elia
Elia Group

# Federal Development Plan
## of the Belgian transmission system
## 2024-2034

FEBRUARY 2023

# The energy transition as socioeconomic protection

The further scaling up of renewable energy sources and far-reaching electrification are creating urgencies that will soon require additional investments to be made.

Dear reader,

Energy is a precious resource which is of strategic importance. We were already accelerating the speed of the energy transition because of the climate; now we are also accelerating it because of high energy prices and a geopolitical crisis. Needs change both in terms of production and in consumption. This has a direct impact on the electricity system. Thinking about the future of the Belgian high-voltage grid therefore carries an essential social quality. It is this quality that we seek toThat is exactly what we want to do with this Federal Development Plan 2024-2034.

Due to the long lead time of infrastructure projects, the further development of the electricity grid needs to be planned in an extremely meticulous manner and in good time. We must take into account developments that we cannot fully assess today. A year ago, for example, there was no REPowerEU Plan distancing Europe from Russian fossil fuels. However, the further scaling up of renewable energy sources and strong electrification are creating urgencies that will soon require additional investments to be made.

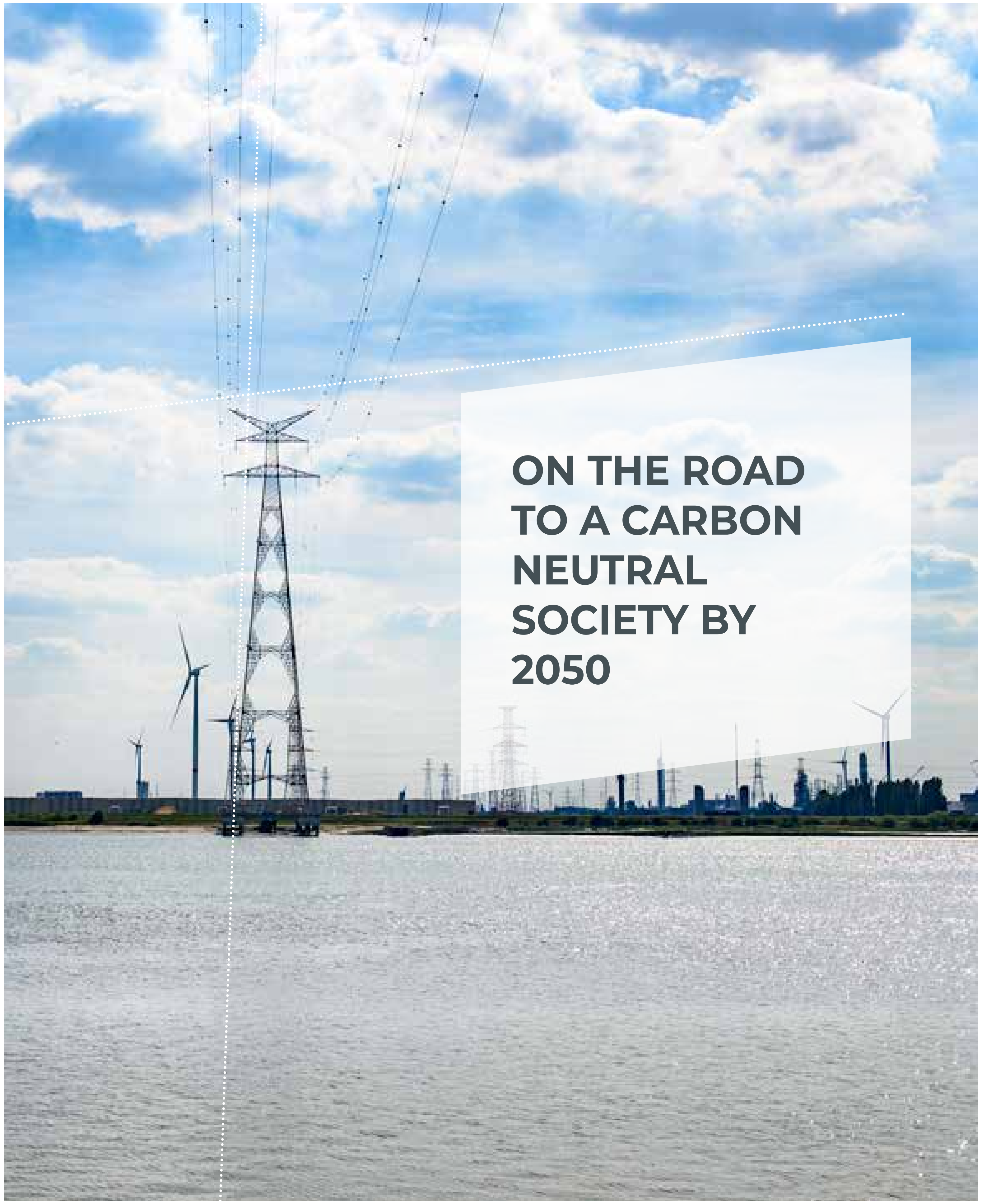
The Netherlands is currently experiencing negative consequences linked to the underestimation of social trends and under-investing in infrastructure. The Dutch Minister for Climate and Energy Policy, Rob Jetten, told the Trouw newspaper last summer that his government was “overwhelmed by the rapid growth of wind and solar power and the increased demand for electricity.” In response to the temporary halting of grid connections in the Dutch provinces of Noord-Brabant and Limburg, he indicated that “the problems would certainly continue until 2030.” He called the energy transition “much more disruptive than imagined.”

We fully recognise the increasing integration of renewable energy and the electrification of industry, which seeks to anchor itself in Europe through these!

During the same period, the Trouw reported that four of the five main Dutch industrial areas are located in regions where new grid connections are no longer possible because the electricity grid is overloaded. Therefore, factories in those areas cannot switch from fossil fuels to sustainable energy, or implement their plans for sustainability, triggering consequences for their competitiveness. Fortunately, we do not yet have the grid connection problems they have in the Netherlands. Through this Federal Development Plan 2024-2034, we have attempted to fully anticipate the urgent demand to make our energy policy more independent, resilient and sustainable. We fully recognise the expected consequences of ever-increasing ambitions related to the integration of renewable energy and major investment plans of industrial players, which want to anchor themselves in Europe by investing heavily in electrification over the next decade. In this Federal Development Plan, we have therefore included a number of concrete proposals, such as the building of additional high-voltage substations, without defining an exact location for them. This will give us the necessary flexibility to quickly respond to requests from our grid users and to ensure that the energy transition is not blocked or slowed down by grid restrictions.

Enjoy the read!

# Executive Summary



## ON THE ROAD TO A CARBON NEUTRAL SOCIETY BY 2050

# Energy is a precious resource and a strategic asset

The world has changed since the publication of our last Federal Development Plan in 2019. The floods in Wallonia were a wake-up call that we must take climate change seriously. The high energy prices have rapidly made us realise just how precious energy is. It is a strategic asset that is high on the political agenda. The war in Ukraine has only reinforced the urgency.

The European Commission reacted in April 2022 with a REPowerEU plan to make Europe independent from Russian fossil fuels by 2030. In addition to the diversification of our gas supply, the focus is on energy efficiency, more renewable energy sources and electrification. It must make European energy policy more independent, resilient and sustainable.

Next to addressing the geopolitical crisis, the climate crisis is also becoming more urgent. The chance of limiting global warming to 1.5 degrees Celsius seems all but gone. Only if the world comes up with much more ambitious plans to reduce $CO_2$ emissions will the Paris climate goal still be achievable, the United Nations Intergovernmental Panel on Climate Change (IPCC) concludes in a recent report [IPC-1].

> The evidence is irrefutable: greenhouse gas emissions are choking our planet and placing billions of people in danger. Global warming is affecting every region on earth, with many of the changes becoming irreversible. We must act now to avert a climate catastrophe. The IPCC report is nothing less than "a code red for humanity".
>
> **António Guterres – UN Secretary-General**

# Different approach for rapid and large-scale integration of renewable energy

To keep the ambitions of the Green Deal – becoming the first climate-neutral continent by 2050 – on track, in July 2021, the European Commission launched the Fit-for-55 programme. With a package of legislative proposals, $CO_2$ emissions must be reduced by 55% by 2030.

Whereas in the past, $CO_2$ reduction was focused predominantly on the energy sector, Europe has now imposed additional targets for all sectors. The Commission expects all sections of society to contribute.

With the Fit-for-55 programme, the speed of the transition is also stepped up. In a recent Elia Group study (Roadmap To Net Zero), we calculated that renewable energy expansion needs to accelerate by a factor of 3 in order to achieve the targets. The war in Ukraine shows the need for an additional acceleration. Renewable energy needs to be integrated more quickly and on a larger scale.

With large-scale investments in infrastructure, digitalisation and sector convergence, our society stands at a turning point. Thanks to digitalisation and the emergence of new technologies, the next 10 years will be the decade of electrification.

> An accelerated electrification of residential and industrial processes combined with the massive integration of larger volumes of renewable energy generation also requires an accelerated expansion of the grid infrastructure. Because the development of the high-voltage grid has a longer lead time, a different approach is needed. If we do not anticipate what is to come in this Federal Development Plan, the electricity grid will be a bottleneck for the large-scale integration of renewable energy and will delay the energy transition. This would go against the wishes and interests of our society.



# Direct electrification is the most energy efficient

Since renewable energy sources mainly generate electricity and direct electrification is the most energy efficient, the electricity system is central to the decarbonisation of other sectors. New technologies such as electrical vehicles and heat pumps are bringing about increasing convergence. Industry is also electrifying its production processes on a large scale.

However, direct electrification is not feasible in a number of end applications; either technically or economically. This applies, for example, to chemical companies, the steel sector and the cement industry. In addition to the use of green electrons, they will also need green molecules in order to decarbonise their business processes.

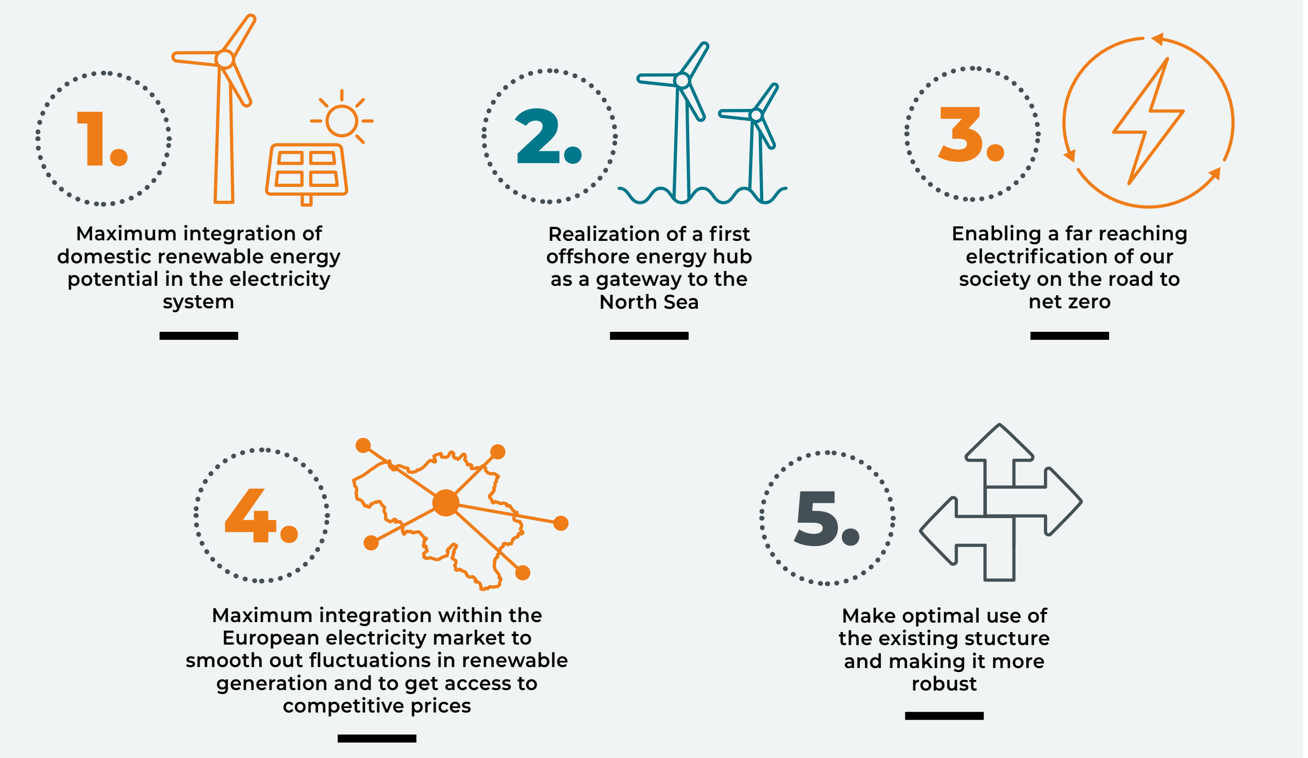
Both energy carriers - green electrons and green molecules - play a fundamental and complementary role in the transition to a carbon-neutral society.

# This federal development plan is based on 5 principles

The energy transition will only succeed if the three objectives of the energy trilemma are met: a reliable, sustainable and affordable energy system. This Federal Development Plan explains how the Belgian electricity system must evolve and be expanded further in order to meet these objectives.

This Federal Development Plan is based on 5 principles:

**FIGURE 1: THE 5 PRINCIPLES FOR THE ELABORATION OF THE FEDERAL DEVELOPMENT PLAN**



# The objectives of the energy trilemma

**1. A RELIABLE SYSTEM**

The electricity system is reliable when generation and demand are constantly in balance and the lights stay on.

A well-functioning transmission grid brings the generated power to the consumer centres at all times, thus supporting socio-economic development.

With increasing volumes of renewable energy, the operation of the system is becoming increasingly challenging.

On the generation side, there are large variations (more wind, less wind, more sun, less sun) that must be absorbed on the demand side. To keep the system balanced, in the future, consumption will have to adapt more strongly to the generation of the moment. This is called the paradigm shift.

**2. A SUSTAINABLE SYSTEM**

A sustainable system makes maximum use of the integration of renewable energy sources. Alongside access to domestic generation (onshore & offshore), a sustainable system also gives access to renewable generation abroad (via interconnectors) and in the North Sea.

Sustainability also means that the system itself must be energy-efficient and expanded in a sustainable manner, taking into account the impact on people and the environment.

**3. AN AFFORDABLE SYSTEM**

Thanks to a strong and optimally expanded electricity grid, consumers get access to the most efficient energy sources; both in Belgium and abroad. This ensures price convergence with neighbouring countries and improves our competitive position.

Elia Group advocates a consumer-centric energy system in which consumers get an active role in the energy system. By gearing consumption to the generation of that moment, consumers help keep the system in balance and are financially rewarded for doing so (lower electricity bill).



## PRINCIPLE 1 .

## MAXIMUM INTEGRATION OF DOMESTIC RENEWABLE ENERGY POTENTIAL IN THE ELECTRICITY SYSTEM

To decarbonise Belgian society, a gigantic amount of renewable energy is needed. Since most renewable energy sources generate electricity and direct electricity consumption is generally the most efficient, a renewable electricity system immediately contributes to a rapid and large reduction in $CO_2$. To achieve the climate objectives, the maximum integration of domestic renewable energy potential - both offshore and onshore - is therefore crucial.

The first concession area for offshore wind in the Belgian North Sea has been fully operational since 2020. A total of nine wind farms are connected, with a combined generation capacity of 2.3 GW. Five wind farms have a direct connection with the onshore electricity grid. 4 wind farms are connected to the so-called Modular Offshore Grid (MOG), an offshore power socket that bundles the farms' export cables and brings them onshore.

This bundling principle will also be applied in the second offshore wind zone (3.5 GW) that our country is currently developing. By 2030, Belgium will have a total offshore wind capacity of 5.8 GW. In time, the capacity should further increase to 8 GW. This was announced by the federal government in March 2022.

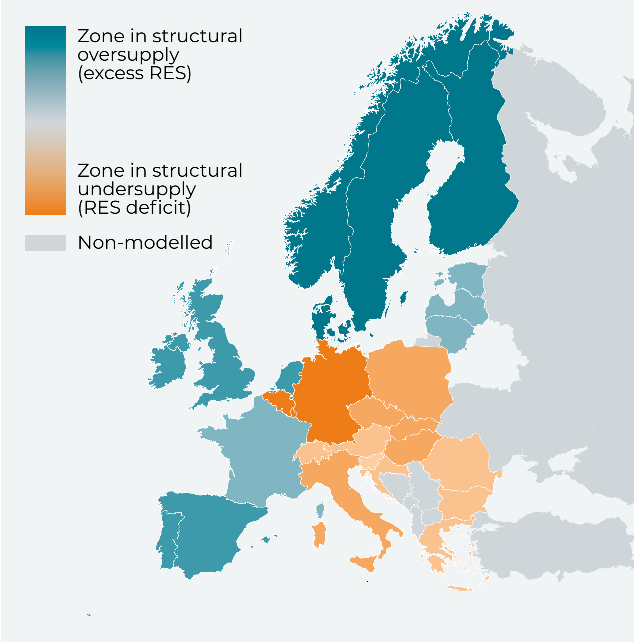
The second offshore wind zone will be integrated in the electricity system via an artificial energy island. The federal government gave the green light for this in December 2021. With this, Belgium can realise an important first: the first energy island in the European seas. This strengthens our country's pioneering role in offshore wind.

Strong growth in wind and solar energy generation is also expected onshore. In the "Established Policies"[1] scenario, solar energy capacity increases from approx. 5.7 GW in 2021 to approx. 14 GW in 2035. The installed capacity of onshore wind evolves from approx. 2.7 GW in 2021 to approx. 6 GW in 2035. With targeted and timely replacements and adjustments in the vertical system (voltage levels below 380 kV), the Belgian transmission grid can be prepared in time to integrate these capacity increases.

Although a great deal of capacity will be added in the coming years, renewable energy generation in Belgium will never be sufficient to decarbonise our society. At European level, however, there is much greater potential. Our Roadmap To Net Zero study has shown that there is sufficient renewable potential for the direct electrification. Prerequisites here are that renewable generation capacity is expanded by a factor of three, that we put maximum effort into electrification and that we build additional interconnectors to better spread the unequal distribution of renewable generation in Europe. However, there will not be enough renewable energy generation for indirect electrification. It will therefore be necessary in due course to import green molecules from other continents.

**Renewable energy is a scarce resource in Belgium. In order to achieve our climate objectives in due course, it is crucial that we establish partnerships today with European countries that have surpluses in renewable energy generation. The Nordic countries in particular are interesting for Belgium because they have a different wind profile (Figure 15 in Chapter 3). If Belgium gets access to this potential and commits to a diversified energy mix (maximum generation from sun, wind both onshore and offshore), the need for complementary back-up power plants that maintain security of supply will be drastically reduced.**

The figure below from the Elia Group study Roadmap to Net Zero shows the unequal distribution of renewable energy generation in Europe. While Belgium has a deficit, the countries in northern Europe have surpluses.




1 The Established Policies is one of the scenarios developed within the context of this Federal Development Plan. Chapter 2.1 Scenarios for the development of the transmission grid addresses the details of this.

## PRINCIPLE 2.

## REALISATION OF A FIRST OFFSHORE ENERGY HUB AS GATEWAY TO THE NORTH SEA

The North Sea is becoming the European power plant of the future. Due to favourable wind conditions and limited water depths, the North Sea is ideally suited for the development of renewable energy from wind.

Since our country has direct access to the North Sea and the potential for renewable energy on land is limited, Belgium has every interest in expanding offshore wind capacity. New and adapted transmission infrastructure is needed, both at sea and on land, to bring the electricity generated to the consumption centres onshore.

Furthermore, investments will have to be made in cross-border electrical connections. Because wind energy generation in Belgian territorial waters is insufficient to meet the climate objectives, our country has every interest in seeking access to foreign wind areas with an excess generation. Cooperative relationships are currently being established to build hybrid interconnectors with both Great Britain (Nautilus project) and Denmark (Triton Link project). A hybrid interconnector is an electrical connection between 2 countries that is also linked to one or several offshore wind farms.

In its position paper "**Harvesting Europe's Full Offshore Wind Potential**" (April 2022), Elia Group highlights several focus points with regard to accelerating the development of hybrid interconnectors. If the development of offshore wind energy is tackled on a country-by-country basis and thus in an uncoordinated manner, part of the European offshore wind potential will remain untapped. Europe then runs the risk that the objectives of the Green Deal will not be achieved - both in terms of timing and volumes.

50Hertz, the German subsidiary of Elia Group, realised the world's first hybrid interconnector in 2020. The Kriegers Flak Combined Grid Solution project is a subsea connection in the Baltic Sea between Germany and Denmark to which both German and Danish wind farms are connected.

In Belgium, Elia is going one step further. Our country wants to connect the hybrid interconnectors Nautilus (BE-UK) and Triton Link (BE-DK) on the Princes Elisabeth Island that will also connect Belgium's 2nd offshore wind zone. The Belgian island will thus become the first energy hub in the North Sea and will be decisive for the further development of the European offshore electricity grid. The island will be the first building block of a meshed European offshore electricity grid that connects to the future north-south connection in the North Sea. Being part of this is of strategic importance for Belgium. Wind conditions in the north and south of the North Sea are diverse, which means that our country can still be supplied on low-wind days and our energy-intensive industry gets access to sustainable energy generation.

The realisation of the Triton Link provides other firsts. It is the first interconnector with a country that is not a direct neighbour of Belgium and, moreover, it is the first interconnector that connects 2 artificial energy hubs. Because Denmark is also building its own hub off the coast, which will be delivered a little later than the Princes Elisabeth Island.

The 700 km long interconnector between Belgium and Denmark will be a technical feat that will give Elia Group, Energinet and all the companies involved an innovative lead at a global level. Building on the competences and experience gained in this way, additional projects can be realised in a later phase of the energy transition.

With regard to the 2050 horizon, 15 – 66 TWh of non-Belgian renewable energy will need to be imported or connected to the Belgian grid. That distant future is already being prepared for today. Elia has active contacts with the North Sea countries in order to define further steps in the development of the European offshore grid and to select the projects with the greatest added value for society.



## PRINCIPLE 3.

## ENABLING A FAR REACHING ELECTRIFICATION OF OUR SOCIETY ON THE ROAD TO NET ZERO

Because renewable energy is a scarce resource, it must be used in the most efficient way. Direct electrification is the best option. Production processes in which fossil fuels are replaced by green energy, in most cases (considering the entire chain), result in a significant $CO_2$ reduction (or equivalents).

The electrification of transport and residential heating is gradually reaching cruising speed. With targeted and timely adjustments (replacements and reinforcements) in the vertical electricity system (all voltage levels below 380 kV) and an adapted market model, the Belgian transmission system can facilitate the electrification of transport and heating.

To achieve the objectives of the Fit-for-55 programme, industry is also making the switch to mass electrification. Elia expects the number of energy-intensive companies that are directly connected to the 380 kV high-voltage grid to increase significantly to at least ten. This will require additional connection points in the highest high-voltage grid. The substation Baekeland in the Ghent region is a first concrete example.

Additional needs have been identified in the provinces of Antwerp, Limburg and Hainaut. It is important that Elia timely anticipates the increasing needs of industry in order to be able to maintain security of supply. Because industry is switching partly to the 380kV grid, capacity is being freed up at lower voltage levels which can accommodate the electrification of less large consumers. Such additional substations on the 380 kV grid go hand in hand with the planned reinforcement and expansion of the 380 kV grid.

A structured dialogue with industrial clusters makes it possible to identify such needs in good time. This dialogue is also necessary in the context of working out innovative solutions to develop maximum flexibility on the user side of such industrial grid users.

## PRINCIPLE 4.

## MAXIMUM INTEGRATION WITHIN THE EUROPEAN ELECTRICITY MARKET TO SMOOTH OUT FLUCTUATIONS IN RENEWABLE GENERATION AND TO GET ACCESS TO COMPETITIVE PRICES

Interconnectors provide access to renewable energy outside Belgium and at the same time contribute to the functioning of a competitive international market operation. In a renewable electricity system with large volumes of variable production, interconnectors will also be deployed to smooth out a local generation dip (less wind or sun). Our Roadmap To Net Zero study shows, for example, that weekly fluctuations in wind energy generation at European level are approximately 50% lower than fluctuations at Belgian level.

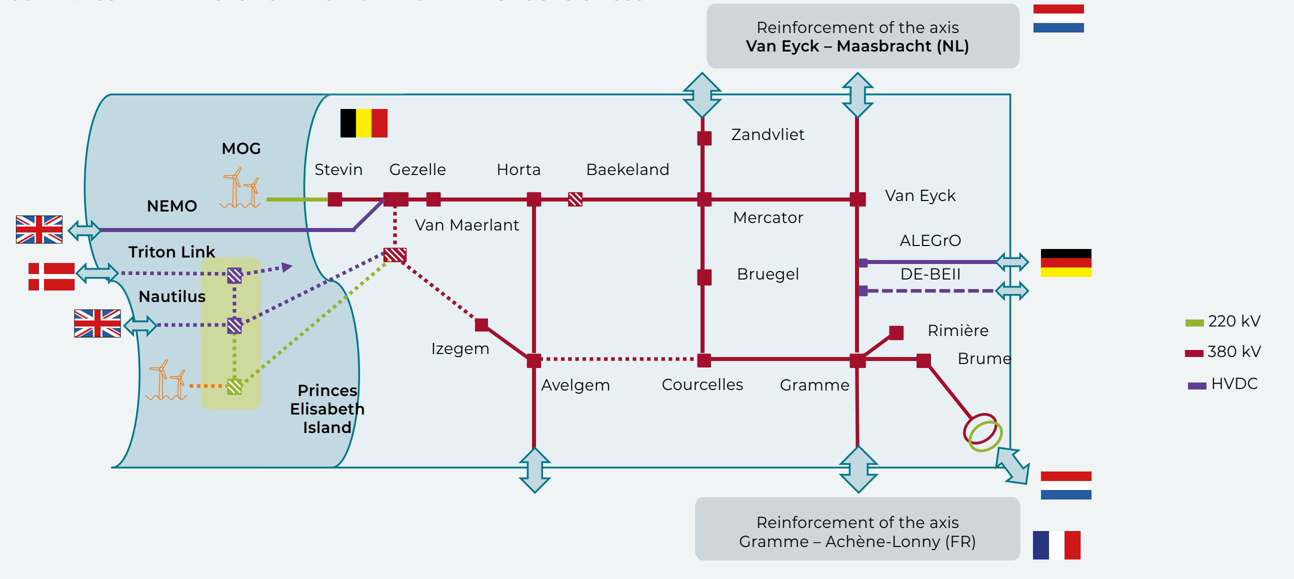
**Interconnectors create a so-called "pooling" effect that can smooth out fluctuations at European level. However, this will only be possible if the domestic grid is adjusted to handle this. An integrated European electricity grid requires a greatly expanded and reliable 380 kV grid. The domestic (highest) high-voltage grid must not restrict the international cooperation and must be prepared proactively.**

That is why, in addition to the development of hybrid offshore interconnectors, this Federal Development Plan also provides for various reinforcements of the onshore grid. These are needed at both the northern (Van Eyck – Maasbracht) and the southern (Lonny-Achène-Gramme) boundaries of our electricity system. The transport capacity of our existing electrical backbone must also be reinforced by making use of conductors with a higher performance.

Furthermore, there are missing links that we must address with the Ventilus and Boucle du Hainaut projects. These new connections provide additional hosting capacity that is much needed. They also make the 380 kV electricity grid more robust, more reliable and more stable.

**By meshing critical connections such as Stevin and Horta-Mercator, the Ventilus and Boucle Du Hainaut projects will contribute to a highly meshed 380 kV grid. In this way, the Belgian grid is evolving from one 380 kV loop to three. This grid architecture offers the necessary robustness and flexibility in order to anchor our central position in the European system and to organise the next steps towards 2050 in an orderly manner.**

**FIGURE 2: ESSENTIAL EVOLUTION FROM ONE TO THREE 3 LOOPS ON 380 KV**




## PRINCIPLE 5.

## MAKE OPTIMAL USE OF EXISTING INFRASTRUCTURE AND INCREASE ROBUSTNESS

The energy transition cannot be realised without investing in new grid infrastructure. In order to exert the maximum control on the investment costs, each new project is first examined to see whether the existing infrastructure offers solutions; provided that adjustments and improvements are made. This involves the integration of equipment and processes which allow to make maximal use of the existing infrastructure, as well as the integration of new products and services.

**Making optimum use of the existing infrastructure is an important pillar of this Federal Development Plan. This concerns, for example, the application of Dynamic Line Rating for overhead lines, Real Time Thermal Rating for underground cables, the installation of phase-shifting transformers to better regulate the flow, upgrading existing corridors with high-performance conductors (HTLS technology), the optimal utilisation of ALEGrO by means of the so-called "Evolved flow based[2]" methodology and a multi-scenario planning of maintenance depending on the weather.**

To improve grid operation further, we are also investigating the use of artificial intelligence and advanced analysis. These new technologies help our operators to perform their two most important core tasks: avoiding congestion and managing grid voltage.

**In addition to improving system management, Elia also works actively on optimising the market operation.**

In this way, Elia has played a pioneering role in the development of industrial demand-side management and flexible grid access for renewable generation units.

In June 2021, Elia Group published a position paper for a Consumer-Centric Market Design (CCMD). We advocate a market model in which consumers with flexible assets (electric vehicles, batteries, heat pumps, etc.) are given an active role in the energy system whereby they adjust their consumption to the generation of that moment. Consumers can thus actively manage their energy bill without any loss of comfort. At the same time, Elia gets access to flexible resources that help it to optimally manage a renewable energy system that is becoming increasingly volatile.

June 2022 also marked an important milestone in the integration of the European electricity system with the introduction of the so-called "**flow-based market coupling**" in the CORE region.

In the 13 countries involved (Belgium, Austria, Croatia, the Czech Republic, France, Germany, Hungary, Luxemburg, the Netherlands, Poland, Romania, Slovakia and Slovenia), market functioning now better reflects the physical reality of the electricity grid, which ultimately results in more efficient use.

2 See box with regard to the working principles of ALEGrO in section 4.3.3 Second interconnector Belgium - Germany

# Technical summary

## SCENARIOS AND FUNDAMENTAL CHOICES

The objective of the long-term scenarios is not to predict the future, but to make it possible to evaluate in a transparent way the impact of policy choices, macroeconomic trends, technological evolutions, etc. on the needs for grid developments under different circumstances.

In order to visualise the influence of these parameters on grid development needs, a number of scenarios has been developed. These differ significantly from one another in order to reflect the various future perspectives. Elia is not in a position to indicate which scenario is most desirable or likely. Choices relating to energy transition are made by the relevant public authorities. Elia therefore calls on the public authorities to develop an energy policy based on a long-term vision. By employing various scenarios, a range of situations can be defined which makes it possible to design a grid infrastructure that offers a robust response to the needs arising from all of these scenarios.

The Development Plan and the scenarios concerned must be elaborated on the basis of the most recent prospective study from the Directorate-General for Energy in collaboration with the Federal Planning Bureau, which was published in January 2015. The fact that no more recent prospective study has been published is considered as an appropriate justification for this Development Plan to take the latest supplementary report of the prospective study into account, the so-called "monitoring report", published by the Directorate-General for Energy in December 2021.

After discussions in the Collaboration Committee and following feedback from stakeholders, it was decided to use the TYNDP scenarios (which are prepared every 2 years at a European level via an extensive consultation process) as the initial basis for developing the scenarios used in this development plan. This basis is then subsequently refined:

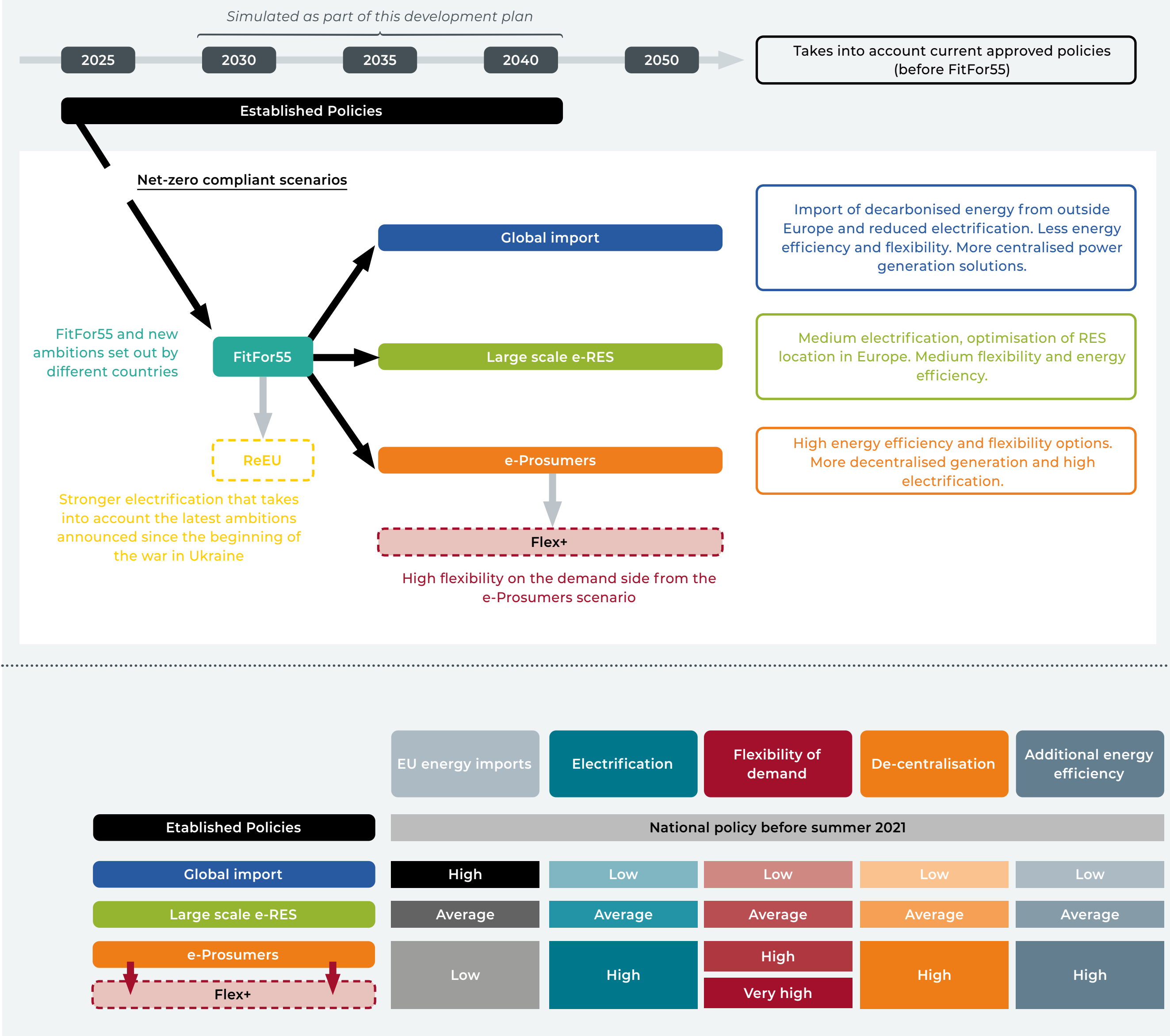
Firstly, **the available recent information** from national studies and new European strategies which have an impact on the electricity system have been taken into account. Since the TYNDP 2022 data collection, many changes in national and European plans have in fact been announced. Furthermore, several new national studies have been published which take a more recent look at the future. The scenarios prepared by Elia therefore take as much of this new information as possible into account. So, for example, the "Fit for 55" scenario includes the German government's ambition to install 200 GW of solar panels by 2030 and the "REPowerEU" scenario takes into account an offshore wind capacity of 21 GW in the Netherlands.

Secondly, several improvements were made for the preparation, simulation and evaluation of scenarios. For example, the **flow-based methodology** was applied for the market simulations of the current Federal Development Plan whereas, in the past, an NTC methodology was still used. Furthermore, 200 forward-looking climate years (+clustering) are also taken into account.

Finally, and complementary to earlier processes, Elia established the "**Task Force Scenarios**" in 2021 as a consultative body for the development of these scenarios. An important added value of this process is the co-creation of storylines together with the various stakeholders. The storylines developed in the Task Force Scenarios contain both qualitative and quantitative information with regard to electricity supply and demand which is then used to carry out long-term studies of the electricity system.

Figure 3 shows an overview of these scenarios and also presents the most important differences between the scenarios in a qualitative manner.

FIGURE 3: SCENARIOS AS BASIS FOR THE DEVELOPMENT PLAN



## UNTIL 2030:

**ESTABLISHED POLICIES [EP]**

**The EP scenario represents a future in which the national energy and climate plans published up to 2020 are generally followed, supplemented with ambitions announced prior to the publication of the "Fit For 55" package.**

This scenario is based on the storyline of "National Trends". It follows the expected and known policy choices of each country as presented in their national energy and climate plans. Updates of these plans were integrated into this scenario insofar as they pre-date the implementation of the "Fit For 55" objectives.

**FITFOR55 [FF55]**

**The FF55 scenario represents a future in which a 55% $CO_2$ reduction is achieved by 2030 through, among other things, accelerated electrification, additional energy efficiency and a faster roll-out of RES, as in the recently announced "Fit For 55" package.**

Starting from "Established Policies", this scenario integrated the more ambitious climate objectives of the "Fit For 55" package with an impact on energy supply and demand. The so-called "MIX" scenario, developed by the European Commission as a possible pathway to attaining the "Fit For 55" objectives, was taken here as a basis and supplemented further with national studies, reports and ambitions prior to the announcement of the "Repower Europe" package.

**REPOWER EUROPE [REEU]**

**The ReEU scenario represents a future in which the measures announced since Russia's invasion of Ukraine become a reality, with a focus on phasing out fossil gas in favour of faster electrification, energy efficiency, accelerated roll out of RES and the production of green molecules.**

This scenario is also the only one in 2030 where the intention announced by the Belgian government to extend the utilisation of 2 GW from the Belgian nuclear park (March 2022) was taken into account.



## AFTER 2030:

**ESTABLISHED POLICIES [EP]**

**The EP scenario reprents a future in which the national energy and climate plans published up to 2020 are generally followed, supplemented with ambitions announced prior to the publication of the "Fit For 55" package.**

**GLOBAL IMPORT [GI]**

**The GI scenario represents a future in which lower ambitions in areas such as electrification and energy efficiency are compensated by being part of a globalised energy market with a focus on European import of decarbonised molecules to meet European climate objectives.**

Following the TYNDP 2022 "Global Ambition", the focus in this scenario is more on the deployment of (green) molecules than on electrification, and energy efficiency improvements are less pronounced in this scenario. In this scenario, Europe is thus dependent on importing large quantities of decarbonised energy from outside Europe.

**E-PROSUMERS [EPROS]**

**The ePros scenario represents a future in which Europe achieves the European climate objectives in a more autonomous way, through a very strong growth of electrification, energy efficiency, flexibility and decentralised energy sources.**

The starting point for this scenario is the TYNDP 2022 "Distributed Energy" storyline. The focus of this scenario is on the electrification of transport and on decentralised energy solutions, combined with an efficiency improvement in the final energy demand. The emphasis is also laid on demand-side flexibility.

**LARGE SCALE E-RES [LSERES]**

**The "LSeRES" scenario represents a future where electrification is somewhere between the "GI" and "ePros" scenarios. This, combined with the smart spatial planning of renewable energy sources, leads to the achievement of the European climate objectives.**

This completely new scenario tries to find middle ground between the "Global Import" and the "e-Prosumers" scenarios. Without deviating from climate objectives in the long-term, it combines centralised RES (mainly offshore) and decentralised solutions while the degree of electrification is higher than the TYNDP "Global Ambition" scenario. The location of RES in this scenario, starting from the TYNDP scenarios, is redistributed over the simulation perimeter on the basis of potential and capacity factor.

**FLEX+ [FLEX]**

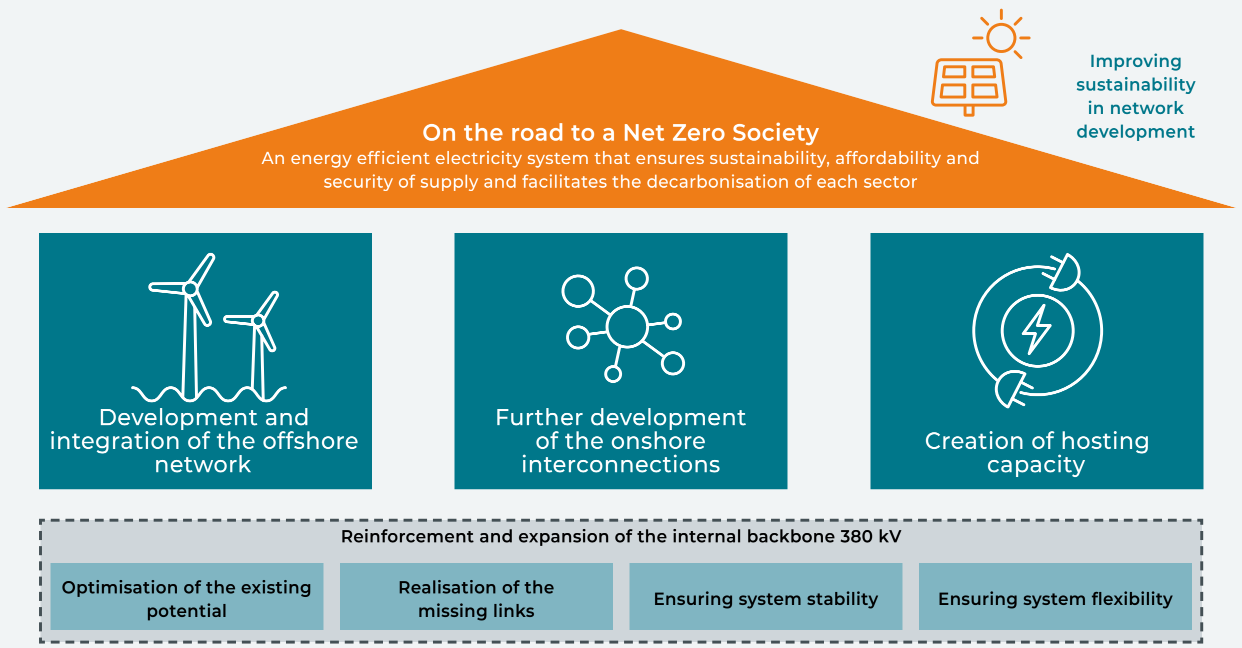
**The "FLEX" scenario represents a future in which, on top of the "ePROS" scenario, there is a very strong focus on additional flexibility in the electricity system in the form of storage and demand management.**

Starting point here is the e-Prosumer scenario, after which the flexibility of energy demand was increased to a very high but still achievable level.

These scenarios were then used to identify the system needs and for the calculation of the market indicators in the context of the cost-benefit analysis of the cross-border projects that are submitted "For approval" or "Conditionally" in this Federal Development Plan.

# The development of the belgian transmission grid

FIGURE 4: SCHEMATIC VIEW OF THE EXPANSION OF THE TRANSMISSION GRID




## THE FOUNDATION – THE REINFORCEMENT AND EXPANSION OF THE INTERNAL BACKBONE 380 KV

An expanded and reliable 380 kV grid lays the foundation necessary for the further expansion of the offshore grid, the development of interconnectors and the creation of hosting capacity. Given the great needs for the further development of these three pillars, this foundation needs to be made sufficiently strong and robust proactively in order to make these developments possible.

### 1. OPTIMISATION OF THE EXISTING POTENTIAL

**WHAT?**

Increasing the transport capacity of the existing 380 kV corridors by replacing existing conductors with high-performance conductors and carrying out the associated tower reinforcements. Whereas in the previous development plan this mainly concerned the Mercator – Massenhoven – Van Eyck – Gramme – Courcelles – Bruegel ring, there is also the need to reinforce the existing 380 kV corridors in the Antwerp Region between the Zandvliet-Doel-Mercator substations and in the South-East region between the Brume – Gramme – Rimière substations.

**NEED AND EFFECT?**

A doubling of the transport capacity of the internal 380 kV grid is necessary to accommodate the increased flows resulting from the integration of renewable energy, electrification and the expansion of cross-border capacity. This will ensure that the internal grid does not form the bottleneck for these energy exchanges.

**TIMING?**

The reinforcement programme is already under way and will be rolled out in phases over a period of about 15 years.



### 2. REALISATION OF THE MISSING LINKS

**WHAT?**

Development of new connections on the 380 kV grid in order to arrive at a robust meshed 380 kV grid. The "**Boucle Du Hainaut**" connection is a new corridor on the 380 kV grid between the Avelgem and Courcelles substations with a transmission capacity of 6 GW. Following on from this, by means of the project between the Gezelle and Avelgem substations, a new corridor of 6 GW on 380 kV will also be realised, the so-called "**Ventilus**" connection.

In the longer term, there are other necessary additions. The first of these is the expansion of the underground 380 kV cable connection between Gezelle and Van Maerlant.

**NEED AND EFFECT?**

The new "**Boucle Du Hainaut**" axis between Avelgem and the centre is an essential link in the 380 kV grid with a four-fold objective.

- Ensuring competitive and affordable access to electricity;
- Increasing the hosting capacity for renewable energy sources. This connection provides a strong and much-needed increase in the transport capacity from the West to the Centre. The only existing connection on the 380 kV grid between Horta and Mercator is already a bottleneck in the grid. With the projected increase in offshore wind energy generation and interconnector capacity with the United Kingdom, additional transport capacity is absolutely essential;
- Supporting economic development in Wallonia and more specifically in Hainaut. Synergy with the already saturated underlying 150 kV grid is possible in order to provide the region concerned with the necessary capacity to facilitate the expected increase in consumption. This includes a further development in the region and the electrification of society;
- Making the electricity supply more reliable for the consumer. This new connection will significantly improve the reliability of the 380 kV grid. Indeed, the sudden loss of the entire Horta-Mercator axis would, without Boucle Du Hainaut, have a major impact on the entire European grid.

At the same time, the "**Ventilus**" connection also answers various needs:

- Ventilus is essential for the connection of additional offshore wind: the evolution from 2.3 GW (2020) to approximately 5.8 GW (2030) and the creation of an offshore energy hub for renewable energy;
- Ventilus is essential for future developments in the high-voltage grid in West Flanders;
- Closing the loop with Stevin creates additional hosting capacity. It also provides flexibility in safeguarding the production of the offshore wind farms or imports from the UK in the event of outages or during necessary maintenance work.

With the realisation of both projects, the Belgian network will evolve from one loop on 380 kV to three loops, which is essential to ensure the robustness and flexibility of the transmission grid.

The further expansion of the underground 380 kV cable connection between **Gezelle and Van Maerlant** is a necessary first step in the context of the expected gradual increase in offshore wind energy generation in the first zone, the so-called "**Repowering**".

**TIMING ?**

The realisation of Ventilus and Boucle Du Hainaut is planned for the period 2028-2030, depending on the progress of the permit procedures. The timing of the reinforcement between Gezelle and Van Maerlant has yet to be confirmed, pending further studies, but is expected to be around 2035.

### 3. ENSURING SYSTEM STABILITY

**WHAT?**

- Installation of **voltage regulating devices** (coils and capacitors) for managing the voltage on the high-voltage grid.
- Installation of **synchronous condensers** in the coastal region.

**NEED AND EFFECT?**

The massive integration of renewable energy and the reduction of conventional thermal generation units is causing a fundamental change in the behaviour of the electricity system. Traditionally, the stability of the transmission grid is ensured by the presence of these conventional power stations. Renewable sources do not yet have the same or similar properties, which means that it is necessary to take the necessary measures on the electricity grid side to guarantee grid stability at all times.

**TIMING?**

- Voltage regulating devices: continually throughout the period of the development plan. The timing is adjusted depending on the evolution of the generating facilities, the market developments for reactive power, the evolution in the reactive behaviour of the load and also on the regulatory requirements. Phase 3 should be completed by 2028.
- Synchronous condensers: In line with the development of offshore wind energy.

## 4. ENSURING SYSTEM FLEXIBILITY

**WHAT?**

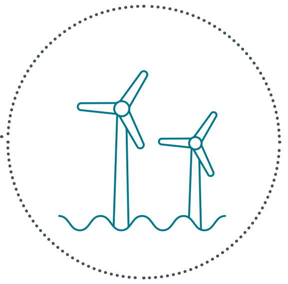
An envelope of various measures that allowing to maximise the available flexibility in the electricity system. On the one hand, this concerns initiatives such as **Consumer Centric Market Design** and **Flex-in Market** which have an impact on the market operation. Furthermore, the use of **Artificial Intelligence** will allow better operational management of the grid in the future. To facilitate all these future data exchanges, the broad roll-out of a fibre-optic network through the **Fiber Everywhere** project is very important.

**NEED AND EFFECT?**

The expansion of new grid infrastructure is essential for realising the energy transition. A robust and reliable onshore and offshore grid is an absolute prerequisite for a successful energy transition to a reliable, sustainable and affordable energy system. Furthermore, a maximum optimisation of the use of existing and future infrastructure is also necessary. The development of flexibility in all aspects of the electricity system, with regard both to the grid and the market, is just as essential as the development of the infrastructure.

**TIMING?**

The **Fiber Everywhere** project has a phased roll-out over the horizon of the Federal Development Plan. The exact timing of the other initiatives will be determined after the results of the initial research phases.



# Pillar 1

### DEVELOPMENT AND INTEGRATION OF THE OFFSHORE NETWORK

**WHAT?**

The development of the necessary offshore infrastructure in order to bundle the connections of both the additional offshore wind farms and the interconnectors and bring them to land cost-effectively. This is ensured through the creation of an energy island, the Princes Elisabeth Island, off the Belgian coast and the construction of an energy hub on this island. Account is taken of a possible future meshing of the offshore grid in order to capture the full potential of the North Sea.

The additional ambitions of the Belgian government, as set out in March 2022, will give rise to a further expansion of this grid. This expansion is under study and will be part of a next development plan.

**NEED AND EFFECT?**

The creation of a gateway to the enormous renewable energy potential in the North Sea – "The green power plant of the future". Given the fact that the domestic onshore renewable energy sources are not sufficient for a complete decarbonisation and the location on the North Sea, this gateway thus ensures that Belgium has direct access to this renewable potential.

The creation of the hybrid interconnectors Nautilus and TritonLink, which combine the functionalities of the grid connection of renewable energy and cross-border connection, allows optimal use of the infrastructure and provides access to additional and decorrelated renewable energy generation.

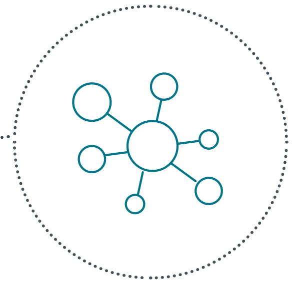
**TIMING ?**

· Princes Elisabeth Island & MOG 2: 2028-2030

· Nautilus: 2030

· TritonLink: 2031-2032





# Pillar 2

### FURTHER DEVELOPMENT OF THE ONSHORE INTERCONNECTORS

**WHAT?**

Maximum reinforcement of the existing interconnector capacity with France and the Netherlands via the installation of high performance conductors and/or phase-shifting transformers on the Lonny (FR)-Achène-Gramme and Maasbracht (NL) – Van Eyck connections. Development of a second HVDC interconnector with Germany.

**NEED AND EFFECT?**

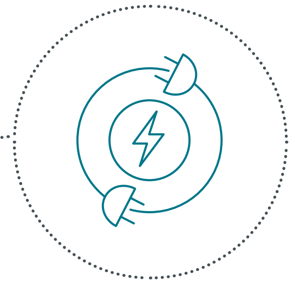
Interconnectors contribute to security of supply, price convergence and the decarbonisation of the European electricity system through the integration of renewable energy on a European scale. Interconnectors produce a renewable energy smoothing effect, levelling the generation fluctuations at European scale.

**TIMING ?**

· Lonny (FR) – Achêne – Gramme: 2030 - 2032

· Van Eyck – Maasbracht (NL): 2032 - 2034

· Second interconnector Belgium - Germany : 2037-2038



# Pillar 3

### CREATION OF HOSTING CAPACITY

**WHAT?**

On the one hand, the creation of additional connection points - spread across Belgian territory - on the 380 kV grid for the direct connection of grid users and for additional transformation to the lower voltage levels.

On the other hand, the provision of the necessary grid developments for hosting new central production units and storage.

**NEED AND EFFECT?**

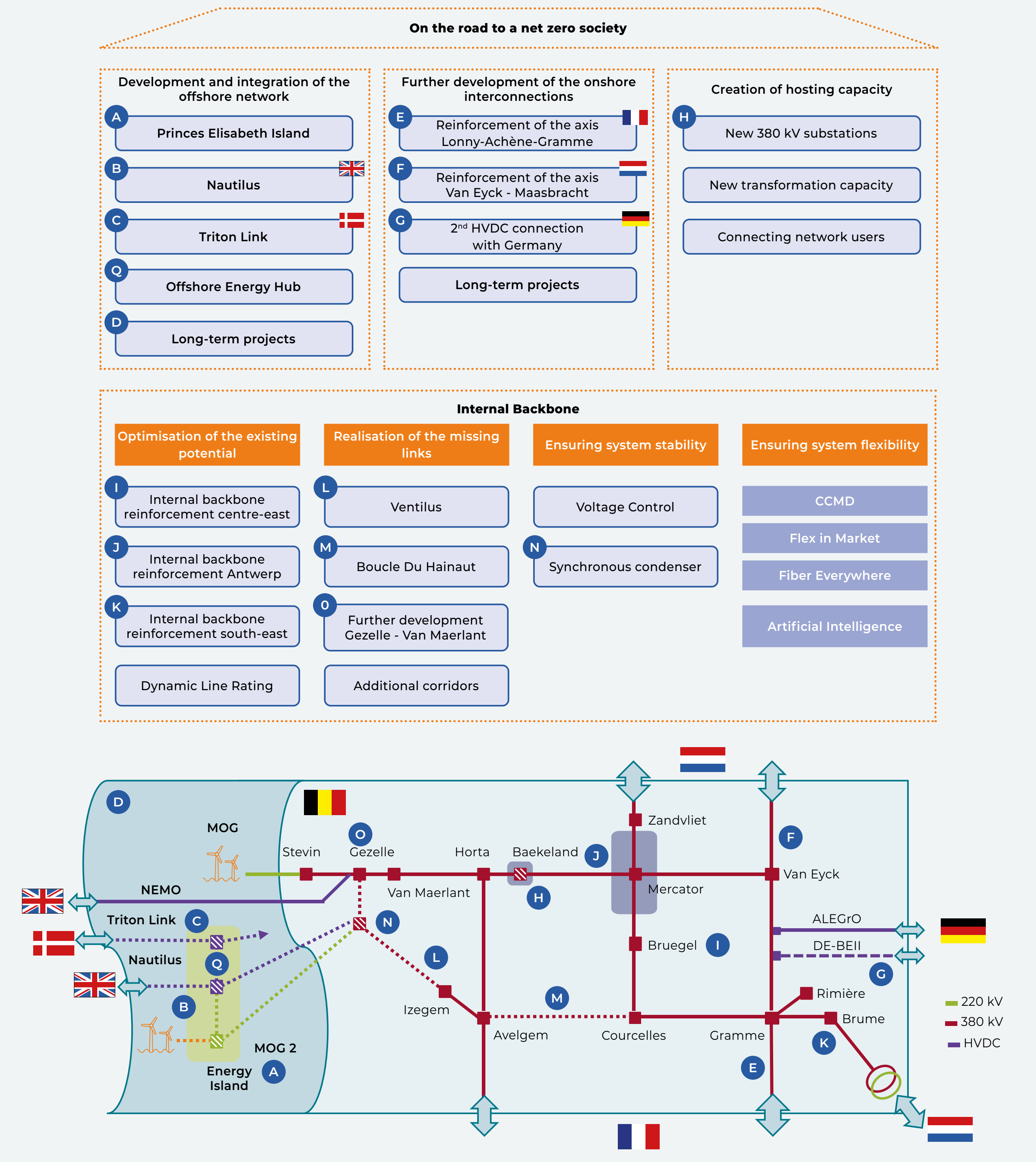
The facilitation of the electrification in both the residential and industrial sectors requires a proactive approach in order to realise this infrastructure in good time. For large grid users, a connection to the 380 kV grid will be made possible. In a first phase, this will also make it possible to rapidly free up capacity on the underlying networks for the electrification of smaller grid users. In a second phase, additional transformation capacity will be provided. The first concrete example is the "**Baekeland**" substation in Ghent.

The need for new central production units and storage follows from the result of the CRM auction.

**TIMING ?**

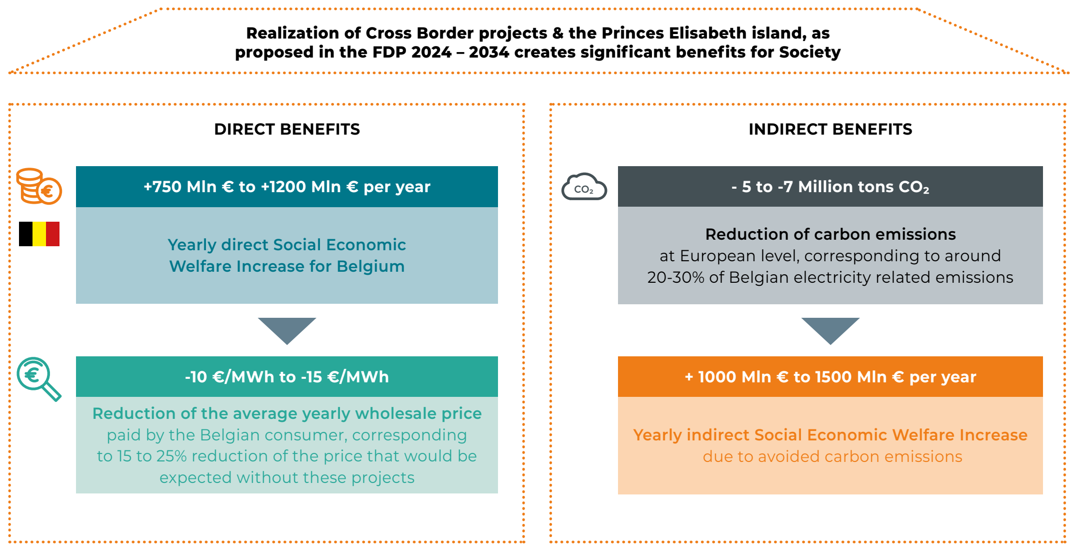
Spread over the period 2024-2034

FIGURE 5: OVERVIEW OF THE INFRASTRUCTURE DEVELOPMENTS OF THE HORIZONTAL SYSTEM




# SIGNIFICANT BENEFITS FOR BELGIAN SOCIETY

The realization of electrical interconnectors and the Princess Elisabeth Island will not only create a more robust electricity grid capable of transporting larger volumes of renewable energy. The additional projects also bring socio-economic benefits that enhance the welfare of Belgian and European society. For example, there is a direct effect on the average annual wholesale electricity price in Belgium (-€10 to -€15 per MWh). There are also indirect benefits through the significant reduction in $CO_2$-emissions (1,000 to 1,500 million euros per year).




# LONG-TERM FACILITATION OF THE ENERGY TRANSITION

The project proposals above fall within the time horizon of this Development Plan answering the challenges posed by the various scenarios studied with regard to the Belgian and European Energy Mix. The 2034 horizon is not the end point of the energy transition in itself, but an intermediate step towards the complete decarbonisation of the entire energy sector by 2050.

However, the further away the horizon, the greater the lack of clarity about the possible evolutions, hypotheses and development of the technology. This is precisely why the Federal Development Plan is updated every 4 years. In this context, this Federal Development Plan already presents a number of indicative study projects, with the aim of anticipating these evolutions in good time.

Firstly, there is the "**Further development of renewable energy generation in the North Sea**" study, which follows up on the ambition of the Belgian government to increase renewable energy generation in the Belgian North Sea to 8 GW.

Secondly, under the heading of the study project **"Development of a 3rd hybrid offshore system"**, Elia is working proactively with other North Sea countries to define the next concrete steps in the development of the offshore grid and to select future hybrid projects which have the greatest added value for society. With regard to the long-term ambition for the 2050 horizon, Elia remains involved in studies on the further development & integration of **a meshed cross-border grid in the North Sea**, building on the first steps described above.

Following the various studies to identify the system needs, it appears that **onshore interconnectors** also require further expansion in the long term. Concrete proposals with the Netherlands, France or Germany must be examined further in this context.

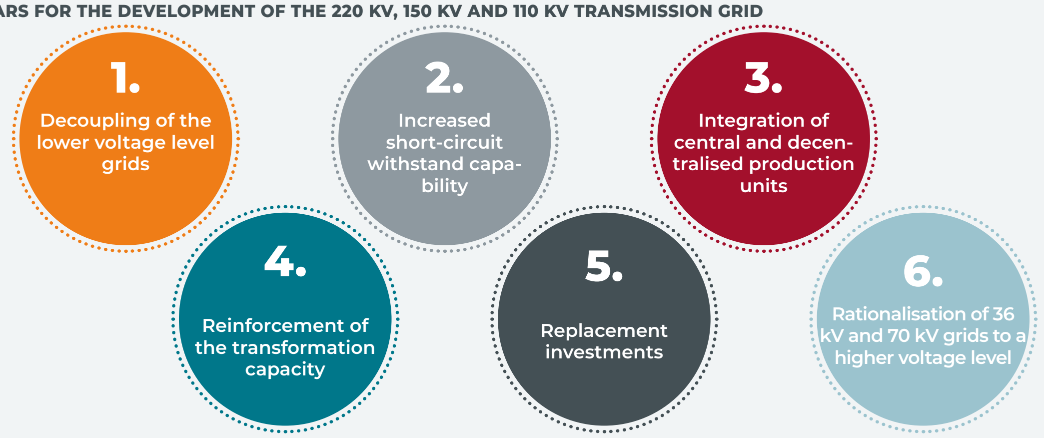
To accommodate these evolutions, the internal grid must of course evolve along with them in good time. In this context, Elia has launched a study to map out these future capacity needs for the 2040 and 2050 horizons and to set out the strategy for the step-by-step roll-out of additional corridors in the Belgian backbone. The aim, as ever, is to propose a solution that best meets all grid needs, takes into account a robust 380 kV grid and maximises public acceptance of the project. In this context, Elia closely monitors the developments in technology, both above and under ground.

## PILLARS FOR THE DEVELOPMENT OF THE 220 KV, 150 KV AND 110 KV TRANSMISSION GRID

This development plan also includes a major investment program for the 220 kV, 150 kV and 110 kV transmission grid, which are crucial for the local security of supply and for the connection of medium-sized central and decentralised production units. Here too, maximum use is made of flexibility to schedule the appropriate investments.

The investments in the 220 kV, 150 kV and 110 kV transmission grids are part of a general vision developed to meet a specific need or group of needs:

FIGURE 6: PILLARS FOR THE DEVELOPMENT OF THE 220 KV, 150 KV AND 110 KV TRANSMISSION GRID




**1. DECOUPLING OF THE LOWER VOLTAGE LEVEL GRIDS**
The larger flows on the 380 kV backbone grid, together with the development of the European energy market, are leading to inadmissible flows in the underlying transmission grid. The vision is to decouple these networks and operate them as isolated zones. However, the reduced mutual support between the 150 kV zones require locally a better support from the above-lying 380 kV backbone grid via the placing of additional 380/150 kV and 380/220 kV transformers.

**2. INCREASING THE SHORT-CIRCUIT WITHSTAND CAPABILITY OF THE 150 KV GRID**
By steadily increasing the number of cable connections compared to overhead lines and by increasing the number of coupling points with the 380 kV backbone grid, the short-circuit power in the 150 kV networks increases. In this context, this development plan includes various investments that provide higher-performance high-voltage equipment in order to continue to guarantee operational reliability and safety.

**3. INTEGRATION OF CENTRAL AND DECENTRALISED PRODUCTION UNITS**
The existing transmission grid already allows for far-reaching integration of production units. However, a reinforcement of the transmission grid is planned at places where significant additional generation potential is expected.

**4. REINFORCING THE TRANSFORMATION CAPACITY TO THE MEDIUM-VOLTAGE GRID AS A CONSEQUENCE OF AN EVOLUTION IN THE CONSUMPTION**
The transmission grid contains a large number of coupling points with the medium-voltage grid, via which residential consumption, SMEs and small industry, among other users, are connected. A general rise in consumption, especially in the context of increased electrification, can therefore lead to a need to reinforce the transformation capacity for a number of coupling points.

**5. REPLACEMENT INVESTMENTS**
The decommissioning of grid infrastructure because of ageing is determined as precisely as possible by a systematic monitoring of the performance of the equipment. However, the grid infrastructure is not systematically reconstructed in an identical way. When replacing ageing infrastructure, preference is always given to the technically and economically best solution. Where appropriate, an isolated 1-to-1 replacement project is started to cover the replacement needs.

**6. RATIONALISATION OF THE 36 KV AND 70 KV TRANSMISSION GRID TO A HIGHER VOLTAGE LEVEL**
A rise in local electricity consumption or the arrival of decentralised generation can cause the capacity of the local 36 kV or 70 kV grid to be exceeded. An evolution towards a higher voltage level such as 110 kV or 150 kV is often preferred over a further reinforcement of the existing grid. Such an upgrade is generally more cost- and energy-efficient.



## DEVELOPMENT METHODOLOGY AND IMPROVEMENT OF THE SUSTAINABILITY IN GRID DEVELOPMENT

In the identification of investment needs, the initial focus is on possible optimisations. Thanks to new methods of system and infrastructure management, the use of new technologies and the application of flexibility where possible, Elia is managing the electricity grid ever closer to the limits. If a reinforcement of the electricity grid is necessary, Elia will first examine whether this is possible within the existing corridor. This can be done, for example, by installing high-performance conductors, phase-shifting transformers and flexible grid access or by installing equipment to use more capacity on an existing line depending on the meteorological conditions. Only as a last resort, and if there really is no other option, will the development of new corridors be considered. **Investment in new grid infrastructure preferably takes place within an existing corridor. Only when no other option is available will the development of new corridors be considered.**

The fight against climate change influences this process in two ways. On the one hand, in its capacity as Transmission System Operator, Elia must facilitate the sustainability of the energy sector and prepare the transmission grid for this in good time, for example for the integration of renewable energy and electrification. **In the assessment and choice of cross-border infrastructure projects, for the first time in this Federal Development Plan, the variation in $CO_2$ emissions associated with this project and the associated additional benefits for society are also specifically calculated and taken into account in the selection of the project.**

On the other hand, the activities involved in the development, utilisation and maintenance of the transmission grid also produce $CO_2$ emissions. In this context, Elia is working on a roadmap to reduce, in the longer term, the use of SF6 gas, a powerful greenhouse gas with a global warming potential of almost 24,000[3], in its high-voltage installations. The **Green Substations** project has also been launched, with the aim of improving the energy efficiency of the +/- 1200 buildings in the substations.

In general, $CO_2$ (and equivalents) is already an important parameter in Elia's decision-making process and its weighting will increase in the coming years. In its role as TSO and in the sustainability of the energy sector, as well as in its daily activities, Elia wants to reduce its $CO_2$ footprint by explicitly integrating the $CO_2$ impact into all of its decisions.

## OUR COMMITMENT

**1. TO MINIMISE THE CONSTRUCTION OF NEW INFRASTRUCTURE** as much as possible by prioritising the optimisation and improvement of existing infrastructure

**2. OPEN COMMUNICATION AND COLLABORATION** throughout the entire development process and this from a very early stage

**3. RESPECT FOR PEOPLE, THE ENVIRONMENT AND CLIMATE** when building and utilising our infrastructure

3 This means that 1 kg of SF6 emissions have the same effect on global warming as (almost) 24 tonnes of $CO_2$.