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Electricity Grid Tariff as a tool for Flexible Energy Systems in a PPP Model

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Summary:

This paper intends to elaborate the case of electricity tariffs as a tool for flexible energy systems. Electricity grid tariffs are a lever for reinforcing the coupling of district heating systems to the electricity system and for activating flexibility Energy tariff tools to bring about change in the energy climate in the country.

As with many other countries the electricity sector is changing as with growth of renewable energy the emergence of decentral electricity production and improved possibility for extended transmission. Although it is a premature area in Afghanistan but with incorporation of private grids this problem will have near term positive impacts once some modules could be implemented.

Incorporating the increased amount of intermittent renewable energy, and other sources combined with imported energy and the option of energy transit requires more flexibility in the electricity system as a whole. Such flexibility can be offered by existing fossil capacity, in particular gas turbines, as well as by new options such as demand side management and storage. The poor investment climate for conventional capacity has led in turn to a policy reaction in several countries among them Afghanistan being one of them, and to be applicable to introduce 'capacity mechanisms' that provide incentives to power producers to keep flexible reserves available.

Introduction

Afghanistan is rich in energy resources, both fossil fuels based and renewables. However, it still depends heavily on imported electricity and fuels and has one of the lowest per capita consumption of electricity in the world. Renewable energy sector development is one of the priority areas for the government, for immediate purpose of providing access to modern energy to remote and rural population and for medium to long term purpose of providing energy security to the country.

Over the past decade, movement in the renewable energy space has been towards greater presence of renewable energy as a means to solve livelihoods and economic crises, as well as a shift towards supporting enterprise demand. There is a palpable shift towards MW scale interventions that can not only meet consumptive loads but also drive productive loads.

The strategic goal of the Afghan power sector is to provide power supply to the population in whole Afghanistan. Currently 30 % of the Afghan households are connected to power supply systems. The connecting rate within the provinces differs in wide range from zero in rural area to nearly 100% in urban regions. More on, Afghan government pointed out the wishes of the development towards more self-sufficient power supply and towards the establishment of an integrated network for Afghanistan.

Based on the facts that the economy of Afghanistan has had significant improvement in the last decade due to the infusion of billions of dollars in international assistance and remittances from Afghan expatriates. The assistance that came from expatriates and outside investors saw this increase when there was more political reliability. Afghanistan's PPP adjusted GDP stands at about 71 billion USD

(where GDP is 20.8 billion USD in nominal terms) and the PPP adjusted GDP per capita is about 2.000 USD.

As with other economics, electricity forms a key primary input into production of goods and services, especially manufacturing and to a lesser extent, services. In its absence, major economic disruption can be expected. Indeed, there is plentiful evidence that the current situation of energy infrastructure is inhibiting business growth and economic activity. As per the latest data Afghanistan consumes in the extent of 1400 MW of Energy of which around 500 MW is domestically generated, and the rest is imported from neighboring countries.

The challenge of rural electrification is ultimately one of supplying electricity to areas with low population densities. Traditionally, electricity has been generated and distributed by centralized, state-owned power utility with natural monopoly here being the DABs.

Further, the environment in which power sector planning must take place in Afghanistan is especially challenging as a consequence of unusually high levels of uncertainty about potential resources, each with different environmental impacts, compounded by the disadvantages of being a land-locked country and difficult geopolitical circumstances that further complicate energy security. In the past years, power sector master plans have been prepared for Afghanistan, including one in 1978 and another in 2004.

The most recent one was prepared in 2012 with financing from the Asian Development Bank (ADB) and is referred to as the Afghanistan Power Sector Master Plan (APSMP). These planning efforts followed the classical route of least-cost planning based on an approach that requires expert judgement to define the likely future (in terms of load forecasts, international fuel prices, generation costs, and so on) and then use relatively sophisticated planning models to define an optimal expansion plan. The difficulty is that such a plan, prepared based on a planning paradigm sometimes described as “predict-then-act,” remains optimal only for the scenario into which it is embedded. Such plans are based on the assumption that the implementation of their conclusions poses few difficulties. In the unusual circumstances of Afghanistan, assumptions about the ability to finance and implement projects are increasingly coming under question, rendering many of the large projects proposed by the master plans unrealistic in terms of scale, likelihood, and timing of completion, and hence the plans are generally too optimistic. Furthermore, methodologies that rely on the predict-then-act approach do not appear to be grounded in a strategic view about optimum use of resources, embedded in economic reasoning. Hence the traditional approach does not lend itself very well to providing decision makers in Afghanistan helpful information about the robustness of particular strategies.

The first point to consider is that investment in Renewable energy has been gaining momentum with installation of many solar plants that are far fetched in the parts of the country that will pave the way ahead for energy sustainability. More aspects can be considered but for this purpose this will help.

Hydropower Development shows that the critical uncertainty in moving ahead with the large candidate hydropower projects is not the uncertainty of assurances from the government of Pakistan about its willingness to take summer surplus power, which in any event would be conditional on technical feasibility. Rather, it is the uncertainty of the cost of domestic thermal generation alternatives (notably

of the Sheberghan gas) and of imported electricity. The Power Purchase Agreement (PPA) that was signed in November 2015 between Afghanistan and Turkmenistan indicates a cost of US¢ 5/kWh, escalated at three percent per year. This is an excellent price for Afghanistan and provides the benchmark cost for domestic hydropower generation at least in the short run, though the quantity available at this price may well not extend to additional imports. The completed feasibility study for the proposed Bagdhara hydropower project indicates a levelized electricity cost of US¢ 7/kWh. It is important to note that the critical question with respect to Bagdhara is whether adequate geological and geotechnical surveying (with drilling to confirm the depth to bedrock) has been done at the proposed site for technical feasibility to be demonstrated. Moreover, as the feasibility study notes, costs are dependent on the security situation, and there is an unpredictable risk of potential increase of cost and construction time. Uncertainty about capital cost estimates remains high. The analysis shows that decision makers have been better served by waiting for the results of the Bagdhara FS so that its results can be used to recalibrate the APSMP estimates before making any decisions about further hydropower development.

Coal-fired Generation uses coal (or coal-bed methane) for power generation as a potentially attractive option for Afghanistan, but until the resources to power these options are verified with some degree of confidence, coal mine and power plant planning is premature. It follows that unless an exploration program is started today, the large future benefits of coal-fired generation (as opposed to imports of baseload power) can never be realized. There are only two options to answer the questions related to coal resource availability: either the private sector explores for and develops the resources it needs, or the public sector funds the exploration and then either develops the resource itself or auctions the proven resource to tender.

The use of coal or coalbed methane for power generation are attractive options for Afghanistan, but the resources must be found and developed. A coal exploration program has high potential rewards. Under the pessimistic outcomes for the cost of coal-generating projects relative to imports, the expected NPV for an exploration program in the known areas of coal resources is $112 million; under expected conditions of coal-generating costs and imports, the NPV is $369 million. If extended to the presently unexplored areas of the deep coal North Afghan Plateau, the NPV rises by $762 million. The current mining law is considered too unfavorable by junior mining exploration companies to give them confidence that they would be able to secure financing from international investors to pursue projects in Afghanistan. Similarly, there are likely to be significant challenges associated with options involving the bundling of mineral exploration and power generation projects in a concession to be given to a foreign minerals mining consortium, given the implementation challenges experienced in the copper mining concession in Afghanistan. It follows from this assessment that the only realistic option currently open to the Afghan government is to finance the exploration work itself.

The results of the analysis demonstrate that the expected value of future benefits of a government-financed exploration program far outweighs its upfront costs. Under the most pessimistic outcomes for the cost of coal-generating projects relative to imports, the analysis shows that the expected Net Present Value (NPV) for an exploration program in the known areas of coal resources is $112 million; while under the expected conditions of coal generating costs and imports, the NPV is $369 million. Potential benefits of this magnitude warrant immediate implementation of the proposed Afghan Geological Survey (AGS) program.

Indeed, if extended to the presently unexplored areas of the deep coal on the North Afghan Plateau, the NPV rises by $762 million. It also follows that even if the AGS program proved to be two or three times more expensive than estimated here, the economic benefits to Afghanistan remain high. Gas-fired Generation Gas-fired generation is a well proven technology with some advantages of modularity over coal and hydropower, especially when using diesel-cycle engines rather than gas turbines. But as with coal, decisions to invest in a gas-fired plant depend on well-characterized and proven reserves of gas. The results of the analysis show that the decision to proceed with reciprocating engines for use of the Sheberghan gas is robust with respect to the main uncertainties over a very wide range of futures. Even if the cost of Sheberghan gas proves to be double the cost now seen as likely (around $8 rather than $4/mmBTU), the probability that a Sheberghan gas project would deliver negative economic returns is very small. The International Finance Corporation (IFC) of the World Bank Group is considering supporting a 50 MW gas engine project in Mazar-e Sharif. This analysis concludes that the proposed project should be strongly supported since it is of reasonable scale and gas engines are the most robust technology, given the likely operating environment.

Transmission Planning Strategies Major transmission investment decisions have recently been taken on the basis of recommendations in the APSMP and are currently being implemented. During the next few years, and as conditions are expected to change in the region, the Ministry of Energy and Water (MEW) and Da Afghanistan Breshna Sherkat (DABS) have the opportunity to revisit the priorities for investing in further development of the transmission network. The review process will need to take into account alternative ways of further supporting power transit operations without limiting the ability to meet the competing financial needs for supporting the country's rural electrification program and developing indigenous generation resources.

This could indeed be an appropriate topic for a real options (RO) analysis of transit strategies based on assumptions and decision criteria that take into account (1) the risk of building 500 kV lines that are underutilized because potential transit opportunities fail to materialize; (2) the options for making a return on investment from either 500 kV high voltage alternating current (HVAC) wheeling or high voltage direct current (HVDC) line availability fees or both; (3) the additional investment required to guarantee an equivalent level of reliability and security for the importer or exporter of power; and (4) the future use of dedicated transit facilities at the end of the life of the PPA.

Clearly, there is less cost and operational risk to Afghanistan if a dedicated HVDC line is built by its proponents and used for transit operations even though there may be a perceived loss of sovereignty in enabling independent commercial operation. A key recommendation of this study is that before 2020, when the new transmission projects are expected to be commissioned, there is an urgent need to develop a national grid code, primarily to facilitate negotiations with Afghanistan's neighbors, but also to determine the incremental investments needed to upgrade substations and generation control systems to meet security and reliability standards for the transmission network.

The review process necessary to formulate the essential features of a grid code must include a strategy for synchronization between Afghanistan and its neighbors to facilitate the more efficient use of domestic generation. This may include a requirement for new investments in back-to-back HVDC (HVDC b/b) or HVAC interconnections or variable frequency transformer (VFT) facilities, which can transmit electricity between two asynchronous (or synchronous) AC frequency domains. Any future master plan will need to establish rules for transmission and generation diversity planning to minimize the potential

for widespread disruptions and facilitate the development of new hydropower and coal-fired generation that may be associated with large mining operations.

There will also need to be a clear policy setting out how Afghanistan proposes to integrate its domestic transmission development (which may be built to achieve a lower standard of reliability) with any new power import, export, or transit proposals that have their own special requirements for security and commercial viability. Last, a strategy for optimizing the development and eventual interconnection of the large number of small grids is required. They should be made ready to connect and disconnect from the grid operating in both grid-connected or island mode. There needs to be greater consumer engagement to solve power issues locally by enabling the penetration of local renewables in residential, commercial, and industrial customer segments. In this way, distribution can become a transmission system resource, with all its components as part of a cohesive system. This will depend heavily on standardization (physical and data) as could also be established in the grid code

Concept:

Increasing use of distributed generation, changing patterns of energy demand and use have all changed the way in which the distribution network for electricity is used, both in Europe and worldwide. These changes raise the question not only of how distribution systems should be used, but also how costs should be met. In particular, there are concerns about whether costs of 'traditional' networks will be stranded, and, if so, who will bear the costs. The Clean Energy Package, proposed by the European Commission in 2016, emphasizes the importance of competitive prices, efficiency and non-discrimination. It focuses on cost as a basis for tariffs, which should also allow consumers to feed in their own generation, and to pay the appropriate share of distribution system costs. This is a viable option and could be used in Afghanistan to stimulate grid extension. More, the Package also acknowledges the importance of social objectives by individual Member States, while reiterating prohibition of specific cross-subsidies. Within this cost-related framework it is outlined that some concepts of fairness, emphasizing that this criterion does not deliver a unique template, but depends both on how some costs are allocated and on different interpretations of fairness. We review some existing tariff structures and simulate the effects of some structures through 'notional' households, allowing some households to self-generate. When consumers respond very differently to tariff signals, those who are unwilling or unable to respond to changing tariffs may find themselves bearing a greater burden of the system's costs, which raises particular issues around fairness.

If the revenue collected from users is insufficient to cover the average costs of supply, the difference can be met from general taxation, and this might be viewed as fair in the sense that the tax and benefits system would presumably be designed to reflect the distributional priorities of each Member State.

However taxes themselves cause inefficiencies elsewhere in the economy, and support of energy systems through taxation raises issues of state aid and distortion of the Single European Market and as such will have a drastic effect in Afghanistan, if compared, and the Electricity zones; they are also challenging to administer if distribution systems are privately owned but the case of DABS it could be implemented during peak load timings. So alternative ways of recouping revenue need to be explored

and that being raising the tariff rates. It is said based on a study that consumer and the provider both benefit if tariff rate and electricity price vary over time.[1] Assuming a complete removal of tariff, the electricity use could generate three times the revenue. And this is the prime concept of this paper.

The fairness of a tariff can be assessed in principle from the extent that it meets the Afghanistan's objectives of cost-reflectivity and providing good incentive signals. We have explored some of the issues of balancing the deployment of new technologies and fairness in efficient cost allocation and distributional justice in the distribution system. Much depends on the design of tariffs, in particular the balance between different charging components. If we ignore the overall savings which we hope would result in the long run from better aligned incentives and consumer responses, then reduced bills for prosumers imply higher costs paid by other consumers. This would inevitably result in some rebalancing of tariffs, though the magnitude and impact depends on the starting point for each Member State. If consumers respond very differently to tariff signals, so that some deliver the benefits for the system, while others merely see their tariffs rise, it becomes important to know who is responding and why. Those who are unwilling or unable to respond to changing tariffs may find themselves bearing a greater burden of the system's costs.

Therefore, it is important for future research to identify the actual aggregate and distributional impacts of tariff reforms in different countries, potentially towards more capacity-based signals, in light of demand-side management, new technologies and efficient measures. In particular, it is crucial to collect and apply empirical evidence on how households change behavior in the energy market, rather than designing systems solely around potential response to tariff changes.

If for instance, the tariff is made a module in energy efficiency it could benefit the wider Energy sector and the whole regional climate in terms of investment generation and cost saving. The emergence of decentral power generation might have important and so far, largely unknown consequences for the organization of the electricity system, including profound impacts on current business models of incumbent parties in the electricity sector, technical impacts on the system as well as socio-economic consequences for end-users. These need to be examined in more detail.[2]

Conclusion

Unforeseen developments could speed up the need for additional flexibility, such as an unexpected further boom of local renewables or an increase in electricity demand due to fast penetration of electric vehicles in the market. The evolving role of decentralized power generation and demand management in the market will require a fundamental rethinking of basic design principles of the electricity system to include bottom-up considerations next to the traditional top-down orientation of dispatch of central generation capacity. This includes questions such as to what degree decentral generation can compete on a level playing field with large-scale generation in central dispatch, to what extent decentral generation could be aggregated and used for flexibility purposes on a central level and what would be consequences for the distribution grids.

This paper proposed the considered electricity grid tariff as a tool for flexible energy systems and in doing so has dealt with a number of options to reach this position. It should be noted that this

[1] Reneses, J., Rodríguez, M.P., Pérez-Arriaga, I.J., 2013. Electricity Tariffs. In: Pérez-Arriaga, I. (Ed.), Regulation of the Power Sector. Power Systems. Springer, London, pp. 397–441.
[2] The Balance of Power – Flexibility Options for the Dutch Electricity Market

concept has been newly implemented in Europe and it will require immense work on the ground in Afghanistan to gain momentum and be applicable, all we can do for now is keep fingers crossed and hope this is not a energy sector strategy.