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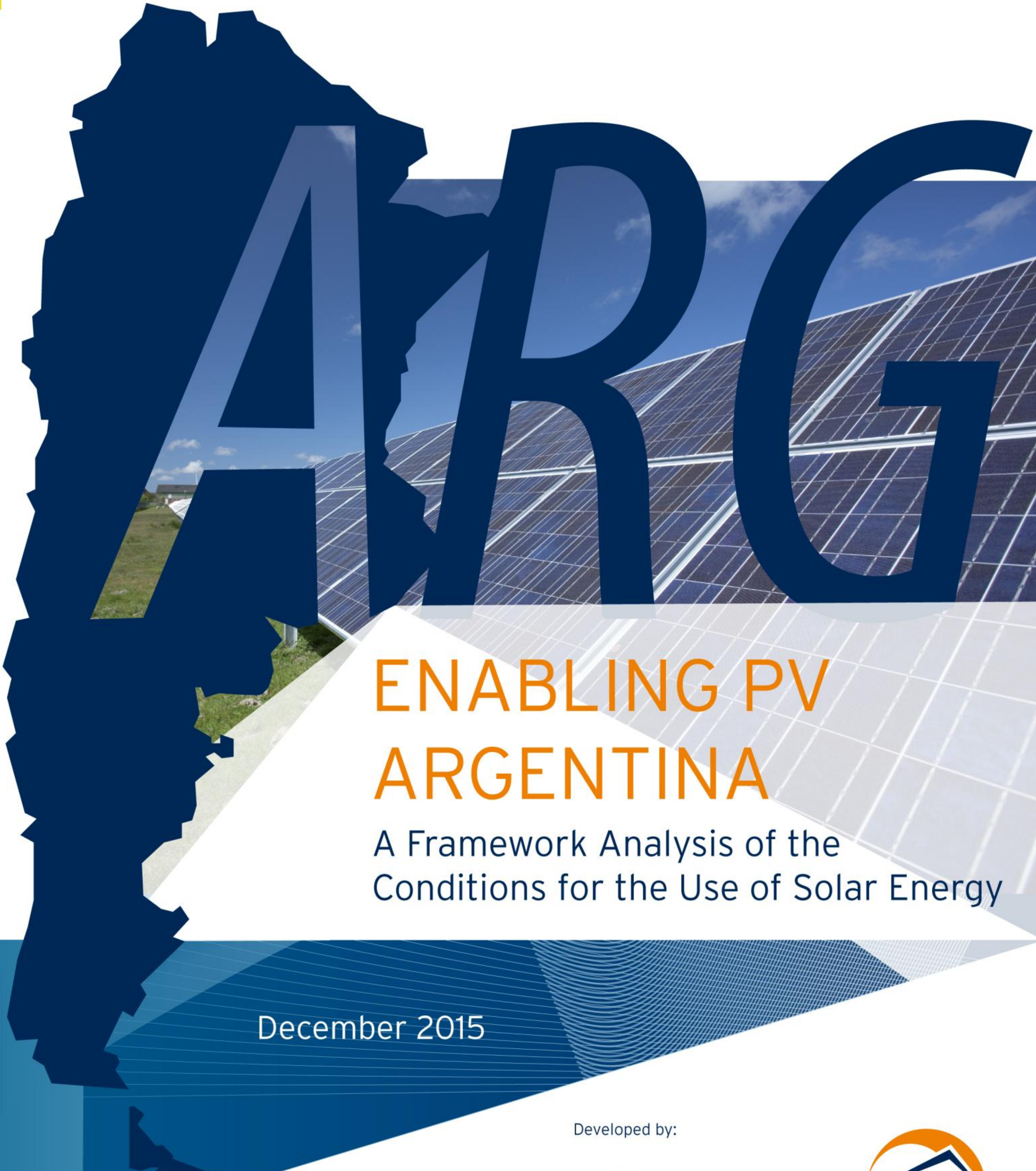

ENABLING PV ARGENTINA

A Framework Analysis of the Conditions for the Use of Solar Energy

December 2015

Developed by:

eclareon

BSW GERMAN SOLAR ASSOCIATION

Enabling PV in Argentina

Study about the solar market and business environment solar PV systems in Argentina

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Energía San Luis

EPSE
Energía Provincial Sociedad del Estado

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List of Abbreviations

BICE	Banco de Inversión y Comercio Exterior
BOO	Build-Own-Operate
BOT	Build-Operate-Transfer
DSO	Distribution System Operator (used here for Distribution
CADER	Cámara Argentina de Energías Renovables
CAF	Caja Andina de Fomento
CAMMESA	Compañía Administradora del Mercado Mayorista Eléctrico
DIA	Declaración de Impacto Ambiental
EIA	Environmental Impact Assessment
ENARSA	Energía Argentina S.A.
EU	European Union
FiT	Feed in Tariff
FOB	Free On Board
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GW	Giga Watt
IDB	Inter American Development Bank
IPP	Independent Power Producer
KV	Kilo Volt
kW/h	Kilowatt Hour
kW/p	Kilowatt Peak
LCOE	Levelized Cost of Electricity
MEM	Mercado Eléctrico Mayorista
MW	Megawatt
MW/h	Megawatt Hour
NOA	Noroeste Argentino
O&M	Operation and Maintenance
PERMER	Renewable Energy in the Rural Market Project
PPA	Power Purchase Agreement
PV	Photovoltaic
RE	Renewable Energy
RES	Renewable Energy Sources
UN	United Nations
US$	US dollar
WACC	Weighted Average Cost of Capital
WB	World Bank

0. Executive Summary

Argentina's potential for PV is extremely high, having an excellent solar irradiation and high and potentially growing electricity demand. Yet, as Argentina is still an infant renewable energy market, there are big challenges to PV investments that need to be overcome. The macroeconomic situation of the country (i.e. high inflation rate, limited access to international finance) and the universal electricity subsidies constitute a difficult framework for the PV development. In addition, knowledge on technology and installation is still limited, thus a strong impetus has to be done on training and qualification. On the other hand, versatile support scheme with Power Purchase Agreements at national level and Net-Metering policies, tax reductions and promotional policies build a strong base for an emerging PV market, especially once Argentina gets access to international capital, again.

Beyond that the report analyses several barriers such as subsidies for electricity, technical standards and unclear guidelines and procedures and high system prices due to trade and import restrictions, which are a barrier to market growth.

The financial analysis of the two cases of the PPA business models of 5 MW installation shows that the high interest rate is the key challenge that limits the investments in the PV sector unless financing of the National Investment External Commerce Bank BICE can be used. By calculating with a low interest rates of 6.7 % are highly profitable, even at 15 year contracts.

Apart from the national scheme, the provinces, most notably San Juan, San Luis and Salta also actively involve in the sector with their own policies to build a market on their own or even promote industrial policies.

Finally the report gives an outlook on necessary changes and reforms that will create a real business case for PV in Argentina. The government's new commitment at the COP 21 as well as the latest reforms in the financial sector are positive signs that it will be soon time to make for solar business in Argentina.

1. Description of the Project

The German Solar Association (BSW-Solar) in cooperation with the international consulting company eclareon GmbH, specialised in the sector of renewable energy and energy efficiency, and the Argentinean partners EPSE and Energía San Luis SAPEM will analyse the processes and barriers of the Argentinean PV sector. In the project "PV Framework Assessment in Argentina" a particular focus on the provinces of a San Juan and San Luis will be given.

1.1 Goals

The general goal of "PV Framework Assessment in Argentina" is to support the development of the PV sector in Argentina improving the knowledge of the solar PV industry through knowledge transfer and exchange of best practices between Germany and Argentina. To achieve this goal the following actions are foreseen:

- Describe business models for the solar PV energy in Argentina, either for off-grid systems as for ground-mounted installations interconnected to the national grid such as auctions and Power Purchase Agreements (PPA) signed with the national electricity market (MEM in Spanish abbreviation). The business models will benefit from international public access.
- Identify the regulatory and administrative framework of the referred business models and make the results available to international investors.
- Strengthen cooperation and transfer of knowledge between relevant stakeholders, in particular between the private sectors of Argentina and Germany.

1.2 Opportunities

The project "PV Framework Assessment in Argentina" offers several opportunities for investors and project developers, as well as for other local actors of the solar PV sector that may benefit from:

- The information about the existent business models for investors and project developers that are currently initiating their activities in the renewable energy area in Argentina;
- The experience of the PV project developers and the international investors that are interested in the Argentinean market, especially by establishing contacts to German companies through the German Solar Association (BSW-Solar);
- The knowledge of German experts with a thorough understanding of German,

European and international solar market developments and current trends regarding business models for solar PV.

1.3 Methodology

By desk research, interviews with market experts, legislators and project developers using standardized interview guidelines, business cases are identified and data for simulations gathered. Plausibility assumptions and an analysis of barriers help to formulate recommendations for policy makers and politicians. Sample calculations of typical projects including cash flow modelling and sensitivity analysis provide an outlook for profitability changes according to changes in system prices, energy yield or remuneration and thus a first guideline for investors. The preliminary results were presented at an event in Buenos Aires on the 15 December 2015 and discussed with industry representatives.

2. Electricity Market and Solar PV in Argentina

2.1 Macroeconomic Conditions in Argentina

Macroeconomic conditions have recently deteriorated in Argentina. According to the National Statistical Institute, Instituto Nacional de Estadística y Censos (INDEC), the inflation rate was about 14.4%, comparing September 2015 with September 2014. This rate meant a decrease in comparison with the inflation rate variation registered in September 2014 (about 23.9%), comparing it with September 2013 (INDEC 2015)[1]. According to private statistic agencies and interviewed stakeholders, however, inflation rate comparing September 2015 with September 2014 is higher than the official 14.4%. The values estimated by the interviewed PV project developers and PV experts range between 25% and 30% for 2015, showing a wide difference with the INDEC value. In fact, the General Direction of Statistic from the government of the Autonomous City of Buenos Aires registered a variation of 25.5% comparing June 2015 with June 2014 (Infobae 2015)[2]. Yet, some of the interviewed stakeholders affirmed that the projected inflation rate for 2016 will slightly slow down.

With regard to interest rates for credits of international bank, interviewed stakeholders agree in a value of about 15% - 20%. International bank interest rates are very high due to the country's difficulty to access to international credits. In order to

[1] See more information in: http://www.indec.gov.ar/uploads/informesdeprensa/ipcnu_09_15.pdf

[2] See more information in: http://www.infobae.com/2015/07/14/1741593-el-gobierno-la-ciudad-midio-14-inflacion-junio

compensate this difficulty and further investments in strategic sectors, the Argentine's Investment and International Trade Bank (BICE) has launched credit lines in national currency as well as US$. Among other sectors, it finances investments in renewable energy projects that allow meeting the greater energy demand in the production sector (see more details in section 0)[3].

2.2 Electricity Market Profile in Argentina

In Argentina electricity consumption has experienced a great expansion since 2003 due to economic recovery, highly subsidized electricity tariffs as well as indirect subsidies to fossil fuels. Projections state that, even implementing energy efficiency policies, the installed capacity would have to at least double for the year 2035 (EEA 2015). The expansion of the electricity demand together with scarce private investments on generation capacity has resulted in the following difficulties for the electricity sector in Argentina:

- Increase of fossil fuels imports that reached a peak of 13 billion dollars in 2013, being the principal reason of the trade balance deterioration (Platform Energy Scenarios 2035 2015).[4]

- Electricity shutdowns, especially during the summer seasons. In the summer of 2013-2014 shutdowns reached a peak affecting 800,000 households. In the same season of 2014-2015 shutdowns have experienced a 90% reduction affecting only 50,000 households (FUNDELEC 2015). This was due to the investments in the medium and high voltage transmission lines and distribution networks as well as the lower temperatures registered in 2014-2015, compared to the previous summer season (FUNDELEC 2015).

- The Business as Usual (BAU) scenario from the Platform Energy Scenarios 2035 (2015) shows that there will be a sustained reduction of the production of conventional hydrocarbons that will be replaced by a progressive increase of the unconventional fossil fuels exploitation and the continuation of hydrocarbon's imports. This may cause a greater dependency on fossil fuels in the energy mix and might contribute to keep low the level of renewable energy

[3] See more information in: http://inversiones.gob.ar/es/incentivos-la-inversion
[4] Platform Energy Scenarios 2035 (2015) in an initiative coordinated by Fundación Avina, Fundación Ambiente y Recursos Naturales (FARN), Centro de Estudios de la Actividad Regulatoria Energética de la Universidad de Buenos Aires (CEARE) and Instituto Tecnológico Buenos Aires (ITBA). The report was written by Fernandez, R.

(RE) participation (Platform Energy Scenarios 2035 2015).

- The share of new RE, excluding hydropower, continues to be very marginal in relation to the share of RE in other Latin American countries. The share of renewable electricity generation is 0.5% including wind energy and PV (Compañía Administradora del Mercado Mayorista Eléctrico (CAMMESA) 2015), and 1.4% including also biofuels (Villalonga 2013).

- The level of investment in the energy sector for the next 20 years starting from 2015 is projected for about US$ 96 billion. This amount is influenced by the great investments that will require the approved nuclear energy and hydropower projects. A risk of incompletion of some of these projects is foreseen (Platform Energy Scenarios 2035 2015).

Despite a strong focus on conventional energies, all experts and PV project developers interviewed for the study estimate that there will be an expansion of renewable energy in the coming years. The reasons of that are twofold:

1. From 2016 on, electricity subsidies will be significantly reduced, making investments in renewable energies considerably more profitable. Experts agree that after the instauration of the new government (10 December 2015), the reduction of energy subsidies will be imminent and it will have a positive impact on renewable energy investments because the political pressure to cover electricity demand in the short-term is very high.
2. The production of unconventional hydrocarbons will most probably not achieve significant increases until 2020, and in some cases until 2025 (EEA 2015).

Thus, a change in the national discourse and energy policy is foreseen.

As it was said before, since 2003 the electricity costs for households and industry sectors in Argentina have been subsidized. Electricity prices change by province and consumed electricity amount (expressed in kWh), as subsidies change accordingly. In 2012, the government started to reduce energy subsidies to certain wealthy private neighbourhoods and industries, but consumers can still request to keep them. In this case, consumers can ask for the subsidy at the offices of the distribution companies (EDEMSA 2015). It is, however, expected that in 2016 subsidies will be drastically reduced and tariffs will be adapted to real generation and distribution costs. Here it will be given the subsidized electricity prices for the household, small commerce and industry sectors expressed in US dollar[5] in the provinces of San Luis and San Juan, as these two provinces are analysed as examples in the present study. For the household and commerce sectors, the price of the electricity without the subsidy will be also provided.

Table 1: Subsidized Electricity Price in San Luis and San Juan as of 2015

Categories		Residential <10kW	Non-residential use <10kW	Industry (kWh)
Provinces	San Luis	0.36-0.68 AR$/kWh[6]	= < 100 kWh 0.52 AR$/kWh > 2,000 kWh 0.59 AR$/kWh	< 300 kW 0.48 AR$/kWh (peak hours) > 300 kW 0.51 AR$/kWh (peak hours)
	San Juan	0.22-0.35 AR$/kWh	< 240 up to 580 kWh 0.30 AR$/kWh = < 4,000 kWh 0.25 AR$/kWh	< 300 Kw 0.14 AR$/kWh (peak hours) > 300 kW 0.17 AR$/kWh (peak hours)

Source: eclareon based on the data of EDESAL and ESJ 2015[7]

[5] The currency exchange rate applied here is of 1 Peso = 14 US$ (12/2015).

[6] The big difference in the subsidized electricity price is due to the difference in the amount of the subsidy provided to households. Households that consume between 161 kWh and 200 kWh of electricity receive a provincial subsidy and one of the highest national subsidies, being the band that pays the lowest price.

As the table shows, the prices vary strongly between regions and type of consumer. Biggest differences can be seen between industrial prices in San Luis (0.68 AR$) and five times lower San Juan (0.14 AR$) which underlines the heterogeneity of the Argentinian electricity market. This is due to the differences in the national subsidy; there are some provinces which receive higher subsidies than others.

In contrast to the above real electricity a price, the calculated prices without subsidy would be significantly higher, as the table below shows:

Table 2: Electricity Price without subsidy in San Luis and San Juan as of 2015

Categories		Residential <10kW	Non-residential use <10kW	Industry (kWh)
Provinces	San Luis	0.62-0.76 AR$/kWh	= or < 100 kWh 0.72 AR$/kWh > 2,000 kWh 0.76 AR$/kWh	< 300 kW 0.68 AR$/kWh (peak hours) > 300 kW 0.69 AR$/kWh (peak hours)
	San Juan	0.52-0.65 AR$/kWh	< 240 up to 580 kWh 0.57 AR$/kWh = or > 4,000 kWh 0.52 AR$/ kWh	< 300 Kw 0.40 AR$/kWh (peak hours) > 300 kW 0.40 AR$/kWh (peak hours)

Source: eclareon based on the data of EDESAL and ESJ 2015

The very low electricity tariffs have caused a great expansion in the electricity demand, especially from 2002 and in the household sector. The demand rate of electricity has increased a 4.35% annually in the last 22 years. The demand has increased from 76,000 GWh in 2002 to 126,000 GWh in 2014 (CADER 2015). The household sector represents 40% of the total electricity demand (FUNDELEC 2015).

[7] Data provided by the distribution companies of EDESAL for San Luis and ESJ for San Juan. See more information in:
http://www.energia.gov.ar/contenidos/archivos/Reorganizacion/informacion_del_mercado/publicaciones/mercado_electrico/cuadros_tarifarios/2015/san_luis/CT_edesal_Enero_2015.pdf
http://www.energiasanjuan.com.ar/ver.cuadro_tarifario_descargar.php?id=54

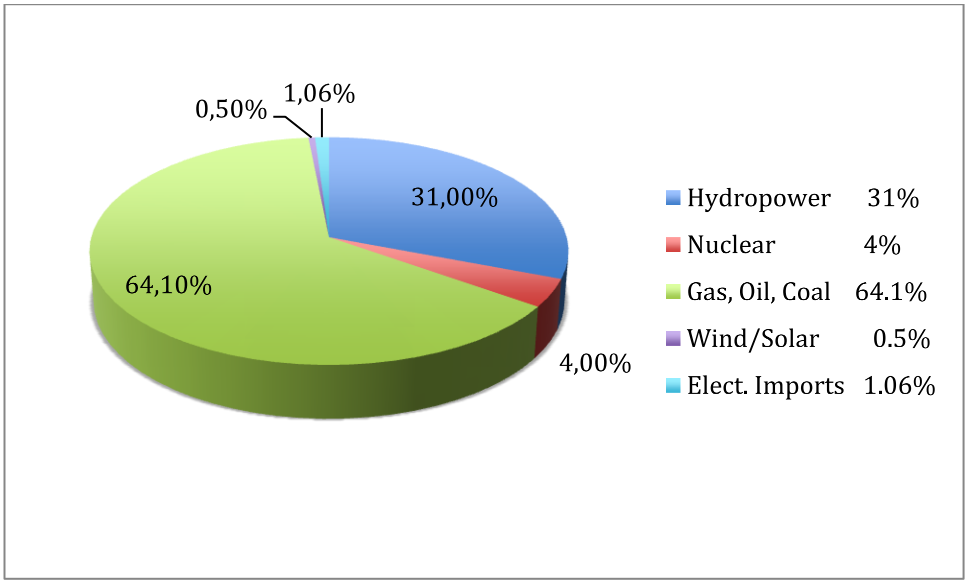
2.3 Electricity Mix and Share of Renewable Energy

In 2014, the share of renewable electricity generation, mostly wind power and some solar PV, was 0.5% that corresponded with an installed capacity of 201 MW (Figure 1). Electricity generation mix is mainly dominated by thermal plants (64.1%), and combined heat and power plants provide the most significant share (39.3%) among these plants (CAMMESA 2015). In many cases thermal plants do not represent the best alternative in economic terms, as a lot of them are too old, expensive and inefficient. Many steam turbines are in a level of obsolescence that makes them uneconomical and inefficient in operational terms (CADER 2015). Since 2006 thermal plants (combined heat and power plants and gas turbines) have been using gasoil, which is mainly imported. In 2014 the country imported about 1,700,000 m3 of gasoil spending a total of US$ 1,200 million, including the fossil fuel cost and the logistic (CADER 2015). The average cost of the imported gasoil is about 390 US$/MWh (Alvarez 2015). The imported gasoil together with the imports of Liquefied Natural Gas (LNG) and Fuel Oil (FO) cost more than US$ 10 billion for the country in 2014 (CADER 2015), almost US$ 3 billion less than the peak reached in 2013 (US$ 13 billion) (Platform Energy Scenarios 2035 2015).

Large-scale hydropower is an important source of electricity (31.3%), but it has decreased from 2001. Nuclear power provided about 4.1% of total electricity generation (Figure 1), which is less than in some previous years.[8] From the mid-2014, nuclear installed capacity has increased by 74% with the new nuclear power plant, Atucha 2, on line (World Nuclear Association 2014). There is still no data on the electricity generation provided by Atucha 2.

[8] The gross generation of nuclear electricity has decreased since 2010 from 5.8% to 4.1% in 2014 because the Embalse nuclear power plant operates currently at 80% of its capacity.

Figure 1: Electricity Mix in Argentina 2014



Source: eclareon based on Annual Report 2014 - "Mercado Eléctrico Mayorista de la República Argentina" (CAMMESA 2015).[9]

2.4 Electricity Regulatory Framework

After the economic crises of the 1980s, the national government introduced one of the largest reforms in the electricity sector compared to other Latin American countries. In 1991 the new Electricity Law (No. 24065/91) was issued, being since then the main legal framework that regulates the so-called Wholesale Electricity Market (MEM). Law 24065/91 liberalized Argentine's electricity sector and unbundled it into separate industries responsible for generation, transmission, and distribution. Apart from Law No. 24065/91, the Secretary of Energy has the authority to publish additional rules, like for example resolutions.

The areas of electricity transmission and distribution were completely privatized, while the electricity generation was largely privatized. The main example was the privatization of the fossil fuels sector. The latter, which between 1920 and 1990 had always a quite limited participation of the private companies (domestic and foreign) due to the state ownership of the largest oil company YPF, was entirely sold to the Spanish company Repsol. It should be noted that in 2012 the YPF was partially re-nationalized, 51% of the assets are now in public hands. Electricity generation is

[9] Source: http://www.cammesa.com/archcount.nsf/LinkCounter?OpenAgent&X=InformeAnual*2014*Vanual14.zip&L=/linfoanu.nsf/WInforme+Anual/5485544A5806855203257E3C0066C1E4/$File/Vanual14.zip

largely in private hands, except for the nuclear generation, which remained always state-owned, and the two bi-national hydropower plants (Yaciretá and Salto Grande).

2.5 History of the Renewable Energy Legal Framework

In 1998, the government enacted the first national law (No. 25019) promoting wind and solar energy. Law 25019 declared wind and solar generation a national interest and introduced a feed-in tariff (FIT) to set up additional payment per generated kWh, which in 1998 meant a 40% premium over market price (ECOFYS Germany GmbH 2009). The tariffs were set in Argentine peso that in 1998 was pegged to the US dollar. Yet the financial crisis and devaluation of the Argentine peso in 2002 made renewable energy projects unattractive for investors employing FITs. As the total tariff of a volatile market price plus a fix premium is a difficult to predict source of financing for investors, this kind of incentive together with the currency risks has not attracted foreign investments since then.

In 2006, the government enacted the FIT Law 26190 for the development of RES aiming to revise the wind and solar regime set by Law 25019, extend it to other renewable energy sources as well as establishing a renewable energy goal of 8% for 2016 (Villalonga 2013). The law was the result of the country's participation in the International Conference for Renewable Energy "Renewables 2004", held in Bonn in the framework of REN21. Still, it was not regulated until three years later in 2009, and only then the law went into effect.

In 2009 the government launched a competitive auction scheme, called GENREN I, to accelerate RE development confirming the target of 8% electricity from RES by 2016 and demanding that half of this percentage was expected to come from wind energy. GENREN was executed by ENARSA (Energía Argentina SA), which launched a call for tenders to purchase 1000 MW of renewable energy, and it was planned to provide tenders with a fixed price through 15-year power purchase agreements (PPA). Then ENARSA would sell the purchased electricity to the Electricity Market. The scheme was very attractive for investors because it guaranteed a fixed price in a context in which electricity prices were strongly distort. From the Secretary of Energy it was estimated that the GENREN would mobilize investments amounting a total of US$ 2,500 million (Villalonga 2013).

ENARSA received offers for 1436.5 MW, exceeding the requested power. After the feasibility analysis of the projects, ENARSA approved a total of 895 MW with the following distribution per energy source: 754 MW of wind energy, 110 MW of thermal biofuels, 20 MW of solar PV, and 10.6 of small scale hydropower. ENARSA approved mainly wind energy installations because the costs of the wind projects were the lowest in comparison with the other RES. Yet, from all the approved projects only 138.4 MW have been constructed, including 131 MW of wind energy, 7 MW of photovoltaics and 1 MW of small scale hydropower, representing only around 10-15% of the allocated projects. Although the assigned PV and wind energy tariffs were very attractive (about 550 and 180 US$/MW respectively), the lack of access to international funding and very high interest rates (15% and 20% in US$) together with limited local funding lines created significant barriers to develop the projects. It has to be noted that the original tariff assigned by ENARSA to the allocated 20 MW solar PV park to be constructed in San Juan was about 550 US$/MW average. It has to be highlighted that in 2015 CAMMESA lowered the assigned tariff to 240 US$/MW.

In 2010, a second GENREN round, namely GENREN II, was launched. From this call no project was executed, however. The evident failure of the auction scheme resulted in the issue of the so-called "Resolution 108" by the Secretary of Energy in 2011. Resolution 108 is the legal framework that applies currently for the signing of power purchase agreements (PPA). Since 2011, project developers are legally allowed to sign RE PPAs with the body that represents the wholesale electricity market, called CAMMESA in Spanish abbreviation (see more details on the PPA resolution in section 0).

Moreover, on 24 September 2015 Argentina's Chamber of Deputies approved a new renewable energy law (Law 27191), which replaces, modifies and somewhat improves Law 26190. It extends the goal to cover 8% of the electricity demand from renewables in 2016, set in Law 26190, to 2017 and declares that renewable energy should cover 20% of the demand by 2025 (Law 27191/2015). Known as "Gingle's Law", in honour of the senator who introduced it, the legislation must go through the regulatory process before taking effect (Law 27191/2015). After the implementation of Law 27191, the latter together with the PPA legal Resolution will be the regulatory framework to support renewables.

One of the measures foreseen under the new law is the establishment of a national public fund to furthering renewable energy projects, called Fondo de Energía Renovables (FODER). This will be funded with at least 50% of the cash savings resulting from shifting subsidies from liquid fuels to renewables, which is estimated to be about US$ 41 billion by 2025, specific charges to the electricity demand and reception of interests from the given credits. The projects that include higher share of national components will have priority access to FODER credits (Energía Estratégica 2015).

The law establishes a sort of fine for large energy users, whose demand is equal to or greater than 300 kW of capacity, to consume RE. Accordingly, 8% of the energy consumed by these large energy users must be renewable by the 31 of December 2017 and must increase progressively until it reaches 20% the 31 of December 2025 (Law 27191/2015).

The law also introduces a maximum price for RE projects of US$ 113/MWh for each contract set by the generators and opens the possibility to modify the price two years after the law takes effect, but only for new contracts (Law 27191/2015). This tariff it was set to provide an orientation for project developers of the process they may receive under the RE contracts signed with CAMMESA, but it is not a FIT. As the law has not been implemented yet, it is not officially clear which will be the scheme to support RE project, i.e. auction or others. According to Argentinean RE experts it is very likely that auctions will be the support scheme adopted by the government. Experts also agree that the tariff is convenient for wind energy investments, but not for solar PV or biomass projects that have set contracts with CAMMESA for 240 and 180 US$/MWh, respectively. Therefore, from their perspective solar PV or biomass projects may continue relying on the PPA regulatory framework (Resolution 108) that allows higher values.

Among the promotional measures planned are an anticipated decrease of Value Added Tax (VAT)[10], exemption of the national income tax, exemption of the returns distribution tax (10%) as far as the returns are re-invested, exemption on import duties on capital goods and equipment until 2017, as well as provincial and municipal extra taxes. The law also allows for the granting of a tax certificate for projects with a large portion of national content (Law 27191/2015).

2.6 National Institutional Framework

The Secretary of Energy, which is under the Ministry of Federal Planning, Public Investment and Services (MINPLAN), elaborates the national energy policy, and sets the regulatory framework for its execution. The National Electricity Regulator (ENRE) is an autonomous entity within the Secretary of Energy that is responsible for regulating and supervising national electricity activity, which has no competence for the provinces. ENRE supervises compliance of generation, transmission and distribution entities with safety, quality, technical and environmental standards set in the regulatory framework and the license agreements.

[10] In Argentina the VAT is 21 %.

CAMMESA (*Compañía Administradora del Mercado Mayorista Eléctrico*) is the administrator and representative of the Wholesale Electricity Market (called MEM in Spanish abbreviation). Its main functions include the operation and dispatch of generated energy, price calculation in the spot market and negotiation with generators of the electricity tariffs related to the renewable energy PPAs. Electricity is connected to the interconnected national network (called SIN in Spanish abbreviation). Moreover, the Electricity Power Federal Council (CFEE) is the administrator of funds that are addressed to electricity operations (i.e. National Fund for Electric Power) and is also adviser of the National and Provincial Governments on electricity market issues and legal questions in the electricity sector.

2.7 Provincial Institutional Framework

As Argentina is a federal country, apart from the national level, also provinces have the legal capacity to regulate energy issues in their jurisdictions, implementing their own laws, regulations and support policies. Provincial energy laws and regulations cannot contradict the national regulatory framework. To regulate the electricity activity in their jurisdictions, provinces have their own Provincial Electricity Regulators (EPRE). EPREs are responsible to supervise that the electricity generation, transmission and distribution activity follows the safety, quality, technical and environmental standards established in their provincial regulatory frameworks.

In order to develop their own energy projects, several provinces have created either private incorporated electricity companies in which they own the largest capital asset share or fully state-owned electricity companies. Provincial utilities often conduct the operation and maintenance service of the electricity generation in their provinces, give support to private companies concerning the provincial management of a project, as well as they are able to execute their energy projects. Regarding particularly the renewable energy sector, provincial utilities can construct, operate and maintain a solar or wind installation, as well as commercialize the energy generated from their own renewable energy plants. They are also allowed to execute these renewable energy projects together with private companies through public-private partnerships, or just to give support to the provincial management when private companies develop a PV or wind project alone. To execute a solar PV installation, public-private partnerships may be advantageous for private companies as provincial utilities have often exemptions on all provincial taxes that imply the construction of an energy project in a provincial jurisdiction. In the present study, two cases--Energía Provincial Sociedad del Estado (EPSE) in San Juan and SAPEM Energía in San Luis--will be analysed for their role in the development of solar PV projects in the provinces of San Juan and San Luis respectively.

The distribution sector is privatized. There is often one distribution company per province, having the provincial monopoly of the electricity distribution. There are only three exceptions, where provinces have more than one distribution company: the provinces of Buenos Aires and Tierra del Fuego as well as the Autonomous City of Buenos Aires together with the Greater Buenos Aires. In San Juan and San Luis, Energía San Juan (ESJ) and EDESAL are the only provincial distribution companies, respectively.

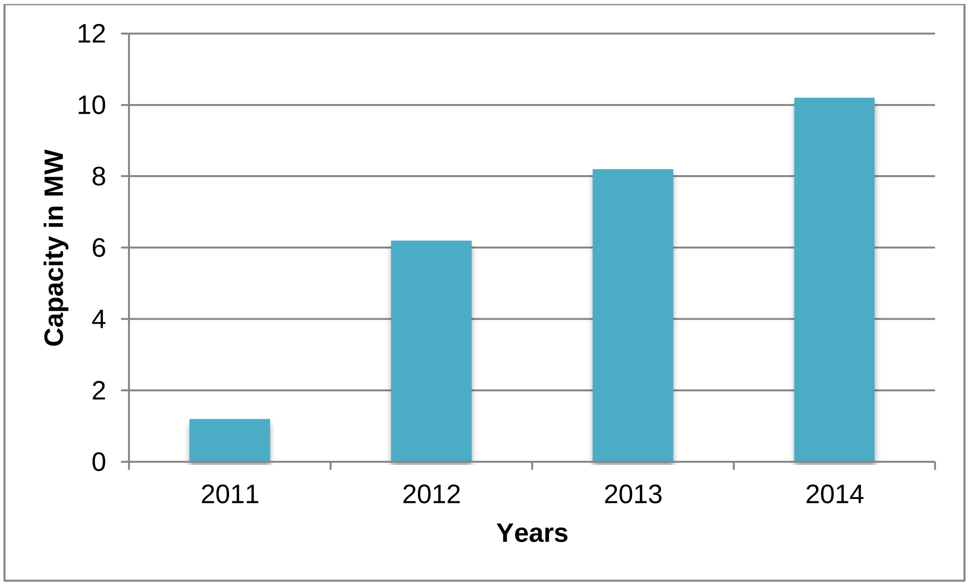
2.8 Solar PV Market and Solar PV Potential in Argentina

The first solar PV installations in Argentina were promoted by the so-called Renewable Energy in the Rural Market Project (PERMER). PERMER ran from March 1999 until December 2012, aiming to support off-grid photovoltaic installations in rural areas and being financed by the World Bank (WB), the Global Environmental Facility (GEF), and the Argentine's national government. Around 58.2 Million US$ were invested. From which about 70% came from the WB and GEF, 4% from the national government, 9% were invested by provincial funds, and the rest 17% by private investors (AHK 2013). The project was the first pillar for solar PV, as private and public companies could develop a project in any remote rural area and apply for the financial support. As San Juan is one of the provinces with the highest PV full load hours, it was one of the focus provinces in the program (AHK 2013).

On April 2011 the first Argentine's on-grid solar PV plant, Ullum, was installed in San Juan. It is a pilot photovoltaic park of 1.2 MW that was executed by EPSE in the framework of the Solar San Juan Program. The following year the solar park Cañada Honda, a project allocated by GENREN I, started to be installed. From the 20 MW allocated, 7 MW have been installed and connected to the central network as of October 2015. Additionally a 1 MW solar PV project, Terrazas del Portezuelo, was developed by SAPEM Energía in San Luis in 2014. This photovoltaic park is not connected to the national grid, but instead of, it provides electricity to provincial government facilities directly.

In the following figure it is possible to see the evolution of the solar PV market since 2010 until 2015 (Figure 2).

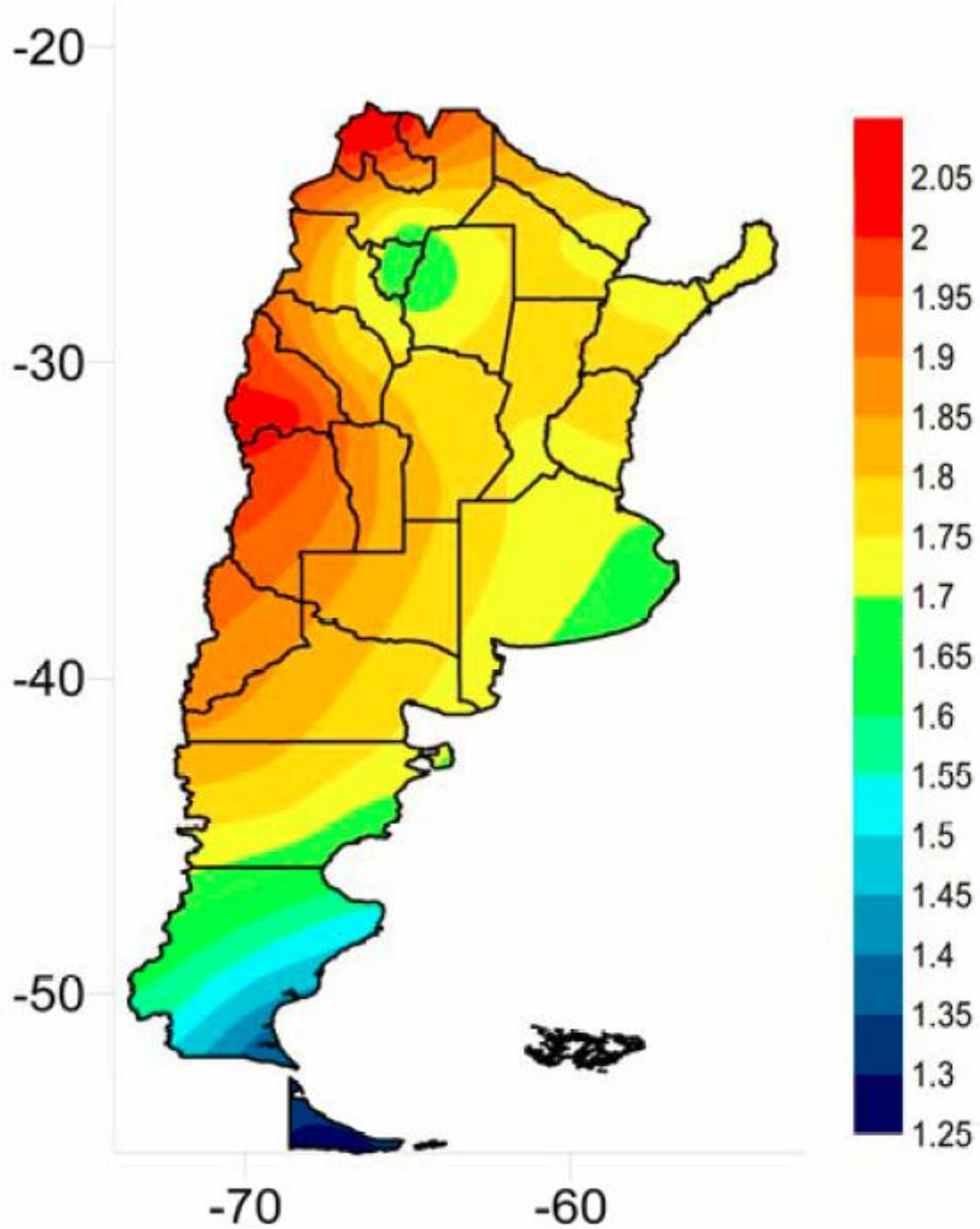
Figure 2: PV Cumulative Capacity (MW) in Argentina



Source: eclareon 2015

For the installation of solar power plants, Argentina has a significant number of very attractive sites due to the low cost of land, high solar irradiation and the existence of many available and good network connection points (CADER 2015). The areas that have the best solar irradiation in the country are the Northwest region (NOA), which encompasses La Rioja, Salta and Jujuy, as well as Cuyo, which encompasses the provinces of Mendoza, San Juan and San Luis. In NOA and Cuyo the solar irradiation ranges from about 1.8 MW/h/m^2 to 2.2 MW/h/m^2 per year (Righini and Gallegos 2011). The rest of the country has also appreciable values of annual irradiation almost throughout all the regions, except for specific zones such as the province of Tucuman, part of Buenos Aires and the Southern provinces of Tierra del Fuego, Santa Cruz and part of Chubut (Righini and Gallegos 2011). In the solar map below it is possible to see the annual solar radiation in MW/h/m^2 throughout the country (Figure 3).

Figure 3: Solar Radiation in Argentina



Source: Righini and Gallegos 2011

- **Off-grid Potential**

The rate of electrification in Argentina is relatively high, namely about over 95% of the consumers. There are still nearly two million people living in dispersed rural areas that lack of electricity access, which represents almost 5% of the national population

(CADER 2015). Off-grid solar PV has a potential to facilitate the energy access more efficiently and economically than the sources used currently by the rural habitants (i.e. kerosene, batteries, candles, etc.). The PERMER programme mentioned above was the first initiative to address rural electricity needs, but it was only focused on households and public service installations like hospitals and schools. When the programme was concluded, December 2012, a total of 27,422 households were supplied with individual systems (23,456 solar PV and 1,615 wind systems, as well as 2,351 through mini grids) and 1,894 schools and 361 public services were electrified. Additionally, it provided 307 solar energy systems for thermal use and 188 for water pumping to public service institutions, mostly schools (PERMER – Secretaría de Energía)[11].

At the end of 2015, a second phase of PERMER started to be implemented, including also micro-productive uses of off-grid PV technology[12]. The main objective of PERMER II is to supply electricity to the following sectors (National Transport and Inland Ministry):

- Households and public services (i.e. schools, health facilities, police stations and gendarmerie facilities) located in rural and remote areas that have no access to the electricity distribution centres;
- Small isolated communities through mini-grids;
- Solar equipment for pumping drinking water;
- Productive micro-enterprises;
- Provision of thermal energy (water heaters, solar cookers and ovens) for schools and other public services located in rural and remote areas

The provinces where the programme will be implemented are: Jujuy, Salta, Tucumán, Santiago del Estero, Chaco, Chubut, Catamarca, Misiones, Río Negro, Neuquén, San Juan together with Córdoba, La Pampa, Mendoza, San Luis, Santa Fe and Tierra del Fuego. According to Marcelo Alvarez from CADER, PERMER II constitutes a step forward in the right direction to include the dispersed rural population, yet it is still insufficient in terms of scale.

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[11] See more information in:
https://www.se.gob.ar/contenidos/archivos/permer/avance_del_proyecto.pdf

[12] See more information at the PERMER website: https://www.se.gob.ar/permer/ and at the National Transport and Inland Ministry site:
http://www.mininterior.gov.ar/municipios/progmasinfo.php?programa=198&idName=municipios&idNameSubMenu=municipiosMun&idNameSubMenuDer=municipiosMunGuia&idNameSubMenuDerNivel2=&idNameSubMenuDerPrincipal=

In October 2015, the division of the WB dubbed International Bank for Reconstruction and Development agreed to lend to the Argentinean government a loan amounting 200,000,000 US$ to support in financing the implementation of the PERMER II project. The loan will support the national government to carry out the project through the Secretary of Energy and the participating provinces. The front-end fee and the commitment charge to be paid by the government shall be about 0.25% of the loan amount and 0.25% per year on the unwithdrawn loan balance respectively (Loan Agreement 8484-AR 2015)

2.9 Key points for PV energy at national level

- Enormous potential to develop solar energy in Argentina: high solar radiation and high electricity demand that needs to be met
- Low ambition at the national level to deploy solar PV: Only the GENREN program launched a goal of 20 MW PV
- Some Provinces like Salta, San Luis and San Juan have set their own programs and laws to support PV investments that will be explained in chapter 5
- There is not one specific policy or support scheme for solar PV so far, but several
- PERMER II constitutes an opportunity to invest in off-grid solar PV
- At the national level there is a support for PV PPAs that will be explained in the next chapter (see chapter 4).

3. Solar PV Framework Assessment and Business Models in Argentina

3.1 PPAs for Renewable Energy – SE Resolution 108/2011

The present chapter will describe the required steps to formalize power purchase agreements (PPAs) between CAMMESA and the generators of renewable energy. At the end of the chapter the main challenges will be explained, barriers and recommendations identified to conclude the PPAs.

3.1.1 Description of Resolution 108/2011

On 29 of March 2011, the Secretary of Energy published Resolution 108, which has opened the possibility to conclude PPAs between CAMMESA and the generators/project developers of renewable energy. Since then PPAs are the foreseen schemes to support the deployment of RES. According to the resolution, offers should be presented by generators, co-generators or auto-generators that do not have generation facilities, or having finalized their interconnection to MEM, they have not set any type of agreement for power generation. To set a PPA, renewable energy generators from MEM must obtain the approval of their project by the Secretary of Energy. For that, generators are required to present to the Secretary of Energy a detailed project description, including following information:

- Siting of the renewable energy project
- Type of renewable source to be exploited
- Renewable energy units part of the project and their technical description
- Duration of the PPA with CAMMESA asked in the offer
- Duration period of project
- Price together with commercial conditions,
- Connection node and data of connection to Argentine System of Interconnection (SADI)
- All disaggregated costs (fix and variables), especially those corresponding to financing, together with documents supporting the presented disaggregation of costs.
- Calculation of the electricity production together with all relevant information regarding the resource to be exploited, including studies that certify the functioning of the technology units. These studies must come from a recognised institution in the field.

In the next step, CAMMESA will evaluate technical and economic-financial feasibility of the projects and will negotiate with generators the electricity tariff they will receive. In the final step, the Secretary of Energy will evaluate the offers and negotiated tariffs and will inform CAMMESA on the accepted projects. It has to be highlighted that under PPAs, CAMMESA guarantees the agreed tariff to generators up to 15 years with the possibility to extend it by up to 18 months, without changes.

3.1.2 PPA Development Procedure

The main steps to conclude a PV PPA can be summarized as follows:

Figure 4: Main Steps to Conclude a PV PPA

Assessment of the investment horizon and site selection	Assess the availability of investment capital and financing and define the investment horizon (according to minimum and maximum capacity of the project) and site where it is desired to build the project
Preparation of "Folder 108"	• Identification of grid connection points and available capacity of lines • Environmental Impact Assessment (EIA) • Land Contract (rent or buy) • Layout solar plant • Energy output projected • Cash flow study and definition of financial scheme
Project presentation and provisional authorization	Once the preparation of the project is finished according to information asked in Resolution 108, the project must be presented to the Secretary of Energy to obtain its provisional authorization and to the correspondent provincial authorities
Negotiation of the Tariff	After provisional authorization from the Secretary of Energy, the tariff should be negotiated and agreed with CAMMESA
Final Approval and PPA signature	Subsequently, the Secretary of Energy should be given the final approval to proceed with the signature of the PPA, called "Contrato de abastecimiento MEM a partir de fuentes renovables por cantidad de energía suministrada".
Registration of the PPA contract	The contract needs to be registered in the province where the plant will be built
Construction of PV Plant	

Connection to the Grid	The interconnection agreement is signed between the transmission or distribution company and the developer, ad referendum of CAMMESA, who is ultimately responsible to approve and validate the interconnection agreement.

Source: eclareon 2015

In detail the steps and procedures are explained as follows:

I Administrative Procedure to prepare a PPA Folder

After a few sites are selected and the investment horizon (according to minimum and maximum capacity of the project) is assessed[13], the project developer should start preparing a folder according to the information requested in Resolution 108.

I.a Preliminary studies

First of all the project developer should identify the available grid connection points and capacity of the line to receive the projected electricity output at the desired site. After the identification of the capacity line and interconnection points, the Environmental Impact Assessment (EIA) and the feasibility of land use should be carried out. Experts agree that the Environmental Impact Assessment is not a critical aspect because PV plants have rather a low environmental impact. The process varies according to the provinces, as the implementation of environmental policies is in the competence of the provincial control bodies. Normally, the process starts with the elaboration of an environmental impact folder, describing a matrix on the project's environmental risks. The environmental impact folder should also propose an environmental management plan indicating how risks will be controlled. It may also be required to conduct public hearings. If after assessing the folder and results of public hearings the provincial control authority considers that the project will not have negative impacts or will not violate any environmental regulation, the environmental impact declaration (DIA in Spanish abbreviation) is issued. The latter is required for the construction of all electricity generation projects.

I.b Land acquisition

After the suitable land is selected, project developers can proceed to buy or rent the land where the PV plant will be built. The prices of lands vary a lot according to their characteristics and region where they are located. For lands without urban or

[13] It is recommended that the availability of investment capital and required financing are evaluated from the beginning.

agriculture value but with available vial access it can be estimated about 2000 - 5000 USD/ha, as of Dec. 2015. In some provinces there are lands that belong to provincial governments (called "terrenos fiscales"); in this case, lands can be obtained for very low costs.[14] Moreover, it should be described the technical characteristics of the solar plant and the projected energy output production together with the cash flow analysis and tariff calculation.

I.c Public authorization

Once the preparation of the project is finalized, the project must be presented to the Secretary of Energy to obtain their provisional authorization. After provisional authorization from Secretary of Energy, the tariff should be negotiated and agreed with CAMMESA. Subsequently, the Secretary of Energy has to submit the final approval and then follows the PPA sign, named "Contrato de abastecimiento MEM a partir de fuentes renovables por cantidad de energía suministrada"[15]. The parties of the contract are CAMMESA and the Project Developer or, when it applies, a consortium (which is a special company built to generate and sell the energy composed by the investor, EPC and project developer). It has to be noted that the contract needs to be registered in the province where the plant will be built because it is subject to the provincial "stamp tax" (impuesto al sello). Subsequently, the PV plant will be constructed.

I.d Quality and certification issues

For the certification of the PV equipment there is no concrete regulation available yet. It is widely accepted that equipment complies with the European certification, i.e. IEC and IEEE. Moreover, the "Instituto Argentino de Normalización y Certificación" (IRAM) recently completed and updated their own set of standards (IRAM 21000), which is based on the European IEC. Probably in the near future, this certification will be required. Regarding imported PV equipment, the certification from the IRAM or the Instituto Nacional de Tecnología Industria (INTI) might be required. With regard to the staff, the technical specialists responsible to make the design and the engineering of the project must be registered in their respective fields (civil, electric, etc.) and in case of electricity related studies they must also be registered and recognised by CAMMESA.

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[14] Land property restrictions for PV use for investors should not be an issue since Argentian Law (Ley 26737) restricts foreign ownership as a measure to prevent "land grabbing" only if more than 15% of available land has been distributed to foreign ownership.

[15] For the PPA contract there is a standard template available in the Resolution 108. See http://infoleg.mecon.gov.ar/infolegInternet/anexos/180000-184999/181099/norma.htm

Professional registrations are often made in the provinces, thus it is required local specialists to execute or validate the plans and designs.

II Connection to the Grid

For the connection to the grid, the project developer should request his authorization as well as a grid feasibility connection to the Secretary of Energy and the electricity transmission or distribution company responsible for the area where the interconnection point will be located. The Secretary of Energy and the electricity transmission or distribution company should approve it[16]. It is often the electricity distribution and transmission company nearest to the project that suggests the interconnection point and complementary works to be done. A project developer may consider that he has to reach the connection point and that he must pay for the connection line from the plant to the grid. In case that the grid reinforcement is necessary due to the plant's connection, the project developer should negotiate with the transmission or distribution company and CAMMESA to share the reinforcement costs. It is often the case that the investment of the grid reinforcement is shared by the developer and the transmission or distribution company because it is considered a benefit for the area. A thorough evaluation should identify the additional costs in advance to prevent unknown risks.

It should be highlighted that there is no possibility to deny the access to transmission grid to a new PPA. Moreover, there are no transmission surcharges, taxes or costs to be paid by the generator because consumers are obliged to pay transmission costs. Subsequently, the off-taker will buy all the electricity produced by the PPA in the selected interconnection point.

After the approval of the connection point, the interconnection agreement is signed between the transmission or distribution company and the developer, ad referendum of CAMMESA, which is ultimately responsible to approve and validate the interconnection agreement. CAMMESA can also ask for changes or additional works to those established by the developer and the transmission or distribution company in the first place[17].

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[16] See more details on the technical procedures of CAMMESA here: http://portalweb.cammesa.com/Pages/BackupBotoneraAneriorIzquierda/Normativa/procedimientos.aspx

[17] Idem previous.

3.2 Funding of Solar PV Projects

Projects can be financed through national and international credits. The national state Bank for Investments and Foreign Trade (BICE) provides a credit line for renewable energy investments, named Financial Line for Renewable Energy Investments. BICE is financed through several financing entities such as the China Development Bank and the Caja Andina de Fomento (CAF). BICE has already financed six renewable energy projects, 3 wind parks and the 3 solar PV parks that have been constructed in Argentina so far: Cañada Honda I (2 MW) and II (3 MW) and Chimbera I (2 MW) (Energy Consulting Services).

The aim of the Financial Line for Renewable Energy Investments is to address the growing electricity demand of the productive sector. Under the funding programme all individuals or legal entities headquartered in Argentina are eligible (BICE)[18]. Granted credits finance up to 80% of the project cost with a maximum amount of 10 million US$ per project, excluding the VAT of the project cost, and a maximum amount of 20 million US$ or its equivalent in pesos per economic group. The maximum loan term is 120 months or 10 years, with a grace period that ranges from at least 6 up to 24 months (for capital investment). Interest rates vary depending on if loans are made in ARS or US$. In the first case, it is used as a reference the BADLAR (public and private banks average) rate, while in the second one the LIBOR rate is used. Interest rates in US$ of the credits conceded in 2011 and 2012 have been of about LIBOR + 7%. Finally, both the loan currency (ARS, US$, or other) as well as the guarantee remains at the discretion of BICE. In addition to the aforementioned credit line, BICE may also participate as an investor in trust funds aimed to finance renewable technologies (BICE)[19].

CAF confers credit lines for infrastructure projects, which is also opened for RE investments. It has to be highlighted that CAF has not financed any RE project in Argentina, yet.

3.3 Barriers and Recommendations

Barrier 1: Financing of Solar PV Projects

[18] More information on the financial line for renewable energy projects under: http://www.bice.com.ar/es/2015/06/08/energias-renovables/

[19] Idem previous.

Renewable energies such as solar or wind have hardly any running costs but need high up-front investments. Thus the availability of financing and financing conditions play a crucial role for those kinds of investments.

a. Guarantees

PV project developers have many problems to obtain funding for their projects as they based their profitability on the tariff guaranteed for 15 years by CAMMESA, whose economic resources are not sufficient and must rely in the national state subsidies. This hardship applies especially when it comes to obtaining international financing. It has to be noted that CAMMESA is a private company, though the state owns the 51% of its assets. The company is highly indebted but receives state subsidies in order to comply with the payments of the tariffs due to electricity generators. The financially weak position of CAMMESA constitutes a serious risk to investments and might prevent investors that are more risk adverse from investments in PV projects.

Recommendation:

Investors may want to apply for extra guarantees, as financial entities may often ask for extra guarantees, other than CAMMESA. It must be highlighted that the CAF gives partial credit guarantees to support some renewable energy investment projects.

b. National Financing

Due to the difficult financial status of CAMMESA, there are many hardships to access to international funds. Therefore, Argentina has opened a credit line to finance renewable energy investments through the national state Bank for Investments and Foreign Trade (BICE) with a favourable interest rate of 7.6%. The aim is to address the growing electricity demand of the productive sector and it is supposed to finance all individuals or legal entities headquartered in Argentina. However, in practice it is quite difficult to access to the BICE's renewable energy credit line. There is a lack of clear criteria and steps to be eligible and therefore the eligibility may be subject of corruption. So far BICE only financed very few RE projects, including 5 MW of PV (Cañada Honda Park in San Juan).

Recommendation

More national credit lines for renewable energy investments should be provided, as there are many hardships to obtain international funding. Moreover national credit lines can be obtained at a lower interest rate than the interest rates of the international funding. It is thus recommended to always start trying to analyse the chances to obtain a national funding like BICE for example by establishing partnerships with public companies like provincial electricity utilities or with local companies that have already experience in the sector. Nevertheless, the authorities should streamline and make funding regulations for BICE credits transparent and other subsidized credits to avoid additional information cost for investors as well as to prevent corruption. The other option is to obtain funding by a trust fund.

Barrier 2: PV Solar Price

a. Lack of PPA Fix Tariffs

As it was said in section 2.2.1, the PPA price is set by CAMMESA, resulting from a negotiation process between CAMMESA and PV project developer at a very late stage of the process. There is not a fix tariff nor a minimum or a maximum price in Resolution 108. The tariff negotiation discourages international investors that must rely on a fixed tariff set in advance per law to avoid risks on stranded planning investments. It should be at least established minimum and maximum reference prices to reduce uncertainty of investors as well as to avoid long unfruitful negotiation processes and unnecessary burdens. Though, CAMMESA under the directive of the Secretary of Energy has an implicit maximum price, which is based on the previous PV PPA. According to the experience of project developers to get a PPA the contract should be equal or cheaper than the previous one. Currently the PPA price for photovoltaics is 240 US$ /MWh for 15 years as of December 2015. In comparison to international PV PPAs or FITs, this is a very high remuneration, though only guaranteed for a short period of time.

Recommendation

Ideally the policy framework should provide orientation with a corridor of minimum and maximum PPA tariffs to reduce uncertainty and attract the investor's interest. The maximum price reduces the risk for CAMMESA, while the minimum price give an indication of the expected tendency of prices as well as to create investor confidence. This is especially important since the very limited number of projects result in a lack of reference prices for PV projects in Argentina. It would also be relevant to evaluate former bidding processes, prices and reasons for non-completion of solar and probably also wind power projects.

Since in developed solar markets, non-component related products make up for more than 50% of the costs, it is recommended that CAMMESA sets a maximum price limit that is reasonable to reduce its own risks, being still attractive to investors. The benefit of a lower PPA tariff is that it may prevent offers to run a high risk of non-realization as well as it may give a signal to project developers on the price tendency. For the first projects, the idea is to create confidence among investors in the market, compliance with laws and procedures. After a limited number of successfully realized projects, the lower limit might not be necessary any more. CAMMESA should continuously monitor and evaluate prices and mechanism on a predefined number of projects or installations (e.g. 10 or 50 MW) to streamline processes involved in the PPA development.

b. High PPA Price for Solar PV

It has to be highlighted that the PPA price for solar PV projects dropped from US$ 560 per MWh in 2010 to US$ 240 per MWh in 2015, but it is still quite high comparing this PPA price with other countries in Latin America and taking into account the high solar radiation of some areas in the country like NOA and Cuyo. Insecure and unclear administrative conditions as well as possibly non-transparent negotiations of the PPA price due to the lack of a reference price further increase time and costs for the project development. The absence of transparent specific selection criteria for PPA-projects contributes to make the problem worse. The high upfront costs make RE projects especially vulnerable to high interest rates which are about 15% per year for international loans in US$. The current high interest rates and limited funding conditions explain mainly the high PV PPA tariff. Unsustainable high remunerations for PPA and FITs, however, have seen retroactive changes or further negotiations in the past, increasing realization costs -- thus reducing overall attractiveness of a market or worse, leading to the reduction of trust in a country.

<u>Recommendation</u>

The price of electricity from solar energy could be significantly reduced by reducing the cost of capital (WACC). Since WACC is one of the main factors for the overall costs of a project its reduction has to be one of the key goals for a sustainable cost reduction. The costs of capital are dependent on the risks that a PV project faces. The higher the risks are the higher is the so called risk-premium that investors and banks will require to face when investing in a project or lending money. Thus a rigorous and consequent reduction of risks (or de-risking) can lead to greater trust and thereby to reduced premium risks and costs of capital. Banks must be able to trust that the investments will generate the expected and agreed return. If that is the case they are willing to accept lower interest rates. In general, the reduction of costs of capital can be obtained through the following steps:

a. De-risking through improving the regulatory framework

The key factor for a de-risking policy on PV projects is the provision of a stable political framework that includes a PV support scheme as well as a market regulation, grid connection, clear administrative processes and access to financing. Once agreed, the policy design for existing projects must be kept. The so-called retroactive changes are particularly harmful as they destroy the foundation of existing calculations. Changes to the policy design of future PV projects should be planned, announced and implemented in a very cautious way. A transparent description of all major laws and implementation guidelines as well as codes and procedures should be available online by CAMMESA and other relevant provincial actors to facilitate preparation of materials. Moreover, administrative procedures, deadlines, required documents and other relevant information should be described in a transparent way and on an easy accessible online platform. Another important aspect is to train all actors that are involved in the development of PV projects. It is important that the responsible decision makers and the clerks in charge who implement the projects have a good understanding of the particularities of PV projects and how such projects differ from other energy projects. Therefore, all actors in administration, PV industry, banks and grid operators should be trained accordingly.

b. Cost reduction of capital

Direct reduction of costs of capital through subsidised loans or reduced bank interest rates and long term repayment conditions are a suitable option. With lower and competitive interest rates as well as repayment periods comparable to those in Brazil, Chile and Uruguay, Argentine's solar PV electricity price would be lower and more competitive than other energy sources that are part of the current electricity mix, especially imported fuel and gas (CADER 2015). In the face of current staggeringly high interest rates it should be seriously considered lowering or subsidizing these interest rates. Lower and more competitive interest rates reduce the WACC of solar PV and, thus, the PPA price for solar PV projects. However, this strategy also comes with certain risks. First of all, an artificial low interest rate can only be obtained through more subsidies, and this will cause additional costs for the public budget. Moreover, high interest rates are also a reflection of how financial institutions assess a market at the moment. Thus, the reduction of interest rates through state intervention can lead to an artificial situation in which interest rates are lower than they are supposed to be. Such a situation can lead to an unsustainable market boom when project developers and financial institutions take investment decisions that are based on too positive assumptions on the market conditions. Financial markets are, however, not always fully rational. It might be necessary to provide a certain development in the Argentinean PV market to incite the interest of investors and lenders to re-assess the risks and opportunities of a stronger engagement in that market. In that sense it could be necessary to introduce lower interest rates as a trigger to start a PV market development. Still such a step must be combined with more sustainable steps of reducing existing risks like improving the regulatory framework.

Barrier 3: Lack of clear Guidelines

There are no clear decision-making guidelines for the PPAs' authorization process, which apart from distracting investors due to insecurity and higher information costs, always opens up the possibility for corruption of entities involved in the processes. The approval of the projects depends on the discretion of the Secretary of Energy. The following guidelines are missing:

a. Regulatory Framework

The regulatory framework does not establish in which areas of the country renewable energy projects and solar PV power plants in particular should be installed.

b. Certification

Certification requirements are not clear. When importing PV equipment, it is subject to criteria of the custom's staff to decide whether certification for the PV equipment is required. In the affirmative case, it is the IRAM or the INTI who can give this certification (IRAM 21000, based on the European IEC).

c. Acceptance

There is a lack of a pre-established deadline for the PPA acceptance or a certain guarantee that the Secretary of Energy will approve a project and then grant a PPA. Based on the experience, the Secretary of Energy informs on the accepted projects between 6 months and 1 year but as any pre-established deadline has been foreseen, this period of time may vary. Moreover, projects may also remain indefinitely waiting for a PPA contract and never receive an answer from the Secretary of Energy.

Recommendation

An improved regulatory framework should establish clearly in which zones of the country it is more recommendable to build a solar PV plant or a wind park based on the most suitable natural conditions shown in a solar radiation's and a wind's map. For solar PV developers it is suggested to look for the radiation maps developed by some provinces of Cuyo and NOA. For San Luis and San Juan see the following links, respectively:

http://www.omegamapserver.com/visorv2/viewer/

http://epse.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=aef41afba996406196 9f4e98eb0f28c3

http://epse.maps.arcgis.com/apps/OnePane/basicviewer/index.html?appid=aef41afba996406196 9f4e98eb0f28c3

It would be also required to state clearly the criteria under which imported PV equipment will require a certification delivered by IRAM or INTI. Finally, deadlines for PPA acceptance or rejection should be set in advance to avoid long lasting and undesired waiting times that cause financial loss and project inefficiencies.

3.4 Key points for the business model PPA at national level

- At national level Resolución 108 is the basis to sign PPAs with CAMESA for 15 years
- Funding is the critical issue since subsidised credits at BICE are difficult to access and international capital is limited and only accessible at high prices
- Specific technical guidelines still have to be developed

4. Solar PV Framework Assessment and Business Models at Provincial Level

4.1 Solar PV Potential in the Provinces

As it was highlighted in section 1.6, in NOA and Cuyo the solar radiation ranges from about 1.8 MWh/m^2 to 2.2 MWh/m^2 per year (Righini and Gallegos 2011). The average performance ratio in NOA and Cuyo is of about 80% - 90% as it can achieve 2000

MW/h for each installed MW. These rates are very high in comparison to for example Germany, where the solar radiation ranges from about 950 to 1150 kWh / m^{2}per year.

4.2 Provincial Support Policies: The cases of San Juan and San Luis

In the present project two provinces from the region of Cuyo, San Juan and San Luis, will be presented. Both provinces are promoting solar PV through their utilities Energía Provincial Sociedad del Estado (EPSE) and SAPEM Energía and have assigned large provincial fiscal lands with the purpose to build large-scale solar PV parks.

4.2.1 San Luis

Since 2014 SAPEM Energía manages and operates the first solar park, namely Terrazas del Portezuelo, in the province of San Luis. Terrazas del Portezuelo is a 1 MW on-grid photovoltaic park aimed to supply electricity to the government facilities. The province's solar park was implemented with the province's economic resources without national or international financial support. Only for its installation the government received technical assistance from the Spanish National Renewable Energy Centre (CENER).

Tax and financial incentives

In 2014, San Luis issued a provincial renewable energy Law No. IX-0921, which introduces fiscal incentives for project developers in order to promote large and small scale RE generation projects in the province. In particular the law introduces exemptions to the provincial Gross Income Tax and the provincial Stamp Tax, which is a tax paid to obtain the required public authorization of the local tax office. The San Luis's general Gross Income Tax applied to the electricity generation activity is 2.8% (or 2.3% if a discount applies) of the gross income (Annual Tax Law for the Tax Year 2014)[20]. Regarding the provincial Stamp Tax, on the other hand, the Provincial Direction for Public Incomes is responsible for regulating its deadlines, procedures and methodology. Still, it has to be highlighted that the RE regulation has to specify the amounts of the Gross Income and the Stamp Taxes for the generation of energy from renewable sources and should say clearly how much investors can benefit from these exemptions.

[20] http://www.rentas.sanluis.gov.ar/resoluciones/2014/Leyes/LEY%20IMPOSITIVA%20EJERCICIO%20FISCAL%202014.pdf

Tax exemptions apply for a period of 15 years, according to the following scale:

1. 100% for the first 5 years from certification of implementation,
2. 50% for the next five 5 years, and
3. 25% for the last 5 years.

Moreover, the law gives possibility for the distributed renewable energy generation. It states that consumers can generate the energy for their consumption. Also, if they produce electricity excess they can also sell it to the MEM, being allowed to apply for the fiscal benefits referred above. Finally, it creates a Renewable Energy Promotion Fund, aimed to support the construction of renewable energy infrastructure by the Provincial Executive and to co-finance research, studies, and development of renewable energy (Law No. IX-0921). The law, however, has not been regulated yet and, thus, it has not gone into effect. Its regulation started to be discussed at the beginning of 2015 and it is expected to be finalized by 2016. The reason is that additional regulations are required to implement the decentralized renewable energy generation and the Renewable Energy Promotion Fund. To issue an additional regulation on the distributed generation, the provincial government has to reach an agreement with the distribution company, EDESAL, on how it will be implemented. EDESAL is a private company that has the monopoly of the electricity distribution in the province. Therefore, the government has to negotiate the conditions of the RE distributed generation with the provincial distribution company. It is very likely that the regulation of the RE distributed generation in San Luis will be similar to the implementation of the Net Metering in Salta (Law No 7824) (see section 4.3). On the other hand, to implement a Renewable Energy Promotion Fund, the government has to take a decision on how the fund will be financed and then issue a specific regulation. This decision has not yet been taken as of December 2015.

Land acquisition and ownership

The government of San Luis has also established an area of about 89,500 hectares per law with the purpose to attract private investments willing to install large scale photovoltaic parks. The plan is to reach the 3000 MWs in a period of thirty years starting in 2015 (Law N° V-0864/2013). According to Law V-0864/2013, the land of the potential solar PV parks, namely Solar Platform Las Quijadas, is property of the provincial government and the plan is that SAPEM Energía will start installing the first PV plant of 1 MW. Subsequently, the provincial government would construct the required infrastructure that enables the installation of larger solar parks, while SAPEM

Energía would look for potential private investors that are willing to participate developing these larger photovoltaic parks. For the installation of some large scale PV plants, SAPEM Energía envisages the creation of public-private partnerships and for the development of other projects the participation of private companies alone. In the latter case the provincial utility would support the firms with the provincial management of the projects. The new provincial government established on 10 December 2015, has explicitly said that it will support the development of PV installations at the Solar Platform Las Quijadas.

4.2.2 San Juan

In San Juan, EPSE has developed the "Programme San Juan Solar", which involves an industrial policy approach aiming to manage the whole value chain of silicon and develop a photovoltaic technological pole in the province. The Ullum pilot solar park was the first implemented project under the programme and the first on grid solar PV plant in Argentina and South America.

San Juan Solar Programme

"The San Juan Solar Programme" has two clear phases. The first one started on 3 October 2013 and is currently under implementation as of December 2015. This phase includes the following steps:

a) Production of ingots and silicon wafers,
b) Manufacture of Photovoltaic Cells and
c) Production of Photovoltaic Modules

Under phase 1, a turnkey 71 MW photovoltaic production facility should be constructed that will belong to as well as it will be operated by EPSE. On December 2014, the Argentinean branch of the German company Schmid Group was created and from the beginning of 2015 Schmid Group started to send the first technical systems for the production of monocrystalline ingots, wafers, monocrystalline cells and photovoltaic modules. Moreover, by the second half of 2015 the company began to provide spare parts and service support to EPSE's production facility. The factory foresees a production capacity of up to 235,000 photovoltaic modules per year with a capacity of 304 watts peak each and 72 cells per panel. The production of the first photovoltaic modules is planned to start by the end of 2016.

The second phase is planned to start by 2017 after completion of the first phase. During the second phase, quartz rocks will be used for the following purposes:

a) Production of Metallurgical Grade Silicon and
b) Production of Solar Grade Silicon or Polysilicon.

The goal of EPSE under the two phases of Programme San Juan Solar is "to manage the whole value chain of silicon, based on the quartz obtained from San Juan's quarries to the production of solar PV panels aimed to produce energy in ground-mounted photovoltaic parks, homes' rooftops, businesses and industries, water pumping, and mining applications. The provincial government expects, thus, establishing the framework conditions to enable a comprehensive development of photovoltaic technology and creating a technological pole for Research, Development, and Innovation (R + D + I) in order to keep the industry competitive" (San Juan Ministry of Environment and Ministry of Finance and Public Works 2012, p. 11). According to EPSE, the province will be able to produce high German quality solar PV modules at a reasonable price, as well as they will avoid import taxes. At present, the import tax amounts to 18% of the Free On Board (FOB) value. The ultimate reason for the local production of solar PV panels is to generate and commercialize electricity and at the same time to support R + D + I in the province, using local technology.

EPSE expects to generate solar power from ground-mounted photovoltaic parks and also at smaller scale through distributed generation to supply San Juan's energy needs, as well as to set PPAs with CAMMESA and sell electricity to the MEM. To achieve this purpose, EPSE foresees not only developing PV projects alone but, above all, developing solar projects together with private international companies through public-private partnerships. Developing public-private partnerships with EPSE may constitute a good opportunity for private international companies in the future because the public company is a MEM's agent and its corporate by-law allows EPSE to associate with private companies in different percentages. EPSE provides expertise in development, operation and maintenance of photovoltaic solar plants as well as extensive experience as operator of power generation. In addition, EPSE can provide strategic locations and the necessary electricity infrastructure to install photovoltaic solar plants. It is important to know that apart from the huge solar radiation potential of San Juan, the 17% of the lands belong to the province or are easy to be expropriated by the government with the purpose to produce energy from renewable sources.

Following the completion of the construction of the EPSE's photovoltaic modules factory, San Juan plans to implement the correspondent regulatory framework to promote private investments in the PV sector in the segments of self-consumption, ground mounted plants and photovoltaic irrigation systems for agriculture uses. The industrial policy pursued in the province is the main reason why the provincial government has not yet implemented the PV regulations. Locally manufactured modules content should be the preferred choice.

4.3 Net Metering in the Provinces

As of December 2015, net metering regulations are currently in force in only three provinces in Argentina: Mendoza, Salta and Santa Fe. The case of Salta constitutes an interesting example to be explained here, as it offers good business opportunities for system integrators. Moreover, Salta has started to receive the first individual requests applying for a net metering system.

Profitability of the Net-Metering in Salta

The net metering law (No 7824) in Salta, which was issued the 26th of June 2014 and was regulated in November of the same year, constitutes an adaptation of the classical net metering. It promotes rather the distributed generation as the connection is made directly to the low voltage network and there are no bidirectional meters. Under the Salta's net metering mechanism, customers have two different meters, the one that counts their consumption of electricity and a new one that counts the produced electricity from renewable sources. Self-consumption is not allowed because of the infrastructure cost. In fact, to allow self-consumption it would be required to count not only the costs of PV equipment installation but also the costs of the adaptation of the interior electricity infrastructure. The majority of the residential buildings are not prepared for electricity self-consumption system at this moment. The following two users' categories are foreseen under the net metering system in Salta:

- Residential users can install a capacity of up to 30 kW
- Industrial users can install a capacity of up to 100 kW.

The law defines that the installed capacity can be up to 1 MW throughout the province. At present, the network connection of the installation should be exclusively three-phase. Single-phase connections are not allowed at this stage of the net-metering's implementation.

To promote the implementation of the net metering, the law set three financial incentives for the customer:
1) Feed-in Tariff: The first two years all the produced electricity is bought at a specific fixed tariff of ARS 2,086/MW/h (149/MWh in US$).

2) Net–Billing: From the 3rd year starts to apply the net-metering or net-billing mechanism with excess feed-in. The consumer pays the tariff that corresponds to its user category established by the distribution company. For example, for residential users the subsidized tariff is about ARS 250 (17.85 in US$) per MWh and for the industry sector the tariff is about ARS 500 (35.70 in US$) average per MWh in peak hours (as of December 2015) for all the consumed electricity. For the electricity that is fed into the grid, the consumer receives the differentiated tariff of ARS $ 2,086/MWh (149/MWh in US$), thus creating a strong incentive for excess electricity production, which can ultimately be considered as a FiT. The net metering incentive applies for a period of 5 years and it is extendible for periods of 5 years.

3) Provincial Tax Credit: The provincial tax credit is set in Argentinean currency and finances up to 70% of the renewable energy equipment. The investor starts to receive the tax credit after the PV equipment is installed and running. The credit line is paid in bonds that can be exchanged for shares or services, has no interest rate and a grace period of 5 years. From the 6th year the bonds' loan must be paid back in five annual payments. Some of the payments can be replaced by goods. For example it was given that hoteliers might be eligible to replace payments by offering some free room nights to the provincial government. Regarding the provincial tax credit incentive, the province has already implemented a similar fiscal credit mechanism to promote the tourism and the industrial sectors.

It has to be highlighted that although the net metering law in Salta benefits both industry and households, the industrial sector is currently in better conditions to adopt the net metering support. In comparison with the residential sector, industries and commerce can better handle the investment required by the net metering system and execute the authorized three-phase network connection for its facilities.

4.4 Excursus: Financial consideration of the Salta Net-Metering Model

According to the cash flow model calculated by the government of Salta in a PV installation of the following characteristics:

- Plant with capacity of 100 kW;
- Net-metering period of 10 years;
- 475,000 US$ of total investment (65% equipment and 35% of labour costs);
- 70% of the total investment covered by the loan;
- Differentiated fixed tariff of ARS $ 2,086/MW/h (149/MWh in US$);
- Maintenance: 2 monthly employees for $ 3000 salary each plus social service charges.

These are the financial results:

- Internal Rate of Return (IRR) 12.14 %;
- Net Present Value (NPV) $ 26,804[21];
- Positive Accumulated Cash Flow from the 6th year;
- Payback period from the 10th year.

4.5 Provincial Barriers and Recommendations

Barrier 1: Electricity subsidies for the implementation of Net Metering

Subsidized and low electricity tariffs have discouraged the implementation of net metering mechanisms. Yet subsidies are very likely to decrease from 2016 and thus tariffs will most probably increase in the short term.

<u>Recommendation</u>

It is recommended to progressively and transparently reduce electricity subsidies, assigning targeted social aids for those most in need. Currently all the population benefits from electricity subsidies, including those citizens who are able to afford higher electricity prices. This constitutes a huge loss for the state and there are no incentives for energy or electricity savings and for investment in new energy technologies. If discriminatory policies are introduced, certain consumer segments or

[21] **Net Present Value (NPV):** Sum of the present values (PVs) of incoming and outgoing cash flows over a period of time.

consumption profiles could be identified to make transparent distinctions.[22] In addition, the government should calculate and communicate how much of the budget it has to be spent on electricity subsidies. These costs should be put into perspective by showing how many PV plants could be installed if the budget for electricity subsidies would be spent for support schemes of renewable energy projects. Furthermore, the government should clarify a fundamental difference between universal electricity subsidies and public support schemes that help deploy renewable energy capacities: Electricity subsidies mainly support the annual import of primary energy sources such as oil, coal and gas which are immediately consumed. Yet, these subsidies do not reduce the demand for future energy imports. State support for renewable energy projects, on the other hand, allows for the deployment of sustainable production capacities that will generate energy from national sources. In the long-run, such investments will reduce the demand for energy imports and thereby reduce future costs. In addition, renewable energy investments conduct to the creation of sustainable jobs and a boost for the national economy.

Barrier 2: High costs of PV equipment

Prices for PV systems considered in the study are by far higher than at the international level. Apart from the high tariffs this derives from little competition, costly qualified labour, which might not be available at the sites as well as complex and costly procedures for imports. In addition the price of the PV equipment is even higher in the provinces due to high domestic logistic costs.

Inland provinces

The inland provinces having the best solar radiation conditions are the provinces of the NOA and Cuyo regions. The location of these provinces, far from the Buenos Aires port, considerably increases the costs of the imported PV equipment due to high domestic logistic costs that have to be added to the final price of the equipment. The main reason of the high logistic costs is the high cost of transport fuels.

Recommendation

As long as no market exists, prices for PV systems will remain relatively high due to little demand, expensive labour and high logistical costs.

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[22] The Mexican energy tariffs may be insightful. See: https://energypedia.info/wiki/Mexico_Energy_Situation. Alternatively differentiation via local stratification as in Colombia could be also applied.

Apart from considering to at least temporarily lower tariffs for imported products, which cannot be provided in the country as long as only a small market exists (e.g. modules, inverters) additional steps should be taken. Companies with experience in streamlining project development, logistic and training should be encouraged to enter the market under strong RE commitment of the government and true market perspectives.

Additional transport cost at the inland provinces have to make up their disadvantage by higher energy yields in the electricity production due to more favourable locations, which only become attractive if remuneration for energy sales or savings are appropriate.

Barrier 3: Agreement with the provincial Regulatory Entity and the Distribution Electricity Company for the Net Metering implementation

At the beginning of the implementation of the Net Metering, the provincial regulatory body might state some problems concerning the modes of transmission and distribution of electricity through the distributed generation of electricity. For the implementation of the Net Metering, an agreement with the provincial regulatory body should be reached.

Recommendation

The ministries involved in the design and planning of a Net Metering regime should strengthen the information exchange with the regulatory body at the provincial level since the very beginning of the planning process. Experience of the implementation of net metering should be exchanged among different provinces as soon as first experience has been gathered to find best suitable solutions for the different provinces.

Barrier 4: Local content as potential threat to investments

Setting up an infrastructure of fully integrated production facility should involve great and continuous demand at regional, national or international level. Although it is possible to set up efficiently running state of the art factories, it depends very much on the utilization rate. Small factories can rarely create economies of scale and accomplish surrounding infrastructure in terms of suppliers, research and providers. In addition, importing the PV equipment may exert pressure on local producers to become more efficient, productive and competitive, though dumping has to be prevented. Therefore, disadvantages of a local small production facility must outweigh additional costs of transport tariffs and import taxes. Quality produced locally has to be high to become bankable for investors. Last but not least, at least temporarily exemptions of import tariffs for all those products, which cannot be locally produced, should be applied. Trade rules of the World Trade Organization (WTO) also apply to its member country Argentina

Recommendation

The production capacity has to be modular to be up-scaled to satisfy growing demand. The challenge is to find a compromise between automatization and manual aspects to react flexibly to variations in demand but producing competitively. High grades of automatization facilitate to produce at a continuous quality level, while high manual activities facilitate downscaling easily.

Still, first a market has to be developed to create demand. It could also be of interest to producers in the country to at least temporarily lower import barriers to stimulate markets and have the influx of products and knowledge to then provide products for this new market. In addition it forces producers to work efficiently.

Acknowledgments and Recommendations for San Luis Province

The San Luis Province provides a comprehensive approach to facilitate investments in solar energy. A long term goal with legislative and executive commitment is on its way and includes important flanking measures involving tax incentives and financing. Tax incentives have proven to be an important lever to push forward investments in solar energy in other countries. Their digressive structure may prove to be a good way to enable investors to pay bank credits, though taxable earnings may be limited due to financial liabilities and high interest payments in the first years of the solar projects. Furthermore, it has to be specified the amounts of Gross Income Tax and Stamp Tax and provided clearly how much investors can benefit from these exemptions. It is vital that technical standards and grid use are regulated and specified with the responsible bodies.

Once the legislative process will be finalized, the given regulatory framework might provide a strong incentive to invest in solar energy, if the referred tax incentives are clearly defined and, above all, if a provincial fund to finance PV investments is appropriately implemented.

Acknowledgments and Recommendations for San Juan Province

The industrial policy in the San Juan Province has advantages but also bears some risks for the provincial government and the market itself. While having a thoroughly planned programme for the industry development and the use of locally available resources, EPSE and partners plan to be the sole buyers, investors and providers of solar energy at the moment. Although the San Juan's factory is not large compared with international standards, 71 MWp output represents a lot for the Argentinian market at present. Qualified planners, engineers and installations staff as well as machinery will have to be available as soon as the production output is ready. Thus, it seems to be vital and urgent to develop the first small and medium scale solar projects to have human capacities ready.

A new factory will have to compete with low international costs that also might involve dumping practices in some cases, which can be especially difficult if the factory is not fully used and, in the first phase, when then process is not entirely integrated. The establishment of the logistical structure has to be lean, efficient and state-of-the-art. It should also consider that logistics will change after a short time with further process integration. Its success depends only partly on local factors such as local demand, quality of output, competitive advantages of local production like low cost energy and resources, the learning curve of the actors involved, economies of scale and skilled and motivated staff as well as lean administrative procedures. Beyond the scope of the local process, there are factors like national tariffs, changes in import and custom taxes, international developments in relation to prices and costs and aggressive market entry policies of other actors. Investing in production capacities at present may be good since any producer gets very favourable conditions and state-of-the-art know how with any PV equipment manufacturer at competitive prices due to the plight of equipment manufacturers and the small size of the PV market. Yet, it cannot be denied that a certain level of financial risk is taken by the province and EPSE, being vital to produce high quality PV modules at an international competitive price. In addition, all those components not manufactured in Argentina yet, such as inverters and balance of system parts still will have to be purchased at the international market at reasonable prices to make entire projects competitive.

Acknowledgments and recommendations for Salta Province

Under the market conditions of December 2015, setting up a net-metering scheme without benefits does not work. At subsidized energy rates it is simply not attractive for the end consumer to off-set energy consumption, thus a combinations of mixture and state subsidies has to be used. The Salta approach provides an interesting and comprehensive example, but also has some shortcomings. The approach involves different instruments such as a FIT for the first 2 years, excess FITs after 2 years, tax incentives as well as financing that are attractive for the investor. Nevertheless, the challenge is to include all these instruments without making the process too complicated by involving too many provincial bodies and, thus, also being expensive for the investor.

The high payments for excess electricity provide incentives for energy savings but also over dimensioning of the PV system. In the worst case companies, might reduce productive, energy consuming activities to benefit from excess payments or not operate at all, though this seems to be highly improbable. Thus a clear definition of eligibility and the amount excess generation seems to be necessary.

The 1 MWp cap will prevent the system of being too costly for the province, which has to subsidize the system. The approach should be based on a first come, first serve project basis under certain eligibility criteria until the successful exhaustion of the programme and realization of the first projects, which should be monitored transparently. Future programmes are to be realized afterwards to support market growth. The challenge is to lower the costs of future programmes.

Speculation with project rights has to be avoided through the obligation of installation within a short period of time, once all legal requirements have been reached. This process should be organized transparently to avoid frustration of investors in cue.

The possibility to repay the credit line via services or goods involves a very high risk of corruption.

Once the first projects (e.g. 10) have been executed, a quick but mandatory evaluation process including all the investors has to be made to streamline and improve the processes. This will allow lowering the overall subsidy costs for the province and making the programme self-sustainable in the long run. Last but not least, though the net metering law in Salta benefits both residential and industrial sectors, the latter is in better conditions to adopt the net metering. Industries are in better conditions than households to take a tax credit paid in bonds that are exchangeable for shares or services and to execute a three-phase network connection for its facilities.

4.6 Common Challenges to any support scheme for PV

High Inflation Rate

Inflation rate in Argentina is about 15%-24% per year according to INDEC and private consulting agencies respectively. It means that the calculated costs for the solar PV parks during the planning phase will increase at the stage of the plant installation. This will impact negatively the calculation of the Levelized cost of electricity (LCOE)[23] for the PV projects, which will be different depending on the project's phase.

Recommendation

One option to tackle this currency risk would be to realize solar investments in a currency less exposed to inflation like the USD or Euro. To minimize the impact of the inflation, photovoltaic parks should be installed as fast as possible after signing the PPA with CAMMESA and having the required official authorizations of the Secretary of Energy and the local tax office. This means that imported products are to be entered the field as well as production has to provide components "just-in-time", requiring very simple, efficient and clear administrative procedures.

High Bank Interest Rate

The interest rates of international banks or financial agencies are currently between 15% and 20% in US$. These rates constitute a huge challenge for investors when they take loans to finance their solar PV investments. In fact, with an interest rate of 15% in US$ and an investment relation of 75% debt and 25% equity, the payback period is of 11.80 years, which will be depicted in the following chapter.

Recommendation

A de-risking policy to reduce the interest rate could be applied. Current high interest rates could be reduced lowering or subsidizing these interest rates. Lower and more competitive interest rates reduce the WACC of solar PV, which is the main factor that

[23] Levelized cost of electricity (LCOE, also called levelized energy cost or LEC) is the per-kilowatt hour cost of generating energy (usually electricity) for a particular installation. Key inputs to calculate LCOE include capital costs, fuel costs, operations and maintenance (O&M) costs, financing costs and an assumed utilization rate for each plant type. A net present value calculation is performed and solved in such a way that for the value of the LCOE chosen, the project's net present value becomes zero.

This means that the LCOE is the minimum price at which energy must be sold for an energy project to reach the break even point.

determines the cost of PV. Therefore, if the WACC is reduced, the PV PPA price can be reduced as well, leading to a kick start of the still nascent Argentinean PV sector. As it was mentioned above, this strategy can imply certain risks, if other more sustainable measures are not also implemented. In particular improving the legal policy framework including clearer, transparent, stable and unchangeable rules should be undertaken as well.

4.7 Key points for support at provincial level

- Versatile support schemes such as PPA and net-metering are being developed at provincial level, ranging from the promotion of market deployment to industrial policies – it is necessary to consider the support in each province and combine local incentives with PPA scheme
- Many barriers still make the implementation of PV projects difficult, most notably energy subsidies, unspecified procedures and regulations, complicated administrative procedures but also high costs for PV systems due to import restrictions as well as transport costs – Argentina is a PV market at infant stage
- The cost of financing will be the most pressing challenge for PV projects in all the provinces, yet the distributed generation approach with a mix of net-metering and FITs in Salta might be easier to implement and use local financing sources.

5. Profitability of the PPA – Simulation

The present study compares the profitability of two similar cases under the PPA business model that have the same characteristics, except for differing interest rates. The objective is to show the incidence of the interest rate in the profitability of the PPA. Both PV PPA cases have the following common characteristics:

- a 5 MW project,
- a contract duration of 15 years,
- a total system cost of US$ 10,000,000,
- a specific system cost of 2,000 US$/kWp,
- fixed operation costs of 172,500 US$ p.a., equivalent to about 25% of the total project costs for 15 years or 1.725% per year,
- an investment relation of 75% debt and 25% equity,
- a loan tenor of 10 years and
- a discount rate of 10%
- PPA Tariff paid by CAMMESA as of December 2015= 0.24 US$/kWh.

However, while one case assumes to have an international credit with an interest rate of 15%, the other has been calculated with the BICE's interest rate of 7.6%. In the figures below it can be noted the different results of the two cases.

5.1 Case 1: PV PPA Business Model with 15% Interest Rate

Under a 15% of interest rate, the payback period is of 11.80 years, the Levelized Cost of Electricity (LCoE) is 0.23 US$/kWh, the Net Present Value (NPV) is of US$ 1,302,185 and the Equity Internal Rate of Return (IRR) is 14.97% (see figure 6)[24]. It can be stated that this case (1) does not present a profitable and attractive PPA business model for

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[24] **Internal Rate of Return (IRR):** Adapted Interest on Capital, so that the NPV is equal to zero. The internal rate of return of an investment or project is the "annualized effective compounded return rate" or rate of return that makes the NPV (NPV as NET*1/(1+IRR)^year) of all cash flows (both positive and negative) from a particular investment equal to zero. It can also be defined as the discount rate at which the present value of all future cash flows is equal to the initial investment or, in other words, the rate at which an investment breaks even.

In more specific terms, the IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment.

an investment in a 5 MW PV project.

Figure 5: PV PPA Business Model with 15% Interest Rate

Project Overview

PV Project			
PV System Size		kWp	5.000
Specific System Cost		USD/kWp	2.000
Additional CapEx (e.g. Battery)		USD	-
Investment Subsidy		USD	-
Total System Cost		USD	10.000.000
Fixed Operation Costs		USD p.a.	172.500
Variable Operation Costs		USD/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2000
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.700
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	15
Equity		USD	2.766.117
Debt (Gearing)	75%	USD	7.500.000
Loan Tenor		Years	10
Interest Rate		%	15,0%
Discount Rate		%	10,0%

PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	USD/kWh	-
Self-consumption		-	USD/kWh	-
	Fees		USD/kWh	-
Net-metering		-	USD/kWh	-
	Fees		USD/kWh	-
	Excess Electricty		USD/kWh	-
PPA Tariff		100%	USD/kWh	0,2400
	Fees		USD/kWh	-
	Oversupply Price		USD/kWh	-
	Undersupply Penalty		USD/kWh	-

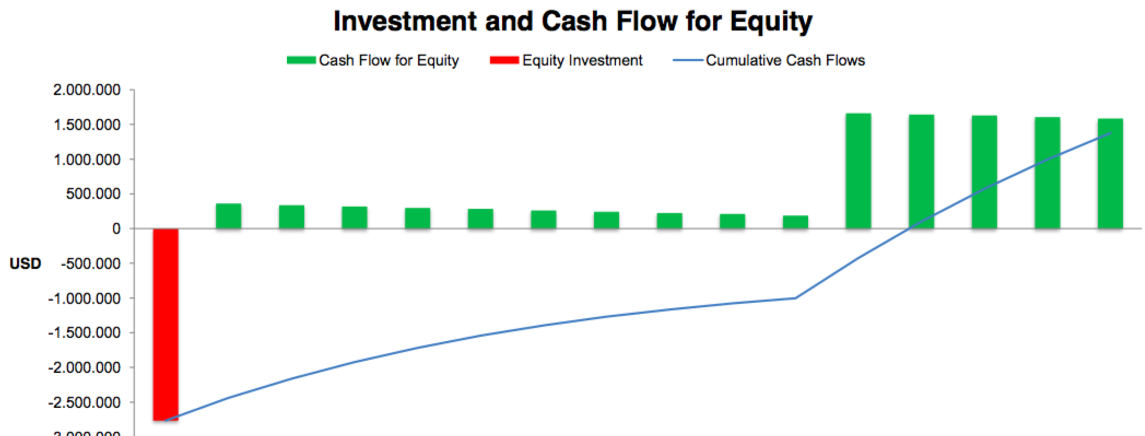
Results		
Net-Present Value	USD	1.302.185
Project IRR	%	14,72%
Equity IRR	%	14,97%
Payback Period	Years	11,80
LCOE* (w/o subsidy)	USD/kWh	0,23
LCOE (w subsidy)	USD/kWh	0,23
Min DSCR**	x	1,12 x
Min LLCR***	x	1,12 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Source: eclareon 2015

As the figure (7) below shows in terms of cash flow for equity, only from the end of the eleventh year, the investor can expect to start receiving benefits from the PPA. Taking into account that the PPA is signed for a period of 15 years, there are only three years and a few months left to make profits under the PPA scheme (Figure 6). Although the investor can amortize the investment, the period of time receiving benefits is very short and, thus, unattractive for international investors as well as local ones.

Figure 6: Investment and Cash Flow for Equity Analysis



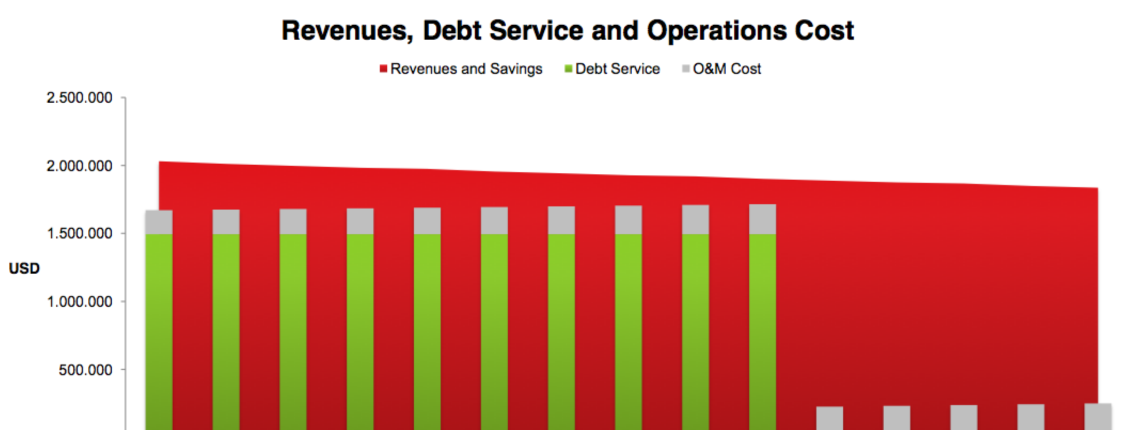
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Equity Investment	(2.766.117)															
Cash Flow for Equity	-	360.067	335.917	317.305	298.679	285.430	261.368	242.676	223.955	210.448	186.410	1.661.969	1.643.092	1.629.268	1.605.189	1.586.153
Cumulative Cash Flows	(2.766.117)	(2.438.783)	(2.161.166)	(1.922.770)	(1.718.769)	(1.541.539)	(1.394.004)	(1.269.472)	(1.164.996)	(1.075.745)	(1.003.876)	(421.366)	102.174	574.115	996.811	1.376.523

Operations Year

Source: eclareon 2015

As a consequence, until the tenth year debt service is very high and the remaining revenues and savings are very low. Operation and maintenance costs increase slightly over the PPA period of 15 years (Figure 7).

Figure 7: Revenues, Debt Service and Operation Cost Analysis



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenues and Savings	2.031.270	2.011.540	1.997.459	1.983.477	1.974.989	1.955.805	1.942.115	1.928.520	1.920.267	1.901.615	1.888.304	1.875.086	1.867.061	1.848.926	1.835.984
O&M Cost	176.813	181.233	185.764	190.408	195.168	200.047	205.048	210.174	215.429	220.815	226.335	231.993	237.793	243.738	249.831
Debt Service	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	1.494.390	-	-	-	-	-

Operations Year

Source: eclareon 2015

5.2 Case 2: PV PPA Business Model with 7.65% Interest Rate

Under the loan for renewable energy provided by the Argentinean bank BICE, the interest rate is 7.6%. With such an interest rate, a profitable and attractive business model for a PV PPA of 5 MW could be identified. In fact, under a 7.65% of interest rate and an investment relation of 75% debt and 25% equity, the payback period is 5.96 years, instead of 11.80 years, the Levelized Cost of Electricity (LCoE) is 0.17 US$/kWh, instead of 0.23 US$/kWh, the Equity IRR is 26.43%, instead of 14.97%, and the NPV is of US$ 3,730,169, instead of US$ 1,302,185 (see figure 8).

Figure 8: PV PPA Business Model with 7.65% Interest Rate

Project Overview

PV Project			
PV System Size		kWp	5.000
Specific System Cost		USD/kWp	2.000
Additional CapEx (e.g. Battery)		USD	-
Investment Subsidy		USD	-
Total System Cost		USD	10.000.000
Fixed Operation Costs		USD p.a.	172.500
Variable Operation Costs		USD/kWh	-

PV Generation		
Specific Yield	kWh/qm/a	2000
Performance Factor	%	85%
Specific System Performance	kWh/kWp/a	1.700
Degradation	% p.a.	0,70%

Investment			
Project Duration		Years	15
Equity		USD	2.701.224
Debt (Gearing)	75%	USD	7.500.000
Loan Tenor		Years	10
Interest Rate		%	7,65%
Discount Rate		%	10,0%

PV Business Model				
Category		Share	Unit	Price
Feed-in Tariff		-	USD/kWh	-
Self-consumption		-	USD/kWh	-
	Fees		USD/kWh	-
Net-metering		-	USD/kWh	-
	Fees		USD/kWh	-
	Excess Electricty		USD/kWh	-
PPA Tariff		100%	USD/kWh	0,2400
	Fees		USD/kWh	-
	Overysupply Price		USD/kWh	-
	Undersupply Penalty		USD/kWh	-

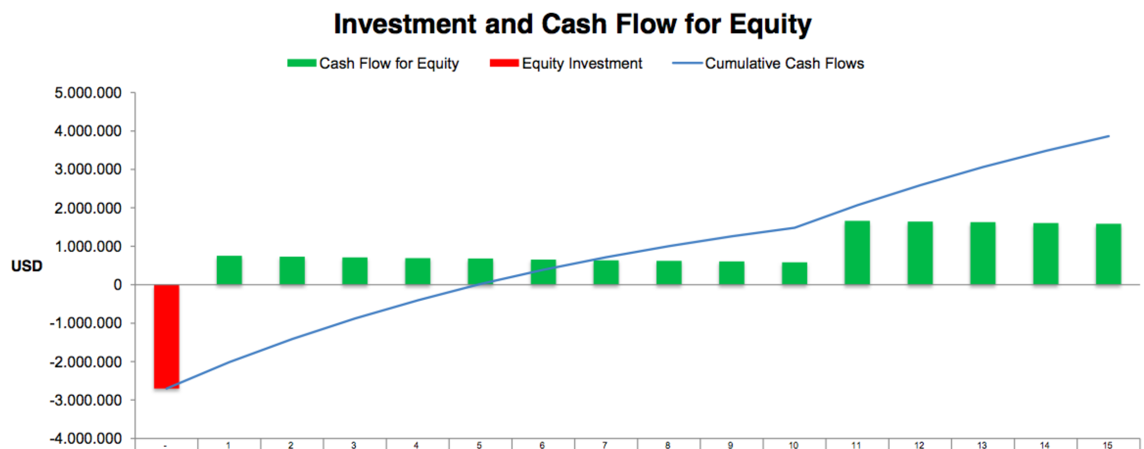
Results		
Net-Present Value	USD	3.730.169
Project IRR	%	14,84%
Equity IRR	%	26,43%
Payback Period	Years	5,96
LCOE* (w/o subsidy)	USD/kWh	0,17
LCOE (w subsidy)	USD/kWh	0,17
Min DSCR**	x	1,53 x
Min LLCR***	x	1,53 x

* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Source: eclareon 2015.

As the figure below shows, in terms of cash flow for equity at the end of the fifth year, the investor can expect to have already recovered the investment and at the eleventh year to have finished paying the debt. Therefore from the eleventh year the investor can start to receive the entire profits from the PV PPA. Taking into account that the PPA is signed for a period of 15 years, there are still ten years and a few months left to make profits under the PPA scheme (Figure 9). Moreover since the eleventh year the cash flow for equity under an interest rate of 7.65% is higher (US$ 2,000,000) than in the case with an interest rate of 15% (US$ 1,500,000). The cumulated cash flows under an interest rate of 7.65% are improved greatly compared to the previous scenario.

Figure 9: Investment and Cash Flow for Equity



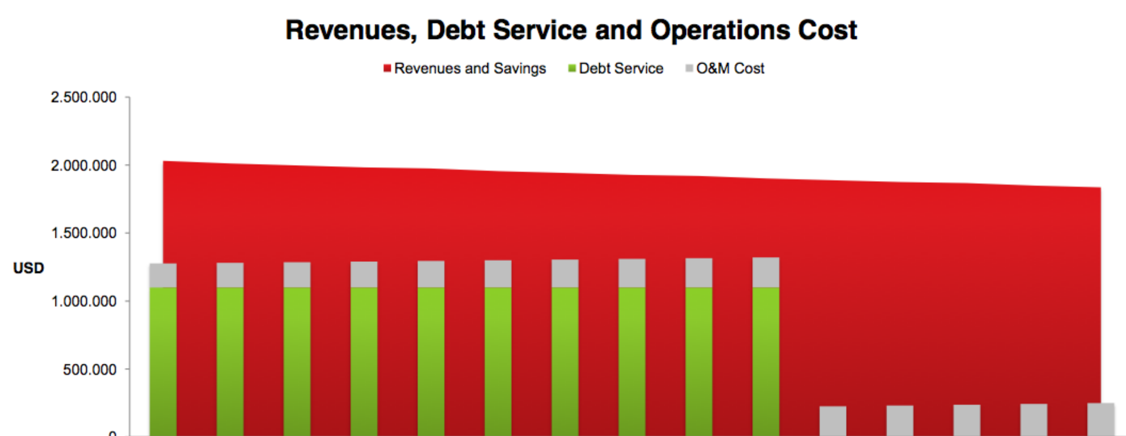
	-	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Equity Investment	(2.701.224)															
Cash Flow for Equity	-	754.317	730.167	711.556	692.929	679.681	655.618	636.927	618.206	604.698	580.661	1.661.969	1.643.092	1.629.268	1.605.189	1.586.153
Cumulative Cash Flows	(2.701.224)	(2.015.480)	(1.412.037)	(877.434)	(404.154)	17.874	387.954	714.798	1.003.195	1.259.646	1.483.516	2.066.026	2.589.566	3.061.507	3.484.203	3.863.916

Operations Year

Source: eclareon 2015.

As a consequence, until the tenth year debt service is comparatively lower than the scenario with the 15% interest rate (about 1,100,000 US$ instead of 1,500,000 US$) and, thus, the remaining revenues and savings are considerably higher (Figure 10).

Figure 10: Revenues, Debt Service and Operation Cost Analysis



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Revenues and Savings	2.031.270	2.011.540	1.997.459	1.983.477	1.974.989	1.955.805	1.942.115	1.928.520	1.920.267	1.901.615	1.888.304	1.875.086	1.867.061	1.848.926	1.835.984
O&M Cost	176.813	181.233	185.764	190.408	195.168	200.047	205.048	210.174	215.429	220.815	226.335	231.993	237.793	243.738	249.831
Debt Service	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	1.100.140	-	-	-	-	-

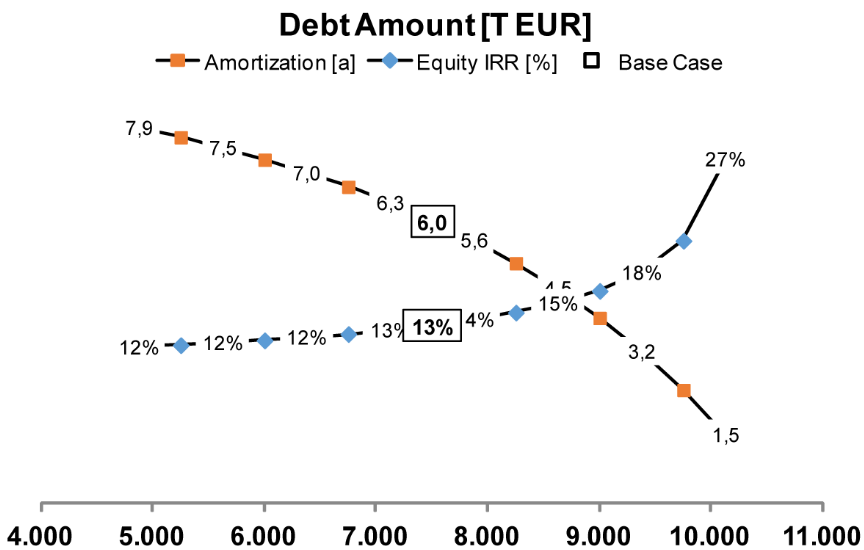
Operations Year

Source: eclareon 2015

Sensitivity Analysis

Under figure 11 the graph shows the correlation between the debt amount in the investment volume and the profitability of the project. It can be noted that the amortization period decreases considerably, while equity IRR or profitability increases accordingly when the debt amount increases.

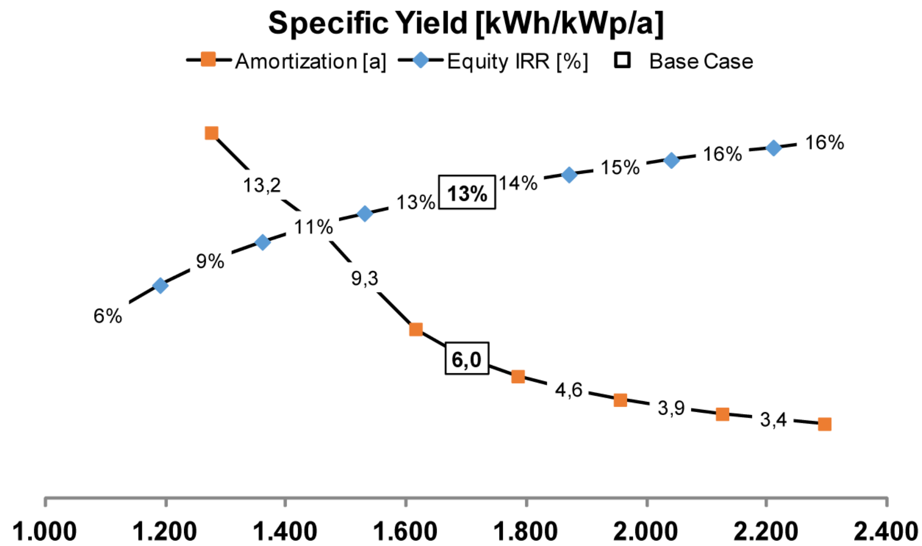
Figure 11: Debt Amount Sensitivity



Source: eclareon 2015

The following graph analyses the correlation between the specific yield produced by the installation and the profitability of the project. The increase of the irradiation and thus the yield has a great impact on the overall profitability and the payback period of the capital employed. Noteworthy is the fact that with an energy yield of 1,700 kWh/kWp/a or more, the amortization time decreases slower than with an energy yield of 1,600 kWh/kWp/ or less. The advantage is that the energy yield of 1,700 kWh/kWp/a is available in many regions in Argentina. It can be noted that a yield of 1,700 kWh/kWp/a has a great impact on the amortization period (Figure 12).

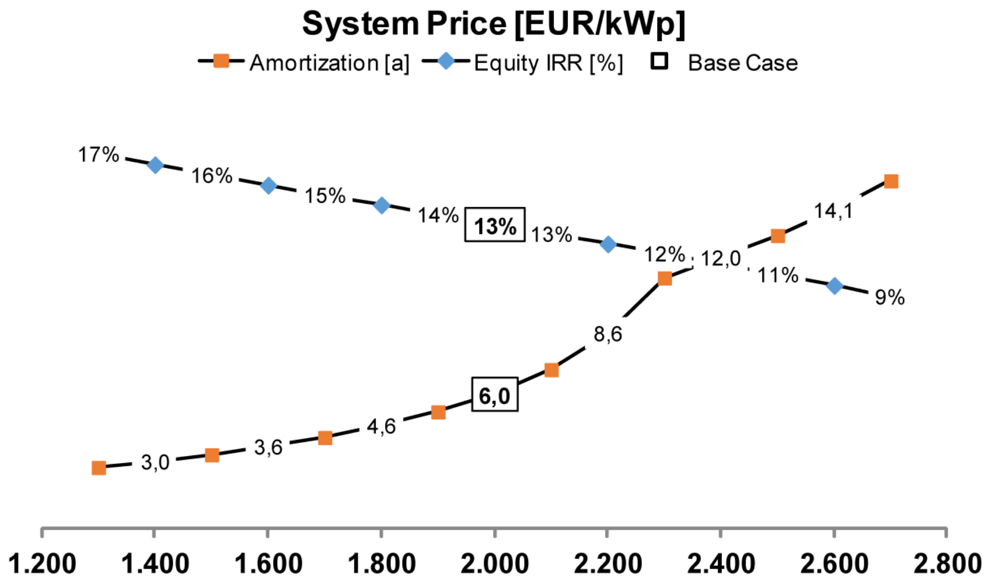
Figure 12: Specific Yield Sensitivity



Source: eclareon 2015

The figure below illustrates the influence of the evolution of PV system prices over the profitability of the project. At a price of 2,000 EUR/kWp the equity IRR corresponds to 13% and the amortization period to 6 years (Figure 13). This is important since the system costs assumed in the study are relatively high compared to international prices. If systems prices were to be reduced to levels of surrounding countries (e.g. Chile or Uruguay), investments would be a lot more attractive or alternatively it would open a room for reducing PPA remuneration to more sustainable levels.

Figure 13: System Price Sensitivity



Source: eclareon 2015

6. Opportunities for International Investors and Outlook

Argentina's potential for PV is extremely high, having one of the best world's solar irradiation and great electricity need. Yet, as Argentina is still an infant RE market, there are big challenges to PV investments that need to be overcome. The macroeconomic situation of the country (i.e. high inflation rate, limited access to international finance, high state debts and scarce trust of the state) and the universal electricity subsidies constitute a difficult framework for the PV development. Still there are specific challenges in the PV sector that can be addressed with appropriate policies and examples from other markets. In addition, knowledge on technology and installation is very limited, thus a strong impetus has to be done on vocational training and qualification.

The financial analysis of the two cases of the PV PPA business model shows that the high interest rate is the key challenge that limits the investments in the PV sector. The interest rate may be lowered by involving national and international development banks such as Investment and International Trade Bank (BICE), Inter American Development Bank (IDB), Caja Andina de Fomento (CAF) and World Bank (WB). Development banks can support PV investments providing credit lines with lower interest rates and additional guarantees that allow access to international financing sources. Besides this, a clear, transparent and stable regulatory framework including non-negotiable and 20 years PV tariffs to reduce the uncertainty of the investor in combination with a sustainable de-risking policy can mitigate many of these challenges for the PV in particular.

Moreover, the universal subsidies limit the PV development especially concerning the implementation of schemes to support distributed generation of RE such as net metering or FITs. A progressive reduction of subsidies is strongly suggested in order to compare real prices of different energy sources and make more efficient investments. It has to be highlighted that the government has mentioned a reduction of subsidies from the year 2016. Furthermore, as of December 2015, the new government has done the first steps to recover the financial confidence and lure investments, such as letting the Argentinian currency float freely. The devaluation of the Argentinean Peso has eliminated the black market for currency exchange.

In addition, Argentina's new commitment at the COP 21 is another good sign that renewable energy, as a powerful instrument to reduce Greenhouse Gas (GHG) emissions, will get a true chance to make their inroads in the Argentinean energy mix.

To sum up, through the first assessment and close exchange with local experts, it was clear that Argentina's PV sector still requires more qualified expertise and know-how. In particular, the following study areas and practical actions should be carried out to enhance an efficient and sustainable development of the PV field:

- Focusing on the institutional arrangement of the PV sector to identify administrative burdens and delays for the deployment of PV projects;
- business model assessing the profitability of a PV net metering under residential and small commerce electricity tariffs without the subsidies;
- transparent and simple presentation of information on online platforms to facilitate and simplify the access to project development and permit procedures at national and provincial level;
- improvement of the implementation of provincial schemes to support the distributed generation of PV, advising provincial and national policy makers and regulators;
- empowerment of banks and venture capital providers to understand technology and framework conditions;
- empowering the civil society and potential PV investors on the implementation of the PV distributed generation;
- greater involvement of national and international development banks to help in the implementation of "de-risking" measures;
- strengthening the cooperation between the Argentinean RE chamber and international PV or RE associations through best practice exhange;
- strengthening the links between public administrative bodies and PV project developers or investors to increase the business opportunities for PV investments.

To conduct and support the referred study areas and practical actions, it is suggested to develop further projects that facilitate capacity building and knowledge transfer to empower key national actors of the private solar PV sector as well as relevant provincial stakeholders such as the provincial energy companies. The ultimate goal is to support the creation of a solar PV market that enables to boost a sustainable socioeconomic development in the country.

It is now the right moment to invest in PV in Argentina?

Right now it is extremely difficult to invest in the Argentinean RE and PV market because the financial situation and the regulatory framework is still unclear. However, under the new government as of December 2015 there is a positive perspective for the RE and PV sector for the coming year 2016.

Thus, our advice for project developers and investors is to invest after the main milestones are established. The main milestones can be summarized as follows:

- The implementation of the regulatory framework to regulate the new RE Law (N°. 27191), which is one of the priorities of the national government and is currently under discussion;
- The stabilization of the overall financial situation, especially the recovery of the access to international financing sources and the lowering of the interest and inflation rates;
- The execution of the first private investments in the PV market, both under the national regulatory framework and under the provincial regulations and programmes.

After these milestones are set, it can be guaranteed that the sector will start to develop positively. It has to be highlighted that the government has already taken the first steps to stabilize the overall financial situation in Argentina and has already had meetings with relevant stakeholders such as CADER to discuss how to implement the RE regulatory framework. Therefore, expectations about a development of the RE and PV markets due to the stabilization of the macro economy and the implementation of the RE regulatory framework are high.

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Interviewed Experts

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Resumen en Español / Spanish Summary

En el proyecto "PV Framework Assessment in Argentina", la Asociación Solar Alemana (BSW-Solar) en cooperación con la firma internacional de consultoría eclareon GmbH y los entes de energía SAPEM Energía en San Luis y EPSE en San Juan analizaron los procesos y barreras del sector (FV) argentino. En el proyecto se le dio un enfoque particular a las provincias de San Juan y San Luis así como también se analizó el esquema de Balance Neto de la provincia de Salta.

El potencial de la energía FV en Argentina es significativamente alto. De hecho Argentina tiene una de las mejores irradiaciones solares del mundo y una demanda de electricidad creciente que necesita ser abastecida. Sin embargo, como el mercado de energías renovables (ER) en Argentina es aún incipiente, son muchos los desafíos que enfrentan las inversiones FV. La situación macroeconómica del país (es decir la alta tasa de inflación, el acceso limitado a la financiación internacional, el endeudamiento estatal y la escasa confianza del Estado) y los subsidios generales a la electricidad constituyen un marco difícil para el desarrollo de la FV. Aparte del contexto macroeconómico, a través del estudio se pudo identificar una serie de barreras específicas del sector FV, tanto a nivel nacional como provincial, que se podrían abordar con políticas concretas y apropiadas. En el informe se pueden encontrar recomendaciones concretas a nivel nacional y provincial para las barreras identificadas.

Uno de los grandes problemas que enfrenta el marco regulatorio que promueve la energía solar FV es la falta de transparencia y claridad de las reglas para desarrollar un proyecto FV, suponiendo una gran incertidumbre para el desarrollador. Esto se evidencia sobretodo en el modelo de "Contrato de abastecimiento MEM a partir de fuentes renovables por cantidad de energía suministrada" (PPA). De hecho, la tarifa no está fijada de antemano por la reglamentación y cada desarrollador debe negociar el precio de PPA con CAMMESA agravando aún más la incertidumbre para el desarrollador. A modo de recomendación para que el desarrollador obtenga una tarifa mejor de PPA, se sugiere que el mismo ofrezca una tarifa exactamente igual a la del PPA anterior. Otro problema es que las tarifas de PPA que se asignan a los proyectos FV son solo por 15 años, cuando en la mayoría de los mercados se asignan por 20 años. Además, para mitigar el efecto de la inflación, la recomendación expresa que se le hace a los desarrolladores es que ni bien firmen el PPA con CAMMESA tienen que comenzar la obra de construcción de la planta solar.

El análisis financiero de los PPA para el sector FV analiza dos casos similares en los cuales todas las variables permanecen igual y lo único que cambia es la tasa de interés. La comparación de los dos casos muestra que el desafío clave enfrentado por los desarrolladores FV es que la tasa de interés es demasiado alta. Por lo tanto, la recomendación principal es bajar la tasa de interés. Si bien las condiciones en Argentina no proveen un marco favorable para tasas de interés bajas, hay ciertas medidas que se pueden tomar al respecto.

Una medida es involucrar a los bancos de desarrollo nacionales e internacionales como el Banco de Inversión y Comercio Exterior (BICE), Banco Interamericano de Desarrollo (BID), Caja Andina de Fomento (CAF) y el Banco Mundial (BM) para que los mismos faciliten líneas de crédito con tasas de interés bajas y provean garantías adicionales que apoyen al inversor en el acceso al financiamiento internacional. Además, es necesario proveer un marco legal claro y estable con tarifas predeterminadas, no negociables y por 20 años para reducir la incertidumbre y que el inversor amplíe sus inversiones. Por último se sugiere una reducción progresiva de los subsidios a la electricidad para comparar precios reales de las diferentes fuentes de energía y hacer inversiones más eficientes. Con respecto a este último punto en diciembre de 2015, el nuevo gobierno en función declaró que aplicará una reducción de los subsidies a partir del año 2016 así como empezó a tomar medidas para recuperar la confianza financiera y atraer inversiones privadas. La más notoria es la unificación del tipo de cambio y devaluación del Peso Argentino, eliminando el mercado negro de intercambio de la moneda.

Estos cambios en la política macroeconómica sugieren que si bien hasta el momento presente (Diciembre 2015), es muy difícil invertir en ER en Argentina debido al deterioro de la situación financiera y a la falta de un marco normativo claro para las renovables, con el nuevo gobierno se abre una mejor perspectiva para el sector. A partir del 2016, se espera la implementación del decreto regulatorio para regular la nueva Ley de ER (Nº 27191), que es una de las prioridades del gobierno nacional y que se encuentra actualmente en discusión. Además se espera la estabilización de la situación financiera general, sobre todo la recuperación del acceso a fuentes de financiamiento internacional y una reducción de las tasas de interés y de inflación. Por lo tanto, en el momento presente hay altas expectativas sobre la evolución del mercado de ER y del fotovoltaico en particular debido a la estabilización de la macroeconomía y de la implementación del nuevo marco regulatorio para las renovables.