

POLIS

CITIES AND REGIONS FOR TRANSPORT INNOVATION

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leuven

Multimodal and Zero- Emissions: Thinking out of the car-box

Decarbonizing by innovation: upscaling e-bus charging
infrastructure

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Department of EMT MADRID

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What is EMT Madrid?





EMT Madrid

Main figures



EMT is the **reference of surface mobility** in the city of Madrid. It counts with 9.833 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**.



9.833 employees



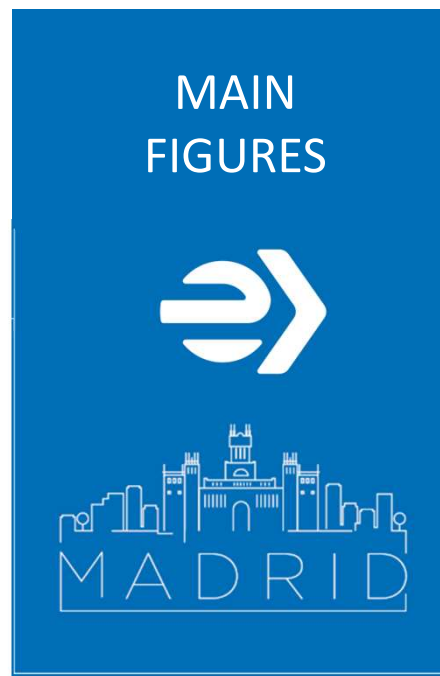
220 lines (30 electrified at the end of 2023)



2.090 buses (100% clean fleet)
5 Operation Centers



373 million clients in 2022
1.200.000 trips per day (working day)



855 M€ Budget in 2023



80 cranes in 7 depots
66.214 operations in 2021



7.500 electric bikes in 611 stations



12.451 spaces in 28 Parking lots



80 cabins in Teleférico
Touristic service





Consulting Services

Sharing knowledge

EMT as a global mobility benchmark

- Oportunidades o propuestas comerciales
- Proyectos de Consultoría
- Colaboraciones institucionales

Ciudad de México, México
- Intercambio de conocimiento en electro-movilidad.

Guadalajara, México
- Elaboración de estudio técnico y desarrollo de capacidades para la implementación de corredores eléctricos de transporte público en la ciudad de Guadalajara (México).
- EMOV Electromovilidad.

Quito, Ecuador
- Asistencia técnica en el Sistema de Transporte Público de la ciudad de Quito y Guayaquil para la definición e implantación del sistema integrado de recaudo, sistema de ayuda en la explotación de datos y sistema de información al usuario.

Lima, Perú
- Consultoría a través de Transvial para la gestión de la operación del BRT de Lima, dentro del sistema Corredor.
- Segregado de Transporte de Alta Capacidad (COSAC) ejerciendo la gerencia técnica de la explotación.
- Elaboración de documento de requisitos técnicos para la creación del Centro de Control y Cámara de Compensación para la red de metro de Lima y Callao.

Catamarca, Argentina
- Asistencia técnica para reorganizar la estructura de gestión del transporte en toda el Área Metropolitana.

Pamplona, España
- Asesoramiento en el diseño del Sistema de Ayuda a la Explotación.
- Estudio de alternativas para el nuevo Centro de Operaciones de la Mancomunidad de la comarca de Pamplona.

Tenerife, España
- Planificación de servicios y análisis de herramientas de planeamiento en el mercado para TITSA.

San José, Costa Rica
- Colaboración en una misión de expertos de la Comisión europea para asesorar sobre transporte COVID-19.

Bogotá, Colombia
- Proyecto Consultoría Operadora Pública.
- Proyecto transilenio.
- **Implantación de Intercambiadores de Transporte.**
- Intercambio de conocimientos y experiencias en la construcción de mejores ciudades y comunidades, a través de la convocatoria de proyecto Piloto Metrópolis (2021-2023).

La Paz, Bolivia / El Alto, Bolivia
- Consolidación de Sistemas de Transporte.

Montevideo, Uruguay
- Gestión de la ocupación de los autobuses mediante sensores estereoscópicos y App para la Intendencia Municipal de Montevideo.

Mendoza, Argentina
- Capacitación de personal técnico y alta gerencia de la empresa de Transporte Público "El C48".

Buenos Aires, Argentina
- Consultoría Electrificación de Buenos Aires.

Madrid, España
- Asistencia técnica en materia de Movilidad al Ayuntamiento de Madrid.
- Informe de diagnóstico inicial y estudio de soluciones para la electrificación de la flota de autobuses de ARRIVA MADRID 2022-2024.

Zaragoza, España
- Redefinición de la red de líneas de autobuses tras la puesta en marcha del sistema de transporte en tren ligero.

Valencia, España
- Servicio de Asistencia Técnica para la Gestión del aparcamiento municipal "Plaza de Brujas" en la ciudad de Valencia.

Riad, Arabia Saudí
- Proyecto de Consultoría a corto y medio plazo para Planificación y Programación del Servicio.

Kyzylorda, Kazakhstan
- Diseño de depósitos, talleres, estaciones de repostado y definición de características técnicas de autobuses para el cambio a flota de Gas Natural Comprimido.

Hanoi, Vietnam
- Diseño de taller y de modelo de autobús.

Da Nang, Vietnam
- Diseño de taller, de depósito y de modelo de autobús.

International Positioning and Consulting y Consultoría

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Electrification at EMT Madrid



Bus Service Transformation

Electrification Strategy

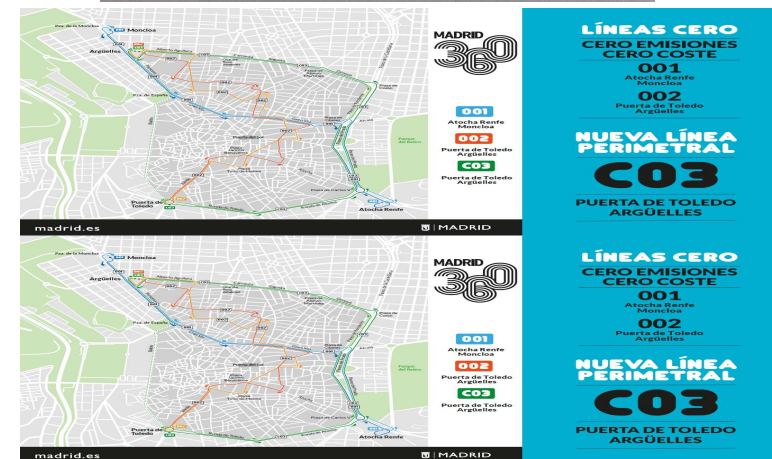
Comply the City Strategies

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.





SUSTAINABLE ENVIRONMENT STRATEGY



2023

100

Madrid becomes first major European city with 100 per cent clean bus fleet

DI In line with the city council's Madrid 360 Environmental Sustainability Strategy, EMT Madrid's 100 per cent clean fleet will be made up of a combination of compressed natural gas, electric and hydrogen buses.



2027 GOAL: ELECTRIC BUSES



19/10/2023

EMT Madrid able to verify and certify its carbon footprint

For the first time, POLIS member, Madrid Municipal Transport Company (EMT Madrid) has been able to verify and certify its carbon footprint in direct and indirect emissions, providing key information to establish strategies to reduce consumption and emissions, as well as to address the offsetting of these.

The capacity to measure and monitor carbon emissions from transport is critical to Europe's race towards climate neutrality. Cities and regions- many of whom are part of the European Commission's Climate Neutral and Smart Cities Mission- are implementing cutting-edge measures to reduce dependency on polluting vehicles; yet, calibrating the impacts of these is frequently complex, and burdensome.

As a result, EMT Madrid's new ability to calculate, verify and certify the direct and indirect emissions of its carbon footprint, comes at a critical time in the city's drive for more sustainable urban mobility.

Today EMT reaches another milestone on its path towards decarbonisation, an objective in line with the Madrid 360 Environmental Sustainability Strategy and with the Strategic Plan that sets the course of the organisation until 2025, says the delegate for Urban Planning, Environment and Mobility, Borja Carabante.

AENOR has favourably certified, and without any 'non-conformity', the municipal company's calculation of its greenhouse gas emissions. This calculation has taken into account Scope 1 emissions (direct emissions from the company's own and controlled sources), Scope 2 emissions (indirect emissions from the production of energy that the organization purchases) and Scope 3 emissions (indirect emissions from sources that are not owned by the company as customers, suppliers, commuting, or waste disposal).

Basic data to implement strategies and achieve objectives

The calculation and its verification provide key information for establishing strategies to reduce consumption and emissions, with the analysis allowing reflection on the points of action and the preparation of a Reduction Plan with the measures and the estimation of the reduction that it entails. This step involves obtaining the carbon footprint calculation seal from the Ministry for Ecological Transition and the Demographic Challenge. The next steps for the municipal company will be to comply with the established reduction targets



The delegate for Urban Planning, Environment and Mobility, collecting the AENOR award. Credit: Ayuntamiento de Madrid

Energy transition. Fleet Transformation

Forecast by fuel type

Fuel	2020	2021	2022	2023	2024	2025	2026	2027
Diesel	388	196						
CNG	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
% CNG fleet	77,3%	82,1%	87,9%	84,3%	79,6%	74,8%	70,0%	65,3%
% 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). Source: EMT Madrid.

Electrification Strategy: Current e-bus fleet (253 units – 26th october 2023)

E-microbuses



- Model: Tecnobus Gulliver (already removed from service, except one unit for research purposes-SHOW project)
- 2007-2020

- Model: Wolta-Rampini
- 24 units



Standard e-buses

- Tempus Castrosua (5 units)
- Retrofit of 5 hybrid-CNG buses for full electrification with induction charging (line 76).
- Pilot project developed by EMT



- Model i2e (2017): 35 units (charging 5 hours) (currently upgraded)
- ieBus model (2019): 54 charge 3.5h



- BYD (65 units)
- Model K9UB: first 15 units in 2020, charged in 3h



- Irizar ietram
- 9 units
- For the BRT service



- Solaris Urbino
- 60 units





Charging e-volution

WIRED CHARGING

143 Chargers

Since 2007 minibuses
(25)



Since 2018 standard
(118)



INDUCTION OPPORTUNITY CHARGING

5 Vehicles

Since 2018
Opportunity charging
on final lane



INVERTED PANTOGRAPH

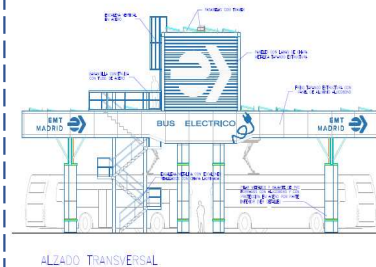
234 pantographs

4 in test project

52 in 2022

118 in 2023

60 in 2024



SMART CHARGING & NEW DEPOT

2 x New Depot

318 + 500 inverted
pantographs + ebuses



Smart Charging

Optimizing charging
power and cost

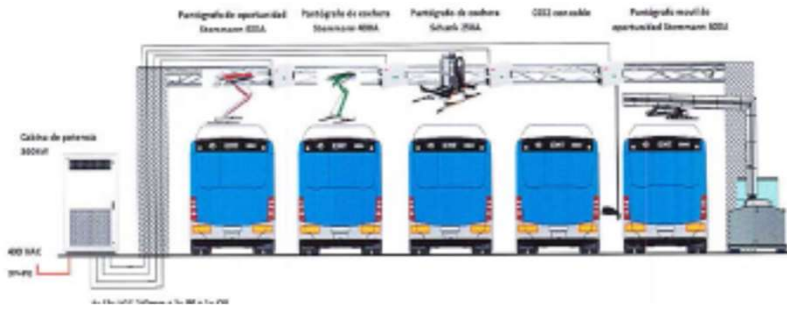


Wired charging

- Since 2007
- 143 chargers
- 25 with 80 kW of power for minibuses
- 118 between 80 and 120 kW of power for standard buses



Inverted Pantographs (Test Project)



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

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Sustainable
infrastructures





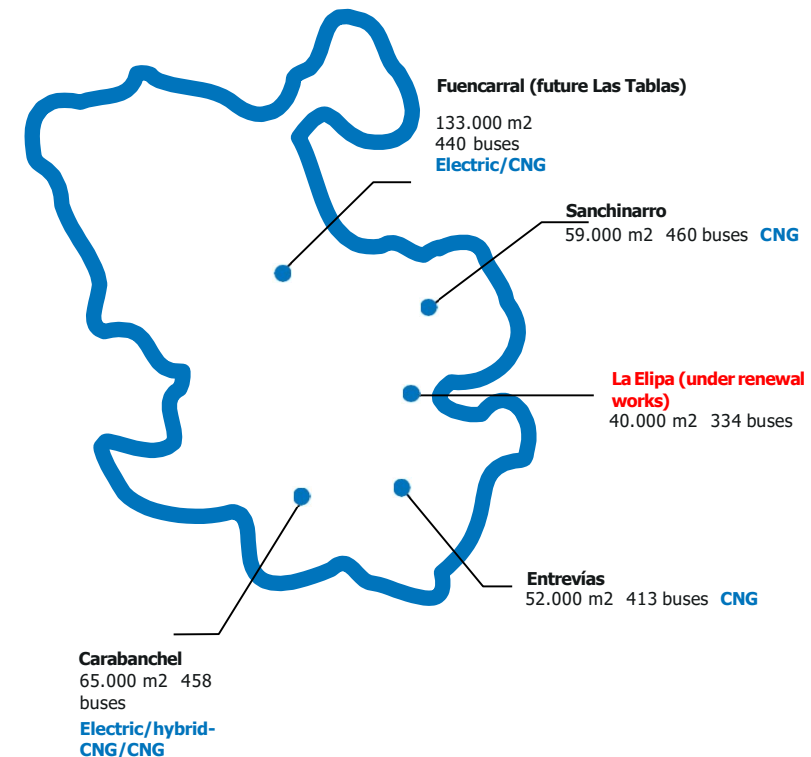
Bus depot adaptations

EMT Madrid Depots (5)

- Carabanchel: Testing bench/Pioneer
- La Elipa: First 100% electric bus depot (same location)
- Entrevías: GNC->Hydrogen+ Electric
- Sanchinarro: GNC -> Electric
- Fuencarral -> Las Tablas (new depot 100% electric, new location)

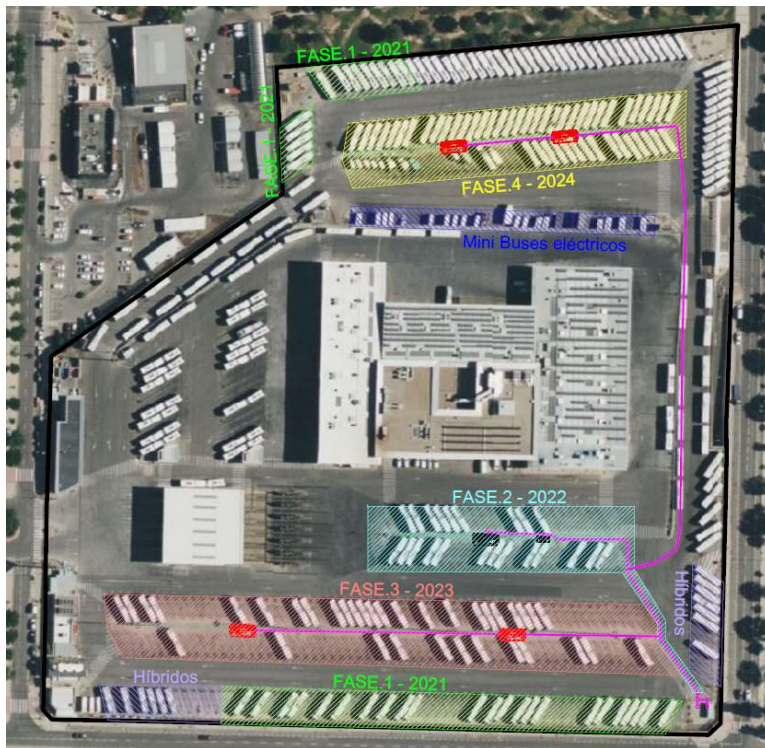
We have already talked about e-buses, but...

How are we charging them?



Infrastructure's Transformation

Scaling up: CARABANCHEL BUS DEPOT



2021	Double connection (2x7,5 MW) 65 plug-in chargers (100 kW)
2022	52 Pantograph chargers (100 kW)
2023	118 Pantograph chargers (360 kW)
2024	60 Pantograph chargers (360 kW)

Total Chargers (Dec .2024) : 295 units

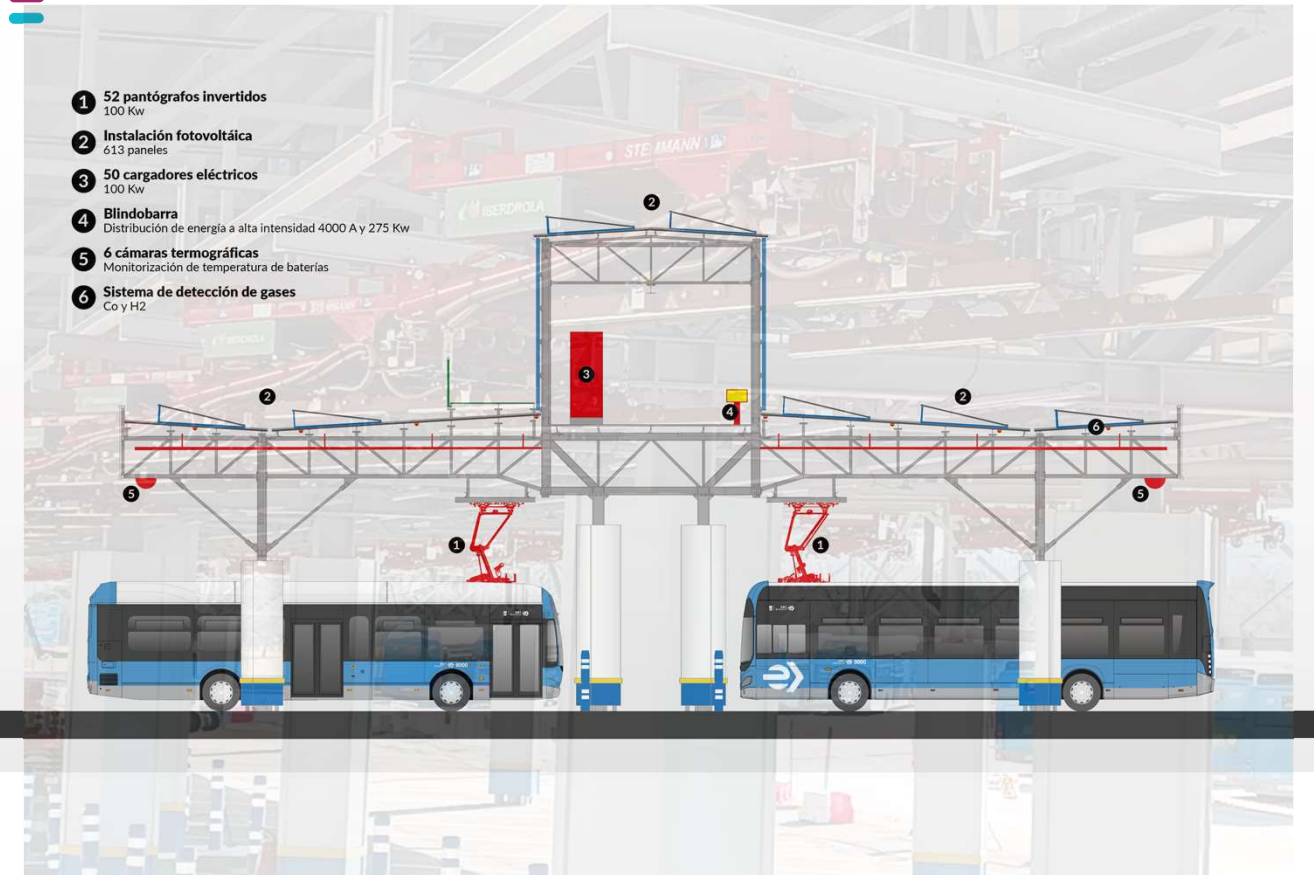
Infrastructure's Transformation

Carabanchel Bus Depot Electrification: Inverted Pantographs

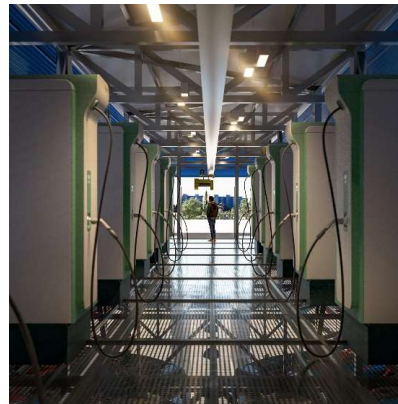
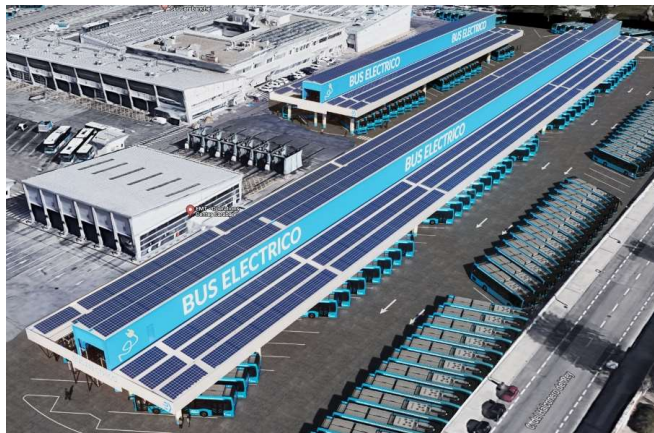
- 1 52 pantógrafos invertidos
100 Kw
- 2 Instalación fotovoltaica
613 paneles
- 3 50 cargadores eléctricos
100 Kw
- 4 Blindobarra
Distribución de energía a alta intensidad 4000 A y 275 Kw
- 5 6 cámaras termográficas
Monitorización de temperatura de baterías
- 6 Sistema de detección de gases
Co y H2

MAIN ELEMENTS

- Steel Structural Canopy
- Subway prefabricated Buildings for MV
- Technical floor of LV installations
- LV distribution by means of busbar
- Photovoltaic installation taking advantage of the whole canopy roof
- Innovative PCI installation



CARABANCHEL: Inverted pantographs



230

Inverted Pantographs
- up to 450 kW

1250

kW Instaled Power
Photovoltaic

1875

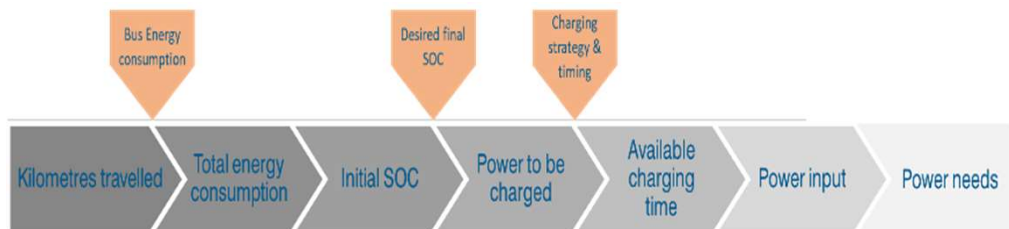
MWh/year, equivalent
to 570 homes

Essential: Fire protection:

- Hydrants, Fire Extinguishers and Fire Alarm Activators
- Conventional detection (methane/ethylene, CO) & HeatProThermal Cam



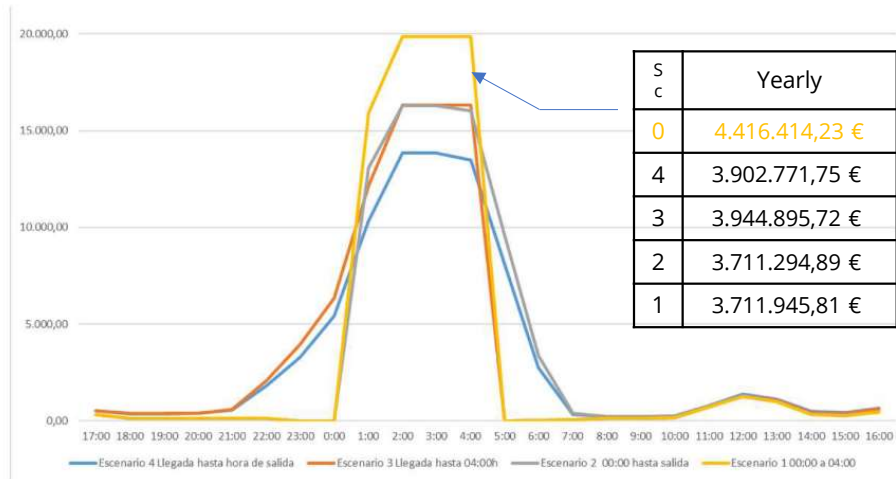
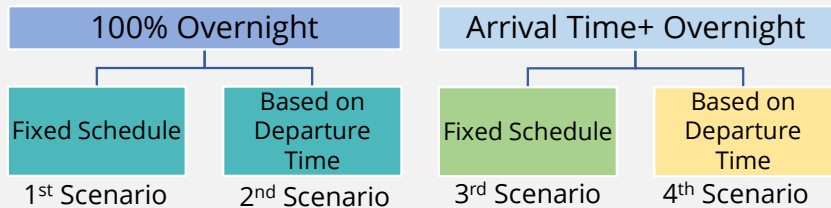
Carabanchel Depot – Smart Charging



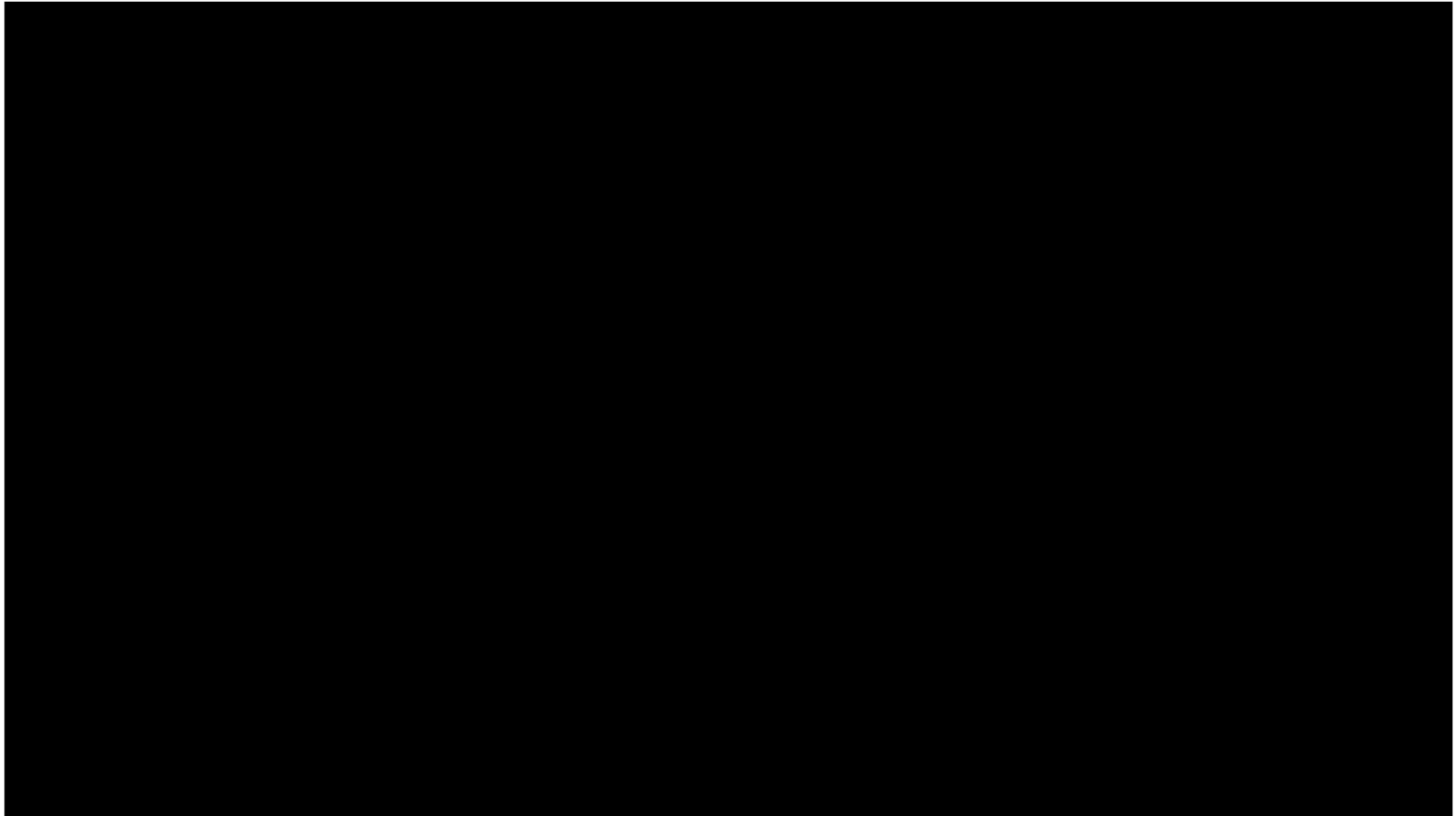
Charging stations

Name	Location	Socket Power	Voltage	Status
EMTCAR001	EMT-Carabanchel	75 kW	600 V	S1 connecting
EMTCAR002	EMT-Carabanchel	75 kW	600 V	S1 available
EMTCAR003	EMT-Carabanchel	75 kW	600 V	S1 finishing
EMTCAR004	EMT-Carabanchel	75 kW	600 V	S1 connecting

Charging Strategy – In Depot Charging



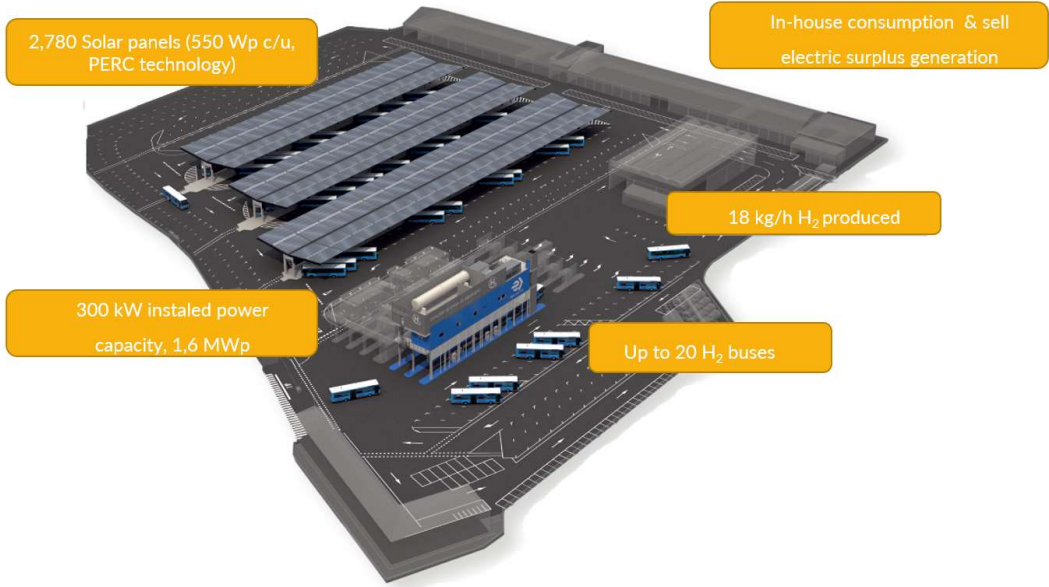
Carabanchel bus depot: PHASE II





Previous experiences

Short term: H2 in Entrevías Bus depot





More to come...Short term: La Elipa

From scratch!



318

Inverted
Pantographs

318

Electric buses

34,000

m² solar panels

Near Zero Emissions
Building

20 MW electrical
power supply



...Mid-term: Las Tablas



Madrid Nuevo Norte: urban redevelopment programme will reshape 2.65 million m²

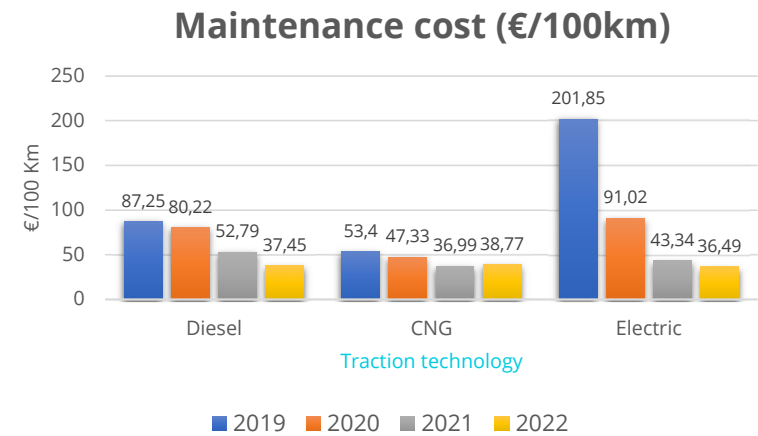
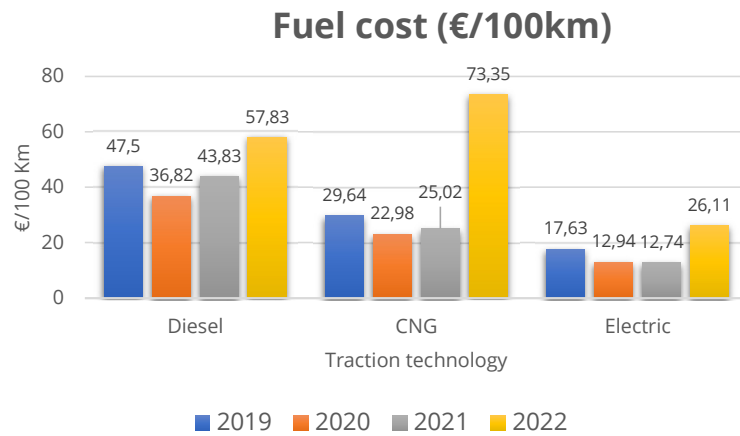
100% ELECTRIC

500 e-buses fleet



Electrification is worthwhile

Comparison of costs

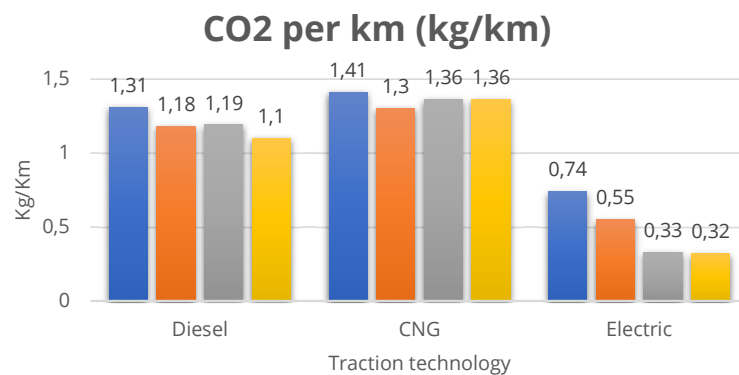
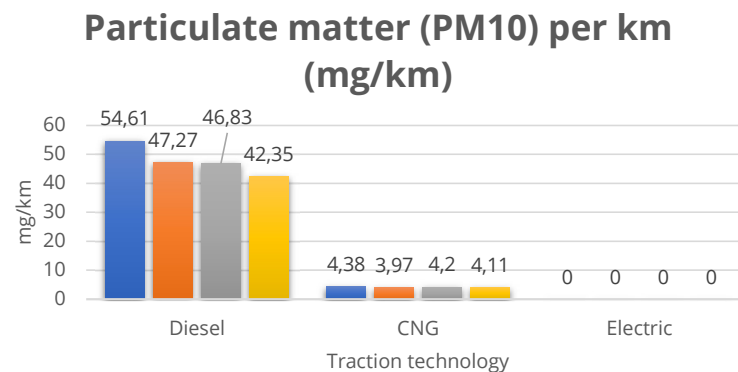
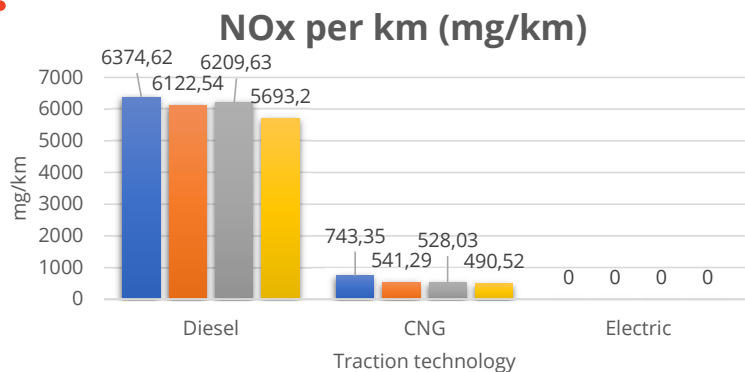


*Fuel Price 2022

- Diesel: 1.1739 €/litre
- CNG: 96.6 €/MWh
- Electricity: 158.6 €/MWh

Electrification is worthwhile

Comparison of emissions



■ 2019 ■ 2020 ■ 2021 ■ 2022

■ 2019 ■ 2020 ■ 2021 ■ 2022



Biogas Project at EMT Madrid



Production and use of landfill biomethane injected into the gas pipeline for municipal passenger transport

- EMT Agreement Madrid – Valdemingómez Technology Park
 - EMT Madrid acquires renewable gas
 - **6 GWh** of biomethane/year
 - Use in EMT's CNG fleet.
 - Supply enough to run the **circular line C1**
 - **20** buses
 - **1 million kilometers** traveled
 - **4,43 million passengers** transported in 2021
- **Circular economy** project: energy supplied to buses is generated from organic waste

1st Award: PublicPrivateProject for its Circular Economy Purpose in the *Green Gas Mobility Summit 2022 (September, 2022)*

4

Conclusions





Conclusions

Future vision of the urban bus at EMT Madrid

At EMT Madrid we are committed to the **transformation of our 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.**
- This transformation needs financing: in Europe the **Next Generation Funds** are driving it.



Conclusions

Future vision of the urban bus at EMT Madrid

Energy transition is not just buying a bus (or machine) with new technology: it requires a **change in the whole chain** (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 12%: 2027 at 34%.

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





**Thank you for
your attention!**



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