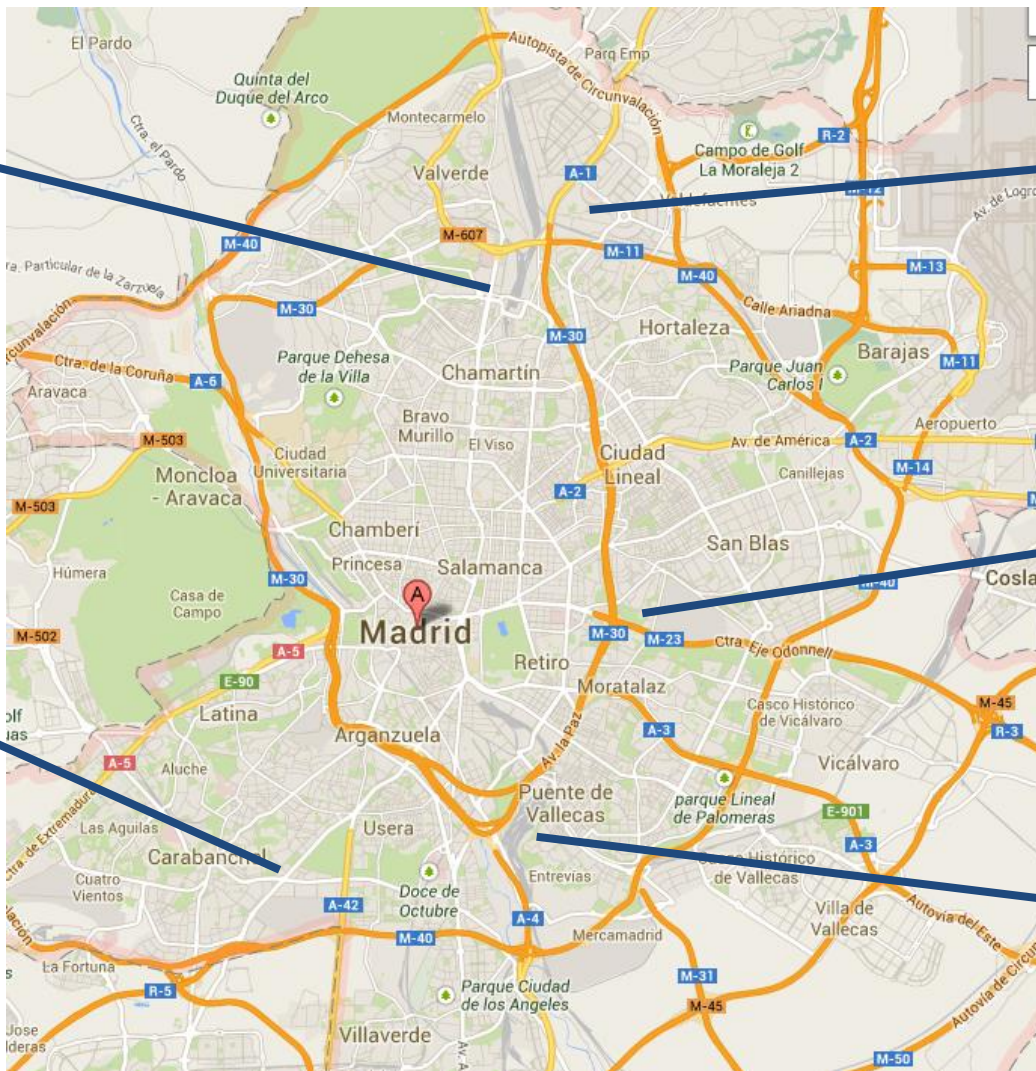
Energies **2022**, *15*, 6107. <https://doi.org/10.3390/en15176107>

Infrastructure's Transformation

EMT Bus Depots



Fuencarral Bus Depot



Sanchinarro Bus Depot



La Elipa Bus Depot



Carabanchel Bus Depot



Entrevías Bus Depot



Entrevías Bus Depot

Hydrogen station



- ✓ Hydrogen station for 10 buses in the Entrevías Depot
- ✓ Photovoltaic panels on roofs for the production of 2 MW
- ✓ Hydrogen production equipment by electrolysis with the capacity to produce up to 18 kg of H₂/h (73 ton H₂/year)
- ✓ Maximum storage system of 1,013 kg of H₂
- ✓ Date for operation: December/2023
- ✓ Total investment €17.2 million (including buses)

Photovoltaic installations



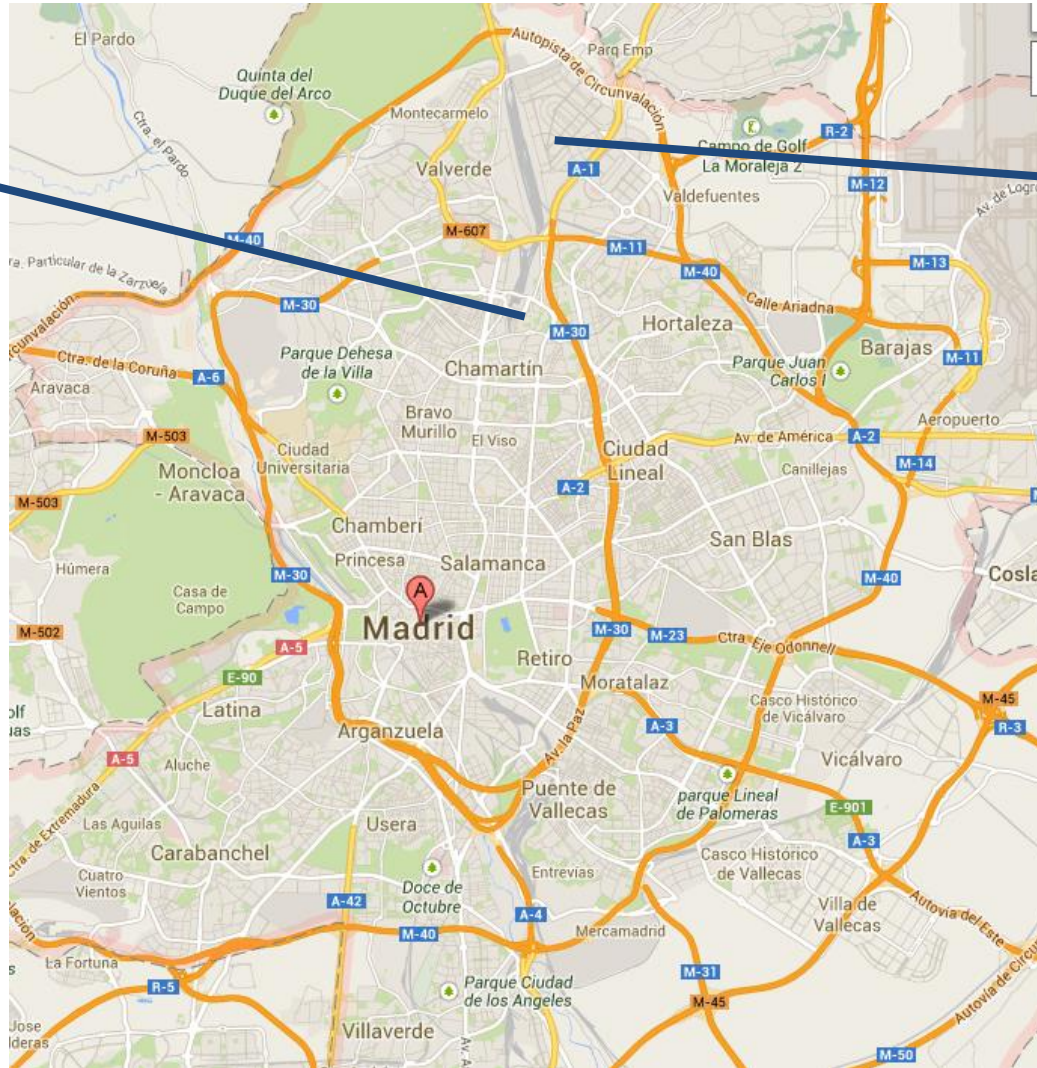
- ✓ All depots investment
- ✓ Area covered: 42,000 m²
- ✓ Savings of 6,135 thousand kWh/year
- ✓ Avoids the emission of 1,533 tons of CO₂/year
- ✓ Total investment €8.6 million
- ✓ In Entrevías up to 2MW for generating Green H₂

Infrastructure's Transformation

EMT Bus Depots



Fuencarral Bus Depot



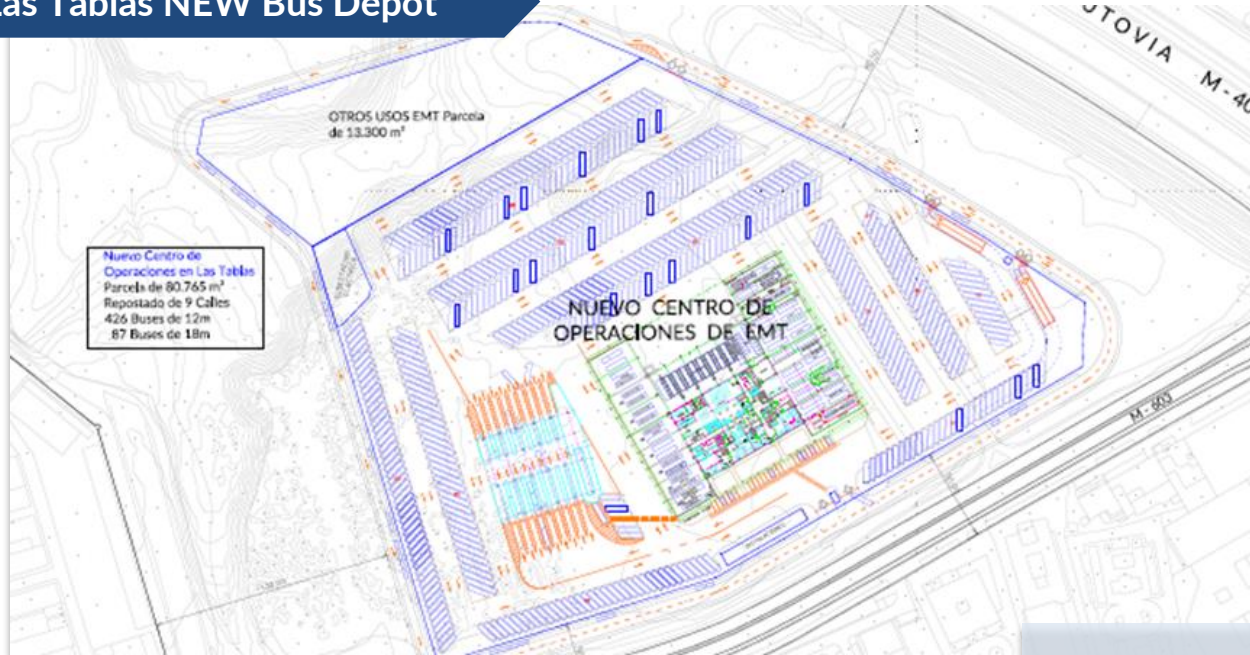
Las Tablas NEW Bus Depot

Infrastructure's Transformation



EMT Bus Depots

Las Tablas NEW Bus Depot



- ✓ Design of a 9,200 m² Depot with a “H” shaped building
- ✓ 100% low emission fleet (electric and CNG)
- ✓ 513 buses parking area
- ✓ E-charging system by inverted pantograph and photovoltaic cover
- ✓ The use of photocatalytic materials for the roof of the garage building, to reduce greenhouse gas emissions
- ✓ **€150 million investment**

Infrastructure's Transformation

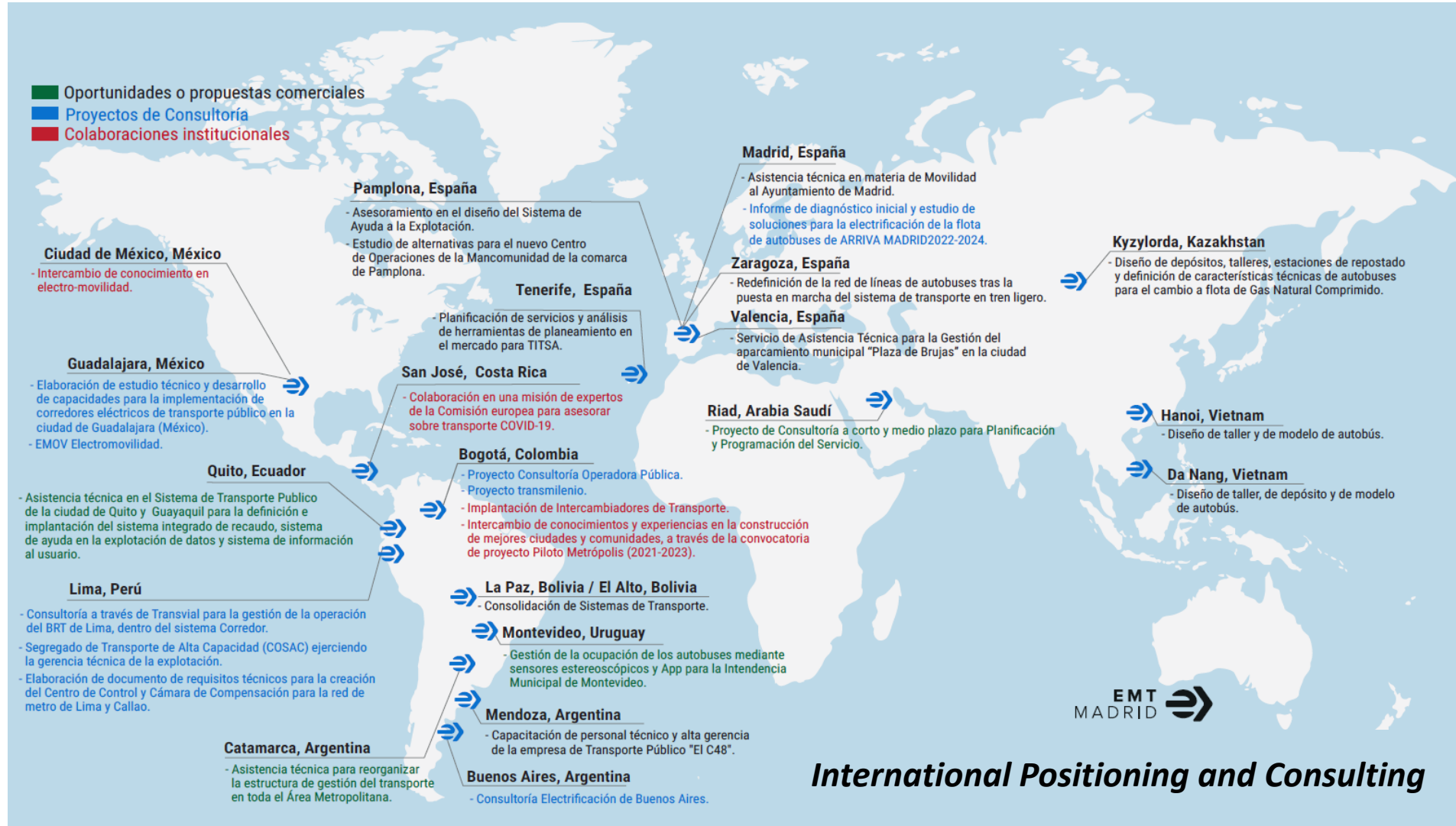
EMT Bus Depots

Las Tablas NEW Bus Depot



Consulting Services

Sharing knowledge





Conclusions

Conclusions

Future vision of the urban bus at EMT Madrid

At EMT we are committed to the **transformation of BUS service**, which is essential to achieve the connected, electric, shared, safe and sustainable mobility set out in the roadmaps.

- **Fleet transformation:** the electrification of the BUS will be the solution in the medium term, but renewable alternatives (H2, biogas) must be explored.
- **Transformation of associated infrastructure.**
- **IT transformation** for smart energy & mobility systems
- But this transformation needs financing: in Europe the **Next Generation Funds** are driving & accelerating it.



Conclusions

Future vision of the urban bus at EMT Madrid

Energy transition is not just buying a bus with new technology: it requires a **change in the chain** (operations, infrastructure, processes, procurement, etc.).

➤ Transitions are long:

- 1994 to 2022 Transition Diesel to CNG 100%!
- 2007 to 2035 Transition from CNG to Electric. Today at 10%: 2027 at 34%.

Electric infrastructures are 10% (approx.) **of the rolling stock investment** (excluding operating and energy costs).

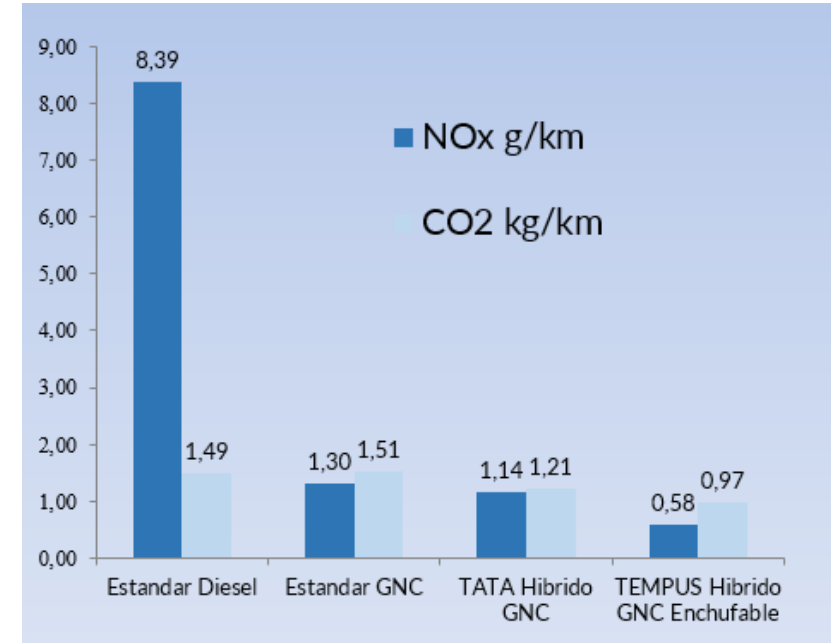
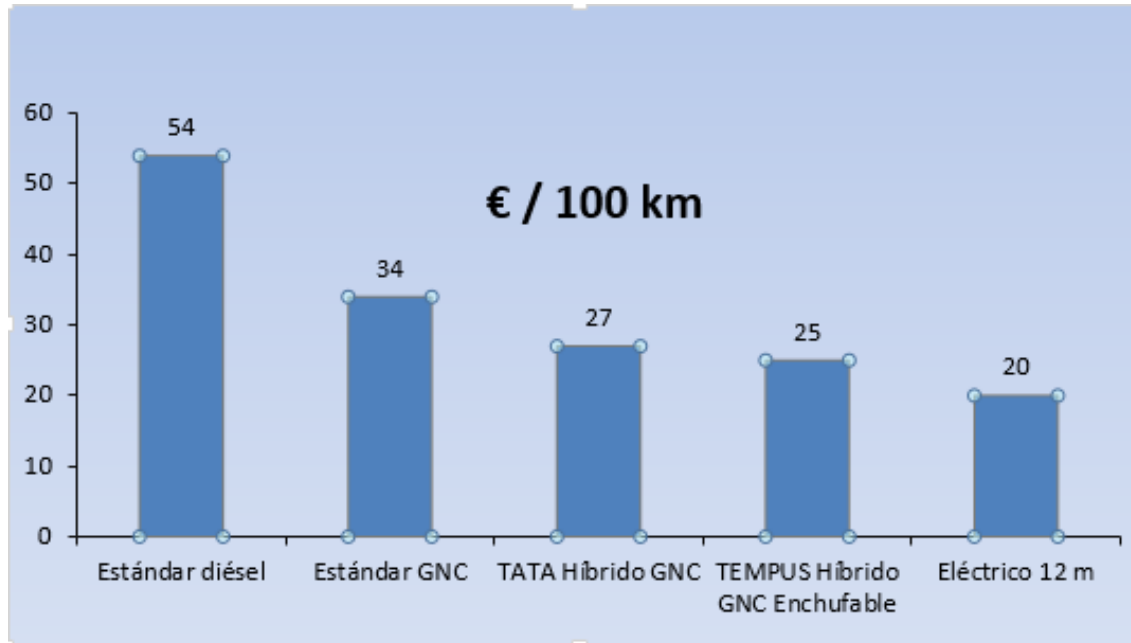


Conclusions

Future vision of the urban bus at EMT Madrid

Electric bus operating costs are lower than other technologies (CNG already was compared with Diesel).

ZERO emissions!



Conclusions

Future vision of the urban bus at EMT Madrid

The future of public transport...

- Will it be autonomous?
- Will it be flying?
- Will it be electric / H2 / biogas?
- Will it be shared?
- Will it be dynamic and flexible?

*What is certain is that it
will be by bus,
the only transport mean that
is **flexible, massive and
adaptable to any city***





Thank you



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