

## Retrofitting trams for energy efficiency in Craiova

CRAIOVA MUNICIPALITY, ROMANIA

### Procurement objectives

The Local Council of Craiova Municipality's main objective was to increase the overall quality of life of its citizens through the reduction of pollution generated by transport, and the implementation of energy-saving measures. To reach this goal, one of the measures undertaken by the city was to improve the energy efficiency of its existing tramlines. At the start of the project, in 2008, Craiova's electric tramway fleet included 36 tramways. 9 of these lines, however, were no longer in use due to high energy consumption of the driving system. To put these trams back in operation, the city aimed to decrease the electrical consumption and costs by using an innovative electronic chopper system. It was also hoped that the measure would increase public transport capacity.

### Background

The city of Craiova, capital of the Oltenia Region, is situated in the South-West of Romania, has 320'000 inhabitants and is an historic, commercial and cultural centre. In 2008 Craiova joined 3 other European cities (Brescia, Coimbra and Victoria-Gasteiz) under the framework of the [CIVITAS Mobility, Development and Energy Reduction \(MODERN\)](#) initiative, co-financed by the European Commission. Through the CIVITAS Initiative, the European Commission aimed to support cities in the implementation of sustainable urban transport strategies that would improve the welfare of their



### Criteria used

Tender documentation was developed based on research carried out regarding the modernisation of electrical drive systems as well as some solutions adopted by other transport operators. Modernisation of the trams would include two major changes to traction equipment:

- the replacement of the old drive system with electric choppers which control the electric current used by the trams; and
- the replacement of the motor-generator group for the power supply of the auxiliary services with a static converter.

#### Subject matter of the contract:

Modernisation of electrical drive vehicles for public transportation

#### Technical specifications:

##### Traction control chopper with Insulated-Gate Bipolar Transistor (IGBT)

- Input voltage: 750VDC / 600VDC (+20%;-30%)
- Output: 150KW
- Construction: modular
- Location: under floor or on the roof
- Cooling: forced ventilation
- Characteristics: IGBT-technology without contactors to change the start - brake mode combined regenerative and rheostatic brake control signal: optical fiber protections: over tension, short-circuit, over temperature
- Control unit with Digital Signal Processor:
  - Construction Printed Circuit Boards, plug-in unit
  - Cooling: natural convection
  - Supply: 24VDC (+/- 20%)

##### Auxiliary power supply static converter

- Nominal output power: 5KVA
- Input voltage: 750VDC (+20%;-30%)
- Output voltage: 24-30VDC adjustable
- Maximum output: 180ADC
- Options:
  - Output: Three-phase voltage 400VAC, 50Hz
  - Nominal power: on request

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### Results

The acquisition procedure concluded in January 2010 and the winning company was assigned the contract in accordance with EU public procurement rules.

9 trams were upgraded with the chopper based system, achieving a 34.8% reduction in energy consumption. The chopper system achieves this by eliminating electric resistance. The older technology controlled the tram's speed by introducing electric resistance into the motor circuit on a gradual basis. The process transformed electric energy into heat which, especially at low speeds, is then lost. This is typical of urban traffic. By integrating the chopper control system, electric resistance is eliminated, which decreases the creation of excess heat and thereby increases the tram's efficiency.

The new system also allows for the conversion of kinetic energy into electrical energy, which is recovered through the power line. This energy is then used by the other vehicles that are powered by the same line.

Due to the installation of this new system, Craiova has been able to reduce the costs of running part of its electric tram fleet, increase passenger capacity across the system, and reduce pollution related to energy consumption. The technology employed in Craiova's trams is also currently being promoted in the neighbouring countries of Bulgaria, Slovakia, Albania and Macedonia.

### Environmental impacts

Electric trams are a potentially environmentally friendly way of moving large numbers of passengers efficiently, reducing traffic and local air pollution. However, trams that use inefficient and out-dated systems can still have a considerable impact on the environment due to their reliance on electrical power generated by burning fossil fuels. Installing regenerative braking technology to recover energy can also substantially reduce energy consumption and contributes to reducing emissions.

Increasing the transport capacity and comfort of trams may also encourage passengers to prefer this type of transportation over the use of cars. According to one source, the amount of CO<sub>2</sub> emitted per passenger and per kilometre by electric tram systems is less than half the amount emitted by a small car. The CO<sub>2</sub> emissions associated with the generation of electricity used to power the trams may, therefore, be balanced and offset by the reduction in emissions from those drivers choosing to travel by tram rather than by car.

### Lessons learned

One of the main lessons learned was that it is better to upgrade old trams rather than replace them with a new system. Trams are an important alternative to transport by private car, and it can provide benefits both for travelers and the surrounding environment. The introduction of a new tram system can be quite expensive, therefore, existing trams should be upgraded instead. Doing so provides economic advantages as well as reducing pollution. These older trams are also an important part of the city's history and identity and they should, therefore, be preserved.

The team also learned that consolidating the different perspectives of political, technical and scientific actors can also be challenging. However, once these views were harmonised, they provided a powerful mechanism for change which ultimately benefitted the city of Craiova.

<sup>1</sup> The CO<sub>2</sub>nnect CO<sub>2</sub> calculator: [http://www.co2nnect.org/help\\_sheets/?op\\_id=602&opt\\_id=98](http://www.co2nnect.org/help_sheets/?op_id=602&opt_id=98)