N470 Project Netherlands

The provincial road N470 was a one-of-a-kind project for the region, involving multiple partners. South Holland aspires to manage and maintain its roads, waterways, bridges, and locks in a carbon-neutral manner. These spectacular goals have been realised in the N470 project by creating the most sustainable road in the Netherlands, and by demonstrating to the market that this is a normal tender, not a demonstration project within the existing ecosystem.

It is the first road in the region to have been renovated entirely in a CO_2-negative manner and to generate its own energy for lighting and traffic signals. Additionally, traffic can continue to flow more freely, and the road has been made safer through the use of new DC technologies. The distances are short, which prevents electricity from being lost during transmission via high-voltage cables and conversion to AC. This minimises energy consumption and CO_2 emissions. The green battery stores the energy generated during the day so that it can be used later in the evening when the sun is not shining.

The N470 is the first to be equipped with a self-sufficient energy system. The Energy Wall is a noise barrier that also produces energy via solar panels embedded in the screen's glass plates. The generated energy can be used directly to power 332 lights and 225 traffic lights further down the road. The noise barrier is made up of 100kW solar and generates 75 megawatt hours of electricity per year. This is approximately the same as providing green electricity to approximately 26 households for one year.

The following are some of the potential benefits of this project:

- The system is powered by a single cable that runs for 4.7 kilometres.
- The cable is powered by DC to avoid the difficulties associated with passing AC power through a water channel.
- The system is capable of operating in islanded mode if the main grid is lost.
- The system is a autonomous microgrid with distributed sources with manged power flow without digital communication. (Current/OS system)
- The system includes energy management features but does not require data or an internet connection for security reasons.
- The system is integrated with renewable energy sources such as photovoltaic (PV) and energy storage.
- It is a commercial project, not a demonstration project within the established ecosystem.

- The first DC project was developed in accordance with the Dutch technical guid for DC installations (NPR9090)

The project's technical specification includes the following components:

- The power distribution cable is 4.7 kilometres long contains a four-core cable of +\-700 Vdc with a +/-60Vdc droop control, and a TN-S earthing arrangement.
- The network is earthed using a TN-S with multiple earthing arrangement with additional stray-current protection provided by the use of diodes to separate the metallic and electric earthing.
- The solar panels are connected to the main power distribution system via DC/DC converters.
- Two active front ends of 100kW each interface with the AC grid (it is worth noting that AC grid support is disabled in this project) and operate on 50kW with limited line currents.
- Ambient requirements include a temperature range of -20 to 50 degrees Fahrenheit and a relative humidity of 95% at sea level.
- The AC station is rated at 150kVA.
- The DC system is electrically isolated from the AC system.
- 1MWh LiFePo4 battery system based on 12 strings connected via DC/DC converters and protected by solid state circuit breakers
- Distributed batteries equipped with autonomous system capable of communicating with the BMS and reacting to the state of the grid (SOG) in conjunction with the state of health (SOH) and state of charge (SOC).
- Streetlights connected to a network of 23 strings x ±350V with a +/-30Vdc droop control equipped with DC/DC led drivers and power line control
- The streetlights are equipped with RCDs to protect the public against direct contact.
- The network incorporates hybrid circuit breakers and solid-state protection.
- Overvoltage protection is incorporated into the network, as well as Arc fault detection
- Power flow and protection, for example, are determined by the Current/OS protocol and requirements.

Reference:

https://www.zuid-holland.nl/onderwerpen/energie/energiewegen-0/n470-geeft-energie/

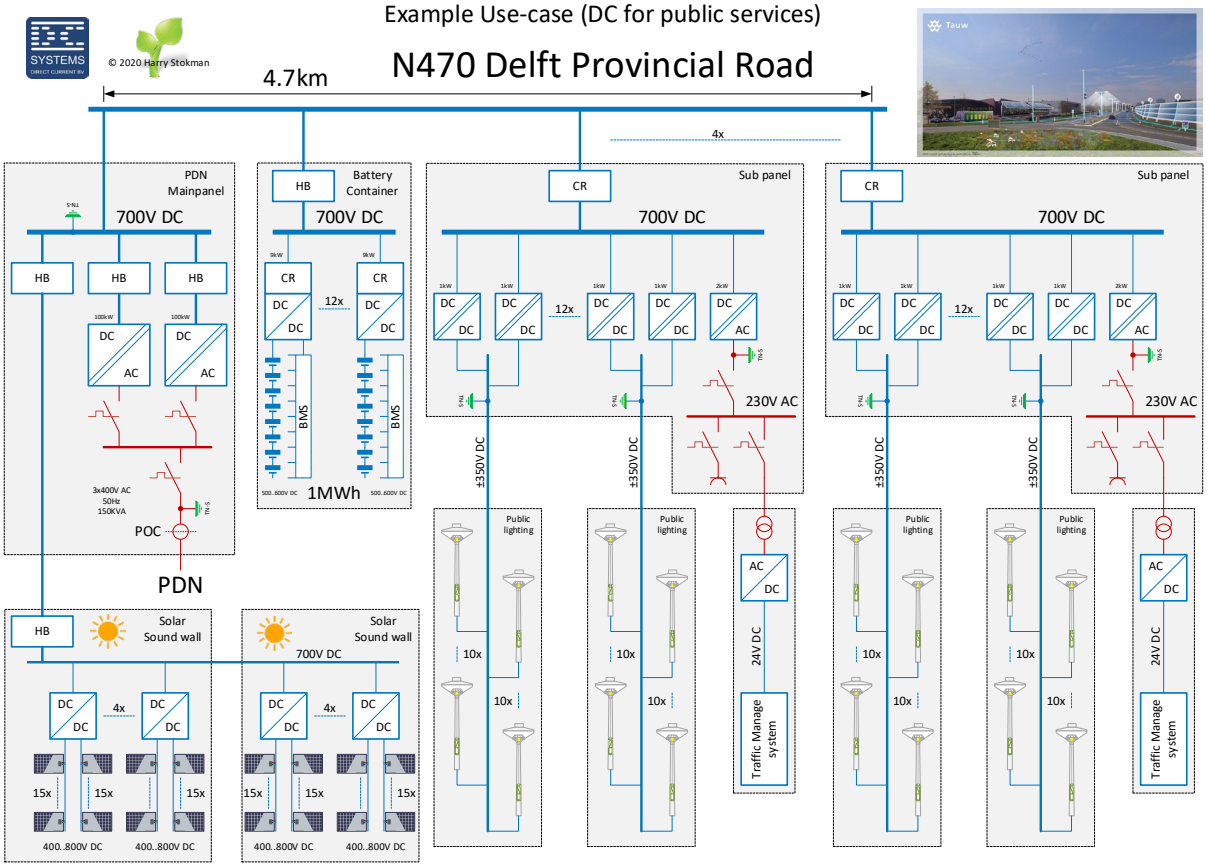
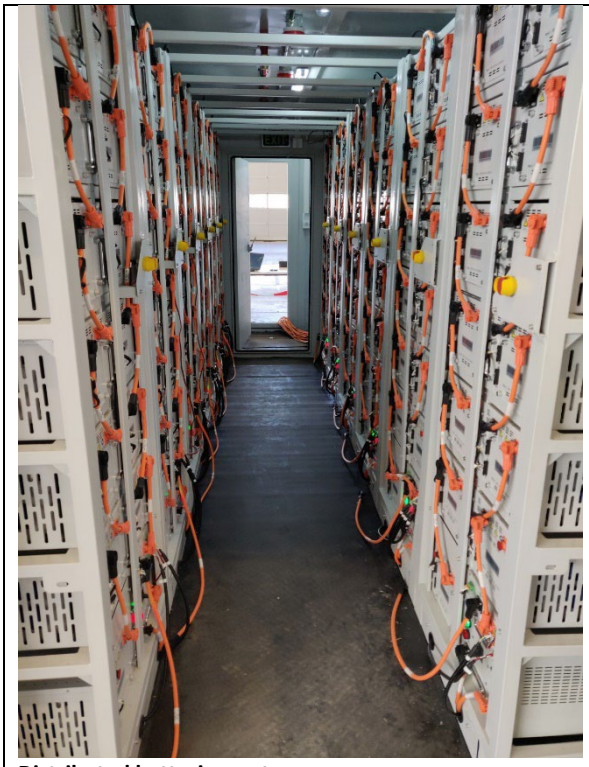
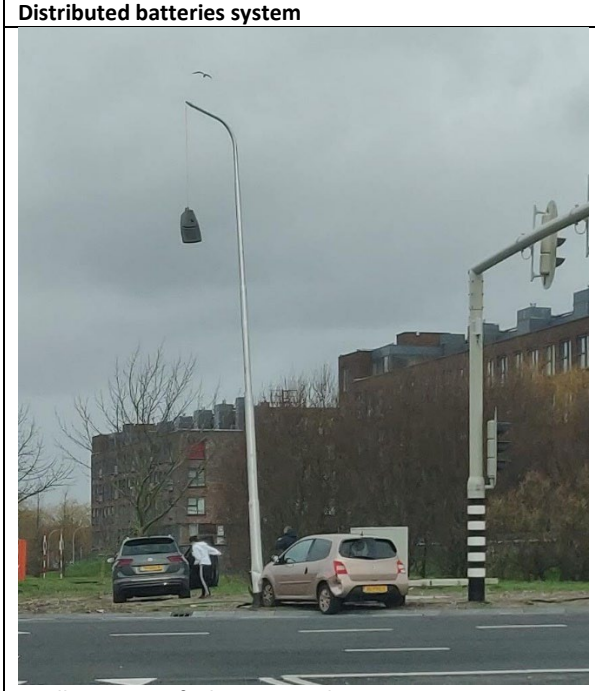


Figure: Single-line diagram of N40 site system.

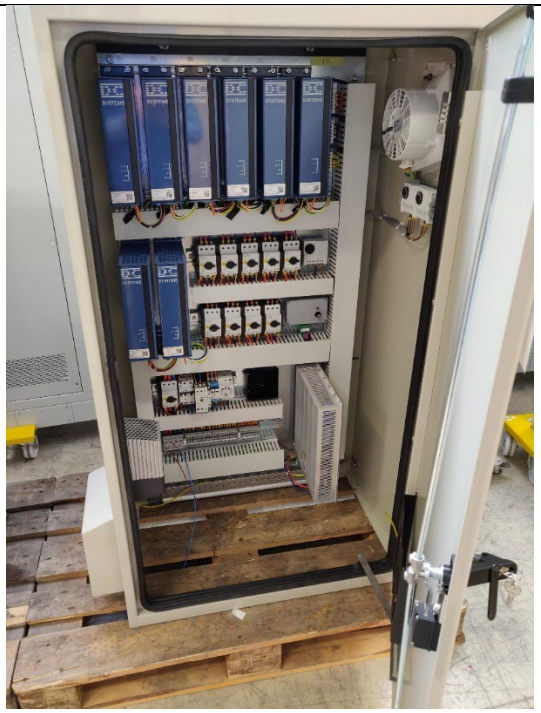


Distributed batteries system

Outdoor substation



An illustration of why RCDs and protection are necessary. A minor accident occurred during testing when one of the cars collided with the project's light pole. (safety comes first).



Outdoor substation for public lighting

Figure: The layout of the N470 project

In accordance with the Dutch standard for DC:

Agency	Number	Year	Name	Abstract	Short description	Voltage level
NPR	9090	2018	DC installations for low voltage	NPR 9090 is applicable to the design and installation of DC installations for low voltage (up to 1500 V DC) related to the scope of NEN 1010. Combined AC and DC installations are also included in the scope of this NPR as long as galvanic isolation is applied between the AC and DC parts.	This standard serves as the legal foundation for installation requirements, as the law refers to the wiring standards. As a result, this was a an important standard to have when constructing DC installations for N470 project.	350-1500 V

https://www.nen.nl/en/npr-9090-2018-nl-250370