RENEWABLE ENERGY AUCTIONS: FROM LEARNING CURVES TO A BETTER ARTICULATION OF STRATEGY, DESIGN AND PORTFOLIO

Kazakhstani's case study

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Content

1) Introduction

This case study aims to identify how the renewable energy sector has matured in an accelerating manner over the past 20 years, with falling costs of new technologies, mostly solar and wind. We underscore how the auction system has contributed to this trend, as a useful alternative for setting of the remuneration of renewable energy projects. [Del Rio, 2017][1] Auction popularity reflects its ability to achieve deployment of renewable electricity in a well-planned, cost-efficient and transparent manner while also meeting other development objectives, such as domestic value creation and ownership. [IRENA, 2017][2]

Figure 1. Number of countries that have adopted auctions mechanisms, IRENA reports from 2013-2019

The latter aspects suggest a sense of trade-offs that ought to be understood as auctions applied to renewable energy auctions taking part in an energetic system and an economic ecosystem.

Auction literature was first structured by IRENA's contributions since 2013, which then led to a better understanding of auction strategies and mechanisms that could be adopted for countries based on political and economic structures and their energy resources in a sorted, logical framework from larger to fine-tuned decisions on parameters. On further examination based on academic literature analysis, renewable energy drop prices and expected auction revenue for auctioneers appear as the main argument in favor of auction development and implementation. In fact, the notion that renewable energy support auctions have increasingly been perceived worldwide as a good alternative to other instruments to control the renewable energy support

[1]del Río, P. (2017). Designing auctions for renewable electricity support. Best practices from around the world. *Energy for Sustainable Development*, *41*, 1-13. https://doi.org/10.1016/j.esd.2017.05.006
[2]*Renewable Energy Auctions : Analysing 2016*. (2017). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf

costs generated by the auction are subsequently well traceable. [Haufe & Ehrhart, 2018][3] Bidders who can supply the renewable energy at the lowest costs are awarded. The reduction of support costs and the identification of the "best" suppliers with respect to predefined targets and criteria are gaining importance. [Haufe & Ehrhart, 2018][4] The advantage of renewable energy auction schemes compared to other supportive policies, including direct negotiation, lies in their potential to achieve lower prices by stimulating competition, as well as in their flexibility, transparency and ability to ensure certainty in price and quantity. [Hansen, Nygaard, Morris, Robbins, 2020][5] Establishing a strong legal and policy renewable energy auction framework is also pointed out by the academic literature as an essential ground to implement an efficient and stable auction system. Indeed, integrating an adequate regulatory framework aims to guarantee a successful integration auction towards investors attractiveness. It is understood that the auctioneer must set rules and obligations that are fair and transparent to the various stakeholders and clearly communicated to all competitors on an equal basis. Auction public policies and rules must nevertheless ensure certain coherence with their existing system. Therefore, the auction system must be articulated with regulatory continuity and coherence of integration into the power system. Different criteria, such as price, socio-political, geographical and technology conditions, among others are relevant for auction awards. [IRENA, 2015][6]

Auctions studies have shown that institutional quality is one of the key factors in attracting investments, in particular for auction investments. Well-functioning conflict resolution mechanisms and transparent administrative procedures support innovative activities and attract foreign investments to new and risky areas.[7] [8] Inconsistent policies and regulations, unfavorable investment environment and the lack of transparency in bureaucratic processes in developing economies create

[3]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027
[4]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027
[5]Hansen, U. E., Nygaard, I., Morris, M., & Robbins, G. (2020). The effects of local content requirements in auction schemes for renewable energy in developing countries : A literature review. *Renewable and Sustainable Energy Reviews*, *127*, 109843. https://doi.org/10.1016/j.rser.2020.109843
[6]*Renewable energy auctions : a guide to design*. (2015). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf
[7]A.R. Keeley, K. Matsumoto, Investors' perspective on determinants of foreign direct investment in wind and solar energy in developing economies Review and expert opinions; J. Clean. Prod., 179 (2018), pp. 132-142, 10.1016/j.jclepro.2017.12.154
[8] *An analysis of Turkey's solar PV auction scheme : What can Turkey learn from Brazil and South Africa?* (2021, 1 janvier). ScienceDirect. https://www.sciencedirect.com/science/article/pii/S0301421520306443#bib47

higher risks and transaction costs for renewable energy investments. (OECD/IEA, 2016)[9] For example, the South African approach uses a specialized task force composed of various agencies which is more reasonable for developing economies to minimize regulatory risks in renewable energy auctions. In Brazil, administrative and permitting problems caused delays and cancellations in solar PV auctions wereas South Africa has a specialized procurement unit with significant experience that implements auctions, which has helped to reduce bureaucratic hurdles. (Eberhard et al., 2018)[10]

Over time, renewable energy auction literature has become more specific, leading to the clarification of main auction actions across countries. This learning curve led to the articulation of the main objectives and strategies to be adopted as well as the variables to be integrated into the auction design and portfolio. The following timeline (Fig.2) allowed us to highlight that in auction methodology there is a time of practice and a time of theory. Through our analysis, we tried to make a bridge between practice and theory with a more specific and detailed approach of strategy, design and portfolio.

[9] IEA. (2016). Re-powering Markets: Market Design and Regulation During the Transition to Low-carbon Power Systems. IEA.
[10] *Kruger, W., & Eberhard, A. (2018). Renewable energy auctions in sub-Saharan Africa: Comparing the South African, Ugandan, and Zambian Programs. Wiley Interdisciplinary Reviews: Energy and Environment, 7(4), e295.*

Figure 2. The timeline on auctions learning (source: author, based on author's survey on Science Direct)

We identified that to ensure a successful roll-out and integration of an auction system, it is necessary to understand the political, economic, technological- and energy system issues and the importance of developing a flexible, integrable and replicable system based on an efficient auction strategy, design and portfolio adapted to country specifics. Without this, the auction systems' understanding could not be comprehensive, both at macroeconomics and technical levels. To establish an efficient system, each auction approach must combine both components.

To explain what it is developed above, we conducted an analysis which lays the elements of designing a methodology support to conduct renewable energy auctions in the scope of country experiences, identifying the more or less effective auction system, sorting the mechanisms and processes that can be replicable to other countries, which could contribute to the acceleration of the renewable energy market. In this sense, it is essential to highlight that auctions are

implemented as a method of choice [Haufe & Ehrhart, 2018][11] that we identified as drivers to strategic choices to determine which criteria are the most appropriate and suitable based on country specifics, realities and government objectives toward energy transition. This is the reason why, it may differ among countries and even change over time [Haufe & Ehrhart, 2018][12]. Once established by a country, it must be part of a long-term strategy at several levels, whereas technical, economic, political, social than territorial. To that extent, we believe that a greater introduction of the auction system should depend on country energy ambition and their ability to attract investors, more specifically on a precise definition of auction strategy, design and portfolio. In order to explain this methodology, we decided to develop it through the experience of Kazakhstan thanks to previous country experiences analysis.

We understand by auction strategy that it will depend on country planning and energy capacity to choose the most appropriate auction technology. Specifics require choosing between auction strategies in order to implement renewable energy infrastructures. Depending on what a country plans, it will have to choose between two main auction strategies: technology-specific auctions and technology neutral auctions. Concerning design, it is defined as the set of components and parameters that have to be taken into account during the whole process to enforce auctions by the system planner: auction demand, qualifications requirements, winner selection process, and seller's liabilities. Finally, what we mean by portfolio the volume is the time horizon of renewable energy capacities, possibly with technology-mix minimum requirements, a phasing of energies inclusion in rows of auctions. Going purely beyond energy addition, a portfolio of auctions, as it targets low prices, builds along payment mechanisms for the winner and risk mitigation, and ultimately, in our mind, an underlying factor of a successful portfolio goes up to specifications in addressing underlying questions like grid and system integration. The portfolio aims to establish a series of effective actions to attract new investors, international or local, by proving the reliability of the market and the prospects of profitability over the long term.

[11]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027
[12]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027

2) Theoretical approach: developing a support methodology for renewable energy auctions through strategy, portfolio and design

In the race for green transition, global investments towards renewables are gaining ground in multiple ways. Many governments have gone forward to renewable energy auction as a mature scheme, such as renewables price may not be an additional barrier, specifically in emerging countries that lack internal investment means. Renewable energy auctions have become a model policy instrument to stimulate investment in clean energy. An auction is defined as a mechanism or an institution [Kirshna, 2009][13] that refers to competitive bidding procurement processes for electricity from renewable energy where those technologies are eligible. The auctioned product can be either capacity (MW) or energy (MWh). [IRENA, 2017][14]

Conventionally, an auctioneer procures a previously fixed amount of renewable generation capacity. Bidders may develop several projects of different capacity size. Bidders submit a bid for each project, specifying the size (MW) and the required subsidy per MWh of electricity generated from that project. The auctioneer gathers bids and choses winning bidder. [Matthäus, 2020][15]. In a simple demonstration, auctions follow three principles steps: first, bids are binding. Second, the bids are chosen, according to a pre-specified evaluation rule based on requirements and criteria. And third, the named bidders will perceive their bid price. [Haufe, Ehrhart, Steinhilber, Del Rio, Wigand, Ortner, 2016][16]

2.1 Methodological choice and drivers to strategic choices: country experiences analysis to design a methodology support for renewable energy auctions

Thanks to the existing renewable energy auction literature, we identified the articulation of the main objectives and strategies to be adopted as well as the variables to be integrated in the auction design. In a way to identify an efficient and replicable methodology support for renewable energy

[13]Krishna, V. (2009). *Auction theory*. Academic press.
[14]*Renewable Energy Auctions : Analysing 2016*. (2017). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf
[15]Matthäus, D. (2020b). Designing effective auctions for renewable energy support. *Energy Policy*, *142*, 111462. https://doi.org/10.1016/j.enpol.2020.111462
[16]AURES. (2016). *Assessment of Auction Types Suitable for RES-E* (Report D3.1). https://auresproject.eu/publications/assessment-of-auction-types-suitable-res-e

auctions, it has been necessary to look at several countries that experienced auctions over the past decades. We mainly focused on Brazil, South Africa, Turkey, India and Germany as key countries by studying their administrative processes and regulatory environment, their consistency with policy targets and with the internal electricity market regarding those countries renewable energy auctions experiences.

AUCTION METHODOLOGY	COMPONENTS (selection)	BRAZIL	SOUTH AFRICA	TURKEY	INDIA	GERMANY
STRATEGY	Technology neutral	X				X
	Technology specific		X	X	X	X[1]
	Site specific	X	X[2]	X	X	X
	Site neutral		X[2]			X
	Project specific	X	X[2]		X	
DESIGN	Decreasing price	X	X	X	X	X
	Accelerating RE development	X	X	X	X	X
	Low technological and reputation requirements					X
	High technological and reputation requirements		X			
	Local content requirements (LCR)	X	X	X		
	Socio-economic developement	X	X		X	
PORTFOLIO	Local currency	X	X	X	X	
	Inflation prices risks	X	X	X		
	Securing grid access	X	X			
	Aggressive to limit risks and enhance resilience by levelized costs parameters				X	X
	Auction planning through a defined capacity for a target horizon	X			X[3]	X

1. Technology-specific is only required for wind projects. Flexibility to attract investors is seeking. Technology neutral is commonly required to location of projects in the auction selection
2. Technology/site/project specific are aimed to support local development industry for a given technology, location, capacity, volume, need and strengthen domestic supply chains
3. Only for solar projects

Figure 3. Synthesis of country experiences analysis to *design a methodology support for renewable energy auctions (based on IRENA reports analysis 2012-2019)*

Based on country experiences, we suggested that the best regulatory practices as strategic choices should include a strong, efficient, inclusive, transparent and long term auction framework and a flexible integration of energies auctioned to the national grid system. Drivers to strategic choices aim to constitute a logical-and implementation flow of an auction processes and mechanisms depending on energy prices, time implementation, project location and inclusion to the grid, promoting local project developers, anticipating energy demand increase through a three stages methodology: strategy, design and portfolio. We agree on the Matthäus statement [Matthäus,

2020][17] that the literature is predominantly aligning on design elements as the major matter of auction models and essential to auction implementation. For us, it is necessary to integrate the strategy, design and portfolio in the auction model as essential to the great auction implementation.

2.2 Auction strategy: specificity or neutrality chosen based on country ambitions, needs and characteristics

Auction strategies ought to be considered for the policy goals they fulfil, then stress-tested within a given national regulatory-cum-market trajectory, to address whether they can lead to some distortion. Ultimately, the payment shall very likely be a trade-off between regulatory stability and avoiding distortions. This is one the most important reasons for introducing several rows of auctioning and some amount of caution in terms of setting a not so over ambitious portfolio of the first rows, even if the country is in a spree to add renewables.

The basic principles of auction strategies are as follows: technology neutral auctions allow accelerating the whole renewable energy market, while technology specific grant developing one type of energy. The level of competition in the auction is determined by the diversity of technologies that can compete, the volume that is auctioned, and the level of participation of bidders in the auction. In deciding how to split products and volumes, auctioneers must choose between technology-specific and technology-neutral auctions. The IRENA reports [IRENA, 2015, 2017, 2019][18] defined the two auctions strategies to foster renewable energy development as:

- Technology-specific auctions can be interpreted as imposing qualification requirements to the bidders regarding the renewable energy source to be trapped and in some cases the generation technology itself. Technology-specific auctions are used as a first "push" favouring matures and depending on the successes of the auction. Technology-specific

[17] Matthäus, D. (2020b). Designing effective auctions for renewable energy support. *Energy Policy*, *142*, 111462. https://doi.org/10.1016/j.enpol.2020.111462

[18] *Renewable energy auctions : a guide to design*. (2015). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf ; *Renewable Energy Auctions : Analysing 2016*. (2017). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf ; *Renewable energy auctions : status and trends beyond price*. (2019). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RE-Auctions_Status-and-trends_2019.pdf

auctions have the potential to further reduce prices due to resulting development of the technology, as well as provide additional guidance to developments.

- Technology-neutral auctions help identify the cheapest technology in the country. If the goal is minimizing costs, a technology-neutral auction can be introduced, allowing competition between multiple technologies- including conventional sources, therefore favouring the more mature and cost-competitive. Technology-neutral auctions reduce the risk of undercontracting due to high level of participation of potential project developers in the bid.

Existing debate on technology neutral or specific

A major issue is knowing whether a country wants or is able to choose a technology specific or neutral sort of auction based on a timeframe it sets for itself, willingness to engage into a learning and adjusting or fine-tuning process as a sort of "repeating game", further refined across classification of modalities also considered here as design.

The recent literature has highlighted that the auction trends have been leaning towards technology-neutral. However, the innovation literature also emphasizes that technology-neutral can also have an impact on technology diversity, which is a major element for energy security. [Kruger, Nygaard, Kitzing, 2021][19] The diversity of technologies is an important outcome of the auctions as they will have varying reactions to sensitivity to changes in the levelized cost of electricity; if the levelized cost of electricity can vary significantly, then the cost competitiveness of two technologies, solar photovoltaic and onshore wind, can vary significantly. Technologically neutral auction can affect the cost competitiveness of different technologies and thus, in effect, undermine technological diversity, which is actually the case for Brazilian experience. It aims to ensure energy capacity addition at competitive costs and enhance competitiveness between renewables and conventional energy in Brazil.[20] While technology neutral policies in the first rows of auctions may be a good option to select cost-effective bidders at current conditions,

[19]Kruger, W., Nygaard, I., & Kitzing, L. (2021). Counteracting market concentration in renewable energy auctions : Lessons learned from South Africa. *Energy Policy*, *148*, 111995. https://doi.org/10.1016/j.enpol.2020.111995

[20] *Renewable energy auctions : status and trends beyond price*. (2019). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RE-Auctions_Status-and-trends_2019.pdf

complementing them with rebalancing technologic-specific auctions – and a precisely defined portfolio - may limit this risk of undermining diversity, and enhance resilience by levelized costs parameters. Technology-specific may require higher policy costs; however, it can also foster the diversity of future technology options and prevent lock-in of the energy system into only a few technologies. [Haelg, 2020][21] Technology-neutral policy typically results in markets picking the currently cheapest and mature technologies, which offer the highest short-term efficiency by excluding premature, more expensive technologies. In theory, technology-neutral policy should thus thwart technology diversity. In practice, however, it is a challenging task to design truly technology-neutral auctions without unintentionally favoring one or another technology. [Haelg, 2020][22]

2.3 Auction design as key parameters and guidance to be developed for auctioneer

Here we appraise auction design as being purely parameters and modalities which need to be integrated to the auction process and mechanisms. There is a consensus in the academic literature that considers technology auction, both neutral and specific, as a design element. In our approach, it is important to distinguish between what is within the purview of the strategy to be adopted and what is associated with the design. In the choice between technology neutral auction and technology specific auction, promoting competition and avoiding under contracting are strategic points, while simplicity, price revelation efficiency and guidance from auctioneer are rather aspects of auction design to be integrated. The main challenge in action design is the balance between cost-efficient procurement and high post-auction realization i.e effective procurement. [Matthäus, 2020][23] In this sense, we agreed on IRENA's definition for auction design elements [IRENA, 2015][24] that encompass trade-off between the most appropriate or the lowest price and the governmental renewable energy objectives and ambitions based on four features:

[21]Haelg, L. (2020). Promoting technological diversity : How renewable energy auction designs influence policy outcomes. *Energy Research & Social Science*, *69*, 101636. https://doi.org/10.1016/j.erss.2020.101636
[22]Haelg, L. (2020). Promoting technological diversity : How renewable energy auction designs influence policy outcomes. *Energy Research & Social Science*, *69*, 101636. https://doi.org/10.1016/j.erss.2020.101636
[23]Matthäus, D. (2020b). Designing effective auctions for renewable energy support. *Energy Policy*, *142*, 111462. https://doi.org/10.1016/j.enpol.2020.111462
[24]*Renewable energy auctions : a guide to design*. (2015). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/Jun/IRENA_Renewable_Energy_Auctions_A_Guide_to_Design_2015.pdf

- Auction demand constitutes the auctioned volume and how it is shared between technologies and project sizes.
- Qualification requirement sets requirements for future participants in the auction.
- Winner selection process defines how the supply curve information is collected and bases on what criteria the winner is selected.
- Seller's liabilities on investors sets specific compliance rules to ensure high implementation rate of awarded projects in a timely manner and to decrease risk allocation.

Depending on the government's policy objectives, some design elements may make more sense than others. First of all, if efficiency of deployment is the primary objective, then it is particularly advisable to assess the possibility of implementation, impose strict prequalification requirements, conduct site-specific auctions, coordinate auction and administrative procedures, and allow sufficient lead time and construction time. Then, if minimizing support costs is the government's priority, single-price auctions, low prequalification requirements, no local content requirements, on-site auctions, long lead times, long duration of PPAs (Power Purchase Agreements), provision of resource measurements, and multiple cycles are preferable. Lastly, if local economic development is a primary objective, then local content rules can make sense, provided there is a minimum production capacity in the country.

The auction literature also defined the auction design based on how the bidding programme is structured [Kurger, Nygaard, Kitzing, 2021][25] and how the auction design has a direct influence on auction outcomes for policymakers, auctions participants and winners. [Haelg, 2020][26] Regarding worldwide auction best practices, the auction design should include a schedule, volume disclosure, price ceilings, penalties and administrative procedures and provision information for participants. [Del Rio, 2017][27]

[25]Kruger, W., Nygaard, I., & Kitzing, L. (2021). Counteracting market concentration in renewable energy auctions : Lessons learned from South Africa. *Energy Policy*, *148*, 111995. https://doi.org/10.1016/j.enpol.2020.111995
[26]Haelg, L. (2020). Promoting technological diversity : How renewable energy auction designs influence policy outcomes. *Energy Research & Social Science*, *69*, 101636. https://doi.org/10.1016/j.erss.2020.101636
[27]del Río, P. (2017). Designing auctions for renewable electricity support. Best practices from around the world. *Energy for Sustainable Development*, *41*, 1-13. https://doi.org/10.1016/j.esd.2017.05.006

Existing debate on low or high criteria

The implementation of these auction design elements depend on the good will of the governments according to their objectives and ambitions toward renewable energy development. The auction design elements establishment is not based on any precise procedure and consensus. Auctions are designed to be a suitable instrument for renewable energy development and integration. The appropriate choice of the auction design and the market framework crucially depends on the political and economic targets as well as on the expected economic and technological development particularly of the renewable energy and electricity markets. [Haufe, Ehrhart, 2018][28] There are worldwide trends towards the way requirements are set and how low or high criteria regarding qualification requirements are expected in the auction participation and rows. First of all, participation may be increased through a transparent and simple auction design with low participation barriers. [Haufe, Ehrhart, 2018][29] but it may lead to a low projects realization rates in time or even not at all by awarded bidders. While high prequalification (physical/financial) in an auction design could contribute to high financial costs for auctioneers and participants but could prevent from default risk. [Matthäus, 2020][30] Based on country experiences, flexible policy auction is essential as a support tool in favor of policymarkers and bidding participants on the applicability of auction types and certain design specifications for country specifics. [Haufe, Ehrhart, Steinhilber, Del Rio, Wigand, Ortner, 2016][31] Consistency with policy targets is important to provide market confidence to investors. However, targets can change to focus on specific objectives and respond to priorities. South Africa is a good example in this sense. South Africa designed auction mechanisms based on local realities, specificities and needs. The Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) has been established in 2011 as a tender process and is considered a pioneer structure for auctions program adapted to specific objectives for a country. The REIPPPP can provide key lessons for developing

[28]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027
[29]Haufe, M.-C., & Ehrhart, K.-M. (2018b). Auctions for renewable energy support – Suitability, design, and first lessons learned. *Energy Policy*, *121*, 217-224. https://doi.org/10.1016/j.enpol.2018.06.027
[30]Matthäus, D. (2020b). Designing effective auctions for renewable energy support. *Energy Policy*, *142*, 111462. https://doi.org/10.1016/j.enpol.2020.111462
[31]AURES. (2016). *Assessment of Auction Types Suitable for RES-E* (Report D3.1). https://auresproject.eu/publications/assessment-of-auction-types-suitable-res-e

countries looking to design, run competitive auctions and control auction demand. (IRENA, 2018)[32] Flexibility towards local market and needs is sought in South Africa. Auction policy flexibility contributes to a repeated conduction of an auction and creates an auction systematical experience for the country which also provides a strong reputation and transparency system among international and local investors.

2.4 Auction portfolio as key components to energy system implementation into a country

Portfolio depends on country strategies, capacities and energy potential. The composition of a country's energy portfolio will depend on its energy resources and its willingness to accelerate/develop its energy transition toward renewable energies. By portfolio, here we mean the volume, time horizon of renewable energy capacities, possibly with technology-mix minimum requirements, a phasing of energies inclusion in rows of auctions. Going purely beyond energy addition, a portfolio of auctions, as it targets low prices, builds along payment mechanisms for the winner and risk mitigation, and ultimately, in our mind, an underlying factor of a successful portfolio goes up to specifications in addressing underlying questions like grid and system integration. The renewable energy portfolio will also depend on the country's ability to attract investors to develop this type of energy. The composition of a country's portfolio is established over time but must follow a precise strategy that targets the energies to be developed. The aim is to establish a series of effective actions to attract new investors, international or local, by proving the reliability of the market and the prospects of profitability over the long term. In other words, a portfolio represents ever component that impacts the national energy system. For example, Brazil developed an energy portfolio based on its domestic resources and priorities: energy demand, access to grid, development times. Despite volatility linked to economic instability, auctions have nonetheless made it possible to reduce the price of renewable energies.

[32] *Renewable energy auctions : Cases from sub-Saharan Africa*. (2018). IRENA. https://www.irena.org/publications/2018/Apr/Renewable-energy-auctions-Cases-from-sub-Saharan-Africa

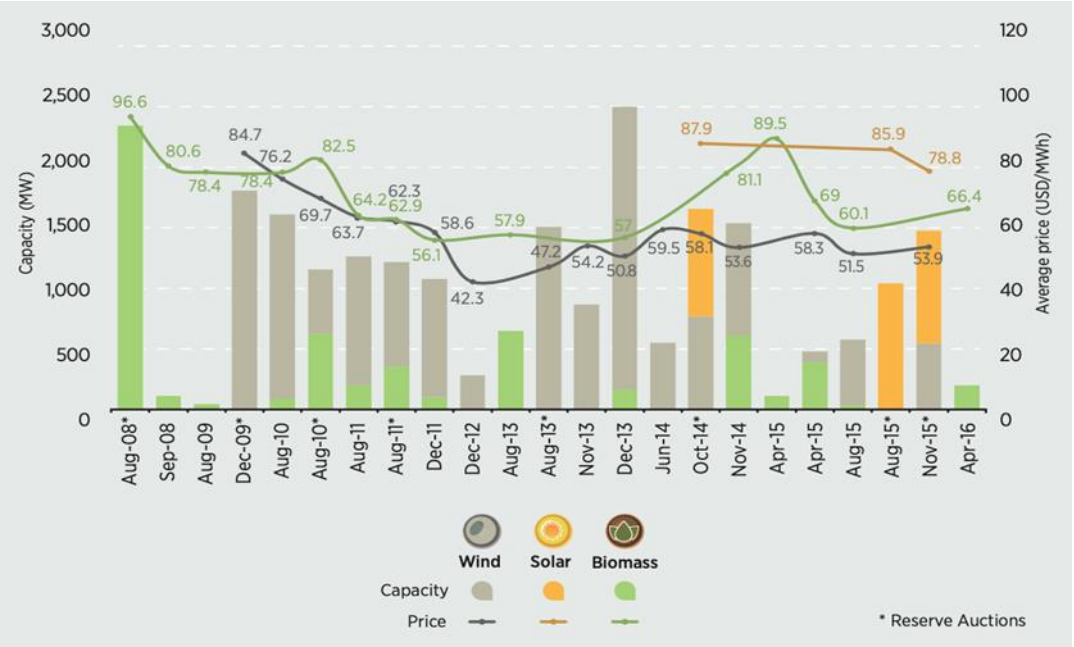

Figure 3. Contracted capacities and average prices resulting from the auctions in Brazil, 2008-2016[33]

It is true to say that some aspects, in particularly in terms of payments are very close to being design elements. In our approach two components were relevant for country's portfolio analysis:

Integration into the national energy system and the landscape

Despite sometimes high ambitions in terms of renewable energy, it is important for a country to intake energy production into the existing grid. To do this, it may be important that integration into the grid is factored in early in the auction process. To measure an auction success, transmission infrastructures, when not yet entirely in place, constitute a crucial element to integrate new renewable energy projects and capacities. In Brazil cost-benefit index projects have been developed to adapt to the actual system in order to accelerate renewable energy integration and energy transition. (IRENA 2019)[34] Also in South Africa, the REIPPPP proposes tenders to

[33] *Renewable Energy Auctions : Analysing 2016*. (2017). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf
[34] *Renewable energy auctions : status and trends beyond price*. (2019). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RE-Auctions_Status-and-trends_2019.pdf

facilitate grid-connected renewable energy generation. (IRENA, 2018)[35] Grid-connection is commonly linked to specific zones development. Specific zones and locations auctions are increasingly appropriate for local development, renewable energy integration support and socio-economic development promotion in region badly distributed in terms of energy infrastructures. Different regional auctions aim to ensure a minimum amount of the system required in a specific area. Location specific auctions, in which land and grid access are provided by the government yield lower prices than auctions in which the developer is responsible for securing grid access and covering all or part of the site costs. (IRENA, 2017)[36]

Risks mitigation

Risks, such as financial and production may impact stakeholders (bidders, auctioneers, off-takers, financial institutions, consumers), which involve the following elements:

- Payment to the winner
- Commitment bond, schedule for contract signature, commencement of commercial operations
- Production and financial risks
- Curtailment
- Penalties for delays and underbuilding and contract duration

To illustrate these elements, exchange rate stability is a good example, among others. Exchange rate stability is recognized as one of the main factors for foreign investors in renewables in developing countries. (Keeley, Matsumoto, 2018)[37] In these countries, USD currency is pegged for support schemes and not local currency. Among 13 developing countries, only South Africa, India and Brazil used local currency in renewable energy auctions since local currency reduces financial

[35] *Renewable energy auctions : Cases from sub-Saharan Africa*. (2018). IRENA. https://www.irena.org/publications/2018/Apr/Renewable-energy-auctions-Cases-from-sub-Saharan-Africa
[36] *Renewable Energy Auctions : Analysing 2016*. (2017). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Jun/IRENA_Renewable_Energy_Auctions_2017.pdf
[37] A.R. Keeley, K. Matsumoto, Investors' perspective on determinants of foreign direct investment in wind and solar energy in developing economies e Review and expert opinions, J. Clean. Prod., 179 (2018), pp. 132-142,

liability on government. (Dobrotkova, Surana, Audiet, 2018)[38] It is necessary to highlight that financing costs are higher in developing countries. Macro-economic shocks lead to an important gap between company debt due to foreign currency and revenue as project capacity grows. For example, Turkey has similar credit ratings and macroeconomic conditions with Brazil and South Africa; therefore, Turkey may consider using local currency with indexation to inflation rate. While it can be argued that it would be difficult to obtain cheaper finance, Turkish state-owned banks may provide favourable finance for the Renewable Energy Resource Zone (RERZ) project as done in Brazil. (Sirin, Sevindik, 2021)[39]

A country's portfolio will have to evaluate its energy capacities and the means to anticipate the risks related to the auction system. Among these risks, integration into the energy system must be considered as a priority. In the auction process, the steeper the learning curves of the system, the more levers are highlighted to limit the risks. For instance, pay-as-bid is the most common method to determine the payment to winner. This system involves less risk for developers and off takers because the remuneration is fixed before the contract is signed. However, other methods can be well adapted such as in Germany or India depending on the country's willingness to allocate risks and strategies. Both countries have introduced aggressive processes for auctioneers to reach low prices, which may lead to other risks. Contracts can be re-negotiated with bidders after the auction to match the lowest bid. (IRENA, 2019)[40] In Germany, a uniform pricing mechanism chooses by setting the highest bid that aims to push projects developers to participate in the auction process by offering a higher remuneration than what was bid. (IRENA, 2019)[41]

[38]Z. Dobrotkova, K. Surana, P. Audinet, The price of solar energy: comparing competitive auctions for utility-scale solar PV in developing countries, Energy Pol., 118 (2018), pp. 133-148,
[39]Selahattin Murat Sirin, Irem Sevindik, An analysis of Turkey's solar PV auction scheme: What can Turkey learn from Brazil and South Africa?, Energy Policy, Volume 148, Part A, 2021, 111933,ISSN 0301-4215,
[40]*Renewable energy auctions : status and trends beyond price*. (2019). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RE-Auctions_Status-and-trends_2019.pdf
[41]*Renewable energy auctions : status and trends beyond price*. (2019). IRENA. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Dec/IRENA_RE-Auctions_Status-and-trends_2019.pdf

3) Kazakhstan's case study

Kazakhstan is a large territory that has the opportunity to develop renewable energy based on its significant potential. Kazakhstan endeavors to diversify its economy by implementing programs. This aims to modernize and accelerate innovation toward greener activities in order to be less dependent on hydrocarbon and its neighboring countries. The government of Kazakhstan has developed several programs and laws to target renewable energy objectives which can be deployed over time. In 6 years, Kazakhstan did more than double its renewable energy facilities, which indicates that this sector is attractive and will contribute, to diversify the energy mix and the national economy. By introducing auction into its renewable energy development, Kazakhstan aims to drop prices and attract foreign investment. Thanks to international support from international institutions, such as UNDP[42] and USAID[43], an effective and transparent auction mechanism has been established. It is now the concern to deepen this system and ensure its long-term viability.

In the auction experience of Kazakhstan, the auction system had been in place since 2018. On paper, a strong system was consistent before we looked at its auction strategy, design and portfolio. Our methodology allowed us to highlight structural issues and realities on the ground specific to each country. It would probably not have been possible to identify without a fine analysis of those three components. Based on this, we build recommendations for the country to accelerate and anchor in time renewable energy auctions and in parallel accelerate the construction of new infrastructures relevant to renewable energy in line with the Kazakh government's ambitions and its capacities and needs.

3.1 Kazakhstani auction experience

Renewable energy auctions are considered successful, effective and transparent in Kazakhstan, as a framework has been implemented thanks to international institutions support and a massive

[42] Derisking Renewable Energy Investment (DREI) Kazakhstan, UNDP, 2017 *DREI Kazakhstan*. (2017). United Nations Development Programme. https://www.undp.org/publications/drei-kazakhstan#:%7E:text=UNDP%20is%20working%20with%20the,small%2Dscale%20renewable%20energy%20investments

[43] *Investor's guide to renewable energy projects in Kazakhstan: USAID power the future regional program*. (2020). USAID. https://pdf.usaid.gov/pdf_docs/PA00X2D5.pdf

participation of companies into the auction processes since it has been established in Kazakhstan. Auction processes started in May 2018. Between May 2018 and December 2020, 63 projects have been selected through 24 auction rows (rows that did not select projected are not accounted here). Projects selected represent 21 WPP, 20 SPP, 18 HPP and 4 bioPP.[44] Many foreign companies took part in the auction but 50 out of 63 projects selected were from Kazakhstani companies. It might be assumed that whilst it is agreeable that auctions brought some projects, it can also be said that the 1st year auction program in 2018 in fact boosted those projects already in the pipeline. The 2019 series of auctions met with lesser number of projects and capacity addition, and 2020 with even lesser. It can further be argued that the initially committed projects were in fact backed by earlier, unrelated to auctions, feed-in tariff. Auctions, though they have been met with a good start, may be considered as less and less attractive in the current environment.

On the first stage of analysis and based on countries experiences, we set up the following hypothesis before integrating Kazakhstan's specificities, which will need to be compared to ground reality as described above, for further establishing recommendations:

- A suggested long-term strategy on auctions to be implemented: policies and effectiveness, in the development of a transparent long-term strategy towards renewable energy, already have a track record in Kazakhstan. This long term strategy in terms of renewable energy will be analyzed and linked with long term auctions planning. What technologies will be needed? What are the objectives regarding specific technology? How will it be implemented?
- National currency or dollar currency in renewable energy auctions? The volatility of the national currency of Kazakhstan (KZT ; 1$ = 420 KZT ; 1 KZT = 0,0023$)[45]; it may be asked if the national banking system is sufficiently efficient to support such debt in local currency, equity being left to be expressed in foreign currency
- Local content requirements to accommodate local and foreign companies into the auction system.
- Participation of international organization doing derisking.

[44] WPP: Wind Power Plant; SPP: Solar Power Plant; HPP: Hydro Power Plant; BioPP: Biomass Power Plant
[45] Exchange rate on December 1st, 2020

Two approaches have been identified as the main scope of work for designing a methodology to support conducting renewable energy auctions in Kazakhstan: utility-scale approach and small-scale approach. Once utility-scales renewable energy auctions are adapted, an aggressive action plan should be adopted with a technology specific and site specified strategy in order to be more specific in terms of capacity, need and mean. But these steps in fact factor-in the aim of fathering learning by doing trajectories, and need to be anchored into countries' specificities. Regarding decentralized projects, it seems relevant to us to establish auction site specific and technologies specific auctions from the starting point of the auction process. In fact, we consider that technology specific and site specified auction are the most efficient to structure and develop renewable energy in some specific localities. A trade-off will have to be made between the most present and efficient energy available and the project developers that will be able to implement new technologies. In the case of Kazakhstan, this is the reality.

Thanks to a deep analysis of auction in Kazakhstan and information collected form interviews, we identified that the above hypothesis-stages, though in spirit of learning curve are interesting, have to be adapted to match with Kazakhstan specificities and needs. It differs from what is established in Kazakhstan and on what USAID developed for Kazakhstan, in particular by the following features:

Technology	Technology-specific		
Site	Site-specific		
How	An auction schedule is developed, approved and published on the Ministry of Energy website		
Where	North	West	South
What	With documentation		Without documentation
Capacity	Small: up to and including 10 MW		Large: over 10 MW
Eligibility criteria	Financial guarantee in the form of a bank guarantee or a standby letter of credit issued with the SWIFT system		
Selection criteria	Lowest price		
Auction validation criteria	At least 2 participants in the auction	The total amounts of bids should be more than 130% of the declared capacity	

Figure 4. Kazakhstani auction feature

Our former analysis was based on worldwide best practices that incorporate a background of stabilized regulatory, systemic and financial environment that are not fully met in Kazakhstan and, though the country's current efforts aim at these, currently differs from Kazakhstani realities. A sort of stabilization transitionary approach (over around 3 years) ought to be considered, ahead of mobilizing the above strategy, in the interest of current reforms gaining ground while learning and refining of auction develops. Before reaching the needed environment, in Kazakhstan, auctions should be developed step by step, firstly in accordance with the grid and regional status, through technology and site specifics that reflect these constraints and specificities.

3.2 Kazakhstan auction methodology analysis

To understand renewable energy specificities, it was necessary to assess Kazakhstan's energy transition scenarios. Our assessment shows that, despite renewable energy development, the country will remain dependent on fossil energy, in particular coal. The current state of the electricity grid is outdated and requires a deep restructuring and modernization beforehand to add new installed capacities from greener energy. To work in this way, foreign investments are required. By analyzing energy transition scenarios and several interviews with local and international entities, it helps us to track trends and inertias regarding renewable energy that could be considered as the groundwork and context of renewable energy auction. In developing countries, renewable energy auctions are established to compete with fossil energy and develop greener facilities. However, ensuring the continuity of the auction system will depend on renewable energy strategy, design and portfolio developed by Kazakhstan.

Strategy: strengthening the auctions framework prior to ramping-up

The current legal framework on auction might not be sufficient as it could be, as there are no clear objectives detailed in regulations, there is no full mastery of renewable energy capacities by the central authority of Kazakhstan and there is frequent change of legislative document, which lead to a lack of comprehension and understanding of what is necessary for Kazakhstan and what for; engaging the grid operator into this is central. Meanwhile, auctions may continue on providing specific projects with maneuverable capacities, but a long term sustained trajectory has bottlenecks, that need a few years' time to be overcome.

Design: bidders pre-requirements towards technology ladder ecosystem expansion

The establishment of an auction system in Kazakhstan was originally intended to lower renewable energy prices. The design of the auction was established so that it would attract broader investors, both nationals and internationals. This may dissuade better players from investing in a system where the reliability of the stakeholders is not always guaranteed. Thus, in the long term and with

the aim of strengthening the auction system, some design elements may need to change such as prequalification, technology and site specificity, and, very core to the current grid situation, services provided by new capacities to the grid maneuverability, and, beyond all, regional rebalancing.

Portfolio: system environment a need of flexibility and manoeuvrable capacity to avoid grid congestion and regulated markets for relooking at currency risk, bankability and Power Purchase Agreement (PPA) in context

Strengthening the current grid is the first priority to enable the renewable energy development ahead of their scaling up via an auction system. Without this, risks such as grid saturation and imbalance would compromise the installation of new energy capacities. However, auctioning small, site-specific capacities that add-up maneuverable capacities, remains an option that has the double value of keeping the auction mechanism refine and demonstrating its use, while contributing to redeploying the grid.

Generally, the local currency in the auction system is not stable enough for foreign investors. For Kazakhstan, the priority is not to massively attract foreign investors via hard currency but to reinforce and maintain a stable local capital market while strengthening the grid, connection regulations and geographical distribution of the mix. As a consequence, there is a risk of non-viability over fast scaled up auction system due to currency, but there is alternatively a real scope for a continued learning through specific technologies and regional, site specific auctions. Thus, we see that the understanding of the country specificities is key to implement a legal cum strategic framework that would create a safer environment for investors and specific projects with ensured profitability in local currency. That may not eradicate every kind of risk, but blend and hedge them, and should nevertheless contribute to the auction system scaling up.

This analysis brought us that the auction must be articulated with regulatory continuity and coherence of integration into the power system and local system specificities. We formerly developed hypothesis that had required be facing and comparing with local realities and established mechanisms in Kazakhstan. We identified that our former analysis was based on

worldwide best practices and differs from Kazakhstani realities in the short term. Ahead of this generic framework for strategy, and in order to wait for –and accompany- the rise of a suitable environment, auctions rollout should currently be developed step by step with technology and site specifics mostly because of constraints and specificities: grid, requirements and legal framework, and, in relative terms, increased reliance on local currency for a time being at least for small capacities, and possibly foreign investors in joint ventures for larger capacities.

3.3 Auctions and renewable energy integration issue into the actual system

Based on our Kazakhstani analysis, we identified that technology specific and site specific are for now good options to keep progressing the learning path on auctions while giving due ground to Kazakhstan energy system specific aspects. To strengthen and promote stepwise auctions system in Kazakhstan depending to technical and financial considerations, we suggest an overtime implementation of both portfolio and regulation aspects.

By implementing gradually a new auction scheme in Kazakhstan, all stakeholders, issues and technologies will be integrated with respect to territory reality in Kazakhstan. We suggest the following priorities, which require being successively carried out and expanded upon overtime:

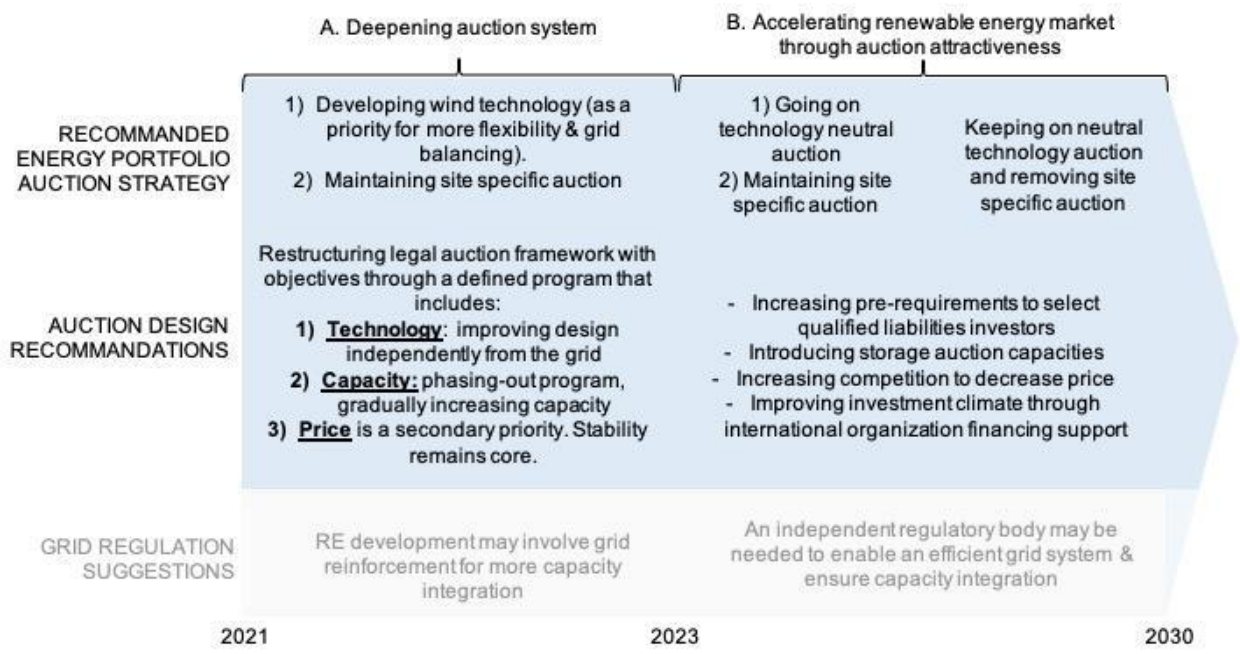

Figure 5. Kazakhstani suggested auction scheme

In terms of methodology, the first priorities revolve around renewable energy auction system reinforcement. Current auction system in Kazakhstan has shown a relative attractiveness since 2018. However, it requires a long term strategy to maintain its attractiveness at high level and prepare to fully exploit the country's energy potential once the environment becomes increasingly conducive.

First of all, to deepen auction systems through auction energy portfolio and auction regulation (Fig.5), we currently suggest to do so on a short and mid-term basis, establishing a viable and stable system regarding both investments and energy portfolio. It would be necessary to focus on extending wind technology and site specific for flexibility and maneuverability establishment and on developing detailed auction regulation and on grid modernization and storage facilities to add more renewable energy capacity to limit electrical overload. Once the grid is retrofitted, more renewable energy capacities and volumes could be added and auctioned in Kazakhstan in order to accelerate renewable energy market through auction attractiveness (Fig.5). After capitalizing on knowledge and experience on auction, we suggest to then move forward from technology specific and site specific to technology neutral and site specific. Renewable energy auction could over time

still be developed across the country with a particular focus on remoted areas by developing small scale utilities. Renewable energy auction market could face acceleration by adding new requirements for investors with the aim of selecting qualified investors and best projects. Last but not least, auction attractiveness would be ensured a stable and long-sustainable development through international organization financing support.

4) Conclusion

Renewable energy auctions are gaining popularity across the world. It reflects countries' willingness to accelerate renewable energy implementation and to use low carbon emission energy. Our work aimed to stress that auctions have moved from implementation and practice, which have led to achieved results in terms of cost-efficient electricity, transparent mechanisms put in place and value creation and ownership, to best practices learning and theory. Throughout this work, we analyzed auction scientific literature in order to measure macroeconomics trends, which are required to better articulate the main objectives and strategies to be adopted and introduced into the auction strategy, design and portfolio into a specific country.

Based on a previous analysis, we laid elements of designing a methodology support of conducting renewable energy auctions in the scope of country experiences in order to identify the more or less effective auction systems and sort the mechanisms and processes that can be replicated in other countries, which could contribute to accelerate renewable energy market. Our findings show that there is confusion between what should be consider as auction strategy, design and portfolio. We've tried to be comprehensive to clarify these three elements in order to evaluate an implemented auction system. These three elements are introduced in a given country on the basis of strategic choices for an appropriate implementation adapted to the territory, policy and energy realities and needs. Thanks to our approach, it can be understood that the auction system's understanding is not completely comprehensive, both at the macroeconomics and technical levels. To establish and efficient system, each auction approach should combine both components.

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