Cover Story

Renewable energies

How to reach the objectives?

TEXT Laure Demezet, Lucie Martin, Catherine Moisy, Max Rosen **TRANSLATION FROM FRENCH** Martin Davies, Hannah Ekberg

The development of renewable energies can help to achieve the United Nations' Sustainable Development Goal (SDG) No. 7: *'Ensure access to affordable, reliable, sustainable and modern energy for all'*. This is also one of the ambitions of Luxembourg's third industrial revolution (TIR) strategy, the 'Rifkin' plan, whose vision is stated in the preamble to the chapter on energy: *'Luxembourg should exploit all of its renewable energy production potential. This could cover up to 70% of its total consumption.'* How can we turn these ideas from pious promises into reality?

In its July-August 2015 edition, Merkur published an article on green challenges: energy already had an important role at that time. Five years later, we can begin to compare the progress with what was written at the time. The subjects of greenhouse gas (GHG) emissions and energy transformation have gained importance since the Paris Conference (COP 21) in December 2015 laid the groundwork for a new international agreement to keep global warming 2°C below the pre-industrial era (1900), an objective re-evaluated at 1.5°C by a recommendation from the Intergovernmental Panel on Climate Change (IPCC). Since then, public opinion has mobilised to demand states take firmer and faster action in favour of the climate. One of the very first initiatives of the 'von der Leyen Commission' was to launch the *European Green Deal*, the new growth strategy of the European Union, and the theme *'How to save the planet'* figured at Davos in January 2020.

The objectives stated in 2015 for 2020 have given way to more ambitious objectives for 2030, whether in terms of the share of renewable energies in the total primary energy consumption (32.5%), energy efficiency (32.5% compared to 1990), or reduction of GHG emissions (-40% compared to 1990). The European Green Deal plans to revise this last objective upwards, by imposing a reduction of between 50% and 55% by 2030 compared to 1990. And the ultimate ambition is total neutrality by 2050!

Boosting the transition

Let's start with a few general observations on renewable energy and what the transition to this type of energy entails. What characterises energy as renewable is the fact that its source (sun, wind, etc.) is constantly renewed, ensuring a stock that will always be enough to cover our needs. This is not the case for fossil fuel sources (coal, oil, gas, etc.), which come from the methanisation (fossilisation) of organic matter several million years ago: their quantity is limited, and their extraction exhausts their supply. While most renewable energies are often called 'clean', this designation may be excessive. They do not produce waste, but they are neither free from pollution, particularly in the construction phase of the infrastructure needed. The notion of 'efficiency' is, moreover, essential to accelerate energy transformation. Reducing energy consumption makes it possible to reach renewable energy's target share more quickly. On this point in particular, the government has been very active, with measures taken in, among others, the mobility and construction sectors.

One planet, several renewable energies

Renewable energies should be regarded as a plural term. They come from several natural sources classified into five major categories: solar, wind, hydraulic, biomass and geothermal. Photovoltaic panels capture the sun's rays and transform them into electricity whilst thermal collectors capture the sun's heat to warm water in sanitary or heating installations. This energy is free, inexhaustible, and present everywhere. Wind and hydraulics use the natural force of wind and water to power a turbine that produces electricity. Wind energy therefore relies on the kinetic force of the wind blowing at more than 15 kph to turn the blades of wind turbines. These can be *onshore* (on land), or *offshore* (installed at sea). As for hydraulic energy, it uses the force of moving water, where the amount of energy produced depends on the pressure and the volume of water available. There

"Reducing energy consumption makes it possible to reach renewable energy's target share more quickly. On this point in particular, the government has been very active, with measures taken in, among others, the mobility and construction sectors."

are many types of infrastructure to exploit this force: dams, turbines installed in the pillars of certain bridges spanning rivers, or tidal power plants exploiting the variation in sea level or sea currents. Furthermore, in biomass power plants, turbines are powered by steam given off by burning organic, vegetable or animal matter, or by burning the gas given off as these materials rot. We speak of cogeneration when part of the steam produced is used in heating circuits. Finally, geothermal energy uses the heat of the earth to transform groundwater into vapor. This steam powers turbines located in geothermal power plants.

Surprisingly, modern man claims to have discovered the many possibilities offered by these energies when most of them had already been used in antiquity (the sun was used to light the Olympic flame at the Greek games, the wind to push boats or grind grain in mills, the flow of rivers to transport goods…). Obviously, everything is a question of scale. Modern life consumes a lot of energy and the contemporary use of renewable energies requires equipment that guarantees large volumes of energy are produced. This has long played in favour of fossil fuels, which are easier to store and transport. If we want to diversify the sources of energy supply today, it is of course to reduce reliance on fossil fuels which have a high ecological cost, but also because renewable energies are more efficient. Indeed, when raw (primary) energies are extracted from nature and transformed into usable electrical (secondary) energy, there is always a loss. This is much lower in the case of certain renewable energies. For example, you can recover about 35% of electrical energy when burning coal, fuel oil or gas, but you can get up to 59% when you use the wind, and you recover up to 90% when the water from a dam drives a turbine. In addition, fossil fuels are not evenly distributed over the planet, causing dependence on certain countries with large deposits. One of the great advantages of renewable energies is that they are present almost everywhere and that they therefore allow decentralised production. In addition to limiting the risks of dependence on countries subject to the often sudden vagaries of geopolitics, this is an undeniable economic opportunity for many countries. Let's take a look at the geopolitics of renewable energies.

Ecological and economical

According to the 2019 report of the International Renewable Energy Agency (IRENA), the world's total renewable energy capacity increased from 1,136 gigawatts (GW) in 2009 to 2,350 GW in 2018, an annual increase of more than 10%. Hydroelectricity represented more than 50% of total capacity in 2018, wind energy almost 25% (including 96% onshore wind energy), solar energy more than 20% (including 99% photovoltaic), bio-energies around 5% and geothermal energy around 0.5%. In addition to this total capacity, there was the so-called 'off-grid' capacity (private facilities for local consumption) of 8,793 GW in 2018, with 33% photovoltaic and 9% hydroelectricity. This autonomous production takes place in areas not connected to the electricity grid *('off-grid capacity')*.

Renewable energies are one of the major tools available to limit global warming to 1.5°C. According to an IRENA report in January 2020, they were the main source of new energy production capacity over the past decade. They could even become the main source of electricity production within the next ten years. They accounted for 26%

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of global electricity supply in 2019 and this share could reach 57% by 2030. Electricity is currently 20% of total global energy consumption and this could reach 30% within 10 years.

However, according to an IRENA scenario, to move towards climate security and sustainable development, renewable energies would have to grow four times faster between now and 2030. This alarming observation places renewable energies among the priorities of many national policies. More generally, 67% of global national climate pledges set renewable energy targets in 2019.

01. 02. The positive signs that emerged from the Paris climate conference in 2015 and its rather encouraging outcome were not sufficiently translated into action. This is the message from the youth movements, inspired by the young Swedish environmental activist Greta Thunberg, which are rising up all over the world.

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Alessandro Boschi
Head of renewable energies division, European Investment Bank (BEI)

"Renewable energies are the key to success."

How does the EIB support the EU's renewable energy goals?

The EIB finances projects related to the whole range of renewable energies, both inside and outside the EU. Each year, it lends around EUR 3 billion to this sector, loans which contribute to the integration in the market of renewable energies or related technologies at an earlier stage of their development. For example, EIB support for offshore wind energy since the 2000s has been crucial to the current expansion and competitiveness of this technology. The EIB recently approved its new energy lending policy, which focuses on decarbonisation. The EIB is also helping the countries of central and south-eastern Europe which are experiencing great difficulties in their energy transition, even though they have real potential which the EIB can help to develop.

Which countries are the most advanced regarding renewable energies?

In Europe, Iceland and Denmark stand out. Iceland is one of the few countries in the world to produce 100% of its electricity from renewable energies, namely geothermal and hydro. Denmark was the pioneer of wind power, erecting the first commercial wind turbine in 1979. By 2030, it intends to produce 100% of its electricity from renewable sources and use the surplus for export or electrification of other sectors.
Outside the EU, Costa Rica and Nicaragua use an energy mix combining hydro, geothermal, solar and wind. Brazil has been a pioneer in hydroelectricity and is now adding biomass and wind power to it. Africa, on the other hand, has enormous potential, but is lagging behind. However, Morocco has the world's largest solar power plant (Ouarzazate) and plans to produce more than 50% of its electricity from renewable energy by 2030. Kenya gets half of its electricity from geothermal energy. In October 2019, it connected the largest wind farm in Africa (near Lake Turkana) to the power grid. The EIB financed these two projects.

An example of a project supported by the EIB in Europe?

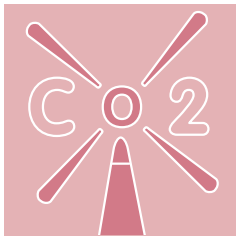
The Talayuela solar power plant in Spain is one of the first renewable energy projects in the country to be funded without public support. It will greatly influence the national energy market, helping Spain to reach its renewable energy target. With 300 MWp, Talayuela will be one of the largest solar power plants in Europe, capable of producing enough electricity to power around 150,000 homes per year, at a very competitive price.

Energy efficiency in the office

Here are some simple ideas for saving energy in the workplace, because we can't emphasise it enough that the 'greenest' energy is the energy that we don't use!

- Take the stairs instead of the lift
- Pool the printers
- Make photocopies rather than printing copies
- Reduce the brightness of computer screens
- Do not leave phone or tablet chargers plugged in when not in use
- Lower the blinds to prevent heat from entering
- Close the doors of rooms with little or no heating...

Find other eco-responsible gestures on our detachable poster at the end of the magazine.



Zero impact on the environment?

Renewable energies are sometimes confused with clean energies. The production of equipment (wind turbines and solar panels for example) generates CO_2 even if these devices do not emit it once in operation. To make them, you must extract raw materials and transport parts and different materials, activities that still often consume oil.

The harmony of the countryside, as well as the flora and fauna, are impacted by the development of renewable energies. We know, for example, that the noise and the shadow cast by wind turbines modify the ecosystems that surround them and that their presence disturbs birds and bats. Hydroelectric dams in turn flood entire valleys and prevent fish from migrating to their breeding grounds.

03. 04. The European Commission aims to eradicate greenhouse gas emissions responsible for global warming by 2050.

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Beyond being a solution to the climate emergency, renewable energies can also become the most competitive option based on cost alone. According to a study by the [french] Environment and Energy Management Agency (ADEME), their production cost, calculated over a period of operation at full power, depends on (1) the investment cost, (2) the quality of the available resource, and (3) the discount rate chosen. The discount rate is defined by the ADEME as *'the opportunity cost of the capital invested, the return that could be obtained by investing the same capital elsewhere. This rate includes a risk premium linked to the project, which reflects its probability of failure'*. The more mature the industry, the lower the costs associated with investment and the discount rate. As wind and photovoltaics are the two most mature technologies to date, their energy is the cheapest, which explains why the Luxembourg government wants to promote investment in these technologies. Thanks to the increase in the production capacity of photovoltaic solar energy and wind energy, their costs could fall between 30 and 40 dollars per MWh by 2030, and they could cover nearly a third of the world's needs by then.

Following these observations, USD 3,000 billion have been invested in renewable energies in the last 10 years. 90% of total investment, or USD 329 billion, came from the private sector in 2018. However, annual spending must be doubled until 2030 to ensure the desired energy transition. To achieve this, the USD 10,000 billion currently invested in fossil fuels should be redirected.

Shared opportunites

Such investments would not leave the social pillar behind, since renewable energies are creating an increasing number of jobs in many sectors of the economy. The IRENA counted 11 million people employed in the sector in 2019, increasing to 30 million by 2030. Between 2009 and 2018, employment linked to renewable energies quadrupled, even quintupled. The share of women in this sector is higher (32%) than in the oil and gas sector (22%). In the solar energy sector, the number of jobs should rise from 4.4 million in 2019 to 11.7 million in 2030, and in wind turbines, from 1.1 million to 3.5 million. Wind power in Europe provides the largest number of jobs to date (324,000 additional jobs since 2014).

Another notable opportunity is that *off-grid* renewable energy has become a real solution to address the lack of access to energy worldwide, thereby providing access to electricity for an additional 1 billion people. Off-grid renewable energy thus contributes to reducing the global energy access gap and will benefit an additional 150 million

Anouk Hilger
Head of Renewable Energies,
Enovos Luxembourg

"Rising to this exciting challenge."

What do renewable energies mean for Enovos?

Renewable energies are one of the keys to energy transformation and sustainable development and as a driving force behind this transition, Enovos have made it one of our priorities. Investing in renewables is essential to build energy sustainability and reduce greenhouse gases. In short, the development of renewable energy is an essential pillar for Enovos, an important element in producing and supplying local green energy to the market.

What sorts of investments are you making to develop renewable energy?

Currently we are mainly developing projects in the fields of photovoltaic and wind energy. We have thus recently been able to inaugurate several photovoltaic installations carried out with partners such as Post Luxembourg and Cactus. Other roof installations with Arthur Welter, Kichechef, Luxtram and Panelux, as well as the first large ground installation in partnership with RTL Group, will follow in the short term. We do not intend to stop there and are constantly looking for new projects in this area. As for wind power, two parks are currently in construction and several other projects are being developed. The time required to finalise these projects is long, given the necessary preliminary studies and the significant constraint to avoid environmental impact. We still see good potential beyond the projects already underway.

In terms of professions and skills within the company, do these developments represent a challenge?

In fact, the energy sector is undergoing profound changes in moving from centralised production to renewable energy production methods over a wide area. This development is a real opportunity for innovation and technological advancement for the sector. For example, Enovos is developing new supply models such as the *Power Purchase Agreement* (PPA), which is the direct supply of green energy from the producer to the purchaser. This model combines plannable (like hydrological energy) and volatile (wind and photovoltaic) renewable sources. Beyond specific professional knowledge and expertise, this requires good collaboration between the different departments and committed teams. And this is precisely what allows us to rise to this exciting challenge.

05. 06. 07. Fossil fuels came from the slow decomposition of living things millions of years ago. They are not renewed. The *encyclo-ecolo.com* site, which defines itself as the encyclopaedia of sustainable development, predicts the exhaustion of oil by 2050, gas by 2072 and coal by 2158.

people, while allowing access to healthier food, education, healthcare and air conditioning, cleaner, better agriculture, healthier water, and even having a positive impact on the phenomenon of desertification. In 2030, 60% of new access to electricity will come from renewable energies. Autonomous systems and mini-networks will provide the means for almost half of the new accesses.

Several of the 17 SDGs set by the United Nations therefore seem attainable thanks to renewable energies.

Natural resources

In most countries, hydroelectric power dominates. However, not all geographic areas are equal when it comes to the production of energy from renewable sources. Indeed, it strongly depends on natural conditions. Each region will logically focus more on solar, wind or hydraulic energy, depending on its specific conditions. Climatic and geological conditions are thus studied in order to determine a production strategy using a combination of solar panels, onshore or offshore wind turbines, or even hydroelectricity.

By way of illustration, being naturally endowed with water, Iceland, Norway and


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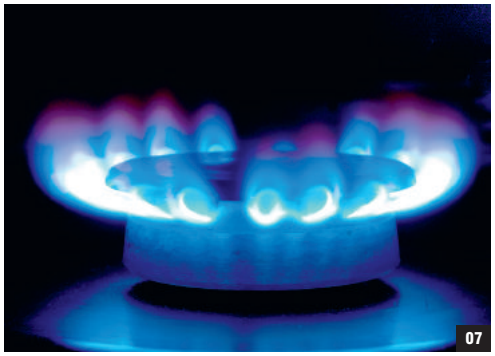
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"As a country that has always covered almost all of its energy needs through imports, Luxembourg is now dealing with the challenge of securing its (sustainable) energy supply."

Canada produce the major part of their renewable electricity thanks to hydroelectricity, while countries like Germany and Spain are more concentrated. on wind power. Large river areas such as northern Europe focus on dams, while countries with long seacoasts can rely on wind power. California and Oceania are logically oriented towards solar energy.

In 2017, according to the International Energy Agency (IEA), renewable energies reached almost 25% of the electricity mix. Iceland was the first country in the world to achieve 100% renewable energy in its consumption. In 2018, the European Union reached 18% of renewable energies, with Sweden, Finland and Latvia occupying the top of the ranking. In China, the IRENA expects to see a 16% increase in energy consumption from renewable sources within three years. Even though this country is the one that invests the most in renewable energies, it remains the most polluting in the world. In India, renewable energy growth reached almost 51%. While in the United States, according to the IEA, wind, solar, and hydraulic power will collectively produce 18% of electricity in 2019 and almost 20% in 2020.

What is the potential in Luxembourg?

As a country that has always covered almost all of its energy needs through imports, Luxembourg is now dealing with the challenge of securing its (sustainable) energy supply. In 2018, national dependence on energy imports amounted to 95% (including renewable energy).

On the European level, this challenge has resulted in, among other things, a position in favour of further European integration in the field of energy and the development of true pan-European energy networks. At the national level, increased energy efficiency was defined as the major lever to reduce Luxembourg's energy dependence. The 2003 Master Programme for Spatial Planning (PDAT) identified a need to promote coherent urban planning and densified urban structures to generate long-term energy savings.

The question of the Grand Duchy's renewable energy production potential then gained importance in the context of the development of a National Action Plan for renewable energies (2010-2020), all of which then became a real priority within the 'Rifkin' strategic study on TIR in 2016. According to the latter, the ecological transition of the Grand Duchy will necessarily go through a large-scale electrification of its energy system, a system which should moreover be organised in regional energy clusters to allow more decentralised energy production at a regional level. This strong growth expected in the electricity sector is mainly based on wind and solar energy. Biomass and geothermal energy should also play a significant role in the future energy mix.

What is the renewable energies development process?

Following European regulations, the National Integrated Energy and Climate Plan (PNEC) project sets the objective of increasing the share of renewable energies in total final energy consumption from 11% in 2020


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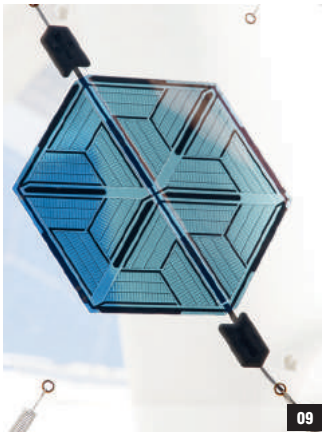
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to 25% in 2030. In 2018, 9.1% was reached. Of the 25% targeted in 2030, government projections show that the total national production of renewable energies should reach 19.6%. In particular, the share of renewable energies in the electricity sector should rise from 8.1% in 2017 to 33.6% in 2030, in the heating sector from 8.1% to 30.5%, and in the transport sector from 11.3% to 25.6%. Note that increasing the part of renewable energy goes together with reducing the total energy consumption. Indeed, when the latter decreases, the further automatically increases.

Regarding the production of electricity based on renewable energy sources, statistics from the Luxembourg Institute for Regulation (ILR) indicate that the latter has experienced continuous growth in the recent past. Thus, while national net electricity production (excluding the Vianden pumping station connected to the German transmission network) amounted to 933 GWh in 2018, net electricity production based on renewable energies amounted to around 688 GWh for that year, that is approximately five times the volume produced in 2003 (137 GWh). This increase can be explained by a favourable development in electricity production from wind power, which after the commissioning of the first wind power plant in Mompach in 1996, multiplied by almost by 10 (from 26 GWh to 255 GWh) between 2003 and 2018; a notable increase in photovoltaic production which, as a result of almost doubling the number of installations between 2012 and 2018, increased from 38 GWh to around 119 GWh; and also an impressive increase (from 24 to 95 GWh) in electricity production based on biomass between 2015 and 2018. According to the ILR, the Grand Duchy was thus able to cover 14.1% of its electricity consumption (6,611 GWh) by net national production (933 GWh) and even 10.4% by production based on renewable energies (688 GWh) in 2018. The rest of the consumption of 85.9% was covered by net imports, mainly from Germany.

While the Grand Duchy does not seem to be on the wrong track, it goes without saying that the 'Rifkin' vision of public transport and a 100% electric vehicle fleet in 2050 will require much more effort, including in the area of spatial planning for renewable energy production. For reasons of space, the development of such a prospective national vision seems to be essential in terms of the location of future wind installations and of large-scale photovoltaic projects on the ground. In a philosophy of improving complementary relations between town and countryside, the role of renewable electricity producers in less densely populated rural areas could be promoted. In return, this development strategy for the rural environment could then be supplemented by defining an energy production plan for urban spaces that would intelligently combine a multi-functional approach to the urban fabric with a multitude of possibilities for integrating photovoltaic energy equipment into buildings and other fixed surfaces.

Interesting opportunities for companies

The climate objectives that Luxembourg has set itself will undeniably impact Luxembourg's companies who are, indeed, the source of a large part of GHG emissions and energy consumption. According to STATEC figures, industries and other companies in Luxembourg alone accounted for 88.02% of the country's final energy consumption


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08. The Ouarzazate (Morocco) photovoltaic installation is one of the largest and most powerful in the world. It consists of a field of 480 hectares of curved mirrors and has a storage capacity of 3 hours of production.

09. 10. 11. 12. Whether on a corporate or individual scale, photovoltaic cells in solar panels capture inexhaustible energy from the sun to transform it into electricity.

Claude Turmes
Minister for Energy

"In Luxembourg, we can develop wind and solar power in particular."

Before being Energy Minister, you were Secretary of State for Sustainable Development. What is the link between these two departments?

These are two departments that must find answers to maintain and develop the quality of life for residents. They deal with the quality of air and water and in maintaining the equilibrium in biodiversity and climate – the elements that form the very basis of life.

How can politicians act on environmental issues and energy choices?

We are basing ourselves on science which clearly establishes a link between greenhouse gas emissions and global warming, and which insists that the next 10 years will be crucial. We therefore have little time to replace harmful fossil fuels with renewable energies. To go faster, it is also essential to encourage everything connected to energy efficiency. Therefore, the law sets strict standards for all new buildings and incentives for home improvements. In addition, we have created, with the EIB, a guarantee fund intended to help companies wishing to make investments in energy efficiency, and this concerns not only buildings but also production processes. Finally, we place emphasis on mobility, by encouraging the replacement of petrol vehicles with vehicles powered by electricity or hydrogen.

In Luxembourg, the objective is to reach 25% renewable energy by 2030. How do we get there?

In Luxembourg, we can develop wind and solar power in particular. With regard to wind power, we are going to develop high-capacity equipment, like that of Wincrange, which was inaugurated in March. For solar, we want to lead a real offensive. Our measures concern both individuals and businesses. For example, last year we increased the price guarantee for the purchase of solar electricity produced by private facilities and fed into the national distribution network. This had an immediate effect and resulted in the installation of thousands of new panels. To encourage the creation of large-scale facilities, in September 2019, we launched a call for tenders to collect applications from private investors.

Joseph Hess
Co-Founder, President
and CEO, Swirl

"We decided to become engineers and suppliers of net zero carbon systems."

What is your company's business?

Our business is the development, manufacture and sale of equipment intended to produce energy or render other services, while being completely carbon neutral.

How did this idea come to you?

In 2000 we developed patents and microsystems to eliminate hydrofluorocarbons from inhalation devices for asthmatics, our first activity in eliminating greenhouse gases! In 2010 we continued these efforts to reduce pollution but based on renewable energies. In 2017, we developed our first product, a certified wind turbine with machine learning. Its manufacture is planned in Africa. In 2019, as the effects of the carbon footprint became more evident, the urgency for radical decarbonisation became more pressing. The problem being systemic, it cannot be solved by a single technology like our wind turbine. We therefore began to diversify by deciding to become engineers and suppliers of net zero carbon systems. Only renewable energy sources are used: water and ambient air. So, photovoltaics, wind and hydro combined. Our research fields are, for example, the generation of hydrogen from water and of drinking water from the humidity present in ambient air. Or transport powered by compressed air or electricity for houses generated by similar systems. Replacing hydrofluorocarbon air conditioners with compressed air systems or innovative nanotechnology is quite radical. We can thus move towards net zero carbon heating and air conditioning systems for homes. This is our key objective, including the manufacture of these systems in Luxembourg. Recently, we have added the circular economy to our business by targeting the pyrolysis of plastics, the production of biogas, the organic treatment of wastewater ...

Who are your potential customers?

We are targeting the housing and construction sectors as well as ministries and businesses in Europe and Africa. Our network is ready for significant growth. We cooperate with partners in Luxembourg, Europe, the United States and India. We develop the technical and financial base of the project and manage it with our technical contribution and intellectual property. In doing so, we are producing an ICT hub of knowledge on decarbonisation available to the public.

13. Wind turbines use the kinetic force of the wind, transmitted from the blades to the central turbine, to produce energy.

© Enovos

14. 15. The kinetic force of water can be captured either by dams installed on rivers (the most spectacular installation in Luxembourg is the Vianden dam, operated by the Société Électrique de l'Our (SEO), photo 15), or by installations at sea, whose turbines are activated by the amplitude of the tides or the coming and going of the waves (here an installation in Northern Ireland), photo 14.

© Société Electrique de l'Our and mby.com

"Luxembourg aims at exploiting the available surface on rooftops as much as possible. Photovoltaic systems installed on rooftops prove to be very profitable as their lifespan is 20 years on average, and so its cost is amortised over about 10 years."


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in 2018, including 14.97% for industry, 11.09% for the tertiary sector, and 61.79% for the transport sector (sales to non-residents included). Without a contribution or active involvement from SMEs, but above all from those industries which are generally very energy intensive, the national and European objectives in terms of renewable energies will be difficult to achieve.

As indicated in the introduction, the TIR strategy recommended that Luxembourg exploit all of its renewable energy production potential, so that, ultimately, they cover up to 70% of final energy consumption. Even if part of the renewable energy will still have to be imported (Estonia and Lithuania, for example, will participate in 2% of the posted objective of 11% of renewable energy in 2020, via direct transfers of kW), this recommendation shows that the potential for Luxembourg's capacity to exploit its renewable resources remains considerable.

Various possibilities, opportunities and aids are available to companies wishing to become more responsible and participate, each at their own level, in the energy transition. Thus, for example, through corporate social responsibility (CSR), all companies can, on a voluntary basis, impose on themselves non-mandatory standards, based on three main pillars: environmental, social and economic. On the environmental level, they can integrate a 'sustainable development' dimension into their daily activities. As examples of responsible initiatives, they can commit to controlling their consumption of water, energy and raw materials, to produce in an ecological way, to limit as well as recycle the waste they generate, or to set up measures and audits to improve their ecological performance.

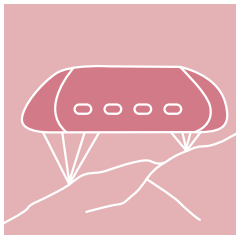
Faced with the development of renewable energies objectives in Luxembourg, public support remains necessary to prolong the cost reductions, facilitate investments or compensate for market failures. In addition to increased aid (financial and general support) for individuals, particularly in terms of energy renovation of buildings (*PRIMe House*, the *myrenovation* of *myenergy* application, etc.) or help to buy electric cars (subsidy plans like *Clever fueren* for low to zero emission vehicles), the Ministry of the Economy and the national innovation agency Luxinnovation, among others, have set up different financial aid systems for both SMEs and large companies.

Thus, direct aid can be granted to invest in environmental technologies or other innovations. To name just a few, industries can receive investment aid for the promotion of energy produced from renewable sources, high-efficiency co-generation, or even district heating and cooling efficiencies. SMEs can, for their part, be supported through external advice to better exploit natural resources, or investment in the sustainability of their premises.

Energy producers and 'green' solutions

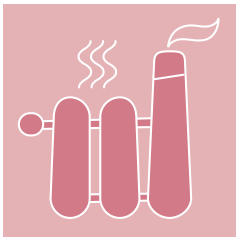
In addition, to encourage companies to invest in their own renewable energy production via photovoltaic installations, injection prices have been raised. These tariffs, guaranteed for 15 years and varying from EUR 0.145 to 0.165 per kWh, depending on the year of the first production and the level of power production, reward companies that feed the electricity they produce into the network, thanks to a contract with a network operator. For installations with a nominal power lower than 500kW, self-consumption will gradually become simpler, in order to encourage more SMEs and office buildings to contribute to the deployment of photovoltaic panels. For large installations (above 500kW), the sale of electricity produced on the market is compulsory according to the market rate principle. Between 2013 and 2018, the number of photovoltaic power plants increased by 60%.

Luxembourg aims at exploiting the available surface on rooftops as much as possible. Photovoltaic systems installed on rooftops



Luxembourg know-how in Antarctica

The Prefalux company from Junglinster participated in the construction of the Princess Elisabeth station in Antarctica. It is a Belgian scientific base inaugurated in 2009 that uses only renewable energies to operate and is unprecedented in the field of polar bases, even when the weather conditions are extreme with winds that can reach 250kph and temperatures varying between -5°C and -50°C. The Luxembourgish company participated in the design, study, calculations and plans, then carried out the construction and assembly on site with a team of seven people. Wood was chosen for this building to minimise thermal bridges thanks to its low thermal conductivity. This material is also available, economical, CO_2-neutral and solid. For the design and construction of the outer wall of the polar station, Prefalux received the prize for innovation in Crafts in 2008.



When a factory warms up an entire neighbourhood

In November 2019, ArcelorMittal received the Environment Award from the Fedil for its project in recovering excess heat generated during the production of sheet steel piling at its Belval site. Since its inauguration in June 2018, the heat emitted by the rolling mill has supplied heating to the Belval, Nonnewisen and Sommet districts, thanks to cooperation with the urban heating company Sudcal. This readily available and untapped energy source covers 70% of Sudcal's heating needs, equivalent to the annual consumption of 4,000 houses. The facility thus avoids consuming 1.6 million litres of fuel oil each year, which corresponds to a reduction in greenhouse gas emissions of some 5,000 tonnes.

16. In Iceland 81.4% of the country's total primary energy consumption came from renewable energies in 2018, including 61.8% from geothermal energy alone, the pipelines of which run through mountainous landscapes.

prove to be very profitable as their lifespan is 20 years on average, and so its cost is amortised over about 10 years. In addition, since solar energy has become cheaper than conventional electricity, it is an attractive investment for businesses. Several major initiatives have already been developed. To cite only two examples of companies having concluded a market premium contract with ENOVOS following the invitation to tender launched by the Ministry of the Economy, RTL had 7,000 solar panels installed in Junglinster, and 16,000 in Beidweiler, making it possible in the future to produce 7,000 MWh per year, capable of supplying 1,800 households. Cactus has also decided to act in favour of solar energy by installing 10,842 solar panels on the roofs of its supermarkets, which can power 630 homes.

Companies directly involved in the energy sector are also very active in the production of renewable energy. For example, ENOVOS and the Société Électrique de l'Our (SEO) partnered to set up the Société Luxembourgeoise des Energies Renouvelables (SOLER) in 2001, specialising in hydraulic and wind energy. Their facilities can supply 47,100 households with renewable energy.

There is no shortage of initiatives at the startup level either. For example, the startup Polaar Energy, created in 2018, has developed a solution to help consumers and businesses manage their water and energy consumption, save money, and reduce their impact on the environment, based on established facilities, and the budget and needs of the client.

In addition, the government has announced the construction of a hydrogen station, making it possible to produce green hydrogen by electrolysis, from photovoltaic and wind power. This constitutes an important opportunity for the industrial, transport and energy storage sectors.

Many other initiatives and opportunities can be cited, including the Google data centre which will be located in Luxembourg and will be powered only by green wind and solar energy, or by opportunities in the


18

building sector thanks to the development of geothermal energy at the national level, enabling the deployment of heat pumps, which are particularly efficient in well-insulated buildings.

PClearly, the key to a profitable and efficient energy transition is undeniably found in innovation and by increasing total renewable energy production capacity. ▬

17. Biomass energy is the oldest form of energy used by man since the prehistoric discovery of fire. This energy makes it possible to produce electricity thanks to the heat released by the combustion of materials (wood, plants, agricultural waste, organic household waste) or biogas from the fermentation of these materials, in biomass plants.

18. 19. Some people criticise wind turbines for their impact on the landscape, but this is not a new development brought by renewable energies. The need for large-scale energy production and transportation has always transformed landscapes.

20. The Luxembourg government is hoping that energy efficiency will reduce consumption and thus improve the renewable energy ratio. The two sectors particularly targeted by incentives are transportation and construction.

"The government has announced the construction of a hydrogen station, making it possible to produce green hydrogen by electrolysis, from photovoltaic and wind power."


19


20