Recovering biogas to power public transport

City of Vaasa, Finland

Background

The City of Vaasa on the west coast of Finland has a population of around 67,500. Regional waste management company Ab Stormossen Oy has been producing biogas from waste from as early as 1990, and the city has become known as a hub for energy technology businesses in the Nordic region.

Building on Finland’s Energy and Climate Map 2050 - which aims to reduce greenhouse gas emissions (GHG) by 80-95% by 2050 compared to 1990 levels - the City of Vaasa created an Energy and Climate Programme in 2016, which fixed the goal of becoming a carbon neutral city by 2035.

The Energy and Climate Programme highlighted growing levels of traffic and associated environmental problems as a particular challenge - the number of cars in Vaasa is increasing by around 3.5% per year despite a population rise of only 1.8% over the same period. In addition to GHG, traffic emissions lead to air, water and noise pollution, and present risks to human health.

One effective strategy for tackling vehicle emissions is supporting an effective public transport network, and in 2014, when procuring new buses, the City decided to increase their impact further by requiring that buses fully run on biogas.

Procurement objectives

Several low emission technologies exist, but in 2014, the City of Vaasa decided that its new buses should operate on biogas.

By using biogas, the buses would not only forgo the fossil fuel that would otherwise have been used, but also support the creation of ‘circular economy loops’ by making use of the energy recovered by regional waste management company Stormossen. Stormossen is a waste processing company partly owned by the City of Vaasa, which generates biogas out of sewage sludge from Vaasa’s waste water treatment facility and separately collected household bio-waste. The aim now is to utilise biogas generated this way as year-round transport fuel.

As such, in September 2014, Vaasa undertook an ‘Open’ procurement procedure to purchase ten new two-axle buses and two new three-axle buses, all powered exclusively by biogas, as well as a ten-year maintenance agreement covering the ongoing maintenance and efficiency of the buses. At the same time, Stormossen invested in a biogas refinery and a filling station. The procurement procedures were carried out simultaneously in the autumn of 2014. The 12 buses acquired by the City are estimated to consume one third of the gas generated by the waste processing company.

Vaasa’s bus procurement process included an extensive dialogue with potential suppliers. The dialogue was based on preliminary ‘call for tender’ documents, to give suppliers a chance to make comments and suggest changes. In addition to the potential suppliers’ comments, the life-cycle costs (LCC) were also considered in the preparation of tender documents.
by comparing fuel and maintenance costs over the estimated life-cycle of the buses. Using a consumption-linked bonus/sanction method, fuel consumption will be monitored over the entire life cycle of the buses (source: Motiva).

**Criteria used**

**Subject matter of the contract:** Biogas powered buses and their maintenance.

**Technical specifications:** Bidders were required to propose buses with engines which can function on biogas (meeting Swedish Standard SS 155438) and are officially EURO 6 compliant. Buses must comply with the European Buses and Coach Directive 2001/85/EC.

**Award criteria:** The contract was awarded to the most economically advantageous tender. Each bid was assigned a score out of a possible 100 points (maximum) using three criteria:

1. Total price (40 points)
2. Price of the maintenance agreement (25 points for the ten two-axle buses, and 5 points for two three-axle buses)
3. Average annual gas consumption over a ten-year period (25 points for the ten two-axle buses, and 5 points for the two three-axle buses)

**Contract performance clauses:** During the initial market dialogue, Vaasa had attempted to gather information via a survey on the fuel efficiency which could be expected from biogas buses. However, the data they received from the manufacturers was difficult to compare. As such, they instead created a calculation method which relied on the real-life use of the vehicles as well as costs related to maintenance. This resulted in the contractor committing to an average gas consumption level of per normal cubic metre (Nm\(^3\))/100km (two-axel and three-axel) for each type of vehicle. If the average annual consumption of a two-axle bus falls below the amount presented in the tender, the City will compensate the supplier by refunding €3,000 per average Nm\(^3\)/100km (€6,000 for two-axel buses). And vice-versa if the opposite occurs.

For example, if the provider agrees to an average annual consumption of 50 Nm\(^3\)/100km for a two-axel bus, and average annual consumption after a year of service is 48 Nm\(^3\)/100km, the bidder will be credited 2 x €3,000.

Driver training to ensure efficient driving is also covered by the maintenance agreement, which the operator is responsible for. In addition, an incentive scheme which rewards low average annual gas consumption has been established.

**Results**

The total price of the biogas buses was €3.2 million, plus the ten-year maintenance contract, which was worth a further €2.2 million. In comparison, the equivalent diesel bus fleet would have entailed a cost of €2.7 million, with an additional €2 million maintenance contract. The additional cost of procuring biogas buses ensures, however, that the ongoing operational costs (that is, fuel) are spent locally, and thus it can be considered an investment in a local circular economy.

The City of Vaasa has its own agreement on gas sales with Stormossen. The gas price also includes the annual rent of 12 biogas buses' slow filling stations (for overnight refuelling). The gas supply agreement has a ten-year duration and the sale price of gas decreases as gas sales increase, that is, the use of passenger biogas cars increase. One diesel...
litre costs about €1.3 and one biogas cubic metre is about 85% of that price. Based on the estimated LCC, the low selling price of biogas was the main reason why 12 biogas buses became 12% cheaper to operate than diesel buses. The biogas powered buses will not be affected by changes in fuel prices.

There were delays in finalising the procurement procedure due to related court proceedings concerning the procurement of the biogas station. Therefore, the 12 biogas buses entered into service in February 2017 – significantly later than planned. Three bids were received as a result of the call for tenders.

The buses were purchased using a leasing contract, and are owned by a (‘green’) finance company. After the end of the contract, the City has the option of purchasing the buses outright.

In terms of monitoring performance of the buses, this is done biannually as part of the agreement between Vaasa and the contractor. At the first meeting, an assessment of the performance data obtained was made for the first six month period in which the buses were in operation: 13 February 2017 to 30 August 2017. A total of 402,000 km were driven with 124,024.10 kg consumed. Average consumption of 2-axle buses was thus 32.06 kg/100 km (43.3 Nm$^3$/100 km) and for 3-axle buses 34.88 kg/100km (47.3 Nm$^3$/100 km), thus significantly lower than the contractors commitment, leading to lower fuel expenses. This triggered the above-mentioned compensation payment to the contractor. However, as noted, biogas is already cheaper than diesel, and the additional savings achieved by such high performance balances out the cost of compensation payments.

For its biogas bus acquisition, the City of Vaasa received an honourable mention in the Sustainable Public Purchaser 2015 contest (‘Kestävä julkinen hankkija 2015’).

**Environmental impacts**

It was estimated that the biogas buses purchased would consume 41 kg of gas per 100 km, on average, which translates into an estimated annual consumption of 300,000 kg. Replacing diesel with biogas will also reduce carbon emissions by more than 1,000 tonnes each year (280,000 litres of diesel every year). When compared to other ‘green’ vehicle options, making use of waste biogas in this instance is roughly equivalent, in terms of carbon dioxide (CO$_2$) emissions, to procuring fully electric vehicles powered by renewable wind energy (source: [German Energy Agency](https://www.dena.de), DENA).

The procurement is also an important action in the general support for biogas in the Vaasa region. This is mainly due to the infrastructure it supports. As well as the slow fuelling station used by the buses, the city’s organic waste from household collection and the sewage sludge from the City’s waste water facility means there is biogas available for a further 1,000 cars, and a fast-fuelling station has also been made available for them.
Lessons learned

Lessons learned that could be of interest to other cities and purchasing bodies:

- Leasing funding works well for bus purchases.
- In addition to purchasing buses, you also get an outsourced service agreement.
- Buses operating on biogas result in a reduction in the production of CO₂ emissions. They do not shift emissions from energy production to another location.
- Project schedules should be drawn up so that the purchase of biogas buses is at the very end of the schedule to thus prevent any unforeseen delays.
- Ensure that sufficient time is also factored in for changing suppliers (up to two months).

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For related information, please see European GPP Criteria for Transport and the Technical Background Report.