On behalf of:

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for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

ICLEI Local Governments for Sustainability

100% RENEWABLES CITIES & REGIONS ROADMAP

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Initial Status Report of the Deep-dive City

AVELLANEDA

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About ICLEI

ICLEI – Local Governments for Sustainability is a global network of more than 1,750 local and regional governments committed to sustainable urban development. Active in 100+ countries, we influence sustainability policy and drive local action for low emission, nature-based, equitable, resilient and circular development. Our Members and team of experts work together through peer exchange, partnerships and capacity building to create systemic change for urban sustainability.

About the 100% Renewables

The project is implemented by ICLEI – Local Governments for Sustainability and funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) through the International Climate Initiative (IKI). The 100% RE Project offers support to national and regional level governments to promote a move towards 100% RE strategies with increased awareness and stakeholder engagement in the countries of Kenya, Indonesia and Argentina. The 100% RE project works with cities and regions in the focus countries to build a path for global south cities to finance and implement renewable energy, through the assessment of local RE potential and project concepts, as well as the development of financeable projects.

Executive Summary

ICLEI has selected the town of Avellaneda, Santa Fe province, as the model city in Argentina for the project "*100% Renewables Cities and Regions Roadmap*". In this framework, the Initial Status Report allows the understanding of the key aspects regarding the energy consumption of the locality, as well as the potential of the renewable resource available to the mentioned region. In this way, the following are sought: (i) a socio-productive understanding of the city, (ii) the elaboration of the consumption profile, (iii) the regulatory frameworks of the national, provincial and municipal orders, (iv) and the local projects that are they are implementing in terms of local energy generation by taking advantage of their natural resources.

The result of this report and its interpretation will constitute the input information to prepare the roadmap to become a city that provides all the energy it consumes from renewable sources.

With a population of approximately 31,000 inhabitants and a gross area of 937 km^2, the predominant economy of Avellaneda is based on the primary agricultural and livestock activity, both agricultural and livestock, including the textile branch detached from the agricultural sector (such as cotton).

Regarding environmental challenges, Avellaneda faces several, which are relatively common to other localities, such as improving the quality of ambient air, optimizing the management of urban solid waste, improving the energy efficiency of homes, among others.

The electrical energy that Avellaneda consumes comes, as it happens in all the towns of the country, from the Argentine Interconnection System. Therefore, "being 100% renewable" is reconverted and means that the generation of the same amount of energy (from renewable sources) that Avellaneda consumes is pursued to feed it to the grid.

Another environmental aspect to consider is to achieve the provision of natural gas, allowing the population to consume this resource (currently vaporized LPG is used in certain areas of the town for residential, bottled gas where LPG is not available, and firewood for industries) . This will reduce GHG emissions by using a less polluting resource.

In terms of renewable energy sources, the solar potential allows an approximate generation, in photovoltaic terms, of 1,450 kWh / year per installed kWp. In wind resources, the wind speed is relatively low to be used for energy, but the predominant type of industry in Avellaneda has a very usable biomass resource. So much so, that there is even a thermoelectric plant based on biogas generated from sugar cane waste, and to this must be added the potential of other types of waste, such as pruning and household waste. . In another aspect, the hydroelectric potential is not abundant and measurement developments are not presented.

The town has already been working on the line of improving energy consumption through various programs, such as the replacement of lights by LED technology, and others on a more environmental level, such as the extension of kilometers for the use of bicycles and discouraging the private car, among others. Finally, the strength of the city is one of its main strengths, thus constituting a great opportunity to take advantage of the roadmap to be 100% renewable.

Considerations on the Initial Status Report

Introduction and guidance to the document

The purpose of this document is to describe **the initial state of energy in the city**, as a starting point to plan the respective roadmap towards a 100% RE horizon.

The initial status report should establish a baseline, identifying opportunities and challenges on the path to achieving 100% renewable energy, as well as gathering data, information, and activities related to renewable energy projects, applications, policies, and city advocacy. at different levels of government. This information will allow to discuss possible measures of political support and direct actions to facilitate the panorama of RE in general and the 100% RE roadmap.

What is 100% Renewable Energy?

"Renewable energy encompasses all renewable resources, including bioenergy, geothermal, hydroelectric, oceanic, solar and wind. One hundred percent renewable energy means that all energy sources to meet all energy end-use needs in a given place, region or country are derived from renewable energy sources 24 hours a day, every day of the year. Renewable energy can be produced locally to meet all local needs for energy end use (energy, heating and cooling, and transportation) or it can be imported from outside the region using supporting technologies and facilities such as power grids, hydrogen or Hot water. Any storage facility to help balance the energy supply must also use energy derived solely from renewable resources. "

IRENA Coalition for Action.

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ADEERA	Association of Electric Power Distributors of the Argentine Republic
AGEERA	Association of Electric Power Generators of the Argentine Republic
AGUEERA	Association of Large Users of Electric Power of the Argentine Republic
ARS	Argentine pesos
ATEERA	Association of Electric Power Transporters of the Argentine Republic
BAU	Trend Scenario [in English, “business as usual”]
BEN	National Energy Balance
BNA	Banco de la Nación Argentina
CAMMESA	Compañía Administradora del Mercado Mayorista Eléctrico Sociedad Anónima
CONICET	National Council for Scientific and Technical Research
COSEPAV	Cooperativa de Servicios Públicos de Avellaneda
COP	Conference of the Parties to the United Nations Framework Convention [in English]
CTBA	Central Térmica a Biogás Avellaneda Sociedad Anónima
DREI	Right of Registration and Inspection
ENARGAS	National Gas Regulatory Body
ENRE	National Electricity Regulatory Entity
EPESF	Empresa Provincial de la Energía de Santa Fe
FIT	Feed-in tariff
FODER	Fund for the Development of Renewable Energies
FODIS	Fund for the Distributed Generation of Renewable Energies
GBA	Greater Buenos Aires [denomination of region by CAMMESA]
GBI	Generation-based incentives [in English]
GEI	Greenhouse gases
LPG	Liquefied petroleum gas
GNCC	National Office of Climate Change
INTA	National Institute of Agricultural Technology
INTI	National Institute of Industrial Technology
IRAM	Argentine Institute of Standardization and Certification
MATER	Term Market of Renewable Energies
MAYDS	Ministry of Environment and Sustainable Development
MEPS	Minimum energy efficiency standards
MINEM	(former) Ministry of Energy and Mining. Then it was SGE until 12/09/2019
MMTEP	Million Tonnes of Oil Equivalent [unit of energy]

NEA	Northeast Argentina
O&M	Operation and maintenance
PANEYCC	National Action Plan for Energy and Climate Change
PCI	Lower Calorific Value
PERMER	Renewable Energy Project in Rural Markets
PIST	Point of Entry to the Transportation System ["well gas"]
PRONUREE	National Program for the Rational and Efficient Use of Energy
PROUREE	Program for the Rational and Efficient Use of Energy in Public Buildings
PYMEs	Small and medium businesses
RN ##	National Route NO. ##
RSU	Municipal Solid Waste
SADI	Argentine Interconnection System
SAIC	Industrial and Commercial Stock Company
SGE	Government Office of Energy
SYESA GAS	Servicios Y Emprendimientos Sociedad Anónima (gas sub-distributor)
SMN	National Metereological Service
TGI	General Property Tax
TGN	Transportadora de Gas del Norte
TGS	Transportadora de Gas del Sur
UAA	Unión Agrícola de Avellaneda
UNL	Universidad Nacional del Litoral
USD	US dollars

1. City

The town of Avellaneda was chosen as the model city for the "*100% Renewables Cities and Regions Roadmap" project.* This will accelerate the transition towards a generation equivalent to energy consumption through renewable energy sources. In this way, the reduction of greenhouse gas (GHG) emissions as a consequence of its actions is pursued.

This Initial Status Report acts as a starting point with regard to planning the 100% renewable supply in the locality. The objectives of this report are therefore the following:

- Parameterize the energy profile of Avellaneda manifested through energy consumption and explained through its characteristics and habits;
- Understand the pre-existing regulatory framework on the subject;
- Identify the characteristics of the financing available, and
- Assess the challenges and opportunities towards 100% RE.

Monument to the city. Source: https://www.argentina.gob.ar/sites/default/files/plan_estrategico_territorial_avellaneda_0.pdf

1.1 Population

The city of Avellaneda, located in the department of General Obligado in the northeast of the province of Santa Fe, has an estimated population of 30,897 inhabitants [1]. Approximately 90% live in urban areas and the remaining 10% in rural areas [2]. It delimits with Reconquista just 5 km to the south, and between both localities they make up the same urban area, that is, a metropolitan area of approximately 117,000 inhabitants [1].

1.2 Geographical location

With respect to the Paraná river, Avellaneda is located on its left bank, and, with respect to Arroyo El Rey, it is located to the north (see Figure 1).

Figure 1: Location of Avellaneda in Argentina.
Source: Municipality of Avellaneda, 2020

The main reference geographic data is summarized below in Table 1:

City of Avellaneda	
Latitude Coordinate	29° 07’ 03” S
Longitude Coordinate	59° 39’ 03” O
Referential distances in the province	It is located 320 km north of the city of Santa Fe, capital of the province, on the RN 11 and 500 km from Rosario
Referential distances outside the province	It is located 225 km from Resistencia, capital of the neighboring province of Chaco and 800 km from the Federal Capital
Average absolute minimum temperature	14.6 ° C in winter
Average absolute maximum temperature	25.7 ° C in summer
Average mean temperature	20.1 ° C
Average annual rainfall	1260 mm. The wet season coincides with the spring-summer period.

Table 1: : Brief geographical and climatic information of Avellaneda.
Source: own elaboration

The neighboring city of Reconquista has a meteorological station of the National Institute of Agricultural Technology (INTA) (it can be accessed by consulting the reference).

In Chapter 4 the energy potential of Avellaneda is described in terms of its nature.

1.3 Territorial extension and land use

In Figure 2 the Avellaneda district can be seen in its entirety [2]. This has an extension of 937 km^2; the urban area covers an area of 7.6 km^2 and the rest of the area is made up of the rural area. Of this, 65% of the territory is the Paraná River flood valley; in this valley is the Jaakunigás[1]wetland, declared as a RAMSAR Site in 2001.

Avellaneda is made up of four contrasting physiographic sectors, arranged in parallel from East to West, called "Island complex and terraces" of the Paraná River to the East of the district, "Domo Agrícola-Ganadero" in the Center-West and "Arroyo basin the King ”across the Southwest. The sectors of "Island Complex" and "terraces" are those that make up the mentioned Jaakunigás wetland.

The city has an Environmental Urban Planning Code, the latest version of which is from 2016. The elements that the Municipality uses for this regulation make up the “Urban Environmental

[1] It is a wetland of approximately 492,000 hectares, forms part of the alluvial valley of the Paraná River and contains a representative sample of the biome *Delta and Paraná Islands*.

Code", whose main structure is made up of the Regulation of Urbanizations and Subdivisions, and the Building Regulations.

Figure 2: Geographic limits of the Avellaneda district on the satellite map.
Source: Municipality of Avellaneda, 2020.

The purpose of this Code is to guarantee that the development of urban areas occurs in harmony with the needs of the convenience and well-being of the population, avoiding inappropriate growth that would cause conflicts of functions, increase in the cost of the installation and use of infrastructures and services with a lack of efficiency in the provision of the same, buildings without guarantee of health, safety and hygiene with vital restrictions to its inhabitants.

Avellaneda is a predominantly agricultural-livestock area, dedicating more than 90,000 hectares to such activities. Of this total, 77,000 hectares are used for livestock, 13,500 for agriculture and about 2,300 correspond to urban, industrial, streets and public roads [2].

According to 2020 data from the Ministry of Production and Development of the Municipality of Avellaneda, the distribution of land is 60% for livestock, 35.8% agricultural, 4% urbanized and 0.2% industrial. This land distribution is shown in Figure 3.

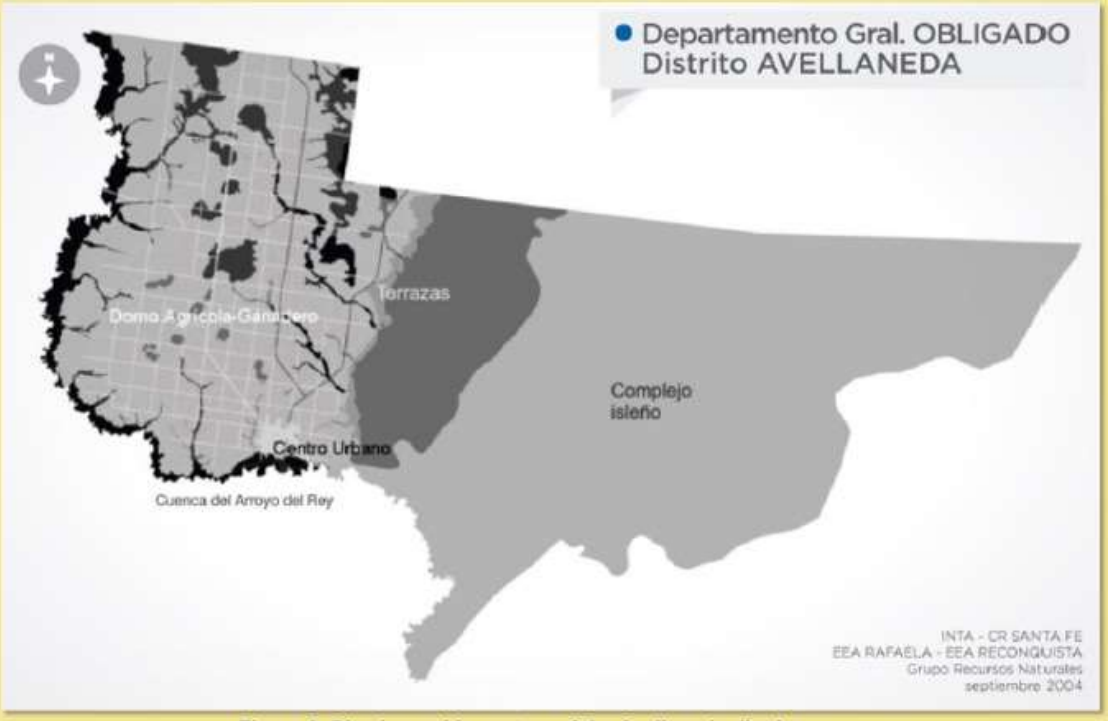

Figure 3: Physiographic sectors of the Avellaneda district.
Source: Municipality of Avellaneda, 2020.

1.4 Economy

The plot of Avellaneda is inserted in a vast rural area whose predominant activity is agricultural (sunflower, soybean, corn, wheat, sorghum, cotton and pastures), livestock (cattle, pigs, poultry). At the same time, it has an important agro-industrial sector generating an industrial and technological pole whose companies are present in the main economic zones of Argentina and export to much of the world.

Regarding agricultural production, sunflower, soybean, corn, sorghum, wheat, cotton and pasture crops (oats, alfalfa, moha) stand out mainly. In livestock, bovine production, breeding and wintering (field and corral) stand out. There are approximately 30,000 head of cattle. The importance of poultry farming in the area is also underlined, with its complete chain (31 producers, 730,000 chickens). Also important - although more incipient - beekeeping (21 producers, 110 apiaries, 3,552 hives), horticulture and pig production (a total of 7,000 pigs is estimated). It should be noted that most of these productions are made in family businesses.

The industry dependent on this primary activity is predominantly developed in the productive chains, with added value at source, in the production of derivatives of grains, cattle, pigs, poultry,

as well as in the refinery of vegetable oils and bioethanol. The entire cotton chain is developed, from ginning to clothing, through the manufacture of hydrophilic cotton and fabrics. The poultry chain is also developed in its entirety with laying and rearing farms, an incubation plant, fattening farms and a refrigerator, complementing the provision in all instances of local balanced feed. Traditionally, the main occupational spaces in rural areas were directly related to primary activities (agriculture and livestock work), but the high degree of modernization currently used in this type of activity meant that, over time, the requirement The workforce decreased notably, causing families to migrate to the city in search of employment.

However, the multiple activities of the secondary sector acquire relevance due to the significant number of agro-industries, which constantly require skilled labor. With regard to services, although it is not a majority sector, it is booming at the local level, which makes it a dynamic component in terms of labor occupation. Similarly, the metalworking industry and technology companies applied to agriculture and industry lead with products that are used nationally and internationally (see Figure 4).

Figure 4: UbLocation of the Industrial Park & Services área.
Source: Municipality of Avellaneda, 2020.

Avellaneda has approximately 100 hectares of Industrial Park and 50 hectares of municipal services with more than 70 PYMEs based, a Center of Services for Entrepreneurs with two incubation warehouses (one of them dedicated exclusively to technology-based enterprises, and a space coworking). In addition, the city is recognized throughout the country due to the presence of important companies, such as Grupo Vicentín SAIC and Unión Agrícola de Avellaneda Coop. Ltda., Key actors in the development of the urban area that includes Reconquista.

The local downtown commercial and recreational activity is in an incipient, but growing development, with a Central Area Reform Project that would give it impetus [2]. This is an executive project technically approved by the IDB in 2018 for the reform of the central area of the city. It involves an investment of 2.8 M USD and aims to consolidate the central area of the city as a center of local, metropolitan and regional attraction through strategic actions of territorial-environmental planning, improving road safety and accessibility conditions. Contributing, in this way, to increasing socioeconomic potential as a civic, administrative and commercial center, in order to sustain and expand the offer of employment, tourist, cultural and recreational services.

According to the Prodem Report [4], a third of the city's companies are in the service sector, mainly in transport and logistics, followed in order of importance by commerce and primary activities, with a quarter of the total. In Figure 5 these quantities are observed:

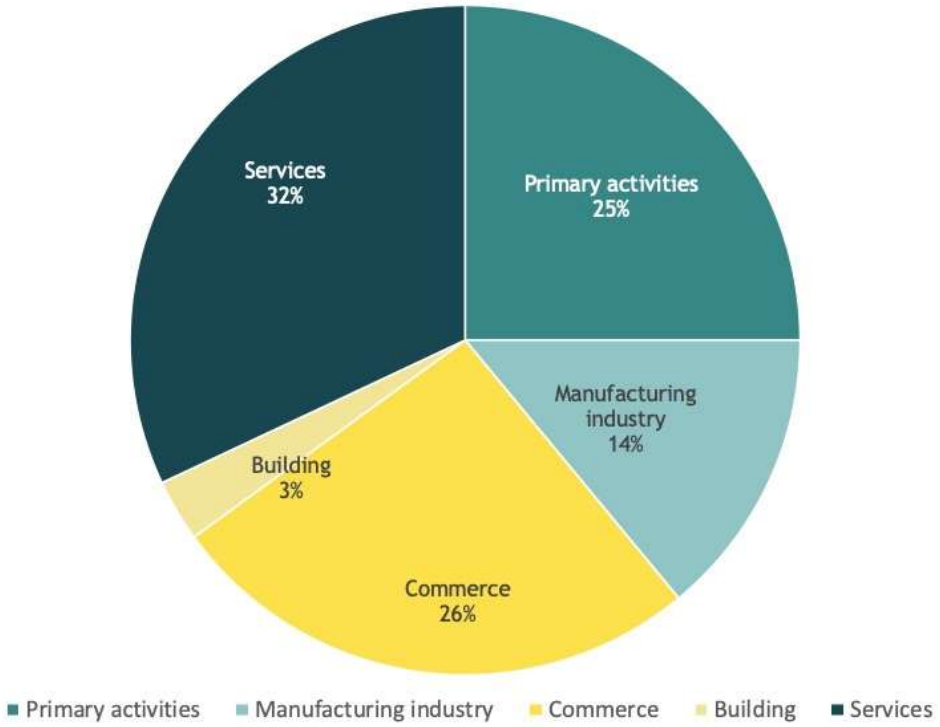

Figure 5: Composition of the business structure of Avellaneda.
Source: PRODEM Report of Avellaneda, 2016.

The Economically Active Population of Avellaneda is calculated at 42% according to data from the 2010 Census. From the previous report [4], this number rises to approximately 13,700 people, becoming the Economically Active Population of 44%. The sector that represents the most employment is the Manufacturing Industry (56%), followed by Commerce (22%), Services (14%) and Primary Activities and Construction.

Finally, the institutions referring to electricity and gas services are:

- Cooperativa de Servicios, Públicos, Sociales y Vivienda de Avellaneda Limitada (COSEPAV), through a concession from Empresa Provincial de la Energía de Santa Fe (EPESF), provides electric power service throughout the district of Avellaneda, both to the urban area, as rural and industrial. It has more than ten thousand users. It is also responsible for other services, including the supply of drinking water.
- SyESA GAS (SERVICIOS Y EMPRENDIMIENTOS) is a government-controlled company with majority state participation (85% of COSEPAV and 15% of the municipality) that, since 2002, provides service to the gas network. Currently, it supplies 2,060 users (only residential; there are approximately 8,500 homes in Avellaneda) of liquefied petroleum gasand vaporized. It has a plant installed in the industrial park of the city, in which the LPG is stored, vaporized, regulated, distributed and measured into the urban area where the houses are located. The service is responsible for pipeline transportation through public space and each neighbor corresponds to the home installation [2]. Homes that do not have this gas through the network must consume other sources, such as electricity or gas packaged in carafes (cylinders).
  For some years now, Avellaneda has been managing to have natural gas supplied by the network, a service that it does not yet have. After several projects this possibility seems to be approaching a reality. Towards the year 2020, the works that allowed the connection with the Gasoducto del Noroeste Argentino (NEA) for the supply of natural gas were completed, and it is expected that the distribution of this hydrocarbon will be imminent in the years 2020 or 2021.

1.5 Current environmental challenges

The main environmental challenges that Avellaneda presents are:

- Diversify the local energy matrix: manage to generate in the city the equivalent of 100% of the energy consumed through renewable sources, in order to position ourselves as an independent city, in energy terms, of the Argentine Interconnection System (SADI).
- Achieve efficient and rational use of energy throughout the territory: promote actions such as the labeling of energy efficient homes, labeling of household appliances, good energy efficiency practices, to encourage the efficient and rational use of energy.
- Starting from the connection with the NEA Gas Pipeline, replacing the provision of LPG by network with that of natural gas, which in addition to allowing the population to expand with the scope of this service, will generate a reduction in greenhouse gas emissions (GHG) as a

consequence of the use of gas for cooking or heating instead of another sourceto more polluting.

- Improve air quality: being immersed in a city with great industrial activity has negative consequences on air quality, mainly due to the presence of particulate material from production processes. This condition has improved notably in recent years, however, there are still parameters to improve in this regard.
- Achieve 100% coverage of the sewage collection network and optimize the treatment of sewage effluents: currently the city has 80% coverage of the sewage collection network and two sewage treatment stations; one of them, the oldest, is already obsolete in terms of treatment capacity for the volume of effluents it receives, for this reason it is necessary to move towards an optimization of this system.
- Optimize Urban Solid Waste (MSW) management: although since 2015 there has been a differentiated waste collection system and a sorting plant in operation, there are still actions to be taken regarding: improvement in the differentiation of waste waste at home, improvement in the conditions in the classification plant to achieve more efficient results, carry out an adequate management of the organic stream, carry out a suitable final disposal, among the most outstanding.
- Develop proper management of pruning waste and bulky waste: pruning waste and also most of the bulky waste are currently used to fill old excavations around the city. Advance towards an adequate management of both streams, in addition to transferring the real cost of managing these streams to the city's residents, constitutes a fundamental challenge.

2. Energy profile of the city

The energy sources used by Avellaneda for its development are:

- Purchase of power and electricity from SADI through EPESF and COSEPAV. This service is provided to all types of clients connected to the network.
- Hydrocarbon fuels with corresponding percentage of biofuel (it is sold as such). These vectors are available over the counter at gas stations.
- Biodiesel. This biofuel is marketed by contract between private parties, usually industries or even the public transport sector.
- Biomass (preferably firewood used by the industrial sector)
- Vaporized LPG distributed by network (it supplies only 2,060 homes).
- Bottled gas (LPG in 10 kg containers sold in public service storesico purchased by households not connected to the LPG network).
- Generation of electrical energy from biodigestion (biogas), which is injected into SADI.

Regarding the usual hours of consumption, the industrial sector, depending on the system, type and production process, works 24 hours in 3 shifts or does it in a shift from 4:00 to 12:00. On the other hand, the commercial and small industry sectors historically work from Monday to Friday from 8:00 a.m. to 12:00 p.m. and 4:00 p.m. to 8:00 p.m., and on Saturdays from 8:00 a.m. to 12:00 p.m.[2].

2.1 Current energy demand

Consumption by energy source and sector is indicated according to the data obtained:

2.1.1 Electricity demand

Table 2 shows the electricity consumption for the period 2014-2019 [5]:

Sector | Year	2014 [GWh]	2015 [GWh]	2016 [GWh]	2017 [GWh]	2018 [GWh]	2019 [GWh]
Residential	23.77	24.74	26.62	25.43	27.1	24.6
Commercial	5.49	5.64	5.68	5.68	5.77	2.25
Small Industries	2.53	2.5	2.61	2.42	2.36	2.36
Large Industries	59.51	56.98	55.95	57.07	63.71	64.09
Lighting	3.45	3.22	3.32	3.33	2.53	1.94
Rural	3	5.68	3	3.08	3.04	2.75
Others	2.04	1.8	1.94	2.05	2.32	2.22

Table 2: Electricity consumption by consumption sector (in GWh).
Source. Data from COSEPAV 2014-2019, 2020.

[2] Given the COVID-19 pandemic, a significant number of businesses began to carry out their activities on a regular schedule, that is, from 8:00 a.m. to 4:00 p.m. some supermarkets even extended their opening hours from 8:00 to 20:00. It is unknown how these, a priori, exceptional measures will continue.

The criterion for differentiating between "large industries" and "small industries" is that the second refers to users with installed powers less than 50 kW; in "large industries" are those of low voltage with powers between 50 and 300 kW, and for values above 300 kW, the user is "large industry" in medium voltage. Although this classification is not directly related to the industrial subsector to which each industry belongs, agroindustrial and agricultural activity predominates in the users with the highest consumption.

The entire population (or at least 99%) has the vector of electricity [6]. It is clarified that the "Others" sector includes the COSEPAV's own use for the distribution of electric power and drinking water pumping, the operation of the water treatment and distribution plants, public offices, schools, non-profit institutions, stations sewage collector network elevators, sewage effluent treatment plant and traffic lights, among the main uses.

To obtain the average power at which a sector is consuming energy (or a plant is generating energy), the following is solved, considering continuous operation throughout the year (8,760 hours). So:

$$P_{med} = \frac{1}{T}\int_0^T P(t)dt$$

Equation 1: Definition of Average Power

where *P (t) .dt* is the product of power times time and, for this case, it is the one registered by COSEPAV [5]. Therefore, the following distribution of average power values for each sector for the 2014-2019 period results, shown in Figure 6:

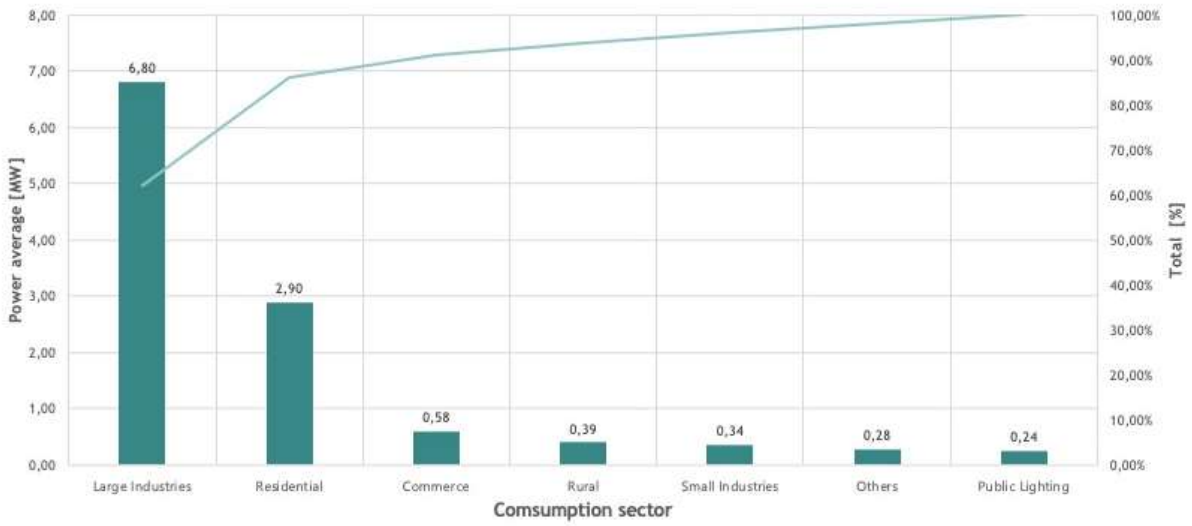

Figure 6: Average power by sector 2014-2019.
Source: own elaboration according to Data 2014-2019 from COSEPAV, 2020.

According to information provided by COSEPAV, its contracted power to consume from SADI is 24 MW [5]. If the average power values of the sectors are added, the total amounts to almost 12 MW. This means that the average power is approximately half the power contracted for the Avellaneda district. Consumption by sector can be seen in Figure 7:

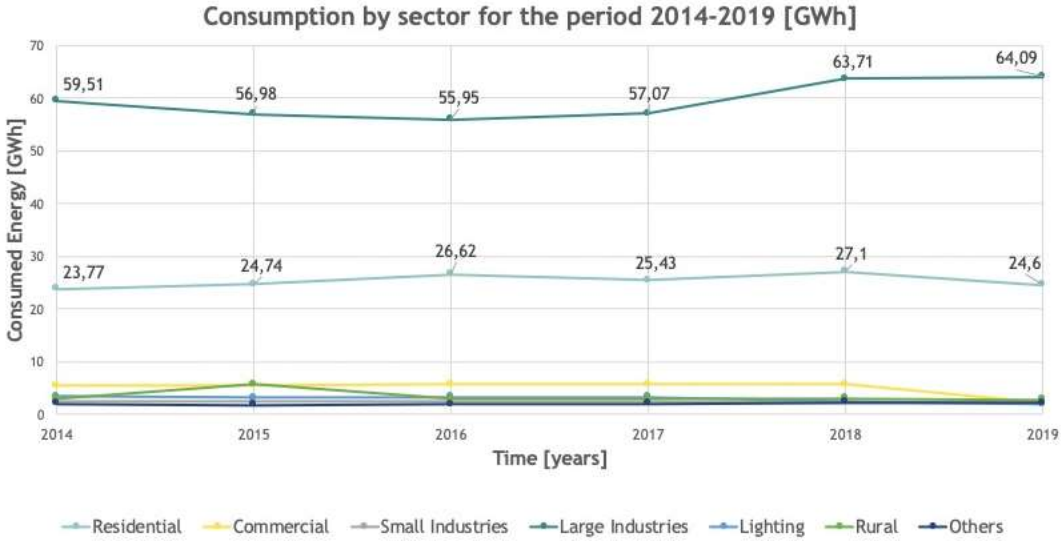

Figure 7: Evolution of consumption by sector in 2014-2019.
Source: own elaboration according to Data 2014-2019 from COSEPAV, 2020.

Adopting 2016 as the base year, the participation of the sectors in the total is plotted (Figure 8):

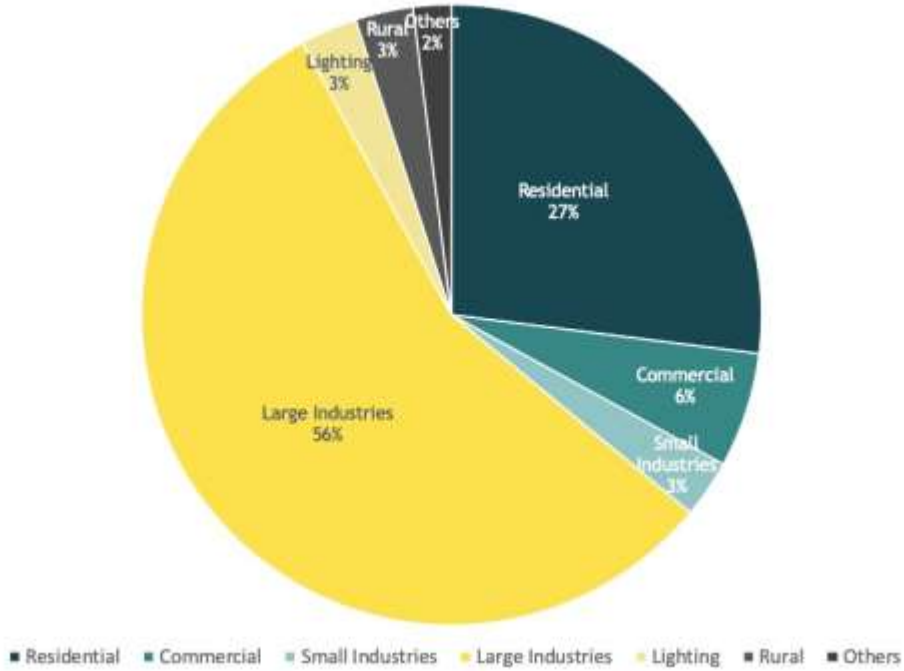

Figure 8: Participation in electricity consumption in 2016.
Source: own elaboration according to Data 2014-2019 from COSEPAV, 2020.

In terms of proportion, Figure 9 shows the variation for the same period:

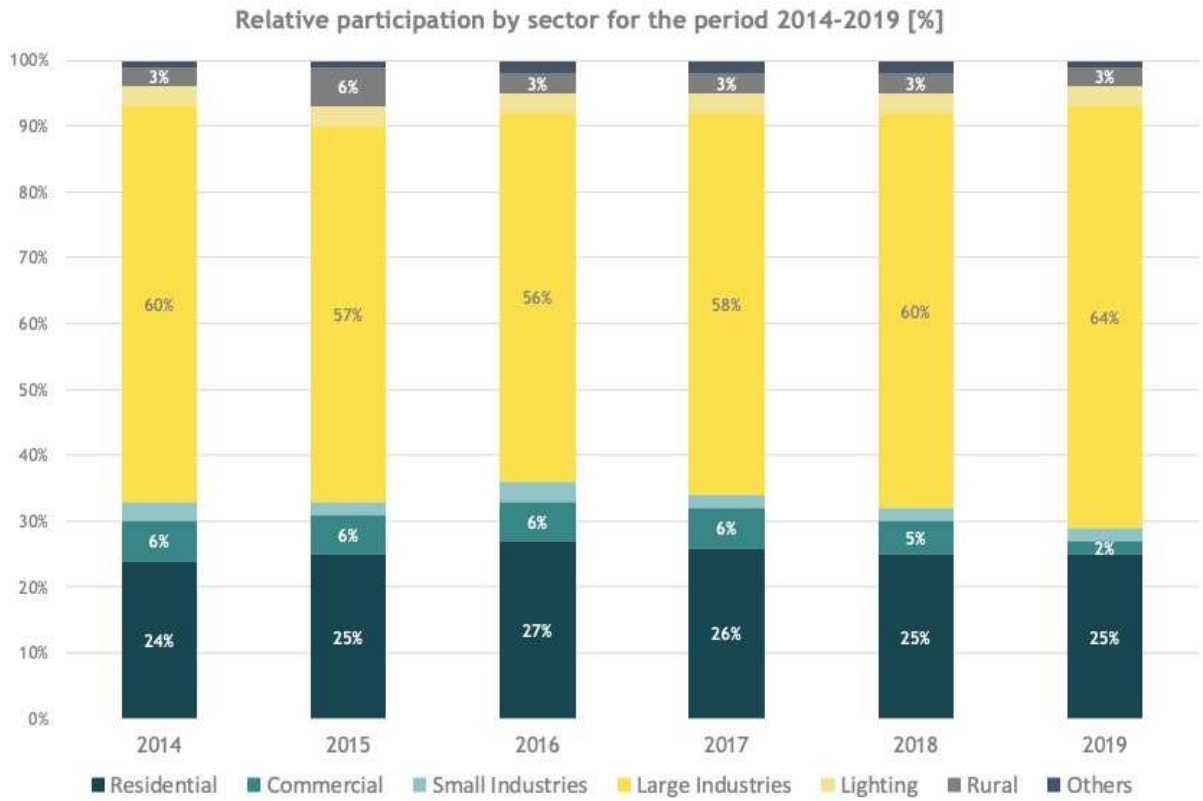

Figure 9: Relative participation by sector for the period 2014-2019 [%].
Source: own elaboration according to Data 2014-2019 from COSEPAV, 2020..

2.1.2 Demand for liquid fuels

From the official database [7], the fuel sales between 2014 and 2019 are reflected in Figure 10.

As explained in Chapter 3, the fuels that are sold at the service station dispensers contain a percentage of biofuels by law (12% bioethanol in naphtha and 10% biodiesel in diesel fuel [8]). In general, the use of these liquid fuels is for transportation, but eventually it can be used for heating at certain times and mainly in areas of the city (happening in other locations in the country given the current penetration of natural gas).

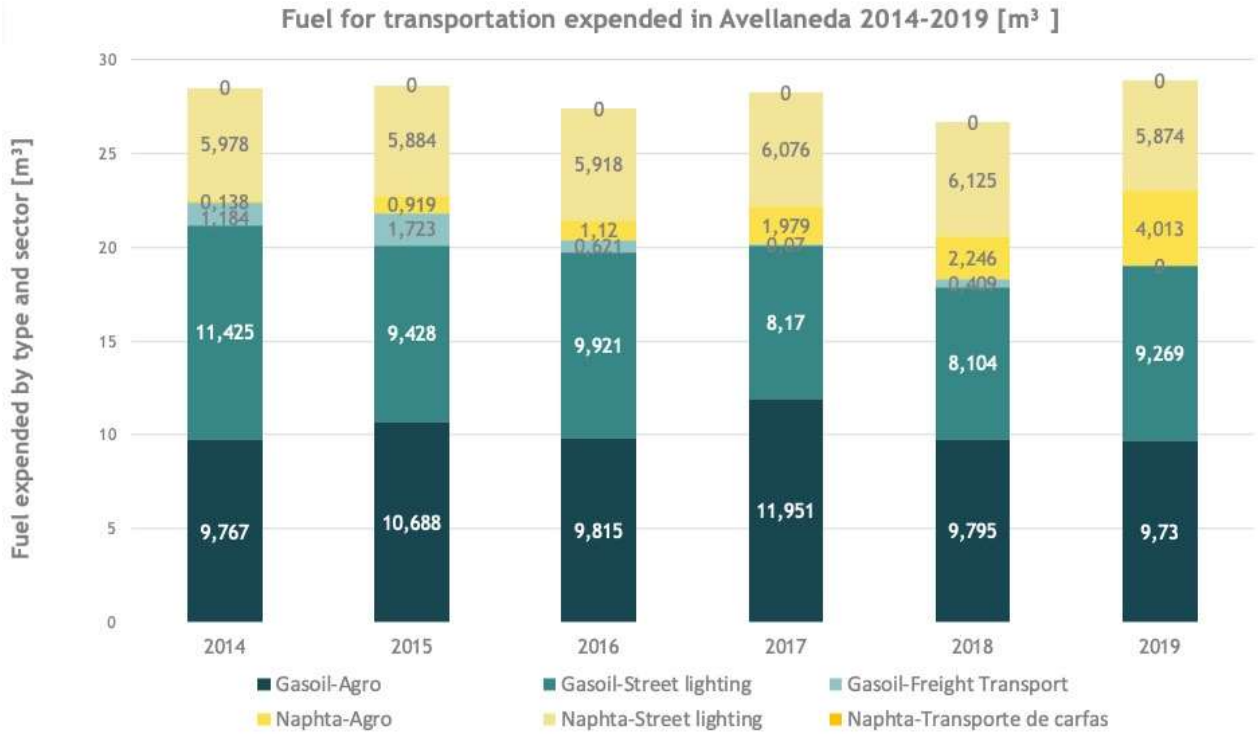

Figure 10: Fuel sold in 2014-2019.
Source: own elaboration according to the Ministry of Energy, 2020.

2.1.3 Demand for dry biomass

Based on consultations with Unión Agrícola de Avellaneda (UAA), the average annual consumption of firewood reaches the value of 37,000 tons; This data is a function of the technical characteristics of the consuming equipment, mainly boilers to produce steam, which are the most consuming equipment of this vector[3] [9]. Vicentín SAIC, another major player in the local industry, presents wood-fired grain dryers, but they have not been used since 2014. However, the acquisition of firewood does not have formal records associated with it and on certain occasions it is obtained from prohibited areas. A large number of companies buy firewood from other provinces, such as Corrientes or Misiones, and the decision criterion is purely economic, so the provision is not unique. Thus, the annual quantity of firewood is higher than the indicated value, but there are no records that can provide further information.

2.1.4 Demand *for LG*P

Although SyESA Gas does not supply vaporized LPG to industries, they buy LPG in bulk from different distributors and store it in cylinders in their manufacturing areas. Here, UAA is also a big consumer of LPG. Annual LPG consumptions per UAA are indicated in Figure 11 [10]:

[3] According to the reference [9] the lower calorific value of firewood is located over 2,000 kcal / kg.

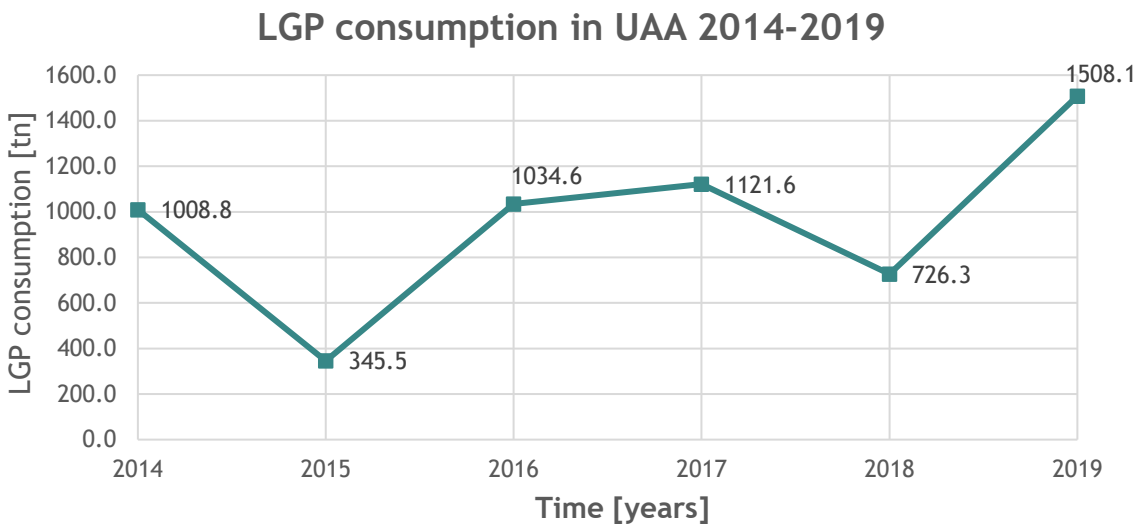

Figure 11: LPG consumption by Unión Agrícola.
Source: own elaboration according to 2014-2019 UAA Data, 2020

Due to its transport characteristics, LPG is consumed in industries in part for the production of steam, but mainly as a direct source of heat.

On the other hand, as indicated, approximately 2,060 homes of the 8,500 in Avellaneda have vaporized LPG distributed over the network. However, based on various notes[4], the connection with the NEA gas pipeline is completed and it is expected for the years 2020 and 2021 to begin with the provision of natural gas[5]. Table 3 shows the LPG consumptions recorded by SyESA Gas during the 2014-2019 period [11]:

Year	2014	2015	2016	2017	2018	2019
Consumption [thousand m^3]	330	339	382	333	338	311.5

Table 3: Residential consumption of LPG.
Source: own elaboration according to Data 2014-2019 from SyESA Gas, 2020.

In greater detail, the bimonthly values (registered by the users meter) for the period 2014-2019 [11] are graphed in Figure 12:

[4] For example, https://www.diarionorte.com/article/171422/fue-un-acierto-politico-pero-hubo-tambien-un-fuerte-apoyo-de-la-comunidad-y-de-entidades or https://eldepartamental.com/content/2227/ieasa-agreement-works-with-cooperatives-to-connect-gas-natural-en-otros-tres-loca.

[5] June 2020 was estimated as the date to start the provision, but the pandemic delayed these events.

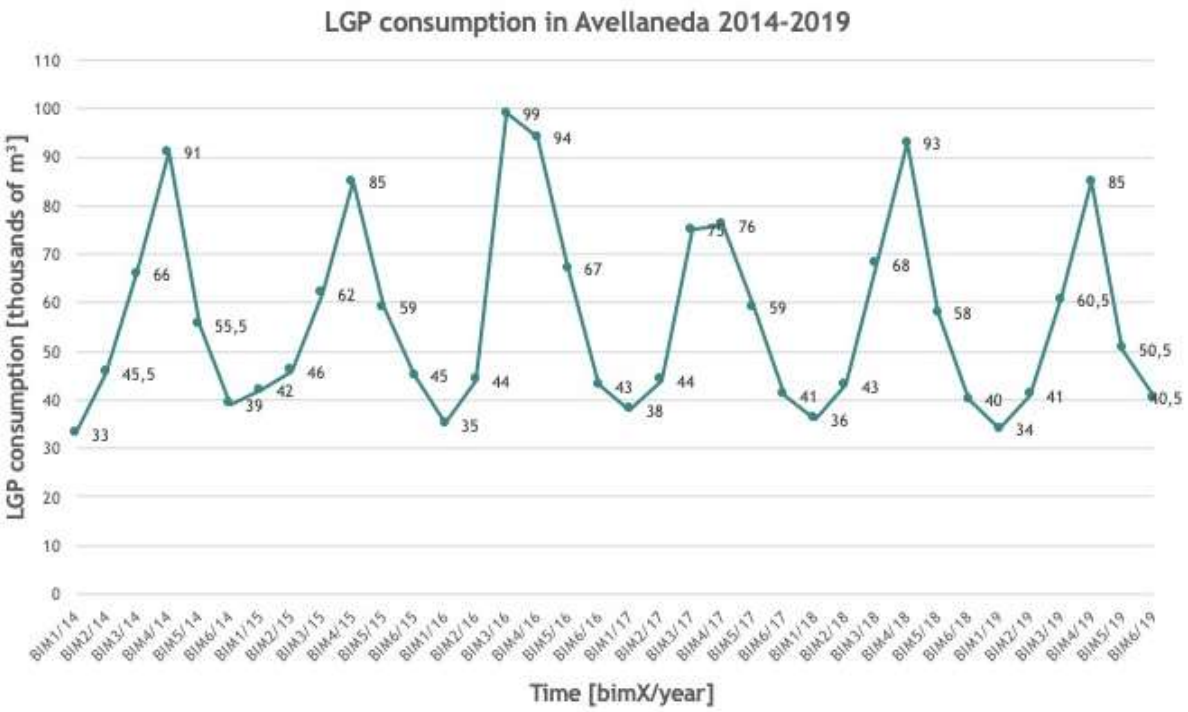

Figure 12: Bi-monthly consumption of LPG.
Source: own elaboration according to Data 2014-2019 from SyESA Gas, 2020.

However, for billing, SyESA Gas converts LPG consumption to natural gas, precisely considering the LPG supply situation as a transitory instance.

2.1.5 Demand for bottled LPG (cylinders)

Given that approximately 23% of homes have gas distributed through the network, the remaining homes consume another source of energy for cooking and heating purposes. The most economical source is the bottled LPG cylinder (known as a "carafe").

Although these cylinders can be purchased in public service stores, the inhabitants of Avellaneda can purchase them in Reconquista and Avellaneda, so there are no records that indicate the amount of kg of bottled LPG consumed by a resident on an annual average. For this reason, the Avellaneda Focal Point proceeded to carry out a virtual survey and revealed that, on average, a resident consumes 35 kg of bottled LPG per year.

2.2 Electricity / Energy matrix - for installed capacity / generation

2.2.1 National

The "National Energy Balance" (BEN) is the account in which the primary energy available to the country to be transformed into energy carriers is recorded, as well as imports and exports. In 2019, the domestic supply of primary energy was almost 77.2 million Tons of Oil Equivalent (TOE[6]), composed of 54% natural gas from wells and 31% oil as the majority resources. Figure 13 reflects the distribution in greater detail:

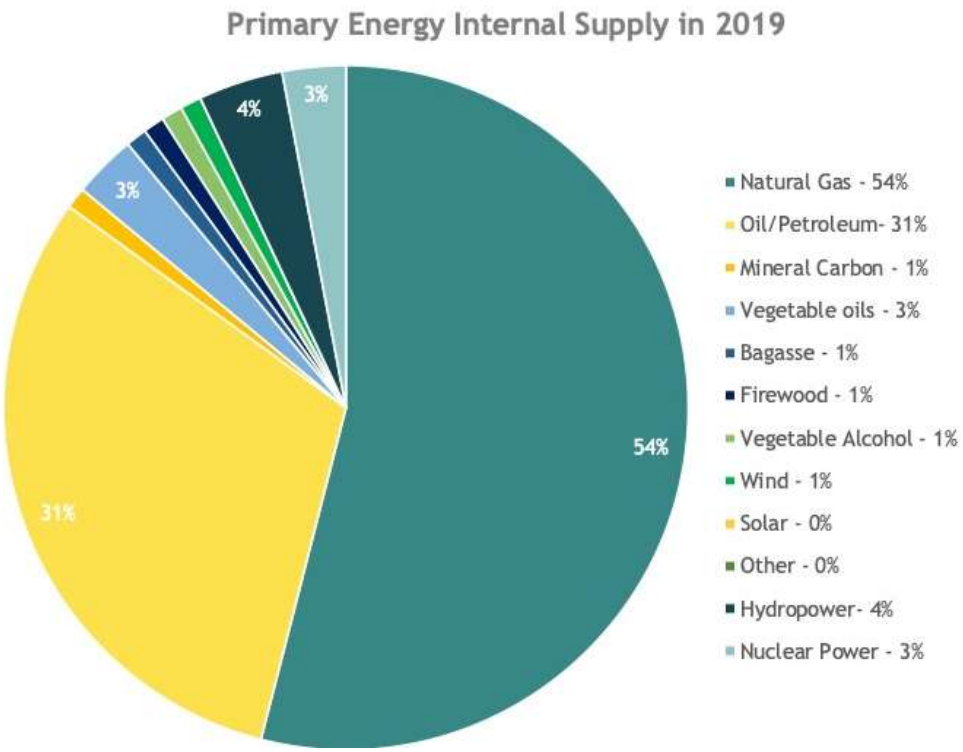

Figure 13: Domestic Supply of Primary Energy nationwide in 2019.
Source: own elaboration according to the Ministry of Energy, 2020.

On the other hand, secondary energy was almost 75.13 MMTEP, comprising 47% of gas distributed by networks, 15% of electrical energy and 14% of diesel and gas oil among the main contributors of the total [12]. Therefore, the participation of well gas in the internal supply of primary energy (and gas distributed in secondary) is evident [12]. Figure 14 indicates the shares of each source:

[6] Equivalent Ton of Oil is a unit of measure of energy, and it is equivalent to the energy released by one ton of oil. The conventional value of 1 TOE = 11,630 kWh was adopted.

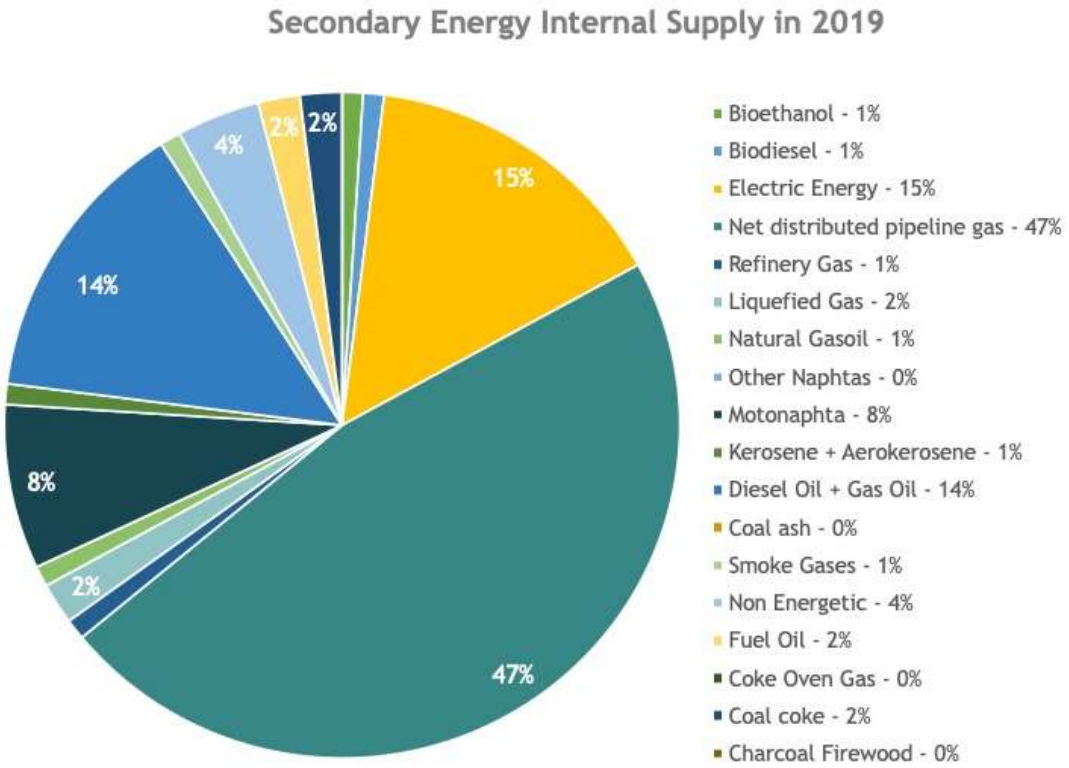

Figure 14: Internal Supply of Secondary Energy nationwide in 2019.
Source: own elaboration according to the Ministry of Energy, 2020.

The production of electrical energy, outside of the contracts between private parties, is injected into the infrastructure that covers the entire country called the "Argentine Interconnection System" (SADI). All the electrical energy generated by non-renewable and renewable sources, as well as imports, converge towards it.

SADI distributes energy through transmission networks (at voltages of 33, 66, 132, 220, 330 and 500 kV) to all regions of Argentina. Given this quality, traceability in generation is exchanged for availability. To have a surface reference, SADI occupies approximately ¾ parts of the European continent with more than 35,000 km of overhead lines and underground cables, although Argentina demands approximately 5% of the power required by Europe [13] [14].

From this system the energy is delivered according to the applicants (provinces and agglomerates). It is a radial system that converges in the center of greatest consumption, the GBA region, which demanded 37.7% of the energy generated in 2019 [15] (see Figure 15).

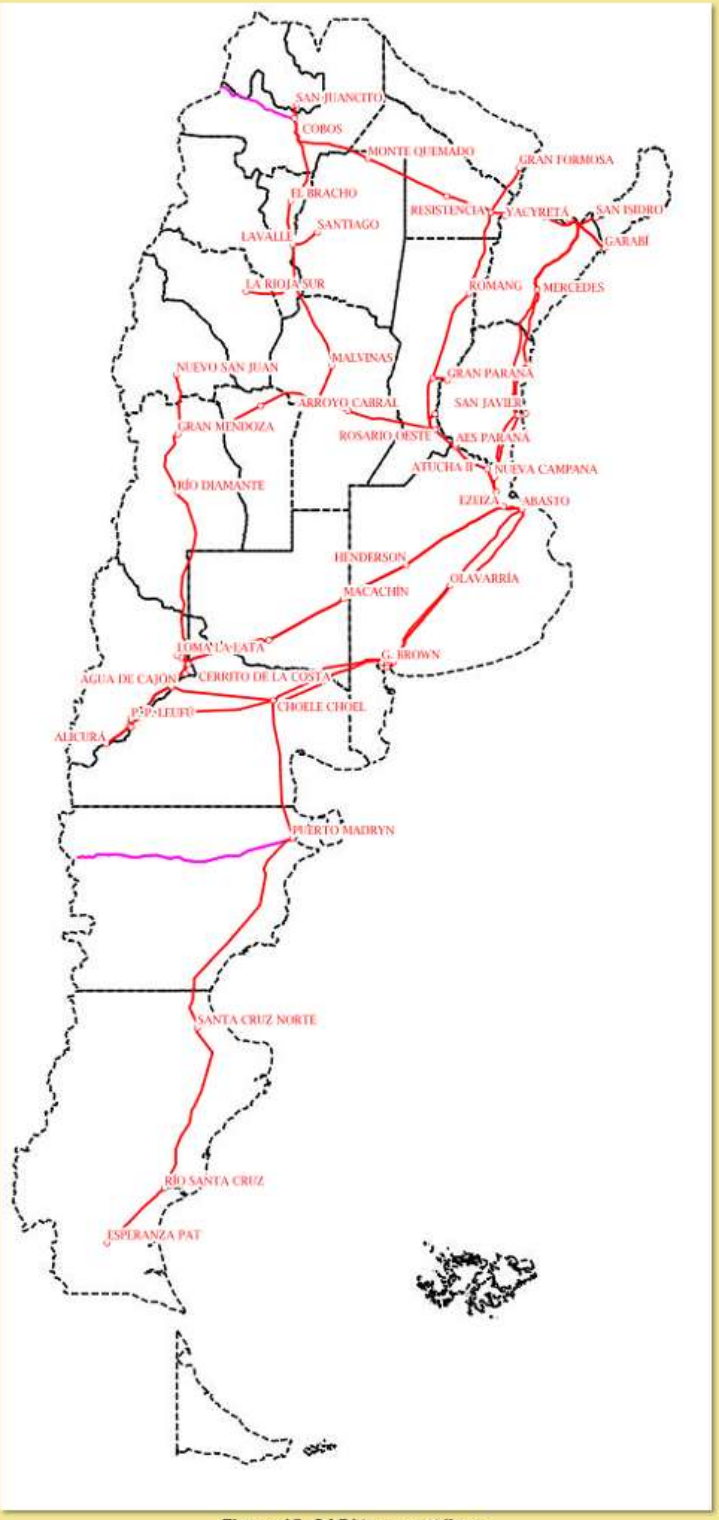

Figure 15: SADI transport lines.
Source: CAMMESA, 2020.

2019 ended with a total of 39.7 GW installed (3% more than in 2018). In terms of installed power, 61.8% corresponded to thermal generation, 27.2% to hydro (powers greater than 50 MW), 4.4% to nuclear and 6.5% to renewables (which includes wind, solar, biomass, biogas and hydro less than 50 MW) [15].

The coverage of the demand with renewables varies depending on the time of year. The organism that gathers the actors that generate 96% of the electrical energy is AGEERA [16].

Regarding the demand for electricity, 128.9 TWh were requested in 2019 (3% less than in 2018). Of this total, 43% corresponded to Residential, 29% to Commercial and the remaining 28% to High demand (which is made up of the Large Users of the Wholesale and Distribution Electricity Market). This categorization is typical of the entity that regulates SADI [15].

During 2019 2,746 TWh were imported and 0.261 TWh were exported. Energy was imported from Brazil, Paraguay and Uruguay (the latter represented almost 88% of the total); instead, only energy was exported to Brazil [15].

According to the recorded values, there is a correlation between ambient temperature and power demand. In summer there is a marked peak around 4 pm and to a lesser extent around 10 pm; in winter the peak is located around 9:00 pm and to a lesser extent around 12:00 pm [8].

Figure 16 acts as a summary.

Principales Valores Anual 2019

DEMANDA [GWh]	2018	2019	Variación %
DEMANDA LOCAL	133,010	128,905	-3.1%

GENERACIÓN Local+Imp [GWh]	2018	2019	Variación %
TOTAL OFERTA	137,825	133,992	-2.8%
Térmico	87,727	80,137	-8.7%
Hidráulico+Imp	40,296	38,116	-5,4%
Nuclear	6,453	7,927	22.8%
Renovable (c/HR)	3,350	7,812	133.2%
%Ren/Dem	2,5%	6,1%	

COMBUSTIBLES [Mm3/d]	2018	2019	Variación %
TOTAL GAS EQUI.	54.8	49.3	-10.2%
%GAS/TOT	98%	99%	1%
CEM [Kcal/KWh]	1,916	1,885	-1.6%

	2018	2019	Variación %
Tasa de Cambio [ar/us]	29.0	49.2	69.6%

COSTO MEM [$/MWh]	2018	2019	Variación %
COSTO TOTAL (Energía+Potencia+Transporte) $ar/MWh	2,181.6	3,364.3	54.2%
COSTO TOTAL - u$s/MWh	75.2	68.4	-9.1%
Precio Monómico Estacional (Energía+Potencia+Transporte) $ar/MWh	1,187.4	2,167.5	82.5%
% Cobertura	54.4%	64.4%	

Principales Valores Anual 2019

CAMMESA

Figure 16: Main values of the year 2019.
Source: CAMMESA, 2020.

The entities that regulate the entire SADI are CAMMESA (Compañía Administradora del Mercado Mayorista Eléctrico SA) and ENRE (National Regulatory Entity of Electricity).

With regard to natural gas, its production is through the basins located at the ends of the country and subsequent treatment in refineries. There are two natural gas transporters that supply all regions: Transportadora de Gas del Norte (TGN) and Transportadora de Gas del Sur (TGS).

In 2019, 24,053 million m^3 of natural gas were delivered to distributors; however, gas dispatched to thermoelectric plants is also included here [17]. The body that regulates natural gas is ENARGAS. Natural gas penetration is 65% by 2016 [18].

Finally, unlike other countries, Argentina has practically no urban heating and cooling networks, leaving the end user to convert these energy vectors into the useful energy required to satisfy such purposes.

2.2.2 Local / regional

Given the previously described context, the generation plants inject the electrical energy they produce into the SADI, so it is not possible to uniquely limit the consumption of a city to the energy production of these plants. However, this does not mean that generation systems that inject their production into SADI cannot be installed in different locations.

100% of Avellaneda has an electric power network. Of the total power contracted by the city (24 MW), the Avellaneda Biogas Thermal Power Plant (CTBA) has a power of 6 MW and injects the energy generated into the SADI. This is a cogeneration plant that produces electrical energy and thermal energy in the form of steam from inputs derived from the processing of bioethanol, corn flour, glycerin and vinasse. Likewise, the internal consumption of the plant is between 8% and 10% of the total energy production (in this way, any possibility of energy efficiency in this internal consumption increases the energy delivered to SADI).

2.2.3 Low-scale local generation

On the other hand, based on the provincial initiative “Prosumers” (described in Chapter 3), end users have been able to install decentralized renewable systems, self-supply and dump the surplus to the distribution network (EPESF). In the city there are low-scale generation projects in operation with the following details:

Residential category:

- 2 installations of 1.5 kWp of installed power
- 1 installation of 3 kWp of installed power

Maximum Prosumer Category:

- 1 installation of 60 kWp.

Among the projects implemented (see Chapter 6), one of them is the supply of electrical energy through photovoltaic panels for a total power of 0.24 kWp. These are located in a rural cooperative without access to the COSEPAV network, but at the moment they are not operational (the project is being resumed around 2021).

2.3 Electricity / energy supplier

2.3.1 Generation, Transmission and Distribution

After being generated and injected into the SADI from the different sources, the electrical energy is transported and distributed. The regulating entities are CAMMESA and ENRE, but the transmission corresponds to the Association of Electric Power Transporters of the Argentine Republic (ATEERA). Among these players is Transener SA, a private company that operates and maintains the network in several provinces, including Santa Fe.

On the other hand, ADEERA is made up of electric power distribution agents (Association of Electric Power Distributors of the Argentine Republic). Among them are the Santa Fe Provincial Energy Company (EPESF), a public company, which is in charge of distributing electricity in Santa Fe [19].

In the province of Santa Fe, the EPESF is also in charge of commercializing electrical energy. However, there are cooperatives in certain localities that purchase energy from the EPESF and then sell it internally to their taxpayers. Such is the case of Avellaneda, which buys energy from EPESF (and EPESF in turn from CAMMESA) through COSEPAV. This implies that the entire distribution network within the city belongs to COSEPAV; Therefore, according to current regulations, a power generation project to inject it into the SADI must pay for the use of the local and provincial transport network until reaching it.

Regarding natural gas, as indicated, the carriers are TGN and TGS. It is then distributed through various distribution companies that are responsible for delivering natural gas to much of the country.

Although TGN would supply gas to towns in the north of the province of Santa Fe [20], the connection of certain towns with the NEA Gas Pipeline (among them, Avellaneda) has been completed, but the provision has not yet started, being this imminent during the years 2020 and 2021.

In areas that do not have physical networks, bottles with bottled gas purchased from distributors are used instead. Until 2020 there were four points of sale, located in Reconquista [21], but, as of the pandemic, another was added in Reconquista and one in Avellaneda [22].

In industrial terms, dry biomass (firewood) is used in large quantities, but its traceability presents difficulties since there are no formal records of these values (mostly coming from forests outside the province of Santa Fe).

In the case of liquid fuels, the distribution companies are Axion Energy (Grupo Bulgheroni), Voy con Energía (Grupo Kalpa), Shell, DAPSA, Pampa Energía, YPF and merchant unions[7].

[7] For more information see reference [7].

Outside of the user categories of each locality and as a comment, there are classifications of users who buy electricity in the Wholesale Electricity Market (the same one that the distributors feed), as well as users who buy gas in PIST (Point of Entrance to the Transportation System, better known as "wellhead").

2.4 Electricity / energy and fuel prices

Given the reality and framework of the generation, transmission and distribution of electric power in Argentina, the rate schedule has a certain complexity and the final value depends on the distributor.

Considering a currency conversion ratio of 49.2 ARS / 1 USD[8], the value at which SADI buys electric power was 68.4 USD / MWh, that is, 0.0684 USD / kWh [15]. As indicated, 96% of the total electrical energy is supplied by AGEERA[9]agents.

Although the above is a value that can technically be used as a reference, the country's exchange reality makes it difficult to compare different years when it comes to rates. As of 2016, there has been a progressive reduction of subsidies, which was stopped in 2019. However, there are categories of users who can buy energy directly from CAMMESA at the previous value, and categories in which energy is purchased from the distributor. This generates inter- and intra-provincial differences that can be significant.

Therefore, the reality of setting prices is not universal for the country, it depends on what type of user requests, which distributor to acquire and additional provincial regulations. This report will not present this situation, and will make the average values available for calculation reference. Large projections require a more in-depth local analysis at the time of the economic evaluation.

Contemplating a ratio of 73.5 ARS / USD[10], for electricity, in Avellaneda the consumption rate for a residential customer ranges between 0.0479 and 0.0962 USD / kWh (stepped rate regime). In the same comparative framework, a customer in the industrial use category of less than 300 kW has a rate between 0.045 and 0.0477 USD / kWh (tiered rates); On the other hand, customers with higher powers have a lower value rate (between 0.0404 and 0.0444 USD / kWh), but they must also pay for contracted and supplied power, which are not billed in a discriminatory way in the previous categories. Regarding network gas, in this case LPG, the rate for residential consumption in this city is 0.1771 USD / m^3, which exceeds that of large customers, which in turn have other components in the final value of the invoice; Regarding bottled natural gas, a 10 kg cylinder (“carafe”) has a value of US $ 4,626. On the other hand, a ton of firewood has a price of approximately 40.8 USD.

[8] See Figure 16.
[9] Chapter 3 will address the regulatory framework for distributed generation.
[10] The currency exchange rate is that of the selling BNA as of 06/30/2020.

In another aspect, there is also the possibility of acquiring liquid fuels (such as diesel, diesel, among others). They are a function of how they are acquired. For reference, towards the end of June 2020, in Avellaneda, the[11] super naphtha costs 0.8 USD / liter and the premium 0.9 USD / liter, while grade 2 diesel has a final price of 0.726 USD / liter and the grade 3 of 0.86 USD / liter [7].

Finally, with regard to trends in prices, it can be indicated that, since the health emergency caused by COVID, it has been arranged to maintain the values of the electricity and natural gas rates (among other services) until 17 December 2020 [23].

2.5 GHG Emissions

The GHG inventory of the city of Avellaneda is based on 2016 and has reported a total of 193,144.4 t CO_2 equivalent (193 Gg CO_2 eq), of which 38.39% correspond to the Energy sector, 20.31% to Transportation, 3.54% to Waste and 37.76% to Agriculture and Livestock [24]. These values by sector are reflected in Figure 17:

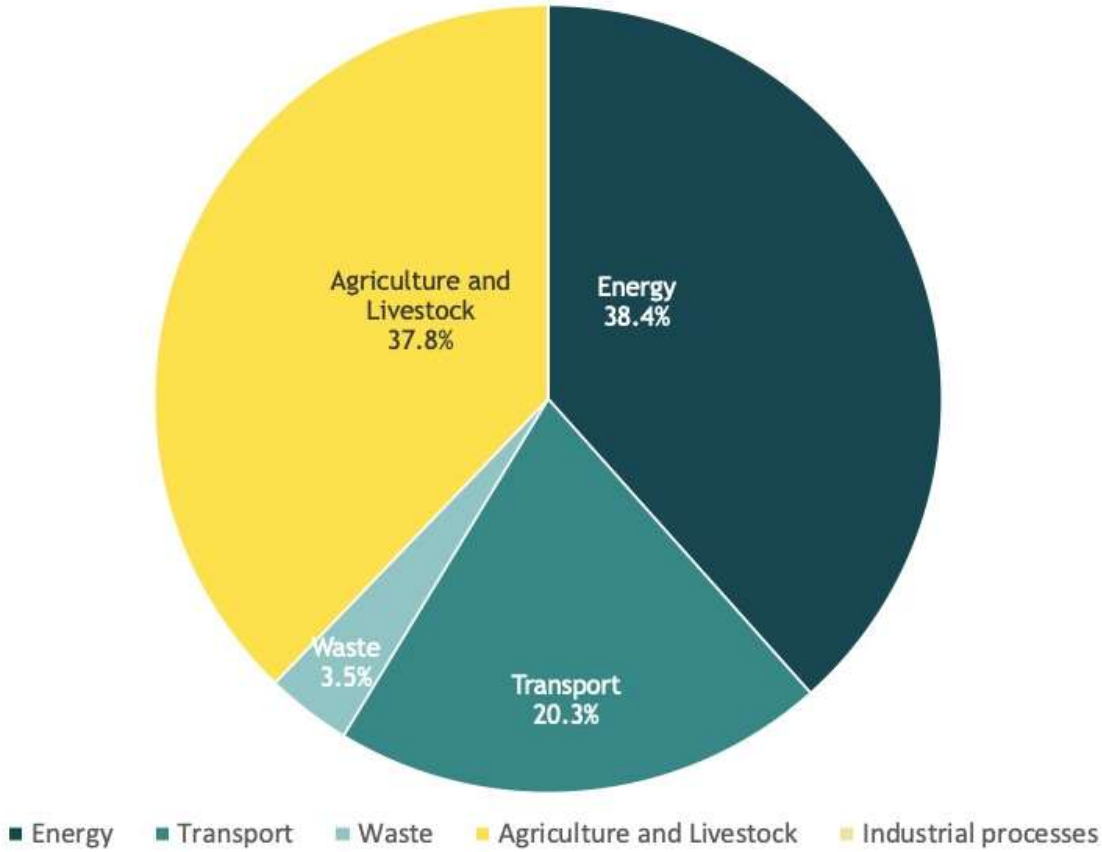

Figure 17: Participation of the sectors in the GHG emissions of Avellaneda in 2016.
Source: GHG Inventory, 2016.

[11] In Argentina, "naphtha" is the name given to "gasoline".

Figure 18 shows the comparison between the emissions of CO_2 equivalent per capita in Avellaneda, Argentina and the world. The full inventory with source details is available at reference. On the other hand, no trends have been elaborated in such a document.

Figure 18: Comparison of emissions per capita of Avellaneda in 2016.
Source: GHG Inventory, 2016.

3. Reference frameworks that allow the implementation of renewable energies.

3.1 National level

In 1998, Argentina created the National Regime for Wind and Solar Energy through Law No. 25019/1998. That law established that the Federal Council of Electric Power will promote the generation of wind and solar energy, being able to affect resources from the Fund for the Electricity Development of the Interior (established by Article 70 of Law 24,065). The law also refers to the provinces, which will be invited to adopt a regime of tax exemptions in their respective jurisdictions for the benefit of the generation of electricity from wind and solar origin.

In the 1990s, the Ministry of Energy developed PERMER. This is a rural electrification and energization project whose broad objective is to provide a reliable and sustained supply of electricity and thermal energy to the rural areas of the participating provinces, based on the priority use of renewable generation sources. The development of PERMER I began in 1999 and ended in 2012; allowed the electrification of a large proportion of the dispersed rural population through solar and wind energy and through the construction of mini-grids, benefiting approximately 1,800 schools, 350 public services and 27,000 homes. In addition, 307 appliances were provided and installed, including solar ovens, stoves and heaters, to public service institutions.

National Law No. 26190/2006 established the National Development Regime for the use of renewable sources of energy for the production of electrical energy. Its article NO. 2 defines the objective of achieving a contribution from renewable energy sources until reaching 8% of the national electricity consumption, within ten years from the entry into force of this regime, that is, 2016 . It also refers to the Renewable Energy Trust Fund (Art. 14).

In 2006, the Nation enacted Law No. 26093 that created the Regime for the Regulation and Promotion for the Sustainable Production and Use of Biofuels. It defined that all projects qualified and approved by the Enforcement Authority will be achieved by the benefits provided by the mechanisms - they are Emission Reduction Rights; Carbon Credits and any other title with similar characteristics. This instrument determines the percentage of biofuels present in hydrocarbon fuels, a concept called *cut*, either for diesel (biodiesel) or naphtha (bioethanol). By Law No. 17319/1967 article 3, it is the National Executive Power that sets the policies related to the exploitation, industrialization, transportation and commercialization of hydrocarbons. Thus, it is who dictates what type of fuel can be dispensed at the pumps of the Argentine territory.

Also in 2006, the National Hydrogen Law, No. 26123/2006, was approved. At that time, special attention had been paid to hydrogen as an energy vector, but there was practically no progress[12]. The potential of hydrogen is very high, not only because of its energy contribution, but also because it helps to decarbonize the Argentine matrix. It is a fuel that does not release CO_2 as a combustion process; however, its means of obtaining it require intensive use of energy. On the other hand, they also have high potential as a means of storage and transport.

On December 21, 2007, Decree No. 140/2007 called "National Program for Rational and Efficient Use of Energy" (PRONUREE) was issued, in which the rational and efficient use of energy is declared of national interest and priority. . This decree acts as protection in subsequent years for all legislative instruments that have the rational and efficient use of energy as a central discipline (among them, all article labels, for example).

One of the reforms of the 2015 Civil and Commercial Code of Argentina is that it turns the environment into a “protected legal asset”, thus generating legal regulations, normative categories and laws in order to protect it, obtaining the State (and requiring the himself) a more active role.

In 2015, National Law No. 27191 was enacted, which amended No. 26190. The objective was to achieve a contribution from renewable energy sources until reaching the same percentage defined in 2016, of 8% of consumption of national electrical energy, at the end of 2017 and decreed to achieve a contribution from renewable energy sources until reaching twenty percent (20%) of the national electricity consumption, at the end of the year 2025.This law also provides that large consumers of the electricity market must reach a minimum of twelve percent (12%) of their own consumption of electricity from renewable sources. This legislation hopes to provide a strong boost in distributed generation and local knowledge capacities to meet this demand. At the national level, it is also expected to reach 10% of the primary energy matrix and 25% of electricity from renewable sources by 2030.

In 2016, Argentina adopted the Paris Agreement through Law No. 27270 and deposited the instrument of ratification with the Secretary General of the United Nations. During the twenty-second Conference of the Parties (COP22), the country presented its Nationally Determined Contribution in its Revised version, which replaced the Expected and Nationally Determined Contribution of 2015.

The review process of the National Contribution carried out in 2016 and, subsequently, the development of sectoral action plans in 2017, were carried out within the framework of the National Climate Change Office (GNCC), which is an articulation instance for the definition of public policies on climate change, created by the National Executive Power through Decree No. 891/2016. The Office is made up of seventeen ministries, is chaired by the Chief of the Office of Ministers and has the technical coordination of the Office for Climate Change and Sustainable

[12] In April 2019, a project was presented to update the aforementioned law.

Development of the Ministry of Environment and Sustainable Development of the Nation (MAyDS). On 12/20/2019 it would be institutionalized with the approval of Law No. 27520/2019.

The *energy* sector is the most important in terms of greenhouse gas emissions (53%) according to the 2016 National Inventory of Greenhouse Gases, so the National Contribution corresponding to the sector is also the one presented by the increased mitigation potential [25].

The National Regulatory Decree No. 531/2016 "National Promotion Regime for the Use of Renewable Energy Sources for the Production of Electric Power", regulates National Law No. 27191/2015 and implements the RenovAr Program, which constitutes the first step for the long-term contracting of electricity from a renewable source.

Likewise, the Public Trust Fund called "Fund for the Development of Renewable Energies" ("FODER") was created, forming an administration and financial trust and which will govern throughout the territory of the Argentine Republic with the scope and limitations established in such law and the regulatory norms issued by the Executive Branch as a result.

Law No. 27424/2017 proposed the Regime for the Promotion of Distributed Renewable Energy Generation integrated into the Public Electricity Grid. Its purpose is to set policies and establish the legal and contractual conditions for the generation of electricity of renewable origin by users of the distribution network, for their own consumption, with eventual injection of surpluses into the network, and establish the obligation to The providers of the public distribution service to facilitate said injection, ensuring free access to the distribution network, without prejudice to the powers of the provinces. However, the provinces must express their adherence to the law.

Additionally, it created the public trust fund called "Fund for the Distributed Generation of Renewable Energies" ("FODIS") or the Fund which will be formed as an administration and financial trust, to apply the trust assets to the granting of loans, incentives, guarantees , the realization of capital contributions and the acquisition of other financial instruments, all of them destined to the implementation of distributed generation systems from renewable sources.

In addition, in 2017, through resolution 281-E / 2017, the “Regime of the Term Market of Electric Power from Renewable Source” (“MATER”) was approved. In this particular market, with its own regulation, there are operations for the purchase and sale of electricity between private parties. It is constituted as an alternative to purchase energy for those users whose power demand is equal to or greater than 300 kW.

During 2017, the country began developing sectoral action plans on climate change to organize the implementation of the Determined National Contribution. The sectoral action plans on climate change establish the strategy of the competent ministries to implement the mitigation and adaptation measures of the Determined National Contribution, including roadmaps for each measure, which define specific guidelines to achieve the objectives.

The National Action Plan for Energy and Climate Change (PANTyCC) is part of the Sector Plans that were developed during 2017 and 2018. Its objective was to plan the implementation of the

measures contained in the National Contribution under the jurisdiction of the former Ministry of Energy and Mining, in order to accompany the development of the country in accordance with the commitments assumed in the matter of climate change.

The vision determined in the plan indicates the following: "*By the year 2030, Argentina will have implemented policies, actions and measures for the affordable supply of energy in a clean, reliable and sustainable way, accompanying productive and population growth and incorporating the responsible use of energy through the promotion of energy efficiency as the guiding principle, achieving a substantial reduction in GHG emissions and adaptation mechanisms to climate change that reduce exposure to risk and social vulnerability and energy systems.*"

The mitigation measures and actions considered in the National Contribution are structured in two central axes corresponding to the supply and demand of energy. As a whole, they would allow an emission reduction by 2030 of 77 $MtCO_{2eq}$. This sectoral objective to reduce GHG emissions is expected to contribute significantly to the fulfillment of the goal of the National Contribution. The measures referring to the transport sector are detailed in the National Action Plan for Transport and Climate Change. Likewise, through a set of additional measures, savings of 24 $MtCO_{2eq}$ could be achieved, which would lead to reductions of 101 $MtCO_{2e}$q by the year 2030, in case of overcoming the barriers to its implementation, which currently underpin its conditionality.

The two central axes consist of the following mitigation and adaptation measures [26]:

Energy supply		Energy demand	
Measure	**Expected reduction by 2030 [$MtCO_{2eq}$]**	**Measure**	**Expected reduction by 2030 [$MtCO_{2eq}$]**
Electricity generation from non-conventional renewable sources connected to the grid (renewable energy).	17.55 unconditional. 4.61 additional.	Efficiency in household appliances (energy efficiency)	3.1 additional.
Distributed electricity generation (renewable energy)	Additional 0.29.	Solar water heaters (renewable energy)	0.64 unconditional. 0.39 additional.
Cutting with biofuels (fuels)	5.11 unconditional. 1.06 additional.	Water savers (energy efficiency)	4.62 unconditional.
Hydroelectric generation (large-scale generation)	6.3 unconditional. 0.73 additional.	Public lighting (energy efficiency)	10.62 unconditional. 1.3 additional.
Nuclear generation (large-scale generation)	11.74 unconditional. 3 additional.	Heat pumps (energy efficiency)	3.2 additional.
Electricity generation isolated from the grid (PERMER) (renewable energy)	0.05 unconditional.	Thermal envelope in buildings (energy efficiency)	1.21 additional.

Energy supply		Energy demand	
Measure	Expected reduction by 2030 [$MtCO_{2eq}$]	Measure	Expected reduction by 2030 [$MtCO_{2eq}$]
Substitution of fossils with a higher emission factor for natural gas in electricity generation (large-scale generation)	New	Efficient water heaters (energy efficiency)	0.38 unconditional. 1.96 additional.
Improvement in the efficiency of thermal power plants (large-scale generation)	New	Residential lighting (energy efficiency)	20.37 unconditional.

Table 4: PANEyCC mitigation measures in energy supply and demand.
Source: Ministry of Environment and Sustainable Development, 2019.

The energy sector includes all GHG emissions emanating from the combustion of fuels for energy purposes and from fuel leaks. Emissions from non-energy uses of fuels are not included in this sector, but are part of the industrial processes and product use sector. Thus, the contributions of the remaining sector plans to the reduction of GHG emissions are described below:

- The measures referring to the transport sector are detailed in the National Action Plan for Transport and Climate Change (PANTyCC). The total emissions to avoid is proposed at 5.9 $MtCO_{2eq}$.
- The measures referring to the industrial sector are detailed in the National Action Plan for Industry and Climate Change (PANIyCC). The mitigation measures and actions considered in the National Contribution in this sector are structured around four central axes: energy efficiency, renewable energy, circular economy and gas capture. As a whole, they would allow an emission reduction by 2030 of 6.4 $MtCO_{2eq}$.
- The fourth of the sectoral plans is the National Action Plan for Agro and Climate Change (PANyCC). The emissions avoided in this proposal reach 25.74 $MtCO_{2eq}$, among which is the success of the mitigation measure called “agroenergy”, with a reduction by 2030 of 3.41 $MtCO_{2eq}$. This measure refers to the “use of biomass for energy generation”, technically, electricity not connected to the grid through the use of biomass.
- The sector plan of the National Action Plan for Forests and Climate Change (PANByCC) proposes a reduction by 2030 of 27 $MtCO_{2eq}$; however, mitigation measures are not directly related to energy.

With regard to electromobility, Decree No. 32/2018 (which modifies Decree No. 779/1995) encompasses electric vehicles within current regulations. This is precisely Law No. 24449/1994, which regulates traffic and road safety at the federal level.

Since the promulgation of Decree No. 140, an energy efficiency labeling process has been started for different articles, whether for home use, as well as for industrial use and even referring to the use of renewable sources. Furthermore, certain families of articles can only be marketed if, in addition to the mandatory labeling, they comply with the corresponding MEPS (Minimum Energy

Performance Standard). Examples of these labeled with MEPS are family refrigerators, washing machines and air conditioning equipment; without MEPS, some items are gas ranges, gas ranges, or electric pumps. On the other hand, solar panels or openings and work carpentry present a voluntary labeling, unlike the previous cases. Finally, since June 2019, the labeling of road vehicles of up to 9 passengers (counting the driver) and cargo transport of up to 3,500 kg began. In this area, not only the label will provide information on fuel consumption (through the information label), but also on the corresponding CO_2 emissions (ie comparative label) [27].

Another program related to energy efficiency that continues to be carried out since 2017 is the Program for the Rational Use of Energy in Public Buildings (PROUREE), in which the figure of the Energy Administrator defined in Decree No. 140/2007. The purpose of the program is to manage the energy of public buildings in the country and improve the level of energy efficiency of the same through different actions, also acting as an element of dissemination of practices.

In the last days of November 2019, the energy efficiency bill (S3290-19) was presented, which has not undergone major advances since its presentation.

Ten days after the assumption of national management 2019-2023, on December 20, Law NO. 27520/2019 was sanctioned, which is titled as “Minimum Budgets for Adaptation and Mitigation to Global Climate Change”. Thus, "the minimum environmental protection budgets are established to guarantee adequate actions, instruments and strategies for Adaptation and Mitigation of Climate Change throughout the national territory in the terms of article 41 of the National Constitution." (Article 1).

One of the most important measures is the creation of the National Climate Change Office, chaired by the Chief of Office. This office “will be made up of the highest authorities from the following government areas: Environment, Energy, Mining, Production, Agriculture and Livestock, Industry, Transportation, Social Development, Foreign Relations, Education, Sports, Health, Science and Technology, Interior, Public Works, Housing, Labor, Economy and Finance and Security and Defense. " , indicating the principle of transversality (art. 4 b) to which the aforementioned law refers. Finally, article 12 establishes that the office must convene an External Advisory Council of the National Plan for Adaptation and Mitigation of Climate Change. As of Decree No. 732/2020 of September 4, the Ministry of Energy is located in the Ministry of Economy, having under its orbit: (i) the Deputy office of Electric Energy, (ii) the Deputy office of Hydrocarbons, (iii) the Deputy office of Energy Planning, and (iv) the Deputy office of Institutional Coordination [28] [29].

According to the presentation of the Director of Renewable Energies [30], the current status of renewable energy projects is as shown below.

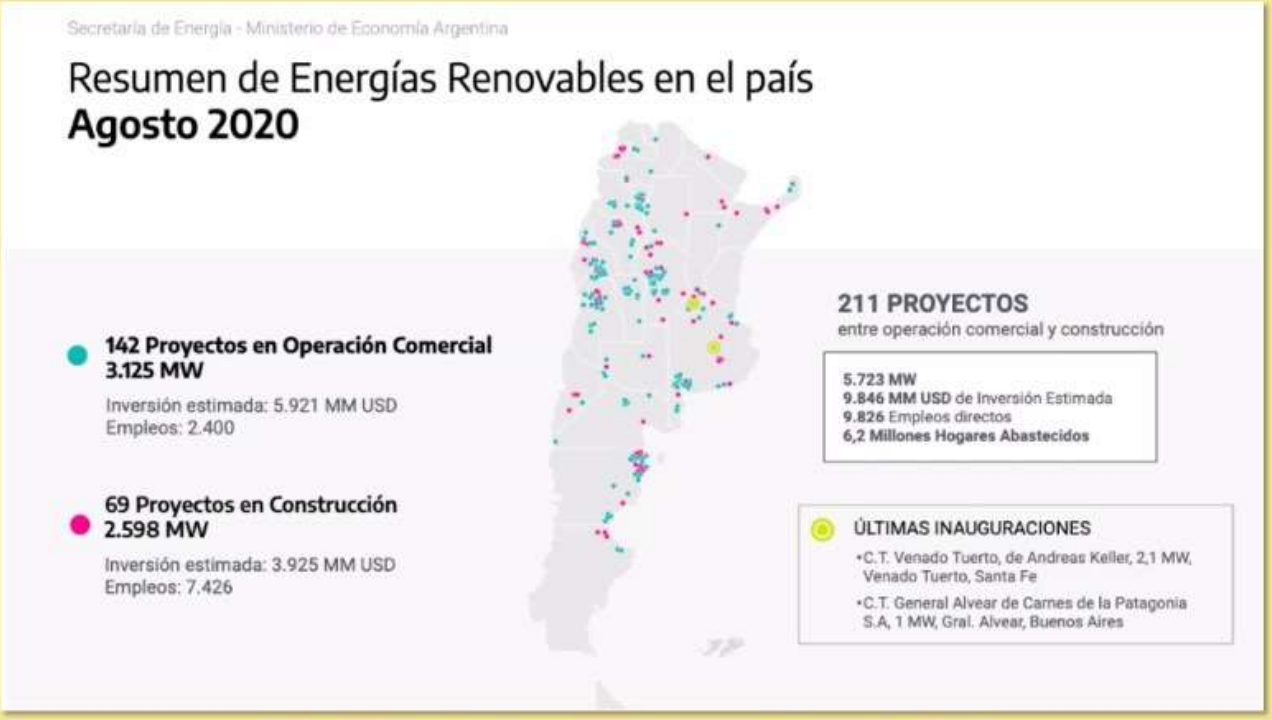

Figure 19: Summary of Renewable Energies in the country, August 2020.
Source: 100% RE National Kick-Off Presentation, 2020.

Since January 2020, unfinished projects under construction are under review [31] [32].

Finally, in terms of solar thermal energy and in the preparation stage is the "Program for the Promotion of Solar Thermal Energy", which seeks to promote direct employment through the manufacture of national hybrid thermal solar equipment. In values, there would be 525 direct jobs and an Argentine manufacturing of approximately 30,000 pieces of equipment through an investment of 16 million ARS and thus avoiding the consumption of 5.7 million m^3 of natural gas per year [30].

3.2 Subnational level

The province of Santa Fe has its own regulations regarding renewable energy and distributed generation.

Provincial Law No. 12503/2005 declares of provincial interest for the generation and use of alternative or soft energies from the application of renewable sources.

Provincial Law No. 12692/2006 defines the “Provincial Promotional Regime for research, development, generation, production and use of products related to non-conventional renewable energies”. Through it, all EPESF users are charged a minimum amount in order to generate a fund for this promotional scheme.

Provincial Law No. 12956/2008 establishes the Provincial Promotional Regime for research, development, generation, production and use of products related to non-conventional renewable energies and stipulates tax exemptions for natural or legal persons who own renewable projects.

Provincial Decree No. 1565/2016 creates the Prosumers Program, the most prominent policy in the field of renewable energy at the provincial level in the 2015-2019 management. Its objective is to promote the acquisition of renewable energy equipment with technical features that comply with the interconnection procedure of the EPESF approved by Resolution 442/2013. The Program allows connections (residential, rural, commercial, industrial and civil society organizations) to inject the electrical energy generated from renewable sources into the network, and receive an economic incentive for it (the funds were obtained from the proceeds via Law No. 12692/2006). Said decree is later modified by Provincial Decree No. 1710/2018, which establishes a new monetary incentive regime, maximum permitted power limits, quota and procedural definitions for its implementation (renamed "Prosumers 2020"). The billing scheme of the program is of the net billing type integrated with FIT (billing balance), while the national scheme is net metering (balance between the energy consumed and injected). This substantial difference was also a key aspect in Santa Fe's decision not to adhere to the national framework.

During the duration of the editions of the “Prosumers” Program, Santa Fe did not adhere to the national law of Distributed Generation (NO. 27424/2017); even the first edition of the program precedes the draft of the national law. In this sense, during the years 2017-2019 the province marked a leadership in a position opposed to the aforementioned law and this was translated into a provincial symbol, as well as a reference for other provinces. Decree No. 1710/2018 indicated December 31, 2019 as the closure of the “Prosumers 2020” program. As of December 10, 2019, a new management enters, which has respected the deadline to accept new entrants to the program, but beginning in 2020, it did not publicly pronounce on its continuity. However, through various means the authorities indicated the non-continuity of the program and had resolved to adhere to National Law No. 27424/2017 [33]. On the other hand, the outgoing management drew up a bill to promote the continuity of the "Prosumers" program. Thus, in July 2020 they managed to get the Chamber of Provician Representatives to give him a half sanction.

Although Santa Fe is not currently adhered to Law No. 27424/2017, it did use the concept of "distributed generation." Instead of injecting energy into the SADI, an electric power generating plant can do so into the local grid of the distributor EPESF. This decision shares economic and technical criteria; However, to be able to deliver energy to the EPESF network, the “Technical procedure for connecting generator sets on an island or in parallel with the EPESF network” [34] must be respected.

Regarding biofuels, Provincial Law No. 12691/2006 establishes the “Regime for the Regulation and Promotion of the Sustainable Production and Use of Biofuels”.

Decree No. 042/2009, framed within the Territorial Planning Law, relies on Native Forests and categorizes according to National Law No. 26311 // 2007, thus creating the Map of Territorial Planning of Native Forests in order to validate the traceability of this biomass.

In 2018, Law No. 13781/2018 was enacted in the province, which seeks to promote the industrialization of electric vehicles and alternative energy technologies, while declaring their incorporation and use as a means of reducing the environmental pollution. The creation of the "Provincial Plan for the Promotion of Electric Mobility" is also regulated.

Through the joint Provincial Resolution between the Office of Transportation No. 002/19 and the State Office for Energy No. 094/19, it was required that the Provincial Urban and Interurban Passenger Automotive Transport companies with head or passers-by of the cities Santa Fe and Rosario that have more than 50 units (and whose routes are exhausted within metropolitan areas), must use 100% biodiesel fuel (B100) in their units (in order to continue receiving the Provincial Transportation Fund Passenger Automotive).

Finally, at the end of October 2019, Law No. 13903/2019 on "Labeling of energy efficiency of properties for housing" is approved, which aims to classify said properties according to their degree of efficiency in global energy consumption primary linked to the use of the same in the scope of the Province of Santa Fe. This law establishes the mechanisms for said certification, creates the Registry of energy efficiency certifiers and the Energy Efficiency Labeling Commission of Real Estate Destined for Housing as an advisory advisory body to the State Office for Energy. In addition, it determines that the Municipalities and Communes may adhere to the law within the framework of their powers according to the Organic Law of Municipalities of the Province of Santa Fe No. 2756, and the Organic Law of Communes No. 2439 and establishes a bonus in the Annual Urban Real Estate Tax on properties that have the current Energy Efficiency Label of up to 30% for category A. At the time of writing the report, the aforementioned law is unregulated.

At the end of October 2020, the 2019-2023 provincial administration launched the "Renewable Energies for the Environment" Program. Through Decree No. 1098/2020, “the Program will facilitate the repayment of renewable electricity generation systems, through a net billing balance, where the user-generator compensates in billing for the avoided costs of self-consumed electricity and obtains an economic recognition for the electric energy injected into the distribution network”.

3.3 Local level

Initially, Avellaneda has regulated what refers to energy efficiency, which is the area in which the projects have been developed to date. For this purpose, it has: (i) Ordinance No. 1870, which establishes the replacement of street lights throughout the city with LED technology devices; (ii) Ordinance No. 1904/2018, which requires the provision of public lighting with LED devices in the

subdivisions subsequent to its sanction; and (iii) Ordinance No. 1962/2020 that establishes the obligation for the Public Services Cooperative to replace LED lights in all green spaces in the city before March 2020. In any case, it is expected to be accompanied by regulations that regulate and support all the new policies that are being implemented from this project or other initiatives.

Finally, Ordinance No. 1965/2020 institutionalizes adherence to Project *100% RE*, while Decree No. 066/2020 formalizes the creation of the Local Work Group.

4. Local potential for renewable energy resources

4.1 Potential

Next, the benefits of renewable resources in Avellaneda will be exposed.

4.1.1 Temperature and rainfall

Retrieving the information from the Reconquista meteorological station, the most detailed historical mean rainfall and temperature values are plotted [3]:

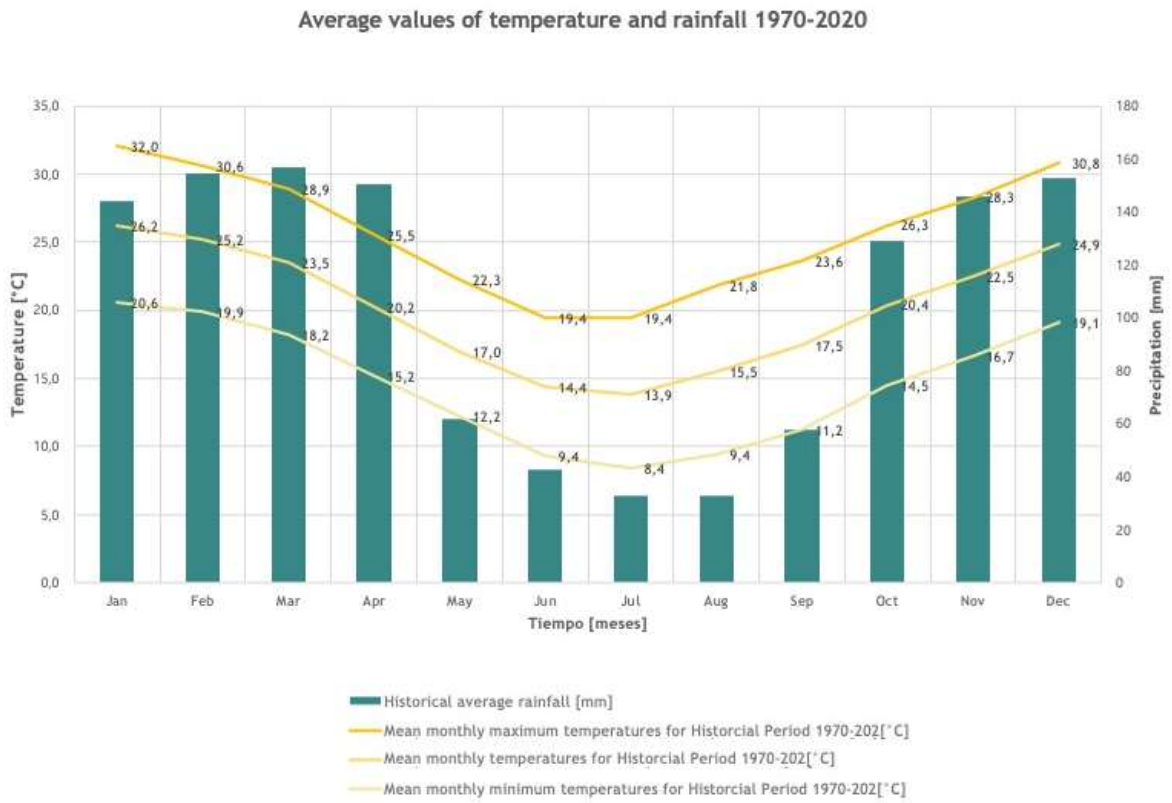

Figure 20: Temperature and precipitation values.
Source: own elaboration according to INTA Reconquista, 2020.

4.1.2 Solar radiation

Measuring instruments have been installed in the province since 2014 in five locations that make up the “Solarimetric Network”. From the information provided, the following quarterly profile is obtained for Reconquista (a town 5 km from Avellaneda) between March 2015 and September 2019 [35]:

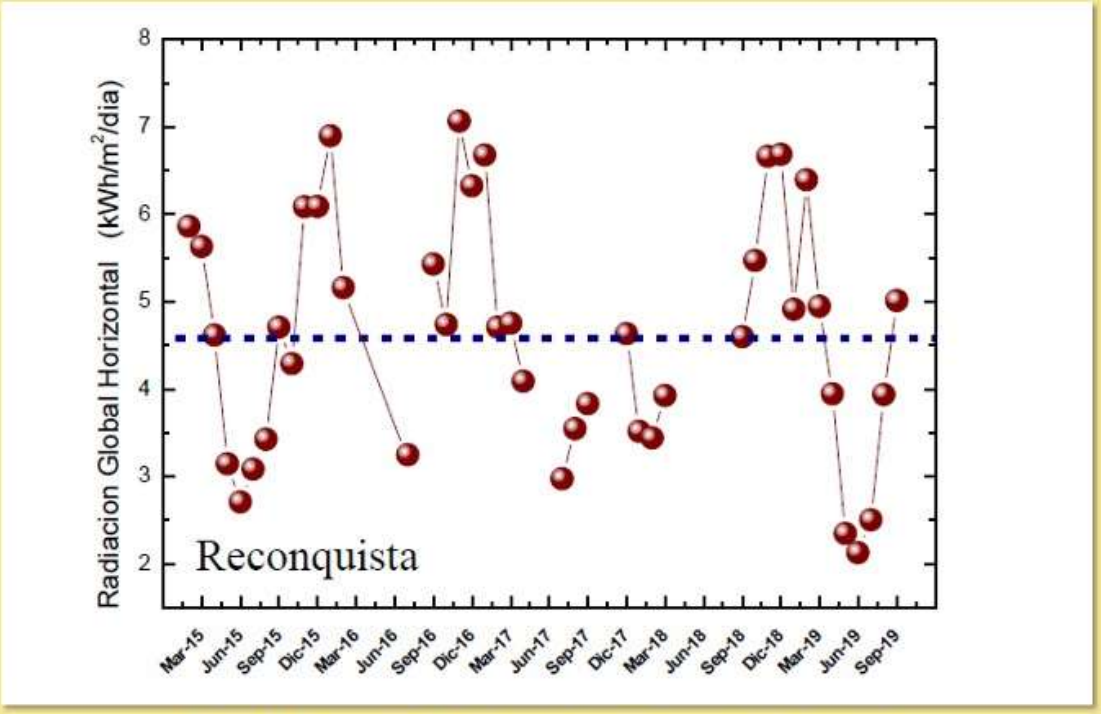

Figure 21: Quarterly profile of horizontal global radiation in Reconquista.
Source: Red Solarimétrica de Santa Fe, 2019.

As can be seen, with these values a historical average of global horizontal radiation of 4.5 kWh / m^2/ day is obtained.

This same report indicates, in its conclusions, that the production index of a photovoltaic plant in the province of Santa Fe would be between 1,390 and 1,500 MWh / MWp / year [35].

The information presented is complemented with the annual variation of this solar magnitude from the "Solar Radiation Atlas" [36].

According to the values in the graph, the town of Avellaneda would have, on average, 1,685 kWh / m^2/ year, that is, 1,685 HPS[13]. A photovoltaic plant would take advantage of this energy and convert it into electrical energy, although a percentage cannot be converted due to dissipative effects. Assuming values close to 10% dissipation, the previous production index interval would be obtained.

[13] Peak Sun Hours: it is the number of hours a surface unit is exposed to a hypothetical solar irradiation of 1 kW so that it is numerically equal to the energy received during a certain time.

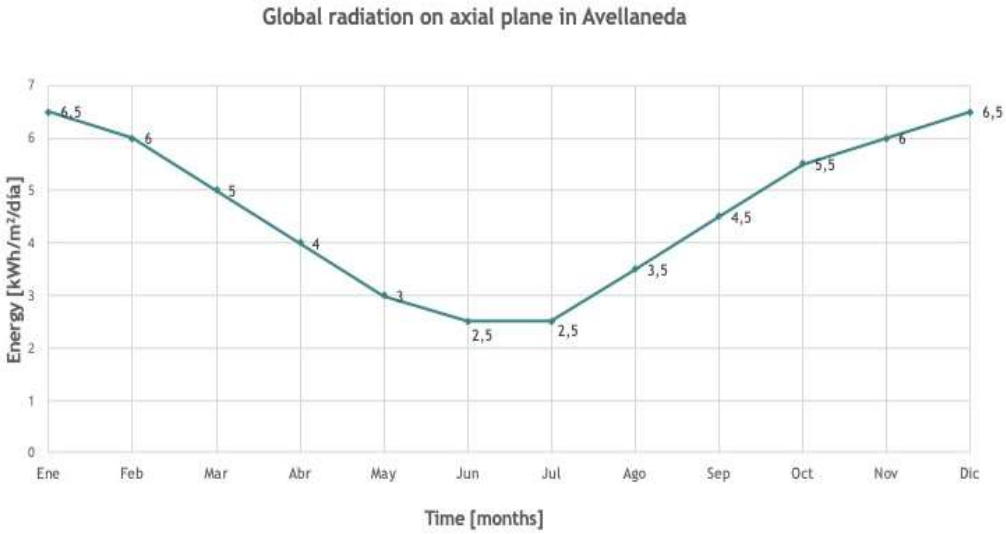

Figure 22: Annual variation of radiation in Avellaneda.
Source: own elaboration according to Grossi Gallegos and Righini, 2017.

Finally, the weighted average of radiation with these values is 4.62 kWh / m^2/ day.

4.1.3 Wind resource

Figures 27 and 28 show the characteristics of the wind resource [37]:

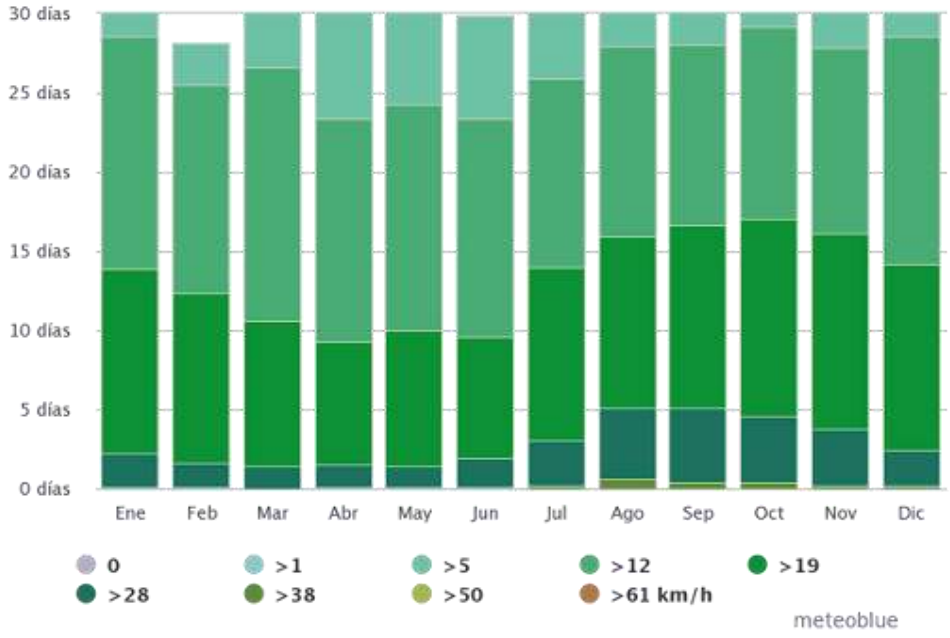

Figure 23: Annual variation of wind speed in Avellaneda.
Source: MeteoBlue, 2020.

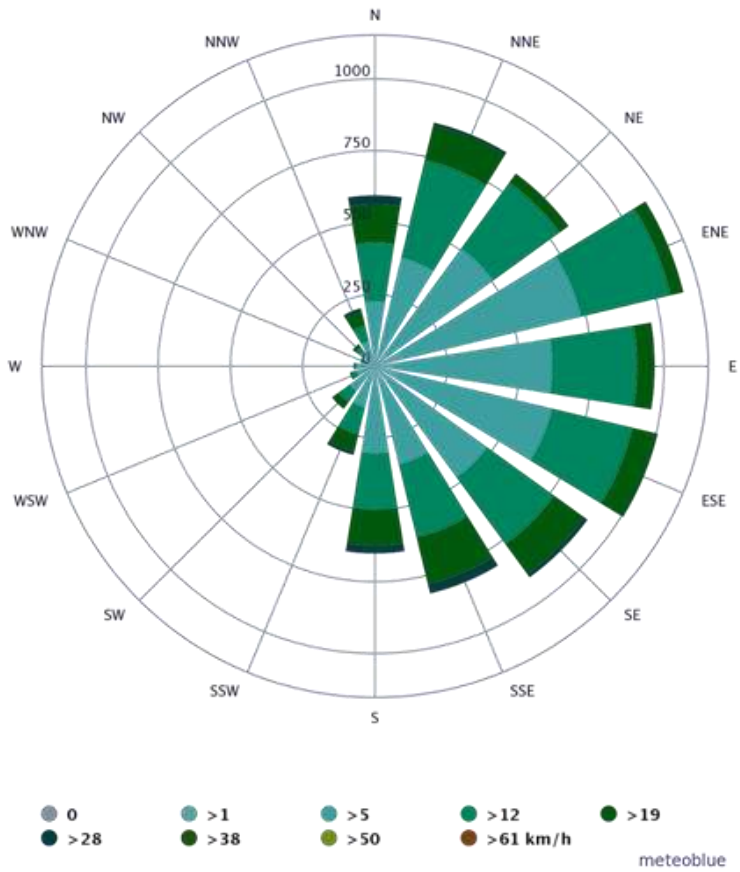

Figure 24: Rose of the Winds for Avellaneda.
Source: MeteoBlue, 2020.

From Figure 27 it is detected that, in more than half of the month, the wind speed is less than 19 km / h (11.8 mph or 5.78 m / s). According to the information provided, the maximum speed recorded is 38 km / h in a few days between August and November (23.6 mph or 10.6 m / s).

Taking into account a commercial model available in Argentina[14], it can be observed that the nominal power of the wind turbine is achieved when the speed exceeds 13 m / s (approximately 48 km / h). Considering another[15]model, it is reflected that the most frequent speed of Avellaneda is far from the speed of the highest production (which also results in 13 m / s). Although the examples are of very small-scale wind turbines, the characterization of the resource provides an idea of how much energy can be generated in the locality.

Link: https://articulo.mercadolibre.com.ar/MLA-811153920-aerogenerador-12v-400w-regulador-energia-renovable-eolica-_JM#position=1&type=item&tracking_id=55d6239d-4764-43c7-be5a- f732af281 https://articulo.mercadolibre.com.ar/MLA-811153920-aerogenerador-12v-400w-regulador-energia-renovable-eolica-_JM

[15] Link: https://www.amazon.com/Primus-Wind-Power -1-AR40-10-Turbine / dp / B00IJZX910 /

A rough estimate shows that in January a 400W commercial wind turbine would produce around 37 kWh of electrical energy from the kinetic energy of the wind. Then, this value must be affected by the higher speed wind adjustment and pitch control mechanical rotations.

4.1.4 Urban Waste

The amount of Urban Solid Waste (MSW) generated is calculated at 18 t / day, composed (by weight) of 45% organic, 12% sanitary and 43% inorganic. Currently, of the inorganic ones, more than 65 tons per month are being recovered, which represent 12% of the total generated and 28% of what is collected in this fraction [2]. Household organic MSW (whose participation is 45%, that is, a total of almost 9 tons per day) differ from other waste given the results obtained from procedures corresponding to its treatment started in 2015.

Currently, both the pruning waste from public trees as well as the pruning and garden waste that private homes take to public roads, are used to fill old excavations that are in the vicinity of the city. This constitutes a challenge to be solved.

The energy from the biodigestion of both industrial and urban wastewater (sludge) is important mainly considering the quality and quantity of the biodegradable waste generated by agro-industry and agricultural production.

4.1.5. Biomass energy resource

Although most of the firewood is not obtained within Avellaneda since it is acquired from various localities and provinces (of which between 10% and 20% is obtained locally depending on the time of year), the city has great biomass potential in general given its agro-industrial activities. Among them is the production of bioethanol, whose residue is placed inside biodigesters to produce biogas, which is the fuel that feeds the CTBA.

Given the nutritive potential for the soil that crop residues have, for what remains in the field after harvesting the harvest, the fallow technique is used, that is, the remains are left on the ground and then the plow disc in order to incorporate it into the soil structure prior to the next sowing shift. Since this situation is widespread among producers, there are no formal records in this regard.

Regarding agricultural activity, considering the manure production values by type of livestock [38], the estimated annual quantity is obtained:

Type of cattle	Daily manure [kg / day / u]	Number of heads [u]	Total estimated manure [t / year]
2 kg bird	0.18	730,000	47,961
Cattle of 500 kg	10	3,000	10,950
50 kg pig	2.25	7,000	5,748

Table 5: Annual manure estimate.
Fuente: own elaboration according to FAO, 2011.

Regarding waste from bioethanol production, although there are no formal records, it must be borne in mind that the biogas produced from such waste feeds the CTBA. Considering a theoretical yield of 35% of the plant, there is raw material equivalent to almost three times, in energy terms, the energy generated. The PCI adopted for biogas is 4,500 kcal / kg [9].

Another important resource is in the industrial sector, where there is currently an installed capacity in boilers for a total production of 100 tons of steam / hour. However, not all of them are permanently operational but rather variable according to the seasonality of the production processes in various cases. However, these boilers are fed with firewood that comes, in some cases, from native forests and, in others, from implanted forests. In the cases of boilers fed with native forest firewood, Decree No. 042/2009 is in force in the province of Santa Fe, which establishes that those forest areas from which firewood can be extracted must have a forest management plan. approved by the competent authority that allows a "Forest Guide" to be issued to those who transport and buy that firewood. Compliance with this law does not happen in its entirety, but in recent times progress has been made.

Furthermore, these boilers installed in the industrial zone also provide significant cogeneration potential; Currently there is only a small experience installed in one of the boilers that can be used to optimize the system and implement it in the other boilers.

4.1.6 Water resources

Hydraulic and hydroelectric development is a characteristic of Argentine history that began at the dawn of the twentieth century, especially in terms of the political development aspects throughout those decades. It is not the objective of this report to make some kind of analysis, but it is mentioned that in the 1970s the Paraná Medio hydroelectric project had been developed, with a great energy potential, which was not carried out. This initiative proposed to create a dam between the cities of Reconquista and Goya on the Paraná River; finally, it was not executed for various reasons, among them, in addition to budgetary reasons, strong opposition from society regarding the consequent destruction of hectares of wetlands due to the need to flood them to generate the dam [39].

The National Water Institute, through the Hydrological Alert and Information Systems Sub-management, is the one who develops and operates the hydrological forecast and alert service of the La Plata Basin. In this regard, Figure 29 shows the elevation and flow values of the Paraná River in certain locations in the province of Santa Fe. In particular, for Reconquista on 09/29/2020, the height was 180 cm; the flow value for that same day in Santa Fe was 9,856 m^3/ s [40] [41].

Station	River	Lecture (cm) 00:00 hs	Previous Day (cm)	Alert	Evacuation	Low Water Limit
Puerto Iguazú	Iguazú	998	994	2500	2800	1000
Posadas	Paraná	1000	1000	1100	1200	900
Ituzaingó	Paraná	94	98	350	400	70
Paso de la Patria	Paraná	196	201	650	700	300
Corrientes	Paraná	185	185	650	700	300
Barranqueras	Paraná	186	195	600	650	320
Empedrado	Paraná	161	160	650	670	280
Bella Vista	Paraná	193	180	600	640	300
Goya	Paraná	206	199	520	570	260
Reconquista	Paraná	180	180	510	530	230
Esquina	Paraná	145	140	500	540	220
La Paz	Paraná	168	149	580	615	320
Paraná	Paraná	89	82	470	500	230
Santa Fe	Paraná	113	107	530	570	260
Diamante	Paraná	111	111	530	550	240
Victoria	Paraná	195	190	460	490	260
San Lorenzo	Paraná	84	84	520	570	230
Rosario	Paraná	82	91	500	530	260
Villa Constitución	Paraná	58	75	400	450	190
San Nicolás	Delta	80	80	420	500	180
Ramallo	Delta	54	52	350	400	160
San Pedro	Delta	66	38	340	360	150
Zárate	Delta	50	20	220	240	30
Paranacito	Delta	128	105	230	260	110

Station	River	Lecture (cm) 00:00 hs	Previous Day (cm)	Alert	Evacuation	Low Water Limit
Ibicuy	Delta	5	0	200	230	40
Pilcomayo	Uruguay	40*	41	535	600	240
Formosa	Uruguay	68*	69	780	830	320
San Javier	Uruguay	170	185	800	1000	130
Santo Tomé	Uruguay	266	260	1150	1250	130
Paso de los Libres	Uruguay	254	272	750	850	140
Salto Grande Arriba	Uruguay	3376	3397	3550	3600	3300
Concordia	Uruguay	510	428	1100	1250	170
Colón	Uruguay	200	248	710	790	140
Concep. del Uruguay	Uruguay	168	200	530	630	90
Pto. Gualeguaychú	Uruguay	130	144	350	380	50
Puerto Ruiz	Gualeguay	70	70	450	500	80
Buenos Aires	de la Plata	64	25	330	390	50

Station	River	Flow (m3/s)	Day variation
Andresito	Iguazú	1441	848
Punto Trifinio	Paraná/Iguazú	9500	400
Yacyretá Afluente	Paraná	9900	300
Pto. Pilcomayo	Paraguay	898	-9
Corrientes**	Paraná	11422	0
Santa Fé	Paraná	9856	163
San Javier	Uruguay	1439	-86
Santo Tomé	Uruguay	1611	96
Paso de los Libres	Uruguay	2538	-298
Aporte Salto Grande	Uruguay	2865*	-100

**Dato estimado. **Caudal en las primeras horas del día.*

Table 6: Hydrometric report of the La Plata Basin for 09/29/2020.
Source: National Water Institute, 2020.

4.2 Renewable energy projects implemented

4.2.1 Photovoltaic Solar Energy through the "Prosumers" program

Decentralized connections are available through the "Prosumers" program, for a total of 66 kWp. Although there are no generation records at the time of this report, the amount of energy generated according to reference [35] for this peak power would be between 91,740 and 99,000 kWh per year.

4.2.2 Performance in generating the CTBA

As indicated, a biogas cogeneration plant (CTBA) is operating in Avellaneda, with an installed power of 6 MW. Here the electricity generation of such a plant is evaluated from official data [42] since its commissioning[16]:

Figure 25: Variation in the energy generated by CTBA.
Source: own elaboration according to CAMMESA Renewables, 2020.

For the average power at which the plant is generating energy, Equation 1 is taken up:

$$P_{med} = \frac{1}{T}\int_0^T P(t).dt$$

Equation 1: Definition of Average Power

where *P (t) .dt* is the product of power over time and, for this case, it is the energy generated by the CTBA registered by CAMMESA. Adopting a sliding horizon results in:

[16] The actual generation will be compared to the ideal one according to its nominal power, not the performance of the system as a heat engine. This can be obtained from the data in the collection sheet.

Nominal power [MW]	Average power [MW]	Average load factor [%]	Average utilization factor [h]	Average production index [MWh/MW]
6	5.97	0.99	8,713	8,712.5

Table 7: CTBA generation performance results.
Source: own elaboration according to CAMMESA Renewables, 2020.

As a conclusion of these data, it can be seen that the operation in the CTBA generation has been almost excellent, given that the average power is 5.97 MW, which means a load factor[17] higher than 99%[18], a factor of use of 8,713 hours per year and an average production rate of 8,712.5 MWh for each MW of the CTBA.

The internal consumption that varies between 8% and 10% is provided by COSEPAV's electrical network.

Finally, it is indicated that the CTBA has a stock of corn flour for emergency cases in the event that, due to operational problems of the bioethanol plant, it runs out of raw material for the biodigesters. It is a preventive measure for critical situations, not for regular use.

4.2.3 “El Timbó” cooperative

In the rural work cooperative, “El Timbó”, without access to the COSEPAV network, photovoltaic panels were installed for a total of 0.24 kWp (6 panels of 40 Wp). Currently they are not operational, but their reactivation is being attempted.

[17] Also called plant factor or capacity factor.

[18] Related to the concepts of "availability" and "reliability" of a generating plant.

5. Local RE and EE objectives and commitments

In Avellaneda, the 100% RE objective is to generate within the territory the equivalent of 100% of the energy consumed through renewable energies. Given the potential available to date and the development opportunities that may arise from this project, this objective, although ambitious, would be, a priori, feasible to project.

Regarding EE, although an important action has already been carried out such as the replacement of street lights and part of the lights in green spaces (thus reducing the energy consumption of this sector by 45% and significant work to make energy efficient to the municipal building) the next steps are:

- Install five solar stations for cell phone recharging and hot water in order to raise awareness about these technologies applied to everyday life.
- Have an energy efficient housing labeling system[19].
- Prepare an efficient Building Code[20] that includes aspects of the energy labeling of homes for new units.
- Prepare a manual to adapt existing homes to the new levels of energy efficiency required.

[19] In the case of the province of Santa Fe, this is precisely proposed by Law No. 13903/2019.

[20] It can be based on the Energy Performance Index and its calculation procedure, the same indicator that is used in Law No. 13903/2019 on the Energy Labeling of Homes.

6. RE and EE projects underway under the supervision of the corresponding city government

6.1 Projects planned, in progress and implemented

The projects in the portfolio are listed below:

Project Name	Start/End	Range	Status	Expected
Autonomy, labor equity and environmental commitment in rural areas	2013-2014	El Timbó work cooperative, rural area of Avellaneda	Executed, but not operational.	Construction of the building with a solar panel system for energy saving and efficiency.
Photovoltaic Park in Municipal Industrial Park	2017-present	Industrial and Services Park	In the state of development of the executive project	Inject energy to SADI through renewable sources.
Efficient lighting plan (PLAE)	2017-2018	Replacement of public lighting fixtures (sodium) to LED technology	In progress	97% of the urban and rural road network with LED technology. 45% savings in energy consumption for public lighting. Goal: 100% as of December 2019 (established by municipal ordinance).
Efficient lighting in green spaces	2018-2020	Urban and rural green spaces	In action	Goal: 14% of the city's green spaces with LED technology. Goal: 100% as of June 2020 (established by municipal ordinance).
Energy efficiency in public buildings	2018-2020	All municipal public buildings	In action	Partial results - reduction in energy consumption as of December 2019: 25%. Goal of 50% energy savings.
Solar stations	2019-2023	Urban green spaces	In action	Install 5 solar stations to recharge cell phones and hot water in order to raise awareness about these technologies applied to everyday life.

Table 8: EE and RE projects in portfolio..
Source: Avellaneda, 2020.

6.2 Business and ownership models

From the implemented initiatives, the following business and ownership models associated with such measures are described:

- For Prosumer projects, the business mechanism is “sale connected to the network”. In any case, as described, the balance is invoiced, so the surplus that is dumped into the network has a discount from the provincial State [43]. It is a six-year contract, and the financial effort belongs to the user (be it private or public order). The program ended on December 31, 2019; There are marked indications that Santa Fe adheres to the Le and No. 27424 (GeneDistributed ration) [33]. For these projects, the user is the one who invested to acquire the equipment, however, the State, through the Municipal Bank of Rosario, developed a line of soft loans. The connections that were made through this program, throughout the province, were mostly made by private users. These contracts are not PPP (Public-Private Participation).
- For the CTBA project, as it is an offer awarded via the RenovAr program (Round 2), it is a APower Purchase Agreement by definition (Power Purchase Agreement, or PPA) where the State, through CAMMESA and with the World Bank as a guarantee, undertakes to acquire the energy generated for 20 years. According to the conditions of the tender, the price awarded was 160 USD for each MWh delivered to SADI [44] [45].

Off-grid or island generation systems (using batteries) have not been driven by government initiatives.

7. Financial structures

7.1 Local finance - local government

The potential income that could be used for the “100% RE” project is indicated:

Income from other jurisdictions:

- Coparticipation Federal Taxes:
  It is a system of tax collection and distribution of the collection between the Argentine State, the provinces and the Autonomous City of Buenos Aires. In this sense, of the mass of coparticipating funds, the province of Santa Fe corresponds to 8.7%. Thus, eventually, the possibility of requesting financing from this income could be evaluated.
- Real estate, gross income and patents:
  The Provincial Tax Administration of Santa Fe is in charge of: (i) the collection of the tax on car licenses, (ii) the collection of real estate tax from all persons who own any property within the provincial territory, and iii) the tax on gross income. These three taxes are coparticipable within the province in municipalities and communes.
- RAMCC Trust:
  The main objective of this trust is to execute joint climate projects or programs at a subnational scale, based on the mobilization of local, national and international resources, promoting economies of scale and networking. Avellaneda joined this initiative in the last quarter of 2020.

Own resources:

- General Property Tax (TGI):
  The local government collects this rate from real estate owners or holders of ownership. Thus, eventually, the possibility of requesting financing from this income could be evaluated.
- Right of Registration and Inspection (DReI):
  This tax applied to commercial, industrial and service premises of the city is paid monthly and is charged by the municipal government for the services it provides. In the same way as TGI, these funds finance activities, although more related to the commercial sector.
- Municipal Environmental Tax:
  It is a tribute required of each citizen in terms of financing for environmental issues.
- Private sector initiatives:
  Although a particular initiative has not been previously established, depending on the characteristics and implications of the investments, there are regional private companies highly committed to the issue that can join the project.
- Contributions, fines and other municipal revenues that could be allocated exceptionally.
- Individual contributions of directly benefited taxpayers.

Through the previous provincial administration, it had been possible to generate various lines of financing for the acquisition (the so-called "green credits"). Within the “Prosumers” program, rate recognition was carried out through Law No. 12692/2006 (every EPESF user pays a minimum

value on their invoice to constitute the fund for this promotional scheme) [33]. Although the locality in which there were prosumers[21] under this scheme did not receive a direct income, it does allow the city to acquire less energy since what was fed into the network was the surplus, that is, the difference between self-generated energy and the consumption from the network.

Finally, if new rounds take place under the characteristics of the RenovAr program, among which the FODER is accessed, a possibility of additional financing would be enabled. When the province adheres to Law No. 27424 (Distributed Generation), the tools of the Tax Credit Certificate (CCF) and the Distributed Generation Fund (FODIS) could be used.

[21] Contraction of "producer" and "consumer" of energy, a concept from which the program takes its name.

8. Main challenges and opportunities

In the current situation, the potential for developing a renewable energy matrix to supply the city of Avellaneda is of great magnitude; To achieve this, it is necessary, firstly, to achieve regulations that allow to inject, but also consume, that energy generated at the local level, so as not to bear the costs of transporting it through the national and provincial network. Likewise, it is also necessary to have a legal framework that differentiates by law the value of kWh from renewable sources, making it higher than that of conventional energy since, in the current situation (with no difference in value and with the high investments that the renewable) the payback periods are too long.

In this sense, it is essential to achieve laws that allow future predictability in the renewable market at the national level, given that in general they are projects that take several years to recover the economic effort made, and a potential change in policies in this regard each time. that there are elections is not attractive to investors.

In addition, through the execution of this project there is an opportunity to obtain financing both at the national and international level for the execution of works that allow the generation and use of renewable energies in the city, which is essential to meet the objective of achieving a 100% RE matrix.

On a complementary level, the development of energy efficiency practices, both at the industrial, municipal and residential levels, is necessary to make it more accessible to generate enough energy from renewable sources in order to equal all of the energy consumed. For this, it is necessary to achieve a greater diffusion and awareness of the impact of the actions of all inhabitants on the energy consumed and, at a later level, the contribution to climate change.

In the local and provincial region there are technicians and professionals trained in these areas, and it is a human value that not only presents knowledge, but is an active actor in the application of different techniques. In recent years there have been non-fee training courses in solar photovoltaic, solar thermal and biomass / biogas. There are also engineering and architecture professionals trained in energy efficiency, both residential and buildings, and industries. As a result, enterprises have been installed that aim to develop this branch of science through professional services. However, a challenge that the town presents is to have local capacities that accompany the characteristics of the efficient building code that is currently under treatment.

An opportunity with outstanding positive points is the connection of the photovoltaic panels in the “El Timbó” cooperative. This would allow the energy generation, the dissemination of photovoltaic technology and its technical concept, presents educational potential and fundamentally satisfies the needs.

On the other hand, there are already developments and success stories in both disciplines that reduce the risks in the implementation of practices and actions by being able to learn about experiences from other places. Both globally and nationally, energy efficiency and renewable

energies are the way to mitigate the impacts of climate change. Other localities (be they provincial, national and even international) have presented advances and allow enriching the state of the art in the applications. There are also guides, especially regarding energy efficiency, which allow fruitful actions in this regard (such as ISO 50001, ISO 50002, ISO 50006, ISO 50045, among others).

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