



# Green Schuldschein

Report 2021





# Contents

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1.	Profile	3
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2.	Our Green Finance Projects	4
2.1	Introduction	4
2.2.	Our Green Schuldschein	4
2.3.	Our Project Categories	5
2.3.1.	Renewable Energy Projects	5
2.3.2.	Energy Transmission, Distribution and Smart Grid Projects	5
2.3.3.	Sustainable Real Estate	5
2.3.4.	Clean Transportation Solutions	5
2.4.	Project Evaluation and Selection	5
2.5.	Management of Proceeds	7

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3.	Reporting	8
3.1.	Allocation Report – Advancement on Projects	8
3.2.	Impact Report	10
3.2.1.	Overview & Metrics	10
3.2.2.	Selected Projects	14
3.2.2.1.	Renewable Energy Projects	14
3.2.2.2.	Sustainable Real Estate	18
3.2.2.3.	Energy Transmission, Distribution & Smart Grid Projects	22
3.2.2.4.	Clean Transportation Solutions	27

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4.	Disclaimer	29
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# 1. Profile

Encevo Group is the leading energy player in Luxembourg and active in Germany, France, the Netherlands and Belgium. Encevo is active all along the energy value chain: production, storage, supply, transport, trading, distribution and services. The group is based on three pillars, essentially represented by three distinct entities and their respective subsidiaries: energy supply and the production of renewable energies through Enovos, grid operation through Creos and energy related services (distributed production, energy efficiency, eco mobility) through Teseos (previously named Enovos Services). As one of the main players in the energy industry of the Greater Region, our vision is to be a leader in the renewable energy sector and to play a proactive role in the energy transition. Hence, an integral part of Encevo Group's strategy is its contribution to proactively shape a sustainable future for energy production and distribution in the Greater Region. In terms of meeting the challenge of the persistent evolution of the European energy market, the Encevo Group is taking a long-term view ensuring it is driving real sustainability and positive progress.



## 2. Our Green Finance Projects

### 2.1. INTRODUCTION

This is the first Green Schuldschein report on the use of proceeds of Encevo's second Green Schuldschein, signed on 8<sup>th</sup> of December 2021, with pay-out date on 16<sup>th</sup> of December 2021 (200 MEUR), based on Encevo's Green Schuldschein Framework<sup>1</sup>.

The issuance was supported by a Second Party Opinion by Sustainalytics which confirmed that Encevo's 2021 Green Schuldschein's use of proceeds is fully aligned with the eligible categories as defined in this Framework. The opinion stated that the Schuldschein was a "Green Schuldschein" with positive contribution to sustainable development, aligned with the Green Bond Principles.

#### OPINION OF SUSTAINALYTICS:

"Sustainalytics considers that the projects funded by the proceeds are expected to promote a transition towards a low-carbon economy. Sustainalytics believes that the Framework is aligned with the overall sustainability strategy of the company and that the green use of proceeds categories will contribute to the advancement of the UN Sustainable Development Goals 7, 9 and 11. [...]Sustainalytics is confident that Encevo S.A. is well positioned to issue Green Schuldscheine and that the Encevo's Green Schuldschein Framework is robust, transparent, credible, and in alignment with the four core components of Green Bond Principles 2021."

This report covers investments of the period from 2020 until 2021 and the investments done in 2022 for the finalization of Creos headquarters (Merl building).

### 2.2. OUR GREEN SCHULDSCHHEIN

Encevo's second Green Schuldschein issue raised 200 MEUR in three tranches of 85 MEUR, 105 MEUR and of 10 MEUR with tenors of 7, 10, and 15 years. The proceeds of our second Green Schuldschein are dedicated to four main project categories:

1. Renewable Energy Projects
2. Energy Transmission, Distribution and Smart Grid Projects
3. Sustainable Real Estate
4. Clean Transportation Solutions

The single categories will be further outlined in the following section. The current Green Schuldschein covers projects in Luxembourg, Germany (only renewables projects, investments in German Power Grid have not been considered), Belgium, and the Netherlands.

<sup>1</sup> Link: <https://www.encevo.eu/en/financial-figures/?title=green>

## 2.3. OUR PROJECT CATEGORIES

### 2.3.1. Renewable Energy Projects

This category means the development, construction, installation and maintenance of renewable energy production units, from sources of wind power and solar PV installations. Investments in these projects can occur either in form of debt or in form of equity.

### 2.3.2. Energy Transmission, Distribution and Smart Grid Projects

This category encompasses the development, construction and reconstruction of electricity networks that enhance the transmission capacity for renewable energy, investments in new and existing infrastructure to increase capacity in order to inject more renewable energies into the system, increase energy efficiency and decrease network losses as well as investments in new infrastructure that improve reliability of energy supply and energy efficiency through the use of smart grid technologies and the installation of smart meters.

### 2.3.3. Sustainable Real Estate

Sustainable real estate or green building is a building that, in its design, construction or operation, reduces or eliminates negative impacts, and can create positive impacts on our climate and natural environment. Green buildings preserve precious natural resources and improve our quality of life.

The proceeds of the Schuldschein will be used for investments in existing and new commercial buildings (more specifically the new headquarter of Creos Luxembourg and the new dispatching center of Creos Luxembourg), which meet at least the minimum requirements of DGNB<sup>2</sup> Gold.

### 2.3.4. Clean Transportation Solutions

Clean transportation is based on non-fossil fuel or hybrid technologies and supporting infrastructure, including improvements of the grid in order to prepare it for the connection and installation of electric vehicle charging stations.

## 2.4. PROJECT EVALUATION AND SELECTION

All projects financed and/or refinanced through the Green Schuldschein proceeds are evaluated and selected by a working group of representatives with the required level of expertise and seniority from Encevo, Enovos and Creos together with Group Finance and the CSR team.

This team of representatives from business, CSR and Group Finance will evaluate the nominated projects and assets in conjunction with potential environmental and social risks and ensure compliance with the green eligibility criteria of the Eligible Categories. The Eligible Projects and Assets must of course also be compliant with applicable national laws and regulations, as well as with internal policies and guidelines. A decision by the team is required to approve the Eligible Projects and Assets before any allocation of net proceeds. As per Encevo Group's internal policies, all projects above a threshold of 25 MEUR will require the additional approval of the Encevo Board of Directors. All decisions will be duly documented.

Where an investment involves the development, re-development or refurbishment of a property, grid or renewable installation, health, safety, environmental and social risks are monitored and mitigated before and during the performance of work in accordance with the Group's CSR policy.

<sup>2</sup> DGNB ("Deutsche Gesellschaft für Nachhaltiges Bauen" e.V. or German Sustainable Building Council) is the most recent green certificate to be developed and incorporates the latest research and understanding of sustainability issues. It aims to offer objective description and assessment of the sustainability of buildings and urban districts and to base assessment on the quality in use of the building or district, i.e. the overall performance of the property or area, over its entire life cycle, rather than on specific items.

To ensure legitimacy in this process a list of all eligible projects and assets that meet the green eligibility criteria will be kept by Encevo. This list shall be used as a tool to determine if there is a current or expected capacity to issue a Green Schuldschein.

For Category B “Energy Transmission, Distribution and Smart Grid Projects”, Encevo applies a pro rata approach to calculate the portion of the grid investments that are considered as “Eligible” using the portion of renewable energy transmitted through the grid.

In concrete terms, this means that each project has been evaluated individually in regards of being “Not Eligible”, “Partly Eligible” or even “Fully Eligible”.

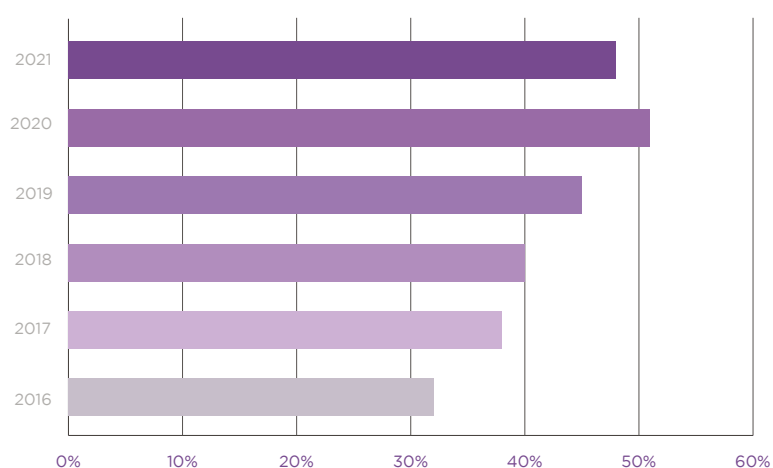
“Fully Eligible” has been applied for projects which have been realized, because of the receipt of a request to upgrade the grid in order to inject power from renewable energy plants, i.e. where an improvement, extension or reinforcement of the grid has been done with the primary purpose to integrate renewable energy systems into the grid.

The attribute “Partly Eligible” has been assigned to projects, where Encevo did not receive an explicit request to integrate a renewable energy system into the grid, but where investments have directly or indirectly a positive impact on the enhancement and extension of the grid in the sense of preparing the grid for the energy transition and supporting the transition this way. “Not Eligible” has been assigned to projects, where none of the criteria described before were applicable.

Projects categorized as “Not eligible” have been excluded, projects categorized as “Fully Eligible” have been multiplied by 1 (respectively by 100%) and projects categorized as “Partly Eligible” have been multiplied by a specifically derived ratio for the respective year (derivation is described in the following section):

- 2020: 51%
- 2021: 48%

For information purposes, past years ratios are shown in the graph below:



This ratio is determined for each year, where investments have been made in projects assigned to Category B, and shall reflect the renewable energy transmitted via that grid in which investments have been done. Hence, for the electricity grid of Creos Luxembourg<sup>3</sup>, there is a so-called “Home Production”, which is injected into the grid and consequently transmitted via this grid, and in addition the “Imports from Germany”.

<sup>3</sup> NB: Apart from a very small part, which can be neglected, the whole grid in Luxembourg belongs to Creos Luxembourg.

“Home Production” in Luxembourg can be divided into the following categories:

- Cogeneration
- Hydroelectric\*
- Wind\*
- Waste Incineration
- Biogas\*
- Photovoltaic\*
- Injections into third-party distribution networks

The energy mix of Germany (published by Agentur für Erneuerbare Energien e.V.), which has been used to derive the portion of renewable energy imported from Germany to Luxembourg is compounded as follows:

- Natural Gas
- Stone Coal
- Nuclear Energy
- Brown Coal
- Renewable Energy\* (sub-divided into Hydroelectric, Photovoltaic, Biomass, Wind (Offshore & Onshore))

By adding all categories marked with a “\*” and dividing this sum by the total amount of energy produced in Luxembourg and imported from Germany, Encevo obtains the aforementioned ratio, reflecting the portion of renewable energy transmitted via the electricity grid. This exercise has been repeated for each year, with the details being as follows:

	2020			2021		
	GWh	% - Eligible	GWh - Eligible	GWh	% - Eligible	GWh - Eligible
Imports from Germany	3784	44%	1668.7	3946.1	40%	1586.3
Home Production	1157.7	73%	841.9	1186.4	74%	872.2
Cogeneration	119.1	0%	0.0	117.2	0%	0.0
Hydroelectric	79.1	100%	79.1	92.9	100%	92.9
Wind	337.7	100%	337.7	308.1	100%	308.1
Waste Incineration	95.7	0%	0.0	93.3	0%	0.0
Biogas	272.2	100%	272.2	289.1	100%	289.1
Photovoltaic	152.9	100%	152.9	182.1	100%	182.1
Injections into third-party distribution networks	101	0%	0.0	103.7	0%	0.0
<b>TOTAL</b>	<b>4941.7</b>		<b>2510.6</b>	<b>5132.5</b>		<b>2458.5</b>
<b>TOTAL RATE - ELIGIBLE</b>		<b>51%</b>			<b>48%</b>	

## 2.5. MANAGEMENT OF PROCEEDS

The proceeds of the Green Schuldschein are or will be allocated exclusively for eligible projects and assets in Luxembourg in accordance with the use of proceeds criteria and evaluation and selection process described above. These projects can be newly built, existing, but can also include refurbishments.

Whilst any Green Schuldschein net proceeds remain unallocated, Encevo will hold the balance of net proceeds not yet allocated to eligible projects and assets in its internal cash pooling<sup>4</sup>. Unallocated proceeds will be subject to Encevo’s prudent liquidity management practices (in-line with existing corporate guidelines and policies) and deposited with several high-quality financial institutions in order to minimize counterparty risk.

<sup>4</sup> Purpose of the so-called „Zero-Balancing Cash Pool System“ is to optimize the liquidity management of the group through cash concentration in order to reduce external cash needs and hence improve net interest position. Therefore, the balances of the sub-accounts are automatically transferred (“pooled”) to the master account, held by the holding Encevo, at the end of each day, which shows the overall net cash position of the group. By means of this “cash pooling” the debit and credit balances on sub-accounts are offset against each other, which leads to the reduction of external cash needs and hence a reduction of interest expenses.

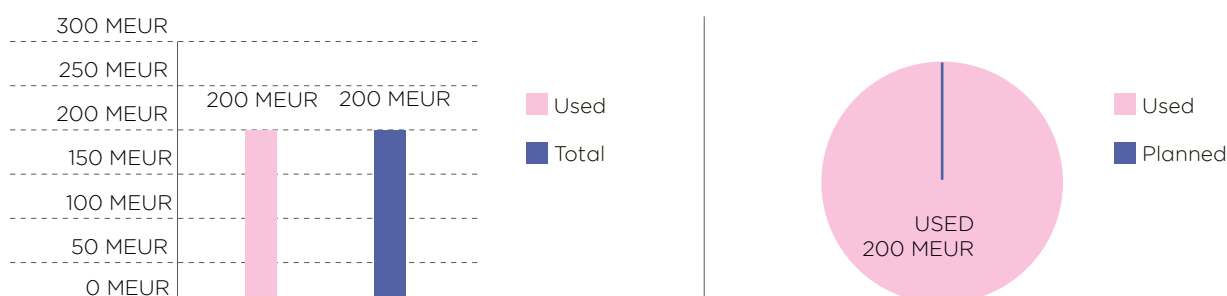
## 3. Reporting

Encevo S.A. will report annually, until full allocation, on the use of proceeds as well as on the positive environmental impacts (where feasible) resulting from the re-/financed projects via the Green Schuldschein Report, which will be published via <https://www.encevo.eu/en/accueil/financial-information>. This report is reviewed and assessed by Sustainalytics, an independent global provider of ESG (Environmental, Social and Governance) and corporate governance research and ratings.

### 3.1. ALLOCATION REPORT – ADVANCEMENT ON PROJECTS

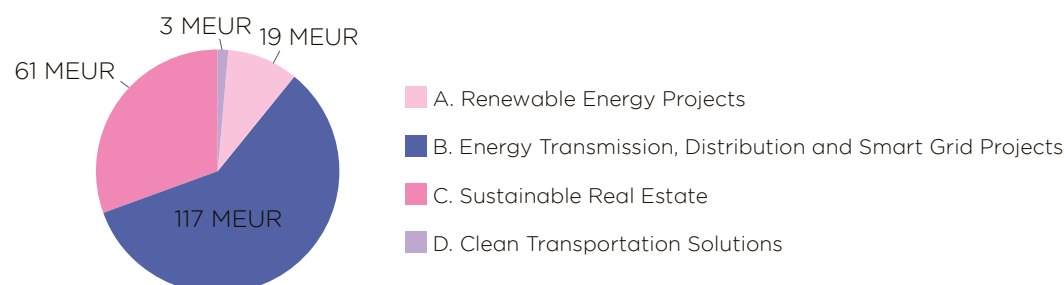
By the end of 2022, 100% of the total funds of 200 MEUR have been used. Of the 200 MEUR used, 58,5% have been allocated to Project Category B “Energy Transmission, Distribution and Smart Grid Projects”, 30,4% to Category C “Sustainable Real Estate”, 9,4% to Category A “Renewable Energy Projects” and the remaining 1,7% to Category D “Clean Transportation Solutions”.

#### PROCEEDS | USED/UNUSED | 2020 - 2022\*



\*For 2022, we have only considered the actual Capex spent for the finalization of Creos headquarters.

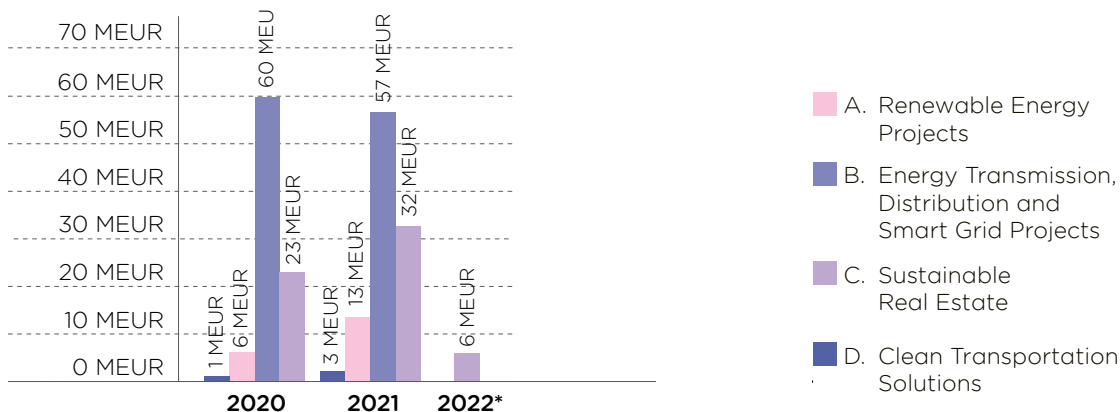
#### PROCEEDS | USED | 2020 - 2022\* | PER CATEGORY



\*For 2022, we have only considered the actual Capex spent for the finalization of Creos headquarters.



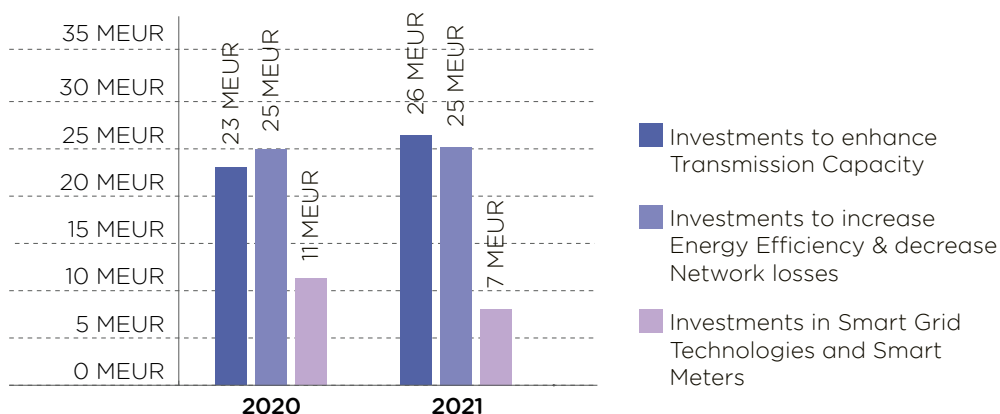
## PROCEEDS | USED/PLANNED | PER CATEGORY/YEAR



\*For 2022, we have only considered the actual Capex spent for the finalization of Creos headquarters.

As a major part of the funds were allocated to Category B "Energy Transmission, Distribution & Smart Grid Projects", further distinction into three sub-categories has been performed. For the development, construction and reconstruction of electricity networks, that enhance the transmission capacity for renewable energy, 49 MEUR have been invested until end of 2021; 50 MEUR were spent for investments in existing infrastructure to increase energy efficiency and decrease network losses and 18 MEUR have been invested into smart grid technologies and the installation of smart meters.

## PROCEEDS | CATEGORY B "ENERGY TRANSMISSION, DISTRIBUTION AND SMART GRID PROJECTS" | PER SUB-CATEGORY/YEAR



## 3.2. Impact Report

### 3.2.1. Overview & Metrics

#### A. RENEWABLE ENERGY PROJECTS

- Impact: Annual CO<sub>2</sub> emission reduction derived from Schuldschein allocation in renewable energy projects.
- Metrics: tons CO<sub>2</sub>/year. The calculation will be based on the electrical output of the financed renewable projects (reflecting the share of the SSD allocation on total CAPEX of the respective projects) multiplied by the CO<sub>2</sub> avoidance factor.

The CO<sub>2</sub> avoidance factor<sup>5</sup> is calculated assuming that the renewable energy generation substitutes conventional generation.

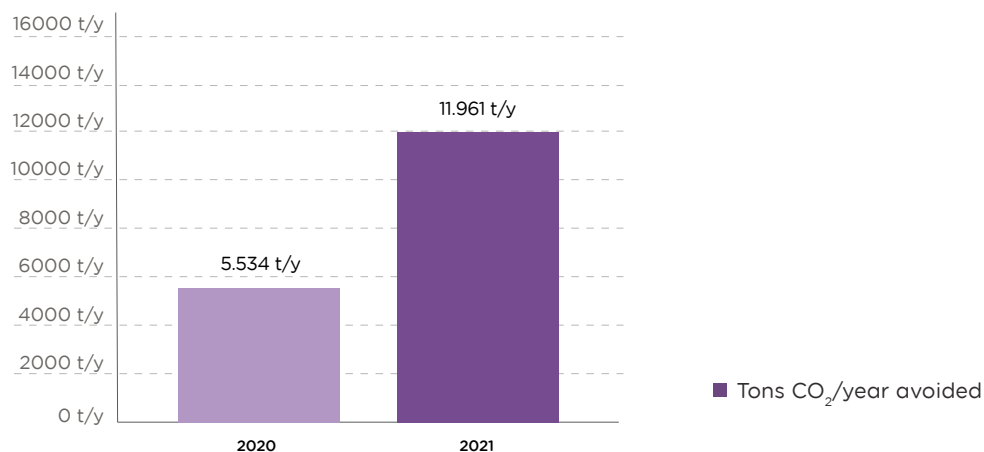
Country	CO <sub>2</sub> avoidance factor 2020 (g/kWh)	CO <sub>2</sub> avoidance factor 2021 (g/kWh)
Luxembourg (PV)*	408	405
Luxembourg (Wind)*	434	432
Belgium (PV)*	192	136
Belgium (Wind)*	221	165
NL (PV)*	537	640
Germany (PV)*	685	684

Sources:

\* Own calculation based on official publication of each country

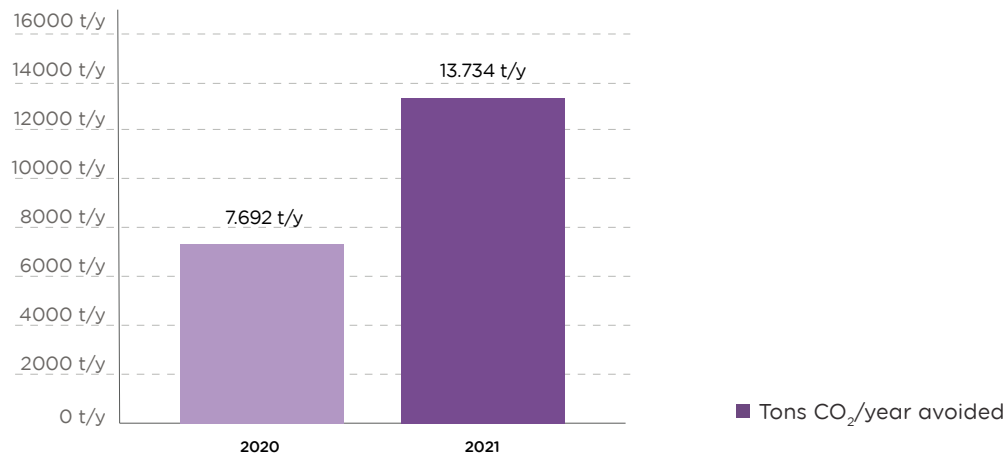
\*\* Germany: Federal Environmental Agency publication

<sup>5</sup>CO<sub>2</sub> avoidance factor= CO<sub>2</sub>eq for conventional energy generation - CO<sub>2</sub>eq lifecycle renewable energy generation (country wise calculation) (For Germany the CO<sub>2</sub> avoidance factor is extracted from the annual report published by Federal Environmental Agency)



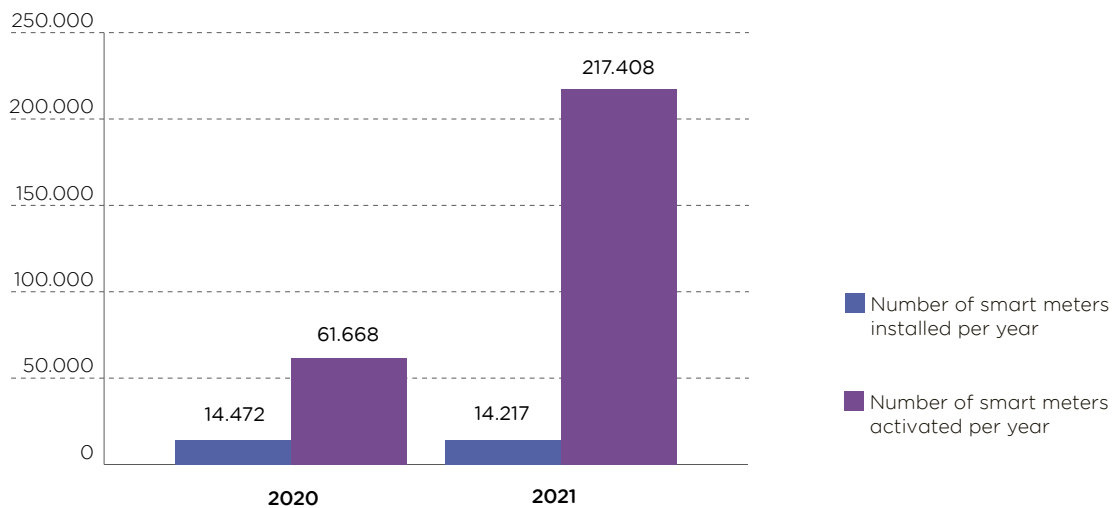
The above graph is showing the CO<sub>2</sub> emissions of the projects financed by 2021 proceeds.

The below graph is including on top the CO<sub>2</sub> emissions reduction of the projects financed with the previous Schuldschein proceeds for the years 2020 and 2021.



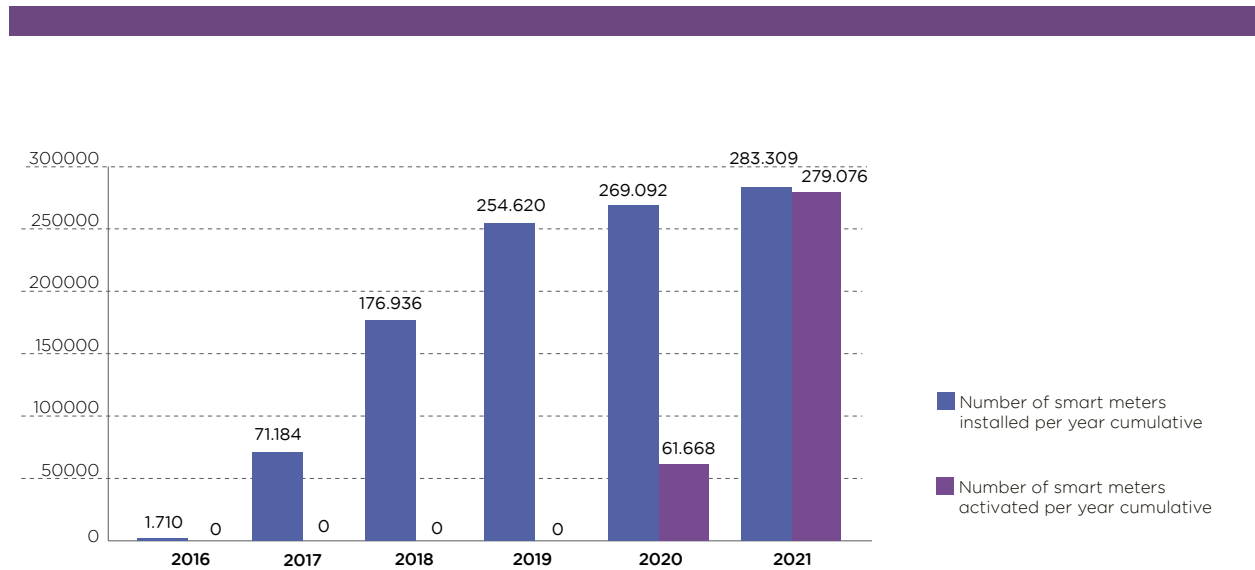
## B. ENERGY TRANSMISSION, DISTRIBUTION AND SMART GRID PROJECTS

- The number of smart grid components installed and the number of smart meters activated (smart meters, smart stations etc.)



As this project started already in the past and the investments done during 2016-2019 were financed with proceeds of the previous Schuldschein, here below a graph presenting cumulative figures of the smart meters installed / activated during this period.



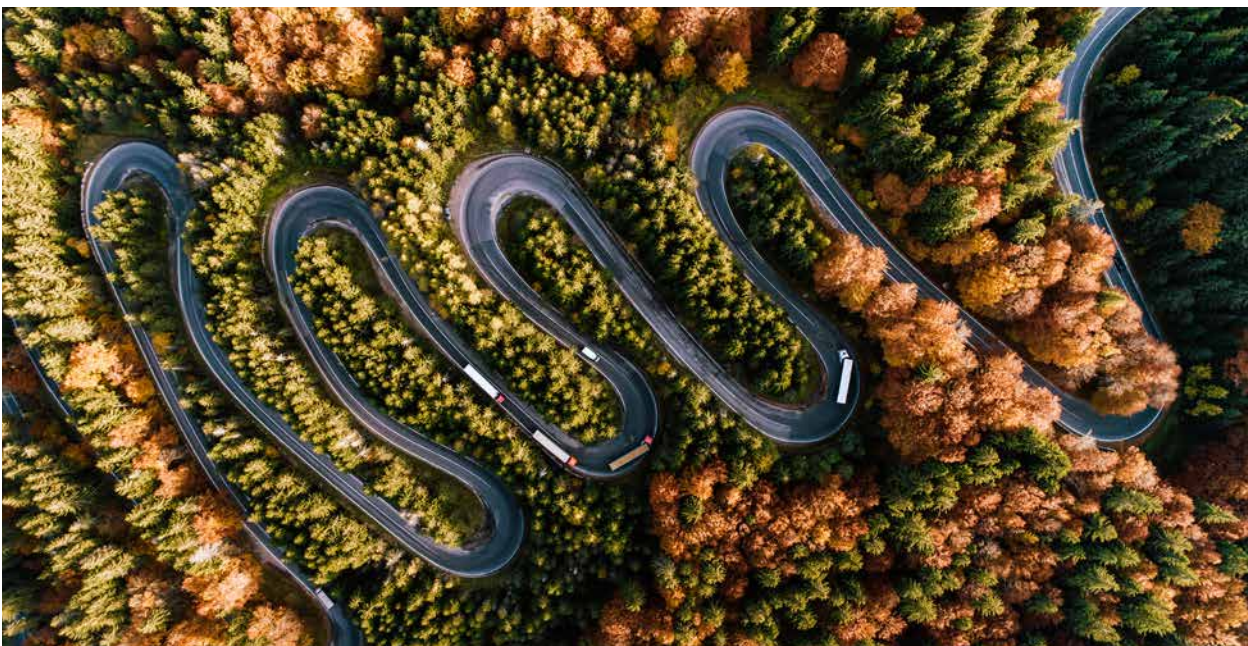


By the end of 2021, a total number of 283.309 electricity smart meters were installed (financed by this current Schuldschein and the previous one), out of which 279.076 were activated. During 2021, Creos focused a lot on the improvement of the communication quality of these smart meters. At the end of 2021, the data collection rate for the load curves exceeded 98%.

### C. SUSTAINABLE REAL ESTATE

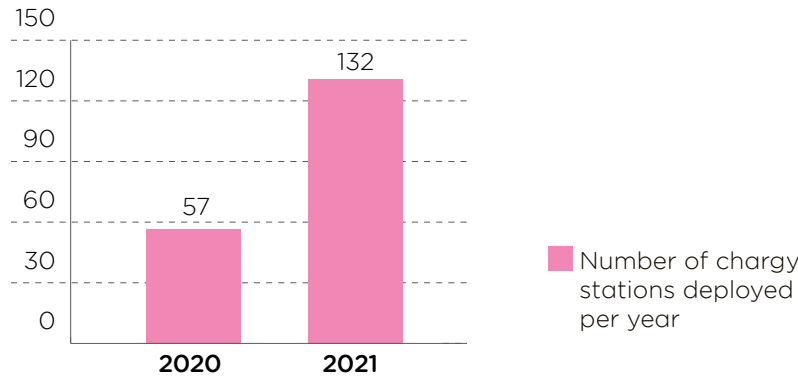
- The certificates regarding energy efficiency of the new buildings.

See section “3.2.2 Selected Projects” under paragraph „REAL ESTATE“.

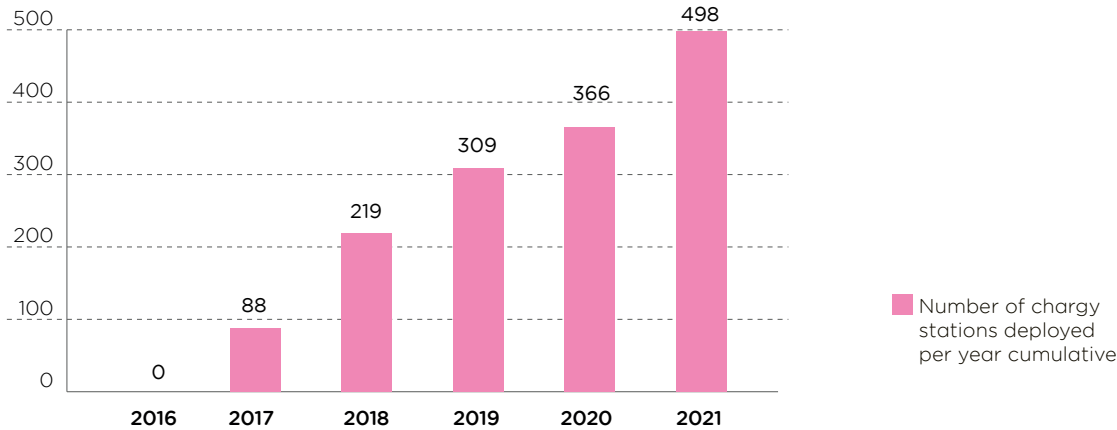


**D. CLEAN TRANSPORTATION SOLUTIONS**

- Number of charging stations provided with access to the grid.



As this project started already in the past and the investments done during 2016-2019 were financed via the previous Schuldschein, here below a graph representing the cumulative number of the charging stations installed during this period.



By the end of 2021, a total number of 498 charging stations were installed.

### 3.2.2. Selected Projects

#### 3.2.2.1. RENEWABLE ENERGY PROJECTS

##### Luxembourg - Soler

Soler ("Société Luxembourgeoise des Energies Renouvelables S.A.") created in 2001 with 50% of its shares held by Enovos Luxembourg S.A. and 50% by SEO, is responsible for the project development, the planning, the construction, and the operation of renewable electricity generating plants. In addition to the operation of several small hydro plants, Soler is actually the initiator and operator of 8 wind parks in Luxembourg. Since the commissioning of 15 windmills in 2016, as of end of 2021, Soler operates 31 windmills in total with a total capacity of 80,2 MW.

The wind project development activities of Soler S.A. continue to prosper. In 2021 the construction of 7 new wind turbines (of which 5 are repowering projects) was initiated, with planned commissioning date before the end of 2022. The total capacity will be increased to 109,6 MW. In addition, a strong project pipeline of 246 MW was developed, and the focus will be to advance those projects for commissioning in the period between 2023 and 2025.

NB: After 2019 no new capital increase has been performed and all new projects were financed by bank loans. (i.e., this project was not financed by 2021 Schuldschein proceeds).

##### Luxembourg - PV Projects

Following 4 European-wide calls for tender for photovoltaic installations, organized by the Luxembourg Government between 2018 and 2021, 27 solar power projects for a total of 40,5 MWp were awarded a Feed-in-Premium. By the end of 2021 the first 17 projects with a capacity of 28,6 MWp out of this project pool were constructed and successfully commissioned. Out of these, 15 projects with a capacity of 27.6 MWp were financed by the proceeds of this Schuldschein (8 projects fully financed and 7 projects partially financed via the Schuldschein). Other 4 projects for a total capacity of 5,4 MWp have been added during 2022. In 2023 the remaining projects with a capacity of 6,5 MWp are scheduled to be built. All these photovoltaic plants comprise large ground-mounted installations, rooftop installations, carports and also one floating installation of 3 MWp. A number of these projects were developed in collaboration with strategic partners.

In addition, a pipeline of more than 100 MWp has been steadily developed and potential opportunities of more than 300 MWp are continuously pursued to support further PV growth in Luxembourg. Agri PV projects will also be added to the focus of the development team supported by the launch of the first national call for tender for this technology in Luxembourg in 2023.





*Floating PV Differdingen*

### Ground mounted PV installations



*PV plant Car park Colmar-Berg*



*PV plant Beidweiler*



*PV plant Junglinster*

### Belgium - Wind Projects

Enovos Green Power developed a wind project of 15 MW in Belgium and participated in the SPV at 40% shareholding, equity that was financed with the proceeds of current Schuldschein. Construction works have started in 2022 and are still on-going. Commissioning is planned in July 2023 (no impact for the time being in the emission reduction metrics).

### Netherlands - PV Projects

Enovos Green Power constructed/acquired 4 MWp PV installations in 2020 and 5,8 MWp in 2021 to reach a total capacity of 15.3 MWp as of 2021. Most of these projects were financed with the proceeds of the current Schuldschein.

Enovos Green Power continued its growth in the Netherlands with the construction of 2.3 MWp PV installations in 2022 and further 19MWp, where construction started in 2022, will be finalized in the first months of 2023 to reach a total capacity of 36.6 MWp as of Q1 2023.



*PV plant De Vlaas*



## Germany PV Projects

In 2020 and 2021 two solar power projects for a total of 22,7 MWp won a tender for a Feed-in-Tariff by the German Government. The projects, both in Rhineland-Palatinate were developed, built, and commissioned in 2020 and 2021.

The construction phase of the first photovoltaic plant Lauperath started in February 2021 and has been finished successfully in May of the same year. The photovoltaic plant was commissioned with a total capacity of 8 MWp in June 2021.

In October 2021 the construction of the photovoltaic park in Leiwen started and has successfully been finished and commissioned with total capacity of 11,3 MWp in March 2022. The construction of a third park with a capacity of ca. 3,4 MWp will start in 2023.

The equity injected in these 2 projects was financed by the Schuldschein proceeds.

As outlook for the near future, the project Südeifel is to be mentioned. In 2021 the construction of the first out of 11 planned photovoltaic parks with a total planned capacity of ca. 200 MWp in Rhineland-Palatinate & Saarland started. In 2022 the construction of another three parks and the ca. 30 km long cable way started. For the project there will be an own transformer substation wherefore the permission process started in 2022. The commissioning of all 11 parks is planned for the end of 2024.



*PV plant Lauperath*



### 3.2.2.2. SUSTAINABLE REAL ESTATE

#### New Creos headquarters - Luxembourg (Merl)

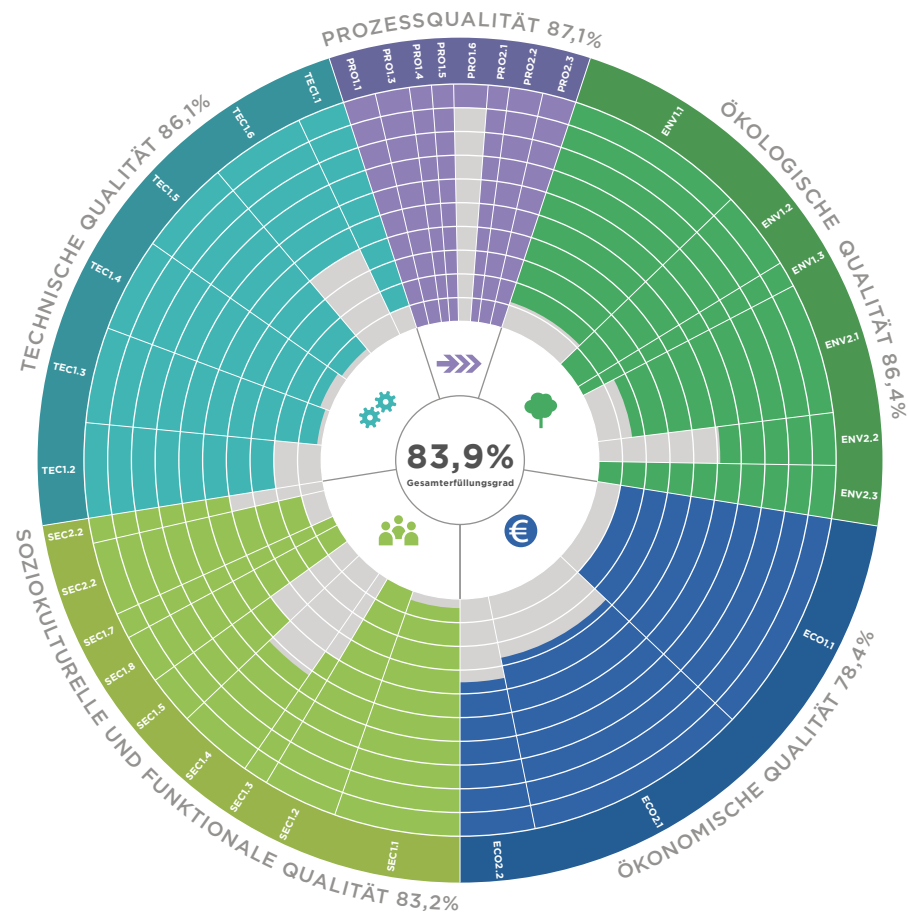
November 2021 has seen the opening of Creos Luxembourg's new headquarters in Luxembourg City, construction of which began in June 2017. The building can accommodate a total of +/- 400 employees. The site consists of a 15,300 m<sup>2</sup> administrative building with +/-300 parking spaces with more than 170 charging points for e-vehicles and 4000 m<sup>2</sup> of space for the Luxembourg City Regional Centre. The buildings meet the highest reference in terms of energy efficiency, which is made possible by the innovative system hydraulics (dynamic system) and the intelligent building control system; thus, the energy certificate of the building certifies class BBB = low energy standard and it is planned to obtain "Platinum" for this building according to the DGNB certification requirements.

At the moment we have received a so-called "pre-certificate" (see below). The final certificate will be obtained after the completion of the orderly commissioning phase, the aim of which is to transfer the completed building into orderly operation in the short term, to minimise risks and to profit economically as quickly as possible.

The buildings are centrally managed with a system that controls key parameters such as temperature, lighting, shading, humidity and security, and the combined heating/cooling ceilings in the offices use the principle of radiant cooling/heating that allows for a comfortable, even temperature distribution. The complex also has a wood pellet boiler for environmentally friendly heating, a condensing boiler to cover peak demand and 2 photovoltaic systems with an output of around 244 kWp (kilowatt peak).



Building Merl



Pre-Certificate "Platin" according to DGNB

## New Dispatching Center Creos - Bettembourg

In 2018, Creos Luxembourg started the construction of its new Dispatching center in Bettembourg. The new building opened its doors to employees in September 2020. The Dispatching center covers an area of +/- 3.000 sqm, offers workspace for more than 60 employees and the latest state-of-the-art technology to best support the core business of Creos, the Dispatching for electricity and gas. The site is located next to a Tier IV datacenter and will thus benefit from the secured network of the latter as well as from its technical networks with respect to heating, cooling and energy supply. We have obtained “Gold” for this building according to the DGNB certification requirements. The energy pass class is ABA.

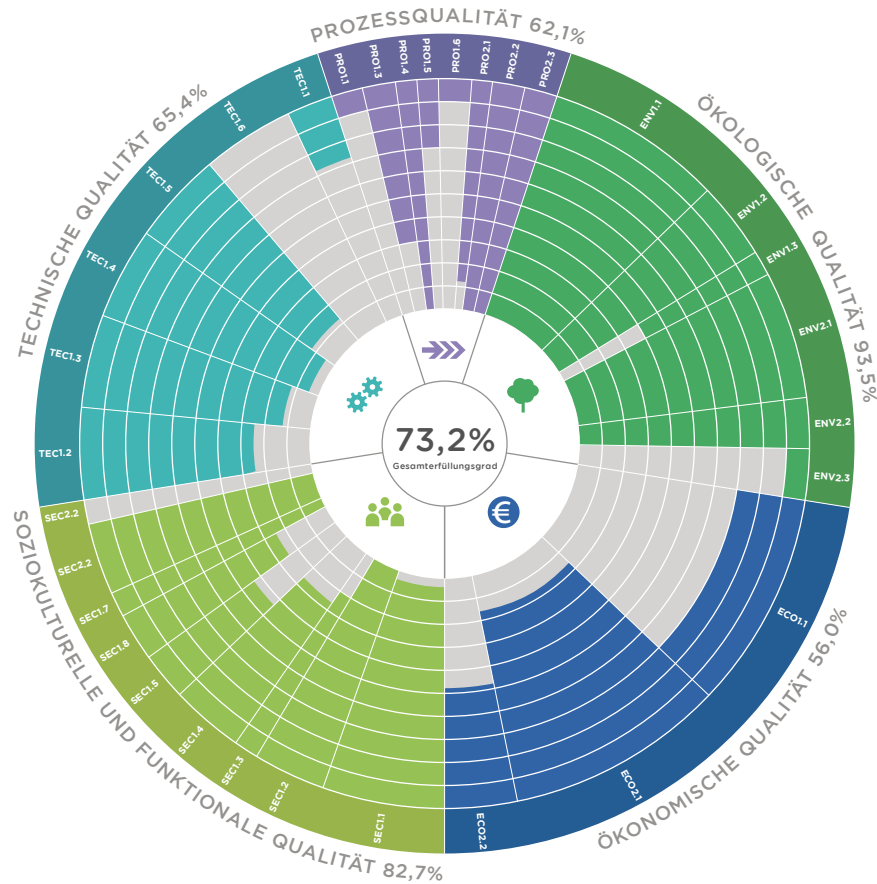


*Building Bettembourg*



*Building Bettembourg inside view*





Certificate "Gold" according to DGNB

NB: The construction of these two buildings was financed with the proceeds of the current, but also of the previous Schuldschein (representing a total of 97 MEUR at end of 2022, out of which 36 MEUR via the previous Schuldschein respectively 61 MEUR via the current Schuldschein)



### 3.2.2.3. ENERGY TRANSMISSION, DISTRIBUTION & SMART GRID PROJECTS

The electricity grid is one of the key pillars of a modern society, as it supplies all citizens with electricity. Hence, both the transport and the distribution grids play an essential role in the energy transition.

The transportation grid respectively the Transmission System Operators (TSOs) play a vital role in transporting energy to the distribution grids respectively the Distribution System Operators (DSOs), and thus to the end consumers. Before the start of the energy transition, electricity was only produced and injected at high voltage levels (HV), and then transported to local lower voltage grids (65 kV). Thus, electricity has been transported via 220 kV grids from production to consumption.

Nowadays, with more and more power being produced by wind and solar locally at 400 V (LV), 20 kV (MV) and 65 kV (HV), TSO and DSO grids are more and more constrained to route the power from more production intense areas (i.e. North of Luxembourg) to more consumption intense areas (South and Centre of Luxembourg). In the coming years, in order to increase the capacities of the grid, we will switch from 220 kV to 380 kV in order to allow for more renewable import, as well as from 65 kV to 110 kV in order to allow for more renewable energy production to be installed in Luxembourg

DSOs will become one of the core components in the energy transition and are essential to achieve the EU objectives for 2030 and beyond. Decarbonization, decentralization and digitalization will change the roles and responsibilities of the DSOs. The energy transition has started and is moving fast. By 2030, the European power sector will look very different compared to today:

- More than half of all electricity is expected to come from renewable assets. Due to an ever-increasing share of variable renewable energy generation, which will be injected into the distribution network, DSOs will be facing more complex grid operations.
- Due to the switch of mobility and heating from fossil fuels to renewable electricity, as well as an ever-increasing share of renewable energy production in the low voltage grids, the grids need to be massively reinforced at DSO level
- The recently agreed legislation concerning transport will bring more than 40 million electric cars onto the road in the same period<sup>6</sup>.
- Due to the ongoing development of micro-grids, Citizens' Energy Communities (CEC) and other new forms of consumption, production, storage and distribution, a continuing development of smart grids is required.
- The roll out of smart meters as well as the related smart meter data and analytics will allow private and industrial customers to go for smart energy efficiency solutions, while DSOs will become data operators.
- The digitalization of the infrastructure involves predictive maintenance of the grid, live monitoring and self-healing capabilities. All this will help to reduce electrical losses. But first significant investments in advanced sensors are required as well as protections to control voltage and frequency in order to stabilize and enhance the network.

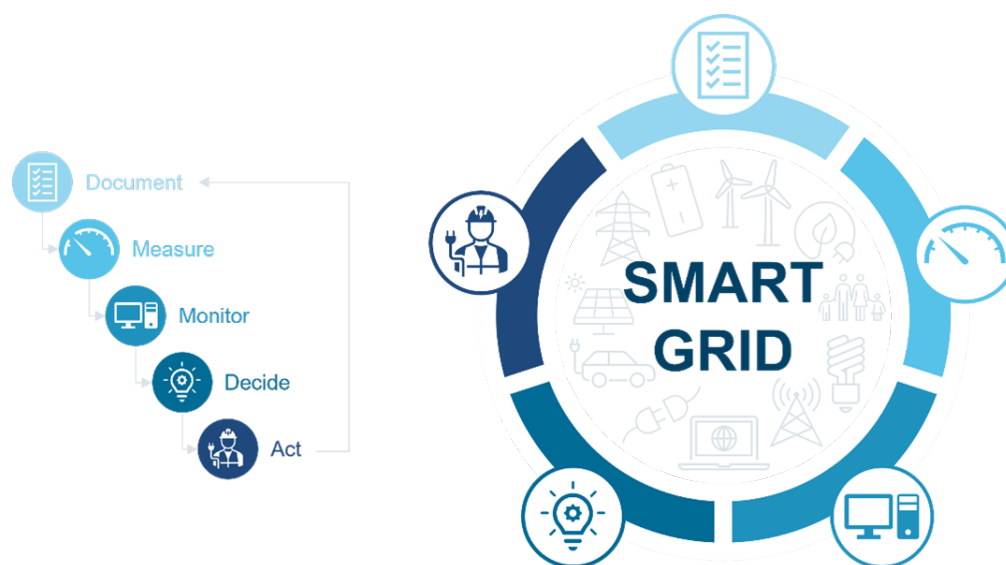
DSOs will be key players in this future system, which will be increasingly decentralized and interactive. This change will require substantial additional investments in the grid.

### Creos Luxembourg's Smart Grid Vision

To be able to cope with increasing requirements on the distribution grids, due to rising decentral production capacities and an increasing consumption load resulting from the installation of heat pumps and electric vehicle chargers, the lower and medium voltage grids (400 V and 20 kV) need to become "smarter" and allow active operation as it is already available on the higher voltage levels. A Smart Grid will allow the deferral of large-scale grid reinforcements and help the company to financially optimize grid planning by efficiently using existing grid assets.

<sup>6</sup> European Commission's Long-Term Strategy A Clean Planet for all, 2018

In order to coordinate ongoing and upcoming efforts in the deployment of smart technologies and software tools, Creos has set up in 2021 a “Smart Grid Vision 2030” based on five pillars: Document, Measure, Monitor, Decide and Act. Each pillar aligns multiple projects that in their ensemble will help us reach our goal of an intelligent and actively operated grid infrastructure on all voltage levels. The following paragraphs will highlight selected projects from each pillar and started in 2021.



*Smart Grid Vision by Creos Luxembourg S.A.*

## Document

The grid infrastructure needs to be correctly digitally documented in Geospatial Information System (GIS) to allow synchronisation with various software tools that provide load flow calculations. Efforts have been increased to enhance the quality of the current documentation by prioritizing selected localities and error categories. This course of action permits to fully test Creos’ software tool developments in certain regions and proceed locally with power flow calculations until a countrywide assessment can be achieved.

Additionally, the scope definition of an application to help digitize the process and support the electricians during the installation of charging stations and photovoltaic installations has been completed in 2021. This application named “Smarty Pro” was released end of 2022, accompanied with adequate training of the installers.

## Measure

In July 2021 Creos, in collaboration with the four other Luxembourgish DSOs and Nexxtlab S.A., has launched the Smarty+ Dongle on the market. Accompanied by an application with the same name, this device allows the low-voltage customers to consult their Smart Meter data in real-time and share them with their distribution system operator. More than 500 dongles have been sold in the first five months. The efforts of 2022 will be focused on offering an increased number of functionalities to our clients and providing them additional features offered by service providers that will be able to join the open Smarty+ marketplace.

As the sharing of data through Smarty+ is voluntary, Creos started in 2021 to define an additional strategy on how to collect real-time data from the low-voltage grid, essential for future active grid operation. The products of various suppliers of equipment for low-voltage feeder measurements have been compared from a hardware and software point of view. Four manufacturers have been selected for a pilot project and installation of the devices started in 2022.



Smarty+ Dongle

## Monitor

Creos' Smart Grid Vision foresees monitoring on three different time horizons: the past, intraday with day ahead prognosis, and a more distant future. Monitoring capabilities on higher voltage levels are already more established due to past requirements and the energy transition has now put the focus on the 400 V level. From 2020 on Creos has focussed on the development of different software tools, each one acting in their specific time frame completing a concise mission: "Grid map" for voltage error analysis, "Digsilent" for an ex-post analysis of the grid and grid planning, "Alva" as a more operational tool and "Grid scope" for long-term scenario simulations.

## Decide

The aim of the developed monitoring tools is to detect congestion and voltage issues that may impact the quality of supply of the customers. In return, a remedy needs to be found to avoid negative consequences. Future issues and past problems should be resolved either via the planification of grid reinforcements or the use of alternative flexible solutions like grid or customer flexibility, which will play an increasingly important role in the future planning process. In the daily operations, possible solutions, i.e., grid reconfigurations or load shedding, would ideally be suggested automatically by the respective tool.

## Act

The last pillar encompasses the implementation of a previous decision. Preferably, any solution could be activated remotely. Through the relays on the Smart Meter, to which charging stations and photovoltaic installations need to be connected to, the grid operator can require a load reduction of the connected devices. As this should only serve as emergency solution to avoid blackouts, Creos is currently investing in the set-up of grid flexibilities, that can be accessed without compromising the comfort of the customer. Therefore, it has been decided in 2021 to start a pilot project to test the utility of voltage regulating distribution transformers (VRDT) and one manufacturer has been chosen. Seven VRDTs will be installed over the course of 2022 in several different locations, selected based on installed capacity of photovoltaic installations and electric vehicle chargers.



Smart meter

## Smart Grid & Smart Meters

Based on the European Directive that was translated into Luxembourgish law in 2016, the Luxembourgish DSOs started to deploy smart meters. Intelligent metering is the starting point toward a better balanced and utilized energy market. It allows the introduction of more flexible electricity tariffs which are better adapted to the market's behavior. In addition, it will give the grid operators some insights into their low voltage networks to allow them to know exactly when and where how much energy has been consumed / produced. Based on information from the past the DSOs can identify weak points and realize forecasts to manage their grids more efficiently and avoid congestion.

By the end of 2021, most of the smart meters have been deployed. At that time Creos had installed 283.309 electricity smart meters (97,8%). During 2021, Creos focused a lot on the improvement of the communication quality of these smart meters. At the end of 2021, the data collection rate for the load curves exceeded 98%.

>97% smart meters deployed



>98% smart meters activated

>98% smart meters collected on a daily basis

98% smart meters load profiles transferred to Creos

98% smart meters data transmitted to supplier

Smart Metering; Data Flow - 31/12/2021

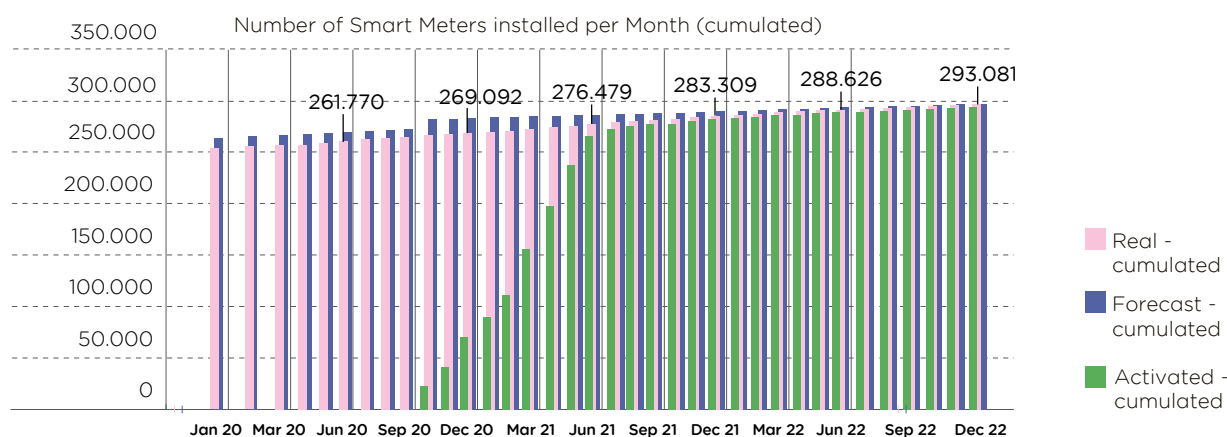
The high meter reading rates allowed Creos to fully activate in the market almost all of their installed smart meters meaning that the load curves are transferred each day from Luxmetering to Creos and from Creos to the suppliers. Thanks to the 15min values the DSOs and suppliers could offer more flexible tariffs, "time of use"-tariffs and the calculation of energy communities can be performed in the future.



With this huge amount of data that is transferred each day between Luxmetering, Creos and the energy suppliers, there was a strong need to install some solid monitoring tools. These tools allow Creos' operators to monitor the data flow between the different actors and to intervene in case of issues. This monitoring function was the first use case of the Creos data platform project which has the goal to become an intranet of energy platform over the next years.

Thanks to the high readings, Creos will be able use the smart meter network for other purposes than data collection as for example the actioning of relays connected to electrical charging stations or production units.

In the years 2020 to 2021, Creos Luxembourg managed the installation of 28.689 smart meters (cumulative 283.309 smart meters as of end of 2021) and as of end of 2021, 279.076 were activated.



## Fiber Optics at the Heart of Smart Networks

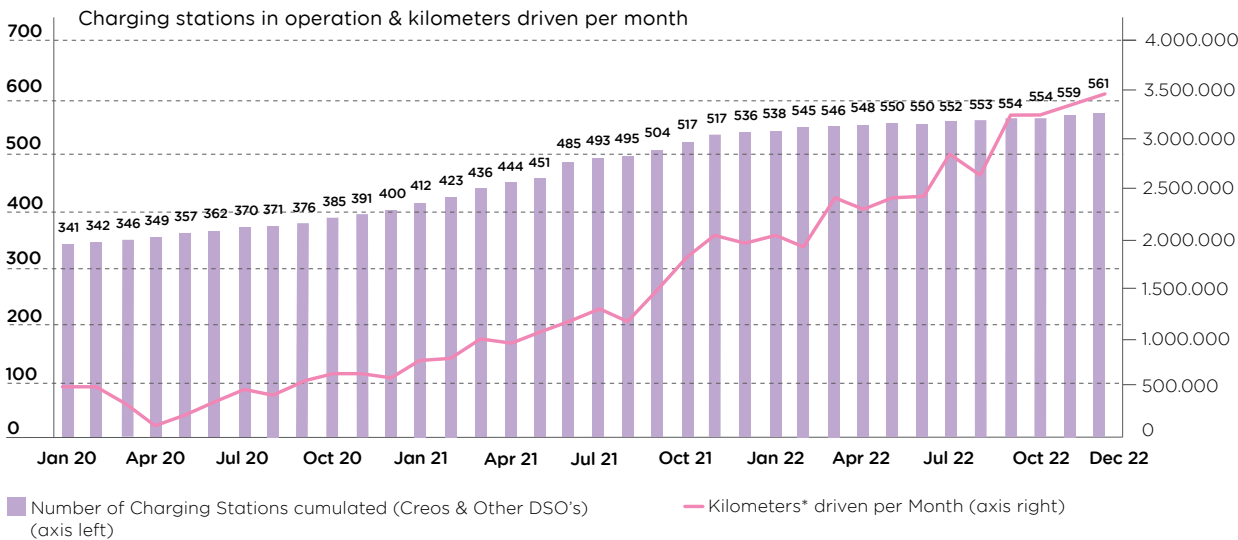
In the context of smart grids and with regard to significant innovations, the implementation of the so-called "TETRA" (Terrestrial Trunked Radio) network should be mentioned. It is a digital mobile radio system, to be used by field staff to coordinate and execute works on the grids and especially for urgent incidents. As the system is very resilient, it will also be used for communication in crises respectively when the public telecommunication system is not available. The system relies on 60 base stations, scattered across the country and connected to the fiber optic network, and runs autonomously up to 72 hours, even during blackouts. Moreover, TETRA provides the opportunity to connect all medium-voltage stations in order to backhaul information from these stations in real time to the SCADA system which is used to manage the electricity grid. Thus, it facilitates decision making for the operator; and in case where substations are controlled remotely, outage times can be substantially reduced.

The Communication Infrastructure Department uses 4 technologies to achieve the smart grid objective: TETRA, fiber optics, DSL modems together with a dedicated copper network in the city of Luxembourg, or 4G routers, for the rest of the country, in case no other technology is working. Around 20% of the medium-voltage stations (1206 stations) have been interconnected by 2022. It is expected to interconnect +/- 300 stations per year in the future, by using the above-mentioned technologies.

By the end of 2023, all analogue phone lines will be replaced by fiber optic connectivity.

3.2.2.4. CLEAN TRANSPORTATION SOLUTIONS

From 2017 until 2021, 536 smart charging stations and 8 SuperCharge stations (=DC station) for electric cars have been installed throughout Luxembourg, whereof Creos Luxembourg deployed 490 (91%) charging stations and other DSOs the remainder. The ultimate goal is to have 710 AC charging stations available by 2023/2024 for electric cars and hybrid plug-in vehicles in Luxembourg, with Creos Luxembourg as the key player, who will implement more than 90% of all stations. These charging stations will be supplied with 100% renewable energy. Each AC charging station includes 2 charging points and each DC station 1 charging point, so the network will finally offer 1.510 parking spaces reserved for electric vehicles.



\* calculation based on an assumed average consumption of 20 kWh/100km

## Chargy Deployment Program (Creos Luxembourg & other DSOs)

Out of the total of 710 AC charging stations 310 will be installed at park & ride car parks and 400 in public municipal car parks. Every municipality in the country will have at least one charging station. The total number of stations for each municipality will vary depending on the number of inhabitants and the number of jobs in each area. The AC stations will always be installed near local points of interest, such as business parks, educational establishments, tourist, cultural or sporting attractions, shops, town halls or council offices.

More DC charging stations will be installed on Highways and major traffic corridors: 16 locations have been selected. By the end of the year 2022, a total of 32 SuperChargy had been installed.

NB: As 70% of the costs for all the public charging stations (AC and DC) have been subsidized in 2023 by the Luxembourg State, we have considered only 30% of the total expenses as being financed by the proceeds of this Schuldschein.



Chargy and Super Chargy Stations

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