PILOT PROJECT APELDOORN
An initiative of Hedgehog Applications B.V.

Artist’s impression of Apeldoorn Station with smartgrid and electric city buses (Courage Architecten)

Introduction

Sustainability, a cleaner environment, particulate reductions, zero footprint, the use of green electricity etc. are all gaining prominence on today’s social agenda. Energy problems are growing, raw materials are becoming ever scarcer, pollution and pressure on the environment are intensifying and the global population is rising.

Sustainability is one of the four ambitions of the municipality of Apeldoorn as an ‘Outdoor City’. The attention given to sustainable development is deep-rooted in Apeldoorn’s DNA. It has to be an integral part of all developments in the municipality. Cleaner air, noise reduction and greater efficiency (energy reduction/neutral) are all key words. All kinds of businesses and civil initiatives are tackling these issues, as we can see from several measures that have already been introduced:

• The Ecofactorij business park;
• Experiments with the Whisperbus;
• The installation of electric charging points in the city.

Alongside these initiatives, together with the Stedendriehoek region Apeldoorn is promoting itself as a Cleantech Region, the aim of which is to be energy-neutral as a region by 2030. This will reinforce the ambition to excel in sustainability in all its aspects. In December 2016, Hedgehog,
together with the Cleantech Region, Community of Apeldoorn, province of Gelderland and the Ministry of Environment of Infrastructure signed a so called City Deal, promising to each other to achieve this pilot Project.

Hedgehog Applications B.V., a Apeldoorn based company, provides a perspective on how to act on sustainable development. The aim of the company is to introduce new ideas and patents to do with sustainability on the market, and by doing so to grow and develop as a sustainable business. The CEO is Arjan Heinen, former CEO of e-Traction Manufacturer of InWheel direct drive motors

The company has made a start on the ‘Project Apeldoorn’ initiative. The aim of this project is to construct and operate a smartgrid connection between the braking trains of the Dutch Railways (NS) and the electric buses operated by Keolis Netherlands in the municipality of Apeldoorn. The smartgrid connection has a buffer station that has sufficient charging capacity for the entire daytime service provided by all electric city buses of the responsible public transport operator Keolis Netherlands. The braking energy produced by the trains in the railway station is buffered, and via this buffer fully electric city buses are charged during the daytime services.

Involvement of the municipality of Apeldoorn

The cooperation of the municipality of Apeldoorn is desirable and essential in order to get this project off the ground. The municipality is one of the key partners envisaged for the project. What is required of the municipality is general support, making the land available, EIA, permits and potentially some modifications to the zoning plans:

- Land needs to be made available for the infrastructure (wiring, buffer station).
• The bus station must be remodelled and made suitable for the installation of charging stations for the buses.
• An Environmental Impact Assessment will probably have to be made.
• The Apeldoorn Fire Service will have to be trained to respond properly and safely in the event of an emergency. The associated permits will need to be issued.
• Municipal permits will need to be applied for and granted.
• Zoning plans may possibly need to be modified.

The requests made to the municipality are wide-ranging and will also place considerable demands on it. If the project is achieved, the environmental benefits to the municipality will be huge. There will be substantial reductions in CO₂ suit particulates and noise levels will be reduced. What’s more, the municipality will then have a superb example of sustainability within its own borders!

**Description of ‘Project Apeldoorn’**

**Background**

In 2012, NS Reizigers, Veolia and the Ministry of Infrastructure and the Environment concluded a Green Deal to make better use of braking energy.

Braking trains of the Dutch Railways and Veolia now return the energy this releases to the overhead power lines. This is known as regenerative braking. The power recovered in this way is currently only used for other trains travelling in the area, and already saves the Dutch Railways around 2% in electricity consumption each year. Information from the Green Deal shows that the energy recovered, if rolled out nationally, could potentially achieve savings of 70 GWh in energy and a 30-kilotonne reduction in CO₂ emissions. At present this energy recovery is not yet possible and local trains, which are unfortunately not available in Apeldoorn, can only reuse the braking energy.

The project Apeldoorn will enable the unused energy produced by braking trains at the railway station to be buffered and then reused to run the fully electric city buses.

**Objective of ‘Project Apeldoorn’**

*The aim of the project is to set up and operate a smartgrid connection between the braking trains of the Dutch Railways and electric city buses operated by Syntus in the municipality of Apeldoorn.*
The smartgrid connection has a buffer station that provides sufficient charging capacity for the entire daytime services of all of Keolis electric city buses.

The project will achieve a cheaper operation of city buses. The Total Cost of Ownership (TCO) of the electric buses is less than that of the existing diesel buses operated by Keolis Netherlands.

But perhaps even more important are the considerable environmental benefits as regards CO₂ reduction, the elimination of particulate emissions from trains and buses and noise reduction.

The project is also intended as a showcase. The combination of various technologies and the utilization of braking energy from trains in combination with electrical busses is unique and patented under PCT/NL2014/050160 (PCTP196399A ) Hedgehog Applications B.V. (Energy distribution and consumption system for railway stations), can be used at multiple railway stations in the Netherlands and patented countries . A transparent, glass building as shown in the views above will contain the batteries and the superfast chargers, as well as the connection between the railway and the batteries. Such a project will in any case generate great interest around the country and maybe European wide.

**Implementation**

The infrastructure consists of a smart combination of existing technologies.

The structure is as follows:

1. NS railway station, where the electrical energy is transferred to the buffer energy storage.
2. Buffer energy storage.
3. Superfast chargers for charging the electric buses during the complete operating hours, which indecently is the same time as the train operation.

The combination is unique. A patent has already been applied for and granted in the EU

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A train’s electro-dynamic brakes convert kinetic energy into electrical energy, which is then returned to the overhead power lines (recuperation). With trains running on DC voltage, as is the case in the Netherlands and Belgium, it is not possible to return the energy to the grid. The rectifier in the substation cannot in fact convert DC voltage into AC voltage that can then be returned to the grid. The energy generated must therefore be used by another train in that section of the overhead power lines, such as for train heating. If no trains are present to consume the power, the braking energy is converted into heat from braking resistance or the train brakes mechanically. This wastes valuable energy and also produces particulates. In addition, the train braking system is subjected to unnecessary wear and tear, which in turn leads to higher maintenance costs for the trains.
In order to achieve the project, the pre-financing for the infrastructure and converting the diesel buses into fully electric must be arranged. In addition, agreement must of course be reached on the availability of land, EIA and the necessary permits. It also involves spatial planning issues for the municipality, potentially involving modifications to the zoning plan.

The recoup period is 4-5 years and there is a fixed, positive cash flow of approx. 4 to 5 million at the end of the term of 12 years operation.

Keolis Netherlands is the concession holder for bus transport in the municipality of Apeldoorn. All the buses currently run on diesel. In June 2014 Keolis concession was renewed for a further six years so a new concession will start at the end of 2020. In consultation with Keolis and the Province of Gelderland, the concession must be amended. The existing diesel buses (VDL) will be converted to fully electric.

What corresponds perfectly is the energy supply (braking energy) and demand (charging electric buses). The timetables for both forms of public transport are coordinated, both of course running a full daily service. Naturally the supply of braking energy can also be combined with a different user, but the coordination between supply and demand would not be as good (households, for example, demand energy mainly in the evening and there are simply not enough electric cars on the road for this to be feasible).
Environmental benefits

This is truly a royal project for a cleaner, quieter and energy-saving future in train infrastructure. It will be possible for public transport in the city of Apeldoorn to operate sustainably with zero emissions. The benefit to the city and the environment is huge:

- **CO₂ savings are impressive.**
  Each year some 2,400 metric tonnes of CO₂, which would be produced under normal operations with diesel buses, will simply not be emitted. Over a concession period of 12 years, this would mean a saving of **28,000 metric tonnes of CO₂** for Apeldoorn alone.

- **Fuel savings**
  The existing 30 city buses in Apeldoorn drive approx. 7200 km each day, for which they need around 2250 litres of diesel fuel. At the current diesel price of EUR 1.25 per litre, this works out at roughly EUR 2,800 a day, or EUR **1,026,562** a year.

- **Reduction in particulates**
  The most significant benefit, however, will be found in reducing particulates. Modern technology means that greater volumes of ever-finer particulates are emitted in the exhaust fumes of diesel buses. Particulates will no longer be produced from mechanical braking of trains and bus braking. Braking trains and buses exploit the principle of regenerative braking, where the operation of the electro motors is reversed. The brake discs are therefore no longer subjected to friction, the brake pads will no longer wear out and therefore no particulates will be produced.

- **Noise reduction**
  It is generally known that the internal combustion engine (ICE) draws its energy from explosions that produce the familiar engine noise. In a standard diesel bus, the outside
noise when the bus is accelerating as well as the internal noise is around 82 dB(a). Electrification will reduce this noise level to approx. 62 dB(a), improving passenger comfort as well as the living environment in Apeldoorn, i.e. the city’s residents!

**Project structure**

A consortium of parties will be formed to carry out the project. A number of parties will be needed to implement the plan.

The following organizations are essential to the project, i.e. the key partners:

1. **Prorail B.V.** Rail network and energy transport/distribution infrastructure
2. **NS Reizigers B.V.** User and owner of the ‘overflow’ of braking energy
3. **ING NV** Financier of working capital
4. **Keolis Netherlands** Operator of electric city buses
5. **Municipality of Apeldoorn** Space for infrastructure, reduction of CO₂ and particulates
6. **Province of Gelderland** Changes to public transport concession, financing
7. **Ministry of Infrastructure** Giving Prorail ‘space’ for participation and the Environment
8. **RVO** Preparing subsidies in a Demonstration Energy Innovation program

Suppliers for the project are:

9. **Bam** Infrastructure and its installation
10. **Schaefer** Supply and installation of 6 MW Superfast chargers for buses
11. **Microvast** Supply and installation of stationary and mobile battery buffers
12. **Staubli** Supply and installation of connecting system for electric buses
13. **Emoss/ VDL** Retrofit Keolis Netherlands buses from diesel to fully electric
14. **Virici** Supply and installation of monitoring/management system
15. **Courage** Courage Architecten
16. **Besaris** Various construction work.
17. **ING Lease** Financing of retrofit work on Syntus buses
18. **Hedgehog Applications** Project management

The technologies suppliers have all committed to the project are all highly specialized businesses. Their knowledge and experience in this specific area of technology cannot be found everywhere. Also the community of Apeldoorn is fully committed to the project and have issued a letter of recommendation and is lobbying actively.

ProRail, Hedgehog and DNV-GL are preparing a simulation to find out the impact on the ProRail network. ProRail is the responsible party for this infrastructure.
The virtual simulation of the system, programmed by Viriciti, in a so called Front End is already online is accessible on the link [https://hedgehog-server.viriciti.com](https://hedgehog-server.viriciti.com)

In this virtual environment all bus and train data are implemented and gives us a good idea of the amounts of energy flowing through the system.

**Project phasing**

The project is divided into the following phases:

1. **Phase 1:** Preparations for work on the project
   For the EIA, zoning plans, permits and quotations from partners and suppliers. Duration of this phase: approx. 6 months from the starting date. At this moment this phase on track.
2. **Phase 2:** Construction of infrastructure. Duration approx. 1 year following on from phase 1
3. **Phase 3:** Commissioning
4. **Phase 4:** Maintenance and supervision.

Following the formal delivery, the project will run for a period of 12 years.

I hope that you will find the above information useful and insightful.

I will of course be happy to provide further information in person and answer any questions you may have.

Yours sincerely,

Ing. Arjan Heinen.

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