Report D4.4-MX, July 2017

Auctions for Renewable Support in Mexico: Instruments and lessons learnt

AURES

HORIZON 2020

Short about the project

Auctions for Renewable Energy Support: Effective use and efficient implementation options (AURES)

This project helps assessing the applicability of different auction types to renewable support under different market conditions. It also explores which auction types and design specifications suit particular requirements and policy goals in European countries. By establishing best practices and a knowledge sharing network, we contribute to informed policy decision-making and to the success of auction implementations across Europe.

Target-oriented analysis: Through analysis of empirical experiences, experiments and simulation, we will create a flexible policy support tool that supports policy makers in deciding on the applicability of auction types and certain design specifications for their specific situation.

Capacity building activities: We undertake specific implementation cases to derive best practices and trigger knowledge sharing amongst Member States. We strive to create a strong network with workshops, webinars, bilateral meetings, newsletters, a website that will serve as capacity building platform for both policy makers and market participants (including project developers, auctioneers,etc.). Wherever required, we can set up specific bilateral and multilateral meetings on specific auction auction issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals issues and facilitate cooperation and knowledge sharing. Additionally, we offer sparring on specific implementation options, drawing from insights gained during the first phases of the project (empirical analysis of previous auctions in Europe and the world), conceptual and theoretical analysis on the applicability of specific designs in certain market conditions and for certain policy goals.

Project consortium: eight renowned public institutions and private firms from five European countries and combines some of the leading energy policy experts in Europe, with an impressive track record of successful research and coordination projects.

The report contributes to the first and second of three tasks in work package 4 of the AURES project:

T4.1 Providing a characterisation of the different auctions

T4.2 Making an assessment of auctions and case-specific lessons learnt

T4.3 Interpreting and summarising the general lessons learnt and resulting and thereby outline specific recommendations

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1. Characteristics of auctions in Mexico

Country features

Mexico is an upper middle-income country and, with a GDP of $1.144 trillion, it is the second largest economy in Latin America. It had a population of 127 million in 2015. Its economy is growing at 2.5% (2015), a growth rate which has been declining since the 5.1% in 2010. Its percentage of the population living below the national poverty lines was 53.2% in 2014, up from 51.6% in 2012. Life expectancy at birth is 76 years (World Bank 2017). The unemployment rate is 3.5% (2016)(Trading Economics 2017).

A profound reorganization of the economy took place in the 1980s, transforming it from an inward-looking system focused on local manufacturing, primarily with the aim of substituting imports, to a liberalised one open to foreign trade, investment and private sector participation. A second impetus that effectively shifted Mexico's economy came from the signature of the North American Free Trade Agreement (NAFTA) with the United States and Canada in 1994. Compared with other major hydrocarbon producers, Mexico has now a much more diversified economy, making it less vulnerable to fluctuations in the oil price. Non-oil exports, notably from the manufacturing sector, now account for more than 90% of export revenue, although oil-related revenue remains an important pillar of the country's fiscal balance (IEA 2016, p.26).

Energy sector features

Total energy demand in Mexico has grown by a quarter since 2000 and electricity consumption has grown by half, but per-capita energy use is still less than 40% of the OECD average. Oil has traditionally played a major role as a fuel for power generation, but it is rapidly losing ground to natural gas. Non-fossil fuel electricity generation, primarily from hydropower and nuclear, currently accounts for one-fifth of the total (IEA 2017).

In 2014, electricity accounted for around 18% of total final energy consumption, slightly below the OECD average of 22%. More than 99% of the population has access to electricity, but per-capita consumption is relatively low.

Among the end-use sectors, industry accounts for well over half (56%) of final electricity consumption, much higher than the average elsewhere in the OECD. However, growth in electricity demand in the buildings sector, which constitutes almost 40% of final electricity consumption, has been faster since 2000, the annual growth rate being more than 4% (IEA 2016, p.20).

On the supply side, electricity generation is dominated by natural gas, which has supplanted oil as the main fuel for power generation. As recently as 2000, oil accounted for almost half of total generation (op.cit., p.22).

Mexico launched an Energy Reform in 2013. Key elements of the Reform include the unbundling and restructuring of Comisión Federal de Electricidad (CFE), opening up the power sector to participation by the private sector and the introduction of competitive electricity markets for energy, capacity and clean certificates. The opening to private investment in power generation is deemed instrumental in the rapid transition of the power mix (IEA 2016).

As part of the new regulatory framework, the Electricity Industry Law was promulgated on 11 August 2014 to open power sector generation and the wholesale market to competition.

The law establishes a new regulatory framework for Mexico´s electricity sector, keeping the planning and control of the national power system as strategic duties of the state. The transmission and distribution of electricity will also be run by the state through the state- owned CFE. However, private entities are now allowed to sign a range of different contracts with the state. All generators are guaranteed the right to compete in the wholesale market and to have open access to the grid. They can sign contracts and sell their electricity in the wholesale electricity market. The provisions of the Electricity Industry Law do not particularly refer to renewable energy but rather all forms of clean energy (Mayer Brown 2016, p.10).

The law permits certain retailers to buy and sell energy in the wholesale electricity market at prices negotiated freely between generators, retailers and qualified users. CFE will buy energy through auctions so it can meet its power needs at competitive prices. [1] In this new scheme, suppliers can offer prices and innovative services to compete for customers, but the Electricity Industry Law does impose low-carbon objectives for the power sector. This takes the form of renewable energy quota obligations for qualified users and retail suppliers to acquire Clean Energy Certificates (Certificados de Energía Limpia, or CELs). The Federal Energy Commission (CRE) will regulate transmission and distribution rates and corresponding subsidies to supply basic users (IRENA 2015, p.32).

CFE was transformed from a government administration into a “productive state enterprise” and unbundled, both vertically (generation, and transmission and distribution) and horizontally. Responsibility for system operation has been transferred from CFE to a new, independent entity, the Centro Nacional de Control de Energía (CENACE)(IEA 2016, p.92). Independent power producers (IPPs) can and do own and operate power plants; but they must sell all power produced to CFE under long-term power purchase agreement.

The Energy Transition Law (issued in 2015) establishes a clean electricity generation minimum share of 25% by 2018, 30% by 2021, and 35% by 2024 (Sosa 2016). The 2012 Climate Change Law had set a goal that at least 35% of total electricity generation in 2024 would be from clean energy sources. According to the Electricity Law, “clean energy sources” are wind, solar, geothermal, hydroelectric, and other forms of renewable energy plus nuclear, certain biofuels and efficient cogeneration, among others. The Energy Transition added the interim goals for 2018 and 2024. To meet the 35% target, SENER established minimum CEL purchase requirements, which will increase gradually. Qualified users, retailers, self-supply users and holders of legacy contracts that produce electricity from non-clean energy sources are required to purchase CELs. For 2018 and 2019 SENER has established the minimum CEL purchase requirements for such obligated parties at 5% and 5.8% of their total energy consumption, respectively (Mayer Brown 2016, p.2). Regarding the main legal background and guidelines for the auction process: On November 19, 2015, the Ministry of Energy / Secretary of Energy (Secretaría de Energía, or SENER) published the rules for the long-

[1] So far CFE has been the only buyer in the auctions but this is open for private offtakers.

term energy auction (the “Auction Manual”). The Bidding Guidelines (“Call”) are published by CENACE for every yearly auction.

Renewable energy in Mexico

The Energy Reform has created great expectations for renewable energy in Mexico. As of 2015, Mexico had around 19 gigawatts (GW) of non-fossil fuel electricity generation capacity (of a total installed capacity of 70 GW), providing around one-fifth of total electricity generation. The largest share from non-fossil fuels comes from hydropower, followed by nuclear and wind. The main source of non-hydro renewables for power generation had traditionally been geothermal, but in recent years the contribution of wind power has grown rapidly. According to the IEA (2016), renewable energy generation technologies are likely to see rapid expansion as the Reform opens investment opportunities to help meet Mexico’s climate pledge and clean power targets. Current generation of clean electricity (2015) is clearly dominated by hydro (10%), followed by wind (3%), geothermal, solar and others (2%) and biomass (1%). Nuclear, which is also considered a clean energy source by the Electricity Law, accounts for 4%.

Table 1. Characterisation of auctions in Mexico

Characteristics	Description
Country characteristics	See text
Market characteristics	See text
Name of auction scheme	Subastas de largo plazo (SLP)(long-term auctions)
Objectives	The long-term auctions are considered one of the cornerstones of renewable energy expansion in Mexico. The main motivation is to increase clean energy generation and capacity at competitive prices (lowest support costs) by fostering competition.
Contracting authority	The system operator (CENACE) is the organiser of the auction. The Federal Energy Commission (CFE) is the off-taker at least in the first two auctions. For future auctions, private off-takers might participate if fulfilling certain requirements (to be determined) and pending the establishment of a clearinghouse.
Main features	- Multi-product auctions: capacity, electricity generation and CELs. - Regional and hourly adjustments of bid prices.

Characteristics	Description
	- Technology-neutral auctions.
Year of introduction	2015: First auction process was started in November 2015 (SLP – 1/2015).
Technology focus and differentiation	The auctions are technology-neutral for clean energy options: the buyer (CFE at this stage) sets out the requirements in terms of energy, capacity or CELs, while the choice of technology is left to the market (IEA 2016, p.95). In theory, all "clean" energy sources can participate in the auction.
Lead time before auction	4 months. 1st auction: CENACE published the call on November 30th 2015. The terms of the tender procedure were published on December 28th 2015. Bids sent in February 2016. Publication of awarded bidders on April 1st 2016 (CENACE 2016a). 2nd auction : CENACE published the call on May 2016, bids sent and awarded winners published on September 2016.
Min./max. size of project	Neither minimum nor maximum project sizes are required.
What is auctioned?	Capacity, electricity generation and CELs. Bidders offer a global package price for the three different products. Each clean electricity generator may offer one, two or the three products. Conventional electricity generators can only offer capacity. Regarding CELS, suppliers and qualified (or non-regulated) consumers are required to buy them. Beginning 2018, major power consumers will be required to buy 5% of their electricity consumption from either PPAs with clean power suppliers or through the purchase of CELs (James 2017). This percentage increases to 5.8% in 2019. The seller is entitled to receive one CEL per each MWh of electricity produced. Only those generators that go into operation after August 11, 2014, can receive CELs. The penalties for non-compliance include a monetary fine to be assessed by CRE (McNeece 2016).
Budgetary expenditures per auction and per year	Not available.

Characteristics	Description
Frequency of auctions	According to the Auction Manual published by SENER in November 2015, the system operator CENACE has to do the best to publish the bidding guidelines ("call") for each auction once a year in April, except for the first auction, which started in November 2015.
Volume of the tender	In the first two auctions, CFE (as off-taker) asked for bids for the following volumes: - First auction: 6.36 TWh of Generation, 6.36 million CELs and 500 MW of capacity. - Second auction: 10.6 TWh Generation, 10.6 million CELs and 1483 MW of capacity.
Auction design elements	(see details in next section)

1.1 Design elements for the assessment of auction schemes for RES-E

Table 2. Design elements in the auction in Mexico.

Design elements	
Single- or multiple-item auctions	Multi-item, multi-product auction.
Auction procedure	Price-only, static auction[2]. Pay-as-bid (PAB) with nodal pricing. Off-takers (in the first two auctions, CFE) submit to CENACE the purchase volume and maximum price of generation, CELs and capacity, including the energy demand curve for the purchase offer per product and segment / range. The awards are based on matching the energy demand and supply curves, as well as CELs and capacity. An optimisation program selects the best bids in terms of cost, capacity and profit margin. The optimisation program aims to contract the largest amount of capacity, energy, and CELs at the lowest possible price. This means that not all the auction volume demanded by the buyer (i.e. CFE) may be contracted.

[2] An iteration may be triggered in case the economic benefit reached is not higher than a defined threshold. So far there has not been a need for an iteration because the threshold was achieved.

Design elements	
	CENACE has the right to declare unsuccessful the tender process in case of no or low participation interest and to call for additional auctions under certain circumstances. The bids included: quantities of each of the products to be offered (MWh of electricity, CELs and/or MW of capacity), the annual price (in MX/year), the indexation of the offer (in USD or pesos), the interconnection point and the date of commencement of operations (PWC 2016) Bids can be done for one, two and/or three products and bids can have excluding character between themselves Awarded bids will have to sign a PPA with a subsidiary of CFE
Pricing rules	Pay-as-bid (PAB) Three types of adjustments: Regional, hourly and inflation/exchange rate. -REGIONAL ADJUSTMENT (NODAL PRICING): Regional adjustments of bid prices (hourly adjustment factors per zone) were included. They reward or penalize those zones where new capacity is needed or where production overcapacity exists, respectively (PWC 2016). In other words, ceteris paribus, a project in a node with higher generation costs would be rewarded. The application of the adjustment factor does not mean that the price of the contract will change, but such factor is used for the evaluation of the bid. This price will be the bid price (Factor 2017). For each yearly auction, the applicable adjustment factor per each node will be defined. The locational signals were reduced in the 2nd auction (the locational penalty decreased by 95%)(IRENA 2017). -HOURLY ADJUSTMENT: Electricity from intermittent clean sources will be paid at the price included in Seller’s bid as adjusted up or down by “hourly adjustment factors” to account for the expected value of the energy delivered at the interconnection node on the hour of delivery relative to the expected value of the average hourly price during the year at the same node (Mayer Brown 2016, p.3), i.e., more will be paid for the electricity generated at times of higher demand and less for the electricity at times of lower demand. Suppliers with intermittent clean sources shall receive a monthly payment equal to the Schedule Hourly Adjustment Factors multiplied by the number of MWh of energy produced on a per-hour basis HOURLY-ADJUSTEMENT PAYMENTS = Number of MWh of cumulative energy produced per hour × Scheduled hourly adjustment factors provided by CENACE (EY 2016). Note that the regional adjustments are used for the evaluation of bids. The hourly adjustments are used for the actual payments to winning bidders.

Design elements	
	-INFLATION AND EXCHANGE RATE ADJUSTMENT: The price is also adjusted to account for inflation and variations in the peso/dollar exchange rate. Each bidder may choose that its payments be indexed to Mexican inflation or the peso/dollar exchange rate. At commercial operation date (COD), the price offered in the bid will be adjusted pursuant to a formula to account for variations in the peso/dollar exchange rate (70% weight), US inflation in proportion to the peso/dollar exchange rate variations (20% weight) and Mexican inflation (10% weight). Such adjusted price is referred to as the "Initial Price". The Initial Price is multiplied by the average of the monthly adjustment factors used to calculate the adjusted monthly prices for the corresponding year (Mayer Brown 2016, p.3).
Ceiling price	The off-taker (CFE) submit to CENACE the purchase volume and maximum price of generation, CELs and capacity, including the energy demand curve for the purchase offer per product and segment / range. For the first auction, CFE offered to buy at a maximum price for generation at 884 MXN / MWh (about $50/MWh), CELs at 444 MXN / CEL (about $25/CEL) and capacity at 10.000 MXN / Mw (about $8,200//MW). For the second auction, ceiling prices offered by CFE were about $40/MWh for generation, $20 for each CEL and $87.500/MW for capacity.
Qualification criteria	**Technical & Execution capability**: the bidder must have built and operated project(s) with a similar technology in the last 10 years with a capacity equivalent to at least 33% of the size of the capacity offered in the auction. In addition, bidders must evidence to be a service provider and to maintain direct or indirect participation in the project company for a certain period of time (up to 3 years after COD) **Financial capability**: the bidder must have obtained financing in the past in order to develop projects of a similar or higher size to the one offered in the auction (Factor 2017, p.88). In order to participate, the bidder has to issue different guarantees: **Bid Bond** ("garantía de seriedad") issued in order to participate in the bid process:

Design elements	
	300,000 UDIs[3], regardless of the number of offers and products presented + 65,000 UDIs per MW of capacity offered in the auction + 30 UDIs per each MWh of electricity offered in the auction + 15 UDIs per each CEL being offered in the auction. **Performance guarantee** (”garantía de cumplimiento”) issued at signing date of PPA until end of contract: 65,000 UDIs per MW of capacity offered in the auction + 30 UDIs per each MWh of electricity offered in the auction + 15 UDIs per each CEL offered in the auction. The amount of the performance guarantee can vary if certain milestones are fulfilled (option to reduce amount) or not fulfilled (obligation to increase amount). The bid must include the interconnection point and certain technical design details of the project offered. In addition, the off-taker has to provide guarantees based on the PPA contract: **Performance guarantee** (”garantía de cumplimiento”) issued not later than 30 days after COD of the contract until end of contract: 32,500 UDIs per MW of capacity offered in the auction + 15 UDIs per each MWh of electricity offered in the auction + 7.5 UDIs per each CEL being offered in the auction.
Penalties	If commercial operations are not commenced by the scheduled COD as indicated in the bid, the awarded bidder must pay a penalty equivalent to 5% of the monthly payments under the PPA. In addition, the amount of the performance guarantee has to be increased in case of delays - in achieving milestones before scheduled COD by 0.75% of the contract price of the PPA, or - of scheduled COD for each month of delay by 10% (delay attributable to electricity generators), 2% (delay attributable to federal government) and 5% (delay attributable to state/municipal government), subject to an overall cap of two times the original guarantee amount (Clifford Chance 2016, p.3).

[3] An UDI or ”Investment Unit” is an unit of account whose value in Mexican pesos is published periodically by the Bank of Mexico. The value of an UDI in March 2017 is around 5.7 pesos. One $ = 19.5 pesos.

Design elements	
	Generators may defer up to 12% of the contracted CELs to be delivered to the off-taker for up to 2 years, but any CELs so deferred shall be increased by 5% p.a. for each deferred year. If after deferring for 2-years there is a deficiency in CELs, the generator must purchase CELs in the market (Clifford Chance 2016, p.3).
Monitoring of realisation progress	Each bidder has to fulfill certain defined milestones before reaching COD. The auction guidelines define a Standard Date for Commercial Operation (SDCO) fixed at the end of the second year after the date of being awarded. The SDCO for the first auction was fixed for March 28, 2018. The bidders may have offered a date which was within a range of -/- 6 months of this SDCO (i.e. October 2017 to September 2018). For the second auction, the SDCO was fixed at January 1, 2019.
Exceptions from requirements for small plants/developers?	Neither exceptions nor requirements for small plants/developers apply.
Support auctioned	-Electricity generation-based support (+ CELs). -Total PPA revenue for the project: (A) Package price (B) unbalances (C) hourly adjustment factors.
Transferability of support right	The generator cannot sell/transfer any of its rights over the power plant to a third party unless the transfer has no material impact on the generator's operating or financial capacity, the transferee assumes all of generator's obligations, and relevant authorizations are obtained (Clifford Chance 2016).

2. Evaluation criteria for the assessment of auction schemes for RES-E

Actor variety and social acceptability

The IEA (2016) sees Mexico's long-term auctions "as an entry point for new players" (p.95), a feature also stressed by one interviewee. Indeed, a considerable amount of actors participated in the auction. In the first

auction: 103 asked for pre-qualification, 81 prequalified, 69 participated in the auction and 11 were awarded contracts. In the second auction, 84 asked for pre-qualification, 68 prequalified, 57 participated in the auction and 23 were awarded contracts (Poyry 2016, CENACE 2016b). The key players in this period have been international turbine manufacturers, utilities and equity funds, including ACCIONA, ENEL, Gas Natural, Iberdrola, EDF, Mitsui, CEMEX, Santander, Corporación Renovable, Mitsubishi, PGGM or Macquarie. Manufacturers participated in the auction because, for them, it was a good product distribution platform (modules represent 40-50% of total costs). A large number of projects are still in the pipeline of other market players such as Sowitec, MPG, WPMex, Soriana, Industrial Peñoles, Alarde, Vive, Aldesa, Comexhidro, Sempra, Eoliatec, among many others (Aymani 2016).
This high level of interest is related to several factors:

1) Investors perceiving Mexico as a country that has a vast potential for the development of renewable energy projects,Mexico's political and economic stability is a key factor attracting international players to participate in the process. The energy reform will also lead to more infrastructure investments to renew / improve the currently low efficiency of the energy distribution network (e.g., Mexico has still a high rate of energy distribution losses compared to other countries). Renewable energy projects are expected to benefit from this (lower interconnection costs).

2) A well-developed project finance sector, which was attributable to the PPAs having longer terms and being denominated in U.S. dollars rather than Mexican pesos (Levey and Martin 2016). According to IEA (2016, p.95), the long-term contracts (15 years for energy and capacity, and 20 years for clean energy certificates) provided some certainty for future cash flows, reduced risks and consequently the cost of capital. In addition, the availability of government secured loans served to reduce the cost of capital (IEA 2016). Although there is a penalty for indexing the payment to dollars, this possibility increased bankability of the projects compared to more restrictive local financing sources (among others: interests & term) and made it easier to obtain funding (ACERA 2016). One interviewee argued that this possibility was very beneficial for the success of the auction.

3) Regulatory clarity, transparency, stability and consistency. Transparency was praised by one interviewee and industry leaders (see Sarmiento 2016). A survey carried out by PWC (2016) among auction participants shows that 65% of the interviewees believed that the handbook of the auction was clear, whereas the Evaluation and Optimisation Program was not clear for 80% of the interviewed participants. Indeed, a 25% of the participants believed that the auction was not a success because more clarity on the final versions of the contracts was needed (PWC 2016). Martín (2016) claims that the program or algorithm for economic optimisation is complex. It allows the comparison of offers with different types of products, i.e., offers of electricity-only with offers of electricity, CELs and capacity. According to one interviewee, part of the regulation was a bit confusing and led to plenty of room for interpretation at the beginning (e.g., the PPA contract was still under discussion at the start of the pre-qualification process and the optimization process was unclear). This initial confusion about the interpretation of the rules and handbooks / guidelines might also be one reason that many interested parties participated in the first part of the tender process (obtaining the guidelines, information, pre-qualification request, etc.), but later neither presented the bid bonds nor a final (economic) bid. However the same interviewee argues that the Questions & Answers rounds during the

process helped to better understand the process and to clarify many issues raised in the initial handbooks / guidelines.

4) PPAs attracted participants. An interviewee stressed that the PPA with a public entity (CFE) was an adequate solution to make projects bankable and attract the interest of international investors and developers, with the 15 years term of the PPA deemed sufficient to obtain an acceptable project finance structure.

This high participation led to strong competition (and low pricing) according to several analysts (e.g. Levey and Martin 2016). Apart from the fact that international investors showed a strong interest in these auctions (Clifford Chance 2016), an interesting feature was the participation of wind and PV manufacturers, which won considerable allocations. Manufacturer SunPower, for instance, was allocated PPAs for 500MW. According to McGovern (2016), half of wind's allocation went to groups that sell wind turbines".

Policy effectiveness (effectiveness of auctions)

Table 3 shows the results of the auction per technology and product. It can be observed that PV was awarded with most electricity and CELs in the first and second auctions (64%) with wind falling behind (35%). The dominance of PV might be related to five reasons. First, Mexico currently has a mere 66 MW of solar PV operational while, in contrast, Central America already has exactly ten times more, a grouping of six countries where financing and topography is considerably more complex (James 2017). Second, Mexico has comparatively very strong solar resources and more limited wind resources (Aymani 2016). Third, price adjustments favoured states like Yucatan and Baja California Sur, which have comparatively better solar radiation than wind resources. This is also the interpretation of IEA (2016, p.74), for which the strong proliferation of solar PV reflects the inclusion in Mexico’s market design of a measure of relative value to the system based on project location. Fourth, there were already a large number of solar developed projects ready to bid (Martín 2016). The high participation of PV in the first tender was not a surprise, because of its shorter development period compared to other technologies (e.g. wind) and the availability of a huge pipeline of PV projects in an advanced stage of development, according to one interviewee. Fifth, manufacturers of solar PV participated as project developers in order to place their product in the market, being able to offer very competitive prices (Martín 2016). One interviewee argues that, in the future, and as already shown in the second auction, participation of other technologies (wind, geothermal, hydro, CCGT projects) will increase because they are able to offer capacity and / or higher load factors, which is a plus in order to be awarded in the tender process.

Table 3. Electricity, CELs and capacity awarded per technology.

	FIRST AUCTION			SECOND AUCTION		
	ELECTRICITY (MWh)	**CELS**	**CAPACITY (MW)**	**ELECTRICITY (MWh)**	**CELS**	**CAPACITY (MW)**
WIND	1920055	1920055	0	3874459	3828757	129
PV	3484825	3457856	0	4836598	4933382	184
GEOTHERMAL	0	0	0	198764	198764	25

HYDRO	0	0	0	0	314631	0
CCGT	0	0	0	0	0	849
TOTAL	5404880	5377911	0	8909821	9275534	1187

Source: Own elaboration.

Wind had higher shares in the second auction (43.5% of electricity and 41.3% of CELs) with respect to the first one (35.5% and 35.7%, respectively). According to Poyry (2016), the participation of wind has increased as a result of a number of factors including: (1) smaller expected price differentials between nodes, benefiting nodes with more wind potential, unlike the first auction, which heavily benefited the Yucatan peninsula; (2) more time to prepare for the auction and to progress the project to an auction-ready stage; (3) more energy being required by CFE, allowing projects further up the supply stack to be selected; (4) the possibility to sell their available capacity; and (5) more clarity over the auction/financing and risk of not obtaining a contract.

Finally, three technologies were awarded in the second auction and did not have a presence in the first one (geothermal, hydro and CCGT). Geothermal had small shares in both electricity and CELs in the second auction (and none in the first one). Hydro were only awarded CELs and CCGT was only awarded capacity (both in the second auction).

Despite a widespread opinion that the auction was successful regarding participation and the low support prices being provided, it is too early to tell about the success in terms of effectiveness, since it is unknown at this stage if the projects will be built. Indeed, some analysts are a bit concerned that the low prices in the auction may lead to ineffectiveness, i.e., that PV and wind players can build at those prices (e.g., McGovern 2016, Factor 2017). This concern is confirmed by one interviewee, given the uncertainties about the development status of each project. At the moment of the tender process, many projects were still in an initial development stage. Thus, the bid winners have assumed certain risks (e.g. about land suitability, environmental impact studies, interconnection capacity and interconnection costs), all of which are the responsibility of the awarded bidder. This interviewee suggests that, in order to guarantee a higher effectiveness, certain development criteria should be set as initial requirements for participation (e.g. evidence of connection capacity equal or higher than the project capacity, land secured, etc.).

Several factors may put the building of projects at risk, including the devaluation of the peso (by 15% since April 2016), the increase in the cost of capital (which, according to James 2017 has led to projects with tighter pricing from the second auction being put at greater risk), environmental impact assessments, land rights and grid connection. Environmental impact studies may find challenges at a number of levels: it is hurricane country, the topography is rocky and jungles are prevalent (and so flora & fauna may be affected by some of these projects). It is also the heart of Mayan civilization and they may encounter cultural and anthropological resistance (James 2017). According to IEA (2016, p.51), the fact that players are not obliged to demonstrate acquired land rights (they need to apply for necessary permissions only after the announcement of the results of the auctions) introduces the risk that not all projects will be implemented as planned (IEA 2016, p.51).[4] Finally, winning projects have no guarantee of securing interconnection agreements to meet commissioning deadlines (Poyry 2016).

Static efficiency or cost effectiveness (including transaction and administrative costs)

There is a common belief among different stakeholders that there was strong competition in the auction and that this has led to high static efficiency and low support costs. For example, according to Poyry (2016), the auction was deemed highly competitive by CENACE, offering at least twice the volume required. Competition may have even been stronger in the second auction, leading to IRRs of 6% for winning projects, which is below standard commercial benchmark rates for this type of projects (Poyry 2016).

The weighted average price in the first auction was $47.7 USD/MWh (it includes both electricity and CELs). This price is 43% lower than the annual average of the 50 local marginal prices published by SENER for 2016 and 26% lower than the estimated prices, which reflects the competitiveness of renewable energy in Mexico (PWC 2016). According to Poyry (2016), the second power auction also led to record low prices for clean energy with an average of 34.25 USD/MWh compared to a 42.73 USD/MWh in the first auction.[5] The average bid for wind projects was 35.7 USD/MWh, the highest accepted bid for wind (non-capacity bids) was more than 10% below the lowest accepted bid of the first auction.[6] The results for solar are similar, with average accepted bids being 33.85 USD/MWh (Poyry 2016).

Despite such low and declining prices, a simple analysis of the location of the winning projects suggests that these have not been deployed in the places with the best resources, i.e., allocative efficiency could have been improved. Figures 2 and 3 provide the resource potentials for wind and solar, respectively, whereas table 4 compares the capacity of the projects being awarded with their location in terms of resources potentials in the second auction.

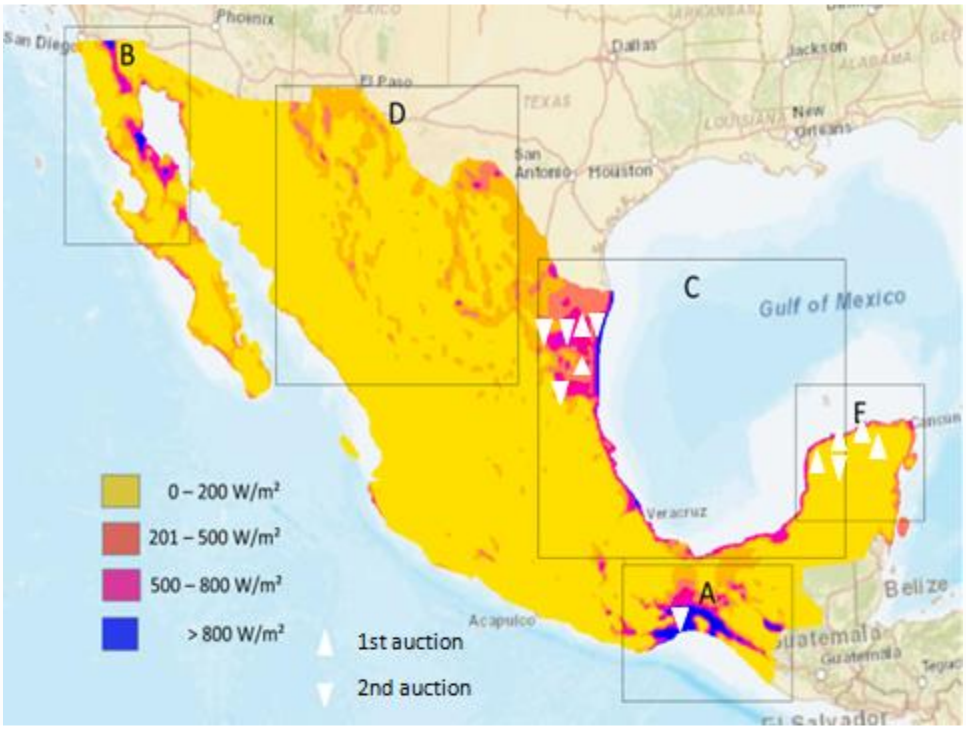
For example, wind energy projects in the first auction are to be deployed in Tamaulipas (336MW) and Yucatan (226MW). While the former has an excellent wind resource, the later does not. The regions with more capacity for wind power are Istmo de Tehuantepec (Oaxaca) and la Rumorosa (Baja California)(Salgado 2016).

[4] This is the case in the Yucatan Peninsula, where most of the solar capacity was awarded in the first electricity auction in March 2016 and where there are significant historical sites and indigenous communities. Engagement with local communities is indispensable to a positive outcome: in Oaxaca, an area with considerable wind resources (but also with an important tradition of active social and indigenous movements), a project to install 132 wind turbines, with a total capacity of 396 MW, has encountered repeated challenges despite an eight month preliminary consultation period (the first of its kind)(IEA 2016, p.35).

[5] The differences between Poyry (2016) and PWC (2016) for the first auction can be explained by the different exchange rate used (19.3 Mexican Pesos (MXN) per US Dollar (USD) in Poyry 2016) and 17.3 MXN/USD in PWC (2016).

[6] Poyry (2016) warns that these prices do not represent the LCOE because projects are spreading their total cost over capacity, clean energy and CELs in different proportions and that it is not possible to discern the value of energy to calculate a LCOE from the packages. The calculations used in this note are the total cost of the project packages divided by the clean energy sold by the projects. See Poyry (2016) for further details.

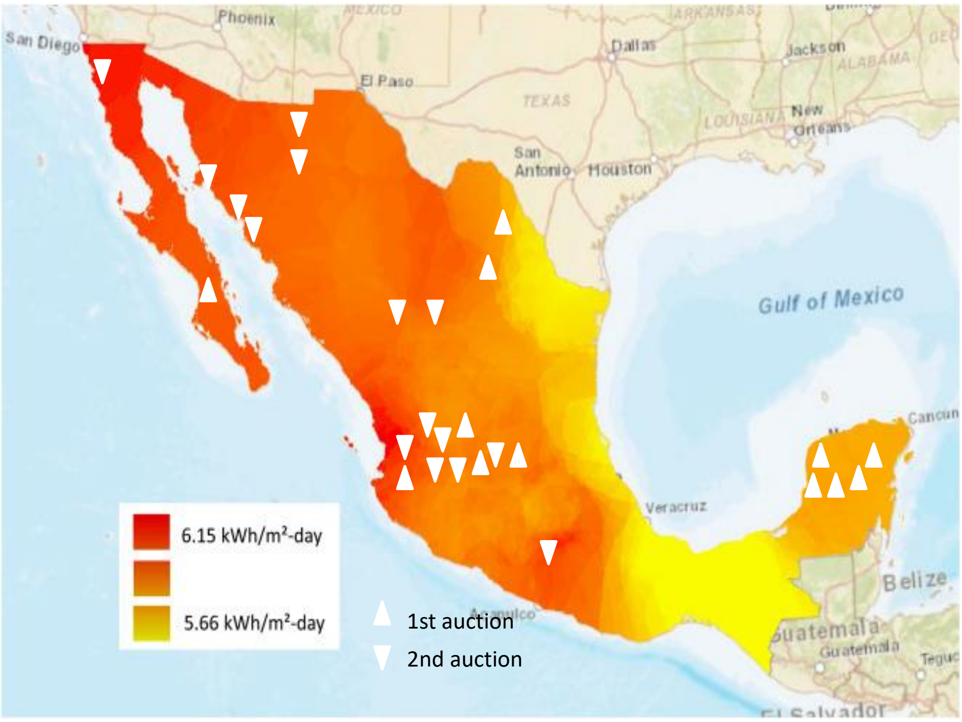
Figure 2: Atlas of wind source potential and approximate location of projects awardad in the first and second auctions.



Source: Own elaboration. Source of the wind atlas: Geographic information system for renewable energies. http://sag01.iie.org.mx/evaluarer/welcomeSIGER.html 2010. Cited in Alemán-Nava et al (2014).

Solar PV projects in the first auction are to be deployed in Guanajuato (307MW), Coahuila (600 MW), Aguascalientes (63 MW), Yucatán (1118 MW), Jalisco (100 MW) and Baja California Sur (23 MW). Baja California Sur has a very high irradiation level and Yucatán has a relatively low irradiation level in Mexico. Coahuila, Guanajato, Aguascalientes and Jalisco have intermediate irradiation levels. Places with the largest radiation (Baja California, Nayarit) and those with high radiation levels (Sonora, Chihuahua, Puebla, Guerrero) do not have any projects. One interviewee argues that only very large scale projects have been awarded because, taking into account the bid price levels awarded, these projects are more benefitting from economies of scale during development and construction and (proportionally) lower interconnection costs (typically high in Mexico).

Figure 3: Atlas of solar potential and approximate location of projects awarded in the first and second auctions.



Source: Own elaboration. Source of the solar atlas: Geographic information system for renewable energies. http://sag01.iie.org.mx/evaluarer/welcomeSIGER.html 2010. Cited in Alemán-Nava et al (2014).

Regarding the second auction, the geographical distribution of winning PV and wind projects as well as the corresponding wind and PV potentials in the respective states are shown in table 4. At first sight, and taking into account only renewable energy resource potentials, allocative efficiency seems to have increased in the second auction with respect to the first one, especially so in the case of wind projects. Apparently, many solar PV projects will be deployed in places with average solar resources.

Table 4. Geographical distribution of PV and wind energy projects in the second auction in Mexico.

STATE	PV (MW)	Solar resource	WIND (MW)	Wind resource
Sonora	755	Good		
Baja California	82	Excellent		
Chihuahua	376	Good		
Coahuila	468,24	Avg		
Aguascalientes	1355,34	Avg		
Guanajato	90	Avg		
Morelos	70	Avg		
Yucatán	180	Avg-low		
San Luis Potosi	600	Avg		
Tamaulipas			924,55	Excellent
Oaxaca			252	Excellent
Nuevo León			498	Good

Source: Own elaboration based on CENACE (2016b). Note: In addition to solar PV and wind projects, a geothermal project of 25 MW in Michoacán and a 68 MW hydro project in Puebla were awarded in the auction.

The locational signals in the first auction contributed to the location of projects in places without excellent solar or wind resources, i.e., the resource potentials were not optimized. In the first auction, SENER calculated future electricity prices for various locations across Mexico to assess the expected value of new investments and adjusted bids in the auction (IEA 2016). Every package bid was adjusted: the “good” locations (where nodal prices are high) were rewarded and the “bad” ones (those with lower nodal prices) were discouraged for bid comparisons in the auction (IRENA 2017, p.14). Strong signals tried to incentivize the location of new projects where they would most benefit the power system, as indicated by expected congestion prices obtained from a long term system simulation. The southeastern state of Yucatan and the southern tip of Baja California Sur in the west have the highest energy costs. Many authors provide examples of how the locational adjustment encouraged location of projects in places with worse wind or solar resource (see, e.g., McGovern 2016, PWC 2016, James 2017 and IRENA 2017).

However, the locational signals were significantly reduced in the second auction (the locational penalty decreased by 95%), as the auction focused instead on the quality of the resources (IRENA 2017). This has led to a more dispersed geographical distribution of the projects and higher capacity factors than in the first auction, contributing to the average price decrease between the first and second auction (Poyry 2016, IRENA 2017). Clearly, projects with the highest load factors have been the winners (Poyry 2016). This has further succeeded in lowering prices in the 2nd auction with respect to the first one (SENER 2016).

In terms of system costs (direct + indirect electricity generation costs, see del Río et al 2015 and Breischoft and Held 2013), the aforementioned inefficiencies are not so clear. The location of projects where they could benefit more the power system was encouraged, i.e., in those nodes with higher electricity generation costs (IRENA 2017). The aim was to ensure the choice of site and technology, which bring the most benefit (value) to the system (IEA 2016, p.96). This suggests that there might be a conflict between allocative efficiency and indirect costs. The auction tries to strike a balance between the two in order to minimise system costs (direct + indirect electricity generation costs).

Dynamic efficiency

The technological diversity in both auctions has been low, especially in the first one, when only wind and solar were awarded. In the second auction, wind and solar dominated, but there was a small share of geothermal, hydro and CCGTs. Less mature technologies, such as offshore wind and concentrated solar power (CSP) did not participate in the auction.

The expected contribution to the local supply chain is uncertain. On the one hand, Mexico has the largest manufacturing base of photovoltaic modules in Latin America, with a production capacity close to 1,220 MW/year (SunPower, Solartec, Kyocera, IUSASOL, Baja Sun Energy, Sanyo, ERDM Solar, and Jabil Circuit). But Mexico currently lacks a full wind supply chain (Salgado 2016).

Compatibility with market principles and integration

As mentioned above, the auctions in Mexico seek to capture the relative value for the system of various electricity generation technologies by location and production profile (IEA 2016). According to the IEA (2016), the Mexican auction, one of the alleged strengths of the Mexican auction is compatible with the wholesale market and the energy reform, whose main objective is liberalization, a market-oriented approach and the integration of RES in the electricity market.

Distributional effects & minimization of support costs

As mentioned above, the support costs have alleged been very low by international standards and were further reduced in the second auction with respect to the first one. The relatively low barriers to participation in the long-term auctions have encouraged private investors to enter the renewables market in Mexico (IEA 2016), which contributed to strong competition and low bids.

3. Lessons learnt: key best practices and pitfalls identified

The auction in Mexico is viewed as very successful by the Mexican government, different types of stakeholders and the IEA. Several lessons from this case can be derived:

- The Mexican case shows the feasibility to include regional and hourly adjustments in auctions. While this may lead to higher direct generation costs, lower indirect costs may more than offset these, leading to lower system costs. This consideration of the value of electricity supplied in different locations and hours is deemed a good practice, which can be applied in the future in auctions elsewhere.
- This case study also shows the positive contribution of several factors to participation and, thus, competition. Transparency, clear rules, information provision and stakeholder dialogue are clear facilitators of participation, by reducing the risks and costs of participation. In turn, this has positive effects on competition and, in the end, on bid prices.
- This case study shows that, contrary to the traditional view, which opposes different types of instruments and design elements (FITs vs. auctions and TGCs vs. FITs), auctions can be combined with other RES-E support instruments. In particular, TGCs can be fitted into RES-E auctions.
- Finally, this case suggests the appropriateness to homogenise the auction procedure and the interconnection process, as recommended by del Río and Linares (2014). Those winning in the auction did not have the certainty that they would obtain the interconnection. Indeed, one interviewee indicates that this was the case in the first auction.

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