High-voltage lines

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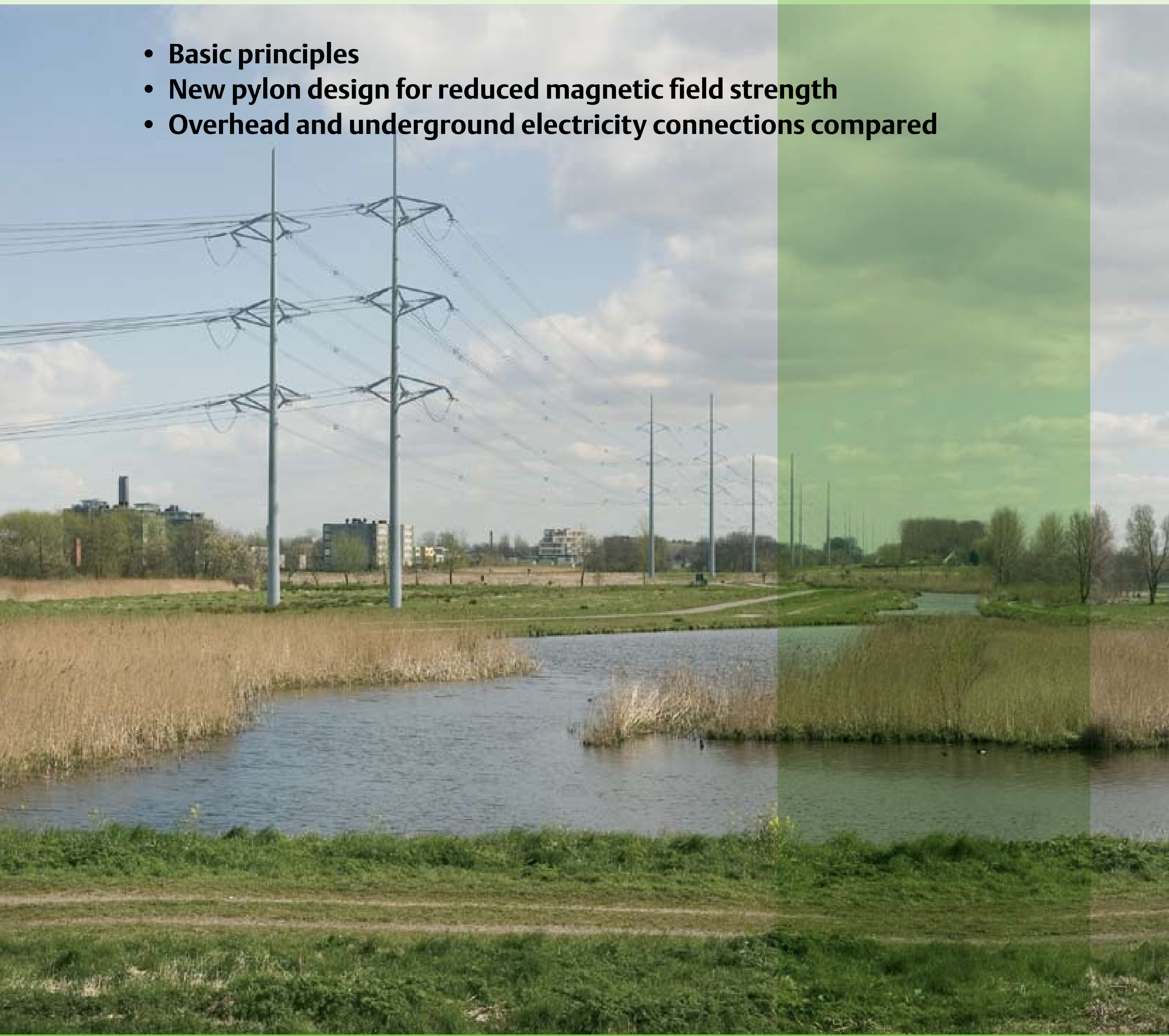


High-voltage lines

Constructing a new high-voltage line requires a great deal of preparation. Before any work can commence, detailed studies are necessary to determine the best possible route and optimum technical execution. Costs and technical options are carefully weighed, taking due account of the quality of the living environment, possible hazards to human health, and preservation of landscape and nature values. This brochure describes the process used by TenneT in constructing new high-voltage lines.

As the Dutch national grid operator, TenneT is in charge of the high-voltage grid – the connections that serve as the 'highways' of the Dutch electricity grid. TenneT manages the transmission grid that provides the basis for a reliable and secure national electricity supply; it connects the regional grids and ensures access to the European electricity market. In order to accommodate the rise in the consumption and transmission of electricity and to facilitate the transition to a sustainable energy supply system, it is essential to upgrade and expand the national transmission grid in a timely manner. TenneT is currently working to expand, maintain and upgrade the grid at several locations throughout the country. One major project being carried out is the construction of a new electricity connection right across the Randstad region, running from Wateringen to Beverwijk. Known as 'Randstad380kV', this project is not just necessary to safeguard the security of supply in this densely populated area – it is also essential for the reliability of the national electricity supply.
As the national grid operator, TenneT is required by law to take the interests of society into account: new electricity connections must offer optimum technical performance and an aesthetically pleasing design at an acceptable cost level. After all, all Dutch citizens help to pay for these infrastructure investments through their electricity charges. All major infrastructural investments must be submitted for approval to the Office of Energy Regulation, the organisation charged with regulating the electricity market in the Netherlands.

Basic principles for the construction of high-voltage lines

Avoiding residential areas

When planning the route of a new high-voltage line, TenneT observes a number of basic principles. We try to leave the landscape intact: the countryside on both sides and directly underneath the line must 'stay green'. As far as reasonably possible, we also try to keep high-voltage lines away from residential districts and other vulnerable areas. Additional measures are put in place if the situation calls for them. Examples include adjusting the height of the line, or relocating buildings. In addition, new connections are often combined with existing infrastructure like roads, railways or other high-voltage lines. In many cases, this can be accomplished by combining a new 380kV connection with an existing 150kV connection on a single line of pylons. In such situations, the old 150kV line is decommissioned upon completion of the new connection. If this solution is not possible, we try to combine the new line with existing (supraregional) infrastructure.

Overhead lines

The general principle in the Netherlands is that new high-voltage connections must be constructed above ground. This method incurs substantially lower costs, and any faults in the completed line can be repaired more quickly. Moreover, the new Wintrack pylon (see below) allows us to reduce the strength of the electromagnetic fields generated by high-voltage lines.
Only in exceptional cases are electricity connections installed below ground – for instance, if it concerns a short section that passes through an area of great natural beauty or high ecological value. Sometimes, TenneT also opts for underground installation on short stretches where the planned connection intersects a waterway. This is the case at the intersection between the Randstad380kV connection and the Nieuwe Waterweg canal near the Maasvlakte industrial area, for instance.

New pylon design reduces magnetic field strength

In response to various social and technological developments, TenneT has designed a new type of high-voltage pylon: Wintrack. This innovative design will replace the traditional lattice tower and significantly reduces the so-called 'magnetic field zone': the strip of land around the line where the average strength of the magnetic field exceeds the maximum permitted value. The Wintrack pylon allows more room for residential development. According to the recommendation produced by the Ministry of Housing, Spatial Planning and the Environment (see below under 'Government policy on magnetic fields'), construction restrictions apply on a strip of land of approx. 300 metres around a high-voltage line that uses the existing type of pylon. With the new Wintrack pylon, the width of this strip can be greatly reduced.

In planning the route of a Wintrack power line, the maximum width of the magnetic field zone is assumed to be 100 metres. However, the width of the magnetic field zone is linked to the height at which the power circuits (i.e. the wire bundles) are suspended. Greater height means a narrower magnetic field zone. Reduction of the magnetic field zone can also be achieved by shortening the distance between one pylon and the next (as in the Wintrack design), so that the wire bundles are pulled tighter. This allows for flexible integration of Wintrack power lines into existing spatial plans. In addition, we aim for optimum integration into the landscape.

The new Randstad380kV line will be combined with existing connections at several locations. The old pylons will therefore be replaced by new Wintrack pylons. This constitutes a significant improvement over the present situation: the magnetic field generated by the new line will be greatly reduced and the new pylon is more aesthetically attractive.

Wintrack: a new pylon design

Why design a new type of pylon?

The familiar lattice towers currently used for power lines throughout the Netherlands were designed to have a life span of one hundred years. They are robust, have an open, 'see-through' structure, are easy to maintain, and relatively inexpensive due to the limited quantity of steel used in their construction. Lattice towers have one major disadvantage, though: high-voltage lines suspended from these pylons generate a wide magnetic field. Because of the width of the pylons' lattice structure, the voltage circuits are so far apart that the line must be separated from vulnerable areas (e.g. residential districts) by a distance of some 300 metres (150 metres on each side, as recommended by the Ministry). This space is not always available.

The Wintrack bi-pole pylon provides an excellent solution to this problem. Each pair of tapering poles carries its bundles of electrical circuits close together. This creates a much narrower magnetic field zone than the one generated by the current lattice towers. In the Wintrack design, construction restrictions apply to a zone of just 50 metres on both sides of the line, where no homes, schools, day-care centres or other 'sensitive' structures may be built. A second important advantage of the bi-pole design is that it requires less maintenance. The pylons have a simple structure with smooth surfaces, making them virtually maintenance-free.

Integration into the landscape

The landscape architect: 'The simpler the design, the less intrusion.'

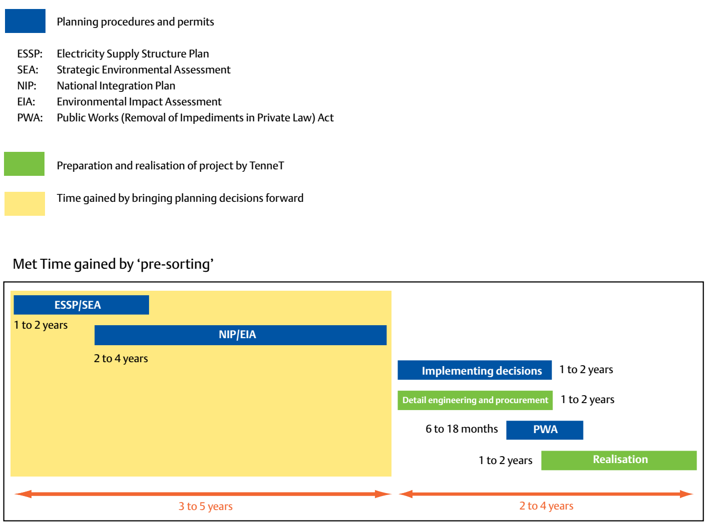
High-voltage lines are infrastructural elements with a strong visual identity. They bear little or no direct functional relationship with their immediate surroundings, bypassing the local landscape, as it were. In an open landscape, this requires independent design and routing, quite separate from other (small-scale) elements in the landscape. In a closed landscape, on the other hand, it is essential to avoid visual clutter as much as possible by harmonising the line's design with local landscape elements like the height of trees or buildings. A tailor-made approach is required for each specific location, so as to achieve optimum integration into the landscape with minimum visual disturbance.
The Wintrack bi-pole pylons offer a basic design with minimal variation. This ensures visual calm, even when 380kV and 150kV connections are combined on a single line of pylons. Changes in direction of up to ten degrees do not affect the design, allowing the standard pylons to be used. Although wider pylons must be used when the angles are greater, the main shape of the design is unchanged.

The Wintrack bi-pole pylon was designed by Zwarts & Jansma Architects in collaboration with the research and consulting firm KEMA. In producing the design, Zwarts & Jansma Architects were guided by the following vision:

- *A simply designed 'family' of pylons*
- *Unobtrusive presence in the landscape*
- *Stylised silhouette, minimalist design*
- *Striking V-shaped brackets*
- *Flexible in use*
- *Contemporary and innovative*
- *Neutral colour palette composed of grey tones*

Planning and procedures

Large-scale new infrastructure projects can have a significant impact on their surroundings, which calls for a careful approach. In the Netherlands, the procedures to be followed are laid down in laws like the Spatial Planning Act. This ensures that the relevant decisions are arrived at a proper manner, which is characterised by the presentation of alternatives, the organisation of public consultation rounds, detailed recording of the relevant information, and careful decision-making at the appropriate level. In a so-called Key Planning Decision, the Dutch cabinet sets out the rationale of a proposed electricity connection, and presents an outline of the preferred route. The Key Planning Decision provides a formal basis for investment in the high-voltage grid and gives the go-ahead for realisation of the connection within a few years. The cabinet determines the final route in accordance with the National Projects Procedure. The Key Planning Decision is submitted to Parliament for approval.



Overhead and underground electricity connections compared

Most high-voltage connections in the Netherlands are overhead power lines suspended from pylons, as this is the most practical and efficient solution. Only in exceptional situations are connections realised underground: near vulnerable nature reserves and airports, and at intersections with waterways, for instance. An example of the latter can be found near Rotterdam, where an electricity cable has been installed below the Nieuwe Waterweg canal.
The use of underground cables has several benefits. There is less disruption to the landscape and it is easier to preserve ecological and cultural-historical elements. An underground cable can also offer solutions to certain design limitations or conflicting claims on space. Moreover, the strip of land required to lay an electricity cable is slightly narrower than the strip required for an overhead line. There are however limitations on land use directly above an underground cable. By contrast, underneath an overhead power line, agricultural activity is possible.

The use of cables has other drawbacks as well. Laying an underground cable for the whole route requires much more extensive excavation work than is involved in the construction of an overhead line. Objects of archaeological interest buried in the ground may be damaged, and the water balance can be disturbed. In the event of a failure, the cable will have to be dug up. Because it takes longer to determine the exact location of a failure, more time is needed to repair faults in underground cables. Finally, additional facilities will have to be installed in high-voltage substations for underground cables. These take up space and produce noise. For all these reasons, the average costs for an underground cable are about five times higher than those of an overhead line.

Government policy on magnetic fields

Is exposure to the electromagnetic fields generated by high-voltage lines harmful to human health? That is not an easy question to answer. Over the past few years, various studies have been conducted into the possible risks of electromagnetic radiation near high-voltage pylons. These studies do show that children living in the vicinity of high-voltage lines are more likely to suffer from leukaemia (one additional case every two years). Correlation is not causation, however. These findings do not necessarily mean that living near high-voltage lines directly causes childhood leukaemia. Future research may reveal that the statistical connection should be attributed to entirely different factors.
Nevertheless, it is completely understandable that people living near high-voltage lines are concerned about possible health risks such as childhood leukaemia. In 2005, the State Secretary for Housing, Spatial Planning and the Environment issued a recommendation on this subject to municipal and provincial authorities and grid operators. In his recommendation, the State Secretary advised the parties concerned to avoid creating new situations that would involve the prolonged exposure of children to magnetic fields exceeding 0.4 microtesla on an average annual basis. (Microtesla is the unit commonly used to express the strength of a magnetic field). This recommendation does not apply to existing situations; the advisory limit for exposure to magnetic fields generated by existing high-voltage lines is 100 microtesla. This precautionary policy does not apply to underground cables, which also generate electromagnetic fields.

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Arnhem, July 2009