SPP REGIONS
REGIONAL NETWORKS FOR SUSTAINABLE PROCUREMENT

SPP TENDER MODEL

Electric buses

Joint Procurement of 19 urban electric buses in Piedmont

Purchasing body:	GTT – Gruppo Torinese Trasporti S.p.A.
Contract:	19 electric buses (length 12m) Awarded: September 2016
Savings:	• 769 tons of CO_2 emissions saved per year • Primary Energy saving of 1.62 GWh/yr • Financial saving of €50,000 over 10 years (emissions cost including)

SUMMARY

- Supply contract of 19 urban buses, 2-axle, pure electric drive, length 12m, M3 category, class 1, low platform, air-conditioned
- 10 years full service maintenance (including batteries and excluding tyres).
- Tender awarded for €10,064,300.00 (excluding VAT): €7,980,000.00 for buses and €2,084,300 for full service, to BYD EUROPE B.V (without rapid charging stations)

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www.sppregions.eu

Procurement Approach

This tender derives from a programme launched by the Piedmont Region to promote the introduction of electric buses into regional transport operators fleets. The Regional government would fund 90% of the bus purchasing cost, based on funding from the *National Programme for the improvement of air quality through the modernisation of local public transport*.

Electric buses market is relatively new and the supply approach followed 5 steps:

1) The Piedmont Region requested and assessed project proposals from public transport companies in the region, asking them to define the proposed number of buses, the route and the charging infrastructure (April 2014)

2) A general market survey about possible suppliers worldwide with information published in newspapers and specialized magazines (April 2015)

3) Pre-qualification: notice published on the official website of GTT and on OJEU[1] in order to collect suppliers' requests (September 2015)

4) Selection of suppliers who could meet the technical and financial requirements (October 2015)

5) Request for proposals sent to the selected suppliers (February 2016)

The tender was awarded on the basis of the most economically advantageous offer (September 2016).

Joint procurement

The Piedmont Region, financing 90% of the buses purchasing cost, identified G.T.T. S.p.A. as the appropriate purchasing body (because of its experience with electric urban mini-buses since 2003) to act on behalf of different public transport local companies in the Piedmont Region.

The Joint Procurement approach was applied for different reasons:

- to reduce administrative costs for the organisations who join
- to manage the Piedmont Region budget in a more efficient and coherent way
- to optimise and to standardise the buses used in the Piedmont Region
- to obtain a better price

After the tender was awarded, each public transport company is independently to sign a supply contract with BYD EUROPE B.V.

Needs analysis

[1] OJEU = Official Journal of the European Union, where all tenders above a certain value must be published

The Piedmont Region established a Commission in order to assess the project proposals of public transport companies in the region, selecting them based on the following evaluation criteria:

1) Environmental criterion: number of times the PM10 daily limit value (50 ug / m3) was exceeded in the area served in 2010, 2011 and 2012;

2) Technical criterion: proposal assessed in terms of bus size and maximum number of transported passengers, as well as the buses' range, the length of the routes and the poles of attraction served.

Market engagement

In order to arrange technical specifications, GTT carried out a market survey to identify the types of electric buses available. In the pre-qualification phase 10 worldwide suppliers presented an offer; only 6 of these were selected because they met the defined technical and financial requirements.

Life Cycle Costing

Within the award phase of the tender, estimated maintenance costs for the vehicles offered were assessed – not as part of the economic assessment, but as part of the maintenance and technical assistance assessment (see points scheme below).

Tenderers were asked to provide figures on preventive and corrective maintenance, and spare parts, based on a 15 year lifespan, averaging 50,000 km/yr, and labour costs of 35 €/hr.

Tender specifications and Verification

TECHNICAL SPECIFICATIONS

- 2-axle buses, pure electric drive, length 12 m, M3 category, class 1, low platform, air-conditioned
- BATTERIES: The system must guarantee, under the conditions of the various route profiles indicated, a range without recharging of at least 170 km. The number of batteries is chosen according to the mission profile, routes, stops and road situation.
- CHARGING STATIONS: If the minimum daily range requirements are not met, rapid charging stations must be provided at the depot. Installation is not necessary.
- FULL SERVICE MAINTENANCE: duration 10 years (the service also includes the traction

batteries)

AWARD CRITERIA

- Economic offer (max 30 points)
- Technical offer (max 62 points) divided into:
    - Energy consumption (0-5 points)
    - Cockpit (0-8 points)
    - Passenger compartment (0-10 points)
    - Performance (0-10 points)
    - Vehicle quality (0-4 points)
    - Drive system: Range without charging, guaranteed lifecycles, battery charger, computer system (0-19 points)
    - Rapid charging stations: charging time and charging type (0-6 points)
- Maintenance and technical assistance (including estimated maintenance costs) (max 6 points)
- Terms of delivery (max 2 points)

VERIFICATION

In the offer phase, the commission requested a sample vehicle to perform a qualitative test.
The bidder also had to indicate any differences between the product offered and the sample vehicle.
The consumption test was carried out in the testing on the first vehicle delivered. For this test, the SORT cycle mode ("Standardised On-Road Test Cycles", planned for diesel-powered vehicles) was adapted to fit with an electric engine, as a standard test cycle for electric buses has not yet been defined. In particular:

- the vehicle must have batteries charged to 100% and not use intermediate charging during the test cycle);
- The test cycle was carried out with the SORT1 speed / acceleration profiles, by measuring the energy consumption with specific instrumentation

The decay curve of the batteries over time was also requested from the supplier, considering them at the end of life when they reach a remaining capacity of 80% (standard IEC 62660).

Results

Environmental impacts

The electric buses demonstrate a **62% reduction in CO_2 emissions** in comparison to a conventional EURO 6 diesel bus – a saving of 769 tonnes of CO_2 per year. This takes into account emissions related to electricity generation. 50% of GTT's electricity derives from renewable energy sources (RES).

The electric bus also emits zero local harmful pollutants – in particular NO_x and particulates (PM) – and also noise emissions.

Table 2: Environmental savings

Tender	Lifetime (years)	Distance (km/year)	CO_2 emissions (tonnes/year)	Primary Energy consumption (GWh/year)
Diesel EURO 3 - Baseline	13	50,000	1,308	4,75
Diesel EURO 6 – Conventional tender			1,230	4,47
Electric – Green tender			461	2,85
Savings - Electric compared to conventional			**769 (62%)**	**1,62 (36%)**

CALCULATION BASIS

- CO_2 emissions factor set at 0,404652 kg/kWh for electricity
- For primary energy consumption a PEF (Primary Energy Factor) of 2.5 was assumed
- More detailed calculations are included in the table below
- Calculation made using the tool developed within the GPP 2020 project (*www.gpp2020.eu*), and refined within the SPP Regions project. Available on the SPP Regions website.

Table 3: NMVOC, NOx and PM 2.5 local emissions

Technology	NMVOC (g/km)	NO_x (g/km)	PM2.5 (g/km)
Diesel EURO 3 - Baseline	0.409	9.38	0.207
Diesel EURO 6 – Conventional tender	0.022	0.597	0.0023
Electric	0	0	0

Source: EMEP/EEA air pollutant emission inventory guidebook 2016

Financial impacts

The Piedmont Region directly funded 90% of the vehicle purchase price up to a maximum of EUR 400,000.00 each. The remainder is paid by the individual clients (transport operators), as well as the full cost of any quick charge station and the fee for maintenance services. The vehicles funded under this announcement are subject to an inalienability restriction with a maturity of 10 years.

Despite the significant cost of acquisition of an electric bus, the analysis of the life cycle costs (LCC) revealed a savings of about 50,000 € in 10 years (more than 2,600 € per bus) including emissions cost.

INNOVATIVE SOLUTION

The required bus, as well as meeting the environmental standards, must be equipped with high technical standards regarding comfort, safety, fuel economy, performance and air-conditioning.

Life Cycle Costing

A complete life cycle cost comparison was conducted following the tender by comparing the winning bus with 2 other bus models. This analysis was performed by Arpa Piemonte by using the calculator "Vehicles – Life Cycle Cost (LCC) Calculator" developed by Clean Fleets[2]. In this case, it was a comparison between:

- 12m diesel-powered Euro III bus (current model in use)

[2] www.clean-fleets.eu/fileadmin/files/documents/Publications/LCC_tool_Aug_2015/Clean_Fleets_LCC_tool_-_EN.xlsm

- 12m diesel-powered Euro VI bus (potential alternative)
- 12m electric bus

To calculate, the following variables were defined:

- acquisition cost
- operation costs (bus use, type of fuel, performances, etc.)
- maintenance costs (including battery replacement – likely after 6.5 years)
- environmental costs (emissions), based on the *operational lifetime costs* methodology prescribed within the Clean Vehicles Directive (2009/33/EC), which gives a value to emissions of CO2, NOx, particulates (PMs), and NMHC[3]

Table 1: LCC analysis results performed by ARPA Piemonte

Tender	Lifetime (years)	Average distance per vehicle in lifetime (km)	LCC (€/unit)*
Diesel EURO 3 - Baseline	13	650,000	652,297.90
Diesel EURO 6 – Conventional tender			607,700.08
Electric – Green tender			605,065.99

**Hypothesis: Diesel price 1,1 €/L; electricity price: 0,15 €/kWh; electric bus maintenance costs: 11,000€ (from GTT tender); diesel-powered bus maintenance costs ~+40%; diesel powered acquisition cost 220,000 €; electric bus acquisition cost 420,000 €; amount of fuel Euro 3: 50 l/100km; amount of fuel Euro 6: 47 l/100km; amount of electricity electric bus: 120 kwh/100km; duration batteries: 6,5 years.*

[3] www.clean-fleets.eu/fileadmin/files/documents/Publications/CVD_Operational_Lifetime_Cost_Methodology_-_Clean_Fleets_Factsheet.pdf

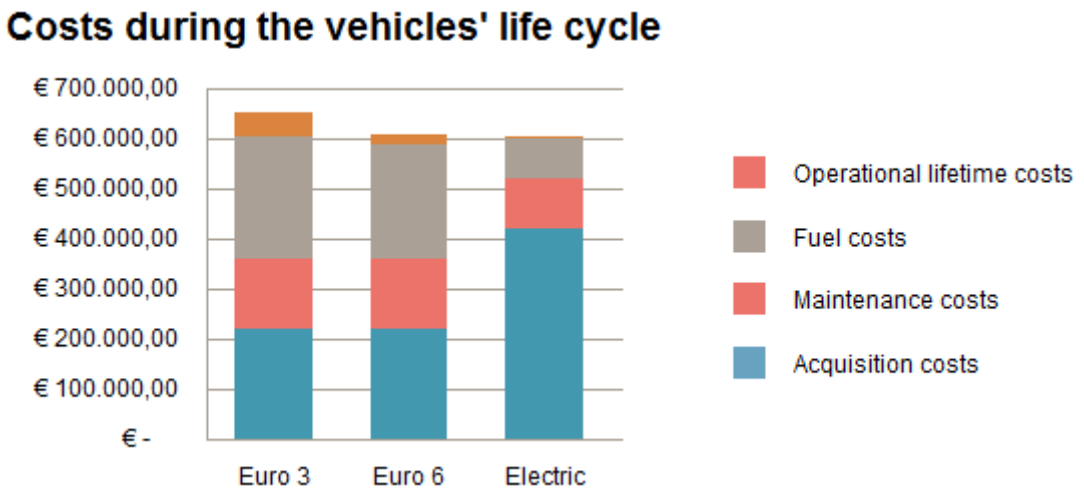

Diagram 1: Total costs for each model at the end of planning horizon

As shown in the diagram, electric buses, despite a higher acquisition cost, have lower fuel, maintenance and environmental (due to emissions) costs in the considered planning horizon (10 years). Results demonstrate that these lower costs offset the higher acquisition cost in the longer term.

Market response

Some suppliers were prevented from bidding due to the strictness of technical criteria on batteries and (in some cases) charging stations. In the final assessment, the only valid offer presented was the winning one (BYD), which shows the still limited availability of electric buses with high technological standards on the Italian and European market.

Despite this, the market for electric buses is evolving. In 2017 GTT will publish two new calls for electric buses - 5 6,5m buses, and 12 e 6.5 – 9m buses).

Lessons learned and future challenges

Lessons learned

- The price of E-buses is still very high, mainly because of the cost of batteries whose duration is not yet sufficiently proven.
- The most appropriate type of electric bus depends on the type of service to be performed (route length and placement of depots), on financial availability (funding for buses and/or of charging station), on market availability and on land morphology.

- In the future, fast charging should be a requirement for the batteries. However this will only be possible when a sufficient number of electric buses are operating in the same area in order to optimize their use.
- The technical requirements and vehicle characteristics were set very high – particularly battery range, charging stations, and full service maintenance – and for the majority of suppliers the economic costs of meeting these requirements were too high. It was also required that all buses were the same despite different route profiles. In the future a better compromise should be found in terms of:
  - Price and range of the buses (according to the specific route profiles);
  - Charging station cost (and interface standardisation to enable use for different types of vehicles);
  - Power available for quick charging station (physical limit of the power distribution network);
  - Potential financing for the charging infrastructure, and potentially servicing, as well as the buses
- In the future it would be better to allow transport companies more freedom to select bus type/design according to the specific usage profile, rather than ensure interchangeability across the region.

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Annex 1 - Calculation of environmental savings

Calculations made using the tool developed within the GPP 2020 project (www.gpp2020.eu), and refined within the SPP Regions project. Available on the SPP Regions website.

- *LCC Calculator and Emission savings Calculator*

clean fleets
purchasing clean public vehicles

VEHICLES - LIFE CYCLE COST (LCC) CALCULATOR

Please fill in the white cells only

GENERAL CONDITIONS							
ⓘ	Contract length/period of vehicle ownership	Year	10				
ⓘ	Discount rate	%	2,00				
ⓘ	Number of bids/offers		3				
ACQUISITION COSTS							
	Name of bidder/vehicle model		**Euro 3**		**Euro 6**		**Electric**
ⓘ	Number of vehicles		19		19		19
ⓘ	Purchase price	€/unit	220.000,00	€/unit	220.000,00	€/unit	420.000,00
	(or) Lease price	€/unit/year		€/unit/year		€/unit/year	
	COSTS OF ACQUISITION € / UNIT		**220.000,00**		**220.000,00**		**420.000,00**
OPERATING COSTS PER VEHICLE							
ⓘ	Annual use of vehicle	km	50.000	km	50.000	km	50.000
ⓘ	Type of Fuel		Diesel		Diesel		Electricity
ⓘ	Fuel consumption per vehicle	l/100km	50	l/100km	47	kWh/100km	120
	Fuel price	€/l	1,10	€/l	1,10	€/kWh	0,15
ⓘ	Add a second fuel type (PHEVs, dual fuel)?		No		No		No
	Type of Fuel 2						
ⓘ	Fuel consumption per vehicle 2						
	Fuel price 2						
	Replacement battery price	€/unit		€/unit		€/unit	
	Expected lifetime of battery	Years		Years		Years	
	(or) Battery lease price	€/unit/year		€/unit/year		€/unit/year	
	OPERATING COSTS € / UNIT		**244.621,09**		**229.943,82**		**80.257,56**
MAINTENANCE COSTS PER VEHICLE							
ⓘ	Estimated annual maintenance costs	€/unit/year	15.400	€/unit/year	15.400	€/unit/year	11.000
ⓘ	(or) Annual service agreement	€/unit/year		€/unit/year		€/unit/year	
	MAINTENANCE COSTS € / UNIT		**138.331,81**		**138.331,81**		**98.808,44**
TAXES AND OTHER COSTS/SUBSIDIES PER VEHICLE							
ⓘ	Vehicle tax	€/unit/year		€/unit/year		€/unit/year	
	Insurance costs	€/unit/year		€/unit/year		€/unit/year	
ⓘ	Infrastructure - one off investment costs	€		€		€	
	(or) Infrastructure - annual costs	€/year		€/year		€/year	
ⓘ	Other costs/subsidies (*click on left + to expand*)						
TOTAL OTHER COSTS AND SAVINGS/ UNIT			-		-		-
ⓘ	**EMISSIONS (OPERATIONAL LIFETIME COST- OLC) PER VEHICLE - OPTIONAL SECTION**						
	Do you wish to apply the operational lifetime cost methodology from the Clean Vehicles Directive?		Yes				
ⓘ	CO_2 Emissions	g/km	1.300	g/km	1.200	g/km	400
	Lifetime cost of CO_2 emissions € / unit		19.500,00		18.000,00		6.000,00
ⓘ	NO_x (Nitrous oxides)	g/km	9,38	g/km	0,597	g/km	0
ⓘ	PM (Particular Matter)	g/km	0,207	g/km	0,0023	g/km	0
ⓘ	NMHC (Non-methane hydrocarbons)	g/km	0,409	g/km	0,022	g/km	0
	Lifetime cost of pollutant emissions € / unit		29.845,00		1.424,45		-
ⓘ	Reference Fuel (Cheapest of petrol or diesel before tax)						
ⓘ	Cost of Reference Fuel (before tax)	€/l		€/l		€/l	
	Lifetime cost of energy consumption € / unit		-		-		-
OPERATION LIFETIME COST (OLC) € / UNIT			**49.345,00**		**19.424,45**		**6.000,00**
END OF LIFE							
ⓘ	Remnant value (at end of contract period)	€/unit					
			-		-		-
	TOTAL LCC PER UNIT		**652.297,90**		**607.700,08**		**605.065,99**
	TOTAL LCC		**12.393.660,09**		**11.546.301,60**		**11.496.253,88**

Location	Italy		CO_2-emissions per kWh (kg CO_2/kWh)	0,405

Input	Baseline					Conventional tender					Green tender				
	Quantity of vehicles	Average distance per vehicle per year (km/yr)	Kind of fuel	Amount of fuel per 100 km		Quantity of vehicles	Average distance per vehicle per year (km/yr)	Kind of fuel	Amount of fuel per 100 km		Quantity of vehicles	Average distance per vehicle per year (km/yr)	Kind of fuel	Amount of fuel per 100 km	
Standard Engine - fuel 1	19	50.000	Diesel	50,0	l/100 km	19	50.000	Diesel	47,0	l/100 km			Diesel		l/100 km
Standard Engine - fuel 2			Diesel		l/100 km			Diesel		l/100 km			Petroleum		l/100 km
Electro Engine			Electricity		kWh/100km			Electricity		kWh/100km	19	50.000	Electricity	120,0	kWh/100km
Hybrid Engine															
Electricity (combined test cycle)			Electricity		kWh/100km			Electricity		kWh/100km			Electricity		kWh/100km
Fuel (combined test cycle)			Diesel		l/100 km			Diesel		l/100 km			Diesel		l/100 km
TOTAL	**19**	**50.000**				**19**	**50.000**				**19**	**50.000**			

Total consumption and emissions	Baseline				Conventional tender				Green tender			
	Annual fuel consumption		Primary energy consumption (GWh/yr)	CO_2-emissions per year (t)	Annual fuel consumption		Primary energy consumption (GWh/yr)	CO2-emissions per year (t)	Annual fuel consumption		Primary energy consumption (GWh/yr)	CO2-emissions per year (t)
Standard Engine - fuel 1	475.000	l	4,75	1.308	446.500	l	4,47	1.230	0	l	0,00	0
Standard Engine - fuel 2	0	l		0	0	l		0	0	l		0
Electro Engine	0	kWh	0,00	0	0	kWh	0,00	0	1.140.000	kWh	2,85	461
Hybrid Engine												
Electricity (combined test cycle)	0	kWh	0,00	0	0	kWh	0,00	0	0	kWh	0,00	0
Fuel (combined test cycle)	0	l		0	0	l		0	0	l		0
TOTAL			**4,75**	**1.308**			**4,47**	**1.230**			**2,85**	**461**

Savings	Total savings (Baseline / Green tender)				Savings (Conventional tender / Green tender)			
	Energy savings (GWh/yr)	CO_2-savings (t/yr)	% of energy savings	% of CO_2-savings	Energy savings (GWh/yr)	CO_2-savings (t/yr)	% of energy savings	% of CO_2-savings
Standard Engine - fuel 1	4,75	1.308	100%	100%	4,47	1.230	100%	100%
Standard Engine - fuel 2								
Electro Engine	-2,85	-461	#DIV/0!	#DIV/0!	-2,85	-461	#DIV/0!	#DIV/0!
Hybrid Engine								
Electricity (combined test cycle)	0,00	0	#DIV/0!	#DIV/0!	0,00	0	#DIV/0!	#DIV/0!
Fuel (combined test cycle)								
TOTAL FOR THE PROJECT	**1,90**	**847**	**40%**	**65%**	**1,62**	**769**	**36%**	**62%**

- *Operational Lifetime Costs are calculated using values from:*

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0033&from=EN

- *Electric bus Maintenance cost (+40%) are supposed from:*

www.enea.it/it/comunicare-la-ricerca/events/rds_elettromobilita_15lug15/ValentiniRSEluglio2015v04.pdf

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About SPP Regions

SPP Regions is promoting the creation and expansion of 7 European regional networks of municipalities working together on sustainable public procurement (SPP) and public procurement of innovation (PPI).

The regional networks are collaborating directly on tendering for eco-innovative solutions, whilst building capacities and transferring skills and knowledge through their SPP and PPI activities. The 42 tenders within the project will achieve 54.3 GWH/year primary energy savings and trigger 45 GWh/year renewable energy.

SPP REGIONS PARTNERS

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