ENVIRONMENTAL PRODUCT DECLARATION OF NUREL S.A. NYLON 6 YARNS

Compliant with ISO 14025

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Global scope

EPD®
THE INTERNATIONAL EPD® SYSTEM

NUREL

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1. Information about the programme.

This Environmental Product Declaration is developed under a Product Category Rule from the following programme:

Programme name:
The International EPD® System

Programme operator: **EPD International AB.**

Address of programme operator:
EPD International AB, Box 210 60,
SE-100 31 Stockholm, Sweden, E-mail: info@environdec.com

The sole responsibility for this DAP lies with the holder, as its owner.

The programme verifier and operator do not issue any opinion nor are they responsible for the legality of the product.

2. Verification.

Product Category Rule (PCR):
PCR 2013:12 Textile yarn and thread of natural fibres, man-made filaments or staple fibres, version 2.1.
- Date of publication: 2019-01-08
- Valid until: 2021-08-01

The review of the EPD was directed by:
The International EPD® System Technical Committee.
President: Barbara Nebel.
Contact: info@environdec.com

Conformity to standards:
General Programme Instruction of the International EPD® System, version 2.5, based on ISO 14025 and ISO 14040/14044.

Independent verification of the declaration and data, in accordance with ISO 14025
☐ EPD certifying process.
■ EPD verification

Third-party verification:
Centro Tecnológico Miranda de Ebro (CTME)
Auditor: Eva Martínez

Accredited by: The International EPD® System.

Geographical scope of application of the EPD: global.

Reference year of data used in the EPD: 2018.

Reference to useful websites to obtain further information:
https://www.environdec.com; https://nurel.com

3. Information on the EPD holder company.

- Company name: **NUREL, S.A.**
- Issuer and contact data: **NUREL, S.A., Mr. José Carlos Martín**
- Address: **Ctra. Barcelona, km 329, 50016 Zaragoza (Spain)**
- Teléfono: **+34 976 465 579**
- Production centre: **Ctra. Barcelona, km 329, 50016 Zaragoza (Spain)**
- Production country: **Spain**

NUREL began producing polyamide fibre in 1968 and in 1999 it was purchased by the **SAMCA group** . The entry of **SAMCA** brought successive investments in the area of polymerization and new spinning facilities. Thanks to this and to the security of belonging to a solid industrial group, **NUREL** has become a global lead supplier of Nylon 6 and 66.

NUREL's production plant in Zaragoza (Spain) is organised in three different business units: ENGINEERING POLYMERS, BIOPOLYMERS and SYNTHETIC FIBRES, with an overall turnover of 80 million Euros, a polymerisation capacity of 27,000 tons, 14,000 tons of compounds and a yarn production capacity of 7,500 tons. NUREL currently employs 350 people.

Around 75% of its production is exported to the main European and Asian markets.

NUREL, has **2 polymerization lines**, 2 compounding lines, a recycling line, **2 nylon spinning plants** and cutting-edge **draw-warping** facilities that allow it to offer a range of products for underwear, swimwear, sportswear and technical applications, that is unique in the market, capable of meeting the needs of the most demanding customers.

Our production of polymers and Nylon fibres is totally integrated.The level of excellence of our products comes from our in-depth knowledge of the chemistry of polymers, our expertise in spinning synthetic fibres and our mastery of draw-warping techniques.

NUREL's goal is to achieve sustainable economic growth that is responsible with the environment and with its surroundings.

NUREL's production processes are defined in accordance with its Health, Safety and Environmental Protection policy. These are top priorities for NUREL over and above any other objective.

In line with its commitment to quality NUREL, S.A. has **ISO 9001, 14001 and ISO 50001** certification.

NUREL is committed to enhancing the sustainability of all of its products and processes, by carrying out cradle-to-gate **analyses of the impacts** of all its products, initiating life cycle assessments. These LCA allow the **environmental impacts of similar products and processes** to be compared.

NUREL recycles and recovers most of the hazardous chemical substances generated, thus reducing the impact on the environment. Its plant in Zaragoza is designed to recover and recycle a large part of the waste itself.

4. Information on the company drafting the life cycle assessment and EPD.

The Life Cycle Assessment study and Environmental Product Declaration have been prepared by Abaleo S.L. whose contact person is:

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- jlcanga@abaleo.es
- info@abaleo.es

5. Product information.

5.1. Product specification.

- Trade name: **Nurel, S.A. Nylon 6 yarns**
- This EPD includes the manufacture of nylon 6 yarns, analysing the extremes of the range of yarns in terms of proportion of titanium oxide and sizing (represented by 33/28/UM yarn and 44/34/BR yarn), their packaging and type of medium.
- CPC code: **2642**.
- The yarns are envisaged for use in the textile industry.

Technical description of the product:

Information	Explanation	Explanation	Test methods
Commercial article description	33/28/UM	44/34/BR	
Composition	100% Nylon 100% basic polymer	100% Nylon 100% basic polymer	ISO 2076:2010/EN ISO 1043-1:2011
Type of fibre	Filament yarn	Filament yarn	ISO 8159: 1987
Type of processing	Partially Oriented Yarn Spinning (POY)	Partially Oriented Yarn Spinning (POY)	BISFA
Intended Use	Textil	Textil	-
Properties	Count(dtex)	Count (dtex)	ISO 2060:1994
	Tenacity at break (CN/Tex)	Tenacity at break (CN/Tex)	ISO 2062:2009
	Elongation (%)	Elongation (%)	ISO 2062:2009
	Shrinkage (%)	Shrinkage (%)	ISO 2062:2009
	Filament number of the final product	Filament number of the final product	Not applicable
Other properties	White or coloured yarn	White or coloured yarn	Not applicable

5.2. Content declaration of materials and chemical substances.

The materials contained in the yarns studied (extremes of the range given their proportion of titanium oxide and sizing) are as follows:

33/28/UM Yarn	% by weight	% recycled material	% recycled waste		Remarks
			Pre-consumer	Post-consumer	
Main material: Nylon 6	99,52%	0	0	0	-
Pigments and dyes	-	-	-	-	-
Sizings	0,48%	-	-	-	-
Water	-	-	-	-	-
Total	**100%**	**-**	**-**	**-**	**-**

44/34/BR Yarn	% by weight	% recycled material	% recycled waste		Remarks
			Pre-consumer	Post-consumer	
Main material: Nylon 6	99,52%	0	0	0	-
Pigments and dyes	-	-	-	-	-
Sizings	0,48%	-	-	-	-
Water	-	-	-	-	-
Total	**100%**	**-**	**-**	**-**	**-**

There are no recycled material contents in the yarns that are the subject of this EPD.

The yarns do not have any type of pigment or dye.

During the lifecycle of the yarns, hazardous substances listed on the "Candidate List of Substances of Very High Concern (SVHC) for authorisation" are not used in a percentage greater than 0.1% of product weight.

5.3. Declared unit.

The declared unit is 1 kg of yarn for textile use, including the corresponding part of the packaging and type of medium.

5.4. Units and quantities.

The units required by the PCR are used. Decimals are indicated with commas, in IS style (French version); for example, 2.156,234.

6. Scope of the EPD

6.1. Geographical scope of the EPD.

The geographical scope of the EPD is global. All of the product manufactured at **NUREL, S.A**. facilities, in Zaragoza (Spain) is valid for sale in any part of the the world.

6.2. Comparison between EPDs of this product category.

EPDs within the same product category, from different programmes, may not be comparable.

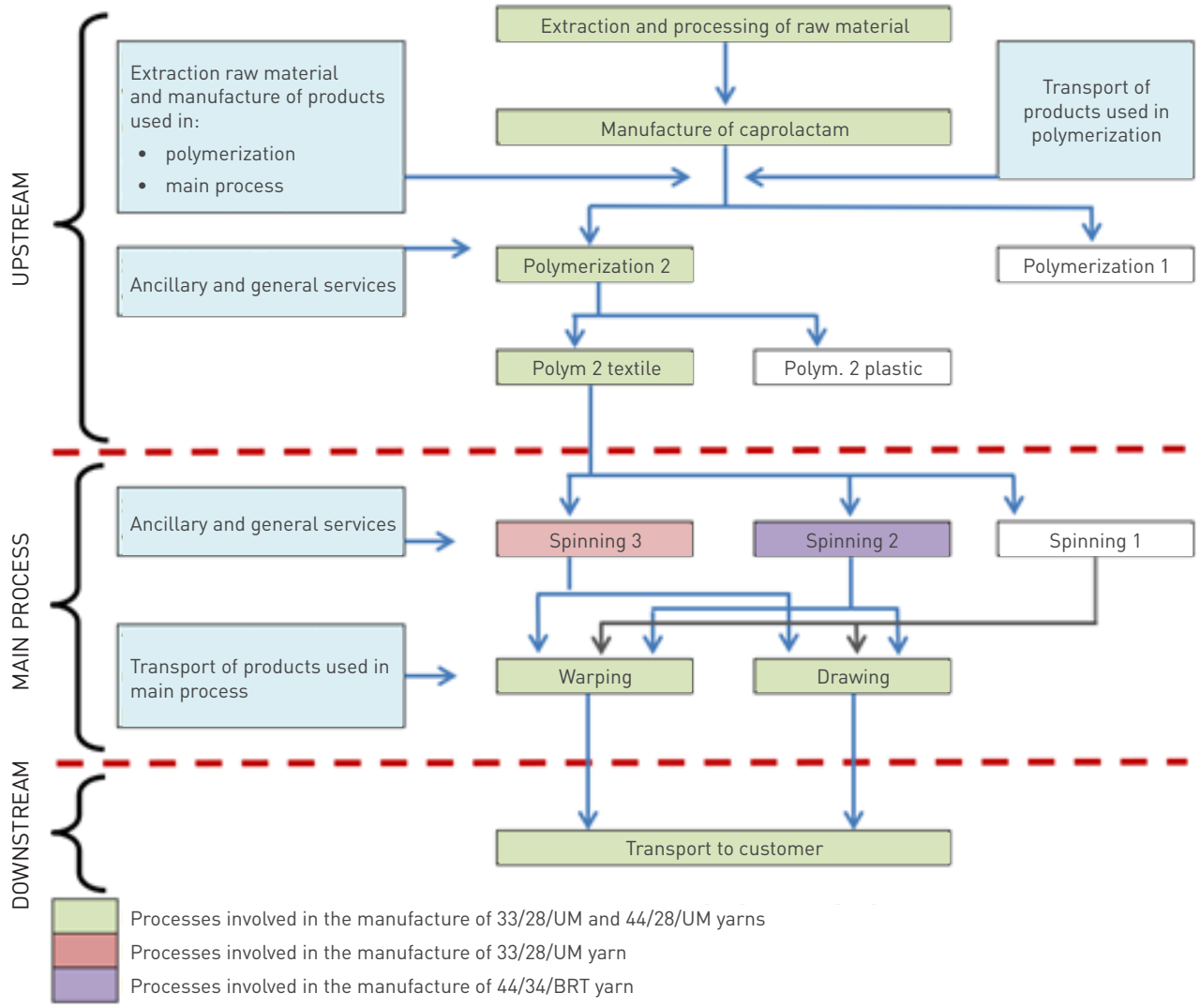
The results presented in this document do not represent comparative statements. However, the EPD will be used to send it to **NUREL, S.A**. customers and may be used to compare **NUREL, S.A**.products with similar products presented in other EPDs that follow the same PCR.

7. Information regarding the Life Cycle Assessment

7.1. Process flowchart of system boundaries studied in the EPD.

All of the life cycle stages have been analysed, from cradle-to-gate.

The boundaries of the system studied in the Life Cycle Assessment are shown below in the production process diagram for nylon yarn:



7.2. Life cycle phases studied in the EPD.

The product system studied is from the cradle to the gate of **NUREL, S.A.** customers (cradle-to-gate). The subsequent yarn processes are outside the scope of this EPD. The upstream phase, main process and downstream phase of yarn production have been studied:

The **upstream** phase includes all the processes required for the:

- Extraction of n**on-renewable resources** used in the yarn manufacturing processes.
- Production of **renewable sources** employed in the yarn manufacturing processes, their refining or processing and storage.

- Production of the **caprolactam** used.
- Production of the **additives** used in the yarn manufacturing processes.
- Production of the primary and secondary **packaging** used for the yarns.
- Production of the **products and materials** used in maintenance tasks.

The **main process** considers:

- All the **material and energy inputs** to the main process, including electricity, fuel, steam, compressed air, nitrogen, air conditioning, etc.
- **Water consumption**.
- The **energy production processes** for energy used in production in the Main Process.
- All **emissions** into the air, water and ground.
- **Treatment of waste** and wastewaters generated by all of the processes, in the Main Process

Only the transport of the yarns from the factory in Zaragoza to the customers is considered in the **downstream phase**, applying a default criterion of a transport distance of 1000 km by road.

In the LCA more than 99% by weight of the materials used in the manufacture of the yarns has been studied.

The LCA does not include:

- In the **polymerization process** it does not include three commercial products for which it has not been possible to find suitable processes in the databases, which represent 0,411% by weight, of the raw materials used in polymerization.
- Any equipment with a **service life of more than 3 years**.
- **Construction of plant buildings** or other capital assets.
- **Business trips** by personnel or the journeys by personnel to and from work.
- **Research and development** activities.

In the LCA the principles followed have been that of the polluter pays and the principle of modularity (environmental burdens are assigned at the stage where the impact occurs).

The EPD only covers the cradle-to-gate phases since the rest of the life cycle phases are highly dependent on specific scenarios and are developed to a greater extent for each specific product.

7.3. Reference year of the data used in the EPD.

The data used to prepare the EPD are from **2018**, which is a period with representative production data.

NUREL only employs electric power from renewable sources and with a Certified Guarantee of Origin.

Therefore, for the production of electricity, the 2018 Spanish electricity mix of renewable source energy has been used, whose composition is shown in the Annex.

7.4. Cut-off rule.

As a general rule, in accordance with the criteria of the PCR, the LCA includes the weight/gross volume of all of the materials used in the manufacturing process so that at least **99% of the weight of the product unit is obtained**.

In the polymerization process 4 commercial products have not been included, representing 0,411% by weight of the raw materials used in polymerization.

7.5. Allocation rules applied.

In accordance with the criteria of the PCR, the criterion applied as been to allocate **system inputs and outputs** based on physical properties (yarn mass).

This allocation criterion has been applied for the plant's general intakes (general services, ancillary services, polymerization, spinning, warping and drawing) and for wastes. It has not been necessary to apply any other types of allocation criteria such as economic allocation.

7.6. Data quality assessment

The data employed in the EPD meet the quality requirements established in the PCR. To assess the quality of the primary data used, the criteria of semi-quantitative assessment of data quality proposed by the European Union in its Product and and Organisation Environmental Footprint Guide have been applied. The following results have been obtained:

- Very good **completeness**. Score 1.
- Reasonable **methodological consistency and adequacy**. Score 3.
- Very good **time-related representativeness.** Score 1.
- Good **technological representativeness**. Score 2.
- Very good **geographical representativeness**. Score 1.
- Low **data uncertainty.** Score 2. Neither uncertainty calculations nor Monte Carlo simulation have been carried out to obtain this score as it is not possible to perform them for factory inventory data. It has been determined by the author of the LCA study based on: the integrity and representativeness of the yarn formulations and of the data relating to material and energy consumptions at the factory, which are necessary for product quality and cost criteria; the integrity and representativeness in emissions, measured and checked by measurements carried out by independent ECAs; the good geographical, time-related and technological representativeness of the inventory data used in the study, which are specific factory data; and the quality and update level of the databases used.

In agreement with the above data, the Data Quality Rating (DQR) takes the following value: 10/6= 1.67, which indicates that the quality level of the data is very good.

To have a better understanding of the data quality assessment carried out, the rating for each criterion runs from 1 to 5 (the lower the rating the better the quality) and to obtain the final rating the following table is applied.

Global level of quality of data according to the data quality rating obtained	
Global Data Quality Rating	**Global Level of Quality**
≤ 1,6	Excellent quality
1,6 a 2,0	Very good quality
2,0 a 3,0	Good quality
3,0 a 4,0	Reasonable quality
> 4	Insufficient quality

8. Information on environmental performance.

8.1. Environmental impacts.

The results obtained for yarns 33/28/UM and 44/34/BR in the categories of environmental impact, required by the PCR in the three life cycle phases, are shown below.

Potential environmental impacts of 1 kg of 33/28/UM yarn						
Impact category		**Unit**	**Upstream**	**Main process**	**Downstream**	**Total**
Global warming potential (GWP)	Fossil sources.	kg CO_2 eq.	4,63	$4,67x10^{-01}$	$1,36x10^{-01}$	**5,23**
	Biogenic sources	kg CO_2 eq.	0,00	0,00	0,00	**0,00**
	Use and change of use of land	kg CO_2 eq.	0,00	0,00	0,00	**0,00**
	TOTAL	kg CO_2 eq.	4,63	$4,67x10^{-01}$	$1,36x10^{-01}$	**5,23**
Acidification potential (AP)		kg SO_2 eq.	$1,85x10^{-02}$	$8,60x10^{-04}$	$3,64x10^{-04}$	**$1,98x10^{-02}$**
Eutrophication potential (EP)		kg $PO4^{3-}$ eq.	$2,47x10^{-03}$	$3,13x10^{-04}$	$6,21x10^{-05}$	**$2,84x10^{-03}$**
Tropospheric ozone formation potential.		kg NMVOC eq.	$2,44x10^{-03}$	$4,87x10^{-05}$	$1,73x10^{-05}$	**$2,51x10^{-03}$**
Abiotic resource depletion potential - Elements.		Kg Sb eq.	$5,17x10^{-06}$	$8,00x10^{-09}$	$2,69x10^{-10}$	**$5,18x10^{-06}$**
Abiotic resource depletion potential - Fossil fuels.		MJ, net cal. value	$1,10x10^{+02}$	1,16	1,96	**$1,13x10^{+02}$**
Water shortage potential		m^3 eq.	1,79	1,22	$3,89x10^{-03}$	**3,01**

Nota: Datos obtenidos mediante la metodología CMLIA baseline V3.05 y AWARE versión 1.01.

Potential environmental impacts of 1 kg of 44/34/BR yarn						
Impact category		**Unit**	**Upstream**	**Main process**	**Downstream**	**Total**
Global warming potential (GWP)	Fossil sources.	kg CO_2 eq.	4,84	$5,11x10^{-01}$	$1,36x10^{-01}$	**5,48**
	Biogenic sources	kg CO_2 eq.	0,00	0,00	0,00	**0,00**
	Use and change of use of land	kg CO_2 eq.	0,00	0,00	0,00	**0,00**
	TOTAL	kg CO_2 eq.	4,84	$5,11x10^{-01}$	$1,36x10^{-01}$	**5,48**
Acidification potential (AP)		kg SO_2 eq.	$1,93x10^{-02}$	$9,42x10^{-04}$	$3,64x10^{-04}$	**$2,06x10^{-02}$**
Eutrophication potential (EP)		kg $PO4^{3-}$ eq.	$2,56x10^{-03}$	$2,75x10^{-04}$	$6,21x10^{-05}$	**$2,90x10^{-03}$**
Tropospheric ozone formation potential.		kg NMVOC eq.	$2,51x10^{-03}$	$5,37x10^{-05}$	$1,73x10^{-05}$	**$2,58x10^{-03}$**
Abiotic resource depletion potential - Elements.		Kg Sb eq.	$5,54x10^{-06}$	$8,74x10^{-09}$	$2,69x10^{-10}$	**$5,55x10^{-06}$**
Abiotic resource depletion potential - Fossil fuels.		MJ, net cal. value	$1,17x10^{+02}$	1,27	1,96	**$1,20x10^{+02}$**
Water shortage potential		m^3 eq.	1,86	1,33	$3,89x10^{-03}$	**3,20**

Note: Data obtained by CMLIA baseline V3.05 and AWARE version 1.01 methods.

The estimated impact results are relative and do not indicate the final value of the impact categories nor do they refer to threshold values, safety margins or risks.

8.2. Use of resources.

The consumption of natural resources and other types of resources used by functional unit, are presented differentiating between upstream phase, main process and downstream phase.

Use of resources of 1 kg of 33/28/UM yarn						
Parameter		Unit	Upstream	Main process	Downstream	Total
Primary energy resources - renewable resources	Use of energy	MJ, net cal. value	6,43	$2,00x10^{+01}$	$5,04x10^{-03}$	**$2,64x10^{+01}$**
	As raw materials	MJ, net cal. value	0,00	0,00	0,00	**0,00**
	TOTAL	MJ, net cal. value	6,43	$2,00x10^{+01}$	$5,04x10^{-03}$	**$2,64x10^{+01}$**
Primary energy resources - non-renewable resources	Use of energy	MJ, net cal. value	$1,23x10^{+02}$	2,02	2,10	**$1,27x10^{+02}$**
	As raw materials	MJ, net cal. value	0,00	0,00	0,00	**0,00**
	TOTAL	MJ, net cal. value	$1,23x10^{+02}$	2,02	2,10	**$1,27x10^{+02}$**
Secondary materials		kg	0,00	0,00	0,00	**0,00**
Renewable secondary fuels		MJ, net cal. value	0,00	0,00	0,00	**0,00**
Non-renewable secondary fuels		MJ, net cal. value	0,00	0,00	0,00	**0,00**
Net consumption of fresh water		m^3	$1,53x10^{-02}$	$2,48x10^{-02}$	$1,09x10^{-04}$	**$4,02x10^{-02}$**

Note: Data obtained by the Cumulative Energy Demand method and from SimaPro inventory analysis; raw materials compartment.

Uso de recursos de 1 kg de hilo 44/34/BR						
Parameter		Unit	Upstream	Main process	Downstream	Total
Primary energy resources - renewable resources	Use of energy	MJ, net cal. value	6,69	$2,18x10^{+01}$	$5,04x10^{-03}$	**$2,85x10^{+01}$**
	As raw materials	MJ, net cal. value	0,00	0,00	0,00	**0,00**
	TOTAL	MJ, net cal. value	6,69	$2,18x10^{+01}$	$5,04x10^{-03}$	**$2,85x10^{+01}$**
Primary energy resources - non-renewable resources	Use of energy	MJ, net cal. value	$1,31x10^{+02}$	2,22	2,10	**$1,35x10^{+02}$**
	As raw materials	MJ, net cal. value	0,00	0,00	0,00	**0,00**
	TOTAL	MJ, net cal. value	$1,31x10^{+02}$	2,22	2,10	**$1,35x10^{+02}$**
Secondary materials		kg	0,00	0,00	0,00	**0,00**
Renewable secondary fuels		MJ, net cal. value	0,00	0,00	0,00	**0,00**
Non-renewable secondary fuels		MJ, net cal. value	0,00	0,00	0,00	**0,00**
Net consumption of fresh water		m^3	$1,48x10^{-02}$	$2,52x10^{-02}$	$1,09x10^{-04}$	**$4,01x10^{-02}$**

Note: Data obtained by the Cumulative Energy Demand method and from SimaPro inventory analysis; raw materials compartment.

8.3. Waste production and outflows

The amount of waste generated to manufacture Nurel S.A. 33/28/UM and 44/34/BR yarns, obtained from the analysis in SimaPro using the EDIP 2003 V1.07 method, is given below:

Generation of waste to manufacture 1 kg of 33/28/UM yarn (in kg per kg of yarn)					
Parameter	Unit	Upstream	Main process	Downstream	Total
Hazardous waste generated	kg	$5{,}52\text{x}10^{-05}$	$6{,}78\text{x}10^{-06}$	$3{,}57\text{x}10^{-07}$	**$6{,}23\text{x}10^{-05}$**
Non-hazardous waste generated	kg	$2{,}49\text{x}10^{-06}$	$1{,}20\text{x}10^{-07}$	$3{,}51\text{x}10^{-07}$	**$2{,}96\text{x}10^{-06}$**
Radioactive waste	kg	$8{,}94\text{x}10^{-05}$	$1{,}35\text{x}10^{-05}$	$1{,}43\text{x}10^{-05}$	**$1{,}17\text{x}10^{-04}$**

Generation of waste to manufacture 1 kg of 44/34/BR yarn (in kg per kg of yarn)					
Parameter	Unit	Upstream	Main process	Downstream	Total
Hazardous waste generated	kg	$5{,}77\text{x}10^{-05}$	$7{,}40\text{x}10^{-06}$	$3{,}57\text{x}10^{-07}$	**$6{,}55\text{x}10^{-05}$**
Non-hazardous waste generated	kg	$2{,}53\text{x}10^{-06}$	$1{,}32\text{x}10^{-07}$	$3{,}51\text{x}10^{-07}$	**$3{,}01\text{x}10^{-06}$**
Radioactive waste	kg	$8{,}92\text{x}10^{-05}$	$1{,}48\text{x}10^{-05}$	$1{,}43\text{x}10^{-05}$	**$1{,}18\text{x}10^{-04}$**

Los indicadores de flujos que salen del sistema en la fabricación de ambos hilos son:

Indicators of outflows from the system in the manufacture of 33/28/UM yarn (in kg per kg of yarn)					
Parameter	Unit	Upstream	Main process	Downstream	Total
Components for reuse	kg	0,00	0,00	0,00	**0,00**
Material for recycling	kg	0,00	0,00	0,00	**0,00**
Materials for energy recovery	kg	0,00	0,00	0,00	**0,00**
Exported electrical energy	MJ	0,00	0,00	0,00	**0,00**
Exported thermal energy	MJ	0,00	0,00	0,00	**0,00**

Indicators of outflows from the system in the manufacture of 44/34/BR yarn (in kg per kg of yarn)					
Parameter	Unit	Upstream	Main process	Downstream	Total
Components for reuse	kg	0,00	0,00	0,00	**0,00**
Material for recycling	kg	0,00	0,00	0,00	**0,00**
Materials for energy recovery	kg	0,00	0,00	0,00	**0,00**
Exported electrical energy	MJ	0,00	0,00	0,00	**0,00**
Exported thermal energy	MJ	0,00	0,00	0,00	**0,00**

8.4. Other environmental indicators

The energy content of the two yarns studied, evaluated with the gross calorific value of the yarn material is 29,3 MJ/kg.

Toxic emissions to produce 33/28/UM yarn (in PAF.m3.day per kg of yarn) USEtox 2 methodology (recommended only) V1.00				
Impact category	Upstream	Main process	Downstream	Total
Freshwater ecotoxicity	0.474	0.0009	0.0002	**0.475**

Toxic emissions to produce 44/34/BR yarn (in PAF.m3.day per kg of yarn) USEtox 2 methodology (recommended only) V1.00				
Impact category	Upstream	Main process	Downstream	Total
Freshwater ecotoxicity	0,494	0,001	0,0002	**0,495**

The co-products generated during the yarn manufacturing process and their destination are as follows:

Co-products generated in the manufacture of 33/28/UM yarn		
Co-product	Quantity (ton)	Destination
Spinning plastic III	2,365	EREMA
Spinning plastic III	113,858	External use
Drawing plastic	0,012	EREMA
Warping plastic	67,497	EREMA

Note: values obtained from factory data and estimates carried out.

Co-products generated in the manufacture of 44/34/BR yarn		
Co-product	Quantity (ton)	Destination
Spinning plastic II	1,277	EREMA
Spinning plastic II	20,082	External use
Drawing plastic	0,500	EREMA
Warping plastic	11,202	EREMA

Note: values obtained from factory data and estimates carried out.

9. Additional information.

As additional information on the environmental performance of the product, the values obtained by applying the ILCD 2011 Midpoint+ environmental impact assessment method, as proposed in 2013/179/EU **COMMISSION RECOMMENDATION** of 9 April 2013, on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations are presented.

All of the results are in reference to the declared unit, which is **1 kg of 33/28/UM yarn and of 44/34/BR yarn**.

The values for the environmental impact categories considered in the methodology applied are shown.

Impact category	Unit	1 kg of 33/28/UM yarn			
		Upstream	Main process	Downstream	Total
Climate change	kg CO_2 eq.	$4{,}58x10^{-01}$	$1{,}36x10^{-01}$	5,02	**4,43**
Ozone depletion	kg CFC-11 eq.	$1{,}41x10^{-08}$	$2{,}54x10^{-08}$	$4{,}98x10^{-07}$	**$4{,}58x10^{07}$**
Human toxicity, non-cancer effects	CTUh	$6{,}86x10^{-08}$	$1{,}89x10^{-08}$	$1{,}14x10^{-06}$	**$1{,}05x10^{-06}$**
Human toxicity, cancer effects	CTUh	$1{,}38x10^{-09}$	$8{,}54x10^{-11}$	$3{,}64x10^{-08}$	**$3{,}49x10^{-08}$**
Particulate matter	kg PM2.5 eq.	$1{,}07x10^{-04}$	$4{,}98x10^{-05}$	$3{,}53x10^{-03}$	**$3{,}37x10^{-03}$**
Ionizing radiation HH	kBq U235 eq.	$1{,}80x10^{-02}$	$8{,}75x10^{-03}$	$1{,}09x10^{-01}$	**$8{,}27x10^{-02}$**
Ionizing radiation E (interim)	CTUe	$1{,}37x10^{-07}$	$6{,}21x10^{-08}$	$8{,}35x10^{-07}$	**$6{,}36x10^{-07}$**
Photochemical ozone formation	kg NMVOC eq.	$6{,}16x10^{-04}$	$4{,}36x10^{-04}$	$2{,}06x10^{-02}$	**$1{,}96x10^{-02}$**
Acidification	molc H+ eq.	$1{,}13x10^{-03}$	$4{,}73x10^{-04}$	$2{,}38x10^{-02}$	**$2{,}22x10^{-02}$**
Terrestrial eutrophication	molc N eq.	$3{,}26x10^{-03}$	$1{,}65x10^{-03}$	$4{,}32x10^{-02}$	**$3{,}83x10^{-02}$**
Freshwater eutrophication	kg P eq.	$9{,}83x10^{-06}$	$1{,}63x10^{-07}$	$1{,}83x10^{-04}$	**$1{,}73x10^{-04}$**
Marine eutrophication	kg N eq.	$2{,}13x10^{-04}$	$1{,}49x10^{-04}$	$3{,}73x10^{-03}$	**$3{,}37x10^{-03}$**
Freshwater ecotoxicity	CTUe	$1{,}16x10^{-01}$	$3{,}82x10^{-01}$	$2{,}81x10^{+01}$	**$2{,}76x10^{+01}$**
Land use	kg C deficit	$7{,}34x10^{-01}$	$9{,}40x10^{-04}$	2,82	**2,08**
Water resource depletion	m^3 water eq.	$2{,}58x10^{-02}$	$3{,}67x10^{-05}$	$3{,}45x10^{-02}$	**$8{,}70x10^{-03}$**
Mineral, fossil & ren resource depletion	kg Sb eq.	$4{,}58x10^{-07}$	$2{,}38x10^{-08}$	$2{,}21x10^{-04}$	**$2{,}21x10^{-04}$**

Impact category	Unit	1 kg of 44/34/BR yarn			
		Upstream	Main process	Downstream	Total
Climate change	kg CO_2 eq.	4,63	5,01x10^{-01}	1,36x10^{-01}	**5,26**
Ozone depletion	kg CFC-11 eq.	4,77x10^{-07}	1,55x10^{-08}	2,54x10^{-08}	**5,18x10^{-07}**
Human toxicity, non-cancer effects	CTUh	1,11x10^{-06}	7,50x10^{-08}	1,89x10^{-08}	**1,21x10^{-06}**
Human toxicity, cancer effects	CTUh	2,41x10^{-08}	1,53x10^{-09}	8,54x10^{-11}	**2,57x10^{-08}**
Particulate matter	kg PM2.5 eq.	3,53x10^{-03}	1,17x10^{-04}	4,98x10^{-05}	**3,70x10^{-03}**
Ionizing radiation HH	kBq U235 eq.	8,19x10^{-02}	1,97x10^{-02}	8,75x10^{-03}	**1,10x10^{-01}**
Ionizing radiation E (interim)	CTUe	6,29x10^{-07}	1,49x10^{-07}	6,21x10^{-08}	**8,41x10^{-07}**
Photochemical ozone formation	kg NMVOC eq.	2,07x10^{-02}	6,73x10^{-04}	4,36x10^{-04}	**2,18x10^{-02}**
Acidification	molc H+ eq.	2,30x10^{-02}	1,24x10^{-03}	4,73x10^{-04}	**2,47x10^{-02}**
Terrestrial eutrophication	molc N eq.	3,95x10^{-02}	3,56x10^{-03}	1,65x10^{-03}	**4,48x10^{-02}**
Freshwater eutrophication	kg P eq.	1,79x10^{-04}	1,07x10^{-05}	1,63x10^{-07}	**1,90x10^{-04}**
Marine eutrophication	kg N eq.	3,48x10^{-03}	2,33x10^{-04}	1,49x10^{-04}	**3,87x10^{-03}**
Freshwater ecotoxicity	CTUe	2,90x10^{+01}	1,29x10^{-01}	3,82x10^{-01}	**2,95x10**
Land use	kg C deficit	2,11	8,00x10^{-01}	9,40x10^{-04}	**2,91**
Water resource depletion	m^3 water eq.	9,09x10^{-03}	2,81x10^{-02}	3,67^{E-05}	**3,73^{E-02}**
Mineral, fossil & ren resource depletion	kg Sb eq.	1,92x10^{-04}	5,00x10^{-07}	2,38^{E-08}	**1,93^{E-04}**

10. Differences between this EPD and previous versions.

This EPD is the third version prepared by Nurel for its yarns:

- **2013:** Valid until 2016, based on 2011 data given that 2012 was not a representative year from the point of view of production.
- **2016:** Valid until December 2019, based on 2015 data.
- **2023:** Versión 3.0 valid until 2025/02/20. **Editorial changes**: Inclusion of a product photo on the cover page. **Correction of the typo in Chapter 2:** Verification. Substittution of "ENAC. Accreditation nº125/C-PR283" por "The International EPD®System". **Revision date update on cover page.**

Between the previous version and this current EPD there have been significant changes, not related to NUREL's manufacturing process (which has remained unchanged) that may have an effect on the results obtained. The following are the most important changes:

- For the EPD drafted in **2016** the **Ecoinvent 3.2** database was used, which was the most updated one at that time. In the **current** EPD the **Ecoinvent 3.5** database has been used; this has involved methodological changes in the creation of processes.
- The details of the **caprolactam manufacturing process** have changed with respect to those used in the 2016 EPD: the caprolactam manufacturing process considered in the previous EPD is from the Gabi 6 Professional database; the process used now is from the Ecoinvent 3.5 database, with the most recent update in 2018, that includes consumption of raw materials, use of energy and infrastructures, and emissions.
- The **electricity mix** used has changed with respect to the previous EPD: in 2016 the electricity mix used was that of 2015; in this new version the Spanish electricity mix of renewable energy sources adapted to 2018 has been used.

With regard to the results obtained, it is observed that in general the values of the analysis are notably lower in respect to the 2016 version, both, both in terms of the environmental impacts of the categories studied and the use of resources and waste generation. The main causes of this notable reduction are:

- The **optimization of the yarn production processes** which enables Nurel to use less energy and water and the reduction of losses at all of the manufacturing stages. These data are reflected in the upstream phase and in the main process.
- The use of **energy that is 100%** from renewable sources, which has a direct effect on the impact, resources and waste values in the main process of the life cycle.

11. References.

- PCR reference document:
  - PCR 2013:12 Textile yarn and thread of natural fibres, man- made filaments or staple fibres, version 2.1. UN CPC 263 and 264. DATE 2019-01-08. VALID UNTIL: 2021-08-01
  - EPD International (2017). General Programme Instructions for the International EPD® System. Version 2.5 date 2015-05-11, based on ISO 14025 and ISO 14040/14044. www.environdec.com
- The PCR Plastics in primary forms (UN CPC 347), 2010:16, VERSION 2.11. has been used as a reference for the production of the polymer.
- Ecoinvent 3.5 database (November 2018)
- Environmental impact assessment methodology:
  - CML-IA baseline V3.05 / EU25+3,2000.
  - ReCiPe 2008.
  - AWARE (Available WAter Remaining) by WULCA March 2017, version 1.01,
  - USEtox 2 (recommended only) V1.00
  - EDIP 2003 V1.07
  - Cumulative Energy Demand V1.11
  - ILCD 2011 Midpoint+
- Databases and environmental impact methodologies applied using SimaPro 9.0.0.30.
- Life Cycle Assessment Report on the production of 33/28/UM yarn and 44/34/BR yarn manufactured by NUREL S.A., prepared by Abaleo S.L.
- UNE-EN ISO 14040 standard. Environmental Management. Life Cycle Assessment Principles and reference framework. 2006.
- UNE-EN ISO 14044 standard. Environmental Management. Life Cycle Assessment Requirements and guidelines. 2006
- UNE-EN ISO 14020:2002 standard. Environmental labels and declarations. General Principles. (ISO 14020:2000).
- UNE-EN ISO 14025 standard. Environmental labels and declarations. Type III environmental declarations. Principles and procedures.
- COMMISSION RECOMMENDATION 2013/179/EU of 9 April 2013, on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations (Published in the OJEU 4/05/2013).
- ILCD handbook (International Reference Life Cycle Data System). 2011.

12. Annex. Electricity mix used

To prepare the EPD, the Spanish Electricity Mix of 2018, obtained from the Annual report on the Spanish Electrical Grid by Red Eléctrica de España, has been used. The GG emissions of this electricity mix are 74.34 gCO2e/MJ, evaluated with IPCC methodology, with a 100-year timescale.

The data table obtained from the aforesaid report and various illustrative graphs are shown below.

	Peninsular System		Non-Peninsular System		National Total	
	GWh	%18/17	GWh	%18/17	GWh	%18/17
Hydraulics [1]	34.103	84,9	3	0,1	34.106	84,9
Pumping Turbination [2]	2.009	-10,7	-	-	2.009	-10,7
Nuclear	53.198	-4,2	-	-	53.198	-4,2
Coal	34.882	-17,8	2.392	-7,9	37.274	-17,2
Fuel/gas [3]	-	-	6.683	-4,5	6.683	-4,5
Combined cycle [4]	26.403	-21,5	3.642	6,5	30.044	-18,9
Hydroelectrics	-	-	24	16,9	24	16,9
Wind	48.946	3,0	625	56,6	49.570	3,5
Solar - Photovoltaic	7.374	-7,8	385	-3,1	7.759	-7,6
Solar - Thermal	4.424	-17,3	-	-	4.424	-17,3
Other renewable [5]	3.547	-1,5	10	-8,3	3.557	-1,5
Cogeneration	28.981	2,9	35	-3,5	29.016	2,8
Non-renewable waste	2.294	-6,7	141	-5,2	2.435	-6,6
Renewable waste	733	0,7	141	-5,2	874	-0,3
Generation	**246.883**	**-0,5**	**14.081**	**-0,7**	**260.974**	**-0,5**
Consumption in pumping	-3.3198	-11,3	-	-	-3.198	-11,3
Peninsula-Balearic Islands Link [6]	-1.233	4,6	1.233	4,6	0	-
Balance international physical exchanges [7]	11.102	21,1	-	-	11.102	21,1
Demand (b.c.)	**253.563**	**0,4**	**15.314**	**-0,3**	**268.877**	**0,4**

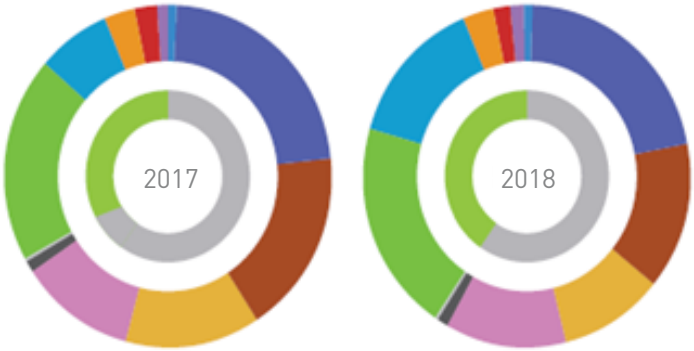
[1] Assignment of production units according to main fuel.
[2] Pure pump turbination + mixed pump turbination estimate.
[3] The generation with auxiliary groups is included in the Balearic electrical system.
[4] Includes open cycle operation. In the Canary Islands electrical system, it uses diesel as the main fuel.
[5] Includes biogas, biomass, marine hydraulics and geothermal.
[6] Positive value: system energy input. Negative value: system power output.
[7] Positive value: import balance. Negative value: export balance. Increment values are not calculated when exchange balances have a different sign.

Source: 2018 Annual Report on the Spanish Electrical Grid, by Red Eléctrica de España.

Renewable energy generation grew in 2018 thanks to the increased production of hydroelectric power plants. In 2018 hydroelectric power plants on mainland Spain have almost duplicated their production in respect of the previous year.

Structure of the peninsular power generation in 2017 and 2018 (%)

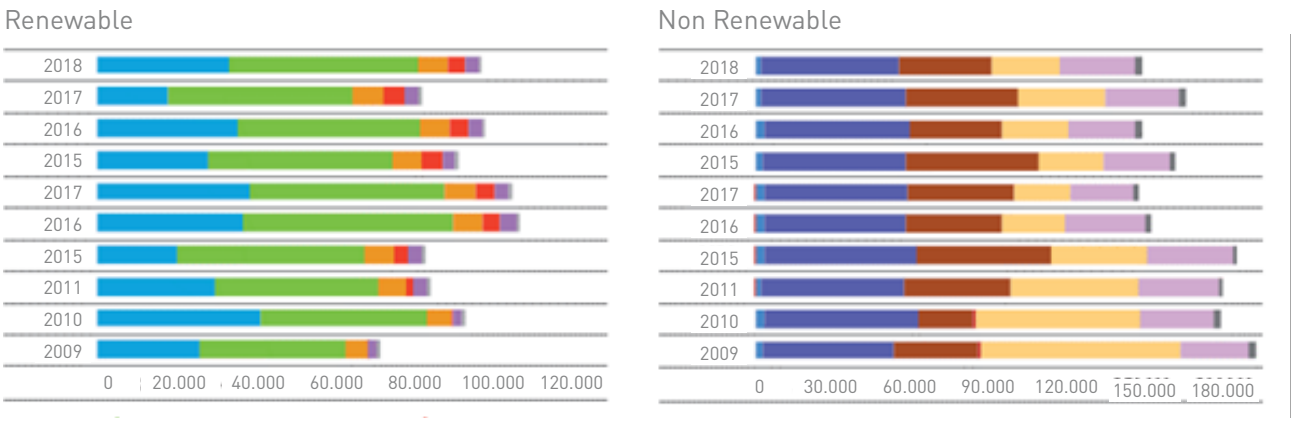
	2017	2018
Pumping Turbination	0,19	0,8
Nuclear	22,4	21,5
Coal	17,1	14,1
Combined cycle	13,6	10,7
Cogeneration	11,3	11,9
Non-Renewable Waste	1,0	0,9
Renewable Waste	0,3	0,3
Wind	19,1	19,8
Hydraulics	7,4	13,8
Solar - Photovoltaic	3,2	3,0
Solar - Thermal	2,2	1,8
Other Renewables	1,5	1,4



	2017	2018
Renewable	33,7	40,1
Non renewable	66,3	59,9

Source: Annual report of the Spanish Electric System of the year 2018, of Red Eléctrica de España.

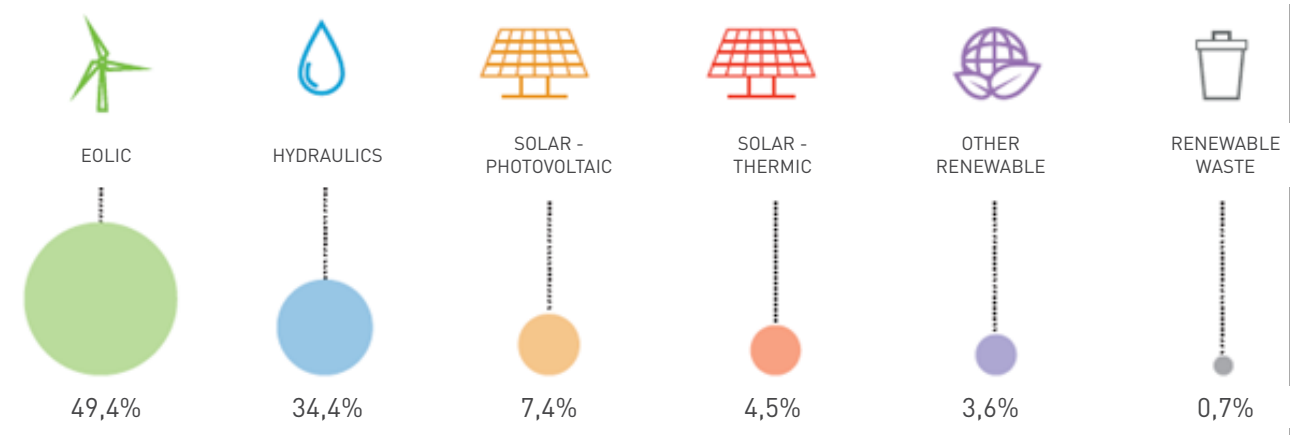
Evolution of the production of renewable electricity and non-renewable pensisular (GWh)



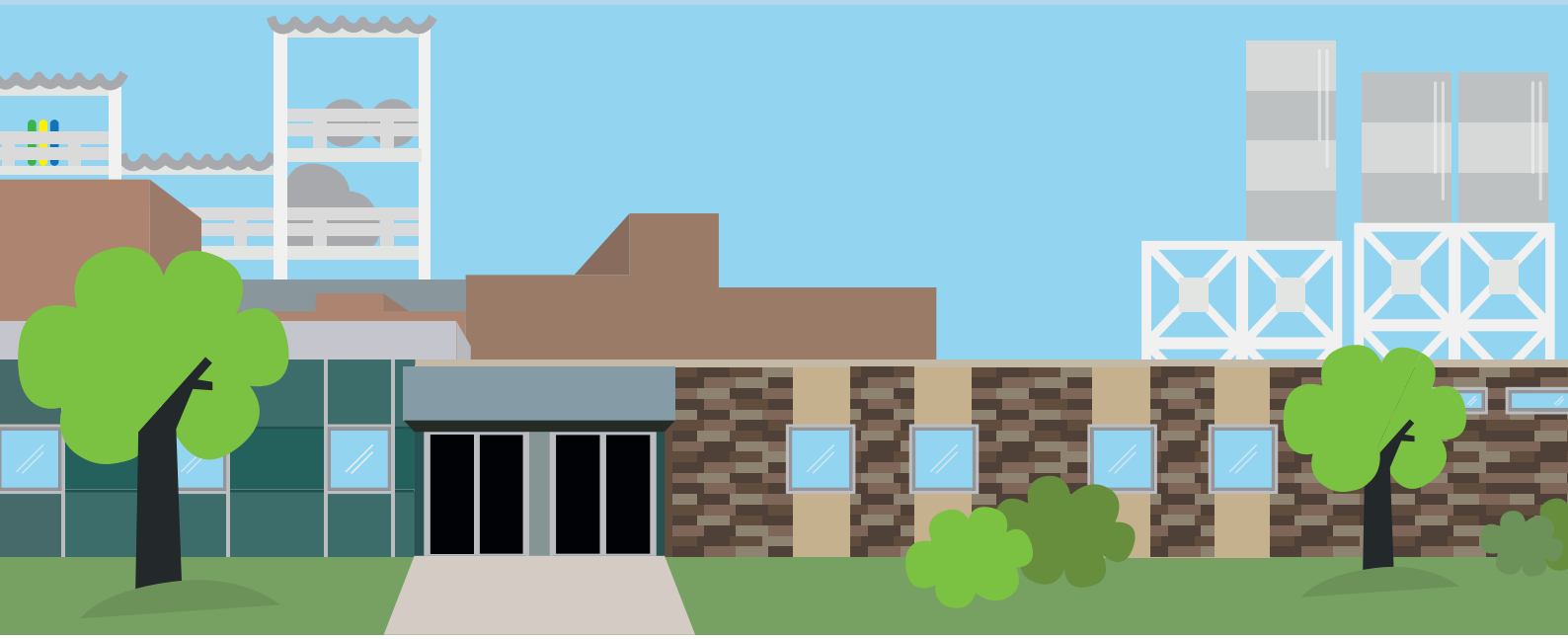
[1] Pure pump turbination + mixed pump turbination estimate.

Source: Annual report of the Spanish Electric System of the year 2018, of Red Eléctrica de España.

Structure of the annual peninsular renewable electricity generation 2018 (%)



Source: Annual report of the Spanish Electric System of the year 2018, of Red Eléctrica de España.



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