24 SEPTEMBER 2024

Elia publishes blueprint for the Belgian electricity system as a stepping stone towards a long-term strategy for a sustainable and competitive energy policy in the lead-up to 2050

- The phasing out of fossil fuels will have a major impact on the Belgian energy landscape in the coming decades.
- By 2050, energy demand is set to fall sharply (by 25-45%) while electricity demand will see an unprecedented rise (of 95-130%).
- There are several options for dealing with this change, each with different economic and technical impacts.
- This report aims to support the federal and regional governments in shaping the desired energy mix in the period 2035-2050 so that necessary changes to the high-voltage grid are completed in time.

BRUSSELS | The Belgian energy landscape will undergo an immense transformation over the next 25 years, but the outlook is nevertheless positive. By 2050, energy consumption from buildings, transport, and industry will fall by around 40%. These efficiency gains will be mainly driven by increasing electrification. Although molecules will remain vital for some parts of industry, system operator Elia expects electricity consumption in Belgium to more than double by 2050. Belgium's existing generation facilities and already-approved investments can provide only half of what is needed in the long term. Therefore, new governments will soon have to consider the desired energy mix for the period 2035-2050 and how reliant the country is willing to be on imports. Elia's blueprint offers insights that can help with this process.

2050 is not far off

Over the next 25 years, the Belgian economy will accelerate the phase-out of fossil fuel use. There will be a decisive switch to electrification, or to low-carbon molecules (hydrogen, methane, ammonia, etc.) where electrification is not possible. This will entail a profound societal change that needs to be well prepared so that the final steps in the energy transition take place in the most sustainable and cost-effective way.

In the *Belgian Electricity System Blueprint 2035-2050*, system operator Elia looks further ahead than the usual 10-year time frame used in reports on security of supply or grid development. The calculation model in this study quantifies, for the first time, the entire energy system, encompassing both electricity and molecules as well as the economic and technical implications of variations in energy mix.

Given the long lead time (at least 10 years) for the development of large-scale generation and transmission infrastructure, there is an urgent need for a long-term vision providing direction for the future. The report shows that not taking a decision is the costliest option in every scenario and will double Belgium's dependence on electricity imports by 2050 (compared with 2020).

Insufficient domestic low-carbon generation

Recent policy decisions (development of the Princess Elisabeth offshore wind zone, extension of the lifespan of nuclear power plants, etc.) mean that low-carbon electricity generation in Belgium will increase significantly in the coming years. However, due to the rising demand for electricity, this will no longer be sufficient in 10 years' time. If policy remains unchanged, we will see Belgium's dependence on electricity imports steadily increase, from 50-60 TWh in 2036 to 70-90 TWh in 2050.

Without a long-term strategy on the future energy mix and new policy measures, Belgium will therefore become more reliant on electricity imports. In an integrated European electricity market, exchanging power is common practice. Even so, the level of dependence we seek to achieve must be based on a carefully considered strategy. Indeed, this choice has implications for the price of electricity, the trade balance, and our autonomy in energy, climate, industrial policy, and fiscal matters.

A strategic combination of multiple sources

Although its domestic renewable generation is insufficient in the long run, Belgium has every interest in maximising its solar and wind potential (both onshore and offshore). Various future scenarios show that domestic renewable generation has a positive effect on the cost of the electricity system, including construction, maintenance, and costs for the proper functioning of the system.

There are several options for supplementing the shortage of domestic renewable generation. In our 'central scenario', 'non-domestic offshore wind' as an additional large-scale electricity source is more cost-effective than 'new nuclear'. However, the study also calculated other scenarios that, based on a sensitivity analysis, arrived at different results. Thus, there is still considerable uncertainty about future technology costs and, especially for nuclear power, about the success of planned technological developments.

Therefore, various considerations and diversification strategies must be taken into account in order to determine the future energy mix. The development of non-domestic offshore wind requires international agreements on planning and financing, among other things. And while new nuclear power plants also appear to be a viable solution, these come with their own challenges in terms of safety, location, complexity, and financing.

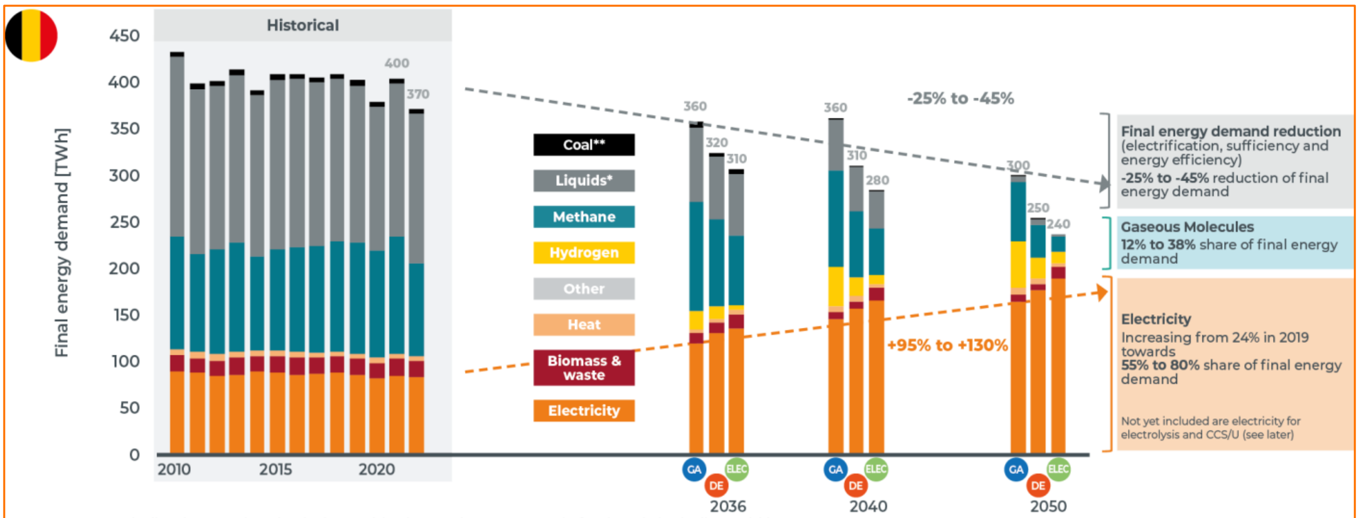
> *"This blueprint is the first time that Elia has published a study on the entire energy system, encompassing both electricity and molecules. Elia is not taking a position on the future energy mix but calls on policymakers to quickly develop a long-term vision. This will be a key factor in Elia's next Federal Development Plan 2028-2038, setting out the further development of Belgium's high-voltage grid. Focusing more on far-offshore wind will require specific grid upgrades different from those associated with new nuclear power plants. This report is not only the work of Elia experts. We received valuable input from various representatives from the energy sector and academics who provided feedback on the results. Their contribution was an absolute added value."*
>
> **Frédéric Dunon, CEO of Elia Transmission Belgium**

5 KEY CHARTS

1. EVOLUTION OF BELGIUM'S ENERGY DEMAND UP TO 2050

The figure below depicts how Belgium's total energy demand (in TWh) is assumed to change over time. The different colours represent the different energy sources. Belgium's historical energy demand is on the left-hand side of the diagram, while the different scenarios are simulated over three time horizons on the right-hand side (2036, 2040, and 2050).

- GA = Global Ambition demand scenario (lower degree of electrification)
- DE = Distributed Energy demand scenario (medium degree of electrification)
- ELEC = Increased Electrification demand scenario (high degree of electrification)



Excluding international aviation & shipping and non-energetic feedstock, including grid losses.
Note that energy demand for transformations such as power-to-hydrogen and carbon capture are not included. Values are normalised for historical climate while in the simulations, a forward-looking climate database is used, therefore the simulated demand can differ from these input values.
** Methane & liquids could be fossil, bio or synthetically sourced, which is defined in the model.*
*** Coal as defined as final energy demand per EUROSTAT (i.e. excluding coal consumed in blast furnaces)*
Historical values based on EUROSTAT

What do we see?

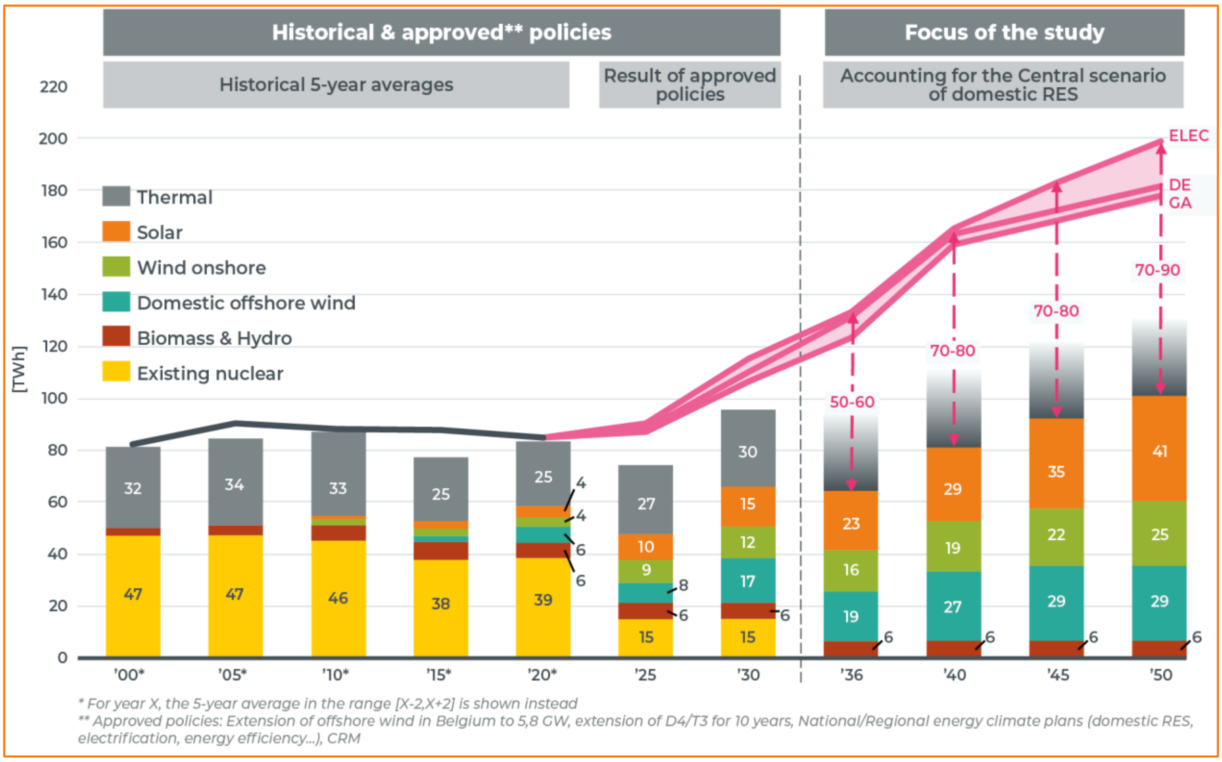
- As a result of electrification and energy efficiency, Belgium's total energy demand decreases by 25-45% by 2050.
- Due to increasing electrification, electricity demand (orange) rises by 95-130%. By 2050, electricity becomes the most important energy source in Belgium's total Belgian energy mix (55-80%). Gaseous molecules make up 12-38% of total energy demand.

What does this tell us?

Total energy demand in Belgium will decrease significantly by 2050 (compared with 2020). Demand for electricity, on the other hand, will increase sharply. Both electrons (electricity) and molecules (hydrogen, methane, etc.) will be necessary in the future energy mix, but their respective proportions will change considerably. The report also shows that electrons and molecules in Belgium will mainly be used in their original form. Since we see limited convergences in the future (hydrogen produced by electrolysis and electricity generated via molecules), the development of future electricity and gas infrastructure can take place independently (provided we have common scenarios). This is not the case everywhere in Europe and is typical of countries with little domestic renewable potential.

2. EVOLUTION OF BELGIUM'S ELECTRICITY DEMAND UP TO 2050

The figure below demonstrates the growing gap between future annual electricity demand (pink lines) and low-carbon electricity generation in Belgium. This is separate from the adequacy requirement, which relates to maintaining the country's security of supply at times of peak consumption.



What do we see?

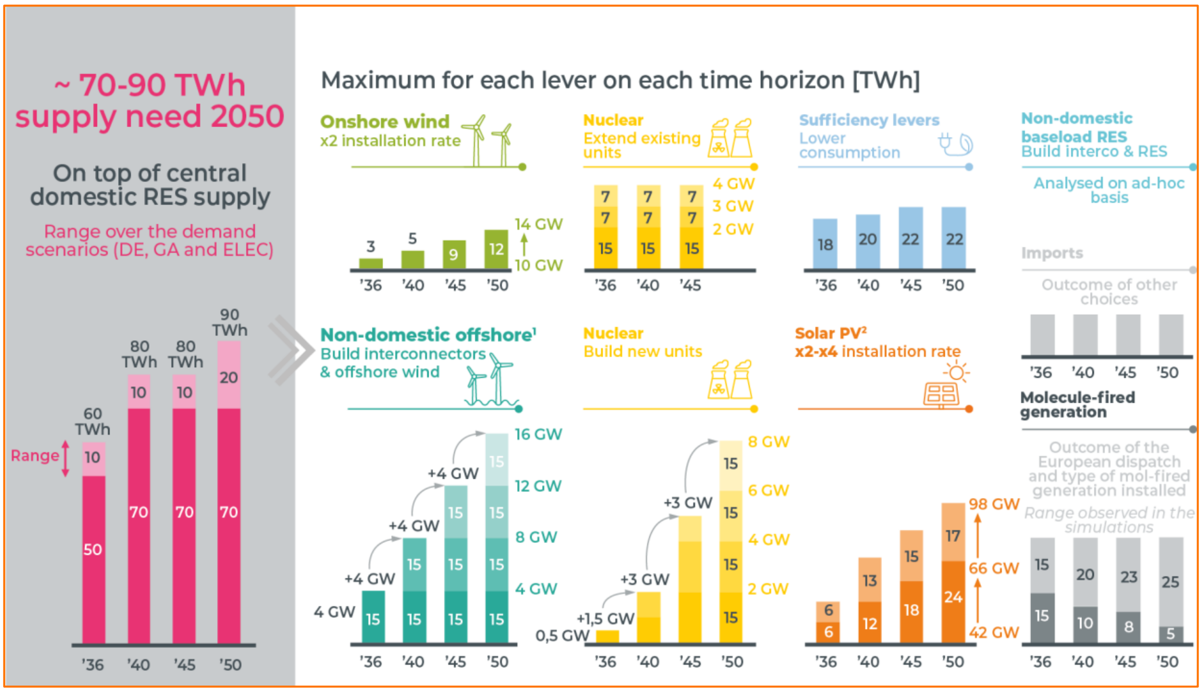
Recent policy decisions will almost double low-carbon electricity generation in Belgium in the coming years. But that is not enough to meet the increasing demand for electricity. Without measures, we see Belgium's electricity dependence on (low-carbon) imports increase steadily, from 50-60 TWh in 2036 to 70-90 TWh in 2050.

What does this tell us?

Domestic low-carbon electricity generation will not suffice to meet growing demand. Without additional policy measures, Belgium will become more dependent on electricity imports.

3. SEVERAL OPTIONS FOR MORE LOW-CARBON ELECTRICITY GENERATION

The figure below outlines multiple levers for increasing low-carbon electricity generation in the lead-up to 2050. These are the potential building blocks for Belgium's future energy mix. A strategic combination of multiple sources will be essential for bridging the 70-90 TWh shortfall in electricity in 2050.



What do we see?

- The bar charts depict the additional electricity (in TWh) that can be generated from 2036 onwards if the additional capacity is used to its maximum. Significant and timely efforts will be needed to achieve these values.
- For example, the installation rate of onshore wind could be doubled, and that of solar photovoltaics (PV) could even be quadrupled. An additional 4 GW of non-domestic offshore wind could be added every five years. Options related to the maximum lifetime extension of current nuclear plants and development of new nuclear plants are also included.

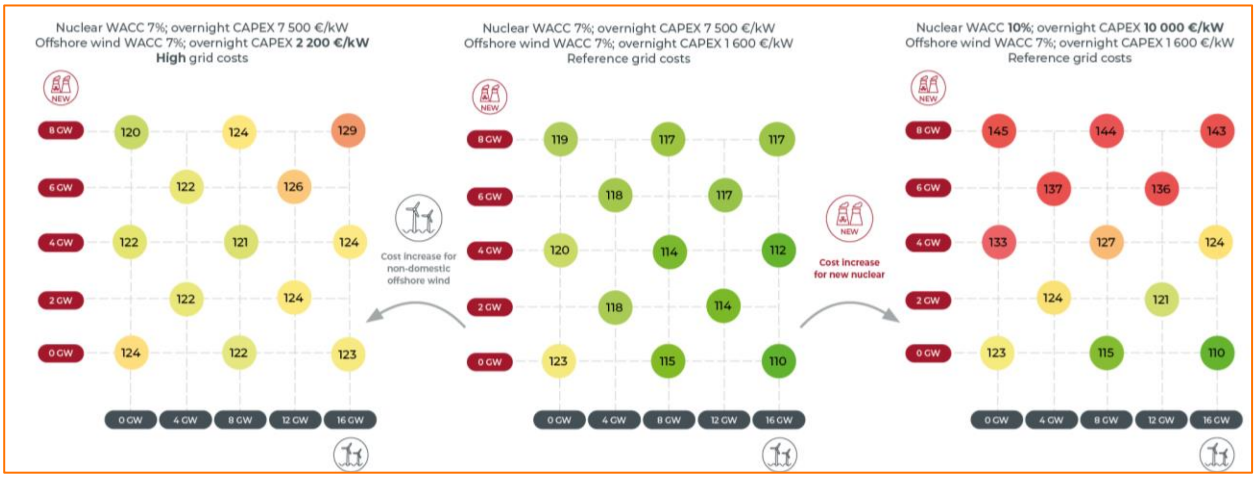
What does this tell us?

Belgian renewable generation (solar, onshore and offshore wind) can contribute significantly to the future electricity mix. However, this alone will not suffice - additional options are needed. Various considerations and diversification strategies must be taken into account in determining the desired energy mix. For example, developing large-scale low-carbon sources such as new nuclear power plants and non-domestic offshore wind is very complex and takes a long time (>15 years). Access to non-domestic offshore wind requires, among other things, international agreements around planning and financing. The construction of nuclear power plants, on the other hand, requires agreements on public-private partnerships and financing. Moreover, there are currently still questions about the technological maturity of the latest generation of reactors (4th generation).

4. TOTAL SYSTEM COST COMPARISON WHEN COMBINING NEW NUCLEAR WITH NON-DOMESTIC OFFSHORE WIND (in 2050 in €/MWh)

The figure below depicts the changes in Belgium's total system cost (generation, infrastructure, security of supply, flexibility, import) by combining different capacity volumes (GW) of large-scale low-carbon electricity generation. The middle chart compares the total system costs for 'new nuclear' and 'non-domestic offshore wind' based on reference assumptions.

The outer charts show the impact based on more conservative assumptions. For offshore wind (on the left-hand side), there are possible risks linked to the supply chain and material costs. The cost risks for new nuclear (right-hand side) are associated with increased design complexity, tougher safety requirements, and immature small modular reactor (SMR) technology.



What do we see?

- According to the reference assumptions (middle chart), taking no action (0 GW along both axes) emerges as the costliest option. Non-domestic offshore wind is the most cost-effective solution (darker green) when compared with new nuclear.
- The outer charts show that price risks increase the total system cost.

What does this tell us?

As a large-scale low-carbon energy source, 'non-domestic offshore wind' appears to be more cost-effective than 'new nuclear'. Because potential price risks (such as material costs) increase the total system cost, it is important that these are also taken into account when determining the future electricity mix.

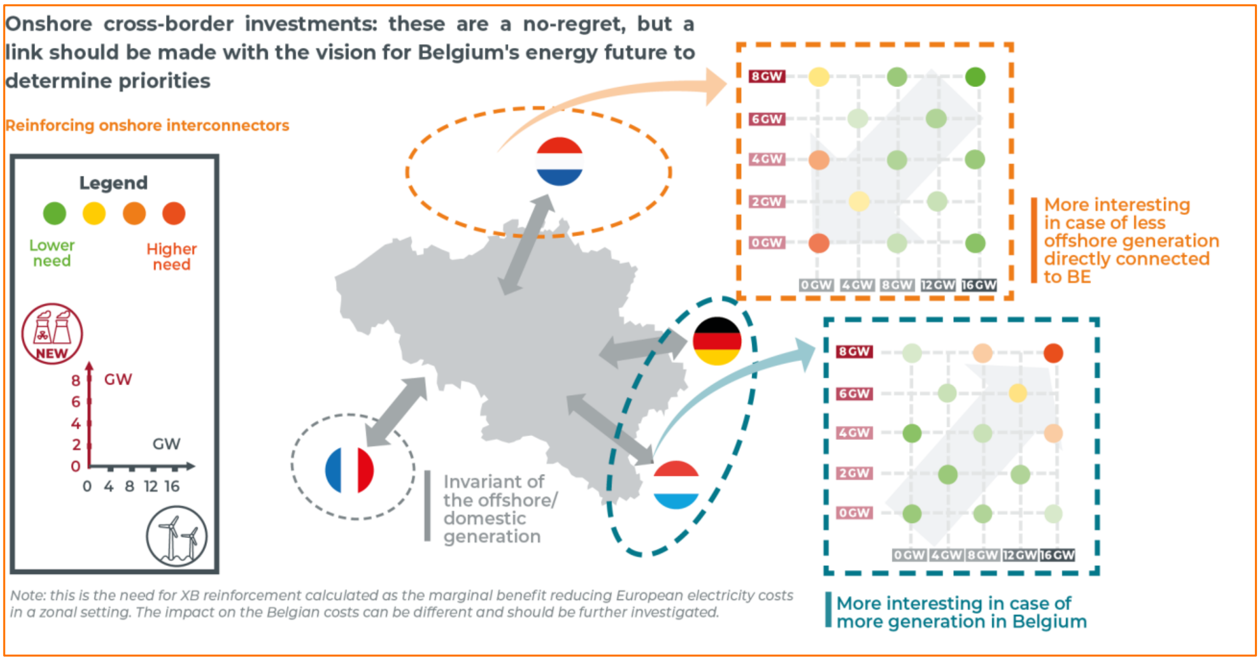
Separately, the large-scale development of non-domestic offshore wind calls for more international coordination (joint planning and funding). This represents a major change. Meanwhile, new nuclear power plants carry their own challenges in terms of safety, complexity, and financing.

In addition to potential price risks, we also point out the different cost structure of the two large-scale technologies. For example, grid infrastructure costs are higher for connecting larger volumes of offshore wind.

Finally, we note that, in addition to defining a long-term vision (2035-2050), the next governments will also need to give attention to the transition period 2035-2040. Faster development of renewable sources, energy-saving measures (less consumption), and extending the lifetime of existing fossil and nuclear units (insofar as this can be done safely) are potential options with a favourable economic impact that could also be considered.

5. FUTURE INVESTMENTS IN INTERCONNECTORS (ONSHORE)

The figure below shows that investments in interconnectors depend on the long-term energy visions chosen for Belgium and its neighbours.



What do we see?

- Reinforcing Belgium's interconnectors with its neighbours is a no-regret measure. Which borders should be prioritised depends heavily on the future electricity mix.
- More offshore wind generation via the North Sea requires further development of east-west interconnectors between Belgium and Germany. Otherwise, it makes more sense to increase access to countries in the north (interconnector with the Netherlands).

What does this tell us?

A reinforced and completed 380 kV high-voltage (AC) grid is the backbone for all further grid developments. Eliminating 'missing links' in the near future (Ventilus and Boucle-du-Hainaut projects) is necessary in all future scenarios. How Belgium's high-voltage grid evolves after 2035 depends on the energy mix chosen in the lead-up to 2050 and the location of new generation sources or units that are expanded or have their lifespans extended.

Nuclear extensions exceeding 2 GW (more than Doel 4 and Tihange 3) as well as new nuclear plants will require significant grid reinforcements. The same applies to offshore wind. Hybrid interconnectors and offshore high-voltage hubs appear to be the most cost-effective approach for integrating non-domestic offshore wind generation. To successfully implement these projects, international partnerships will be needed in order to conclude the necessary agreements and set up cooperation structures.

In developing this report, we were able to count on the support of the partners listed below. We would like to extend our sincere gratitude to them for the interesting discussions and for their feedback.

The full report can be viewed at the following link: **https://www.elia.be/en/publications**

About Elia Group

One of Europe's top five TSOs

Elia Group is a key player in electricity transmission. We ensure that production and consumption are balanced around the clock, supplying 30 million end users with electricity. Through our subsidiaries in Belgium (Elia) and the north and east of Germany (50Hertz), we operate 19,460.5 km of high-voltage connections, meaning that we are one of Europe's top 5 transmission system operators. With a reliability level of 99.99%, we provide society with a robust power grid, which is important for socio-economic prosperity. We also aspire to be a catalyst for a successful energy transition, helping to establish a reliable, sustainable and affordable energy system.

We are making the energy transition happen

By expanding international high-voltage connections and incorporating ever-increasing amounts of renewable energy into our grid, we are promoting both the integration of the European energy market and the decarbonisation of society. We also continuously optimise our operational systems and develop new market products so that new technologies and market parties can access our grid, thus further facilitating the energy transition.

In the interest of society

As a key player in the energy system, Elia Group is committed to working in the interest of society. We are responding to the rapid increase in renewable energy by constantly adapting our transmission grid. We also ensure that investments are made on time and within budget, with a maximum focus on safety. In carrying out our projects, we engage in proactive stakeholder management by establishing two-way communication channels between all relevant parties very early on in the development process. We also offer our expertise to different players across the sector in order to build the energy system of the future.

International focus

In addition to its activities as a transmission system operator, Elia Group provides consulting services to international customers through its subsidiary Elia Grid International. In recent years, the Group has launched new non-regulated activities such as re.alto – the first European marketplace for the exchange of energy data via standardised energy APIs – and WindGrid, a subsidiary which will continue to expand the Group's overseas activities, contributing to the development of offshore electricity grids in Europe and beyond.

The legal entity Elia Group is a listed company whose core shareholder is the municipal holding company Publi-T.

eliagroup.eu

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