“Stolichen Autotransport” EAD

Presentation

Sofia Autobus Company

- Bus fleet investment through deployment of Low Emission Vehicles
- Politehnica University of Bucharest, Splaiul Independentei 313
- 24 April 2018, 09:00 – 15:30
“Stolichen Autotransport” is a sole-owned stock company, with 100% owned by Sofia Municipality.

We are an internal operator within the meaning of Regulation (EU) 1370/2007.


The company carries more than 40% of all passengers using public transport in the capital (tram, trolley, subway, other bus operators).

The company has 3 bus depots.
Our Service

- 65 bus lines out of 95 in Sofia
- Served by 417 buses in same time
- 38 urban and 27 suburban lines
- Annual mileage is over 32 million kilometers
- Main operator when replacing tramway, trolleybus and metro lines
"Night Transport"

- The new night transport project started on 07.04.2018
- Serves on 4 independent lines with 1 cross point
- 14 shuttle buses are provided
- Time range from 00:00h to 04:30h.
- One ticket of 1 euro for the whole night
State of the company until 2012

Age of the fleet

- up to 5 years: 1%
- from 5 to 10 years old: 27%
- from 10 to 15 years old: 23%
- from 15 to 20 years old: 5%
- over 20 years old: 44%

Level of pollution

- Euro 0: 32%
- Euro 1: 18%
- Euro 2: 23%
- Euro 3: 20%
- Euro 4: 6%
- Euro 5: 1%
State of the company until 2012

Average age of fleet: 21.8 years

- 18 m buses: Average 24.6 years
- 12 m buses: Average 18.8 years
The “STRATEGY”

• First Stage: PROGRAM 2012-2016
• Second Stage: PROGRAM 2016-2018
• Step 1 and 2
First Stage: 2012-2016
Step 1

- At the end of 2011, Sofia Municipality assigns development "Bus fleet renewal program 2012-2016"

- Finding a possibility of financing from a European fund
First Stage: 2012-2016
Step 1

- The implementation of the Program starts with a contract DIR-51315001-C003 under the project "Implementation of Actions for Improvement of the Ambient Air Quality by Buying and Supplying of Buses"
- As a result, at the end of 2014 begins the delivery of 126 pcs. CNG articulated (18 m) buses MAN Lion's City G
- 20% own funds and 80% of the European fund under the Operational Program "Environment 2007 - 2013"
Result of Step One 2012-2016 in two aspects

**Ecological**
- Reduction of harmful emissions

**Economical**
- Reduce operation costs by using alternative fuels
Ecological Result of Step One 2012-2016

- Reducing pollution by nearly 665 tons per year
- Verified by the European Court of Auditors in 2017

<table>
<thead>
<tr>
<th>CO</th>
<th>CH</th>
<th>NOx</th>
<th>micro particles</th>
<th>Total, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Pollution of 126 old buses with engine EURO 0 with an annual mileage of around 60,000 km, kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 220</td>
<td>115 337</td>
<td>582 952</td>
<td>15 671</td>
<td>789 179</td>
</tr>
<tr>
<td>Annual Pollution of 126 new CNG buses with engine EURO 6 with an annual mileage of around 60,000 km, kg</td>
<td></td>
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</tr>
<tr>
<td>80 744</td>
<td>10 497</td>
<td>32 298</td>
<td>807</td>
<td>124 346</td>
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<tr>
<td>Decrease, kg</td>
<td></td>
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<tr>
<td>508 984</td>
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</tbody>
</table>
Economically Result of Step One
2012-2016

Advantage of using alternative fuel - CNG

• Similar fuel consumption per 100 km for diesel and natural gas (~50 L - diesel; ~60 Kg - CNG)
• Approximately 60% lower price of natural gas
• With an annual mileage of 60,000 km, one bus saves an average of €15 500 from fuel every year
• All 126 buses have saved €5 800 000 of the company's funds for the past 3 years of operation
First Stage: 2012-2016

Step 2

- In the summer of 2014, Sofia Municipality decided to start negotiations on a long-term loan.
- At the same time, we obtain permission from the municipality to launch a tender for the purchase of 110 solo (12 m) diesel Euro 6 buses.
First Stage: 2012-2016

Step 2

- In December 2015 a contract was signed with the winner in the tender - Chinese producer Yutong.
- In September 2016, all 110 buses are in Sofia.
- The brand is Yutong ZK6126HGA certified model Euro 6 for the European market.
Result of Step Two 2012-2016 in two aspects

**Ecological**

- Reduce emissions by another 509 tons per year

<table>
<thead>
<tr>
<th>CO</th>
<th>CH</th>
<th>NOx</th>
<th>micro particles</th>
<th>Total, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 764</td>
<td>80 905</td>
<td>408 921</td>
<td>10 992</td>
<td>553 582</td>
</tr>
</tbody>
</table>

Annual pollution of 110 old engines EUR 0, kg

**Economical**

- The basis for the ranking in the tender is "The most economically profitable offer"
- The company saves just over EUR 4,300,000 from the funds allocated
- In the future, the saved funds will be used to buy more eco-friendly buses

<table>
<thead>
<tr>
<th>5 025</th>
<th>10 050</th>
<th>28 895</th>
<th>628</th>
<th>44 598</th>
<th>Decrease, kg</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>508 984</td>
</tr>
</tbody>
</table>
End of Stage: 2012-2016

Fleet

- Euro 3,2: 49%
- Euro 4: 6%
- Euro 5: 1%
- Euro 6: 44%
“The other side of the coin”

- Alternative fuel vehicles also means charging!
- Additional charging equipment like CNG stations - means additional investments
- Need of precise planning of CNG station capacity and charging time
- Time for building and putting into work
"How it’s made"

Establishing source data
(For example one of our depots)

- Compressor inlet pressure (6 bars in Sofia)
- Tank capacity of the bus (1800 L \( \div \) 150 \( \div \) 200 Kg)
- Total buses for charging (40 buses in one depot)
- Time to refill all buses (8 hours in the night)
- Is enough electricity available to compressors

Capacity Calculation

- 40 buses \( \times \) 200 kg = Total 8000 kg
- \( \text{Nm}^3 \) = 8000 kg / 0.70 = 11 500 \( \text{Nm}^3 \)
- The fast compressed capacity should be as follows: 11 500 \( \text{Nm}^3 \) / 8 h = 1437.50 \( \text{Nm}^3/h \)
- It is recommended that the compressor/s have 30% more capacity
- Think about the future
"How it’s made"

- Recommendations for planning the required construction time
- The physical construction of one CNG station takes about 6 months
- If it’s done with a tender, it may take up to 1 year
- It’s recommended simultaneously purchasing buses and building CNG stations
- Necessary costs
- The average price for one new CNG station is about EUR 500,000
- In the case of 126 buses, 3 depots and other source data, the required investment would be no more than EUR 1,500,000
The expected summary if CNG buses are selected

**Initial investment**
- € 1,500,000 for CNG stations and equipment (as in our example)
- From 6 months to 1 year for construction
- A higher single price (about 10%) for the CNG vehicles vs. Diesel

**Achievement**
- The most important is the high level of environmental friendliness
- Quite low running costs for operation (as in our example, we save € 1,900,000 in one year)
- Lower maintenance cost
- The return of investment - after only 1 year of operation
Second Stage of “Strategy” 2016-2018

- In the middle of 2016 Sofia Municipality adopts the final development program
- Sofia Autotransport was assigned to make tenders for:
  - 60 CNG Solo (12 m) buses with a lease
  - 60 CNG articulated (18 m) buses with a lease
  - Another 22 CNG buses, with the money saved
  - 20 full electrical buses with a lease
  - 20 hybrid or other alternative fuel sources
The challenge

- The idea of buying fully electric buses has given us a real challenge
- We had to quickly get in touch with new technologies
- And to understand what we need
Tests on Electric Buses

- Testing of electric buses started in January 2017
- The first testing bus is Yutong E12 for 4 months

Type E12 - capacity 90 people
Electric engine: Yutong M280-CV9-H – 215 kW – 1200Nm

Dimensions (mm) 12 170 * 2 550 * 3 340
Lithium-ion batteries; capacity 290 kW / h
Charging time 60Kw: 6-6.5h; 120kW: 2.5-3h
Tests on Electric Buses

• The second electric bus provided to us for the test is SOR Ebn 11
• In operation for one month

Type Ebn 11 – capacity 85 people

Electric engine: asynchronous, six-terminal, watercooling, 120 kW - 968 Nm

Dimensions (mm) 11 100 * 2 525* 2 920

Winston Battery / Lithium – ion; capacity 172 kWh
Tests on Electric Buses

• The third electric bus provided to us for the test is SOR Ebn 8
• In operation for 3 months

Type Ebn 8 – capacity 46 people

Electric engine: asynchronous, six-terminal, watercooling, 120 kW - 968 Nm

Dimensions (mm) 8 000* 2 525* 2 920

Winston Battery / Lithium – ion; capacity 172 kWh
Tests on Electric Buses

• Another electric bus is Solaris Urbino 12 - tested in Sofia by our colleagues

Type Urbino 12 – capacity 70 people

Electric engine: Rear portal bridge ZF AVE 130 - with built-in 2 - 110 kW engines

Dimensions (mm) 12 000* 2 550

Battery: Lithium – ion; capacity 240 kWh
## Test results

<table>
<thead>
<tr>
<th></th>
<th>Yutong E12</th>
<th>SOR Ebn 11</th>
<th>SOR Ebn 8</th>
<th>Solaris Urbino 12</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total mileage, km</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Winter, whit heating</td>
<td>13 082,00</td>
<td>1,0672</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kw/km</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring, whitout heating</td>
<td>10 112,00</td>
<td>0,8593</td>
<td>0,9926</td>
<td>0,7704</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kw/km</td>
<td>Kw/km</td>
<td>Kw/km</td>
</tr>
<tr>
<td>Summer, whit aircondition</td>
<td></td>
<td>4 986,00</td>
<td>11 884,00</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 137,00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>23 194,00</td>
<td>1,0099</td>
<td>0,9926</td>
<td>0,7704</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kw/km</td>
<td>Kw/km</td>
<td>Kw/km</td>
</tr>
<tr>
<td><strong>Cost per km</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Possible mileage with one charge</td>
<td></td>
<td>0,0827 €</td>
<td>0,0812 €</td>
<td>0,0704 €</td>
</tr>
<tr>
<td>Over 250 km</td>
<td></td>
<td>Over 160 km</td>
<td>Over 200 km</td>
<td>Over 200 km</td>
</tr>
<tr>
<td>up to 290km</td>
<td></td>
<td></td>
<td>0,1052 €</td>
<td></td>
</tr>
</tbody>
</table>
Overview of electric buses

Initial investment and weaknesses

- Very high unit price
- More than double compared to diesel bus
- Ensuring sufficient electrical power for the charging stations in depot
- A low mileage with one charge
- Moving emissions into areas with a power plant

Achievement

- Zero emissions in the city
- Extremely low running cost
- Almost without need of maintenance
- Silent
Summary of Running costs

Running costs (Energy or fuel) per 100 km, €

- Diesel bus: €40.00
- CNG bus: €15.00
- Electric bus: €0.00
General Summary

![Bar chart showing initial investment, running cost, and environmental factor for Diesel Euro 6, CNG Euro 6, and 100% Electric vehicles.](image-url)
Second Stage of “Strategy” 2016-2018

• Where are we today?
  • Contract for 60 CNG (12 m) buses is ready for signing
  • Contract for 20 full electrical (12 m) buses is already signed in 20.04.2018
  • Tender for 22 CNG (12 m) buses is almost at the finish
New E12 expected in Sofia
State of the company at the end of 2018

Fleet (Ecology)

- Electric: 4%
- Euro 6: 69%
- Euro 5: 1%
- Euro 4: 6%
- Euro 3: 20%

Fleet (Extras)

- All Buses: 655
- CNG: 275
- Aircondition: 398
- Low Floor: 501
Thank you for your attention