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Review

Solar Energy in Argentina

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Abstract: There is a large gap between the vast solar resources and the magnitude of solar energy deployment in Argentina. In the case of photovoltaics, the country only reached the 1000 GWh electricity generated yearly landmark in 2020. Solar thermal technology is even less developed, in part due to the low natural gas prices resulting from political strategies that aim to soften the impact of an unstable economy on family budgets. This review describes this gap by summarizing the current state of Argentine solar energy. We summarize the fundamental legal and strategic tools which are available for solar energy deployment, survey the penetration of solar energy into the country's energy landscape, identify national contributions to the local value chain, and review past and present research and development achievements. Both photovoltaic and solar thermal technologies show a historical fluctuation between local technology development and imported technology and know-how. Finally, a discussion on the main ingredients required to abridge Argentina's solar gap indicates that stronger, consistent long-term strategies are required in Argentina in order to take advantage of the present window of opportunity, and to play a considerable role in the global energy transition.

Keywords: Argentina; solar energy; deployment; value chain; photovoltaic; solar thermal

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1. Introduction

There is a measure of agreement that Argentina's solar resource is ideal for photovoltaic (PV) and solar thermal (ST) development, both for large- and small-scale (distributed) installations. The yearly Renewable Energy Country Attractiveness Index published by Ernst and Young places Argentina in the 18th position for PV [1]. Notwithstanding the early recognition of the abundant radiation levels and extensive available land area for PV deployment [2], solar energy utilization struggled with political and economic hurdles that are very specific to Argentina. The persistent political conflict between alternating governments, with distinctly different views about the government's role in the national economy, has prevented the development of long-term renewable energy (RE) strategies. Only in the past few years has Argentina attracted substantial investments in the RE sector, and PV surpassed 1 GW installed power very recently, during 2020, setting the stage for a landmark 24.7% RE participation in the electrical energy supply of September 2021 [3].

Because of its potential to contribute to the global energy transition, it is appropriate to offer an overview of Argentina's solar deployment that allows us to understand its status and the drivers that can impact its future development. In this paper, we attempt to provide an understanding of the factors influencing solar technology and its potential future in Argentina. We present information on the development and status of photovoltaic and solar thermal energy in this country, including legal, economical, policy, technical, and human resources. The paper contains six sections: Section 2 gives a brief overview of the energy landscape in Argentina, Section 3 describes the legal basis for RE deployment, and Section 4 details the penetration of solar energy throughout the country, separating photovoltaic from thermal power in different subsections, and discusses the local contribution to the value chain in both technologies. Section 5 summarizes the main contributions to research and development by the scientific community in Argentina since its early days, and in Section 6 we give a discussion of the main factors slowing solar deployment in Argentina, followed by the conclusions in Section 7.

2. Energy in Argentina

According to official data, the primary energy mix for 2019 was composed of 89% fossil fuels, 3.9% hydroelectric power, 2.8% nuclear power, and smaller amounts from other sources, including renewables. From this primary energy, 16% is transformed into electricity, with Argentina being the third largest electricity consumer in Latin America, after Brazil and Mexico [4]. In the decade of 1990, Argentina´s electricity generation landscape shifted from a balanced generation scheme between hydroelectric and fossil-fuel power plants, to be more fossil-fuel based, largely through gas-powered thermal power plants, with large hydroelectric plants (i.e., >50 MW power) taking second place [5]. After a shortage of gas reserves in 2004, renewables became increasingly important, and legal instruments promoting investments in RE sources appeared in 2009 (see next section). The first contribution of photovoltaic electricity to Argentina´s grid system occurred in 2011, with a participation of 0.0014% to the total electricity demand, which is a modest contribution to the 1% incidence of renewable energy (RE) at the time, which included small, i.e., ≤50 MW, hydroelectric plants [6]. As shown in Figure 1, 63% of the remaining electricity demand was covered by thermal plants, 31% was covered by large hydroelectric plants (labeled as 'hydro'), and 5% was covered by nuclear plants. Despite to the discovery of large shale gas reservoirs in 2011 [7], within less than a decade, renewables increased their share in 2020, contributing 9% to the electricity demand, largely due to photovoltaic and wind energy [6]. As of October 2021, despite the 24.9% RE peak contribution mentioned earlier, the yearly accumulated RE energy production amounted to 12.9% [3].

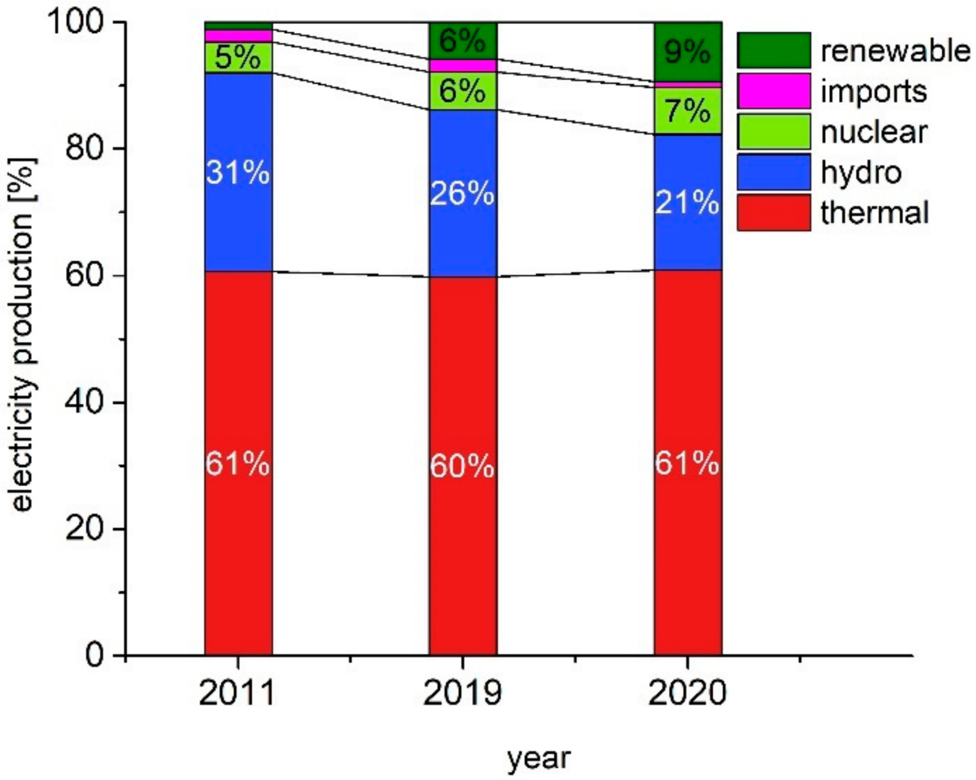


Figure 1. The growth of renewables in the energy landscape of Argentina, as shown by the partition of different energy sources with regard to the total electricity supply. The evolution is seen between the first year of photovoltaic contribution (2011) and the last 2 years.

3. Legal Framework for Renewables

In this section, we describe the key actors and legal tools regulating energy production and RE deployment in Argentina. For a detailed timeline listing the relevant legislation and Argentine Government promotion programs, we refer the reader to Gomel and Rogge (see Section 4.3 below).

3.1. Electricity Regulatory Framework

In 1992, Argentine Law 24065 established the following guidelines and principles to regulate the electricity industry [8]:

- Generation, transmission, and distribution are divided into three independent sectors, with specific rules. Distribution and transmission activities are considered a public service, while power generation is market driven, with specific sources which are nationally regulated.
- Electricity generators, distributors, transmission companies, large users and brokers are "agents" of the wholesale electricity market (WEM). The WEM is regulated in order to allow agents to trade electricity in spot transactions and in long-term power purchase agreements (PPAs). A private company, Compañía Administradora del Mercado Mayorista Eléctrico (CAMMESA), was appointed to administrate the WEM.
- The national electricity regulatory agency (ENRE, for its Spanish acronym) is responsible for supervising and controlling concessions related to the national power grid.

3.2. Heat Regulatory Framework

Argentina does not have a specific regulation for thermal heat production as it has for electricity. Nevertheless, there are regulations for the gas and electrical systems used to generate heat. Gas water heaters, space-heating systems and all other devices that use natural gas or Liquified Petroleum Gas (LPG) are regulated by a national gas regulation authority (ENARGAS). The regulations for natural gas distributors and other large-scale operations address system configurations, installation, safety measures and the final customer price.

Regarding electrical heat, regulations apply to the use of electricity rather than to the electrical heat-generating systems. There is no regulation authority that applies to electrical heat systems as there is for those that operate with natural gas. In this case, regulations apply to electrical variables, and not to the final use of the product. Therefore, in general terms, gas water heating systems are regulated by a specific agency, while electrical water heating systems are not.

3.3. Legal Basis and Promotion of Large-Scale Photovoltaics

PV development in Argentina was provided an initial 'window of opportunity' in 2006 by Law 26190 'National Promotion for the use of renewable sources of energy in the production of electricity', which promoted the use of renewable energy sources to reach 8% of the Argentinean electric matrix by 2016 [9]. The GENREN program, launched in 2009, established a framework to achieve 1 GW of RE by 2016 by means of tenders administered by ENARSA, an energy company created by the Argentine Government as a tool to reorganize the energy industry in the country following the privatizations in the 1990s [10]. The 15-year tenders had the following nominal power targets: 500 MW of wind, 150 MW of thermal power based on biofuels, 120 MW of thermal power based on urban residues, 100 MW of thermal power based on biomass, 60 MW from micro-hydroelectric turbines, 30 MW of geothermal power, 20 MW of solar power, and 20 MW from biogas. The GENREN program included stimuli to integrate local manufacturing into the supply chain. However, a lack of investment led to its discontinuation. In order to overcome this barrier, the original 2006 Law 26190 was modified by Law 27191 in 2015 [11]. The new law set forth a mandatory objective: the generation of electricity from renewable sources will progressively increase, and will reach a 20% share of the energy matrix by 31 December 2025. In order to promote private investment, this law granted a variety of tax benefits, and sought to decrease investor risk by creating the Trust Fund for the

Development of Renewable Energies (FODER, for its Spanish acronym), whereby the Federal Government would act as trustor and residual beneficiary, the Bank of Investment and Foreign Trade (BICE) would act as trustee, and owners of investment projects would be the beneficiaries.

In July 2016, the Ministry of Energy and Mining issued a resolution for the submission of bids for the purpose of executing PPAs under the RenovAR Program, Round 1 [12]. Under this program, the bidding process was carried out by the electrical market regulator CAMMESA with the supervision of the Undersecretariat of Renewable Energy. The terms and conditions of the PPA model were as follows: CAMMESA administers the contracts on behalf of distributors and large users, with its functions being the coordination of dispatch operations, the establishment of wholesale prices, and the administration of the economic transactions. Contracts are typically for 15 years, and are denominated in USD, with payment in Argentine Pesos in the sum necessary to acquire the outstanding USD. The price is altered annually by a price adjustment factor, and by an incentive factor which is designed to encourage the faster construction of the projects. The new legislation facilitated the establishment of the RenovAR Program, which resulted in a steep increase in Argentina's large-scale PV capacity (see Section 4).

3.4. Legal Basis for Distributed Photovoltaics

A regime of the promotion of distributed generation of RE integrated into the public electricity grid was established by the Argentine Congress in 2017 by means of Law 27424 [13]. Under this regime, each distributor can calculate the compensation and control the remuneration for each kWh of RE energy injected into the distribution network under a net billing scheme. The user-generator will receive an injection rate price for each kWh delivered, which is established based on the seasonal price that distributors must pay in the Wholesale Electricity Market (MEM) in accordance with Law 24065 [11], which regulates energy transport and distribution.

The value received by the user-generator results from a net calculation between the value of energy demanded and the energy injected. Any monetary surplus for the energy injected in favor of the user-generator sets up a credit for the billing of the subsequent periods. If this credit persists, the user-generator can request from the distributor the value of the favorable balance accumulated in a period not to exceed six months. User-generators identified as a consortium of co-owners of horizontal property, or a real estate complex, own this credit. The distributor may not add any charge for network maintenance, access toll, electrical backup, or any other cost associated with the distributed generation equipment operation.

Profits derived from the injection of energy from renewable energy sources by user-generators that have a maximum of 300 kW of contracted power and comply with the requirements and authorizations specified in this standard and its regulations will be exempt from income tax. The sale of the injected energy will be exempt from value-added tax under the same conditions, and with the same requirements established above (art. 314 of Law 27430 [11]). This law creates a public trust fund for the distributed generation of renewable energies (FODIS) to grant loans, price incentives and guarantees, and implements capital contributions and the acquisition of other financial instruments to promote distributed RE generation. The law also establishes a Promotion Regime for the National Manufacturing of Systems, Equipment and Supplies for Distributed Generation from RE Sources, or FANSIGED. The Ministry of Production and Labor regulates the eligibility criteria for the promotion activities included in FANSIGED, the procedures to request a Tax Credit Certificate, the application criteria, and other conditions to access the benefits of accelerated depreciation of income tax and, together with the Ministry of Finance, the early repayment of value-added tax. The regime also includes access to financing with preferential rates, and to a supplier development program.

Decree No. 986/2018, regulating Law 27424 [13], approved the Distributed Energy Generation Incentive Scheme. The Decree defines the legal and contractual conditions required for the implementation of the Incentive Scheme.

3.5. Legal Basis for Solar Thermal Energy

In the case of ST technology, there is no national law that mandates the use of this technology wherever feasible. However, the Ministry of Social Housing issued, in 2018, regulations that contemplate the "minimum sustainability requirement in social housing" which requires the inclusion of ST water heaters in social housing in the entire territory [14]. The requirement also includes an agreement with national ST technology standards defined in technical resolutions [14]. Apart from the above, several law projects to foster ST have been presented to the Senate, with no success up to this date.

Regarding ST regulation, the national gas regulatory entity ENARGAS has issued specific regulations on ST systems connected to gas backup systems, and isolated attempts at the provincial and municipal levels have been made, aimed at the voluntary market.

4. Penetration of Solar Energy

4.1. Grid-Connected Photovoltaic Power Plants

Figure 2 shows the evolution of PV´s contribution in terms of generated annual energy (yellow bars) and installed capacity (line-connected dots) in Argentina. The logarithmic y-axis reveals two waves of PV deployment: the first wave of PV installation corresponds to the GENREN program launched in 2009, while the second corresponds to the RenovAR program starting in 2016, with its successive rounds still being under execution. The 1 GW mark for installed PV capacity was reached very recently, in 2020, during the COVID-19 pandemic.

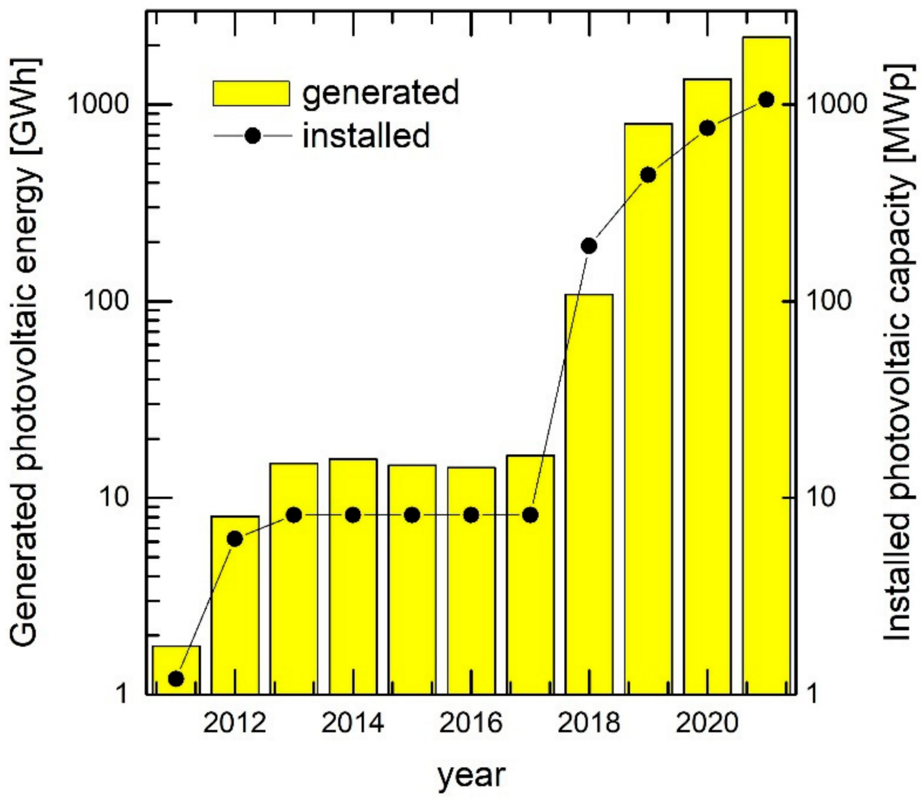


Figure 2. Evolution of yearly photovoltaic electrical energy production (yellow bars) and installed photovoltaic power (dots) since the first grid-connected PV power plant in 2011, in Argentina.

Figure 3 shows the distribution of the currently contributing PV power plants (white dots) over Argentina´s territory [15], where each dot groups the PV plants found in each of the provinces where PV installations are operative, accompanied by the total power in MWp (the lower solar radiation, southern region of the country is omitted due to the lack of MW-sized PV installations). Comparing the location of the installations with the solar energy distribution map (the yearly average on a horizontal surface [16]), it becomes evident that the amount of solar insolation determines, to a large extent, the profitability of each project.

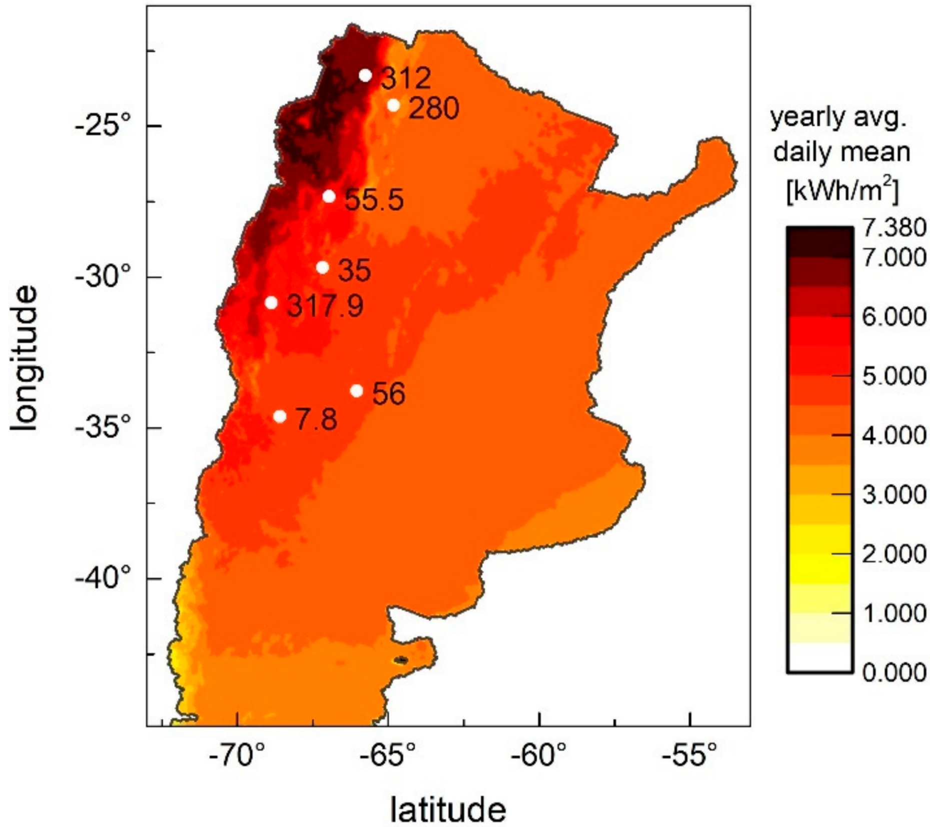


Figure 3. Distribution of photovoltaic plants in Argentina, grouped by provinces (administrative divisions). The total power in MWp in each province is indicated next to each location point. The color map indicates the yearly average of daily solar radiation on a horizontal surface (see the reference bar).

Let us briefly mention a few examples of Argentine PV power plants with different sizes and characteristics. A remarkable case is the 300 MWp Cauchari plant located at ca. 24° S 66°50′ O, i.e., in the far northwest Puna region, at 4200 m above sea level, where the daily global tilt radiation levels surpass 7.7 kWh/m^2 at an optimum tilt angle of 26°. This plant is currently the largest PV plant in South America [17], and was acquired from PowerChina as a turnkey power plant, starting operations in late 2019. Based on fixed-mounting, crystalline silicon module technology, it is connected to the Argentine Interconnection System via a 345 kV transmission line. A recent press release announced a capacity expansion to 500 MWp, partly driven by the increased demand from lithium mining operations in the region [18].

Figure 4 shows an aerial view of Ullum IV, located at 31° S 68° O in the center-western, Andean province of San Juan. This is a medium-sized solar plant with 16 MWp nominal power, which contains ca. 44,000 c-Si, fixed mounting, 365 Wp modules. The plant started to provide energy in 2019 through the national grid system using a 33 kV transmission line, which is further connected to a 132 kV grid. The photograph also shows the 1.68 MWp

Solar San Juan I (far right, center), the first MW-sized plant in South America, which was connected to the grid in 2011 (see Section 4.3.1 for details).

Figure 4. A view of Ullum IV, a 16 MWp photovoltaic plant located in the desertic province of San Juan, which went operative in 2019. Also shown is the San Juan I PV technology testing plant (far right, center). Photograph courtesy of Estrada.

Figure 5 shows Anchipurac, a 3 MWp PV solar plant installed during 2021 between the pre-Andean mountain chain Sierras Azules and the city of San Juan. The multicrystalline silicon modules, with 18% efficiency and 330 Wp, are mounted on single-axis trackers. An inverter–transformer station connects the plant to a 13.2 kV grid, which provides energy to the city of San Juan.

Figure 5. Anchipurac is a small-sized 3 MWp PV solar plant provided by single-axis tracking, located in Argentina's west-central province of San Juan. Photograph courtesy of Estrada.

Small Grid–Connected Generators

Data on distributed generation (DG), available from the Energy Secretariat of Argentina and updated monthly, reports the number of participating user-generators for different applications: residential, commercial and industrial [19]. As of November 2021, a total of 679 DG projects have been connected to the grid, for a total of 8.6 MW, of which 1.5 MW are residential, 6.4 W are industrial and commercial, and 0.7 MW are allocated to other applications. Possible reasons for the small number of residential connections are the net billing scheme adopted in the legislation and the low, subsidized electrical tariffs which are applicable to electricity from conventional sources and large hydro plants. Additionally, there is a question as to whether all grid-connected generators report their projects to the Energy Secretariat, or only those meeting Distributed Energy Generation Incentive Scheme regulations do, which would tend to undercount DG installations.

4.2. Off-Grid Photovoltaics

Despite their much smaller size in terms of installed capacity, off-grid photovoltaic installations deserve a separate mention, as they started to appear some 10 years before the grid-connected power plants. The driving force was a government initiative: the Project for Renewable Energy in Rural Markets (or PERMER, for its Spanish acronym).

PERMER's goal is to provide access to energy generated by renewable resources to rural populations located too far from the electric distribution networks to be cost-effectively connected. The project targets homes, rural schools, small communities and small productive initiatives, and subsidizes the equipment and installation cost for the end users [20]. Since the beginning of the project in 1999, up to 2015, rural systems were installed, with a total PV power of over 8 MWp, providing access to electricity to rural residents [20]. Several studies show the immediate social, health, educational and economic benefits linked to project [21]. However, diverse factors slowed down the rate of new installations [22], resulting in an extension of the project (PERMER II) in 2018, which aimed to provide electricity access to more rural residents. The project is currently active, and it is estimated to practically close the electricity access gap nationwide [23].

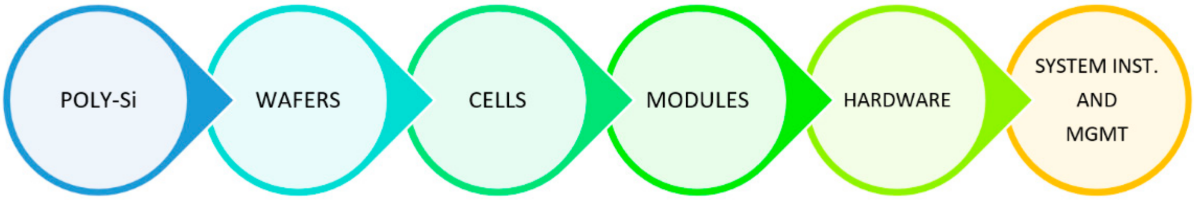
4.3. Analysis of the Local PV Value Chain

Figure 6a shows the succession of links composing the PV value chain. Because Crystalline Silicon is used in most installations in Argentina, we limit our discussion to this technology. Argentina had a relatively late entry to the PV Industry; therefore, if we were to limit ourselves to the description of actors in the PV value chain only up to the module stage (as is common practice [24]), we would fail to present a complete picture of Argentina's PV industry. Therefore, our expanded view of the PV value chain includes links that are key in the delivery of PV energy to the user: 'Hardware' and 'System Installation and Management', cf. Figure 6. Under this view, Hardware includes, e.g., electronics and module mounting components, while System Installation includes the tasks specified in Figure 6b. According to Gomel and Rogge, data on PV and wind projects show a stated average local component content in the first RenovAR tenders which is typically between 20% and 30% [25].

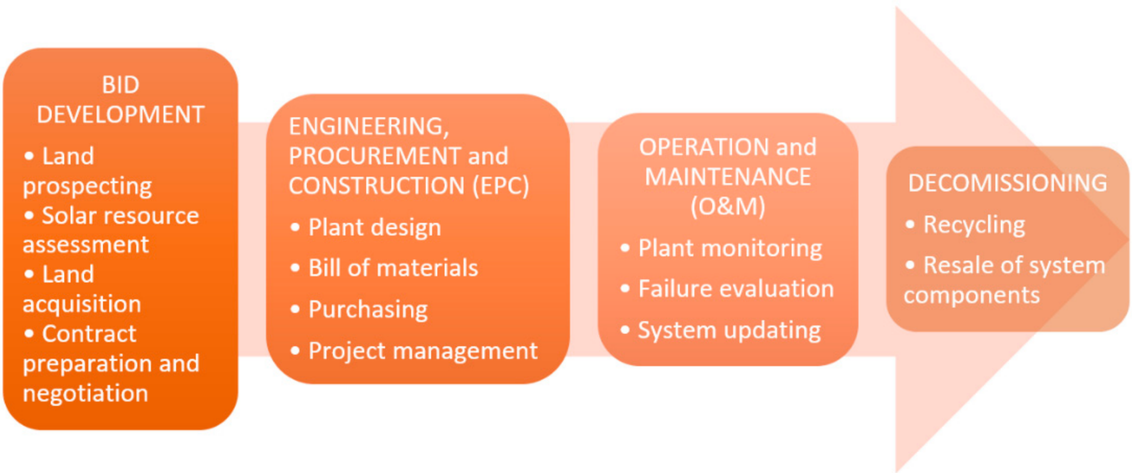
In the system component area, local industry contributes BOS components such as ground mounting systems, including trackers, cables, and accessories. Despite the government's intentions to create industrial policies which are capable of providing local products and services to the local PV industry [26], the pace at which the local industry started to offer such products lagged behind the installation of solar power plants. Imported manufactured products cover a large part of the value chain: PV modules, converters, batteries, and in many cases module support structures [25].

The areas of services are shared between Argentine and foreign engineering companies. Local service companies offer project engineering, logistics planning, terrain preparation and installation, and the operation and maintenance of the solar power plants [27], as well as a variety of consulting services assisting PPA contract bidders. Such services include Resource Evaluation and Prediction (RPE), involving the search for optimal land and solar resources, resource measurement, and land contract negotiation. Also offered are Engineering, Procurement and Construction (EPC) services, involving system engineering, component procurement and system construction, again typically for PPA contract bidders. Operation and Maintenance (O&M), usually the PPA contractor's responsibility, offers opportunities for local participation. We are aware of at least one company with substantial experience in the O&M of wind power projects that offers services for several megawatt PV installations [28]. Other actors in the Argentine PV market are commercial systems integrators that manage the O&M of their own systems. Large PV systems installed in Argentina are at the beginning of their life cycle: we do not expect, nor are we aware of, activities in the Plant Decommissioning area.

We note that there are also examples of local module manufacturing and plans for entry into earlier stages of the value chain in Figure 6, which we describe in Section 4.3.1 below.



(**a**)



(**b**)

Figure 6. Value chain for crystalline silicon photovoltaic systems (part (**a**)), and disaggregation of the installation and management chain link (part (**b**)).

4.3.1. Local Manufacturing

There is currently no large-scale module manufacturing in Argentina. SOLARTEC was an early participant in the industry, and operated a manual production module line beginning in 1986 with an output, which was highly dependent on the changing protection measures in the local PV market [29]. Its market was initially in communications infrastructure and off-grid rural applications within the PERMER project, with the company eventually expanding into grid-connected applications. A relatively recent entrant, LV-Energy has operated a fully automated module plant since 2014, using solar cells as the input, offering IEC61215 and IEC61730-1/2 certified 280 Wp modules.

Regarding larger module production volumes, a key Argentine organization planning to become a high-technology PV manufacturer is EPSE (Energía Provincial Sociedad del Estado). The company, owned by the Province of San Juan, manages and distributes the conventional and alternative energy produced in its territory. In order to incorporate PV technology as a tool in the province's future, EPSE is currently installing a fully integrated module manufacturing line with a projected yearly output of 71 MW. The semiautomatic line includes all of the processes from casting to module assembly. The German company Gebrüder Schmidt GmbH is supplying the turnkey plant [30]. This project is sited in an area of approximately 41,000 m^2, including internal roads and raw materials storage, and includes approximately 12,000 m^2 of production and 1100 m^2 of offices. This planned line appears too small to compete in price with 'tier one' PV manufacturers; however, EPSE's strategy is to selectively place its product in projects where the effect of the module cost on LCOE can be compensated by other local advantages, while developing PV technology skills and a local material supply chain. EPSE plans first to complete the module production line using imported cells, and to install 350 MW of PV in San Juan during the next five years [31].

We note, as an aside, that during over ten years of PV activity, EPSE has also developed valuable skills in the service side of the PV supply chain, with focus on project design and management. In 2009, EPSE built a 1.2 MW PV pilot plant Solar San Juan I in Ullum, which is shown in Figure 7. The plant includes three silicon technologies: amorphous, multi- and single-crystal silicon, mounted on single- and two-axis trackers and adjustable fixed structures. It is equipped with data acquisition, supervision and control systems, and a state-of-the-art weather station. The data from this pilot plant contributed to a decision to adopt crystalline silicon as the basis for EPSE's efforts in the industry. A program operated in Argentina and Europe offers training for local professionals using this plant as a tool. EPSE is also promoting other PV projects, notably the construction of a 132 kV/32 kV transformer station and a 132 kV line to connect 185 MW of PV power to the Argentine grid, as well as pilot PV irrigation plants and distributed generation plants [32]. Recently, EPSE has been involved as an EPC contractor in a 50 MW PV plant in Neuquén province. Remarkably, with the approximate coordinates of 38° S, 69° W (cf. Figure 2), this project would be the first MW-sized PV plant located in Patagonia [33].

Figure 7. Solar San Juan I pilot solar plant, a 1.2 MW test facility using different module and mounting technologies, including fixed and single axis orientation for crystalline, multicrystalline and amorphous silicon modules. Photograph courtesy of Estrada.

4.4. De-Centralized Solar Thermal Energy

Solar thermal energy in Argentina was already considered a potential key energy source in 1975 [2], when a national R&D program for the development of solar energy and other renewables was launched, leading to numerous research programs (see next section) and the elaboration of norms and certification criteria for ST collectors [34]. However, the deployment of this technology was hindered by the lack of long-term governmental promotion initiatives, as well as the sustained subsidies to conventional energy sources, which held until the present day [35,36]. Hence, ST persisted for decades as a solution serving only isolated communities and schools in rural areas with reduced access to a gas supply [37,38].

The 2001 economic crisis resulted in serious instability in the price structure, driven by frequent devaluations of the local currency. Through the Economic Emergency Law enacted on 6 January 2002, the Legislative Power temporarily delegated administrative powers to the Executive Power. In this framework, the rates of public services were frozen in the middle of the crisis in order to try to counteract the loss of the purchasing power of wages. However, after the crisis and with prices stabilized, the objective of economic policy was to maintain the new relative price structure based on a competitive (high) exchange rate and a scheme of low-cost tariffs, transport, and fuels. In this context, an explicit scheme of subsidies was established in order to maintain the low prices of public services (energy and passenger transport) [39]. During the period of 2002 to 2015, natural gas tariffs for final-use customers were subsidized to varying degrees by as much as 100% for social tariff users [40]. Such low prices in a growing economy did not encourage the use of ST technologies for heat generation. From 2015 to 2019, and with the aim to diminish the country's fiscal deficit, tariff subsidies started to disappear, resulting in strong market growth for ST. As a result, local technology production was overrun by demand, international markets were open, and the importation of technology started to be a profitable option. In this period, ST equipment import grew each year [41]. Due to the sudden rise of the market, there was a boom of ST equipment import from Asia, with no regard to equipment quality. Given the low price of equipment imports, local manufacturers started to turn from local manufacturing to equipment importation, and the remaining manufacturing organizations started the chamber of ST manufacturers (CAFEEST), which nucleates most of the manufacturers and importers in the country. As is typical of other technologies, low-quality systems are cheaper than high-quality systems; in order to address this issue, CAFEEST helped define minimum technology requirements and quality standards. After discussion with solar thermal importers, and after 9 years of regulatory updates, mandatory national quality standards were implemented in 2019 by Resolution 520/2018 [14], stating that all solar thermal systems entering the country (whether imported or fabricated) must comply with the defined regulations. Because, in Argentina, there is no accredited laboratory for solar thermal devices, reports from international labs are accepted as a proof of compliance. In 2019, the new government implemented import and currency exchange restrictions, and implemented subsidies to natural gas one more time. Although the current natural gas tariffs are still very low, solar thermal energy is growing with the momentum gained during the 2015–2019 period.

Equipment importation has become increasingly complicated due to exchange rate variability, importation permits, and recent equipment quality requisites (the Update of Resolution 520/2018). In this context, local manufacturing has gained a renewed interest among entrepreneurs, and even importing companies. The main issue is that most of the materials needed for ST systems are either commodities or imported plastics (stainless steel, copper, thermoplastics, and polyurethane, etc.). Consequently, local manufacturing is affected by the same problems that affect equipment importation.

Additionally, manufacturing activities are highly taxed. A regular solar thermal equipment sale must pay 21% VAT, 4% for gross income tax, and 30% over the profit and municipal taxes, which can take another 10% away. A further issue is that the sale is carried out in local currency, in what is essentially a by-monetary economy, and cannot be transformed into the foreign exchange needed to purchase the input materials and devices needed for local manufacturing without large financial risk.

Solar thermal technology deployment is taking a different path from PV. Coincidentally with PV, Argentina has a huge potential for ST technologies, but in order to be competitive with imported equipment, technology transfer from academia and leveraged finance (both for manufacturers and end users) need to be in place. Currently, ST technology is mostly implemented at a household level, with very few examples in hotels and industries, with 2 m^2 collectors being the typical household average. The advance of the ST market should be coupled to a progressive elimination of fuel subsidies in all sectors. Furthermore, the correct deployment of local ST technology manufacturing needs clear investment conditions, which are not likely to happen in the short–medium term. Last but not least is the equipment quality issue, which should be monitored in order to provide a fair competition among manufacturers and importers.

5. Research and Development

Scientific research around solar energy is divided into three areas: radiation assessment, solar thermal power, and photovoltaic power. The ongoing radiation assessment efforts focus on the obtention of field data [42–48] and comparison with satellite estimations [49–51], whilst also combining efforts with photovoltaics for the design of photovoltaic radiometers. The first solar radiation map for Argentina was published in meteorological reports in 1972, while the more detailed, digitally available solar radiation maps based on a larger number of solar measurement stations across the country appeared only after 2005 [51,52].

Research on solar thermal is mainly oriented toward finding cost-effective solutions for communities deprived of access to conventional energy, mainly in solar greenhouse and distiller design [53–55], cooking [56], drying [51,57–62], and pasteurization [63]. A few exceptions to this trend are larger-scale, industrial applications, where research efforts are directed towards the design of solar ponds to be applied to salt and metallurgical mining in Argentina's highest radiation region in the northwest [64,65]. More recently, at INENCO (the Institute for Non-Conventional Energy), the solar thermal research division developed medium-to-large-scale concentrating systems, which led to the construction and operation of several prototypes, including a 172 m^2 linear Fresnel concentrator [66–68]. Most of the research activities are oriented towards the use of locally available materials and tailored design, with some potential for technology transfer to the regional economy.

Together with INENCO, an ONG called EcoAndina has worked—since 1989—on the transfer of solar cooking and water heating developments to rural villages near the Andes, both to grant access to better sanitary conditions and to help develop a local regional economy [69].

A key issue of research is that most of the ST research is not transferred to the market. Most national universities have little connection to the market and little experience in technology and knowledge transfer. As such, efficient mechanisms to build startups from research innovations are limited. An exception of public–private spinoff is the company Jujuy Solar, which manufactures solar thermal systems for the northwestern region of Argentina, oriented towards social housing in this high-insolation region of the country (see [70] for a manufacturing video). Another example is the company SOLARMATE, a spinoff from the University of San Martin. The company develops portable ST devices which incorporate compound parabolic concentrators and industrial design to allow users to experiment with solar heat at a personal level.

Most of the local solar thermal manufacturers do not incorporate into their products well-known technological innovations such as selective surfaces (aerosol or sputtering deposited), or low-emissivity/textured/low-iron glass covers. This is due either to manufacturing costs or a lack of technical knowledge, with the latter being possibly due to poor know-how transfer from the academic sector. Some manufacturers have tried to import fin-tube-selective surface parts, joining them locally by means of conventional copper–silver welding, but eventually dropped the idea because market costs were lower for the imported collector than for the locally soldered collector. Others have tried to use aerosol selective coatings with very little result in the overall efficiency, and thus abandoned the original idea of using solar selective surfaces.

Given the large range of the country's insolation and climate conditions—above 6 kWh/day and 20 °C annual average in the north, and less than 3 kWh and 10 °C annual average in the south—the market needs a variety of technologies that respond adequately to each climate. Low-efficiency collectors do not work in the south of the country, and high-efficiency collectors produce overheating in the north. Given the different technology needs, transfer from the academic sector must play and important role in the development of the solar thermal market in Argentina.

Research and development in photovoltaics followed a different path. PV research began in the early 1980s, as Argentine graduate students were trained in photovoltaics in technologically developed countries, where photovoltaics gained impulse during the 1970s and 1980s. The first published articles appeared in the early 80s, and were aimed at theoretical solar radiation assessment [49], solar concentration studies [71–73], and the optimization of silicon cell design [74]. Thin-film solar cell research began in the early 1990s with CdTe/Cds films prepared by the chemical vapor deposition of both CdTe and CdS [75–77]. These research lines were, however, isolated attempts which did not lead to long-term R&D projects, in part due to the lack of governmental policies aimed at the development of renewable energy technologies. Public funding eventually began in the mid-1090s for the development of space photovoltaic power systems for Argentine satellites. This applied research line included the design and fabrication of Si solar cells using commercial monocrystalline silicon wafers, the terrestrial testing of space radiation damage in local particle accelerators [78], and satellite mission testing [79,80]. SAC-A—the first Argentine satellite mission provided with a photovoltaic array—was launched in 1988, and could be regarded as the first practical application of photovoltaic devices fabricated in Argentina. The space photovoltaics group continued to produce solar arrays for subsequent commercial satellite missions [81], eventually switching to commercial triple-junction solar cells from Emcore, USA (later SolAero Technologies Corp. [82]). The long-term involvement in space applications derived in the development of EDRA, a facility dedicated to radiation damage in a simulated space environment and the in-situ characterization of solar cells and materials during irradiation [83]. In the meantime, scientific research gained some governmental attention after the economic crisis of 2001. Though modest, the increase in public research funding produced new research groups in different regions of the country. These groups focused mainly on low cost, inorganic and organic thin-film solar cells, covering modeling [84–91], characterization techniques [92–97], and the preparation of solar cells [86,98–105]. In the last decade, the research focus moved to alternative chalcopyrite and perovskite solar cells, covering modeling [106–108], preparation [109–117] and characterization [109,110,118–120].

6. Discussion: Barriers to Argentina's PV Development

When presenting data on the status of solar power in Argentina, the question understandably arises as to whether one can use the data to predict the speed and depth of the energy transition in the country. In order to help put into context Argentina´s energy transition process, we compare the evolution of PV deployment with the experiences in other countries. Figure 8 shows the cumulative installed PV power in Australia [121], Chile [122], and Argentina [3] over time. These three countries were selected due to their overall similarities and differences relevant to PV generation: Argentina and Australia have valuable solar resources [16] spread over large territories, and low population densities. Chile has similar resources in a smaller territory neighboring Argentina. The most striking feature shown in Figure 8 is the "time-lag" between countries: at the GWp-level, a time lag of ca. 5 years can be observed between Chile and Australia, and Argentina and Chile. A key difference is that Australia is a rich country, with a per capita GDP more than triple that of Argentina and Chile, and this offers a great opportunity for investment in DG, a major tool for PV technology diffusion. In Figure 8, this is evidenced by the distinction between small-scale DG and the total PV power for Australia. The strong influence of DG in helping to diffuse PV technology is very clear for Australia, where DG led the early growth, with high PV generation becoming important beginning in 2016, which is a relatively late entry date. We must also note the pioneering role of the UNSW School of Photovoltaics and Renewable Energy Engineering in educating a generation of Australian PV scientists, which is a key factor in PV diffusion. Chile's per capita GDP and its solar resources are comparable to Argentina's, yet the country has pursued a more aggressive PV development program enabled by a healthier macroeconomic situation. Chile's PV growth—beginning in 2012—has been focused on large PV plants [123], which we attribute to a policy decision designed to alleviate Chile's scarcity of gas resources for power generation.

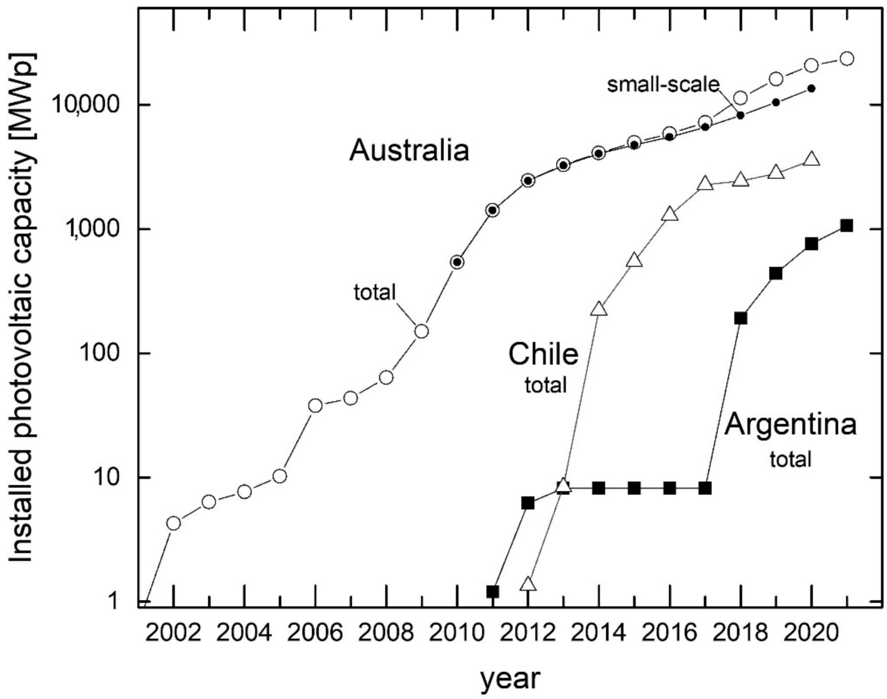


Figure 8. Evolution of the installed photovoltaic capacity in Australia, Chile, and Argentina. At the GWp-level, a "time lag" of ca. 5 years can be observed between Chile and Australia, and Argentina and Chile. The data for Australia is separated into the total PV capacity (open circles) and small-scale, distributed generation capacity (black circles), showing its dominance of Australia's PV generation history.

The slow development of PV in Argentina immediately poses the following question: What are the reasons for Argentina's "PV-lag" in comparison with countries endowed with similar solar resources? The straightforward answer is a lack of prioritization in a context of financial instability. Although a more rigorous answer to this question requires a major undertaking exceeding the scope of this work, we attempt—in what follows—to identify a set of key barriers to Argentina´s PV development. This task has been addressed by Schaube et al. for the specific case of distributed PV generation [20]; however, we stress that the most important findings from Schaube et al.'s paper apply equally to large-scale PV generation. The authors used the Technical Innovation System (TIS) technique to analyze the dynamics that currently enable or constrain the diffusion of DG PV in Argentina [20]. To this end, Schaube et al. held interviews with key stakeholders to determine the strengths and weaknesses of Argentine TIS functions, and how these are influenced by endogenous or exogenous system strengths and weaknesses [20]. An important result of the study is that several functions of the Argentine TIS have well established strengths, notably knowledge development [20]. Argentina's education system and academic R&D efforts provide appropriate knowledge development. This knowledge has been diffused through national and provincial government-funded PV projects. Examples of the former are the PERMER program addressing rural markets, and the RenovAR program (cf. Section 4), directed to large PV power generation. An example of the latter is the San Juan effort supporting EPSE's program of PV promotion in the province (cf. Section 4.3.1).

Regarding weaknesses in Argentina's TIS, Schaube et al. [20] identified the key factors obstructing the breakthrough of RE technologies as the lack of allocation of sufficient (A) financial and (B) human capital resources.

The lack of financial resources (A) originates in "political instability and macroeconomic uncertainties caused by high inflation rates and loss in value of the national currency" [20]. While Argentina has a strong, stable political system [124], the political contenders disagree on the basic roadmap towards national growth. The disagreement has often led to large political differences, making the system dysfunctional [125]. This results in conflicting economic models and a difficulty in establishing a sustainable economic policy and committing resources to not only RE development [25] but also to basic government functions such as health, education, and economic development. A major outcome of the conflicting RE resource allocation is the negative effect of electric tariff subsidies, which were introduced to alleviate economic hardship at the lower income levels but turned distributed generation into a financially unjustifiable proposition: the average retail electricity price per kWh in Argentina is $0.053 (US Dollars), while Chile and Australia show threefold higher average prices, at $0.151 and $0.172, respectively [126]. Moreover, the average value for Argentina includes values from high-subsidy areas as low as $0.024 [126]. We argue that the inadequate deployment of not only DG PV but also large-scale PV which is evident in Argentina is connected to high consumer-side subsidies. As was pointed out recently, between 2005 and 2014, energy subsidies increased ten times as a share of Argentina's GDP (gross domestic product) [36]. While subsidies provide an economic relief from economic instability to part of the population, they appear to constitute a long-term policy trap, which arises once "politicians facing political uncertainty have strong incentives to leave [subsidy] programs in place [. . .]. Over time, rapid price level changes and concerns about avoiding blame for repealing a program benefitting the majority of the population can reinforce one another, together greatly increasing government expenditures on subsidies" [35].

The second weakness identified in Schaube et al.'s work is a deficiency in human resource allocation (see B above). Here, the key word is 'allocation': the resources are available but are not dedicated to the policy development tasks. In our opinion, there exists a knowledge gap between the many well-trained scientists and technologists and the players in the upper strata of the political decision-making system [20], who often lack the necessary policy development tools. We agree with Spiller et al. [125], in that "Even though Argentina has a more developed civil service system than some of the poorer Latin American countries, political shortsightedness and lack of consistency have contributed to weaken its bureaucratic apparatus way below what one could expect from a country with the level of human capital of Argentina" and in that "Argentina appears as an outlier with a very weak bureaucracy compared to its level of development". As a result, there is no lasting knowledge accumulation in the decision-making system: a recent, telling example is the slowing of the RenovAR PV installations, which was coincident with a change of administration in 2019 and the resulting change of personnel.

The two weaknesses described above were identified as first-order hurdles for the sustained incorporation of significant new RE sources. Second-order hurdles are found in the technical field: a governmental report from 2019 identified several energy transport bottlenecks, and listed the short-term infrastructural expansions required by 2022, most notably the required addition of 2200 km of 500 kV high-power transmission lines (p. 122 in [1]). The economic difficulties discussed previously, together with the decrease in energy demand during the 2020–2019 COVID-19 pandemic, has delayed the required network expansions until January 2022, when several significant projects were officially announced [127]. We expect other technical hurdles to arise as PV deployment progresses:

recycling facilities and the expertise to decommission systems and resell still-useable PV hardware, including modules, will no doubt be necessary as the new installations reach the end of their life cycles.

Regarding the future of PV in Argentina, tackling the electric tariff subsidy issue will be key to PV growth. Moreover, we concur with [20] that the ongoing development of distributed generation regulations that do not fluctuate with the rhythm of administration changes could greatly leverage the diffusion effect of DG in the promotion of PV technology. In addition, given the ongoing financial difficulties, "Argentina's dependence on imported equipment and essential components for photovoltaic installation due to an embryonic national industry in the sector" [20] is a threat that should be addressed if the country is to be more than a spectator in the energy transition.

In the near term, the Argentine government is showing initiative in recovering from the lag introduced by the change in administration in 2019 and the COVID-19 pandemic. In November 2021, the sub-Secretary for national Energy Planification issued a resolution which enumerated possible strategies to overcome the difficulties discussed above [128]. Annex I in [128], entitled 'Guidelines for an energy transition plan towards 2030', the government announced the addition of 2.35 GW large scale and 1 GW distributed PV by 2030. With a consistent PV growth policy with a focus on PV industry development and the elimination of the barriers to DG discussed above, we can expect Argentina's 2021 commitment to the energy transition to be a driving force for future RE deployment [128], targeting 30% RE participation in 2030.

7. Conclusions

Our work found a large gap between Argentina's potential for solar energy utilization and the current solar energy deployment, despite advantages such as a high solar and land resources. This gap is, however, not static: different legal frameworks and governmental promotion programs have led to the deployment of large-scale and distributed off-grid photovoltaic installations, but they are at a volume (in terms of installed capacity) that lags years behind other countries with which Argentina shares relevant characteristics. For example, renewable energies Law 27424 [19] and its implementations through the RenovAR promotion programs for RE led to a promising initial PV deployment, which nevertheless stagnated. We identify the absence of a timely emergence of a sustainable national policy and solar development plan as the reason for this stagnation, caused in turn by macroeconomic constraints and political disagreement among key stakeholders [25].

From a broader point of view, we stress that a key issue in the determination of the success of Argentina's energy transition will be the existence of an explicit RE national policy and its impact on societal and technical change in the Argentinean energy sector. We can expect any such policy to produce results depending on the extent to which the policy promotes the development of a national renewables industry rather than the simple deployment of RE technology. For example, while the RenovAR program succeeded in quickly increasing RE deployment, opportunities for Argentine industry development were not part of the plan. The data on PV and wind projects show a stated average local component content in the first RenovAR tenders typically between 20% and 30% [25], even though the Argentine wind industry entered this period with strong technical credentials. The emergence of a consistent policy is, at this point, hindered by political disagreement: in this paper, we simply note its critical importance and its unresolved status. At least at the regional, if not the national level, we consider the persistence of EPSE's initiative with the financial support of the Province of San Juan a promising approach to addressing this problem. We also note that, while financial instability and the ensuing difficulty in the assessment of risk can hinder private investment in RE by Argentine corporations with sufficient capital resources, Argentine private companies have participated, together with overseas companies, in several RenovAR PV projects [3]. We conclude that, given the right financial stability conditions, a public–private RE policy leading to accelerated PV growth could be implemented successfully in Argentina.

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References

1. Ernst & Young Global Limited Renewable Energy Country Attractiveness Index—Report 55. Available online: https://www.ey.com/en_gl/recai (accessed on 30 November 2021).
2. Fernandez, R.; Saravia, L.; Scheuer, W. National Solar Program for Research and Development in Argentina. In Proceedings of the UNESCO/WMO, Symposia: Solar Energy, Geneva, Switzerland; 1977; pp. 263–271.
3. CAMMESA. E-Renovables (Renewables Report). Available online: https://cammesaweb.cammesa.com/erenovables/ (accessed on 3 November 2021).
4. International Energy Agency. IEA Energy Atlas. Available online: http://energyatlas.iea.org/#!/tellmap/-1118783123/0 (accessed on 3 November 2021).
5. Argentine Secretary of Energy—Ministry of Economy of Argentina. *Indicadores del Balance Energético Nacional (1960–2018)*; Official Reports; Ministry of Economy—Argentina: Buenos Aires, Argentina, 2019. Available online: https://www.argentina.gob.ar/economia/energia/planeamiento-energetico/infografias-de-escenarios-energeticos (accessed on 9 March 2022).
6. CAMMESA. Annual Statistics Report 2005–2020. Available online: https://cammesaweb.cammesa.com/informe-anual/ (accessed on 18 October 2021).
7. Di Sbroiavacca, N. Shale Oil and Shale Gas in Argentina. State of Situation and Prospective. In *Oil and Natural Gas Economy in Argentina: The Case of Fracking*; Bravo, V., Di Sbroiavacca, N., Eds.; The Latin American Studies Book Series; Springer International Publishing: Cham, Switzerland, 2021; pp. 281–300, ISBN 978-3-030-65520-4.
8. Argentine Senate and Congress. Law 24.065: Régimen de la Energía Eléctrica. 1991. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
9. Argentine Senate and Congress. Law 26.190: Régimen de Fomento Nacional para el Uso de Fuentes Renovables de Energía Destinada a la Producción de Energía Eléctrica. 2006. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
10. Argentine Congress. Energía Argentina Sociedad Anónima—Su Creación. 2004. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
11. Argentine Senate and Congress. Law 27.191: Modificaciones a La Ley 26.190, Régimen de Fomento Nacional para el Uso de Fuentes Renovables de Energía Destinada a la Producción de Energía Eléctrica. 2017. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
12. Argentine Ministry of Energy and Mining. Resolution 136—E/2016: Energía Eléctrica de Fuentes Renovables. Convocatoria Abierta Nacional e Internacional. 2016. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
13. Argentine Senate and Congress. Law 27.424: Régimen de Fomento a La Generación Distribuida de Energía Renovable Integrada a la Red Pública. 2017. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).
14. Argentine Ministry of Internal Affairs, Public Works and Housing. Progress Report: Actualización Exigencia Mínima de Componentes de Sustentabilidad. 2018. Available online: https://www.argentina.gob.ar/sites/default/files/actualizacion_exigencias_minimas_de_sustentabilidad_if-2018-51237809-apn-dnasyfmi.pdf (accessed on 23 November 2021).
15. Compañía Administradora del Mercado Mayorista Eléctrico (CAMMESA). Annex: ANEXO Informe MATER Enero. 2022. Available online: https://cammesaweb.cammesa.com/mater/ (accessed on 17 February 2022).
16. Solargis, S.R.O. Solar Resource Map/Global Horizontal Radiation/Argentina. Available online: https://globalsolaratlas.info/download/argentina (accessed on 3 November 2021).
17. Koop, F.; Pike, L. China Builds Latin America's Largest Solar Plant. Available online: https://chinadialogue.net/en/energy/11117-china-builds-latin-america-s-largest-solar-plant/ (accessed on 14 December 2021).
18. Matias, M. Cauchari Está a la Espera de Firmar el PPA con CAMMESA para Ampliar el Parque Solar a 500 MW—Energía Estratégica. Available online: https://www.energiaestrategica.com/cauchari-esta-a-la-espera-de-firmar-el-ppa-con-cammesa-para-ampliar-el-parque-solar-a-500-mw/ (accessed on 14 December 2021).
19. Argentine Secretary of Energy—Ministry of Economy. Progress Report: Implementación de la Ley 27.424. 2021. Available online: https://www.argentina.gob.ar/economia/energia/generacion-distribuida/que-es-la-generacion-distribuida/reportes-de-avance-implementacion-de-la-ley-27424 (accessed on 13 December 2021).

20. Schaube, P.; Ortiz, W.; Recalde, M. Status and Future Dynamics of Decentralised Renewable Energy Niche Building Processes in Argentina. *Energy Res. Soc. Sci.* **2018**, *35*, 57–67. [CrossRef]
21. Alazraki, R.; Haselip, J. Assessing the Uptake of Small-Scale Photovoltaic Electricity Production in Argentina: The PERMER Project. *J. Clean. Prod.* **2007**, *15*, 131–142. [CrossRef]
22. Schmukler, M. Is Local Adequacy of Technology a Pathway towards Social Inclusion? The Challenges of Rural Electrification in Argentina. *Innov. Dev.* **2020**, *10*, 263–278. [CrossRef]
23. Fernandez-Fuentes, M.H.; Eras-Almeida, A.A.; Egido-Aguilera, M.A. Characterization of Technological Innovations in Photovoltaic Rural Electrification, Based on the Experiences of Bolivia, Peru, and Argentina: Third Generation Solar Home Systems. *Sustainability* **2021**, *13*, 3032. [CrossRef]
24. Haley, U.C.V.; Schuler, D.A. Government Policy and Firm Strategy in the Solar Photovoltaic Industry. *Calif. Manag. Rev.* **2011**, *54*, 17–38. [CrossRef]
25. Gomel, D.; Rogge, K.S. Mere Deployment of Renewables or Industry Formation, Too? Exploring the Role of Advocacy Communities for the Argentinean Energy Policy Mix. *Environ. Innov. Soc. Transit.* **2020**, *36*, 345–371. [CrossRef]
26. Castelao Caruana, M.E. Renewable Energy in Argentina as an Energy and Industrial Policy Strategy. *Problemas del Desarrollo* **2019**, *50*, 131–156. [CrossRef]
27. Singh, N. El Listado de Fabricas Líderes que Apostaron al Desarrollo de la Cadena de Valor Para el Rubro Eólico y Solar en Argentina. Available online: https://www.energiaestrategica.com/fabricas-rubro-eolico-y-solar-en-argentina/ (accessed on 28 October 2021).
28. Fabri, S.A. Ingeniería, Construcciones y Montajes Industriales. Available online: https://fabrisa.com.ar/ (accessed on 25 November 2021).
29. SOLARTEC. Available online: https://www.solartec.com.ar/en/aboutus.html (accessed on 13 December 2021).
30. EPSE (Energía Provincial Sociedad del Estado). Fábrica Integrada De Lingotes De Silicio Solar, Obleas y Celdas Cristalinas Y Paneles Solares Fotovoltaicos 71 MW. Available online: https://www.epse.com.ar/web/proyecto/fabrica-integrada-de-lingotes-de-silicio-solar-obleas-y-celdas-cristalinas-y-paneles-solares-fotovoltaicos-71-mw/1 (accessed on 25 November 2021).
31. Medinilla, M. EPSE Avanza en la Fábrica de Paneles Solares y en el Desarrollo de las Renovables en San Juan. Available online: https://www.energiaestrategica.com/epse-avanza-en-la-fabrica-de-paneles-solares-y-en-el-desarrollo-de-las-renovables-en-san-juan/ (accessed on 25 November 2021).
32. EPSE (Energía Provincial Sociedad del Estado). Proyectos Fotovoltaicos en San Juan. Available online: https://www.epse.com.ar/web/proyecto/proyectos-fotovoltaicos-en-san-juan/27 (accessed on 25 November 2021).
33. EPSE (Energía Provincial Sociedad del Estado). EPSE Realizará El Proyecto Para El Parque Solar Neuquén, de 50 MWp. Available online: https://www.epse.com.ar/web/novedad/epserealizaraelproyectoparaelparquesolarneuquende50mwp/380 (accessed on 25 November 2021).
34. Instituto Argentino de Normalización y Certificación (Argentine Quality Standards Institute). Norma IRAM 210001-1/-2. 1985. Available online: https://www.iram.org.ar (accessed on 25 November 2021).
35. Bril-Mascarenhas, T.; Post, A.E. Policy Traps: Consumer Subsidies in Post-Crisis Argentina. *St. Comp. Int. Dev.* **2015**, *50*, 98–120. [CrossRef]
36. Giuliano, F.; Lugo, M.A.; Masut, A.; Puig, J. Distributional Effects of Reducing Energy Subsidies: Evidence from Recent Policy Reform in Argentina. *Energy Econ.* **2020**, *92*, 104980. [CrossRef]
37. Gonzalo, G.; Gonzalo, R. Development through solar energy. A project in NW Argentina. Entwicklung mit Sonnenenergie. Ein Projekt in NW-Argentinien. *Sonnenenergie* **1990**, *15*, 5.
38. Lawand, T.A.; Ayoub, J.; Alward, R.; Brunet, E. Renewable Energy Activities in Rural Argentina. *Renew. Energy* **1994**, *5*, 1334–1341. [CrossRef]
39. Herrera, C.B. *Subsidios En El Servicio Público de Distribución de Gas*; Research Report; Univ. Nacional de Cuyo: Mendoza, Argentina, 2016.
40. ENARGAS Informe Especial: TARIFA SOCIAL. Available online: https://www.enargas.gob.ar/ (accessed on 30 November 2021).
41. INTI Censo Solar Térmico (Solar Thermal Census). Available online: www.inti.gob.ar (accessed on 30 November 2021).
42. Grossi Gallegos, H.; Lopardo, R.; Atienza, G. Solar Radiation Network in Argentina. In Proceedings of the International Solar Energy Society, Brighton, UK, 1 January 1982; Volume 3, pp. 2456–2460.
43. Gallegos, H.G.; Lopardo, R. Spatial Variability of the Global Solar Radiation Obtained by the Solarimetric Network in the Argentine Pampa Humeda. *Sol. Energy* **1988**, *40*, 397–404. [CrossRef]
44. Albizzati, E.D.; Rossetti, G.H.; Alfano, O.M. Measurements and Predictions of Solar Radiation Incident on Horizontal Surfaces at Santa Fe, Argentina (31°39′ S, 60°43′ W). *Renew. Energy* **1997**, *11*, 469–478. [CrossRef]
45. Piacentini, R.D.; Cede, A.; Bárcena, H. Extreme Solar Total and UV Irradiances Due to Cloud Effect Measured near the Summer Solstice at the High-Altitude Desertic Plateau Puna of Atacama (Argentina). *J. Atmos. Sol.-Terr. Phys.* **2003**, *65*, 727–731. [CrossRef]
46. Arboit, M.; Diblasi, A.; Fernández Llano, J.C.; De Rosa, C. Assessing the Solar Potential of Low-Density Urban Environments in Andean Cities with Desert Climates: The Case of the City of Mendoza, in Argentina. *Renew. Energy* **2008**, *33*, 1733–1748. [CrossRef]
47. Almorox, J.; Bocco, M.; Willington, E. Estimation of Daily Global Solar Radiation from Measured Temperatures at Cañada de Luque, Córdoba, Argentina. *Renew. Energy* **2013**, *60*, 382–387. [CrossRef]
48. Sarmiento, N.; Belmonte, S.; Dellicompagni, P.; Franco, J.; Escalante, K.; Sarmiento, J. A Solar Irradiation GIS as Decision Support Tool for the Province of Salta, Argentina. *Renew. Energy* **2019**, *132*, 68–80. [CrossRef]
49. Frulla, L.A.; Gagliardini, D.A.; Gallegos, H.G.; Lopardo, R.; Tarpley, J.D. Incident Solar Radiation on Argentina from the Geostationary Satellite GOES: Comparison with Ground Measurements. *Sol. Energy* **1988**, *41*, 61–69. [CrossRef]
50. Podestá, G.P.; Núñez, L.; Villanueva, C.A.; Skansi, M.A. Estimating Daily Solar Radiation in the Argentine Pampas. *Agric. For. Meteorol.* **2004**, *123*, 41–53. [CrossRef]

51. Righini, R.; Grossi Gallegos, H.; Raichijk, C. Approach to Drawing New Global Solar Irradiation Contour Maps for Argentina. *Renew. Energy* **2005**, *30*, 1241–1255. [CrossRef]
52. Grossi Gallegos, H.; Righini, R.; Raichijk, C. Analysis of Alternatives for the Assessment of the Solar Resource in Argentina. In Proceedings of the World Renewable Energy Congress IX, Florence, Italy, 19–25 August 2006.
53. Saravia, L.; Echazú, R.; Cadena, C.; Condorí, M.; Cabanillas, C.; Iriarte, A.; Bistoni, S. Greenhouse Solar Heating in the Argentinian Northwest. *Renew. Energy* **1997**, *11*, 119–128. [CrossRef]
54. Iriarte, A.; Bistoni, S.; Saravia, L. Heating systems of special solar-greenhouses; Calefaccion solar de invernaderos especiales. In Proceedings of the ISES Millenium Solar Forum 2000, Mexico City, Mexico, 1 July 2000; pp. 473–477.
55. Franco, J.; Saravia, L.R.; Esteban, S. Multistage Still. In Proceedings of the 24th National Passive Solar Conference, Portland, OR, USA, 1 July 1999.
56. Franco, J.; Cadena, C.; Saravia, L. Multiple Use Communal Solar Cookers. *Sol. Energy* **2004**, *77*, 217–223. [CrossRef]
57. Condorí, M.; Saravia, L. The Performance of Forced Convection Greenhouse Driers. *Renew. Energy* **1998**, *13*, 453–469. [CrossRef]
58. Condorí, M.; Echazú, R.; Saravia, L. Solar Drying of Sweet Pepper and Garlic Using the Tunnel Greenhouse Drier. *Renew. Energy* **2001**, *22*, 447–460. [CrossRef]
59. Condorí, M.; Saravia, L. Analytical Model for the Performance of the Tunnel-Type Greenhouse Drier. *Renew. Energy* **2003**, *28*, 467–485. [CrossRef]
60. Altobelli, F.; Condorí, M.; Duran, G.; Martinez, C. Solar Dryer Efficiency Considering the Total Drying Potential. Application of This Potential as a Resource Indicator in North-Western Argentina. *Sol. Energy* **2014**, *105*, 742–759. [CrossRef]
61. Duran, G.; Condorí, M.; Altobelli, F. Simulation of a Passive Solar Dryer to Charqui Production Using Temperature and Pressure Networks. *Sol. Energy* **2015**, *119*, 310–318. [CrossRef]
62. Condorí, M.; Duran, G.; Echazú, R.; Altobelli, F. Semi-Industrial Drying of Vegetables Using an Array of Large Solar Air Collectors. *Energy Sustain. Dev.* **2017**, *37*, 1–9. [CrossRef]
63. Franco, J.; Saravia, L.; Javi, V.; Caso, R.; Fernandez, C. Pasteurization of Goat Milk Using a Low Cost Solar Concentrator. *Sol. Energy* **2008**, *82*, 1088–1094. [CrossRef]
64. Lesino, G.; Saravia, L.; Galli, D. Industrial Production of Sodium Sulfate Using Solar Ponds. *Sol. Energy* **1990**, *45*, 215–219. [CrossRef]
65. Lesino, G.; Saravia, L. Solar Ponds in Hydrometallurgy and Salt Production. *Sol. Energy* **1991**, *46*, 377–382. [CrossRef]
66. Dellicompagni, P.; Franco, J. Potential Uses of a Prototype Linear Fresnel Concentration System. *Renew. Energy* **2019**, *136*, 1044–1054. [CrossRef]
67. Gulino, S.; Rodas, J.; Gregor, R. Linear Fresnel Concentrator: A Review of Its Implementation in South American Countries. In Proceedings of the 2020 IEEE PES Transmission Distribution Conference and Exhibition—Latin America (T D LA), Montevideo, Uruguay, 28 September–2 October 2020; pp. 1–6.
68. Dellicompagni, P.; Hongn, M.; Saravia, L.; Altamirano, M.; Placeo, C.; Gea, M.; Hoyos, D.; Bárcena, H.; Suligoy, H.; Fernández, C.; et al. Concentrador solar termico fresnel lineal de San Carlos, Salta. Primeros ensayos de operación y funcionamiento (172m2). *Avances Energías Renovables Medio Ambiente-AVERMA* **2021**, *20*, 1–12.
69. Solar Villages Light up the Andes. Available online: https://www.ecoandina.org/blog/8-solar-villages-light-up-the-andes (accessed on 30 November 2021).
70. Instituto de Vivienda y Urbanismo de Jujuy—IVUJ. Proceso de Fabricación Del Termotanque Solar—Jujuy Solar. 2016. Available online: https://www.ivuj.gob.ar/index.php/2016-05-16-11-40-48/251-con-el-sol-ahorramos-una-excelente-opcion-para-el-hogar (see also https://www.youtube.com/watch?v=Ka3YBTiRLW4); (accessed on 9 March 2022).
71. Nicolás, R.O.; Durán, J.C. Theoretical Maximum Concentration Factors for Solar Concentrators. *J. Opt. Soc. Am. A JOSAA* **1984**, *1*, 1110–1113. [CrossRef]
72. Durán, J.C.; Nicolás, R.O. Development and Applications of a Two-Dimensional Optical Analysis of Non-Perfect Cylindrical Concentrators. *Sol. Energy* **1985**, *34*, 257–269. [CrossRef]
73. Nicolás, R.O.; Durán, J.C. Generalization of the Two-Dimensional Optical Analysis of Cylindrical Concentrators. *Sol. Energy* **1980**, *25*, 21–31. [CrossRef]
74. Durán, J.C.; Venier, G.; Weht, R. Optimization of the Junction Depth and Doping of Solar Cell Emitters. *Sol. Cells* **1991**, *31*, 497–503. [CrossRef]
75. Vaccaro, P.O.; Meyer, G.; Saura, J. Effects of $CdCl_2$ on the Growth of CdTe on CdS Films for Solar Cells by Isothermal Close-Spaced Vapour Transport. *J. phys. D Appl. phys.* **1991**, *24*, 1886–1889. [CrossRef]
76. Meyer, G. Transient Current Measurements for the Determination of the Fermi Level in Semiconductors. *Meas. Sci. Technol.* **1993**, *4*, 1489–1492. [CrossRef]
77. Meyer, G.; Saura, J. Undoped and Indium-Doped CdS Films Prepared by Chemical Vapour Deposition. *J Mater Sci* **1993**, *28*, 5335–5339. [CrossRef]
78. Alurralde, M.; Tamasi, M.J.L.; Bruno, C.J.; Martínez Bogado, M.G.; Plá, J.; Fernández Vázquez, J.; Durán, J.; Schuff, J.; Burlon, A.A.; Stoliar, P.; et al. Experimental and Theoretical Radiation Damage Studies on Crystalline Silicon Solar Cells. *Sol. Energy Mater. Sol. Cells* **2004**, *82*, 531–542. [CrossRef]
79. Bolzi, C.G.; Bruno, C.J.; Duran, J.C.; Godfrin, E.M.; Martinez Bogado, M.G.; Merino, L.M.; Pla, J.C.; Tamasi, M.J.L.; Barrera, M. SAC-A Satellite: First Experiment of Argentine Solar Cells in Space. In Proceedings of the Conference Record of the Twenty-Eighth IEEE Photovoltaic Specialists Conference—2000 (Cat. No.00CH37036), Anchorage, AK, USA, 15–22 September 2000; pp. 1344–1347.

80. Bolzi, C.G.; Bruno, C.J.; Durán, J.C.; Godfrin, E.M.; Bogado, M.G.M.; Merino, L.M.; Plá, J.C.; Tamasi, M.J.L.; Barrera, M. First Experiment of Argentine Solar Cells in Space: Modules Fabrication, Characterisation, and Telemetry Data Analysis from SAC-A Satellite. *Sol. Energy Mater. Sol. Cells* **2002**, *73*, 269–280. [CrossRef]
81. Alurralde, M.; Barrera, M.; Bolzi, C.G.; Bruno, C.J.; Cabot, P.; Carella, E.; Di Santo, J.; Durán, J.C.; Fernández Slezak, D.; Fernández Vázquez, J.; et al. Development of Solar Arrays for Argentine Satellite Missions. *Aerosp. Sci. Technol.* **2013**, *26*, 38–52. [CrossRef]
82. EMCORE. Announces Closing of Sale of Its Space Photovoltaics Business to an Affiliate of Veritas Capital for $150 Million | EMCORE. Available online: https://investor.emcore.com/news-releases/news-release-details/emcore-announces-closing-sale-its-space-photovoltaics-business (accessed on 4 October 2021).
83. Ibarra, M.L.; Garcia, J.A.; Dato, A.; Yaccuzzi, E.; Prario, I.; Filevich, A.; Barrera, M.; Alurralde, M.E.D.R.A. The Argentine Facility to Simulate Radiation Damage in Space. *Radiat. Phys. Chem.* **2019**, *154*, 79–84. [CrossRef]
84. Rubinelli, F.A.; Jiménez, R.; Rath, J.K.; Schropp, R.E.I. Using Computer Modeling Analysis in Single Junction A-SiGe:H p–i–n Solar Cells. *J. Appl. Phys.* **2002**, *91*, 2409–2416. [CrossRef]
85. Zambrano, R.J.; Rubinelli, F.A.; Arnoldbik, W.M.; Rath, J.K.; Schropp, R.E.I. Computer-Aided Band Gap Engineering and Experimental Verification of Amorphous Silicon–Germanium Solar Cells. *Sol. Energy Mater. Sol. Cells* **2004**, *81*, 73–86. [CrossRef]
86. Strengers, J.J.H.; Rubinelli, F.A.; Rath, J.K.; Schropp, R.E.I. A Combined Experimental and Computer Simulation Study of HWCVD Nip Microcrystalline Silicon Solar Cells. *Thin Solid Films* **2006**, *501*, 291–294. [CrossRef]
87. Taretto, K.; Rau, U.; Werner, J.H. Numerical Simulation of Grain Boundary Effects in Cu(In,Ga)Se2 Thin-Film Solar Cells. *Thin Solid Films* **2005**, *480–481*, 8–12. [CrossRef]
88. Taretto, K.; Rau, U. Numerical Simulation of Carrier Collection and Recombination at Grain Boundaries in Cu (In, Ga) Se_2 Solar Cells. *J. Appl. Phys.* **2008**, *103*, 094523. [CrossRef]
89. Kirchartz, T.; Taretto, K.; Rau, U. Efficiency Limits of Organic Bulk Heterojunction Solar Cells. *J. Phys. Chem. C* **2009**, *113*, 17958–17966. [CrossRef]
90. Kirchartz, T.; Pieters, B.E.; Taretto, K.; Rau, U. Electro-Optical Modeling of Bulk Heterojunction Solar Cells. *J. Appl. Phys.* **2008**, *104*, 094513–094519. [CrossRef]
91. Kirchartz, T.; Pieters, B.E.; Taretto, K.; Rau, U. Mobility Dependent Efficiencies of Organic Bulk Heterojunction Solar Cells: Surface Recombination and Charge Transfer State Distribution. *Phys. Rev. B* **2009**, *80*, 035334. [CrossRef]
92. Schmidt, J.A.; Longeaud, C. Density of States Determination from Steady-State Photocarrier Grating Measurements. *Appl. Phys. Lett.* **2004**, *85*, 4412–4414. [CrossRef]
93. Schmidt, J.A.; Budini, N.; Ventosinos, F.; Longeaud, C. Theoretical Analysis and Experimental Results on the Modulated Photocarrier Grating Technique. *Phys. Status Solidi (A)* **2010**, *207*, 556–560. [CrossRef]
94. Kind, R.; Van Swaaij, R.A.C.M.M.; Rubinelli, F.A.; Solntsev, S.; Zeman, M. Thermal Ideality Factor of Hydrogenated Amorphous Silicon Pin Solar Cells. *J. Appl. Phys.* **2011**, *110*, 104512. [CrossRef]
95. Troviano, M.; Taretto, K. Analysis of Internal Quantum Efficiency in Double-Graded Bandgap Solar Cells Including Sub-Bandgap Absorption. *Sol. Energy Mater. Sol. Cells* **2011**, *95*, 821–828. [CrossRef]
96. Troviano, M.; Taretto, K. Temperature-Dependent Quantum Efficiency Analysis of Graded-Gap Cu (In, Ga) Se_2 Solar Cells. *Sol. Energy Mater. Sol. Cells* **2011**, *95*, 3081–3086.
97. Cossutta, H.; Taretto, K.; Troviano, M. Low-Cost System for Micrometer-Resolution Solar Cell Characterization by Light Beam-Induced Current Mapping. *Meas. Sci. Technol.* **2014**, *25*, 105801. [CrossRef]
98. Budini, N.; Rinaldi, P.A.; Schmidt, J.A.; Arce, R.D.; Buitrago, R.H. Influence of Microstructure and Hydrogen Concentration on Amorphous Silicon Crystallization. *Thin Solid Films* **2010**, *518*, 5349–5354. [CrossRef]
99. Schmidt, J.A.; Budini, N.; Rinaldi, P.; Arce, R.D.; Buitrago, R.H. Large-Grained Oriented Polycrystalline Silicon Thin Films Prepared by Nickel-Silicide-Induced Crystallization. *J. Cryst. Growth* **2008**, *311*, 54–58. [CrossRef]
100. Jimenez Zambrano, R.; Rubinelli, F.A.; Rath, J.K.; Schropp, R.E.I. Improvement in the Spectral Response at Long Wavelength of A-SiGe:H Solar Cells by Exponential Band Gap Design of the i-Layer. *J. Non-Cryst. Solids* **2002**, *299–302*, 1131–1135. [CrossRef]
101. Rath, J.K.; Rubinelli, F.A.; Schropp, R.E.I. Effect of Oxide Treatment at the Microcrystalline Tunnel Junction of A-Si:H/a-Si:H Tandem Cells. *J. Non-Cryst. Solids* **2000**, *266–269*, 1129–1133. [CrossRef]
102. Rubinelli, F.A.; Rath, J.K.; Schropp, R.E.I. Microcrystalline N-i-p Tunnel Junction in a-Si:H/a-Si:H Tandem Cells. *J. Appl. Phys.* **2001**, *89*, 4010–4018. [CrossRef]
103. Valdés, M.H.; Berruet, M.; Goossens, A.; Vázquez, M. Spray Deposition of CuInS2 on Electrodeposited ZnO for Low-Cost Solar Cells. *Surf. Coat. Technol.* **2010**, *204*, 3995–4000. [CrossRef]
104. Di Iorio, Y.; Berruet, M.; Schreiner, W.; Vázquez, M. Characterization of CuInS2 Thin Films Prepared by One-Step Electrodeposition. *J. Appl. Electrochem.* **2014**, *44*, 1279–1287. [CrossRef]
105. Berruet, M.; Di Iorio, Y.; Troviano, M.; Vázquez, M. ZnO and Copper Indium Chalcogenide Heterojunctions Prepared by Inexpensive Methods. *Mater. Chem. Phys.* **2014**, *148*, 1071–1077. [CrossRef]
106. Taretto, K.; Soldera, M.; Koffman-Frischknecht, A. Material Parameters and Perspectives for Efficiency Improvements in Perovskite Solar Cells Obtained by Analytical Modeling. *IEEE J. Photovolt.* **2017**, *7*, 206–213. [CrossRef]
107. Soldera, M.; Taretto, K. Combining Thickness Reduction and Light Trapping for Potential Efficiency Improvements in Perovskite Solar Cells. *Physica Status Solidi (A)* **2018**, *215*, 1700906. [CrossRef]

108. Soldera, M.; Frischknecht, A.K.; Taretto, K. Optical and Electrical Optimization of All-Perovskite Pin Type Junction Tandem Solar Cells. *J. Phys. D Appl. Phys.* **2020**, *53*, 315104. [CrossRef]
109. Suarez, B.; Gonzalez-Pedro, V.; Ripolles, T.S.; Sanchez, R.S.; Otero, L.; Mora-Sero, I. Recombination Study of Combined Halides (Cl, Br, I) Perovskite Solar Cells. *J. Phys. Chem. Lett.* **2014**, *5*, 1628–1635. [CrossRef]
110. Frischknecht, A.K.; Yaccuzzi, E.; Plá, J.; Perez, M.D. Anomalous Photocurrent Response of Hybrid TiO_2:P3HT Solar Cells under Different Incident Light Wavelengths. *Sol. Energy Mater. Sol. Cells* **2016**, *157*, 907–912. [CrossRef]
111. Iorio, Y.D.; Berruet, M.; Gau, D.L.; Spera, E.L.; Pereyra, C.J.; Marotti, R.E.; Vázquez, M. Efficiency Improvements in Solution-Based $CuInS_2$ Solar Cells Incorporating a Cl-Doped ZnO Nanopillars Array. *Physica Status Solidi (A)* **2017**, *214*, 1700191. [CrossRef]
112. Berruet, M.; Iorio, Y.D.; Pereyra, C.J.; Marotti, R.E.; Vázquez, M. Highly-Efficient Superstrate Cu_2ZnSnS_4 Solar Cell Fabricated Low-Cost Methods. *Phys. Status Solidi (RRL)–Rapid Res. Lett.* **2017**, *11*, 1700144. [CrossRef]
113. Suárez, M.B.; Aranda, C.; Macor, L.; Durantini, J.; Heredia, D.A.; Durantini, E.N.; Otero, L.; Guerrero, A.; Gervaldo, M. Perovskite Solar Cells with Versatile Electropolymerized Fullerene as Electron Extraction Layer. *Electrochim. Acta* **2018**, *292*, 697–706. [CrossRef]
114. Koffman-Frischknecht, A.; Gonzalez, F.; Plá, J.; Violi, I.; Soler-Illia, G.J.A.A.; Perez, M.D. Impact of the Titania Nanostructure on Charge Transport and Its Application in Hybrid Solar Cells. *Appl. Nanosci.* **2018**, *8*, 665–673. [CrossRef]
115. Pereyra, C.J.; Di Iorio, Y.; Berruet, M.; Vazquez, M.; Marotti, R.E. Influence of a Nanostructured ZnO Layer on the Carrier Recombination and Dynamics in Chalcopyrite Solar Cells. *J. Mater. Sci.* **2020**, *55*, 9703–9711. [CrossRef]
116. Gómez Andrade, V.A.; Herrera Martínez, W.O.; Redondo, F.; Correa Guerrero, N.B.; Roncaroli, F.; Perez, M.D. Fe and Ti Metal-Organic Frameworks: Towards Tailored Materials for Photovoltaic Applications. *Appl. Mater. Today* **2021**, *22*, 100915. [CrossRef]
117. Solis, C.; Durantini, J.E.; Macor, L.; Heredia, D.A.; Gonzalez Lopez, E.J.; Durantini, E.N.; Mangione, M.I.; Rappich, J.; Dittrich, T.; Otero, L.; et al. Electrochemical Formation of Photoactive Organic Heterojunctions. Porphyrin-C60 Polymeric Photoelectrochemical Cells. *Electrochim. Acta* **2021**, *365*, 137333. [CrossRef]
118. Córdoba, M.; Herrera, W.; Koffman-Frischknecht, A.; Correa, N.; Perez, M.D.; Taretto, K. Electroluminescence Transients and Correlation with Steady-State Solar Output in Solution-Prepared CH3NH3PbI3 Perovskite Solar Cells Using Different Contact Materials. *J. Phys. D Appl. Phys.* **2020**, *53*, 115501. [CrossRef]
119. Ventosinos, F.; Koffman-Frischknecht, A.; Herrera, W.; Senno, M.; Caram, J.; Perez, M.D.; Schmidt, J.A. Estimation of Carrier Mobilities and Recombination Lifetime in Halide Perovskites Films Using the Moving Grating Technique. *J. Phys. D Appl. Phys.* **2020**, *53*, 415107. [CrossRef]
120. Perez, M.D.; González, F.D.; Correa Guerrero, N.B.; Viva, F.A. Carrier Conduction Mechanisms of Mesoporous Titania Thin Films Assessed by Impedance Spectroscopy. *Microporous Mesoporous Mater.* **2019**, *283*, 31–38. [CrossRef]
121. Australian Photovoltaic Institute • Market Analyses. Available online: https://pv-map.apvi.org.au (accessed on 26 January 2022).
122. Energia, S.I.-C.N. Electricidad—Comisión Nacional de Energía. Available online: https://www.cne.cl/normativas/electrica/consulta-publica/electricidad/ (accessed on 4 February 2022).
123. Agostini, C.A.; Nasirov, S.; Silva, C. Solar PV Planning Toward Sustainable Development in Chile: Challenges and Recommendations. *J. Environ. Dev.* **2016**, *25*, 25–46. [CrossRef]
124. Roy, D. Argentina: A South American Power Struggles for Stability. Available online: https://www.cfr.org/backgrounder/argentina-south-american-power-struggles-stability (accessed on 7 February 2022).
125. Spiller, P.T.; Stein, E.H.; Tommasi, M.; Scartascini, C.; Melo, M.A.; Mueller, B.; Pereira, C.; Aninat, C.; Londregan, J.; Navia, P.; et al. *Policymaking in Latin America: How Politics Shapes Policies*; Inter-American Development Bank: Washington, DC, USA, 2008; ISBN 978-1-59782-061-5.
126. Cable.co.uk. Worldwide Electricity Pricing—Energy Cost per KWh in 230 Countries. Available online: https://www.cable.co.uk/energy/worldwide-pricing/ (accessed on 3 February 2022).
127. Argentine Secretary of Energy—Ministry of Economy of Argentina. Reactivación de Obras de Transporte Eléctrico. Available online: https://www.argentina.gob.ar/economia/energia/energia-electrica/linea-extra-alta-tension-rio-diamante (accessed on 9 March 2022).
128. Argentine Ministry of Economy—Energy Secretary. Resolution 1036/2021: Lineamientos para un Plan de Transición Energética al 2030. 2021. Available online: http://www.infoleg.gob.ar/ (accessed on 9 March 2022).