Update on DC voltage

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Public lighting

by Rutger Bianchi, Thijs Verboon and Liesbeth van Klink

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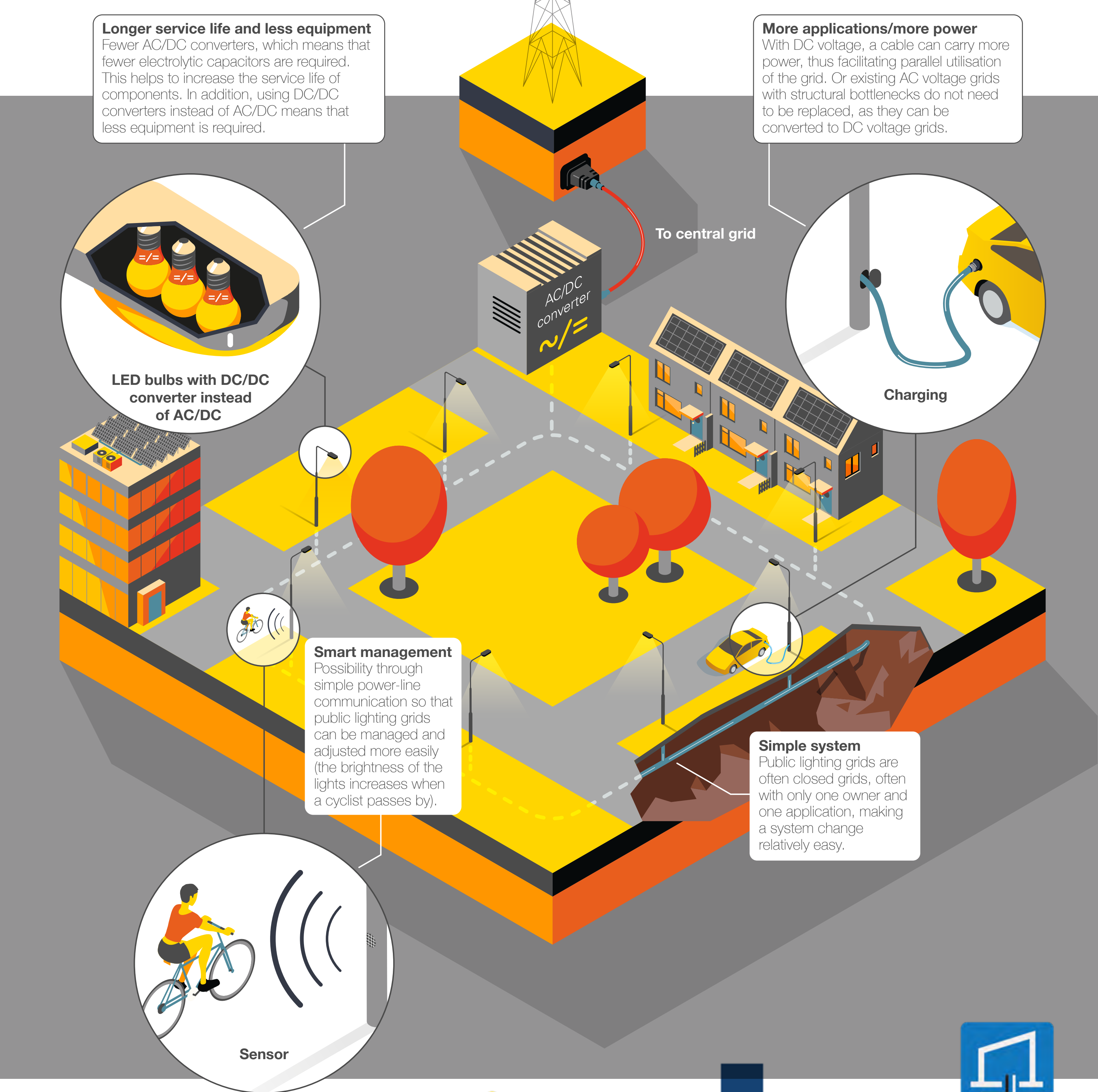

Berenschot

TKI URBAN ENERGY
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DC voltage developments in public lighting

The application of DC voltage in public lighting helps to ensure that more power can be transported within existing grids, enabling parallel utilisation of public lighting grids. In addition, the service life of the LED bulbs in the grids is increased and power-line communication (PLC) is possible, thus facilitating adaptive lighting. There are a number of difficulties when it comes to adoption of DC voltage in public lighting – (1) the costs of DC voltage components, (2) regulations governing parallel utilisation and (3) trust and awareness. Consequently, it is recommended that innovation in the field of parallel utilisation be stimulated to help draw attention to innovation programmes, whereby governments would set targets for the use of LED lighting in public lighting, and in addition, set targets for standardisation and the development of knowledge. This in turn would help to ensure, inter alia, that recommendations for tenders based on standardisation prevent reluctance and promote adoption. We look at these aspects in more detail below.

Background

This white paper is part of a report on the current state of affairs of DC voltage in the Netherlands. The report is an update of the DC Roadmap, which was compiled in 2018. General information and details about the benefits, drawbacks and challenges of DC voltage are explained in the appendix. In addition to the update on DC voltage, we also look more closely at five specific market segments by means of five white papers. In this white paper, the market segment that we will focus on is the DC voltage grid for public lighting.

Introduction

The current, conventional public lighting grid consists of an AC voltage power supply to which various fixtures are connected. These fixtures use either AC voltage technology or DC voltage technology. Development today trends strongly towards sustainability, which involves traditional fixtures being replaced by more energy-efficient LED lighting, with DC voltage used in those fixtures. In addition, the growth of more energy-efficiency LED lighting is helping to reduce the demand for electricity, thus freeing up capacity on existing grids. Current public lighting grids are primarily closed grids, often with only one application and one owner (usually governments), which makes it relatively easy to implement a system change from AC voltage to DC voltage. If the grid is switched to DC voltage, fewer AC/DC converters will be required. This will reduce the need for electrolytic capacitors, thus increasing the service life of components. In addition, it is expected that a DC voltage grid will be able to transport more energy safely over the same cable when compared to an AC voltage grid. Consequently, the cable can be used for other applications as well. This is known as parallel utilisation. DC voltage also makes power-line communication easier, thus facilitating more straightforward management of public lighting. Additionally, the option of a ring-shaped grid offers benefits in terms of both reduced loss of electricity and more rapid troubleshooting. The characteristics of a DC voltage public lighting grid are shown in Figure 1.

These characteristics highlight the fact that public lighting grids are a market segment where there is an opportunity for a dedicated DC voltage grid. The DC Roadmap revealed that public lighting grids on a dedicated DC voltage grid are the only market segment of those investigated that is already market ready. This makes for an interesting analysis as to why this technology has or has not been widely adopted and what is needed in terms of innovation to make further steps in this direction.

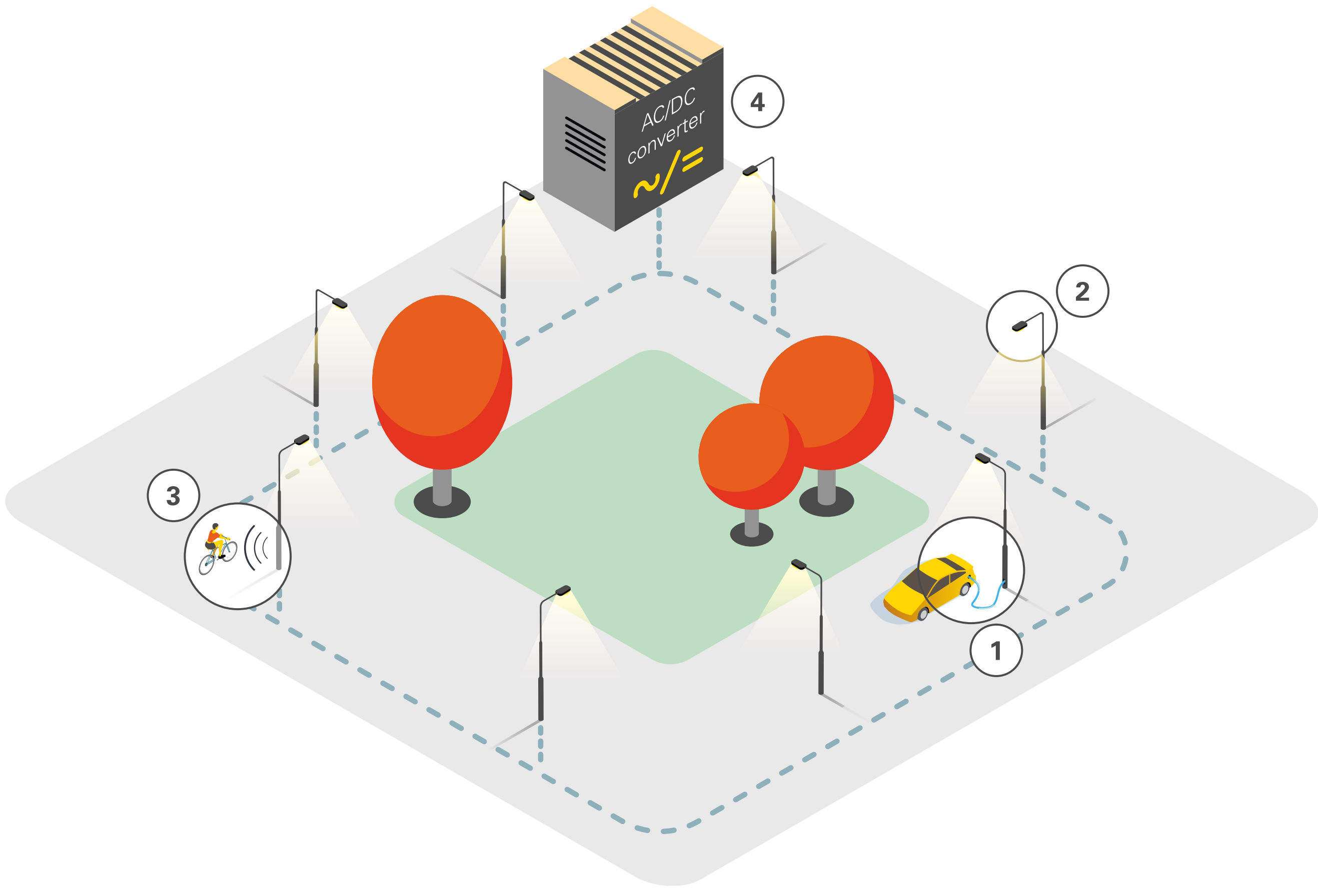

Figure 1 Concept and benefits of using DC voltage in public lighting

1. DC voltage allows more power to be carried along existing cables. This allows parallel utilisation with DC voltage applications and/or means that obsolete AC voltage grids do not need to be replaced as they can be converted to DC voltage.

2. Fewer AC/DC converters as LED lighting uses DC voltage. This will reduce the need for electrolytic capacitors, thus increasing the service life of components.

3. Straightforward power-line communication for easier grid management and adjustment.

4. Closed grid, often with a single owner and application, thus making a system change relatively easy.

Areas of overlap with other market segments

Public lighting has a relatively high number of interfaces with the other market segments – greenhouse horticulture, charging infrastructure and residential and non-residential buildings. In both public lighting and greenhouse horticulture, the grid has one dedicated application – lighting. The dedicated application is also a characteristic of the charging infrastructure market segment. An interface with the residential and non-residential market segment can be found in the link that can be established with sustainable (DC voltage) technologies. For example, both applications of DC voltage offer a solution for feed-in from roof-mounted solar or the storage of energy in batteries. Domestic batteries and solar panels could also be connected to the public lighting grid.

Current state of affairs

As indicated in Table 1, a number of projects are currently under way involving DC voltage in public lighting. The projects are generally small scale and intended as 'learning projects' and demonstrations of the potential and benefits of DC voltage.

The DEI subsidy projects demonstrate the operation of DC voltage in public lighting in order to highlight the benefits and to share the knowledge and experience gained. This applies to both conversion and new-construction projects. The integration of a number of different parallel functions is also being tested and DC voltage components are undergoing further development. A ring-shaped grid is being used for the new-construction of public lighting grids in order to test the benefits of feed-in at multiple points.

Several local authorities are also testing the use of DC voltage in public lighting, with a link to other technologies such as electric charging, sustainable generation and LED lighting. In addition, the benefits of DC voltage are also being demonstrated, including dimming via an app, a reduction in the number of junction boxes and lower sensitivity to faults. The motivation to use DC voltage varies from energy savings to realising innovative sustainable uses.

As the following table shows, no projects are yet being carried out to upscale DC voltage in public lighting. The majority of projects are being carried out without subsidies. This suggests that the technology is market ready.

Project name	Project	New DC/ conversion AC/ DC	Link to other technologies	Organisation	Subsidy	Type	Year (start of project)
DC OVL XXL (1)	Route on the Rijndijk	Conversion		CityTec/SGNL	DEI	Demonstration	2017
DC OVL XXL (2)	New-build development, Rietlanden	Newbuild		CityTec/SGNL	DEI	Demonstration	2017
DC OVL XXL (3)	Meshed grid, Driemanspolder	Conversion	Sewer/EV/PV/ street furniture	CityTec/SGNL	DEI	Demonstration	2017
Meshed DC grid	The Green Village			CityTec/TUd	TSE Urban Energy	Proof of concept	2018
De Liede industrial estate	De Liede industrial estate	Conversion	LED	CityTec		Demonstration	2014
Ecolonia	Ecolonia	Conversion, ring-shaped	LED	CityTec		Demonstration/ application	2015
Centre plan, Musselkanaal	Centre plan, Musselkanaal		Sustainable generation	CityTec		Demonstration	2014
Sloeweg project	N62	Conversion		CityTec		Demonstration	2014
Vlietwijk	Vlietwijk	Conversion		CityTec			
Centre, Delfzijl	Centre, Delfzijl			CityTec/Henk Ensing		Demonstration	2016
Port of Amsterdam	Cycle path, harbour area		Sustainable generation and storage, app for cyclists	CityTec/Luminext		Demonstration	2016
KIEM energy project	Combination cable	Combination of AC and DC		The Hague University of Applied Sciences		Research and practical simulation	2018
Energy wall	N470 (17 km)		Renewable generation and EV	Dynniq/Province of South Holland		Demonstration/ application	2017
New Reijerwaard industrial estate	New Reijerwaard industrial estate	Newbuild	Future: storage system and sustainable generation	Engie/CityTec		Demonstration/ application	2019

Table 1 Projects with DC voltage applications in public lighting

Market adoption

The 2018 Roadmap outlined a timeline for market adoption for the various market segments. This timeline is shown in Figure 2. Looking at the current state of affairs, this timeline is developing according to the path outlined in the DC Roadmap. As indicated in ‘Existing projects’, there are several ongoing public lighting projects involving DC voltage. Market adoption would, therefore, appear to be following the anticipated trend – although this is not being directly monitored. Most projects are still relatively small scale and focused on demonstration – this means that the technology is market ready, but has not yet reached a market share of >10% as shown in the timeline.

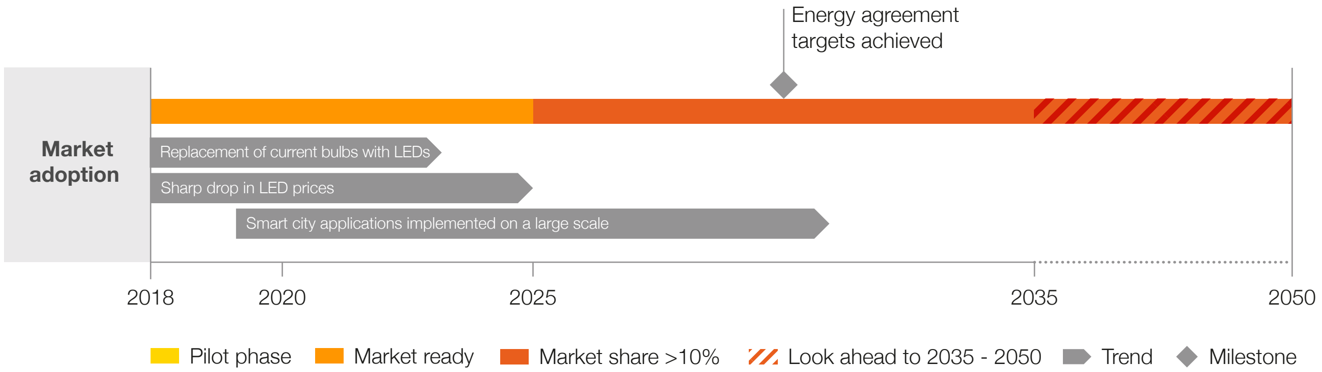

Figure 2 Anticipated timeline for market adoption of public lighting from the DC Roadmap

Difficulties

Public lighting faces a number of difficulties that could prevent large-scale implementation – standardisation, trust and safety, awareness, availability and cost. Some of these difficulties also play a role in other DC voltage technologies. Specific difficulties for public lighting are related primarily to trust and awareness, regulations governing parallel utilisation and availability and costs.

- **Current costs for DC components**
  Active protective devices are required in DC voltage grids. These are more expensive than the mechanical protective devices that can be used in an AC voltage grid. Consequently, there can only be a positive business case for a newly constructed public lighting grid if at least 50 lighting columns are connected to a DC voltage grid. As a result, DC voltage cannot always compete with AC voltage.

- **Regulations governing parallel utilisation**
  The regulations governing the linking of DC applications to a public lighting grid are not unambiguous, which could limit the benefits of DC voltage application in public lighting.

- **Trust and awareness**
  It has been indicated that the market is not sufficiently aware of the existence of DC voltage technologies in public lighting or is reluctant to make the switch because of safety concerns. These safety concerns are partly related to a lack of knowledge and to DC voltage lagging behind AC voltage. In addition, the applications and benefits of DC voltage are not clear to everyone. This can be considered a ‘knowledge barrier’, as a result of which AC voltage is still chosen for new public lighting projects.

Recommendations

DC voltage in public lighting is relatively effective to implement as public lighting grids are closed grids, often with only one application and one owner. For large-scale adoption, innovation, policy, standardisation and knowledge sharing are needed.

- **Innovation**
  The possibility of parallel utilisation is an opportunity for DC voltage in public lighting, as the applications that can be linked are DC voltage applications. Moreover, these applications are innovative, sustainable and, therefore, in line with market trends. More research into and development of DC-ready products should be carried in respect of parallel utilisation in order to further stimulate the market. This could help to create a market advance towards DC system components. Flexibility for experimentation could also be created in existing projects, such as in Nieuw Reijerwaard, Alphen aan den Rijn, on the N470 or in Zoetermeer.

- **Points for attention for innovation policy**
  In addition to the market, government policy should also focus on reducing costs and developing system components. This could be achieved by setting targets for the application of LED lighting, for example, in order to support innovation in public lighting. In addition, the regulations governing parallel utilisation should also be amended to ensure clarity.

- **Standardisation and knowledge sharing**
  There is a gap in standardisation and a lack of knowledge when it comes to the general use of DC voltage. Discussions also show that knowledge and standardisation are a barrier to parties when making a well-considered choice for applications in public lighting. Extending standards and sharing knowledge are desirable to help eliminate that barrier for both the development and application of DC voltage technologies. Recommendations and technical specifications for tenders based on standardisation could help with adoption.