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# 1 Executive Summary

This report analyzes how the criteria established by the European Union for Renewable Fuels of Non-Biological Origin (RFNBO) impact the design and viability of renewable hydrogen and Power-to-X (PtX) projects in Argentina. The main objective is to provide practical guidance for project developers and other private-sector actors who are evaluating access to the European market as one of the main destinations for their exports, and to serve as a reference for decision-makers to analyze how to orient public policies and regulations if they seek to align an export strategy for these products with that market.

In the first part, the report provides a reading and interpretation of the RFNBO criteria defined by the European Union. Within this framework, the following is highlighted:

- Definition of RFNBO: RFNBO includes hydrogen produced by electrolysis of water using renewable electricity and products derived from that compound (e.g., ammonia, methanol, or synthetic fuels).
- European regulatory framework: The Second Renewable Energy Directive (RED II), complemented by RED III and Delegated Acts 2023/1184 and 2023/1185, establishes the definitions, criteria, and rules for RFNBO production, supported by interpretative documents.
- Emissions savings threshold: For a fuel to be considered an RFNBO, it must meet an emissions savings threshold of at least 70% compared to a fossil reference fuel, which translates into an emissions intensity of less than 28.2 gCO<sub>2</sub>/MJ of fuel, equivalent to 3.38 kgCO<sub>2</sub>/kg H<sub>2</sub>.
- Life-cycle approach: Emissions intensity must be calculated considering the entire value chain: production and supply of inputs, conversion processes, transport, storage, distribution, and final use of the RFNBO.
- Determining role of electricity: Electricity is an important determinant of associated emissions. When the electricity used in the production of the RFNBO can be considered “fully renewable” according to the criteria of the regulation, the emissions associated with that electricity are accounted for as 0 gCO<sub>2</sub>/MJ. Otherwise, the emissions from the electricity consumed must be added, calculated in accordance with the rules of Delegated Act 2023/1185.
- Criteria for renewable electricity: The regulation allows for electricity to be considered fully renewable both from renewable generation facilities directly connected to the RFNBO plant and from electricity taken from the grid, provided that at least one of the cases defined in the Delegated Acts is met. These cases combine requirements on renewable share and the carbon footprint of the grid with conditions of additionality, geographical correlation, and temporal correlation between generation and consumption.
- Specific definitions used: European regulations use very specific concepts in their rules for RFNBO production, some of which come from EU electricity system regulations, such as

“bidding zones.” The application of these concepts in countries outside the EU can pose significant interpretation challenges.

- Eligible carbon sources: For RFNBOs that require a carbon source (such as methanol or synthetic fuels), CO<sub>2</sub> may come from direct air capture, biogenic sources, or certain industrial sources, subject to time limits and specific conditions.
- Certification and verification: Verification of compliance with all these criteria is carried out by certification bodies who collaborate with certification schemes approved by the European Commission, which are required to evaluate each project, production process, and production batch. These schemes, together with the Commission, will also play a key role in the practical interpretation of the regulations in countries outside the EU, whose electricity markets and institutional frameworks differ from the European context.

In the second part, the report evaluates the **applicability of these criteria to projects located in Argentina** that seek to export RFNBO to the European Union. This analysis highlights:

- Structural differences in the electricity market: The Argentine electricity market is designed very differently from the European market and does not use the concept of “bidding zones,” which complicates the direct application of some criteria in the regulations, particularly those related to the geographical correlation of renewable electricity.
- Importance of the concept of bidding zones: The interpretation of the concept of bidding zones is central to understanding how future RFNBO projects may interact with the Argentine electricity transmission system. There are at least two possible approaches: considering the entire country as a single bidding zone, or subdividing it into several equivalent “zones,” for example, based on the electricity regions already used by CAMMESA.
- Role of institutional actors: This interpretation is not unilaterally determined by companies or national authorities but will ultimately depend on certification schemes and the European Commission. However, actors such as the Secretariat of Energy and CAMMESA can, and should play, an active role by providing information and technical assistance to guide this definition.
- Impact on projects and energy planning: The way in which bidding zones are defined may affect different projects either favorably or unfavorably, particularly those that plan to source part of their energy from the grid and account for it as fully renewable. It may also influence the optimal location of new renewable generation and RFNBO production plants within the country.
- Regional opportunities within Argentina: Argentina has regions where the renewable share in generation is very high, such as *Patagonia* and the *Noroeste*, which translates into electricity emission intensities that are significantly lower than the national average. This could create opportunities for grid-connected projects that can take advantage of these generation profiles. However, such opportunities depend on how Argentina interprets the equivalent of a bidding zone.
- Availability and quality of electricity data: CAMMESA records and publishes detailed information on generation, demand, fuels, and emissions by region and technology, with hourly granularity. This data availability makes it possible to estimate electricity emission

factors consistent with the methodology of Delegated Act 2023/1185 and, therefore, to robustly calculate the contribution of electricity to the footprint of RFNBOs produced in Argentina.

- Available carbon sources: With regard to carbon sources, the country has relevant biogenic sources (e.g., bioethanol and pulp and paper plants) and several potentially usable industrial sources (cement plants, steel production, ammonia, refineries, thermal power plants).
- Eligibility of biogenic carbon sources: Carbon sources from biomass must comply with the European Union's sustainability guidelines for biomass in order to be eligible as carbon sources for RFNBO production.
- Regulatory risks for industrial source uses: The lack of a domestic emissions pricing system creates uncertainty as to whether industrial sources are eligible as inputs for RFNBOs exported to the EU.
- Considerations regarding maritime transport for RFNBOs: Maritime transport of RFNBOs from Argentine ports to Europe can represent a significant contribution to the product's emissions footprint, particularly if shipping routes and vessel fuel efficiency are not optimized. This reinforces the importance of considering the entire logistic chain in project design.

Overall, the report shows that the feasibility of developing renewable hydrogen and PtX projects in Argentina that qualify as RFNBOs under European regulations depend not only on the abundance of renewable resources, but also on the coordination between the technical and contractual design of the projects, the structure and operation of the Argentine electricity system, the interpretation of European concepts such as bidding zones, and the existence of adequate traceability and certification instruments. Early coordination between developers, energy authorities, the system operator, and potential certification schemes will be key to transforming technical potential into export-oriented, certifiable, and competitive projects in the European market.



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## 2 Glossary

<b>AMBA</b>	Buenos Aires Metropolitan Area
<b>BW LPG</b>	Shipping company specializing in the maritime transport of liquefied petroleum gas (BW LPG)
<b>CAMMESA</b>	Wholesale Electricity Market Management Company (operator of the Argentine electricity system)
<b>CBAM</b>	European Union Carbon Border Adjustment Mechanism
<b>CCS</b>	Carbon capture and storage
<b>DAC</b>	Direct air capture
<b>e-SAF</b>	Synthetic sustainable aviation fuel produced from renewable hydrogen (e-SAF)
<b>eCCS</b>	Term used for emissions avoided through carbon capture and storage (eCCS)
<b>EEOI</b>	Energy Efficiency Operational Indicator for maritime transport
<b>eSAF</b>	Variant spelling of e-SAF (synthetic sustainable aviation fuel)
<b>ETS</b>	EU Emissions Trading System
<b>EU</b>	European Union
<b>Fit for 55</b>	EU regulatory package to reduce net emissions by at least 55% by 2030
<b>FuelEU</b>	FuelEU Maritime Regulation on reducing the GHG intensity of marine fuels
<b>GHG</b>	Greenhouse gases
<b>geoSADI</b>	Geospatial database of the Argentine Interconnection System (geoSADI)
<b>LPG</b>	Liquefied petroleum gas
<b>LPG</b>	Liquefied petroleum gas (LPG)
<b>HFO</b>	Heavy fuel oil used as marine fuel (Heavy Fuel Oil)
<b>ISCC</b>	International Sustainability and Carbon Certification
<b>MATER</b>	Argentine Renewable Energy Term Market

<b>NOA</b>	Northwestern Argentina
<b>PPA</b>	Long-term power purchase agreement (Power Purchase Agreement)
<b>GDP</b>	Gross Domestic Product
<b>PtX</b>	Power-to-X (production of fuels or derivative products using renewable electricity)
<b>Q&amp;A</b>	Questions & Answers documents issued by the European Commission
<b>RCF</b>	Recycled Carbon Fuels
<b>RED</b>	European Union Renewable Energy Directive
<b>RED I</b>	First EU Renewable Energy Directive
<b>RED II</b>	Second EU Renewable Energy Directive (Directive (EU) 2018/2001)
<b>RED III</b>	Third EU Renewable Energy Directive (Directive (EU) 2023/2413)
<b>REPowerEU</b>	European Union REPowerEU plan to reduce dependence on fossil fuels and accelerate renewables
<b>REGRT</b>	European Network of Transmission System Operators for Electricity (ENTSO for Electricity)
<b>RFNBO</b>	Renewable Fuels of Non-Biological Origin
<b>RIGI</b>	Large Investment Incentive Scheme (Argentine tax regime project)
<b>SADI</b>	Argentine Interconnection System (high-voltage electricity transmission grid)
<b>SAF</b>	Sustainable Aviation Fuel
<b>EU</b>	European Union
<b>VLGC</b>	Very Large Gas Carrier (large gas carrier vessel used to transport ammonia or LPG)

## 3 Introduction and Scope

### 3.1 Introduction

The development of the renewable hydrogen and derivatives production sector in Argentina is projected to be predominantly export-oriented, at least in its initial stage. This is reflected in the National Hydrogen Strategy, which estimates production of around 5 million tons per year by 2050, of which approximately 4 million tons per year would be destined for export, as well as in the current portfolio of projects under evaluation in the country, most of which are conceived as large-scale initiatives for the production of renewable hydrogen derivatives, such as ammonia or synthetic fuels, aimed at foreign markets.

At the same time, when analyzing the expected evolution of the international market for hydrogen and its derivatives, the European Union is emerging as the region with the greatest potential demand for these products. This is explained by the combination of ambitious decarbonization policies, projections for low-emission domestic hydrogen consumption, and the limitations identified for producing locally, competitively, and at the required scale.

In this context, it is essential that countries that view renewable hydrogen as a primarily export vector in the short and medium term, such as Argentina, understand in detail the European criteria for certifying these products as Renewable Fuels of Non-Biological Origin (RFNBO). This understanding is key not only to assessing the viability of projects targeting the European Union as a destination market, but also to anticipating how these requirements may be applied in Argentina and interact with the regulatory and operational framework of the national electricity system.

### 3.2 Objective of the study

The objective of this report is to provide technical support to developers of renewable hydrogen projects and Power-to-X products, as well as other relevant actors in the Argentine energy sector, so that they can understand the rules and criteria that these products must comply with in order to be certified as RFNBO under European Union regulations and, thereby, gain access to that market.

To this end, the study is organized into two parts. First, it describes the main provisions of the Second Renewable Energy Directive (RED II) and its Delegated Acts regarding the requirements of renewable hydrogen and its derivatives. Second, it analyzes possible strategies for implementing and applying these criteria in projects located in Argentina that seek to export to the European Union and identifies potential challenges or areas that are still subject to interpretation and official definition.



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## 4 Introduction to the European Union Regulatory Framework for renewable H<sub>2</sub> and PtX products

Since the ratification of the Paris Agreement in 2016, the European Union has been building a regulatory framework that combines binding targets, carbon pricing, and sector-specific standards to place its economy on the path to climate neutrality. The European Green Deal (2019) and the European Climate Law (2021) enshrined in legislation the goal of reducing net emissions by at least 55% by 2030 and achieving climate neutrality by 2050. By 2023, emissions were already around 37% below 1990 levels, while GDP grew by nearly 68%, which is often presented as evidence that decarbonization and economic growth can be compatible.

To achieve this, the European Union relies on a set of heterogeneous instruments:

- **Quota targets.** Successive Renewable Energy Directives (RED I, RED II, and RED III) require each Member State to reach a minimum share of renewable energy in its final consumption, while the Energy Efficiency Directive sets annual energy-savings targets.
- **Price signal.** The EU Emissions Trading System (ETS) currently covers electricity generation, part of heavy industry and, from 2024, maritime transport; in recent years, the CO<sub>2</sub> price has remained at elevated levels, strengthening the signal to replace fossil fuels. Similarly, the Carbon Border Adjustment Mechanism (CBAM) is a climate measure under the European Green Deal that applies a carbon price, aligned with the EU ETS, to a selected group of products imported into the EU, such as steel, cement, fertilizers, aluminum, hydrogen, and electricity, with the aim of reflecting their carbon content and acting as a complementary price signal to the European emissions trading regime.
- **Sectoral standards.** There are CO<sub>2</sub> limits on vehicles, efficiency requirements for buildings and, more recently, mandatory quotas for renewable fuels in aviation and maritime shipping.

The progress achieved with this combination has been significant, but it has exposed the so-called *hard-to-abate sectors* (steel, fertilizers, long-distance transport, aviation, and maritime), where direct electrification is technically difficult or economically unviable. It is in these sectors that renewable hydrogen and its derivatives are no longer a future option but are becoming an explicit pillar of European climate policy.

### REPowerEU and the hydrogen strategy

The European Hydrogen Strategy (2020), within the framework of the Green Deal, places renewable hydrogen as a priority vector for the decarbonization of energy-intensive industrial sectors and certain segments of transport and proposes a progressive deployment of electrolysis capacity in the Union towards 2030. Following Russia's invasion of Ukraine, the REPowerEU plan (May 2022) reinforces this orientation and introduces, as a political signal and order of magnitude, the ambition to significantly increase domestic production of renewable hydrogen and to complement this supply with imported volumes by 2030.



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An important financial instrument to achieve these objectives is the European Hydrogen Bank, which offers production support auctions within the EU. Through these initiatives along with sectoral RFNBO incorporation quotas, the Union seeks to send a signal of long-term demand and, at the same time, contribute to the formation of a price reference for renewable hydrogen in the European context.

### The concept of RFNBO in RED II

The revision of the Renewable Energy Directive in 2018 (RED II) introduced the category of **Renewable Fuels of Non-Biological Origin (RFNBO)**: hydrogen generated with renewable electricity and synthetic fuels derived from it (e-ammonia, e-methanol, e-SAF, e-diesel, etc.). Two Delegated Acts adopted in February 2023 set the rules for certifying a fuel as RFNBO:

1. The criteria for considering the electricity used as renewable.
2. The methodology for calculating *well-to-grave* emissions, which requires a saving of at least 70% compared to the reference fossil fuel.

These criteria are the main focus of this report and are discussed in detail in the following sections.

### RED III and the shift to binding renewable hydrogen quotas

The latest revision of the directive, published in October 2023 (RED III), introduces a qualitative change: it not only raises the overall target for renewables to 42.5% of gross final energy consumption in 2030, but it also incorporates specific consumption obligations for renewable hydrogen and RFNBOs:

- **Industrial sector.** At least 42% of hydrogen consumed must be renewable by 2030, increasing to 60% by 2035.
- **Transport sector.** At least 1% of final energy consumed in 2030 must come from RFNBOs, in parallel with a separate target for advanced biofuels.

With these obligations, renewable hydrogen and e-fuels are no longer voluntary options and become part of mandatory quotas in the European energy matrix.

It is important to clarify that RED III does not replace RED II or the Delegated Acts on RFNBOs; rather, the third directive amends the previous one in some areas. For example, it may modify objectives in some sectors, introduce new ones, or keep others in force, as established under RED II.

### ReFuelEU Aviation and FuelEU Maritime: drivers of sectoral demand

The **Fit for 55** package complements RED III with specific rules for international modes of transport:

- **ReFuelEU Aviation** establishes that sustainable aviation fuel (SAF) must represent 2% of kerosene in 2025, 6% in 2030, and 70% in 2050. Within that figure, there is a sub-target for synthetic SAF (i.e., RFNBO) starting at 1.2% in 2030 and reaching 35% in 2050.
- **FuelEU Maritime** imposes a progressive reduction in the GHG intensity of marine fuels: -2% in 2025, -6% in 2030, and up to -80% in 2050, granting a favorable multiplication factor to e-fuels until 2033. Additionally, it is important to note that RFNBOs are expected to play an important role as tools for sectoral emissions savings, since, after efficiency solutions in ship design and engine optimizations, there are not many additional alternatives for

defossilization in long-distance maritime transport to replace fossil fuels with low-emission fuels.

Together, these regulations guarantee growing demand for e-SAF and maritime e-fuels based on renewable hydrogen.

Nature	Transport	Industry	Storage	Infrastructure	
Target & Rules	RED II and RED III			Ten-E	AFIR
	Delegated Acts on RFNBOs				
	CO <sub>2</sub> Emissions standards for cars and vans				
	CO <sub>2</sub> Emissions standards for Heavy-Duty Vehicles				
	Fuel EU Maritime				
	REFuel EU Aviation				
Hydrogen and Decarbonized gases Package (Directive and Regulation)					
Carbon pricing	EU-ETS				
	EU CBAM				
Financing & Incentives	EU Hydrogen Bank				
	Modernization and Innovation Fund				
	EU Taxonomy				
	Net Zero Industry Act				
<div style="display: flex; justify-content: space-around; align-items: center;"> <span>Regulation</span> <span>Directive</span> <span>Delegated legislation</span> <span>Other</span> </div>					

Figure 1 - European Union regulatory framework for RFNBOs. Source: International PtX Hub

### Domestic scarcity and opportunities for exporters

Member States have limited renewable potential and, except in some cases such as Spain or Portugal, face higher hydrogen production costs than regions with particularly abundant solar and wind resources. The EU itself recognizes that it will not be able to meet all its targets with domestic supply: REPowerEU is an early signal of this, estimating that approximately half of the renewable hydrogen needed in 2030 will need to be imported. Additionally, several EU Member States are already anticipating a structural role as importers of renewable hydrogen and derivatives (RFNBOs). Germany's updated National Hydrogen Strategy estimates a demand of 95-130 TWh of hydrogen and derivatives in 2030, of which 50-70% (~45-90 TWh) should be covered by imports, which is further developed in the Hydrogen and Derivatives Import Strategy adopted in 2024 (Eckardt, Hoehne, & Stenzel, 2023). Belgium, with its federal hydrogen strategy, explicitly positions itself as an import and transit hub in Northwestern Europe and projects consumption of 10-15 TWh/year of renewable hydrogen in 2030, over 90% of which would come from abroad (FPS Economy, 2022). Meanwhile, the Netherlands is developing the port of Rotterdam as a key hub for the arrival of hydrogen and carriers such as ammonia, with plans to supply several million tons per year to Europe

by 2030, largely from imports. Taken together, these national strategies and the numerous supply agreements announced for Germany and the Netherlands reinforce the signal that a significant portion of future European demand for RFNBO will be supplied via imports from third countries (Port of Rotterdam, 2024).

For projects such as those planned in Argentina, this has two direct implications:

1. **A market with a “premium” price.** European buyers will be incentivized to pay a premium for certified molecules because they need to demonstrate regulatory compliance.
2. **The obligation to certify.** Full compliance with the Delegated Acts (additionality, traceability, and emissions threshold) is a condition of market access so that EU Member States can count these products toward their obligations. Voluntary schemes recognized by the Commission, such as CertifHy, REDCERT, or ISCC EU RFNBO, act in practice as commercial “passports.”

In less than a decade, the European Union has shifted from focusing on the deployment of renewable electricity to legislating mandatory quotas for renewable hydrogen and e-fuels, setting up a framework in which it acts as a global benchmark: it sets rules for production (RFNBO criteria) and demand (RED III, ReFuelEU, FuelEU).

For any Argentine project aiming to supply renewable hydrogen or PtX products to the EU, understanding this regulatory ecosystem is not only desirable but essential: it conditions the technical configuration of the plant, the emissions baseline, and, ultimately, the project’s bankability. The following section analyzes in detail the Delegated Acts of RED II, a key instrument for translating European political objectives into concrete and verifiable certification requirements.

## 5 Renewable Energy Directive and Delegated Acts on renewable H2 and PtX products

### 5.1 Emergence of RFNBOs

The first two Renewable Energy Directives (RED I and RED II) establish a common framework for promoting energy from renewable sources in the EU and define the rules on state aid, self-consumption, heating and cooling, transport, regional cooperation, guarantees of origin, and sustainability criteria for biofuels and biomass.

This directive introduces the concept of Renewable Fuels of Non-Biological Origin (RFNBO) in a context linked to the decarbonization of the transport sector (which was later extended to other sectors) and in the quotas established by the directive in that sector, on the understanding that, in addition to electrification and biofuels, there was a family of fuels produced from renewable energies (through electrolysis) with great potential for the sector's defossilization and scalability. By introducing this new family of clean fuels, the directive provides basic guidelines on the criteria for

defining when a fuel is an RFNBO and lays the groundwork for the European Commission to design specific technical criteria for certifying RFNBOs.

This discussion and design of certification rules was a process that included consultation with stakeholders and development time. Finally, in February 2023, the European Commission published two Delegated Acts<sup>1</sup> defining these technical certification criteria.

Following the publication of the Delegated Acts on RFNBO, the third Renewable Energy Directive (RED III) was adopted. With Directive (EU) 2023/2413 (RED III), the European Union decisively expands the scope of renewable fuels of non-biological origin: it no longer considers them almost exclusively as a tool for decarbonizing transport and makes them a cross-cutting pillar by imposing binding quotas for renewable hydrogen in industry (42% in 2030 and 60% in 2035), maintaining a specific sub-target within the new 29% renewable energy target for transport, and introducing indicative targets for the maritime sector. As a result, RFNBOs are moving from being a niche solution to playing a central role in the European decarbonization strategy for the next decade.

## 5.2 Delegated Acts

Delegated Act 2023/1185 establishes a **methodology** for assessing the greenhouse gas emissions savings resulting from RFNBOs.

Delegated Act 2023/1184, in turn, focuses on the characteristics that **electricity** used in RFNBO production must meet for it to be considered “**Fully Renewable**.”

Additionally, it is worth clarifying that Delegated Act 2023/1185 not only establishes rules for quantifying the emissions intensity of RFNBOs, but also includes another family of fuels called Recycled Carbon Fuels (RCF). RCFs are fuels produced from non-renewable liquid or solid waste streams. They are not linked to renewable H<sub>2</sub> and its derivatives, but they need to be mentioned because the emissions intensity quantification methodology described in the Delegated Act was designed for both fuel families, meaning some terms have more relevance for RCFs than for RFNBOs.

## 5.3 Criteria for a product to be an RFNBO:

### 5.3.1 70% criterion and emissions threshold

RED II regulation introduced in its Article 25 that, for a fuel to qualify as an RFNBO, it must reduce greenhouse gas emissions by at least 70% compared to the fossil reference alternative.

$$\text{Emissions savings} = \frac{E_{ref} - E_{RFNBO}}{E_{ref}} < 70\%$$

<sup>1</sup> A Delegated Act is a non-legislative, general-scope, binding rule that the Commission issues to supplement or refine non-essential details of an EU law.

Delegated Act 2023/1185, in its annex, explicitly sets the emissions intensity of the fossil fuel reference at 94 gCO<sub>2</sub>/MJ.

This means that an RFNBO must have a GHG emissions intensity equal to or less than **28.2 gCO<sub>2</sub>/MJ**, which is equivalent to 3.38 kg CO<sub>2</sub>/kg H<sub>2</sub>.

$$E_{RFNBO} \leq 28,2 \frac{gCO2_{eq}}{MJ} = 3,38 \frac{kgCO2}{kgH2}$$

### 5.3.2 GHG equation

Delegated Act 2023/1185 establishes the methodology for quantifying the emissions intensity of an RFNBO (and RCFs). This methodology is of the “Well-to-grave” type, which means that all emissions produced from the production chain to the use or consumption of the RFNBO must be taken into account.

It is not a complete life-cycle analysis, as the regulation explicitly states that emissions generated in the manufacture of machinery and equipment should not be quantified.

The equation included in the Delegated Act is as follows:

$$E = e_i + e_p + e_{td} + e_u - e_{ccs}$$

Before going into detail on each of the terms in the equation, the following diagram shows a visual simplification to better understand the scope and approach of the regulation. It should be noted that the equation includes the most common and obvious emissions, but it must also consider slightly more specific cases of recycled carbon fuel production. As a result, some terms are more intuitive to understand and relevant in general terms for RFNBOs, while others are intended for specific projects where additional emissions must be considered.

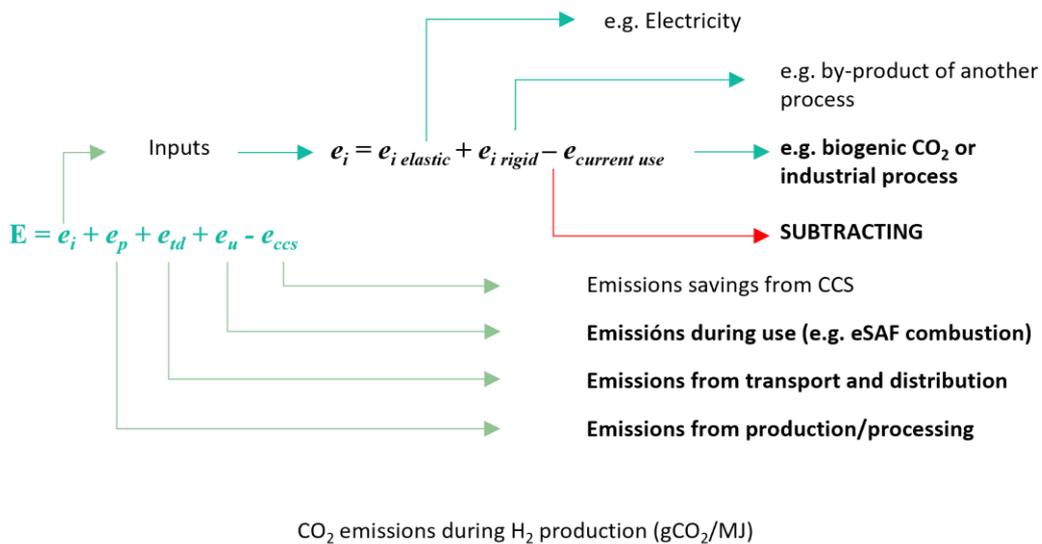


Figure 2 – Equation for calculating GHG emissions intensity for RFNBOs

### 5.3.3 Terms of the equation

#### Emissions from input supply (e<sub>i</sub>)

This term incorporates emissions associated with elements used as inputs in the RFNBO production process.

Within this term, two points can be critical in RFNBO production: *electricity* and *carbon sources* (when dealing with carbon-containing molecules).

This category includes three types of input emissions:

- **Elastic input emissions** – Emissions associated with inputs used in RFNBO production that may increase if more inputs are needed. Clear examples include:
  - Water – If desalinated water from a third-party plant is used. The emissions associated with the water used must be quantified.
  - Electricity – If the electricity consumed during RFNBO production cannot be considered “Fully Renewable,” the emissions associated with non-renewable electricity must be included in this term. The report will later provide further details on the criteria for considering energy as Fully Renewable.

If the electricity can be considered “**Fully Renewable**” under the criteria defined in Delegated Act 2023/1184, the CO<sub>2</sub> emissions associated with that electricity are considered to be zero (2023/1185, Annex A, point 5).

- **Emissions from rigid inputs:** these are emissions associated with inputs that cannot be supplied in greater quantities to meet additional demand. This term is more closely linked to RCFs and the use of recycled coal.
- **Emissions from existing use or fate:** The first point to note about this term is that it is subtracted in the equation. This is because it accounts for the emissions that are avoided by their incorporation into the fuel molecule.

In the case of RFNBOs, this term applies to molecules that contain carbon and therefore, in addition to hydrogen, require a carbon source for their production. The regulation indicates that, if the carbon source is accepted according to the criteria described, the avoided CO<sub>2</sub> emissions must be quantified and subtracted from the overall equation, since incorporating it into the molecule prevents CO<sub>2</sub> from reaching or being in the atmosphere.

#### **The carbon sources accepted under the regulation are:**

- A. *CO<sub>2</sub> from specific industrial sources:* Activities that can be considered as accepted sources require two conditions:

- i. The activity must be listed in Annex I of Directive 2003/87/EC. This list includes electricity generation, chemical plants, refining, cement plants, steel production, aluminum production, among others.
- ii. CO<sub>2</sub> emissions have been previously taken into account in an effective emissions pricing system. They must pay carbon tax or be in a Cap & Trade scheme such as the European Union ETS.

If these conditions are met, the use of this CO<sub>2</sub> source is considered eligible until 2041, except for CO<sub>2</sub> originating from electricity generation, in which case its use is permitted only until 2036. More information on carbon sources eligible under EU regulations can be found in the study “Identification of suitable carbon as feedstock for PtX products to be exported to Europe” (Reihle & Scheyl, 2024).

The feasibility of subsection ii) as applied to projects in Argentina will be reviewed in a later section.

- B. *Direct Air Capture*: CO<sub>2</sub> has been captured from the air (DAC processes).
- C. *Biogenic sources*: CO<sub>2</sub> comes from biogenic sources, either during the production of biofuels (liquid or gaseous) or during the combustion of these biofuels. Biofuels must comply with European Union sustainability criteria.
- D. *RFNBOs and RCFs as carbon sources*: CO<sub>2</sub> comes from the combustion of these clean fuels.
- E. *Geological CO<sub>2</sub>*: The carbon comes from a geological source and was previously released naturally.

### **Emissions from processing (e<sub>p</sub>):**

This term must take into account emissions from processing, including direct atmospheric emissions from the processing itself, waste treatment, and leaks. This should include all direct emissions from the production process (H<sub>2</sub> production, conversion to derivatives, and all systems necessary for this to occur). An example of this would be the thermal use of natural gas to regenerate amines from a carbon capture plant in an e-methanol facility.

### **Emissions from transport and distribution (e<sub>td</sub>):**

This term includes emissions associated with the transport and distribution of products (emissions associated with the transport and distribution of inputs should not be accounted for here, but rather under input emissions). It should be noted that this category should include, for example, emissions associated with the transport by ship of RFNBOs exported from Argentina to Europe, and emissions from distribution by land transport to their point of use (if any).

### **Emissions from utilization (e<sub>u</sub>):**

Under this term CO<sub>2</sub> emissions that may occur during the use of RFNBO must be taken into account, for example, in the combustion of eSAF or e-methanol. These emissions will depend on the

stoichiometric ratio and conversion during the combustion reaction. Emissions associated with the combustion of eSAF or e-methanol are well above the 28.2 gCO<sub>2</sub>/MJ threshold; however, as discussed in the explanation of emissions savings, when CO<sub>2</sub> that is accepted by the regulations is used as an input, the emissions from its use are offset by avoided emissions.

#### **Emissions savings from carbon capture and storage (e<sub>CCS</sub>):**

Here, consideration must be given to the emissions savings that can be achieved if the project includes CO<sub>2</sub> capture with subsequent geological storage (CCS). These are very specific situations that are not usually common in RFNBO projects.

#### **5.3.4 Concept of relevant energy and RFNBO share**

Delegated Act 2023/1185 distinguishes the concept of “relevant energy” from the total energy consumed in the production chain of an RFNBO product.

Relevant energy is the part of the energy from the inputs that actually contributes to the energy content of the final fuel (or its intermediate), measured by the Lower Heating Value (LHV), and including only the share of electricity and heat that effectively serves to increase that energy content.

For example, the energy content of hydrogen produced by electrolysis comes from the electricity that powers the electrolyser, and this electricity counts as relevant energy. On the other hand, the electricity that powers the motor of the water feed pump to the electrolyser is non-relevant energy, as it does not increase the energy content of the hydrogen product.

The most important relevant energy in RFNBOs production processes is the electricity that powers the electrolyser. Some conversion processes may incorporate other energy inputs that can qualify as relevant energy, an example is the heat required for endothermic reactions, such as the RGWS reaction used in e-methanol.

When the relevant energy does not qualify entirely as fully renewable under the criteria of the Delegated Acts, the percentage of product that can be certified as RFNBO is calculated based on the relevant energy that is fully renewable divided by the total relevant energy of the process.

This means, for example, that if at any time an electrolyser is supplied with more energy than can be verified as fully renewable, only the fully renewable fraction can qualify as RFNBO.

This analysis of relevant renewable energy and the share that can be counted as RFNBO must be carried out in parallel with the total calculation of the emissions intensity of the products. To this end, it will be important for production plants to have certified instrumentation to verify electricity flows.

As an additional reference and by way of providing another example, if the electricity supply of an RFNBO plant is mixed (fully renewable energy and a portion of energy that is not fully renewable) but the relevant electricity (electrolyser consumption) is fully covered by fully renewable energy, and the energy that does not qualify as fully renewable is only counted for non-relevant energy consumption, that plant may still certify 100% of its product as RFNBO. Provided that the emissions intensity does not exceed 28.2 gCO<sub>2</sub>/MJ.

### 5.3.5 Considerations for quantifying emissions intensity

#### One fuel, two labels: RFNBO, non-RFNBO, and co-processing cases

If the product is a mixture of RFNBO with biofuels or other fuels that do not qualify as RFNBO (for example, in the case where not all production can be considered RFNBO due to the criteria explained in the previous section on relevant energy), the emissions intensity will be the same for all the product produced in that batch. That is, all emissions included in the equation, linked to that entire production batch, must be considered and divided by the total production. Thus, two products with different commercial values (RFNBO and a low-carbon product that does not qualify as RFNBO) can be obtained, and both have the same emissions intensity, which must be below 28.2 gCO<sub>2</sub>/MJ.

The exception to this rule is the case of **co-processing**, in which RFNBOs only partially replace a conventional input in the process.

In this situation, the calculation of greenhouse gas emissions intensity will distinguish, in proportion to the energy value of the inputs, between:

- the part of the process based on the conventional input, and
- the part of the process based on renewable liquid and gaseous fuels of non-biological origin and recycled carbon fuels, assuming that the other parts of the process are identical.

An example of this would be the partial replacement of grey hydrogen feedstock in a Haber-Bosch unit with renewable hydrogen. In this case, the production batch can be divided into two commercial products with different emission intensities: renewable ammonia (RFNBO) and grey or conventional ammonia.

#### Production of more than one product:

When the RFNBO plant has co-products that are exported from the plant with commercial value, including chemical compounds with energy value, chemical compounds without energy value, energy in the form of heat, and electricity, emissions must be allocated according to the following criteria:

- All emissions from the co-production process and upstream of it (inputs, processes, transport, etc.) must be included in the analysis.
- If there are processes that treat only one co-product, the emissions associated with that process should be considered only for that specific product.
- When the process allows the proportion of co-products manufactured to be changed, the allocation shall be made on the basis of physical causality, determining the effect on process emissions of increasing the production of a single co-product while keeping the other final products constant. This may apply, for example, to the production of eSAF by Fisher-Tropsch, where the yield of eSAF can be adjusted relative to other synthetic products, but this adjustment may represent an increase in total emissions. This increase should be allocated to the extra yield of eSAF, not distributed evenly to all co-products.

- When the proportion of products is fixed and all co-products are fuels, electricity, or heat, the allocation shall be based on the energy content. If the allocation refers to exported heat on the basis of energy content, only the useful portion of the heat may be considered, as defined in Annex V, Part C, point 16, of Directive (EU) 2018/2001.
- where the proportion of products is fixed and some co-products are materials with no energy content, the allocation shall be based on the economic value of the co-products. The economic value considered shall be the average ex-factory value of the products over the last three years. If such data are not available, the value shall be estimated on the basis of raw material prices minus transport and storage costs.

Examples of co-products for RFNBOs include oxygen from electrolysis, surplus heat from processes, or, in the case of eSAF production, other synthetic co-products such as synthetic gas, synthetic diesel, or synthetic fuel oil.

In order for a share of emissions to be assigned, these co-products must have economic value; emissions cannot be allocated, for example, to oxygen that is vented or to process heat that is removed via cooling water.

### 5.3.6 Importance of electricity emissions

The above equation shows that it is necessary to conduct an in-depth analysis of the emissions intensity of the RFNBO production chain up to its consumption. However, there is one component in particular that is of greater relevance due to the production process of these fuels: emissions associated with electricity. These emissions must be added to the term “input emissions.”

The electricity used in electrolysis contributes the largest percentage of the chemical energy contained in RFNBO, and although the electrolysis process from renewable sources is a process with almost zero emissions, if the electrolysis is powered by electricity generated from fossil fuels, the emissions can be very high, higher than conventional methods of hydrogen production from natural gas reforming.

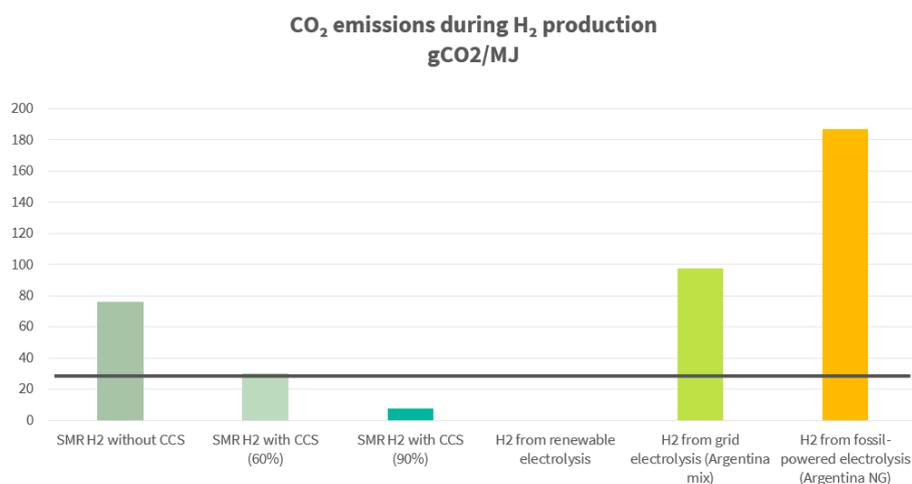


Figure 3 - Emissions associated with H<sub>2</sub> production by different technological routes. Source: Own elaboration.

The potential negative effect of using electricity generated from fossil fuels can be very significant and negates the main objective of RFNBOs, which is to reduce GHG emissions.

The Delegated Act discussed above, which establishes the methodology for quantifying fuel emission intensity, determines that the electricity consumed must be classified into two categories for the quantification of emissions:

- a) “Fully Renewable” electricity
- b) Electricity that is not “Fully Renewable”

The regulation establishes that zero emissions are assigned to electricity that can be considered (and demonstrated) as “fully renewable.”

The European Commission dedicated a specific Delegated Act to establishing the criteria and rules for when energy can be considered “Fully Renewable,” which is explained below.

On the other hand, the regulation does not prohibit the use of non-renewable electricity, but requires that its emissions be taken into account. In practice, these emissions depend on the mix of the electrical grid from which it is extracted. If the emissions intensity corresponds to that of fossil-fuel thermal generation, even with a small percentage of electricity use of this type, the established threshold of 28.2 gCO<sub>2</sub>/MJ is reached.

The regulations establish three alternatives for assigning emission intensity to electricity that does not qualify as fully renewable:

- A- Annual calculation according to “Part C”
- B- “Full load hours” method
- C- Marginal unit emissions intensity according to the Transmission System Operator

#### Alternative A

Alternative A cites the methodology detailed in Part C of the annex to the Delegated Act.

This methodology requires the quantification of emissions from the entire electricity supply in the bidding zone (or country), for which data on fuel consumption and electricity generation by technology is necessary.

The following types of emissions must be quantified:

- CO<sub>2</sub> emissions during combustion at the power plant
- Emissions of other GHGs during combustion, expressed in terms of CO<sub>2</sub> equivalent
- CO<sub>2</sub> emissions from the fuel source (upstream emissions)

The same section provides tables of all the emission factors to be considered.

It should be noted that emissions from the fuel source must also be considered in the case of nuclear energy (although there are no emissions during use, there are emissions during extraction and processing).

#### Alternative B

The “full load hours” method involves assigning emissions by comparing the load factor of the RFNBO plant (expressed in hours at full load) with the number of hours per year in which renewable

or nuclear generation sets the marginal price of grid energy. If the plant's load is less than the hours during which the grid energy price is set by “clean” energy, 0 gCO<sub>2</sub>/MJ is assigned; if it is greater, 183 gCO<sub>2</sub>/MJ is assigned.

If this simplified method is used, the same criterion must be used to establish emissions for all energy consumed, regardless of whether the energy is considered Totally Renewable (in this case, the criterion in point 5 of Annex A would not be valid; totally renewable energy is not assigned zero emissions by default, but rather all energy is judged using this method of 0 or 183 gCO<sub>2</sub>/MJ).

Alternative C

If the transmission system operator publishes the emission intensity of the marginal unit (the last generation unit to enter based on marginal cost) at the time the RFNBO is produced, that value may be used as the emission intensity of the grid electricity consumed on an hourly basis that is not fully renewable.

For the analysis of the case in Argentina, the implementation of alternative A will be analyzed.

**5.3.7 “Fully renewable” electricity – Delegated Act 2023/1184**

It was mentioned in the previous section that, in the case of electricity that can be calculated and certified as “fully renewable,” the assigned emissions will be 0 gCO<sub>2</sub>/MJ for that energy.

Delegated Act 2023/1184 defines the criteria under which energy can be considered *fully renewable*. It classifies the explanation into two types of cases:

- i. Energy obtained from directly connected renewable generation facilities (Article 3), which we will identify as **“direct connection;”**
- ii. Electricity extracted from the electricity grid (Article 4), which we identify as **“grid energy.”**

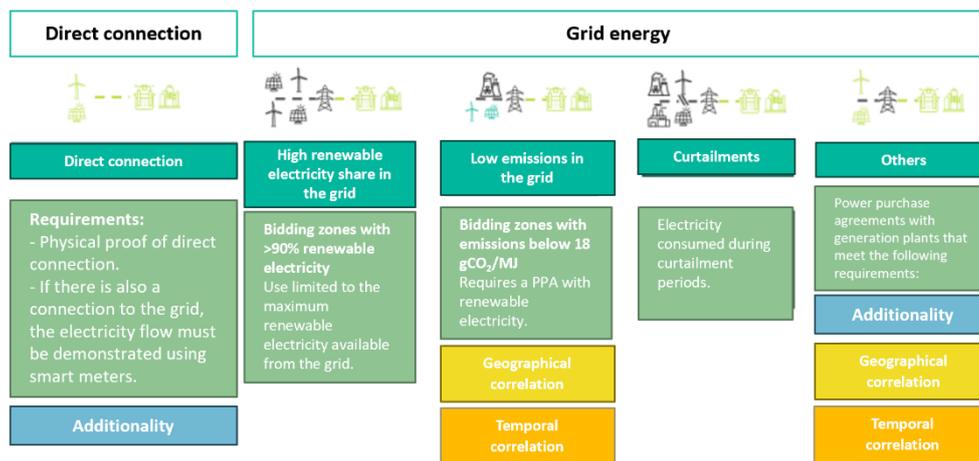


Figure 4 - “Fully renewable” electricity supply alternatives in accordance with Delegated Act 2023/1184

### 5.3.7.1 Fully renewable energy in cases of DIRECT CONNECTION

To verify that the electricity obtained from a direct connection to a renewable energy generation facility is *fully renewable*, the RFNBO producer must provide evidence of the following:

- A. Demonstrate that there is a direct connection between the generation facilities and the RFNBOs production plant.
- B. The renewable generation park began operating no more than 36 months before the start of operation of the RFNBO production plant.
- C. The renewable generation park is not connected to the grid, or if it is, it has a smart meter that can be used to monitor energy flows and verify that no energy from the grid has been used for RFNBO production.

### 5.3.7.2 Fully renewable energy in cases of GRID ENERGY

To verify that the electricity drawn from the electricity grid can be counted as *fully renewable*, the RFNBO producer has four alternatives.

#### 1- Electricity grid with a high percentage of renewables

Electricity can be counted as *fully renewable* if the RFNBO production plant is located in a **bidding zone** where the share of renewable generation exceeded 90% in the previous calendar year. In this case, the usage factor of the RFNBO plant cannot exceed the share of renewable energy in the bidding zone. If it is verified that the share of renewable electricity exceeds 90% during a year, it will continue to be considered above 90% for the following five calendar years.

#### Electricity grid with a very low carbon footprint

If point 1 is not met, in the event that the RFNBO production plant is located in a **bidding zone** where the electricity emission intensity is less than 18 gCO<sub>2</sub>/MJ. Provided that the following is also met:

- D. The production plant has a PPA with renewable generators for at least the total energy to be certified under this criterion.
- E. **The temporal and geographical correlation** explained in the following section is met. In this case, it is not necessary to prove the additionality criterion.

#### 2- Electricity taken from the grid to avoid curtailments<sup>2</sup>

Electricity taken from the grid for an RFNBO product can be counted as *fully renewable* if it can be demonstrated that the injection of renewable electricity into the grid has been redispatch, and that

<sup>2</sup> Forced reduction in available electricity generation (e.g., from wind or solar farms) due to grid limitations, congestion, operational restrictions, or lack of demand, even though the units could continue to produce energy from a technical and resource standpoint.

the electricity consumption of the RFNBO plant reduced the need for redispatch of renewable energy.

### 3- Electricity grid with a contract for renewable generation, additionality, geographical and temporal correlation

If none of the above three cases apply, the RFNBO producer may consider electricity taken from the grid to be *fully renewable* if it meets the following criteria:

- **ADDITIONALITY**
- **GEOGRAPHICAL CORRELATION**
- **TEMPORAL CORRELATION**

#### Additionality criterion

The additionality criterion can be met both by generating renewable energy within the RFNBO production facilities and by contracting renewable electricity from the grid with economic operators. In both cases, the energy generated by these facilities must be equal to or greater than the electricity consumed by the RFNBO plant that will be certified as renewable under this criterion. To meet the additionality criterion, the following two conditions must be met:

- 1) The renewable generation facility must have become operational no more than 36 months before the RFNBO production plant.
- 2) The facility generating renewable electricity has not received support in the form of operational aid or investment aid.

These conditions will not apply until January 1, 2038, to facilities producing RFNBOs that become operational before January 1, 2028. This exemption will not apply to capacity added after January 1, 2028, for RFNBO production.

#### Temporal correlation criterion

The temporal correlation indicates that, for the electricity consumed by an RFNBO production plant to be counted as *fully renewable* under cases 2 and 4 described at 5.3.7.2 (through a PPA with a grid-connected renewable generation facility), the electricity must be generated and injected into the grid by the contracted facility during the same period in which it is consumed.

The period for performing this energy balance between generation and demand will be hourly as of January 1, 2030. Prior to that date, the energy balance may be monthly.

The temporal correlation allows the use of intermediate electricity storage, provided that it is new. In such cases, the temporal correlation of the battery charging must be demonstrated, as well as the hourly correlation between the electricity delivery from the storage system and the RFNBO plant. The battery storage system may be located either at the renewable generation facilities or at the RFNBO production facilities.

### **Geographical correlation criterion**

The geographical correlation indicated for counting electricity as fully renewable under cases 2 and 4 described at 5.3.7.2 (through a PPA with a renewable generation facility connected to the grid) shall be considered to be met when:

- the facility that generates renewable electricity under the renewable energy purchase agreement is located, or was located at the time of its entry into operation, in the same **bidding zone** as the electrolyser;
- the facility generating renewable electricity is located in an interconnected **bidding zone** and the electricity prices during the relevant period on the daily market in the interconnected bidding zone are equal to or higher than those in the bidding zone where the renewable liquid and gaseous fuel of non-biological origin is produced;
- the facility generating renewable electricity under the renewable electricity purchase agreement is located in an offshore bidding zone interconnected with the bidding zone in which the electrolyser is located.

As can be seen, the geographical correlation of the regulation uses the concept of **bidding zone**, which is a very clear definition that plays a fundamental role in the European Union's electricity market and the interconnected transmission system.

### **5.3.8 Definition of Bidding Zone in Europe and Interpretation of Bidding Zone for other countries**

#### **5.3.8.1 Use of the concept of “Bidding Zone” for RFNBO: RED II, Delegated Act, and Q&A**

As indicated in the previous section, the **bidding zones** of the European Union's electricity market play a decisive role in the RFNBO certification criteria. They are used to define the criteria for fully renewable electricity in cases 1 and 2 of the section 5.3.7.2, and for the geographical correlation criterion.

To better frame the European Commission's intention behind the use of bidding zones in the regulation to certify RFNBOs, it is worth highlighting some issues described in the RED II regulation, prior to the Delegated Acts. The document states the following:

*“The Commission should develop, by means of delegated acts, a reliable Union methodology to be applied where such electricity is taken from the grid. That methodology should ensure that there is a temporal and geographical correlation between the electricity production unit with which the producer has a bilateral renewables power purchase agreement and the fuel production. For example, renewable fuels of non-biological origin cannot be counted as fully renewable if they are produced when the contracted renewable generation unit is not generating electricity. **Another example is the case of electricity grid congestion, where fuels can be counted as fully renewable only when both the electricity generation and the fuel production plants are located on the same side in respect of the congestion.** Furthermore, there should be an element of additionality, meaning that the fuel producer is adding to the renewable deployment or to the financing of renewable energy”.*

**It is therefore understandable that RED II focuses on ensuring that the introduction of RFNBO plants does not contribute to congestion in the electricity transmission network.**

#### **Delegated Act 2023/1184**

The Delegated Act on definitions of *fully renewable* energy for RFNBO production states the following:

***Bidding zones are designed to avoid grid congestion within the zone. To ensure that there is no electricity grid congestion between the electrolyser producing renewable hydrogen and the installation generating renewable electricity it is appropriate to require that, both installations should be located in the same bidding zone. Where they are located in interconnected bidding zones, the electricity price in the bidding zone where the installation generating renewable electricity is located should be equal or higher than in the bidding zone where the renewable liquid and gaseous transport fuel of non-biological origin is produced so that it contributes to reducing congestion; or the installation generating renewable electricity under the power purchase agreement should be located in an offshore bidding zone interconnected to the bidding zone where the electrolyser is located***

In the previous section, the European Commission first highlights that bidding zones do not have (structural) electricity congestion and then implies that the use of the bidding zone concept as a criterion for RFNBOs is to ensure that there is no congestion between the electrolyser and the renewable energy facility.

Finally, the document “Questions and Answers – Implementation of hydrogen Delegated Acts” (European Commission, 2023), published after the publication of the Delegated Acts for RFNBO certification, adds, among other issues, some clarifications for possible interpretations of the concept of geographical correlation and the equivalent of European Union bidding zones.

It indicates that the interpretation of bidding zones could be transferred to a country outside the EU based on the objectives of EU regulation and similar concepts in the country in question. These similar classification concepts may be similarities in the electricity market, physical characteristics of the electricity grid, the level of interconnection, or, ultimately, the country as a whole.

This document, which, unlike Delegated Acts, is non-binding, states that the following approach should be taken:

- If there are rules establishing hourly electricity prices in a given area, that area should be considered equivalent to a bidding zone.
- If there are no rules establishing hourly electricity prices, certifiers must assess whether there is an integrated grid or several separate grids. If there are several separate grids, each grid could be considered as a bidding zone.
- Finally, if the country's electricity grid is fully integrated and there are no geographically differentiated electricity prices, the entire country can be considered as a single bidding zone.

The interpretation of bidding zones in a country that has an electricity market design similar to that of the EU, with dispatch organized by regions, within which there is no structural congestion, and there are unified hourly prices for each region, will be simple. However, in countries where the electricity market design differs conceptually from the European electricity market, the interpretation will require further analysis, with support from certification schemes and the European Commission, if necessary.



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## 6 Application of criteria for RFNBO certification in Argentina

The previous sections have presented and described the RFNBO certification criteria required by European Union regulations.

Below, we analyze how these criteria could be applied to RFNBO production projects located in Argentina.

### 6.1 Equivalence for “bidding zone” in Argentina

First, it should be noted that there are no electricity “bidding zones” in Argentina. As these are markets regulated in completely different ways, the European definition cannot be directly applied to Argentina. The only option is to interpret the regulation established in the Renewable Energy Directive and in the Delegated Acts, and propose an equivalent delimitation of areas for Argentina.

In the Annex: *EU bidding zones vs. the Argentine electricity market* provides a technical explanation of the definition of bidding zones in the European Union's electricity market, along with a simplified description of Argentina's electricity system, in order to highlight relevant issues that will affect the interpretation of the concept of bidding zones for projects located in Argentina.

A priori, two ways are identified for Argentina to transfer the use of the EU bidding zone concept in the Delegated Acts to certify RFNBOs:

1. **Argentina as a single bidding zone**
2. **Establishing several bidding zones in Argentina**

Delegated Act 2023/1184 does not establish specific rules for interpreting the concept of bidding zones for countries outside the EU, which makes sense because the range of cases outside the EU is too broad and diverse to be able to write a regulation that can be applied directly throughout the world. Although not very specific, the Delegated Act states:

*When referring to bidding zones and the imbalance settlement period, concepts that exist in the Union but not in all other countries, it is appropriate to allow fuel producers in third countries to rely on equivalent concepts, provided that the objective of this Regulation is maintained and the provision is implemented on the basis of the most similar concept that exists in the third country concerned. In the case of bidding zones, this concept could correspond to similar market regulations, the physical characteristics of the electricity network, in particular the level of interconnection, or, as a last resort, the country.*

#### 6.1.1 Argentina as a single bidding zone

The Delegated Acts indicate that it is possible to consider the country as a single bidding zone only as a last resort. However, they indicate that it is first necessary to analyze whether there are electricity market rules similar to those in the EU and also to consider the physical characteristics of the grid.

In addition, in the RFNBO Questions and Answers document, which serves as a non-binding reference guide for the implementation of RFNBO certification criteria, devotes a section to the analysis of “bidding zones” for countries outside the EU.

There, as mentioned above, it states:

- If there are rules establishing hourly energy prices for a given area, that area should be considered a bidding zone.
- It then states that a country can be considered a bidding zone if it meets two conditions: it is interconnected and there is no geographical differentiation in energy prices.

Reasons for considering the entire continental territory of Argentina as a single bidding zone:

- There are rules that establish hourly energy prices for the entire country. This is justified because economic dispatch is carried out with all power plants in the country based on marginal cost; dispatch is not segregated by area.
- The country is practically fully interconnected, with 22 of the 23 provinces interconnected. The only province that is not yet connected to the electricity transmission system is Tierra del Fuego, so if this interpretation is followed, it should be clarified that this province would not, in principle, be included in what would be considered the equivalent of the “continental” Argentina bidding zone.

Reasons that challenge the consideration of the entire country as a single bidding zone:

- Although there is a uniform rule for setting hourly prices for the entire country, and the economic order for electricity dispatch is carried out with all the power plants in the country, it cannot be said that there is no geographical differentiation in energy prices, since Argentina has a system of nodal energy prices, which start from an energy price at a reference node, but which are affected by nodal factors that introduce structural characteristics of congestion and transport, affecting the price at each node.
- Even more relevant, both the RED II regulation and Delegated Act 2023/1184 explicitly state that there should be no congestion between the renewable electricity generation facility and the RFNBO production plant. If the entire Argentine territory were considered equivalent to a single European bidding zone, a project could produce RFNBO in Buenos Aires while considering renewable energy sources from power plants located in the Cuyo region and/or Patagonia, more than a thousand kilometers from the RFNBO plant, connected by high-voltage electricity corridors that are already known to be congested.

### 6.1.2 Argentina divided into several “bidding zones”

In contrast to the previous alternative, if the European Commission's main objective in introducing the concept of “bidding zones” for geographical correlation is interpreted as is to prevent RFNBO production projects from negatively affecting the efficient operation of the EU's electricity transmission network, it is necessary to conduct a more transparent analysis of the coexistence of the Argentine electricity network with potential RFNBO projects connected to the network.

### Reasons for subdividing Argentina into the equivalent of several “bidding zones”

- In order to comply with the objective set out in RED II and DA 2023/1184 of preventing significant structural congestion between renewable generation and RFNBO production.
- Considering a subdivision of areas not only pursues the spirit of the wording of the Delegated Acts and the geographical correlation considered by the European Commission, but also prevents inefficient use of the Argentine transmission network. If the country were a single bidding zone, RFNBO projects would compete directly with other electricity consumption, such as direct electrification solutions, for the transmission capacity of high-voltage lines that are already saturated. And for the purposes of reducing emissions, it is much more efficient to use the electricity grid to electrify uses than to produce RFNBO.
- In an analysis focused more on the territorial, federal, and resource management levels, rather than on the technical aspects of grid use, subdividing the country would promote the industrialization of regions that currently have lower levels of economic development and fewer productive alternatives. The decentralization of industrial plants associated with the RFNBO production promotes the creation of quality jobs and industrial development in the regions where the renewable energy resource is obtained, facilities that, on their own, generally do not generate a significant positive impact in the places where they are located.

### Reasons that challenge the idea of subdividing Argentina into several “bidding zones”

- Although there is regionalization in the interpretation and monitoring of electricity generation and demand data by the Argentine transmission system operator (CMMESA), no radical change is expected in the electricity market that would introduce zoned energy prices similar to European bidding zones. Economic dispatch will continue to be centralized, with all the country's power plants.
- The most literal interpretation of the guidance provided in the annex to the Q&A document refers to the same hourly pricing rules, and the rules are national, not regional.

If it is possible to further analyze the subdivision of the country into the equivalent of several “bidding zones” for the application of European criteria, one proposal could be to use the electricity regions used by CMMESA and the electricity market, and to define each electricity region as equivalent to an EU “bidding zone.” Thus, the country could be considered divided into nine “bidding zones”:

Table 1 - Delimitations of the electrical regions of the Argentine electrical system

ELECTRIC REGION	PROVINCES
<b>Buenos Aires</b>	Province of Buenos Aires
<b>Centro</b>	Córdoba and San Luis
<b>Comahue</b>	Neuquén, Río Negro, and La Pampa
<b>Cuyo</b>	Mendoza and San Juan
<b>Gran Buenos Aires</b>	Ciudad Autónoma de Buenos Aires and Gran Buenos Aires
<b>Litoral</b>	Santa Fe and Entre Ríos
<b>Noreste</b>	Corrientes, Misiones, Chaco, and Formosa
<b>Noroeste</b>	Jujuy, Salta, Tucumán, Catamarca, and Santiago del Estero
<b>Patagonia</b>	Santa Cruz and Chubut

Strictly speaking, this division would not guarantee the absence of electrical congestion within a single electrical region, but it would certainly reduce the load or utilization of the high-voltage lines that interconnect the regions.

On the other hand, this subdivision makes sense when analyzing how CMMESA has historically managed information on the electrical system. CMMESA formally records and publishes all its generation, demand, and transmission data, segregated based on this regional classification. Therefore, a delimitation of areas using these regions could be applied in a simple, transparent, and official manner. This allows for knowledge of historical generation by source type, with granularity down to 15 minutes if required, demand in each region, interregional transmission capacity, emissions from generation in each region, etc.

### 6.1.3 Interpretation Resolution for the “bidding zone” in Argentina

The official interpretation of the application of the RFNBO certification criteria (including these points of geographical correlation and the equivalent of a bidding zone for Argentina) is the responsibility, in the first instance, of the certification schemes approved by the European Commission for RFNBO certification and, in the second instance, if necessary, of the European Commission directly.

In simpler matters, certification schemes may already have clarified the path to take to define the applicability of the criteria defined in the RFNBO Delegated Acts. However, on some key and sensitive issues with high potential impact, both for RFNBO projects and for the country in which they will be located, there is precedent for technical intervention by the European Commission to provide guidance on certain interpretations.

Although the definition is not in the hands of local actors, such as project developers, economic operators, transmission system operators, or the relevant government agencies, the input of these actors is key to interpreting the potential impact of the regulation's application in countries outside the EU.

In particular, the perspective of the transmission system operator (CAMMESA, in the case of Argentina) and the National Energy Secretariat may carry significant weight when analyzing certain issues, especially where the link between the national electricity market and RFNBO production is at stake.

Until there is an official determination of the interpretation of geographical correlation and bidding zones, it is worth considering both scenarios for the analysis that continues in the following sections.

#### **A. Scenario A: Argentina as a single bidding zone**

#### **B. Scenario B: Argentina subdivided into several “bidding zones”**

The reader should understand that, for the time being, both scenarios are possible and must manage this uncertainty in their projects until a formal resolution is reached.

## **6.2 Fully renewable electricity through the grid**

Next, we will analyze the application of cases in which electricity taken from the grid can be considered fully renewable, specifically for projects installed in Argentina. For the analysis, we will consider the two scenarios for interpreting the concept of geographic correlation and bidding zones mentioned above.

### **6.2.1 Fully renewable electricity - Grid case > 90% RE**

Case 1 explained in the section 5.3.7.2 indicates that electricity taken from the grid in a bidding zone can be considered *fully renewable* if the share of renewable energy generation in a calendar year is greater than 90%.

The Argentine electricity system coordinator, CAMMESA, periodically publishes data related to the system operation. Below is the electricity generation connected to the grid for 2023 and 2024, classified by province, region, and generation technology.

Table 2 - Electricity generation 2024 (GWh). Source: CAMMESA

Region/Province	Total Nuclear	BIOG	BIOM	WND	HY<50	HY>50	SOL	Total Renewable	CC	DI	GT	ST	Total Thermal	Total
BUENOS AIRES	6,167	60	0	6,304	0	0	0	6,363	7,701	219	1,703	976	10,599	23,130
BUENOS AIRES	6,167	60	0	6,304	0	0	0	6,363	7,701	219	1,703	976	10,599	23,130
CENTRO	4,282	149	70	1,040	220	552	264	2,294	2,901	4	332	0	3,238	9,814
CORDOBA	4,282	101	70	667	220	552	45	1,654	2,901	4	332	0	3,238	9,174
SAN LUIS	0	48	0	373	0	0	219	640	0	0	0	0	0	640
COMAHUE	0	14	0	940	174	11,457	14	12,598	9,585	197	2,047	0	11,829	24,427
LA PAMPA	0	14	0	169	45	267	12	507	0	6	0	0	6	512
NEUQUEN	0	0	0	348	0	11,190	1	11,540	8,400	126	2,047	0	10,573	22,113
RIO NEGRO	0	0	0	423	129	0	0	552	1,185	65	0	0	1,250	1,801
CUYO	0	0	0	0	553	2,531	1,410	4,495	2,961	101	246	216	3,524	8,019
MENDOZA	0	0	0	0	323	2,256	38	2,617	2,961	101	193	216	3,470	6,087
SAN JUAN	0	0	0	0	230	276	1,372	1,878	0	0	54	0	54	1,931
GRAN BUENOS AIRES	0	201	0	0	0	0	0	201	26,258	229	430	2,288	29,205	29,406
BUENOS AIRES	0	201	0	0	0	0	0	201	26,258	229	430	2,288	29,205	29,406
LITORAL	0	78	0	0	0	5,346	0	5,424	8,459	205	96	4	8,764	14,188
ENTRE RIOS	0	0	0	0	0	5,346	0	5,346	0	5	0	0	5	5,351
SANTA FE	0	78	0	0	0	0	0	78	8,459	200	96	4	8,759	8,837
NORESTE	0	0	579	0	0	10,965	77	11,621	0	118	0	0	118	11,739
CHACO	0	0	73	0	0	0	77	150	0	33	0	0	33	182
CORRIENTES	0	0	354	0	0	10,965	0	11,318	0	12	0	0	12	11,331
FORMOSA	0	0	0	0	0	0	0	0	0	35	0	0	35	35
MISSIONS	0	0	153	0	0	0	0	153	0	38	0	0	38	191
NOROESTE	0	11	98	657	396	119	2,176	3,458	6,650	270	499	148	7,567	11,025
CATAMARCA	0	0	0	0	0	0	164	164	0	45	0	0	45	209
JUJUY	0	0	0	0	97	0	850	947	0	118	0	18	136	1,084
LA RIOJA	0	0	0	650	0	0	364	1,014	0	17	33	0	49	1,063
SALTA	0	0	68	0	50	119	798	1,035	2,363	65	173	130	2,731	3,765
SGO. DEL ESTERO	0	0	0	7	109	0	0	116	0	25	29	0	55	171
TUCUMAN	0	11	30	0	140	0	0	181	4,288	0	264	0	4,552	4,733
PATAGONIA	0	0	0	7,224	168	2,454	0	9,847	334	131	79	0	545	10,392
CHUBUT	0	0	0	5,673	168	2,454	0	8,296	334	10	17	0	361	8,657
SANTA CRUZ	0	0	0	1,551	0	0	0	1,551	0	121	62	0	183	1,734
<b>Grand total</b>	10,449	512	747	16,165	1,512	33,424	3,941	56,301	64,851	1,473	5,433	3,632	75,388	142,138

Table 3 - Electricity generation 2023 (GWh). Source: CAMMESA.

Region/Province	Total Nuclear	BIOG	BIOM	WND	HY<50	HY>50	SOL	Total Renewable	CC	DI	GT	ST	Total Thermal	Total
BUENOS AIRES	3,293	34	0	5,215	0	0	0	5,249	8,124	422	2,968	3,265	14,779	<b>23,321</b>
BUENOS AIRES	3,293	34	0	5,215	0	0	0	5,249	8,124	422	2,968	3,265	14,779	<b>23,321</b>
CENTRO	4,176	130	84	535	189	715	156	1,809	3,222	12	379	0	3,614	<b>9,599</b>
CORDOBA	4,176	90	84	535	189	715	0	1,612	3,222	12	379	0	3,614	<b>9,402</b>
SAN LUIS	0	40	0	0	0	0	156	197	0	0	0	0	0	<b>197</b>
COMAHUE	0	14	0	1,019	131	7,693	0	8,857	9,950	235	2,664	0	12,849	<b>21,706</b>
LA PAMPA	0	14	0	173	15	84	0	286	0	7	0	0	7	<b>292</b>
NEUQUEN	0	0	0	377	0	7,609	0	7,986	8,851	172	2,664	0	11,686	<b>19,672</b>
RIO NEGRO	0	0	0	469	116	0	0	586	1,099	57	0	0	1,156	<b>1,742</b>
CUYO	0	0	0	0	307	1,223	833	2,362	2,843	60	123	150	3,176	<b>5,538</b>
MENDOZA	0	0	0	0	187	1,164	27	1,378	2,843	60	90	150	3,143	<b>4,521</b>
SAN JUAN	0	0	0	0	119	59	806	984	0	0	33	0	33	<b>1,017</b>
GRAN BUENOS AIRES	0	156	0	0	0	0	0	156	22,241	401	1,453	3,103	27,200	<b>27,355</b>
BUENOS AIRES	0	156	0	0	0	0	0	156	22,241	401	1,453	3,103	27,200	<b>27,355</b>
LITORAL	0	76	0	0	0	3,798	0	3,874	9,214	627	153	17	10,011	<b>13,885</b>
ENTRE RIOS	0	0	0	0	0	3,798	0	3,798	0	8	0	0	8	<b>3,806</b>
SANTA FE	0	76	0	0	0	0	0	76	9,214	619	153	17	10,003	<b>10,079</b>
NORESTE	0	0	589	0	0	14,133	0	14,721	0	160	2	0	161	<b>14,883</b>
CHACO	0	0	60	0	0	0	0	60	0	42	0	0	42	<b>102</b>
CORRIENTES	0	0	394	0	0	14,133	0	14,526	0	13	0	0	13	<b>14,539</b>
FORMOSA	0	0	0	0	0	0	0	0	0	30	0	0	30	<b>30</b>
MISSIONS	0	0	135	0	0	0	0	135	0	75	2	0	77	<b>211</b>
NOROESTE	0	8	97	421	375	167	1,939	3,007	8,479	291	281	146	9,197	<b>12,205</b>
CATAMARCA	0	0	0	0	0	0	158	158	0	48	0	0	48	<b>206</b>
JUJUY	0	0	0	0	99	0	828	927	0	120	0	12	132	<b>1,059</b>
LA RIOJA	0	0	0	411	0	0	133	545	0	45	28	0	73	<b>617</b>
SALTA	0	0	69	0	46	167	820	1,103	3,495	60	91	134	3,779	<b>4,882</b>
SGO. DEL ESTERO	0	0	0	10	117	0	0	127	0	20	36	0	55	<b>182</b>
TUCUMAN	0	8	28	0	112	0	0	148	4,984	0	127	0	5,110	<b>5,259</b>
PATAGONIA	0	0	0	6,975	58	2,458	0	9,491	499	112	116	37	764	<b>10,255</b>
CHUBUT	0	0	0	5,411	58	2,458	0	7,927	499	12	15	0	526	<b>8,453</b>
SANTA CRUZ	0	0	0	1,565	0	0	0	1,565	0	100	101	37	238	<b>1,803</b>
<b>Grand total</b>	<b>7,469</b>	<b>418</b>	<b>769</b>	<b>14,164</b>	<b>1,060</b>	<b>30,186</b>	<b>2,928</b>	<b>49,527</b>	<b>64,571</b>	<b>2,321</b>	<b>8,139</b>	<b>6,719</b>	<b>81,751</b>	<b>138,747</b>



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### 6.2.1.1 Scenario A: Argentina as the only bidding zone

When analyzing the entire country as a whole, in 2023, energy generated from renewable sources (including large and small hydropower plants, solar farms, wind farms, and biomass and biogas plants) was 49,527 GWh, while total energy generated was 138,747 GWh, representing **35.7%**. During 2024, renewable generation was 56,301 GWh out of a total of 142,138 GWh, representing **39.6%**.

**With these values, Argentina's entire electricity grid clearly does not qualify for the 90% criterion. If the interpretation of bidding zones is that of scenario A, renewable energy taken from the grid cannot be certified in this case.**

### 6.2.1.2 Scenario B: Argentine electricity regions equivalent to EU bidding zones

When analyzing electricity generation in 2024 using data published by CAMMESA, the following shares by energy source per region can be observed.

Table 4 - Share of renewable energy in electricity generation in 2024 classified by electricity region.

Source: CAMMESA

Region	Nuclear	Renewable	Thermal
Buenos Aires	26.7	<b>27.5</b>	45.8
Centro	43.6	<b>23.4</b>	33.0
Comahue	0.0	<b>51.6</b>	48.4
Cuyo	0.0	<b>56.1</b>	43.9
Gran Buenos Aires	0.0	<b>0.7</b>	99.3
Litoral	0.0	<b>38.2</b>	61.8
<b>Noreste</b>	0.0	<b>99.0</b>	1.0
Noroeste	0.0	<b>31.4</b>	68.6
<b>Patagonia</b>	0.0	<b>94.8</b>	5.2
<b>Grand total</b>	<b>7.4</b>	<b>39.6</b>	<b>53.0</b>

Among Argentina's nine electricity regions, two have very high percentages of renewable generation: the *Noreste* and *Patagonia* regions. The *Noreste* region is characterized by the binational Yaciretá hydropower plant, which it shares with Paraguay. Yaciretá is a reservoir hydropower plant with an installed capacity of 3,100 MW. Electricity is distributed 50% to Paraguay and 50% to Argentina. However, because there is a surplus in relation to demand on the Paraguayan side, Argentina normally buys part of the energy that corresponds to its neighbor from Paraguay. As noted above, the *Noreste* region exports almost half of its energy to the Gran Buenos Aires and Central regions.

The Patagonian region, for its part, has a major reservoir hydropower plant (Futaleufú) located in Chubut, which accounts for about 30% of the region's renewable generation; the remaining 70% comes from wind generation. The Patagonian region is also an energy-exporting region through the Patagonia-Comahue-Buenos Aires corridor.

The remaining regions have a lower share of renewable generation. Comahue, with its hydropower plants, and Cuyo, with solar energy, are regions with a high percentage of renewables, but they do not reach 90% threshold.

**In conclusion, if this were to be the regulatory framework for interpreting Bidding Zones, the Noreste and Patagonia regions would qualify as areas where renewable energy accounts for over 90% of the total. Energy taken from the grid in these regions could qualify as fully renewable under this criterion.**

### 6.2.2 Fully renewable electricity - Case of grid with emissions intensity < 18 gCO<sub>2</sub>/MJ

Case 2 explained in the section 5.3.7.2 indicates that electricity taken from the grid in a bidding zone can be considered fully renewable if the emissions intensity of the grid is less than 18 gCO<sub>2</sub>/MJ.

The data published periodically by CAMMESA includes CO<sub>2</sub> emissions data. Emissions are calculated based on fuel consumption by type, by power plant, and are published on a daily basis. CAMMESA's calculation methodology is similar to that established in Delegated Act 2023/1185, part C of the Annex, based on the fuel consumed and the emission factor of each fuel. However, the following points are not considered in CAMMESA's quantification of emissions and are required by European regulations:

- CH<sub>4</sub> and N<sub>2</sub>O emissions during stationary combustion for electricity generation
- Emissions associated with the supply of these fuels (upstream emissions)
- Emissions associated with fuel supply in nuclear generation
- Emissions associated with biomass power plants (they do not emit net CO<sub>2</sub>, but they do emit CH<sub>2</sub> and N<sub>2</sub>O).

The change in the value of emissions when these issues are taken into account increases the emissions of Argentina's electricity matrix by approximately 20-25%. The following table shows emission intensity values using the emission data and calculation methodology indicated by the European Union. Emissions associated with biomass generation were estimated using expected yields for this type of technology. However, the impact of these plants is extremely low, so any discrepancy between assumed consumption and reality is negligible in the final result.

Table 5 - Electricity emission intensity of the electricity grid in 2024. Source: CAMMESA.

Region	Emission factor kgCO <sub>2</sub> /MWh	Emission factor gCO <sub>2</sub> /MJ
Buenos Aires	275	76
Centro	202	56
Comahue	287	80
Cuyo	238	66
Gran Buenos Aires	526	146
Litoral	315	88
Noreste	11	3
Noroeste	350	97
Patagonia	35	10
<b>Grand total</b>	<b>292</b>	<b>81</b>

### 6.2.2.1 Scenario A: Argentina as the only bidding zone

The average intensity of electricity from the grid in Argentina is 81 gCO<sub>2</sub>/MJ, which is above 18 gCO<sub>2</sub>/MJ, and the overall mix could not qualify under case 2 for fully renewable energy.

### 6.2.2.2 Scenario B: Argentine electricity regions equivalent to EU bidding zones

If the analysis is carried out in electricity regions as “bidding zones,” the *Patagonia* and *Noreste* regions are the only ones with emission intensities below 18 gCO<sub>2</sub>/MJ. However, as indicated above, these regions would fall under case 1 to qualify as fully renewable energy, so the emission intensity analysis would not be relevant for these two regions.

The remaining regions have emission intensities well above the established limit.

## 6.2.3 Fully renewable electricity - Grid case with Curtailments

This study does not address in detail the option of certifying electricity as *fully renewable* during curtailment hours in accordance with DA 2023/1184, as this is currently a marginal scenario in Argentina. Unlike European markets with clear hourly signals (including very low or negative prices), in the Argentine wholesale electricity market, the conditions that trigger this case are not yet frequent or predictable enough to be incorporated into the design and financing of RFNBO projects. As renewable penetration increases, price signals are modernized, and measurable systematic curtailments appear on an hourly basis, this mechanism could gain relevance and should be reevaluated in future analyses.

## 6.2.4 Fully renewable electricity – Grid case with PPA + Additionality + Temporality + Geographic correlation

Case 4, explained in the section 5.3.7.2 , is notable because it can be applied regardless of how renewable or clean the electricity grid is where the RFNBO production plant is located. It is presented as a possibility of using the electricity grid to connect the renewable generation facility to the production plant. The three required criteria are analyzed below: additionality, temporal correlation, and geographic correlation.

### 6.2.4.1 Additionality

The additionality criterion first requires signing a PPA with a new renewable generation plant that has been in operation for no more than 36 months prior to the RFNBO production plant. No issues have been identified in meeting this requirement; in fact, this is the way the MATER (Renewable Energy Forward Market) operates.

### No-Aid Clause

Additionally, the regulations indicate that the renewable energy plant with which the energy supply contract is signed **must not have received support in the form of operating aid or investment aid.**

In Argentina, there are incentive programs that establish or may establish tax benefits that apply to renewable generation parks, and these benefits must be analyzed to determine whether or not they fall within the restriction indicated in the Delegated Act. The programs or laws applicable to renewable generation parks are:



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- 1) Renewable Energy Law: All renewable energy parks connected to the grid installed since 2015 were installed under this regulation, which grants benefits such as exemption from import tariffs.
- 2) RIGI: The Large Investment Incentive Regime includes 30-year fiscal stability, import and export tariff exemptions, accelerated depreciation, among other benefits. To apply for this regime, projects must meet certain requirements, including being worth more than \$200 million and applying within two years of the law coming into force in August 2024.
- 3) H2 Promotion Bill: In August 2025, the ruling party presented a bill to promote low-carbon hydrogen based on the RIGI but extending the deadlines for joining the scheme and for investments disbursements. At the time of publication of this study, the bill is under consideration in Congress and has not yet been put to a vote.

Delegated Act 2023/1184, which defines the concept of additionality, does not explicitly specify the scope of what is included under “support in the form of aid.”

On the other hand, the Q&A document published by the European Commission elaborates on this point, indicating that the operating aid or investment aid referred to in Article 5(b) could be considered to include any payment received from public authorities for the construction of renewable electricity generation facilities and any benefit received from public authorities for the production of renewable electricity, including regulated feed-in tariffs, feed-in premiums, production reductions, contracts for difference, or any direct payment linked to the production of renewable electricity. Operating aid or investment aid does not include obligations or restrictions imposed on consumers, producers, or energy suppliers, such as renewable energy obligations.

These clarifications by the European Commission are not explicit regarding how tax and fiscal incentives, such as those included in the aforementioned promotion regulations, should be treated.

On the other hand, the REDCERT certification scheme (approved by the European Commission to certify RFNBO), in the document published on its website “*Scheme principles for the production of RFNBO and RCF*” (REDcert GmbH, 2024), indicates that if facilities that generate renewable electricity receive preferential tax treatment compared to facilities that generate non-renewable electricity, this is also not considered operational aid or investment aid.

The European Commission assigns an important role to certification schemes for the application and interpretation of the criteria of Delegated Acts for certifying RFNBO, which is why the document published by REDcert is of significant value. It does not carry the same weight as an official and binding publication of the European Commission, but it is an indication of how European regulations may be interpreted in these cases.

If a development in Argentina seeks to demonstrate compliance with the additionality requirement for case 4 explained in the section 5.3.7.2, it should seek specific advice on this point from a certification scheme accepted by the European Commission for RFNBO certification.

It is important to clarify that, for direct connections between the renewable energy generation facility and the RFNBO production plant, the “no-aid” clause does not apply; it only applies in order to consider electricity taken from the grid as fully renewable under the criteria of case 4.

### 6.2.4.2 Temporal correlation

In order to comply with the hourly temporal correlation required from 2030 onwards, direct communication between the RFNBO production plant and the renewable generation park(s) with which it has a supply contract must be considered.

To certify hourly renewable use, the wind/solar farm(s) and the RFNBO plant need to share reliable hourly data on how much renewable energy was generated and how much was consumed by the plant, via a secure channel. This can be solved with the same industrial technologies that companies already use today (telemetry/SCADA and certified meters), similar to when multiple power plants are operated from a dispatch center. No complex cross-checking is necessary; it is sufficient to automatically send these readings every few minutes so that the plant can adjust its consumption and demonstrate the hourly correlation without complications.

Load variations at the plant must be managed so that they remain within the flexibility capabilities of the chemical plant. These variations required of chemical plants (H<sub>2</sub> production and conversion) are not, in technical terms, any more complex or demanding than the variations required when there is a direct connection between RFNBO plants and renewable energy parks without grid support. In fact, in those cases there is much less capacity to manage energy and the rate of variation than when the electricity grid is in the middle and there is an hour's margin for balancing.

In summary, the electricity transaction between renewable generation facilities and the RFNBO plant can be explained as consisting of three levels:

- **Technical operation:** Direct communication system (it is sufficient for this to be between private actors only) to vary the load of the RFNBO plant according to the hourly generation (or with less granularity) of the renewable park, as mentioned in the previous paragraph.
- **RFNBO certification:** To verify compliance with European regulations, certified meters must be installed at the injection point of the renewable generation park and at the consumption point of the RFNBO plant, in order to record and audit the volumes of energy transferred from the grid on an hourly basis and verify that the temporal correlation is met.
- **Commercial:** At the commercial level, electricity transaction balances will probably continue to be carried out on a monthly basis; there is no requirement for certification under European regulations.

### 6.2.4.3 Geographical correlation

For geographical correlation, the regulation indicates that renewable generation facilities must be located in the same bidding zone as the RFNBO plant.

The regulation allows renewable energy facilities to be in a different bidding zone from the RFNBO plant if electricity prices are higher in the bidding zone where the renewable generation facilities are located than in the bidding zone where the RFNBO plant is located.

### **Scenario A: Argentina as a single bidding zone**

If the entire country is considered equivalent to a single bidding zone, the renewable generation park(s) could be located anywhere within the continental national territory (the province of Tierra del Fuego is not interconnected), regardless of the location of the RFNBO production plant.

### **Scenario B: Argentine electricity regions equivalent to EU bidding zones**

In this case, the renewable generation park would, in principle, need to be located in the same electricity region as the RFNBO production plant in order to comply with the geographical correlation. If the interpretation of bidding zones is as described above, it would be necessary to review how the exception for supplying renewable energy with a generation park located in a different bidding zone can be translated, which indicates that this is possible when electricity prices are higher in the generation zone than in the zone where the RFNBO plant is located.

## **6.3 Emissions from energy that does not qualify as “Fully Renewable”**

As described in section 5.3.6, European regulations do not prohibit the use of electricity from the grid that cannot be considered *fully renewable*, but rather require that the emissions associated with such non-renewable electricity be included in the equation for calculating the RFNBO emissions intensity to verify that the intensity is below the required limit of 28.2 gCO<sub>2</sub>/MJ.

Below, emissions from the Argentine electricity grid will be estimated using the methodology proposed by the European Commission in Delegated Act 2023/1185, part C.

Although CAMESA estimates and reports the carbon emissions associated with electricity generation in a manner similar to the methodology proposed in the Delegated Act, there are certain differences that require adjustments in order to use the values in accordance with European regulations.

### Alternative A

Alternative A cites the methodology detailed in Part C of the annex to the Delegated Act.

This methodology requires the quantification of emissions from the entire electricity supply in the bidding zone (or country), for which data on fuel consumption and electricity generation by technology is necessary.

The following types of emissions must be quantified:

- CO<sub>2</sub> emissions during combustion at the power plant
- CH<sub>4</sub> and N<sub>2</sub>O emissions.
- CO<sub>2</sub> emissions from the fuel source (known as “upstream” emissions)

The same section of the Delegated Act provides tables of all the emission factors to be considered.

In addition to emissions associated with fossil fuel consumption, the regulation states that emissions associated with electricity generation from nuclear energy and from biomass and biogas must also be considered.

### Estimation of emissions from nuclear energy:

According to the methodology, a 33% efficiency rate should be considered for nuclear energy and an upstream emission factor for nuclear fuel of 1.2 gCO<sub>2</sub>/MJ should be considered.

### Estimation of emissions from electricity generation from biomass fuels:

The methodology indicates that CH<sub>4</sub> and N<sub>2</sub>O emissions and upstream emissions for biomass and biogas must be considered.

Table 6 – Emission factors from the fuel source. Source: Delegated Act 2023/1185.

		Biomass	Biogas
FE CH <sub>4</sub>	gCO <sub>2</sub> /MJ	0.03	0.001
FE N <sub>2</sub> O	gCO <sub>2</sub> /MJ	0.004	0.0001
FE “upstream”	gCO <sub>2</sub> /MJ	0.7	13.7

In the case of generation from biomass and biogas, CAMMESA has not reported biogas and biomass consumption by generation source. For the purposes of this estimation, an energy efficiency is assumed and emissions are calculated from there. The efficiencies considered are low in relation to typical values in order to obtain a conservative calculation:

- Energy efficiency of electricity generation with biomass : 18%.
- Energy efficiency of electricity generation with biogas: 28%.

As will be shown in the following tables, the impact of emissions from the nuclear and biomass sectors is not significant in the total system emissions.

Table 7 - GHG emissions from electricity generation in 2024 by electricity region. Source: own elaboration based on CAMMESA data and criteria from Delegated Act 2023/1185.

2024	GHG EMISSIONS (tons of CO <sub>2</sub> )									
	Fossil fuel emissions				Nuclear	Biomass	Biogas	Total emissions	FE kgCO <sub>2</sub> /MWh	FE gCO <sub>2</sub> /MJ
Region	MINERAL COAL	FUEL OIL	GAS NATURAL	GAS OIL						
BUENOS AIRES	590,246	235,215	4,784,776	662,098	80,731	0	10,559	6,363,624	275	76
CENTRO			1,416,344	484,280	56,046	3,639	26,377	1,986,686	202	56
COMAHUE			6,994,595	6,027			2,388	7,003,011	287	80
CUYO		31,914	1,877,631	358				1,909,903	238	66
GRAN BUENOS AIRES		503,274	14,382,761	553,204			35,481	15,474,720	526	146
LITORAL		85,403	3,426,517	948,194			13,722	4,473,836	315	88
NORESTE				98,954		30,110	-	129,064	11	3
NOROESTE			3,688,516	162,091		5,112	1,970	3,857,689	350	97
PATAGONIA			361,170			-	-	361,170	35	10
<b>Grand total</b>	590,246	855,806	36,932,311	2,915,205	136,776	38,861	90,497	41,559,703	292	81

Table 8 - GHG emissions from electricity generation in 2023 by electricity region. Source: own elaboration based on CAMMESA data and criteria from Delegated Act 2023/1185.

2023	GHG EMISSIONS (tons of CO <sub>2</sub> )									
	Fossil fuel emissions				Nuclear	Biomass	Biogas	Total emissions	FE kgCO <sub>2</sub> /MWh	FE gCO <sub>2</sub> /MJ
Region	MINERAL COAL	FUEL OIL	NATURAL GAS	GAS OIL						
BUENOS AIRES	1,134,081	802,170	5,186,792	1,061,835	48,943	0	9,721	8,243,542	385	107
CENTRO			1,339,117	399,753	68,382	3,831	23,130	1,834,214	182	51
COMAHUE			6,314,342	9,399		-	1,627	6,325,369	254	71
CUYO		13,895	1,734,073	181		-	-	1,748,150	274	76
GRAN BUENOS AIRES		1,370,009	12,588,342	596,725		-	28,856	14,583,932	537	149
LITORAL		278,755	2,170,337	1,609,550		-	11,795	4,070,437	379	105
NORESTE				117,300		30,191	-	147,491	8	2
NOROESTE			3,980,856	216,787		4,043	1,899	4,203,585	378	105
PATAGONIA	81,730		449,449			-	-	531,179	49	14
<b>Grand total</b>	1,215,811	2,464,829	33,763,308	4,011,531	117,325	38,065	77,028	41,687,898	295	82

As can be seen in the tables, the carbon intensity to be used for energy that does not qualify as fully renewable depends on the final interpretation of the concept of bidding zones and geographical correlation for Argentina.

In scenario A, where the entire SADI is recognized as a single bidding zone, the average carbon intensity of the entire system should be used, which in 2023 was 82 gCO<sub>2</sub>/MJ and in 2024 was 81 gCO<sub>2</sub>/MJ.

In the case of scenario B, where each electricity region is considered equivalent to a European bidding zone, the average annual intensity of each region should be taken.

As a reference for the impact of electricity consumption with this carbon intensity on the carbon footprint of the RFNBO product, if the consumption of the electrolysis plant is 55 kWh/kg of hydrogen, and 10% of that electricity does not qualify as *fully renewable*, with a carbon intensity of 81 gCO<sub>2</sub>/MJ, the hydrogen would have a footprint of 13.4 gCO<sub>2</sub>/MJ due to the input of non-renewable electricity.

## 6.4 CO<sub>2</sub> Sources and Emissions

As we have seen, the Delegated Acts recognize several carbon sources that may be accepted for RFNBO production, such as eSAF or green methanol.

The most relevant sources for commercial-scale projects in the short term are biogenic point sources and industrial point sources permitted by the regulation.

The study “CO<sub>2</sub> Sources for PtX Production in Argentina” and the interactive map of point carbon sources in Argentina (International PtX Hub, CO<sub>2</sub> Sources for PtX Production in Argentina, 2024) identified the main carbon sources that can be found in Argentina.

Among the biogenic point sources, bioethanol plants located mainly in Córdoba, Tucumán, and Salta stand out, as they are sources of significant volumes.

Other biogenic sources, such as biomass and biogas power plants, are also relevant, but they are more decentralized and the scale of carbon availability is generally insufficient to satisfy medium- or large-scale eSAF or methanol projects.

Table 9 – Biogenic point sources by province, (International PtX Hub, CO<sub>2</sub> sources for PtX production in Argentina, 2024)

Province	Biogenic Point Sources (kt/year)			Total
	Bioethanol	Biogas Power Plant	Biomass Power Plant	
	1.012	477	394	1.882
Buenos Aires	-	229	0	229
Santa Fe	99	64	-	163
Córdoba	336	96	145	577
San Luis	62	35	-	96
La Pampa	-	13	-	13
Tucumán	261	20	29	310
Salta	174	-	99	273
Jujuy	80	-	-	80
Misiones	-	20	121	141

The pulp and paper industry is associated with significant amounts of CO<sub>2</sub> emissions per industrial plant. A large share of these emissions are biogenic in origin, however, there is generally also a fossil fraction. In such cases, the characteristics of the available CO<sub>2</sub> emissions must be studied on a case-by-case basis. In Argentina, the pulp and paper industry has a strong presence in Misiones, Santa Fe, Buenos Aires, and Jujuy.

Table 10 - Point sources of CO<sub>2</sub> from the pulp and paper industry by province, (International PtX Hub, CO<sub>2</sub> Sources for PtX Production in Argentina, 2024)

Province	Pulp and Paper (kt/year)
	2.287
Buenos Aires	422
Santa Fe	416
Jujuy	298
Misiones	1.147
Entre Ríos	4

For biomass-derived carbon to be used as a carbon source in RFNBO production, such biomass must comply with the sustainability and greenhouse gas emission savings criteria established by the European Union. These criteria include requirements related to land use and land use change, sustainable forest management, emissions throughout the biomass production and supply chain, as well as requirements for traceability of the sustainable origin of the resource.

With regard to specific industrial sources of fossil fuel, according to Delegated Act 2023/1185, the activities listed in Annex I of Directive 2003/87/EC are accepted. European regulations allow their use until 2041, except in the case of electricity generation, where their use is only allowed until 2035.

As can be seen in the figure, when surveying these types of point sources in Argentina in the aforementioned study, greater availability in terms of scale and geographical distribution was identified than for biogenic sources. Among these specific fossil-fuel sources, those linked to cement plants, steel, aluminum, ammonia, and refining production stand out. The provinces with the largest industrial carbon sources are Buenos Aires, Córdoba, Catamarca, and Santa Fe.

Table 11 - Point sources by province (International PtX Hub, Sources of CO<sub>2</sub> for PtX Production in Argentina, 2024)

Province	Industry Point Sources (kt/year)						Total
	Cement	Steel	Aluminum	Ammonia	Ethylene	Methanol	
	12.059	7.054	612	821	611	309	21.466
Buenos Aires	5.419	5.936	-	747	585	-	12.687
Santa Fe	-	1.118	-	-	26	34	1.152
Mendoza	534	-	-	-	-	-	534
Córdoba	2.366	-	-	-	-	-	2.366
San Luis	840	-	-	-	-	-	840
Neuquén	305	-	-	-	-	275	581
Chubut	-	-	612	-	-	-	612
Santa Cruz	458	-	-	-	-	-	458
Salta	-	-	-	74	-	-	74
Catamarca	1.374	-	-	-	-	-	1.374
Jujuy	763	-	-	-	-	-	763

#### 6.4.1 Carbon tax on industrial CO<sub>2</sub> from fossil-fuel sources

Although European regulations allow the use of industrial carbon from fossil-fuel sources until 2041, such as emissions from a cement or steel production plant, it imposes a specific condition that calls into question the applicability of industrial sources in Argentina: the captured emissions must have been part of an effective carbon pricing system.

In the European Union, activities covered by the scheme are subject to the EU ETS (EU Emissions Trading System), an emissions trading system based on the “*cap and trade*” principle. The system sets a cap on the total volume of greenhouse gases that covered operators may emit, and that cap is progressively reduced in line with the EU's climate targets. Within this limit, facilities must purchase and surrender emission allowances for each ton of CO<sub>2</sub>eq emitted, so that, in practice, emitters pay for their emissions and may *trade* those allowances among themselves, while facing penalties if they do not surrender enough allowances to cover their emissions.

In Argentina, there is no emissions pricing system for industry. The closest mechanism that exists in the country is a carbon tax on liquid fuels. Regardless of the discussion about the level of the tax and whether it could be considered “effective” under EU criteria, this tax does not apply to natural gas consumption, and the vast majority of point-source industrial emissions arise from the use of natural gas as a fossil fuel rather than from liquid fuels.

Although the official pronouncement of the analysis must be under European Commission, a priori, it could be said that most industrial fossil sources in Argentina are not covered by an effective pricing system. This may mean that they cannot be used as carbon sources if RFNBOs are to be certified under European regulation, at least not as that regulation is currently written.

The use of biogenic carbon sources, together with the possible capture of carbon directly from the air, seem to be the most convenient options in terms of sustainability and certification of RFNBOs for access to the European market. In the absence of a carbon pricing system in Argentina, combined with the temporal restriction on the use of industrial carbon sources (only until 2041 or 2036 for thermal power plants), relying on such sources may introduce an element of regulatory risk and cost uncertainty into economic models beyond 2041, potentially undermining project development and bankability.

## 6.5 Emissions from maritime transport of RFNBOs

As seen in the section 5.3.2, in order to calculate the emissions intensity of an RFNBO and verify that it is below 28.2 gCO<sub>2</sub>/MJ, not only production but also the transport of the products must be considered. This term is particularly relevant when the product must be transported from a port in Argentina to a port in the European Union.

Below, an estimate is provided of the emissions that may be associated with the maritime transport of products from an Argentine port to different ports around the world.

Green ammonia is used as the reference product, as it is the main product involved in RFNBO export projects from South America to Europe.

Transporting ammonia by ship is a common practice today, as it is one of the most internationally traded chemicals.

Large-scale maritime transport of ammonia is carried out using fully refrigerated tanker vessels, where ammonia is stored in liquid form at temperatures below -33 °C. Ammonia currently shares vessels designs with liquefied petroleum gas (LPG) transport; therefore, the global fleet of vessels available for these purposes is extremely important.

As indicated in the study “Analysis of the Port Infrastructure of the Patagonian Coast of Argentina for the Development of Renewable Hydrogen and Power-to-X Projects,” these medium- and large-scale vessels range from 22,000 m<sup>3</sup> to 90,000 m<sup>3</sup>. For the purposes of this estimation, a *Very Large Gas Carrier* (VLGC) vessel with a capacity of 80,000 m<sup>3</sup> is considered.

Table 12 — Ammonia carrier vessel types (International PtX Hub, Analysis of the port infrastructure of Argentina's Patagonian coast for the development of green hydrogen and Power-to-X (PtX) projects, 2024)

Nominal DWT	Class name	Total length (LOA) (m)	Length between perpendiculars (LBP) (m)	Beam (B) (m)	Draft (T) fully laden (m)	Cargo capacity (m <sup>3</sup> )
64,000	LPG-Very Large Gas Carrier	230	225	36.6	13.6	90,000
50,000	LPG-Very Large Gas Carrier	230	223	36.6	12.1	73,000
43,000	LPG-Large Gas Carrier	205	195	33.2	12.6	59,000
30,000	LPG-Medium Gas Carrier	196	186	30	11.6	37,000
22,000	LPG-Medium Gas Carrier	170	161	26.6	11.4	22,000
10,000	LPG-Small Gas Carrier	146	138	21.6	8.8	12,000
5,000	LPG-Small Gas Carrier	122	115	20	7.1	6,000
3,000	LPG-Small Gas Carrier	102	95	16.8	6.8	3,500
1,000	LPG-Small Gas Carrier	70	65	12.4	4.5	1,500

Source: Own elaboration based on PIANC WG 235 – 2022

This type of vessel, which usually operates on fossil fuels such as HFO, has an operational emissions intensity (EEOI) that, under optimally planned conditions, can be 14.3 g CO<sub>2</sub>/t\*mn (BW LPG, 2024). By contrast, in cases of non-optimized routes, partial loads, and ballast-free returns, these values may double. The following figure shows how emissions associated with maritime transport vary depending on distance and operational emissions intensity.

Table 13 - CO<sub>2</sub> emissions associated with maritime transport of ammonia. Source: Own elaboration.

		Emissions associated with maritime transport (gCO <sub>2</sub> /MJ)				
		Distance (nautical miles)				
		6,000	8,000	10,000	12,000	14,000
EEOI (gCO <sub>2</sub> /t*mn)	15	4.8	6.4	8.0	9.6	11.2
	20	6.4	8.6	10.7	12.8	15.0
	25	8.0	10.7	13.4	16.0	18.7
	30	9.6	12.8	16.0	19.3	22.5
	35	11.2	15.0	18.7	22.5	26.2
	40	12.8	17.1	21.4	25.7	29.9
	45	14.4	19.3	24.1	28.9	33.7

This indicates that the management and monitoring of the maritime transport logistics contracted to transport RFNBO products from Argentina to Europe are critically important, in order to prevent transport-related emissions from pushing the product out of the specification in terms of carbon intensity.

For example, if an EEOI of 20 gCO<sub>2</sub>/t\*mn can be achieved in the transport of green ammonia from Argentina to Europe, the contribution to the emissions intensity of the RFNBO by maritime transport would be similar to that indicated in the following table:

Table 14 – Estimated CO<sub>2</sub> emissions associated with the maritime transport of ammonia from Argentina to Europe. Source: own elaboration.

Port of departure	Port of Rotterdam		Hamburg	
	Distance mn	Emissions gCO <sub>2</sub> /MJ	Distance mn	Emissions gCO <sub>2</sub> /MJ
Bahía Blanca	6,620	<b>7.08</b>	6,873	<b>7.35</b>
Comodoro Rivadavia	7,005	<b>7.49</b>	7,258	<b>7.76</b>

This means that, if these EEOI values are achieved in maritime transport, projects seeking to export RFNBOs from Argentina to Europe will need to carefully review their remaining associated emissions in order to stay below 20 gCO<sub>2</sub>/MJ, since approximately 8 gCO<sub>2</sub>/MJ already correspond to maritime transport, in a case considered good in terms of maritime transport emissions.

## 7 Links of interest

Below are some documents and links that may be useful for understanding and learning more about European Union regulations on RFNBOs.

### Official Publications of the European Commission:

- [Delegated Act 2023/1184: Definitions and rules for RFNBOs](#)
- [Delegated Act 2023/1185: Methodology and threshold for assessing RFNBO emissions](#)
- [Questions and Answers on the implementation of Delegated Acts](#)
- [Renewable Energy Directive \(RED II\)](#)
- [Renewable Energy Directive \(RED III\)](#)
- [Voluntary schemes approved by the European Commission for certification](#)

### Publications by International PtX Hub:

- [Webinar: EU regulatory framework and certification in a nutshell](#)
- [EU requirements for renewable hydrogen and its derivatives](#)
- [Briefing on certification for green hydrogen and Power-to-X](#)
- [Legal considerations of global trade in green hydrogen & Power-to-X](#)
- [Identification of suitable carbon as feedstock for PtX products to be exported to Europe](#)
- [Non-fossil fuel categories in EU legislation and their significance for hydrogen](#)

## 8 Conclusions

The analysis carried out in this report shows that the European framework for the certification of Renewable Fuels of Non-Biological Origin (RFNBO) offers a significant opportunity for renewable hydrogen projects and PtX products in Argentina, but at the same time poses technical and regulatory requirements that decisively condition their design, location, and bankability.

First, the European Union has built a coherent regulatory framework that covers both the definition of RFNBOs and the criteria for their certification and mandatory demand mechanisms:

- RED II introduces the concept of RFNBOs, defining a family of fuels produced from renewable electricity (hydrogen, ammonia, methanol, e-fuels, etc.) as a decarbonization tool.
- Delegated Regulations (EU) 2023/1184 and 2023/1185 establish the technical criteria for certification, setting a maximum threshold of 28.2 gCO<sub>2</sub>/MJ and a methodology for calculating emissions that covers the entire value chain: input supply, production, transport, storage, distribution, and final use.
- Electricity is recognized as the main determinant of the carbon footprint of RFNBOs. When the electricity used can be considered “fully renewable” according to the cases defined in the regulations, its emissions are counted for as zero; otherwise, they must be explicitly incorporated into the emissions equation.
- The regulation allows the plant to be supplied through a direct connection to renewable energy parks or through the transmission grid, provided that at least one of the four cases under which electricity grid may be considered fully renewable is met. These cases combine renewable share and the carbon footprint of the grid, together with additionality, geographical correlation, and temporal correlation requirements.
- For RFNBOs that require carbon (methanol, synthetic fuels), the range of acceptable sources is limited to direct air capture, biogenic sources, and certain industrial sources that are clearly defined and time-limited, reinforcing the focus on real emissions savings.
- Verification of compliance with all these criteria is entrusted to certification schemes approved by the European Commission. These schemes will evaluate specific projects, processes, and batches in accordance with legislative and regulatory texts and will play a central role in interpreting the application of Delegated Acts in third countries with electricity markets and institutional frameworks different from those of the EU.

Secondly, when applying these criteria to the Argentine case, the report shows that the interaction between RFNBO projects and the Argentine Interconnection System (SADI) is a critical element that cannot be addressed solely from the perspective of the individual developer:

- The Argentine electricity market is organized very differently from the European market and does not use the concept of “bidding zones,” which is key in European regulations for defining geographical correlation and certain cases of fully renewable electricity. This conceptual asymmetry complicates the direct application of some criteria.
- How the concept of bidding zones is interpreted and adapted to the Argentine reality (for example, considering the entire country as a single zone or subdividing it into several zones analogous to the CAMMESA electricity regions) will condition the interaction between RFNBO projects and the electricity transmission system, as well as the optimal location of new renewable generation and production plants.
- This interpretation does not depend exclusively on companies or national authorities: ultimately, it will be defined by certification schemes and the European Commission. However, actors such as the Secretariat of Energy and CAMMESA can (and should) provide technical input and participate in the dialogue to guide a definition consistent with the realities of the SADI and with local energy policy objectives.
- The lack of definition regarding bidding zones particularly affects projects that plan to take part of their energy from the grid and count it as fully renewable. On the other hand, projects based on a direct connection between renewable generation and the production plant are not affected by this issue, although they face other challenges (sizing, backup, system integration, etc.).

In this context, a relevant finding of the study is that Argentina has sufficient information and electrical heterogeneity to build a robust approach to emissions calculation:

- CAMMESA records and publishes detailed data on generation, demand, fuel consumption, and emissions by region, source, and technology, with daily granularity and the possibility of accessing hourly or higher-resolution data. This allows for the estimation of electricity emission factors aligned with the methodology of Delegated Act 2023/1185 and the transparent calculation of electricity's contribution to the RFNBO footprint.
- Although the average share of renewable electricity generation nationwide is 39.4%, there are two regions with very high shares of renewable energy: the Noreste region with 99.0% and the Patagonian region with 94.8%. Depending on the final interpretation of “bidding zones,” this could imply significant opportunities for the installation of RFNBO projects in these regions.
- The average emission factor for electricity in Argentina is around 81 gCO<sub>2</sub>/MJ, but there are marked differences between regions: in regions with greater renewable penetration (e.g., Patagonia and the Noreste), the calculated factors are reduced to values in the range of 3-10 gCO<sub>2</sub>/MJ, while in regions with high fossil fuel share, they can reach around 146 gCO<sub>2</sub>/MJ. This heterogeneity reinforces the importance of the interpretation of the bidding-zone concept, as well as project location and grid-connection scheme.
- There are also potentially usable biogenic and industrial carbon sources in Argentina (bioethanol, pulp and paper, cement, steel, refineries, thermal power plants). However, the

absence of a domestic emissions-pricing system for industrial sectors introduces uncertainty regarding the eligibility of some of these carbon sources for RFNBO production intended for export to the EU.

- Finally, the study highlights that even maritime transport from Argentine ports to Europe can add a significant contribution to the RFNBO carbon footprint (on the order of several gCO<sub>2</sub>/MJ even under logistically efficient scenarios), and therefore must be explicitly integrated into the life-cycle emissions assessment.

Based on these elements, some key messages can be drawn for project development and public policy:

1. **RFNBO criteria must be incorporated from the conceptual design stage of the project.** The choice of location, grid connection scheme, plant configuration (on-grid, off-grid, or hybrid), carbon sourcing strategy, and export logistics directly affect the possibility of meeting the 28.2 gCO<sub>2</sub>/MJ threshold and, therefore, of accessing the European market.
2. **The connection to the Argentine electricity system is crucial.** The abundance of renewable resources alone does not guarantee competitiveness and RFNBO certification. Having an interconnected electricity system with the characteristics of the SADI is an infrastructure advantage for the country compared to other regions with great potential for renewable H<sub>2</sub> but without this infrastructure, such as the Chilean region of Magallanes. Being able to take advantage of this infrastructure could be a differentiating factor for projects in Argentina, which is why decisions on network expansion and the eventual definition of "bidding zones" compatible with European logic are factors that condition the technical and economic viability of projects.
3. **There is a window of opportunity to influence the interpretation of the regulation.** Although the final decision rests with the certification schemes and the European Commission, the active participation of national bodies (such as the Secretariat of Energy and CAMMESA) and the private sector can influence how key concepts, such as bidding zones or the treatment of certain carbon sources, are interpreted in a manner consistent with the Argentine context.

In this regard, the need to proactively advance from within the Argentine sector is emphasized, in order to obtain technical definitions from the relevant institutions on the interpretations for applying the European regulation in the country, especially the interpretation of bidding zones.

4. **The availability and quality of data is a competitive advantage that should be exploited.** Argentina's ability to generate emission factors and traceability based on official CAMMESA data and methodologies aligned with EU regulations can facilitate certification and reduce the perception of risk by buyers and financiers.

Finally, it is worth emphasizing that all analysis presented in this report refers specifically to compliance with the RFNBO certification criteria required by the European Union. In cases where the target market is different, it will be necessary to carry out a parallel analysis in light of the regulations applicable in each jurisdiction, which may differ in definitions, emission thresholds, calculation methodologies, or traceability requirements.

As for the local market, there are currently no instruments or regulatory frameworks in Argentina that explicitly require the certification of renewable hydrogen or its derivatives, whether through demand quota systems, emissions trading mechanisms, or other instruments that directly value the use of RFNBO to demonstrate emissions savings. In the absence of domestic certification criteria, European regulation may serve as a technical reference and starting point for future regulatory discussions, but it is not mandatory in the country.



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## 9 Appendix: EU bidding zones vs. Argentine electricity market

### 9.1 European Union electricity market bidding zones

The concept of bidding zones is part of the structural and regulatory design of the European Union electricity market. Regulation 2019/943 states:

Definitions:

**Bidding zone:** the largest geographical area in which market participants can exchange energy without capacity allocation;

**Capacity allocation:** the allocation of interzonal capacity;

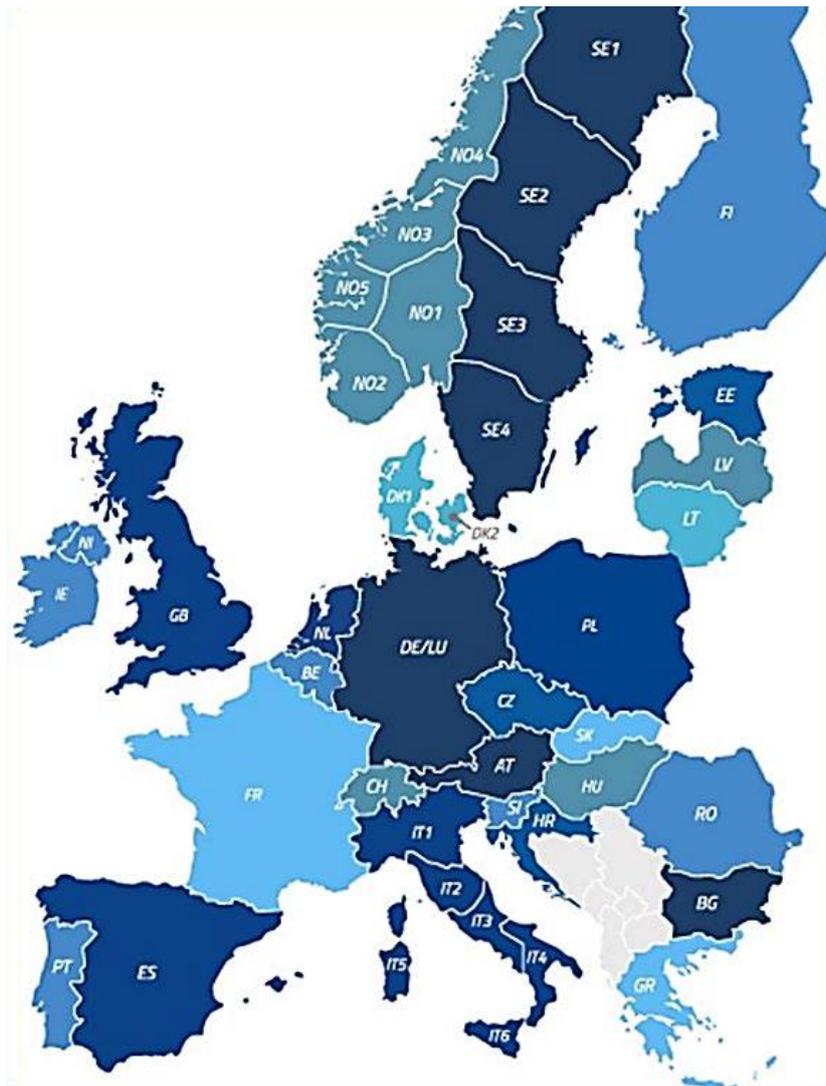
Then, in Chapter 3 of the same regulation, Article 14 “Review of bidding zones” states:

1. Member States shall take all appropriate measures to address congestion. **The borders between bidding zones shall be based on long-term structural congestion in the transmission network. Bidding zones shall not contain such structural congestion unless it has no effect on neighboring bidding zones** or, as a temporary exemption, its effects on neighboring bidding zones are mitigated by the use of remedial measures and such structural congestion does not lead to reductions in interzonal trading capacity, in accordance with the requirements of Article 16. The configuration of bidding zones in the Union shall be designed in such a way as to maximize economic efficiency and maximize trading opportunities between zones, in accordance with Article 16, while maintaining security of supply.
2. Every three years, ENTSO for Electricity shall report on structural congestion and other significant physical congestion between and within bidding zones, including the location and frequency of such congestion, in accordance with the guideline on capacity allocation and congestion management adopted on the basis of Article 18(5) of Regulation (EC) No. 714/2009. That report shall include an assessment of whether the interzonal trading capacity reached the linear path under Article 15 or the minimum capacity under Article 16 of this Regulation.
3. In order to ensure an optimal configuration of bidding zones, a review of bidding zones shall be carried out. That review shall identify all structural congestion and shall include an analysis of different configurations of bidding zones in a coordinated manner, involving the relevant stakeholders from all relevant Member States, in accordance with the guideline on capacity allocation and congestion management adopted pursuant to Article 18(5) of Regulation (EC) No 714/2009. The current bidding zones shall be assessed in terms of their ability to create a reliable market environment, including flexible generation and load capacity, which is crucial to avoid grid bottlenecks and balance electricity supply and demand, ensuring the long-term security of network investments.

From these definitions, it is understood that bidding zones are defined based on the structure of the transmission grid and the balance of supply balances within the zone, in order to avoid structural congestion within the bidding zone. Transmission capacity allocation is reserved on an interzonal basis.

In addition, European Union electricity market regulations establish that once a bidding zone has been defined, the hourly price of energy within that bidding zone is unique for the entire area covered and is established using the marginal cost principle of generation bids within the bidding zone.

The figure below shows the bidding zones in the European Union.



5 Figure - European Union electricity system bidding zones

## 9.2 Argentine electricity market and interconnected grid

### About energy dispatch in the Argentine electricity market

Unlike the European Union electricity market, the Argentine market is not based on zonal supply-demand ranking, but on a centralized system with nodal prices based on marginal generation costs. Dispatch is based on variable generation costs (economic dispatch) with technical and system security restrictions. The price is set hourly at a reference node (Ezeiza) and adjusted by nodal factors to obtain hourly marginal prices per node in the rest of the country. Trading takes place on the forward market (contracts) and/or the spot market. There are no price zones, but rather an hourly marginal price at a given node, which is then translated into nodal prices based on the corresponding node factor. Node factors are calculated quarterly for hourly bands (peak, off-peak, and intermediate).

The economic ranking of energy dispatch from the different power plants is carried out at the national level, not by area.

### Access to the transmission grid and congestion

Until 2017, the rule for connecting to the high-voltage system was the **Access and Expansion Regime** provided for in Annex 16 of “The Procedures” (regulations for the electricity market in Argentina). The developer submitted an application to the relevant transmission company; the system coordinator (CAMMESA) analyzed flows, transmission limits, N-1 criterion, stability, and short circuits conditions, and prepared a technical report. With this support, the National Electricity Regulatory Entity (ENRE) decided whether or not there was sufficient remaining transmission capacity to accommodate the new injection. When capacity was available, access was authorized and the connection was formalized; when not, the applicant had to promote an expansion (through public tender or by contract between parties, financed by the beneficiaries). It is important to emphasize that this authorization did not amount to a firm dispatch guarantee: it allowed connection and use of the grid, but dispatch remained economic and subject to the system's operational restrictions.

The projects of the RenovAr program (2016–2018) also entered this framework. Although their purchase agreements with the administrator were defined by tender, the connection was processed through the classic Annex 16 access channel, with the same studies and, if applicable, connection works and reinforcements. There was not yet a periodic “quota” mechanism nor an explicit right to determining among many competing projects, who would inject first when transmission became scarce. The evaluation was done on a case-by-case basis, and each file went through its own process of publication, potential hearings, and regulatory decision.

A new era began in 2017 with the creation of the Renewable Energy Term Market or MATER (private contracting of renewables). To accommodate a lot of new supply on a network that was already showing bottlenecks, a new concept was incorporated into the Argentine standard: **dispatch priority**. Since then, the administrator organizes periodic calls and publishes, by electric transmission system corridor and connection point, the available transmission capacity to allocate this priority. The conceptual leap was moving from authorizing access one by one to assigning, in a transparent and competitive manner, an injection right during congestion: those who obtain priority inject before those without if the corridor becomes saturated.

With the maturation of the scheme and the persistence of bottlenecks in electricity transmission, the regime was refined in 2023: in addition to “full” priority (when studies show sufficient capacity), a reference priority was enabled that allows for an expected limited cut in energy while the works to relieve the bottleneck are carried out. At the same time, a clear framework was established for projects financing expansions to reserve the incremental capacity enabled by their own works, linking investment in transmission with a right of use and preferential injection over that increment.

Today, the process combines both tracks. The Access and Expansion Regime continues to be the legal gateway for connecting to or expanding the grid, with the regulator determining whether or not there is technical capacity and what works are necessary. On top of this track, MATER organizes scarcity: in each round, transmission quotas are published by zone, projects compete for dispatch priority, and if the network is insufficient, they can push for expansions and retain the right to use the capacity they create. The practical result is more predictable for investors: they know in advance if their node and corridor have capacity, what curtailment risk they assume if they opt for reference priority, and the path to transform a “possible” connection into a firm injection through works.

This shift did not replace the original technical logic (the network continues to be evaluated from end to end, and dispatch continues to be economical and conditioned by safety limits), but it institutionalized something that renewable growth made unavoidable: when transmission is the bottleneck, an explicit and public rule is needed to decide who enters first, how risk is shared while the works are underway, and how investment in expansions translates into clear rights over the released capacity.

Until 2017, installed renewable capacity (excluding large hydropower plants) was only 753 MW (most of which was small hydropower plants). From 2017 onwards, new renewable generation parks began to enter into operation, initially driven by the RENOVAR program (starting in 2015) and later by MATER, reaching 4,000 MW in 2020 and 6,672 MW in 2024, see Figure 3. The lack of high-voltage infrastructure development accompanying this renewable growth quickly saturated the transmission capacity of the main corridors. The renewable generation sector emphasizes that the lack of investment in electricity grids (and clear rules to allow it) is currently the main obstacle to the development of new renewable generation.

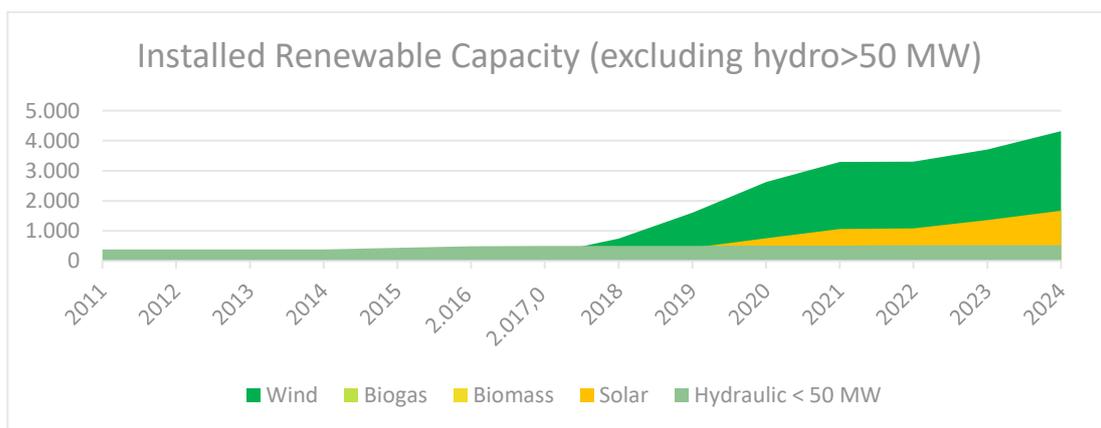


Figure 6 - Installed renewable capacity. Source: Own elaboration based on CAMMESA data

### Characteristics of generation, demand, and the electricity grid

Argentina's large territory, combined with its geographical diversity and varying levels of residential and industrial development, means that electricity generation and demand vary greatly across the country. The Argentine electricity market classifies the country's territory into nine different electricity regions:

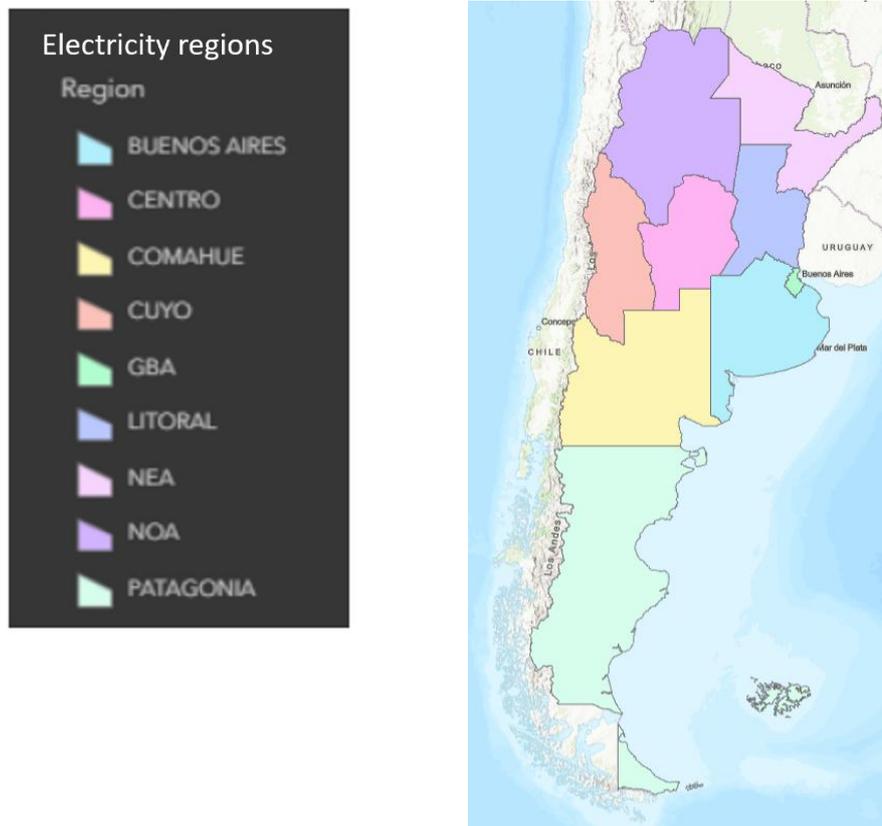


Figure 7 - Electrical regions of the Argentine electrical system. Source: CAMMESA (geoSADI)

Each region is characterized by different electricity generation profiles, depending mainly on natural resources and infrastructure development, and different levels of demand linked to population density and the location of industries and commercial activities.

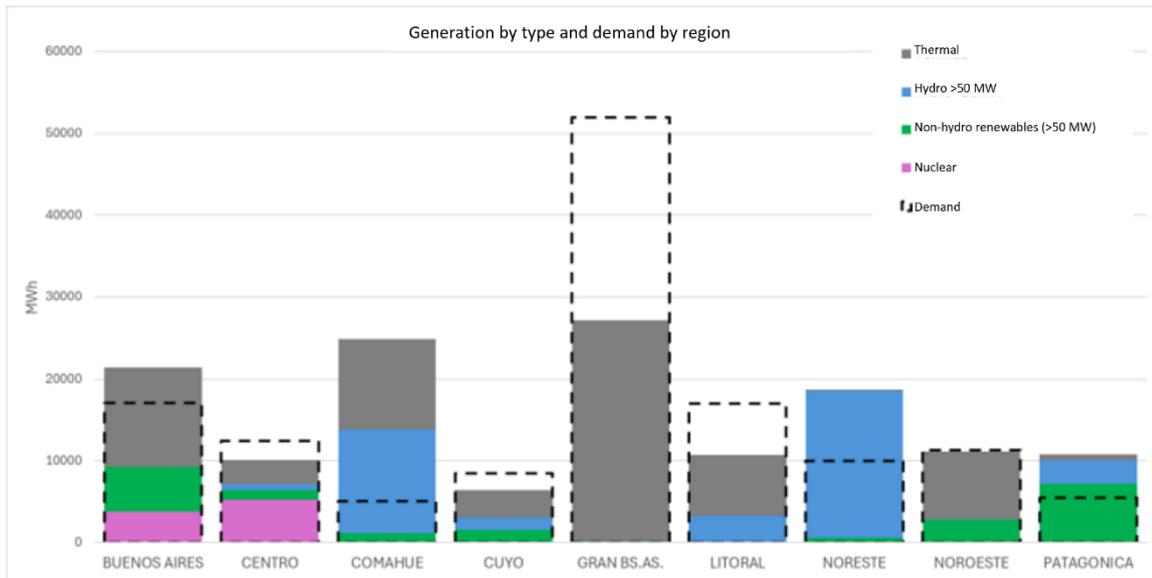


Figure 8 - Electricity generation and demand by region. Source: Own elaboration based on CAMMESA data.

As can be seen in Figure 8, Gran Buenos Aires is the region with the highest electricity demand and requires energy imports from other regions; the same applies to Litoral, Centro, and Cuyo. On the other hand, regions such as Comahue, Noreste, Patagonia, and, to a lesser extent, Buenos Aires, are electricity-exporting regions.

It is the Argentine Interconnection System (SADI) that enables electrical linkage of the regions, mainly supported by the 500 kV transmission lines that run across the national territory.

The distribution of power plants connected to the grid throughout the country and the high-voltage connection system are shown below.

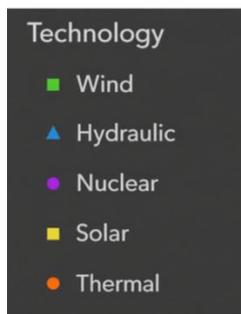


Figure 9 - Power plants and regions.  
Source: CAMMESA.



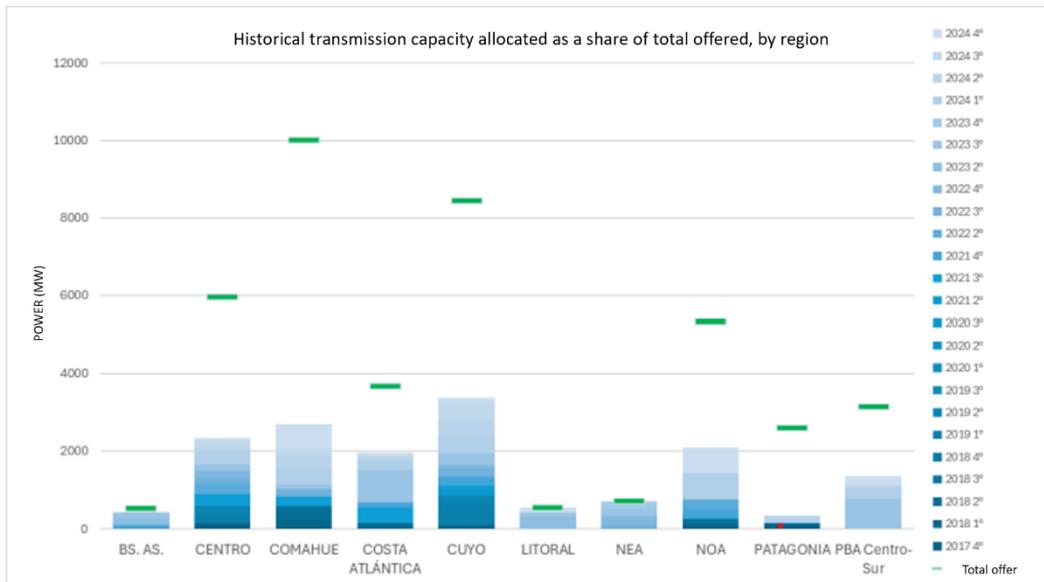
Figure 10 - High-voltage electricity transmission. Source: CAMMESA.

### Congestion of high-voltage lines

As shown in the regional generation/demand balances, it can be seen that the electricity corridors linking the Comahue region with AMBA and CENTRO are those that transport the largest amount of electricity, followed by the Patagonia corridor (which connects to the Comahue – Buenos Aires – AMBA corridor), and the Northeast-Litoral-AMBA corridor, which mainly transports energy from large binational hydropower plants.

Below are the dispatch priority allocations (along with the capacity submitted in each tender and was not allocated) based on the transmission capacity tendered by CAMMESA on a quarterly basis since 2017. On the one hand, it can be seen that the submission of priority requests has always been well above the capacity finally allocated (tendered capacity), mainly in the corridors of greatest interest (Comahue, Buenos Aires, NOA); Furthermore, it is noteworthy that corridors such as Patagonia had

allocations for only a marginal amount of capacity during the period, explained by the particular lack of electricity transmission capacity from that region to AMBA, which results in very low transmission capacity tendered in the annexes, even with the flexibility of Reference A (which allows for curtailment).



11 Figure - Electricity transmission capacity tenders. Source: CAMMESA

The latest annex published in June 2025 indicates that the full available transmission capacity of the Comahue, Patagonia, and NOA corridors is zero. Meanwhile, for the NEA-Litoral corridor it is 190 MW. Considering up to 8% curtailment, the transmission capacity zero for Comahue, 109 MW for Patagonia (or 200 MW if solar), 0 MW for solar energy for NOA, but allowing 92 MW for wind, while the capacity for the NEA-Litoral corridor increases to 475 MW.

The biggest bottlenecks in the 500 kV grid are identified in the Patagonia-Buenos Aires, Comahue-Buenos Aires, NOA-Buenos Aires, and Cuyo-Buenos Aires corridors. These are particularly exporting regions with great potential for wind and/or solar development, which is currently stalled due to transmission restrictions.

Based on the above, it can be said that the high-voltage lines connecting the country's highest electricity-consuming regions with the export regions have excellent renewable energy resources are congested and represent a bottleneck for the integration of new renewable generation.

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