December 2017

Vade-Mecum

Best Practices for Management of Vegetation

Owners and Managers

LIFE Elia-RTE (2011-2017)

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Life

Contents

LIFE Elia
Enhancement of the electricity transmission network's easements as active vectors for biodiversity

CE Reference
LIFE10 NAT/BE/709

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The LIFE Elia project benefits from the co-financing of the LIFE+ tool of the European Union

1 Introduction

The LIFE Elia-RTE project is pleased to publish this Vade-Mecum on Best Practices for Management of Vegetation under high voltage power lines for forest owners and managers.
The Latin word *"Vade-Mecum"* means *"Come with me"*. It is therefore a real invitation to dive into the world of the electrical corridors in our forest ranges.

The purpose of this document is to present the main lessons of the LIFE Elia-RTE project in terms of best practices for management of vegetation, and to see how forest owners and managers can incorporate them into management in their forest ranges of corridors opened by Elia or by another "Transmission System Operator".

The LIFE Elia-RTE project was carried out in Belgium as well as in France over 6.5 years (2011-2017). This project was part of the LIFE+ project of the European Union. It was financed by the European Commission, Wallonia, Elia and RTE, the latter two being managers of the Belgian and French transmission network respectively.

The main goal of the LIFE Elia-RTE project is the transformation of forest easements of high voltage transmission line routes into ecological corridors in Belgium and France. Restoration activities aim at implementing innovative practices for management of vegetation of these green corridors in the forest, and raising the awareness of various audiences about the importance of biodiversity in these linear habitats.

Forest owners and managers are essential players since nowhere (or with very few exceptions) are the Transmission System Operators also owners of the spaces under the high voltage lines. Having to systematically obtain authorization to carry out ecological restoration work could have been a constraint, but in reality, the discussions with these field players have helped enrich the project. This diversity of interests and approaches has contributed to the success of the project. This aspect of the project was emphasised by the European Commission, since in 2016 it received the Natura 2000 Award in the *"Reconciliation of Interests and Perceptions"* category.

In addition to being a great challenge in ecological engineering, this project has also been a real human adventure. In view of the results obtained and their positive impact on biodiversity, it has been a real pleasure to work in this exciting environment.

We wish you good reading!

The LIFE Elia-RTE Project Team

The LIFE Elia-RTE project in numbers

Duration: 6.5 years (2011-2017)
Budget: €3.2 M
Financing: European Commission (36%), Wallonia (25%), Elia (24%) and RTE (15%)
Team: 7 people
Sites: 28 in Belgium, 7 in France
Ha restored: 485 ha in Belgium, 40 ha in France
Actions: 7 different actions
European contacts: 18 countries

2

Summary

Chapter 3 reports on the reality of electricity transmission by the System Operator. Essential in today's society, transmission of electricity is an important link between energy production sites and the places where it is used by industry and distributed for households.
This chapter details the other part of the concept of an ecological network, and stresses the potential synergies that exist between these two networks.

Chapter 4 addresses the major safety issues related to transmission of electricity in the forest. When the high voltage network crosses forest ranges, management of vegetation becomes a fundamental fact since it prevents any outages in supply. The challenge for the electricity Transmission System Operator (TSO) is then to prevent trees from getting too close to the conductors.

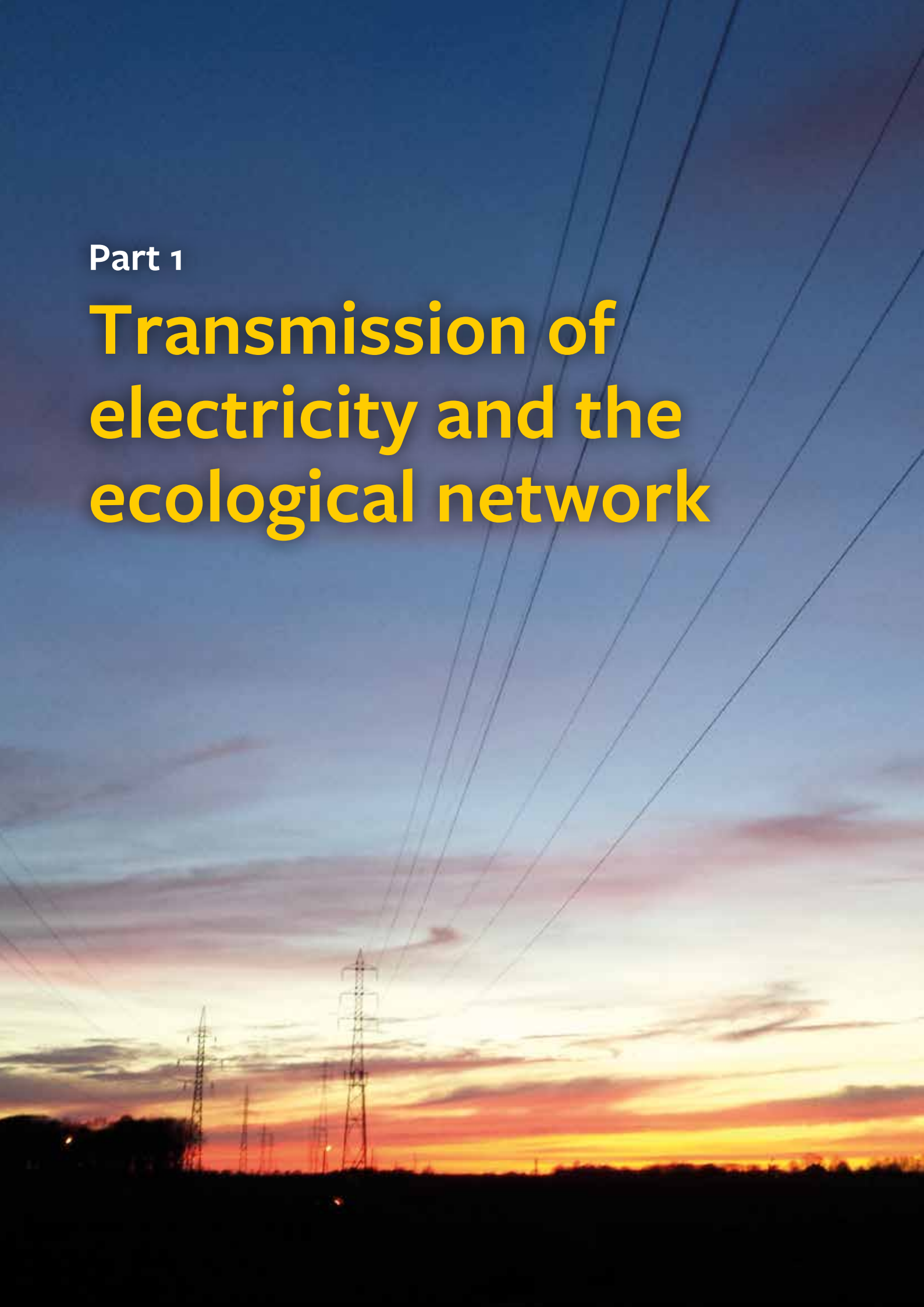
Chapter 5, devoted to conventional management of vegetation, will present the conventional and simplified methods used by many TSOs. They regularly prune or cut vegetation when it is still young. However, this practice actually promotes the growth of the targeted trees which the TSO is trying to combat. It's a vicious circle which affects the landscape dramatically, limits the development of biodiversity, poses a problem for the forest manager, is not in tune with the aspirations of local players and requires considerable financial resources.

Chapter 6 details alternative methods to management of vegetation. Our LIFE project has demonstrated that there are innovative alternatives which consider vegetation as an opportunity, and which make it an ally to achieve the goal of electrical safety while promoting biodiversity. Several actions, tested as part of the LIFE Elia-RTE project, can be prioritised in the field.

Chapter 7 explains what the various interests for these alternative methods for management of vegetation can be for forest owners and managers. If the owner or manager used to leave management of these spaces under the lines since they were maintained by the System Operator, we will see that it is possible for them to find a real interest in developing management methods that can be favourable to them.

Chapter 8 mentions some areas for further study for readers who would like to go further, both on alternative methods for management of vegetation and on biological indicators. Many resources, created during our project, are available on the internet.

Chapter 9 summarises the conclusion of this Vade-Mecum.



Part 1

Transmission of electricity and the ecological network

3 Transmission of electricity, forest legislation and the ecological network

This chapter addresses 3 fundamental aspects of electricity transmission in the forest:

- The technical aspects of transmission of electricity
- Forest legislation
- The ecological network

The end of the chapter is devoted to reconciling the challenges of these 3 components.

3.1. Transmission of Electricity

3.1.1. Electricity – from production to consumption

The electrical energy which is consumed by our industries and our household appliances travels a long way from its place of production to the place where it will be used.

Production of electricity

Electricity is produced at production sites located at different points of a territory. These sites can be nuclear power plants, facilities using fossil energy (oil, coal, gas), renewables (solar, wind, water) or energy related to biomass. The emergence and rise in power of renewable energy is causing decentralisation and dispersal of production sites.

Transmission of Electricity

Transmission begins at the exit from the production site. It is provided by a network which constitutes the backbone for transmission of electrical energy, with major strategic and economic significance for the States. Transmission of electricity ends in two ways:

Pylons and high voltage lines providing transmission of electricity

- at a large energy consumer (industry, business,...), or
- at an electrical substation which transforms the high voltage to low voltage, which is then transmitted over the distribution network.

The high voltage network is characterised either by lines carried on large pylons (aerial network) or by buried lines (underground network).

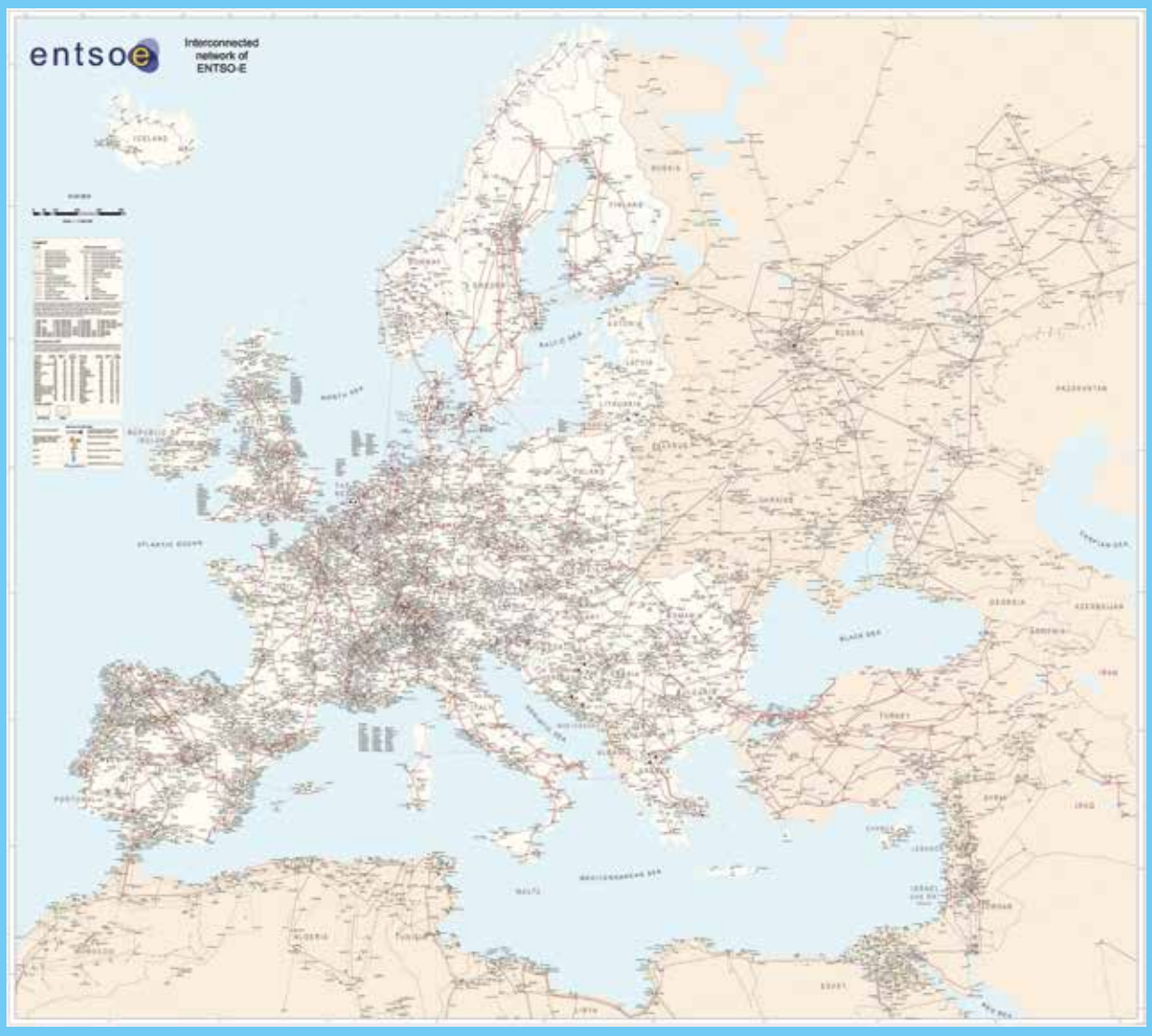
In nearly all European countries, there is a single company responsible for this transmission. This company is subject to legislation and regulation which governs its activities. There is a European Federation of Electricity Carriers called ENTSO-E.

High voltage network in Europe – in numbers

High voltage (HV) is a term that concerns voltages higher than 1,000 volts for alternating current and 1,500 volts for direct current. In Europe, most high voltage lines have a voltage of 110,000, 220,000 or 400,000 volts. Although there is no official terminology, beyond 100,000 volts the lines are usually referred to as very high voltage (VHV).

In this document, we will more generally refer to "high voltage lines" regardless of their voltage.

The European network has close to 308,000 km of high voltage lines and is managed by 41 System Operators.

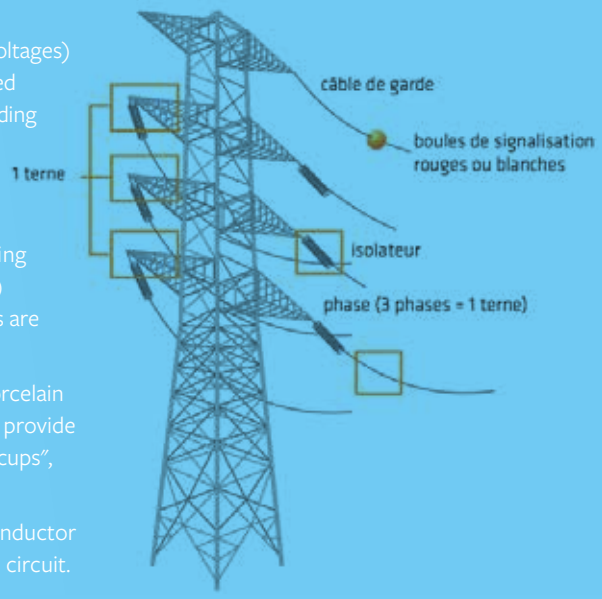


Map of the high voltage and very high voltage network of ENTSO-E members (© ENTSO-E)

(Source: ENTSO-E)

How to recognise a high voltage line

High voltage lines are supported by concrete poles (for the lower voltages) or by metal pylons (for the higher voltages). It is generally considered that the height of the pylons and the distance between them (excluding specific relief) increases with the line's voltage.



Above the electrical wires there are one or two shielding wires. These do not carry current but act as a lightning conductor. They also often act as a support for the optic fibre. In addition, the shielding wires are often equipped with markers (for example, coloured balls) which let them be seen by aircraft pilots, for example. These devices are more particularly used near aerodromes and airports.

The electrical wires are attached to insulators, which are glass or porcelain "cups" that are stacked. They serve to support the wire as well as to provide electrical insulation for the pylon. The higher the number of these "cups", the higher the voltage of the line.

Most high voltage lines have two circuits, being two sets of three conductor wires, each set of three wires together carrying a single three-phase circuit.

Finally, high voltage posts and pylons also have a metal plate at their base. This plate is an identification nameplate which usually includes the contact details of the electricity carrier, the pylon number and the line number.

In the description, the pylons may have denominations related to their architecture: lattice pylon (the most common), lily pylon (supports resemble a lily flower).

Distribution of Electricity

Distribution conveys low voltage electricity from an electrical substation (where it is transformed) to villages and houses. The low voltage network is generally characterised by supports in the form of simple posts (concrete or wood). Unlike the high voltage network, low voltage distribution can in some cases tolerate the presence of branches close to the wires, due to the wire's insulation. The safety constraints are not therefore the same for these networks which are usually managed by different operators.

It is not unusual for forest corridors to be occupied by both a high voltage line and a low voltage line.

Electrical substation raising the electrical voltage for transmission, then lowering it back for consumption by users

"Mixed" corridor with high and low voltage lines

3.1.2. The challenges of the 21st century

24/7 comfort

For many European citizens, the availability of electricity 24/7 throughout the year is an evident fact. This service can only be rendered if the production, transmission and distribution of this electricity is guaranteed at all times. The TSO must therefore continuously oversee the network's safety and manage the flow of electricity.

Renewable energy

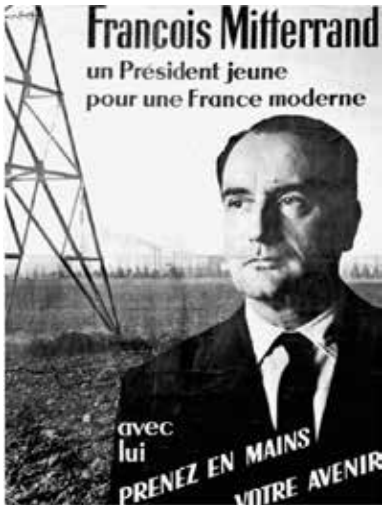
At the beginning of the 21st century, political choices for a greater share of renewable energies in the overall consumption of electricity are imposed in several countries. As part of its energy and climate policy, the European Union has adopted a directive to increase the share of renewable energy consumed by each Member State to 20%. When green energy is produced at a given location (wind, water,...) its integration into the network must be set up. In some places this involves renovation of existing lines or creation of new lines.

Protection of nature

The erosion of biodiversity has been central to the concerns of European institutions for several decades now. The "Birds" and "Habitats" directives, adopted in 1979 and 1992 respectively, provide a legal framework to be transposed by each Member State into their national or regional law and form the basis of the Natura 2000 network.

No development project can now do without environmental impact studies, demonstrating that protection of nature has become an indispensable parameter for economic and industrial development.

Taking the landscape into account



In 1965, a candidate to the French presidency appeared on election posters standing in front of a high voltage line pylon, symbolizing the beneficial power of electrical energy and the opening up of remote rural areas. Today, in the eyes of the citizens, this promise of technological progress must be accompanied by taking the landscape into account.

The routes of new sections of the high voltage network, like the installation of wind power projects, are often the target of citizens associations who wish to protect the landscape. These landscapes have become the founding elements of the identity of certain territories, and development of the electrical grid cannot neglect it. It is for this reason that many network expansion projects today are planned, or required, to be underground.

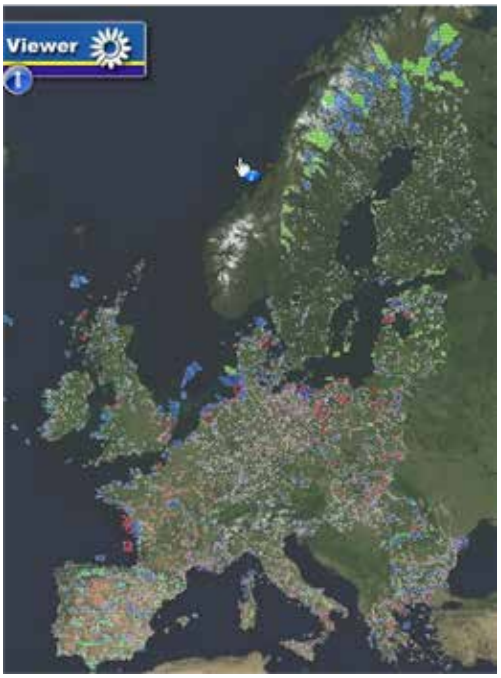
3.2. Forest legislation

Management of forests and natural environments is subject to a set of laws that aim to meet issues related to the ecosystems – production of wood, conservation of nature, landscape function or the social and recreational functions. In each country in Europe are superimposed European laws, national laws, sometimes regional and finally local laws.

To these laws and regulations are added incentive programs encouraging owners and managers to go further. These programs include forest certification (FSC or PEFC) which provides a complete wood sector that guarantees the final consumer that the wood he is buying comes from sustainably managed forests.

How do all these laws and incentives interact with management of vegetation under the lines? Here are the main elements of this legal context.

3.2.1. The Natura 2000 network – two European directives



Map of the Natura 2000 network (Natura 2000 Viewer)

To stop erosion of biodiversity, two European directives have been adopted by the European Commission – the Birds Directive in 1979 and the Habitats Directive in 1992. They are the basis of the Natura 2000 network and require of Member States the conservation of a whole range of species (birds, insects, mammals, etc.) as well as natural habitats (types of forest, types of grassland, wetlands...). Each Member State therefore has the obligation and responsibility to transpose these directives into national or regional law.

In all, about 27,000 Natura 2000 sites have been designated in Europe, covering a total area of 1,100,000 ha of land and marine areas... about 36 times the size of Belgium!

Each Member State is therefore responsible to set up measures for management within the Natura 2000 sites. These management measures have the dual goal of promoting biodiversity while more specifically targeting certain species or certain natural habitats, while allowing reasonable pursuit of production activities. In any industrial project, particularly in the case of renovation or creation of high voltage lines, the TSOs are required to carry out impact studies for the project on these species and habitats.

In the same spirit as for establishment of the Natura 2000 network, the European Commission does not exclude an industrial or socio-economic activity, provided that it is compatible with conservation of the targeted species and habitats.

3.2.2. The Forest Code

Girdling of a tree that is problematic for the line and which will be a source of standing deadwood

The Forest Code is a set of rules which governs and regulates management and protection of the forest, in particular public. Each Member State has the legitimacy to legislate in these matters. This does not preclude the mandatory taking into account of specific supra-national provisions, such as the implementation of the Natura 2000 network.

Alternative manage of corridors can meet the goals of the Forest Code, which aims to ensure the multi-functionality of the forests. We can cite, for example, the plantations and restorations of shrub edges, with the various interests known for them, whether purely silvicultural (better wind resistance, diversification of species, alternative productions, etc.) or other (biodiversity, hunting, landscape...).

The importance of dead wood in the forest is well established and alternative management of the corridors can also be a source of dead wood. Girdling can be an alternative to ground-cutting and some trees without value can be stored in the form of ridges or windrows.

3.2.3. Forest Certification

Sustainable management of the environment and forests in particular is more than ever the centre of attention. A sustainably managed forest is a forest whose management is environmentally friendly, socially beneficial and economically viable.

People who buy certified wood are guaranteed that this wood comes from forests managed taking these three pillars into account. Owners who voluntarily commit to the path of forest certification have to satisfy certain obligations which may in fact prove to be opportunities, such as when a high voltage line crosses the forest range. Indeed, the edges of the electricity corridor can be planted with shrubs in order to create stepped edges and thus have a positive effect on the stability of the stand, landscape integration of the line, biodiversity, forest-game balance, etc. Restoration of wetland habitats or digging of ponds also falls within the criteria of adherence to forest certification.

The best-known forest certification programs are PEFC and FSC.

3.2.4 The Green and Blue Framework

In France, the Environment Code seeks to maintain connections between reservoirs of biodiversity and thereby offers species conditions favourable to their displacement and achievement of their life cycle.

A more ecological management of areas under high voltage lines can therefore only be more favourable for the environments and species found there.

3.3. The ecological network

The ecological network comprises various zones each having a specific role:

- nodal zones (also called "core zones") – these are areas of great ecological interest. Conservation of nature is a priority in them. These zones must be protected, restored as necessary and managed.
- buffer zones (also called "development zones") – conservation of nature can be envisaged in parallel with human activity, possibly by taking certain precautions.
- liaison zones (also called "corridors") – they facilitate movement of species and therefore colonisation of new territories and genetic mixing of populations.

3.4. Reconciling the Two Networks

The fragmentation of natural habitats, that is, the reduction of their area as well as their subdivision is a cause of regression or even disappearance of a certain number of species. On the one hand, certain species are no longer able to find environments that can meet their different needs (food, reproduction, rest,...) and on the other hand, the colonisation of new territories and the genetic mixing, indispensable for the survival of species, are increasingly thwarted by the impediments placed on their movement. Also, the most peripheral populations are the most susceptible to extinction.
Simple connectivity between populations is therefore vital for their survival.

The network of high voltage lines, by its extent, by the environments and regions which it crosses, as well as by its contiguous character can be considered as a real opportunity for the ecological network.

In green: Natura 2000 areas, in red: electrical grid. High voltage lines connect parts of the Natura 2000 sites

Indeed, the concepts of electrical grid and ecological network are clearly reconcilable. The forest segments linked to passage of a power line can constitute linking elements (ecological corridors), provided they have appropriate management. In some cases, the area under the power line may constitute a nodal zone, that is, a zone with a broad biodiversity, possibly including rare habitats and species. This is the case, for example, when there is chalky grassland or a bog that has survived in the middle of adjacent coniferous stands.

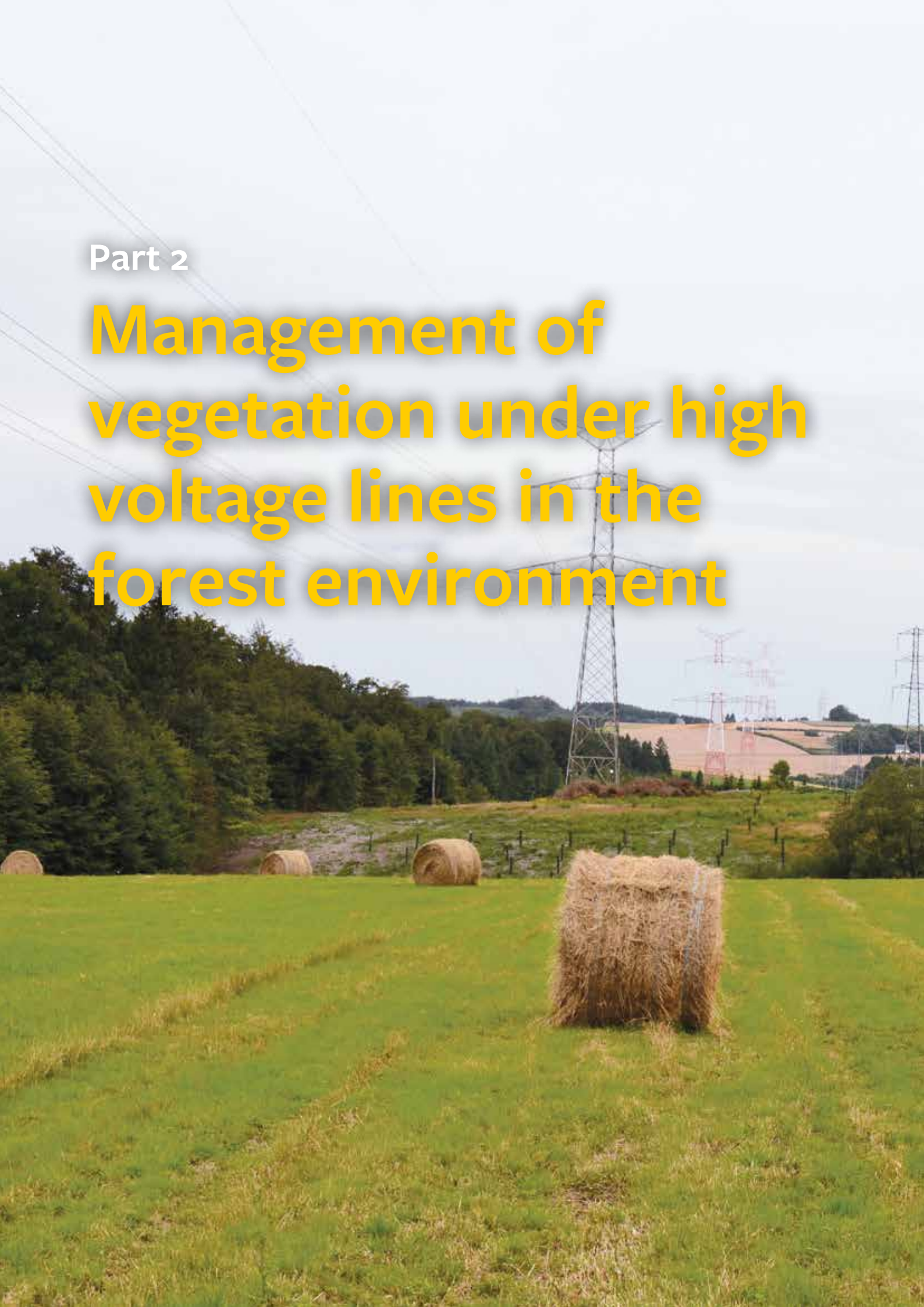
The great interest in electrical corridors lies in the fact that they provide an opening in a wooded environment. Much like a hedge in an agricultural environment, an open area in a forest environment provides very interesting opportunities for biodiversity in that it diversifies the natural habitats present in a single space.

Compared to road or rail transport infrastructure, the linear infrastructure of the high voltage electrical grid is interesting since it does not constitute a physical obstacle on the ground. Species can follow them as they pass through, since the high voltage lines are neither a barrier nor a rail, nor asphalt on the ground. One of the ecological priorities of System Operators is the protection of birds that can suffer from the presence of wires. These are equipped with markers on migration routes, to make them visible and reduce collisions as much as possible.

Finally, a certain similarity can be seen between the electrical grids and the ecological networks. They cover the whole of Europe and the former can really contribute to the movement of species desired by the latter.

Part 2

Management of vegetation under high voltage lines in the forest environment



4 Vegetation under the lines – a risk for electrical safety

To ensure the safety of the electrical grid and thus avoid any incidents or supply interruptions which could happen, the System Operator must monitor the critical points of its installations, including substations and overhead lines.

These overhead lines cross the territory, crossing several types of natural or anthropogenic environments.

4.1. The safety issue: contact or fall

The conductors, or electrical wires, are not insulated and are suspended at varying heights on pylons. In the middle of the distance separating two pylons the height of the wires decreases under the effect of their weight. In case of high heat as well as high network loading, they expand and this results in an even more marked drooping of the wires. With the wind, they can also sway on either side of their axis. Safety must therefore be closely taken into account throughout this margin of lowering and swaying of the wires.

The challenge for the electricity Transmission System Operator is to prevent any trees contacting or falling on the conductors:

- contact causes a loss of electric charge and can cause a supply interruption
- falling trees can physically damage the conductors as well as pull them out or make them fall to the ground

The costs associated with this interruption of electricity supply are extremely high. The consequences of an outage represent costs for the companies, municipalities and users who are largely dependent on the continuity of electricity supply. In addition, the Belgian high voltage network constitutes a strategic node in the European network. An outage can have repercussions well beyond our community, regional or national borders.

Clearly, vegetation under high voltage lines is a critical and delicate safety issue for the System Operator. It must therefore anticipate the risk of accidents and manage vegetation in the safest way for the network, but also at the lowest possible cost.

4.2. In the agricultural environment, the farmer manages vegetation

Where high voltage power lines cross agricultural areas, vegetation is managed in two main ways:

High voltage lines in an agricultural environment

- In cropland: the farmer cultivates cereals, beets or others
- In grassland/meadows: the farmer grazes cattle or mows

In both cases, vegetation is kept low by the farming activity. The System Operator does not have any concrete actions to take to ensure the network's safety since vegetation will always be well below the height of the electrical wires. His main concern will be monitoring the conductors and the proper maintenance of the pylons and their bases.

Foot of pylon developed in farm field

The high voltage network is supported by a very large number of pylons. It can be considered that the higher the voltage, the higher the pylon will be and therefore the more space its base will occupy. In some cases, the System Operator is the owner of the pylon sites, but this is not a general rule.

Especially in an agricultural environment, the base of these pylons, if it occupies a few square metres, can constitute an area that can be developed in favour of biodiversity. These are mainly bases located in agricultural crops below which the farmer is unable to drive farm machinery.

Several types of development can be envisaged: planting of shrubs, setting up a feeding shelter for grain-eating birds of the agricultural grasslands, etc.

These developments favourable to small wildlife may be of interest to naturalists as well as hunters. Incidentally, these arrangements, when done in France, have the very suggestive name of "green socks".

4.3. Ensuring safety in the forest environment

In forest areas, however, management of vegetation is essential. If these areas are not managed, trees eventually pose a danger to the conductors and to the network. The natural growth of woody species must therefore be controlled at all times.

With a few exceptions[1], since vegetation must be kept low, the free growth of trees under the lines is not compatible with the network's safety.

Corridor about 100m wide related to 2 parallel electrical power lines

This precaution is valid just below the conductors and also on either side of them to take into account their swaying due to wind, expansion during the hot months and the risk of trees falling on the installations. We will then discuss a safety margin to be respected beside and under the line.

Depending on the precautionary measures put in place by System Operators, the configuration of the ground and potential parallel positioning of several lines, there may be a safety corridor to be maintained ranging from 25-30 metres to sometimes more than 200 metres, especially in the vicinity of power generation plants.

1 Example of Christmas trees

4.4. In (sub)urban areas: management of garden areas

In urban and peri-urban areas it is not uncommon for high voltage lines to cross over residential areas and therefore gardens with trees.

The requirements for conductor safety are identical to those encountered in the forest, but intervention here is often more delicate. Owners are indeed more resistant to interventions that can affect the trees in their garden. Many reasons are given for this – the concept of private property, fears of potential aesthetic loss, sentimental loss or a simple spirit of protest.

For the reasons given above and in view of maintaining good relations with owners, interventions in garden areas are frequently more targeted, more "surgical" and of smaller scope than in the forest.

Thus, at the request of owners, it is not uncommon for trees to be topped or pruned, rather than being felled. These operations represent an additional cost to the System Operator, especially since they must be repeated periodically.

There are also solutions to limit the impact of interventions and especially to reduce the number of interventions. Adjustments can be made by using smaller trees, or by promoting new types of management in areas under the wires. In Quebec, the System Operator (Hydro-Québec) offers owners an interface allowing them to choose the tree best suited to their situation (https://arbres.hydroquebec.com/recherche-arbres-arbustes)

5 The conventional method of vegetation management

To manage vegetation in forest areas, the System Operator mainly uses:

Safety corridor along high voltage lines

- successive mulching of vegetation in the corridor
- manual felling of woody species located in the safety corridor
- topping of trees, under or alongside the network
- pruning of side branches

This management leads to the creation of safety corridors.

These actions for vegetation management are subcontracted to contractors who do the work in the field.

5.1. Mulching

Tractor with rotary cutter

Cuttings on the ground after rotary cutting

Mulching is most commonly used to maintain high voltage network corridors in the forest. Mulching is carried out periodically using an adapted tractor. This work is repeated every three years on average, but the period depends on the dynamics of the local vegetation which can be highly variable from one region to another. This frequency of passage is set by the operator and lets the work be done quickly (largely mechanised) on trees that have a very small diameter.

The result of this management operation is soil devoid of vegetation and covered with wood chips. Control of the site is therefore easy and the specification's requirements are limited.

5.1.1 Benefits of mulching

This management practice has the following benefits:

- use of mulching is kept well under control since it is known by the System Operator's scouts, contractors and forest managers
- the action reassures the System Operator for which understanding of the dynamics of vegetation is not the primary task No trees = no electrical risk
- opening up of the environment provides a sense of easy accessibility and visibility along the entire line (surveillance, maintenance and intervention on the structures)
- clear "border" between the neighbouring forest and the electrical corridor by the System Operator

Traditional silviculture incompatible with the lines

Forest production is based on large diameter species, which can reach over 30 metres in height. Allowing these trees to grow to significant dimensions can generate income from logging. However, felling large trees is costlier and especially dangerous (proximity to pylons and lines). Producing large trees close to the lines leads to costly precautions to fell them, but great risks if they fall. For this reason, early mulching of vegetation is preferred to felling, since it lets the work be done faster on smaller trunk sections, at lower prices and safely.

5.1.2 Disadvantages of mulching

Mulching has the following drawbacks:

- exposure of the soil with the following consequences:
  - ease of germination of seeds produced by neighbouring trees or by the bank of seeds aroused by being in sunlight
  - total disappearance of competition, an element that promotes so-called pioneer species of trees, with rapid growth in a context of sunlight reaching bare soil
- the root system of cut trees will produce very fast-growing suckers (more than one metre per year for some species)
- the light working of the soil and the chips generated by mulching contributes to setting up conditions ideal for the growth of the very trees the operator wishes to limit
- destruction of the fauna and flora present on the parcel of land (even though the period for intervention outside April 1 to June 30 reduces this impact)
- a negative visual effect

Landscape impact from mulching in a two-line corridor

- compaction of the soil by regular passage of heavy machinery
- multiplication and potential dispersal of certain invasive species (e.g., Japanese knotweed) by dissemination and involuntary transport of fragments
- regular enrichment of the soil by decomposition of the chips, which will contribute to dispersion of flora
- management costs that are not insignificant

5.1.3 The Vicious Circle of mulching

This lighting and enrichment of the soil therefore ends up favouring the very species of trees which the System Operator is seeking to fight. It therefore establishes a sort of vicious circle in which growth of the trees that pose a problem is actually promoted with management by mulching.

5.2. Manual felling

Manual felling is done to maintain the corridors in places where the machines used for mulching cannot go, mainly due to the relief of the terrain (steep slopes or very hilly terrain) or the nature of the ground (exposed rocks). This felling is carried out manually using chainsaws under difficult conditions, which explains its high cost.

5.3. Topping

Topped trees

Topping (heading) consists of cutting the upper part of the tree (1/5 to 1/3 of its total height) and is done on trees whose height represents a risk relative to the conductors. This situation can be encountered in an urban or peri-urban context, when the neighbouring owner opposes mulching/felling but also in a forest context when the owner or manager opposes a sufficient widening of the safety corridor[2].

5.4. Pruning of Side Branches

Pruning of side branches target trees at the edge of corridors whose peripheral branches threaten the conductors. This situation is often encountered when the electrical corridor is bordered by neighbouring gardens. A costly intervention, pruning is done mainly in urban or peri-urban areas as well as in a forest context when the owner or manager opposes a sufficient widening of the safety corridor.

6 Alternative methods of vegetation management

In order to get out of the vicious circle described above and promote biodiversity, alternative methods can be implemented for management of vegetation. Most are actual methods to substitute for the conventional management of vegetation, while other actions are favourable to biodiversity on an ad hoc basis but do not constitute a substitution solution for all vegetation under the lines.

As part of the LIFE Elia-RTE project, actions where implemented in the field under high voltage lines with the aim of differentiated management of vegetation. Before detailing them further, here are different actions that have been tested under the high voltage network:

→ "Forestry" type actions

- Planting of stepped borders
- Restoration of stepped borders
- Planting of conservatory orchards

→ Actions aimed at "open" environments

Installation of a pasture

- Mowing
- Sowing of flower meadows

2 Often to prevent the forest from "receding"

- → Actions for restoration of natural habitats
  - Restoration of peatlands
  - Restoration of moors
  - Restoration of chalky grasslands
  - Restoration of lean meadows for mowing
- → Other actions
  - Digging of ponds
  - Combating invasive species

6.1. Actions by LIFE Elia-RTE for vegetation management

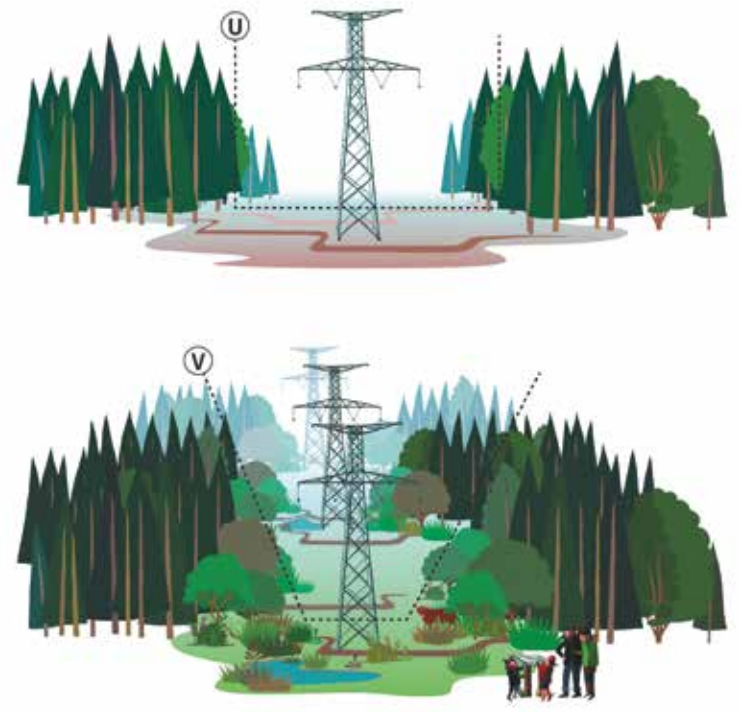
6.1.1 Creation and restoration of shrub edges

Forest borders on either side of the electrical corridor

This action is intended to create stepped borders on either side of the power line. The centre of the corridor, under the wires, remains grassy, while the side edges are planted with shrubs and woody species with a gradient of increasing size from the centre of the corridor to the forest stand.

Planting is not always a required step – when the site is naturally diversified and rich in short species (a few metres), it is possible to promote them by systematic cutting of tall or fast-growing species (birch, ash, maple, aspen, poplar...) which could in time pose a danger to the line.

After a few years, the electrical corridor will gradually change from a "U" profile to a "V" profile.



Electrical corridor in the forest in U and V shape

Planting aligned with the power lines

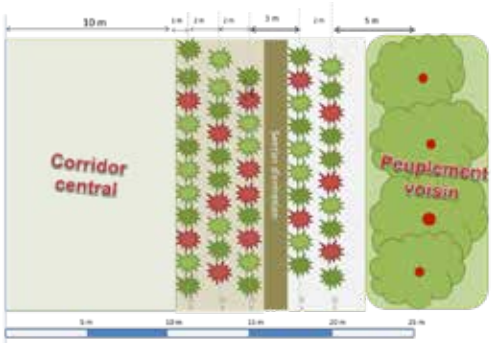


Diagram of planting border lines

Plants are arranged in lines parallel with the conductors. Spacing between the plants must be sufficiently small so that the bushes, as they grow sideways, soon touch each other and close the canopy, thereby preventing germination of natural seedlings of fast-growing heliophilous species and preparing the place for tall species (confirming what happens in the settling of large-scale forest stands). The diagram opposite shows the planting method as applied in the LIFE project.

Planting distances

Planting borders in lines

To ensure rapid saturation of the borders, we decided to set the distance between plants at 1.5 m in the planting lines and to space these lines 2 m apart. A space of 3 m between two lines (lines 3 and 4 starting from the middle part of the corridor, which can be called maintenance partitioning) is maintained to allow future maintenance of the border by facilitating access to the thicket for the management operator. The final planting line is located at least 5 m from the forest trees bordering the corridor to facilitate maintenance of the plantation, allow exploitation of the trees of the stand and avoid planting in areas that are too shady.

The selected species

To obtain stepped edges which fulfil the objectives desired (safety of lines and biodiversity), the choice of plant species is essential. Based on a review of existing literature, we chose the most appropriate species based on:

- the maximum height at maturity
- the adaptation to different types of soils encountered (acidic, chalky, hydromorphic...)

Ten plant species thus form the basis of the composition of our borders. The proportion of species in our planting mixtures may vary depending on the type of soil (wet or not, rich or poor), the game pressure and the quantities available from the supplier. Thorny species or species quite supportive of grazing are preferred while species with a lower canopy, allowing more light to penetrate, are in the minority. The table below shows the base species and the proportions in the mixtures.

Alder buckthorn plant (Frangula alnus)

Cranberrybush plant (Viburnum opulus)

Common name	Latin name	%	Advantages	Height max (m)	3 inner lines	2 outer lines
Hawthorn with 1 style	Crataegus monogyna	20	Good resistance to grazing thanks to its thorns	10	x	x
Common Hazel tree	Corylus avellana	20	Good ground cover, rapid growth, good resistance to grazing, no thorns	4	x	x
Alder Buckthorn	Frangula alnus	10	Quick cover capacity for multiplication thanks to suckers	5	x	x
Blood Dogwood	Cornus sanguinea	10	Fast cover, very low species	5	x	
Blackthorn	Prunus spinosa	10	Quick cover, resistance to grazing thanks to its thorns, capacity for multiplication thanks to suckers	4	x	
Round-ear Willow	Salix aurita	10	Rapid cover, suitable for moist soils, cuttings capacity and natural layering	3	x	x
Rowan tree	Sorbus aucuparia	5	Second magnitude tree with flowers and fruit	10-20		x
Black Elder	Sambucus nigra	5	Quick cover, shrub with flowers and fruit	10	x	
Red Elderberry	Sambucus racemosa	5	Quick cover, shrub with flowers and fruit	4	x	
Cranberrybush	Viburnum opulus	5	Quick cover, shrub with flowers and fruit	4	x	
Wild apple tree	Malus sylvestris	Depending on the opportunity	Second magnitude tree with flowers and fruit Production of small, quality logs and genetic reservoir of a species in decline.	6-10		x
Wild pear	Pyrus pyraster	Depending on the opportunity	Second magnitude tree with flowers and fruit Production of small, quality logs and genetic reservoir of a species in decline.	8-20		x

Protecting plantings from game

Damage on young plant from rubbing

One of the most important factors in failure of plantings is game pressure. Roebuck, deer and does graze the seedlings and thus find in the borders a source of food that is no longer found in the mono-specific forests of the ranges bordering the electrical corridors.

In areas with strong game pressure some provisions can be taken to ensure the survival and growth of plants:

- **Choice of resistant species:** hawthorn, hazel tree, willow and alder buckthorn have proved to be the most resistant to grazing by game
- **Fencing:** Ursus® trellis fences 2 m high or wood palisades (larch or untreated Douglas fir) can be used to protect the planted area. Fencing by Ursus® has been widely preferred for many reasons (lower cost, better durability...).
- **Individual protection:** inexpensive, it helps provide protection for plants, and thus allow them an effective regrowth. It is important to provide more protection for species most preferred by game to allow the best possible regrowth.
- **Individual repellents:** two repellents were tested as individual plant protection. On the one hand, laying of sheep's wool, and on the other hand, spraying of taste, smell or a combination of the two types of repellent: Certosan© or Trico© (the latter is not approved in 2016 in Belgium). These are biological protections against damage from grazing and fraying caused by game.

Individual protection of plants with sheep's wool

Protection of an entire plantation with 2 m high fences

Short and long-term management

In the short term, it may be necessary to carry out 2 main actions:

- **compensatory planting:** if the overall regrowth of the plantation is poor, replanting of plants in empty spaces
- **clearings:** removing from around the plants species which prevent good growth (brambles, ferns, broom shrubs,...). This can be done with the forest sickle (for brambles or ferns) or with a brush cutter (brambles, ferns, broom shrubs...)

Long term maintenance consists of keeping the central strip grassy and occasionally cutting the tall species that grow spontaneously in the margins.

The technical details for implementing this action are the subject of booklet n°4.

6.1.2. Creating conservation orchards

This action aims to plant apple trees (*Malus sylvestris*) and wild pear (*Pyrus communis*) along the borders of the corridors. These two species have declined dramatically in certain regions over the last century. They have the advantage of being native, their flowers are a source of nectar for insects in spring, their fruits are appreciated by birds and some mammals (from the dormouse to deer!) and the logs of fruit trees are desired for the quality of their wood.

Planting distances

The plants are planted 5 m apart in the same line as between the planting lines.
In general, the orchards are planted on relatively small surfaces (20 ares) in one piece. Wild pear, larger when mature, are rather placed along the edges of the corridors, near the forest stands.

The species selected and their source

Wild apples, hard to eat by humans but appetising for wildlife

The species chosen are the apple tree (Malus sylvestris), the wild pear (Pyrus puraster), the medlar (Mespilus germanica). Apple and pear trees were harvested and multiplied by the LIFE project, as explained in the context of the species that make up the borders. The common juniper (Juniperus communis) was provided by the scientific administration of the Walloon region as part of a project to reimplant this species.

Method of planting and individual protection

In-line planting of orchards

After possibly dressing the plant (root and branch size), the seedlings are planted using an axe hoe (facilitating the planting of bare-rooted seedlings) at a spacing of 5x5 m.

Immediately afterwards, a Nortène® sheath is placed around the plant, stapled to one or ideally two spruce stakes. This individual protection will prevent the plant from being grazed, barked or rubbed by game. It maintains the plant and allows better identification of it during maintenance operations on the surrounding vegetation. If planting without a protective sheath is considered, it is recommended to plant a guard next to the plant to locate the plants in the surrounding vegetation.

Long term management

Maintenance is limited to maintaining the grassy strips between the lines of fruit trees.

The technical details for implementing this action are the subject of booklet n°4.

6.1.3. Restoration of habitats with high biological value

The electrical grid passes over various types of environment among which some are (semi-)natural habitats of high biological value. Particularly targeted here are dry or wet moors, peatlands, chalky grasslands and lean meadows.

Under the pressure of human activities (reintegration, agricultural intensification,...), these environments have regressed strongly in some regions.

Their maintenance as well as their restoration when necessary are essential since they shelter a great biodiversity including species which are subservient to them and sometimes rare. Such habitats are also targeted by Natura 2000, a network of natural sites that shelter rare habitats and species Europe-wide.

In restoring such environments under the lines, the System Operator contributes to strengthening the ecological network and ensures the safety of the line, since the actions carried out aim to maintain the open environments on which the growth of trees is thwarted by maintenance of these environments.

Restoration and management of peatlands

Peat bog area with flowering cottongrass

Restoration of a peat bog by tillage and windrowing

Restoration of peatlands is mainly done by:

- **Blocking of drainage:** under the electrical grid in the forest, one of the first actions to implement to restore peaty environments is blocking old drainage ditches. The purpose of this operation is to ensure a rise in the water level of the peatland by removing the old flow. When this is possible, blocking must be total, by filling the drainage completely with peat or white clay.
- **Tillage:** Degraded peatlands gradually dry out and constitute terrain increasingly favourable for the establishment of moorgrass, a grass that forms dense monospecific carpets then allows establishment of woods. When this drying out is confirmed, restoration of the peatland can involve blocking of drainage followed by tillage, which is a scraping of the superficial layer of the soil. This operation consists of baring the soil and reactivating the dormant seed bank. This technique makes it possible to retrieve the original natural habitat fairly quickly.

Long term maintenance of peatlands must be carried either

- manually by regular cutting of the trees that grow there
- by grazing with a low load of rustic cattle
- Restoration of these environments allows them to be stabilised over the long term and save on interventions that are costly and disruptive of the environment.

Restoration and management of moors

Heather, a typical moor plant

Before undertaking the work of restoring a moor, it is necessary to ensure the site's potential for regeneration. This potential is reflected in the nutrient-poor soil and by the presence of seed plants in the immediate vicinity of the work area.

An effective method for restoring a moor is tillage. The presence of trees and shrubs of less than 4 metres height and a diameter of about fifteen centimetres does not hinder tillage, provided that the specification has provided for this and that the operator has therefore been able to take equipment most appropriate for this work.

In any restoration work, it will be necessary to mark off the "seed" zones which have to preserved. The work should be carried out outside the period for vegetation and nesting, from October to March.

1. Before tillage in an overgrown area

2. Restoration of a dry moor by tillage

3. Formation of the windrow

4. Four months after tillage

This work allows the excavated materials to be swathed (earth, stumps, shrubs...). They will be placed along the edge of the corridor, parallel to the electricity lines and along the edge that receives the most sunlight. Well exposed, a windrow can be a habitat of choice for reptiles (lizards and snakes). Ensure that they do not exceed a height of 2m.

The main threat for restored moors is their spontaneous recolonisation by trees and shrubs, especially if the following conditions come together: dry soil and presence of seed trees near the corridor. Note that certain plants present in the moors, by their significant cover, may prevent establishment of other woody species.

Their long-term management can be done by:

- **manual brush clearing and surface mulching:** the progression of bracken fern and bramblebush will be prevented by brush clearing or by rolling over for several years for fern. To combat woody colonisation, a first choice may be surface cutting to promote establishment of heather. If the woody plants are larger, girdling will practised.
- **pasturing:** associated with isolated brush clearing, it allows the open environment to be maintained and ensures establishment of the moor over the long term.
- **mowing:** if no breeder is interested in pasturing the moors created, mowing can also be done at the end of the summer (after flowering and fruiting). This will rejuvenate the heather, promote production of seeds and the possibility of saturating the environment to the detriment of woody plants. This mowing can be done about every 2 to 3 years and must be carried out about 10 cm from the ground. Ideally, 10% will be maintained as an unmowed refuge area.

Restoration and management of chalky grasslands

Chalky grasslands are transient environments which, without human intervention, will progressively evolve towards bushy stages and then to forest.

Restoration of chalky habitats therefore requires the elimination of most of the shrubs in place, either:

Orchids are typical plants of chalky grasslands

- by brush clearing if there are few shrubs or if the terrain is inaccessible by a machine,
- or using a rotary cutter. In this case, it is advisable to carry out mulching above ground in order to preserve the herbaceous flora already in place.

Long term management is done by:

- grazing (sheep will be most effective in this type of environment)
- clearing by brush cutting on steep and rocky terrain

Very occasional brush clearing can also take place after the grazing season ends, in order to eliminate "grazing holidays", that is, any areas not consumed by the livestock.

Restoration and management of lean meadows for mowing

The 4 major phases of establishment of lean meadows for mowing are:

1. mulching of remnants from forest exploitation
2. mulching at depth/soil refining
3. sowing (in spring or fall) and rolling the soil immediately after
4. mowing and ideally exporting of production

The sustainability of a lean meadow is related to respect of the following conditions: no fertiliser inputs as well as establishment of a mowing regime with exporting (at least for the first few years during the restoration phase), taking into account the biological cycle of the species present, that is, mowing carried out on July 15th at the earliest in low-lying areas.

The technical details for implementing this action are the subject of booklet n°6.

6.1.4. Establishment of a pasture or mowing

Especially when the forest corridor covers a large area, it can be interesting to manage vegetation by mowing or grazing. Management is carried out by third parties, generally farmers (grazing or mowing) or hunters (mowing).

These management methods, often implemented by managers on the property of others, require preparation of an agreement which binds the various parties and lists the rights and duties of each. The agreement is accompanied by a specification for the manager who will find in it benchmarks so that this management has an ecological purpose (late mowing dates, low grazing pressure, use of rustic and/or local breeds...). These two management modes are of value for maintaining the safety of the power line over the long term since the growth of woody species is prevented.

With these two actions, the operator can apply for agro-environmental premiums which will compensate for the relatively poor quality of the fodder and which underlines the contribution to management suitable for biodiversity.

In order to establish both mowing and grazing, the following minimum conditions must be fulfilled:

- find local players interested in implementing management, mainly farmers but also, in some cases, hunters.
- have a sufficient area to ensure some profitability for the local player
- have easy access to the sites, to permit farm machinery to get there (monitoring, mowing, water supply, movement of livestock).

- be located at a distance from relatively close villages in order to allow control of the area and to limit travel.

Grazing

Management by grazing involves containing herbivorous animals in the forest corridors of the high voltage lines so they consume the vegetation present. Grazing also lets young woody shoots be restrained.

Grazing of rustic Highland cows

Grazing sheep in an area with a steep slope

A grassier vegetation gradually settles in with the repeated passage of animals. Most commonly, this grazing is practised with rustic animals that require very little care (veterinary treatment, deworming and dietary supplements) and having a low-demand diet.

These are therefore animals that replace the rotary cutters.

Management of these species is entrusted to local breeders who work with:

- cows (cattle grazing)
- horses (equine grazing)
- sheep (sheep grazing)
- goats (goat grazing)

They way in which the grazing activity is implemented depends on:

- preparation of the site
- the choice of the type of animal and the breed selected
- the type of fences installed

To optimise both management of vegetation and biodiversity, the ideal balance should be found in terms of the livestock density. The presence of too few animals exerts too little pressure on the vegetation and risks gradual reforestation. Conversely, excessive density of animals leads to dispersion of the flora and certainly to emaciation of the livestock.

The livestock density will be more important at the start of converting the electrical corridors into grazed areas (restoration phase), which could be lightened as the density of woody regrowth diminishes (management phase).

To permit certain plant species to live out their life cycle including seed production, the dates for grazing is also important.

The grazing dates and load may be adjusted after a few years depending on the development of the vegetation.

All these parameters must be established by environmental experts.

Mowing

To be able to mow an area the following three conditions must at least be met:

- flat or slightly inclined terrain
- soil which is sufficiently dry and supportive at the right time
- absence of large stones, debris from branches or other obstacles

For management by a farmer or hunter, the mowing date must be determined on the basis of site conditions (altitude, exposure, region) which sets the seeding periods. It is of course necessary to perform mowing once the plant species have completed their flowering cycle. As an example, the 1st or 15th of July (on the plain) are pivotal dates often recommended as the beginning of the possible period for mowing. Respect for this calendar also favours the procession of insects which depend on these blossoms. This mowing date can be adapted depending on the development of the vegetation after a few years.

Mowing grassland under the lines

Fodder bales after mowing

The more nutrient-poor the soil is (mainly nitrogen), the greater is the diversity of plant species. The ideal is therefore to contribute to the depletion of the soil, by removing the residues of cutting carried out in the forest corridor. Fodder can be used to feed the cattle in winter or set in swathes along the corridor's border.

In some situations, a mixture of seeds can be sown in the electrical corridors. In the case of establishment of a mowing meadow in a wooded area, it will be necessary to first fell and remove the wood and branches. The aim of this is to eliminate as much organic material as possible. The wood will be used as much as possible and the branches will either be stacked nearby (providing shelter for microfauna) or exported in pallets and valued as biomass energy (this operation is often the costliest but can be self-financed in some cases by the value of the wood).

Last mulching before seeding flowered grassland

Finally, passing a rotary cutter over the cut is necessary to eliminate the last shoots of woody species, flush and break as much as possible the strains and superficial roots.

Depending on an analysis of the habitat, if conditions are good and the work is sufficiently thorough, grassy vegetation may already be established as a result of this operation. The following year, a mowing will already be sufficient to finally eliminate the last woody species.
This mowing is done with sturdy equipment (rejection mower, with flails,...). Fodder can also be required to be exported to contribute to soil depletion, always beneficial to the expression of biodiversity.

If the surface of the soil is still uneven or still strewn with pieces of branches, it is then necessary to rework the soil in depth with heavy equipment to break up the roots and the soil to a depth of 40 cm (forest mill or Meri Crusher ©).

Harrowing before seeding

Deep milling of the soil is followed by harrowing to level the soil and break up the clods of earth. This operation is most often carried out by a farm tractor also equipped with a seeder and Packer roller allowing the working depth of the harrow to be set, compacting the soil in the first pass, breaking up the earth more finely and possibly covering the seeds slightly. In a single pass, the soil is therefore harrowed, sown and rolled.

Finally, rolling the soil with a heavy smooth roller is sometimes recommended when the soil has been worked to depth (more than 10 cm). Indeed, the rise of water which takes place naturally by capillary action is broken by milling. Rolling lightly decompacts the soil and so recreates moisture conditions favourable to germination and development of seedlings.

Manual seeding of small areas

For sowing, since there are various seeds harvested from grasslands of high biological value (see seed harvesting below), seeding on the fly with a "Vicon" type centrifuge or with pendulum movement is recommended. The use of pneumatic seeders is often difficult, given the risk of blockage caused by the lack of uniform seed size.

In small areas, seedlings can also be planted, traditionally by hand.

Complete technical details for implementation of this activity are the subject of booklet n°3.

6.1.5. Creation of ponds

Ponds dug as part of the LIFE Elia-RTE project are as natural as possible, meaning that they will be left for natural colonisation – no plants or fish will be introduced. To avoid the use of tarpaulins for water retention, the site selected for digging will be chosen based on the nature of the soil and the potential for water supply (water table, runoff).

Pond dug in the shape of a bean with gentle slopes

Educational visit on the theme of life in the pond

View of pond a few months after digging it

This action does not on its own change management of the TSO. On the other hand, it constitutes an undeniable value in terms of biodiversity, provided that the ponds are not dug in an already rare habitat or in a site where rare species are found.
These wetlands are also very good tools to raise awareness about the environment.

In general, if water collects rapidly, ponds are very quickly colonised by wildlife. Early colonisers often include aquatic bugs and beetles, newts and dragonflies. These can cover great distances quickly and are therefore able to quickly discover a new body of water. Amphibians make their appearance there soon afterwards. These animals are the prey of certain birds, so a whole food chain benefits. From the point of view of vegetation, algae, water plants and shore plants are gradually established.

Several criteria prevail for correctly digging a pond:

- The location of the pond
- The shape of the pond
- Exposure
- The slopes of the banks
- The pack of supply of fish or plants

Ponds are environments for which the lifespan is linked to their size and depth. The smaller and shallower they are, the faster they will naturally fill up. From the point of view of biodiversity, it is very interesting to have a network of ponds, with some that dry out or fill up faster than others, to provide a wide spectrum of micro-habitats suitable for a large number of both animal and plant species.

The technical details of implementing this action are the subject of booklet n°5.

6.1.6 Combating invasive species

Invasive species are considered as one of the world's leading causes of biodiversity loss. The electrical grid and in particular management inadequate for vegetation under it can contribute to dispersion of invasive plant species.

This is particularly true with mulching since highly invasive plants such as Japanese knotweed can multiply from fragments of just a few grams and furthermore this method of management also allows contamination of new sites by the accidental transport of fragments.

Fighting invasive plant species is very costly, time-consuming and sometimes futile, especially where invasive populations are well established. The emphasis must therefore everywhere by on preventing dispersion of these species.

The technical details of implementing this action are the subject of booklet n°5.

Japanese knotweed (Fallopia japanica) under a high voltage line

Manual picking of late cherry (*Prunus serotine*)

Part 3

Owners and Managers of Forest Spaces

7 From the viewpoint of land stakeholders

7.1. Methodology for establishing actions in the field

To carry out actions on a private or public property, the System Operator follows a very specific methodology that has been developed in the LIFE Elia-RTE project. There are several steps to this methodology:

1. Initial mapping
2. Preparation of development proposals
3. **Consultation with the owners and managers of the parcels concerned and final choice of developments**
4. **Signing of agreements with the owners and managers**
5. Writing specifications, calling for tenders and selecting contractor
6. Site work
7. Writing management plans

7.2. Consultation and responsibility of private and public owners and managers

7.2.1 Consultation with owners and managers of forest parcels

Forest owners are always consulted before implementing alternative vegetation management methods on their property.

After an initial contact prior to beginning the process on their property, the owners and managers are therefore practically involved in the 3rd step of this methodology. In the discussion which takes place to choose the actions to be undertaken, the persons concerned share their interest in certain actions. It is the search for a solution that can, all at the same time, meet the interests of the owner, any manager of his property and the electricity System Operator which makes this consultation useful and interesting.

Consultation with the owners and managers of property under the high voltage lines.

Following the agreement reached between the System Operator, the owner and, in some cases, the manager (forest administration, farmer, hunter, etc.), a final map of actions to be implemented is made.

7.2.2. Signing of a written agreement

In most cases, an agreement that specifies the actions to be undertaken and the responsibilities of each is signed by the System Operators and by the owners of lands crossed by the high voltage line. This is the 4th step of the methodology detailed above.

Signing an agreement with owners and a farmer

The term of the agreement may vary, but the idea is to set up a sustainable approach to management methods. The initial investment of these actions, as well as the time for negotiation, are not insignificant, and the agreement ensures that these investments can continue over time.

For private owners

For private owners, the agreement is a conventional document that includes the elements of the actions to be implemented, and the roles and responsibilities of each party. As stated below, it is the System Operator who remains responsible for both the electrical risk and the costs associated with maintenance of vegetation.

For public owners

At the community or public level more broadly, the agreement that seals the various aspects of actions to be deployed takes the form of a communal deliberation or a state convention. It is therefore the elected representatives who, on the basis of a dossier containing all the details of the project as well as discussions with the experts responsible for implementation of the new methods, make a decision which will be recorded in the minutes of communal or municipal deliberations.

When managers take part in management of publicly owned property, several scenarios may arise:

- For a farmer who is required to graze on public or private land under the lines, he will be an integral part of the signatories to the agreement to be signed. In Walloon law, this agreement, called *"precarious and free"*, gives access to the parcels to the farmer. The precarious character means that if he does not manage the parcel and grazing infrastructure (fencing, barriers, watering points) with *"responsible and due care"*, his access to the parcels may be withdrawn in order to find another farmer or simply that the owner is not locked into a lease and can regain full possession of his property. In view of the difficult character of this type of grazing (woodier and less herbaceous than grassland) and the low profitability that results, these parcels are made available free of charge. This free provision also avoids any future claim from the farmer on the property that he would have managed for a lease. It therefore puts the owner in a secure position with regard to durable alienation of its property. Here it is necessary to consider grazing more as management of vegetation with a multifunctional purpose (production, natural heritage, landscape, biodiversity) than as solely an economic activity. The reflection is identical for implementation of management by mowing.
- For hunters, municipalities or public authorities can add technical procedures in the specification related to the allocation of hunting leases. These measures aim to maintain the actions implemented, such as the annual mowing of corridors under the electricity power lines. Very often this arouses the interest of hunters who value them in the firing line or in feeding areas.

Highland cows breeder

→ In a manner completely independent of the municipality, a farmer can apply for agro-environmental subsidies, or other types of incentive bonuses. If the case is accepted by the decision-making authority, the operator will receive annually, in 5-year periods, renewable, an amount that will compensate for the low productivity of the environment and the workload related to management of such marginal environments. It will also "finance" the collective interest services generated in terms of conservation of nature, biodiversity and landscapes. Associated with these premiums, many measures are established to guarantee a maximum impact for biodiversity: mowing/grazing dates, livestock density, non-use of pesticides and fertilizers, etc.

7.2.3. Responsibility which remains with the System *Operator*

Regardless of the alternative method for management of vegetation that is implemented on its property, the responsibility related to this management does not rest with the owner. It is the System Operator who remains responsible for electrical safety. For reasons of safety, the System Operator will be able to carry out the actions necessary to avoid any electrical accident.

Concretely, an owner who accepts implementation of actions on his property does not undertake to himself manage the electrical risk. He rather agrees that management actions may be undertaken while allowing the System Operator to retain full and entire responsibility for safety, as was the case when vegetation was managed in a conventional way.

Consequently, the owner must not take out any additional insurance.

7.2.4. Maintenance costs for the System Operator

Unlike what can be practiced on the electricity distribution network, the costs related to safety of a space under the high voltage lines are always at the System Operator's expense.
The private owner will therefore not have to bear the costs of establishing or managing alternative methods of vegetation management developed on his property.

7.3. Interest for private and public owners

Private and public owners have many reasons to accept or even wish to deploy alternative methods for management of vegetation on their properties. While the electrical corridor has been little valued in the past, there are real opportunities to establish actions beneficial to owners or the users of their property.

The rest of the document discusses the many interests owners may find in these actions.

7.3.1. From the point of view of silviculture

- **production of firewood:** management of a forest border is done in the same way as for the stands: selection, felling, evacuation. In this area, species will become smaller, and will meet the requirements for production of firewood, by their small dimensions and their accessibility outside the stand.
- **diversification of species:** planting of borders and conservatory orchards brings a diversity of secondary species compared to production species which constitute the main stand on either side of the forest corridors. They thus support a necessary diversification of forest ranges, which

is necessary for forest resilience in the context of climate change. Producing small fruit for game and wildlife in general, they are a reservoir of seeds for the neighbouring stands.

- **production of logs of valuable species:** the establishment of borders or orchards of local wild species permits the production of valuable, fruity and light-seeking species. It also enables silviculture producing small and high-quality logs particularly sought for cabinetmaking, marquetry or violin making.
- **stability of stands:** stepped borders play a springboard role for prevailing winds and thus mitigate their impact on the forest stands. They ensure better stability of the forest ranges and limit the risks of windfall.
- **better quality logs at the edge of the stand:** often the trees along the border develop side branches that seek light from the electrical corridor. These branches have many knots in the wood that will depreciate its economic value. Establishment of a border will play a sheathing effect that will significantly limit the development of these side branches.
- **respect for Natura 2000 management measures (in Belgium) and measures for forest certification programmes (PEFC, FSC):** establishment of borders meets the obligation, the Walloon public forests in any case and in certain private forests, to allow a 10m wide shrubby band at the outer border of the range or to leave standing dead trees or trees of biological interest.
- **a plus for the municipalities:** they offer the possibility of allocating firewood logs in agreement with the department that manages the forests (Department of Nature and Forests in Belgium and National Forests Office in France)

7.3.2. From a hunting point of view

Deer on a feeding area set up under a high voltage line

- **nesting and food:** sowing lean meadows for mowing, forest borders and restoration of certain natural habitats offer game an environment for nesting and/or feeding. These two characteristics are the result of the presence of species attractive to game that grazes them, of appetizing fruit, grassy feeding areas and resting places. Orchards also offer an important source of food through production of wild apples and pears that are very highly appreciated by wildlife.
- **firing line:** although conventional management provides for cutting vegetation when it reaches the shrub stage, establishment of flower meadows or mowing meadows ensures the permanent presence of a line of fire.
- **water points:** the presence of ponds is, among others, beneficial for wildlife which finds it a drinking point throughout the year.

7.3.3. From the point of view of biodiversity

- **the increased area of restored natural habitats:** the actions of restoration of peatlands, moors or chalky grasslands are perfectly incorporated in a global context of conservation of nature and biodiversity, a goal pursued among others by the establishment of the Natura 2000 network. These habitats are home to a very specific fauna and flora. This contribution to the conservation of nature resonates strongly with regional, national and European policies for measures to counter the erosion of biodiversity. They can be usefully integrated into the target objectives of the regional Nature Parks charters or in their contribution to implementation of

ecological networks (Green and Blue Framework, Main Ecological Structure)

- **the capacity for hosting species:** the restored natural habitats under the high voltage lines will provide an interesting host environment for animal and plant species. A suitable pasture also allows a large number of plant and animal species to be enhanced. A varied choice of species appropriate to the region also gives the borders a great diversity, both in terms of flowers and fruits, and be of increased interest to bees. This diversity is favourable to many insects, birds and micromammals, which find food, rest sites and sites for reproduction. Certain species are even endemic to these borders and natural environments.
- **the connectivity of the ecological network:** open corridors (mowing, pasturing, restoration of natural habitats) created within forest stands offer animal and plant species opportunities for movement. Taking advantage of the wind, the seeds disperse; taking advantage of the grassland, butterflies and dragonflies are no longer stopped by the forest. The borders also play an important role in connectivity, allowing animal or plant populations to disperse and thus extend their territories. They offer an ideal growth environment thanks to the diversity of special conditions they create. Restoration of natural habitats or even digging ponds will also strengthen connectivity of the ecological network, by providing conditions conducive to the development and movement of specific species. This connectivity thus avoids confinement of species in confined "reserves" with an increased risk of isolation, loss of genetic diversity or even disappearance. These corridors allow species located on either side of a forest range to move within the forest areas.

Connectivity between sites is very important for butterfly species.

- **diversification of environments:** essential to favour as many species as possible, the heterogeneity of environments, natural habitats and their diversity will permit a great hosting capacity for species of flora and fauna. The mosaic of habitats created by the diversification of actions in a forest context is particularly interesting in this respect. Alternating open areas (flowered meadows), semi-open areas (borders, bushy areas,...) and closed areas (forests) favours a multitude of species that are already present and also permits the arrival of new species.
- **preservation of local plant and animal heritage:** the establishment of orchards of scarce local forest fruit trees, endangered junipers or seedlings of local and diversified meadow plants makes it possible to preserve the genetic heritage of these species. Even better, electrical corridors in the forest become a source of potential redeployment programmes for these species. Seedlings from locally harvested seeds on grasslands with high biodiversity allow for the preservation of these plant associations which become scarce in the agricultural environment. The use of ancient and protected breeds for grazing is also a way of ensuring the continuation of these species and traditional practices.

Grazing with endangered breeds (in this case Ardennes Roux sheep) contributes to its preservation

- **soil conservation:** by managing the spaces under the lines using lighter machines or livestock, compaction is limited. Preservation of forest stations will be ensured by consideration of repeated passage or on access. Open corridors can be used to pass through, or for temporary storage outside production plots. This consideration allows full integration of the open corridors in management of the ranges. Maintenance of vegetation by mowing also has a significantly reduced impact over mulching.

- **combating invasive species:** invasive species can develop under the high voltage lines. Establishment of flowered grasslands or meadows for mowing will considerably limit their growth and dispersion. Similarly, dense planting of secondary species in the borders limits their development within the forest ranges. In addition, limiting the movement of cutting machines will further reduce the risk of intake of invasive plants from another "contaminated" site. For this delicate subject, monitoring and regular inspection permits action to be taken quickly and effectively. Measures impeding the arrival of invasive species and raising the awareness of the different players will preserve the integrity of forest stands confronted with future problems.

7.3.4. From a landscape point of view

Impact of a border on the landscape

Landscape impact of a flowered meadow

- **improvement of integration of the forest corridor in the landscape:** a newly opened safety corridor can have a significant visual impact. The "green" cover has disappeared and left in its place a brown scar within the forest. The aesthetic appeal of the moors when the heaths are in bloom, of blooming meadows or even chalky grasslands is clearly a landscape alternative preferable to the clear cutting of conventional management. Similarly, planting of stepped borders lets the "U" angled structure of the forest corridor be attenuated and replaced with a gentler open "V" shape. In time, the curves formed by ingrowth of the borders breaks the abrupt lines and integrates these elements in the forest landscape. They thus ensure better acceptance of these slices in the forest by the owner and the general public.

- **screen effect:** in certain cases, setting up a planted visual break in strategic locations limits the visual impact of the safety corridor. In places where poaching has been identified, this may be a hindrance to finding game with headlights. This screen effect will also permit creating quiet areas for large game.

- **enhancement of the edges of roads and paths:** sowing a flowered meadow can really embellish the aesthetic aspect of the electrical corridor in the forest, especially if the colours of the different paths are visible from the road or path.

7.3.5. For a socio-economic point of view

For the municipalities:

- **diversifications of forest functions:** the multifunctional aspect of the forests is a certain expectation of forest policy and users. Enhancement of spaces under the high voltage lines to promote environmental, social, silvicultural and hunting functions is a real opportunity for the Administration in charge of forest management. And this enhancement can be done without economic competition and loss for the municipality, since the electrical corridors are, for safety reasons, removed from areas contributing to forestry production.
- **enhancement of new spaces for local operators:** access to the land for a young farmer is not always easy given the price for rental or purchase of land in some regions. Giving farmers the possibility to have new land is positive for the local economy and to combat the desertion of rural areas.
- **possibility of employing local companies:** the work to be done in the context of alternative methods of vegetation management calls for a more targeted and local know-how. This makes it possible to promote entrepreneurs in a rationale of short networks and sometimes also solicit companies working in social and professional insertion.
- **possibility of diversifying economic activities:** diversification of environments also makes it possible to diversify activities. It is also possible to foresee the production of honey under the high voltage lines, revitalization of a bovine, ovine or other local breed in decline....
- **education, tourism and raising awareness of conservation of nature:** the spaces under the lines, by their interest in nature and their diversity, offer an ideal ground for educational visits for schools and the general public. Installation of communication tools such as interpretive panels and viewing areas makes it really possible to bring an additional attraction for tourism to a municipality and enhancement of its heritage.
- **reinforcement of synergies between different partners:** the multitude of actions to be carried out under and in the vicinity of the high voltage network leads immediately to networking with partners. A property manager wishing to become involved in differentiated management will be able to be supported by new partners hitherto little or not solicited. A hunter will be able to provide differentiated management of mowing, more favourable to biodiversity. A naturalist will be able to provide biological data that can support an application for subsidies to maintain high biological quality environments. A breeder will be provided with an open area under the high voltage line, removing repeated mowing actions from the agenda. A farmer, mowing under

Workshop for recognition of plant species with school children at the Nature Festivities

Educational visit by school children at the Nature Festivities

Inauguration of a viewing area with the Minister Responsible for Nature Conservation and Rural Policy, a representative of the European Commission, Elia and the mayor of the municipality where the viewing area was set up.

the lines, will facilitate the work of the hunting rights manager, maintaining nice feeding areas. These examples multiply the possibilities of positive interactions to ensure new functionality in the safety corridors. These positive synergies will guarantee sustainability of actions undertaken and they could be emulated at other levels of territorial scale.

7.4. Recognitions of the LIFE Elia-RTE project

The LIFE Elia-RTE project has received 3 international awards which underline the work done and especially the relevance of this approach in the current socio-economic context:

- *"Best Practices for Environmental Protection"* awarded in 2015 by the Renewables Grid Initiative, a European consortium of electricity transmission network operators and of NGOs active in respect for the broader Environment.
- Natura 2000 award in the *"Reconciliation of interests/perceptions"* awarded in 2016 by the Environment DG of the European Commission. This award underlines the interest in the approach for collaboration to find practical solutions that meet the perceptions and expectations of each stakeholder. The other aspect emphasised by the European Commission is that these actions can be replicated in all European countries, provided they are adapted to local biogeographical contexts.
- *"Sustainable partnership"* award granted in 2016 by The Shift, a unique and diversified network of companies and associations in Belgium who want to support adding value to society.
- In France, the project has been labelled as part of the ITTECOP research programme. This research programme is piloted by the Ministry of Ecological Transition and Solidarity and aims to develop the field of knowledge related to linear transmission infrastructures and biodiversity.

7.5. Joining the process

Many private and public owners, as well as many managers of natural spaces, have shown an interest in these alternative methods of vegetation management. Both in Belgium and in France, some of them did not expect to be contacted by the team to testify to their desire to join the LIFE Elia-RTE project. They have expressed themselves directly to the LIFE project team or to managers of the Elia network in Belgium or RTE in France.

Concretely, any owner or manager interested in the process can contact the project team (www.life-elia.eu) or the System Operator. It is with interest that winning solutions will be sought, with the owner or manager, to best meet local issues.

Although the LIFE Elia-RTE project terminates at the end of 2017, the two-electricity transmission system operation companies have decided to continue and extend the experiment. It is therefore always possible, and even strongly encouraged, to display interest in these actions. Without commitment and free of charge, a meeting can then be arranged with the experts responsible for setting up these actions on your property.

8 To go further

The www.life-elia.eu website contains a lot of useful information about all the tools for mapping, negotiations, field actions, communication, training.

8.1. The sites worked

http://www.life-elia.eu/fr/Sites-travailles

In order to be able to get a better idea of the sites on which actions have been undertaken, the website contains a space from which it is possible to consult, for each site, the actions carried out as well as georeferenced photos taken at different times of our restoration work. This tab can let you view the actions taken, and inspire you from these illustrated examples of achievements.

8.2. Our publications

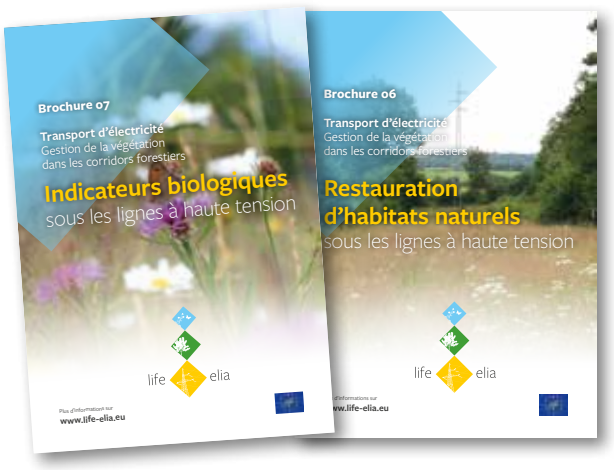
www.life-elia.eu

Different types of documents are included in the section **"Our publications"**. It contains a large number of documents useful for better understanding the details of the actions. In addition to the documents described below, this section includes articles written by professional forestry, scientific and naturalist organisations, answering questions that a manager or owner may ask about potential developments.

8.2.1. News

This section includes news about the project since it was implemented and its completion at the end of 2017. It illustrates the various actions undertaken, step by step, showing the collaborations established, tests done, etc. It creates a timeline to inform anyone who would like to be involved in another management of his safety corridor and to see the essential steps with concrete examples.

8.2.2. Booklets



In all, 10 booklets are available. Each of these documents explores in detail a theme developed by the team as part of the LIFE Elia-RTE project. The subjects are as follows: mapping, a cost/benefit analysis, grazing and mowing under the lines, planting borders and orchards, digging ponds and management of invasive species under the lines, restoration of natural habitats and partnership and the agreement with owners and managers.

8.2.3. Information leaflets

8 information leaflets give general information about the project but also focus on targeted actions undertaken at sites in France. They can be used for information, education and tourism. They provide a lot of information on the species and natural habitats targeted by these restorations.

8.2.4. Vade-Mecum

2 vade-mecums were written, one for forest owners and managers, and the other for the electricity Transmission System Operators throughout Europe.

8.3. Media

http://www.life-elia.eu/fr/Mediatheque

For a virtual visit in pictures of achievements in the field, many photos and videos can be viewed.

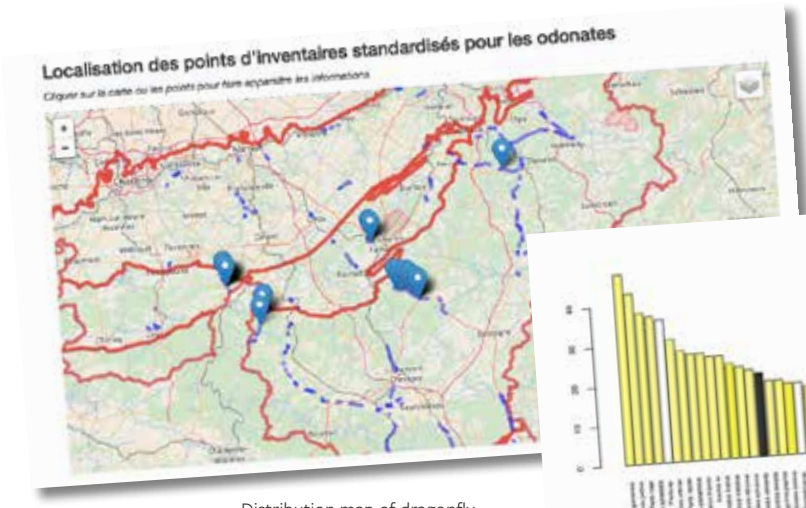
Online consultation of photo and video albums

8.4. Biological indicators

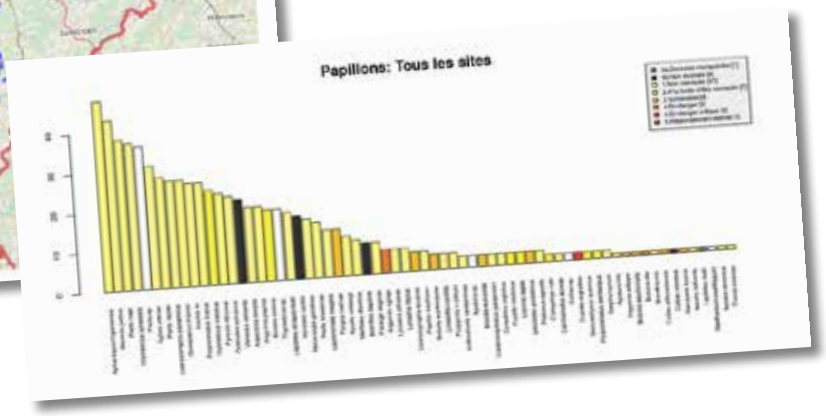
http://www.life-elia.eu/fr/Indicateurs-biologiques-14

This part of the site provides access to the results of biological inventories taken as part of the LIFE Elia-RTE. All the groups studied are included (odonata, amphibians, birds, diurnal butterflies, reptiles, bats, plants).

The report can be consulted in complete or summary form. It includes inventory data, distribution maps and the analyses that can be drawn from these data on the effectiveness of these management methods favourable to biodiversity.



Distribution map of dragonfly inventories



Results of butterfly inventories

9 Conclusions

When the high voltage electrical grid crosses our forest ranges, the System Operator faces a real safety challenge. It must ensure that no trees come too close to the lines or fall on the wires. This challenge is critical since the supply to industries and households depends on this transmission of electricity and therefore the integrity of the electrical grid.

Regular clear cutting of vegetation in the forest corridors crossed by high voltage lines was the most effective and least costly method used by the System Operator and this was done in a quite general way for all European TSOs. After periodic rotary cutting or crews passing on the ground for manual cutting, the vegetation was destroyed and the corridor again free of vegetation. But the problem is that this method of management creates better conditions for the regrowth of the very trees that System Operator has just being trying to combat.

Faced with this vicious circle, the LIFE Elia-RTE (2011-2017) project has set up field actions which are alternatives to the conventional method of vegetation management. In addition to reducing the frequency and intensity of interventions by the System Operator, the solutions found all have one point in common – they favour biodiversity.

In this approach, the forest owners and managers are key players of these alternatives since they are the ones who own and manage the forest spaces under the high voltage lines. So it is with them that all the alternatives implemented are locally built. For each part of the electrical grid, the actions carried out as part of the LIFE Elia-RTE project were chosen, in a spirit of consultation, on the basis of the interests of owners and managers. Whether attached to forestry production from forests bordering the forest corridors, hunters or involved in nature conservation, everyone has been able to enrich the project with their vision and reclaim a space that was somewhat "lost".

For Municipal owners, the solutions found make it possible to include the electrical corridors in the forest in the local network, by interesting the local residents and nearby economic players to get involved in management of the vegetation. Where management of vegetation was a constraint, it has become a real opportunity.

For forest managers, these spaces are the most relevant to develop all the multifunctionality that is now expected from the forest. This deployment of biological, social and hunting functions can be done with competition to the economic function which was absent in view of maintenance of vegetation by the System Operator. Quite the contrary, some of the actions put in place are part of the possibilities for deployment of a rural economy (mowing, grazing).

If the notions of the electrical grid and ecological network are aligned, we quickly find how well they complement one another. The electrical grid, through the connections it provides between biodiversity-rich sites, provides animal and plant species a real opportunity to move around. So these are real highways for biodiversity which are enhanced by the System Operator.

For forest owners and managers, it is a perfect opportunity to take a closer look at these spaces, value them and become part of a broader consideration of the major energy and environmental issues of today.

Areas of implementation of natural space restoration under high voltage lines

In Belgium (Walloon region):

- 155 km of electrical corridors

In France:

7 sites in the different biogeographic regions

- Atlantic: Finistère, Seine-et-Marne
- Continental: Aube, Ardennes, Doubs
- Mediterranean: Drôme
- Alpine: Hautes Alpes

Follow the project on:

www.life-elia.eu/en/