Power Markets Database[1]
Literature Review

Background

Through the development of its AIMM Framework the IFC identified five desirable market attributes: competitiveness, resilience, integration, sustainability, and inclusiveness. While competitiveness, resilience and integration relate to economic concepts of how markets evolve, sustainability and inclusiveness address the role of markets in promoting sustainable development. The *Power Markets Database* was created in tandem with IFC's Flagship Report on *Creating Markets: Power Markets for Development*. This database presents data on the structural characteristics of power markets across countries and inform users' assessment of the level of development in these markets along these market attributes. Indicators in the database were selected based on an extensive review of existing literature as well as IFC sector expertise underlying the AIMM power framework. It is important to emphasize that selected indicators in the database are not exhaustive of the overall list of potential indicators that could be considered conceptually under each attribute. The choice of indicators is based on availability, and subject to time and resource constraints. This document presents a brief summary of key findings from the literature review.

I. Competitiveness

Electricity markets are relatively unique when compared to other markets due to the low demand elasticity for electricity, specificity of competition resulting from lack of product differentiation, the quasi-public good nature of electricity provision, among others (Gazeev et al, 2015; Böckers, 2013).

Historically, power markets around the world begun as vertically integrated monopolies with one utility, often state-owned, controlling all segments of the electricity value chain – generation, transmission and distribution (Ouriachi and Spataru, 2015). However, like most monopolies, vertically integrated utilities are usually characterized by inefficiencies resulting in low access rates, unreliable supply, poor financial performance (Joskow, 1998). As a result, power markets have evolved over time in most countries (VanDoren, 1998; Harris, 2011; Hunt and Shuttleworth, 1996; Gazeev et al, 2015). Starting from the 1980's many countries in Europe and the developing world adopted policy measures aimed at

[1] The Power Markets Database was prepared by the Economic Modeling, Analytics and Research unit in within the Sector Economics and Development Impact department of the International Finance Corporation. For comments and enquiry about the database, please contact the team via email: marketsdata@ifc.org. The team acknowledges comments received from IFC colleagues on this review.

unbundling state-owned vertically integrated utilities and liberalizing the sector to allow private sector participation in different segments of the electricity value chain (Ouriachi and Spataru, 2015; Foster and Rana, 2020). The experience of private sector participation in the sector has been different across countries and often a key determinant of the market structure. For instance, in most markets with a single-buyer model, private sector participation is mainly concentrated in generation, whereby independent power producers (IPPs) sell power to a central off-taker. On the other hand, relatively more sophisticated markets with wholesale and retail competition tend to have private sector participation in different segments of the power market.

The regulatory environment also plays a key role in power market development (Foster and Rana, 2020). As power markets are liberalized to allow entry of private players, the need for independent and functional regulators cannot be overemphasized. This ensures coordination among the players in the value chain and ensure efficient delivery of services. Implementation of market-oriented policies is critical to attracting private sector investment and introduce new technologies in the sector. Foster et al (2017) identify four main features of power market evolution: (i) establishment of an independent regulator, (ii) a restructuring process for unbundling incumbent state-owned monopolies, (iii) private sector participation that catalyze investment and introduce efficient managerial practices into the sector, and (iv) competition between generators who sell to a natural monopoly as well as retail competition whereby customers are allowed to negotiate contracts with distribution/retail companies. Thus, regulations are not only important for reform but also a catalyst for healthy competition in the market.

Therefore, to assess competitiveness in power markets, the database focuses on three main elements: market structure (including private sector participation); regulatory and pricing instruments in the market that incentivize competition (such as mechanisms to set market based tariffs); and technology and innovation in the market. Table 1 presents a list of the indicators in the database on competitiveness.

Table 1: Indicators on Competitiveness

Indicators
Market Structure
Private sector share of installed capacity (%)
Share of power generation by private companies (% of total)
Share of market players that are private companies (% of total)
No. of generation companies
No. of companies in renewable electricity generation
No. of companies in non-renewable electricity generation
No. of Independence Power Producers (IPPs)
No. of public (state-owned) generation companies
No. of public (state-owned) generation companies (Non-Renewables)
No. of public (state-owned) generation companies (Renewables)
No. of private generation companies
No. of private generation companies (Non-Renewables)
No. of private generation companies (Renewables)
No. of captive/commercial & industrial (C&I) generation companies
No. of grid network (transmission & distribution) companies
No. of private grid network (transmission & distribution) companies
Structure of electricity market
Regulatory and Pricing instruments
Presence of a day-ahead-market (DAM)
Presence of intraday market
Presence of a balancing market
Presence of ancillary services market
Agency responsible for tariffs setting
Technology and Innovation
Smart meter penetration rate (%)

II. Resilience

A barometer for evaluating the strength of power systems is their resilience to shocks. A resilient power market is one able to overcome shocks in generation to deliver reliable power supply to customers, with financially viable business models across all segments of the value chain, and with robust institutional and legal frameworks.

The power sector is capital intensive. Hence the ability of firms (private or public) to recover costs is a key determinant of investment and private sector participation (Asian Development Bank, 2003). In markets where (regulated) tariffs are below cost-recovery levels, independent power producers (IPPs) have less incentives to invest in the sector unless they are offered power purchase agreements (PPA) with "take-or-pay" guarantees. This is prevalent in many African countries where IPP contracts have "take-or-pay" clauses offering power purchase by the off-taker(s) even in the absence of demand (Foster and Rana, 2020). Thus, "take-or-pay" contracts are symptomatic of financial viability of utilities in the region. Trimble et al (2016) for instance, studied electricity utilities across 39 African countries and showed that only two countries (Seychelles and Uganda) have a financially viable power sector. The authors cite below cost-recovery tariffs and operational inefficiencies of public utilities in these countries as among the key factors for the financial distress of the power sector. Improving the financial viability of utilities is therefore critical for optimal investment in the sector and thereby improving the resilience of the sector against shocks.

Furthermore, there are risks associated with various sources of electricity generation particularly in relation to the reliability of supply. Overreliance on a single source of electricity generation exposes the system to generation risks resulting in prevalent outages that negatively affect countries' energy security (Gasser et al, 2020; Wu and Rai, 2017). For instance, overreliance on hydro-generation exposes the entire power system to climate and hydrological risk that could result in electricity outages (Allcott et al, 2016). Similarly, disruptions in global oil markets can affect electricity supply in non-oil producing countries heavily reliant on thermal generation. Therefore, power markets with diversified generation source mix are in general expected to be more resilient to shocks in generation.

Energy imports also introduces another dimension of resilience. Cross-border energy trading is beneficial to both exporting and importing countries. However, over-reliance on imports have implications for energy security. For example, forex risks can impair the ability of countries to pay for energy imports.

Climate resilience is another important dimension. Aside, changing rainfall patterns and its effect on reliability of hydro power generation, extreme weather events such as cyclones, flooding, lightning, etc., can create severe disruptions to energy systems and the cost of maintaining power infrastructure.[2] Technologies that minimize exposure of power systems to these hazards are key to improving resilience of power markets.

The institutional and legal frameworks for the electricity sector are also important for its resilience. As power markets evolve, they face several challenges including climate (cyclones, flooding, droughts), natural (earthquakes, volcanoes), human-induced (cyber-attacks on grid networks and control systems), and technological (dam failure, nuclear accidents) threats (Stout et al, 2019). Dealing with the myriad of risks they face, power markets require careful planning and building of strong institutions to implement plans and policies that mitigate future risks (Stout et al, 2019). For instance, an independent and well-

[2] https://toolkit.climate.gov/topics/energy-supply-and-use

resourced regulator will ensure the design and implementation of reforms that support the development of the market and prepare it for future risks and opportunities, as well as implement regulations that provide safeguards for market participants (European Bank of Reconstruction and Development, 2019). Also, the ability to regulators or power sector firms to forecast climate disruptions and incorporate them into design and building of climate resilient infrastructure as well a crisis planning capabilities, maintenance, planning for supply disruptions, and long-term adaptation is critical.

In the current version of the power market database, we present data on three dimensions of resilience: financial, generation (supply), and institutional framework. Table 2 presents indicators in on resilience in the database.

Table 2: Indicators on Resilience

Indicators
Cost Recovery & Financial Resilience
Presence of electricity subsidies
Subsidy rate per kwh (US$/ kWh)
Government expenditure on electricity subsidies (million US$)
Current ratio of main utility
EBITDA (million US$) of main utility
Bill collection rate (%) of main utility
Number of off-takers
Average generation cost (1000 US$/GWh)
Ownership structure of off-taker(s)
Whether power purchase agreements (PPAs) between off-taker(s) and generation companies are guaranteed by the govt
Legal and Institutional Framework
Presence of energy law
Presence of stakeholder groups in energy sector
Presence of a regulator for the sector
Year regulator was established
Sources of funding for regulator
Regulator responsible for periodic review of T&D companies
Regulator responsible for third party access charges
Regulator responsible for issuing licenses for new generation companies
Regulator responsible for monitoring and investigation of breaches of regulation (incl. anti-competitive behaviors)
Regulator is responsible for issuing binding decisions to companies and imposing penalties on those that do not comply with their legal obligations
Regulator is responsible for allocating, revoking, modifying licenses

Regulator is responsible for administering universal service
Regulator is responsible for enforcing regulation through imposition of civil penalties and other means
Regulator is responsible for overseeing environmental matters related to e.g. Natural gas and hydroelectricity projects and other matters
Regulator is responsible for administering accounting and financial reporting regulations and conduct of regulated companies.
Which body, other than a court, can overturn the decisions of the regulator?
Which body has the legal authority to make the final appointment of the regulator's head/board members?
Can the regulator's head/board members hold other offices/appointments in the government or industry?
Tenure of office of regulator head/board
Are there restrictions on post-employment of regulator's head/board members?
Who sets the regulatory fee?

Diversity of Generation Mix and Resilience to supply shocks
Thermal (coal) % of total generation
Thermal (HFO) % of total generation
Thermal (gas) % of total generation
Hydro % of total generation
Solar % of total generation
Wind % of total generation
Other renewables% of total generation
Other sources (incl. Nuclear) % total generation
Implementation of demand response programs

III. Integration

There are two dimensions to market integration to consider: spatial (domestic and international) integration of power markets, and integration of power and capital/financial markets.

Spatial integration is the most widely known concept of market integration. Given the unequal distribution of factors of production, technology and productivity, trade allows economic agents to produce goods and services for which they have comparative advantage. In the power sector, cross-border trading of electricity is growing around the world. Cross-border trading of electricity takes several forms, ranging from bilateral trading between neighboring countries to multilateral trading markets such as regional power pools. The frequency, volume of trading, and pricing mechanisms vary as well.

Several factors motivate the participation of power markets in cross-border trading. These include, but are not limited to: efficiency gains through economies of scale as larger markets enable capacity utilization of larger generation plants (Eberhard, 2003; Charpentier and Schenk, 1995; Blimpo and Cosgrove-Davies, 2019; International Energy Agency, 2019); addressing supply shortfalls in countries with insufficient generation (Eberhard, 2003; UN-DESA, 2005; World Bank, 2008; Blimpo and Cosgrove-Davies, 2019); and increased competition from the entry of new players resulting in lower end-user tariffs (Ouriachi and Spataru, 2015). The effects of cross-border trading on pricing are salient in more sophisticated trading regimes such as market coupling and integrated power pools, where multiple power operators in different countries engage in wholesale power trading (day-ahead, real time), thereby resulting in price convergence across participating countries (Ouriachi and Spataru, 2015). However, in less sophisticated trading regimes, cross-border trading is based on long-term bilateral contracts and often fixed tariffs.

Integration of domestic electricity networks is also important to ensure energy security and enhance resilience against systemic risks in generation. Connecting isolated grids also improves allocative and technical efficiency of networks in the country. For instance, in countries where grid networks are segmented into zones, having an interconnectivity platform can facilitate sub-national power exchange that allow (regional) distribution systems operators (DSOs) to manage asynchronous demand and supply peaks.

With regard to integration of power and capital/financial markets, it is a well-recognized fact that investments in power are capital intensive and long term in nature. As a result, the availability of long-term financing to power sector firms is crucial for the development of power markets, particularly if private sector participation is to be sustained. The importance of the link between these markets is amplified in developing economies, where the funding gap in is not only large, but financial (and capital) markets remain underdeveloped. The capital and financial markets also play a key role in the direction of investments in power markets. For instance, the emergence of green bonds and climate funds have spurred investment in renewable energy technologies around the world and contributed to increased private sector participation in power generation (Hussain, 2013). The database presents data on both spatial and financial integration, as shown in Table 3.

Table 3: Indicators on Integration

Indicators
Spatial integration
Type of cross-border exchange
Electricity imports
Electricity exports
Import share of consumption
Structure of grid network
Financial integration
Sources of domestic financing of energy projects

IV. Inclusiveness

Access to reliable electricity is a key anchor for development and a necessary condition to address inequality; hence its inclusion in the sustainable development goals (SDGs). Electricity access rates across developing countries are disproportionately distributed across income groups: low access rates in rural areas and even in urban areas with communal access to electricity, as well as low connection rates for low income households and marginalized groups (Blimpo and Cosgrove-Davies, 2019; International Energy Agency, 2019). Vulnerable customers also face affordability issues: low income and/or seasonally employed households with unpredictable income flows are unable to afford the cost of using electricity at market prices (Blimpo and Cosgrove-Davies, 2019; European Bank of Reconstruction and Development, 2019). Therefore, the design of power markets play an important role in addressing these gaps and ensure that service delivery is inclusive and serves the needs of all groups within the population.

Inclusive power markets adopt business models that promote access to affordable and reliable electricity by vulnerable customers and underserved groups of the population. For instance, pay-as-you-go (pre-paid) meters enable households to sufficiently plan their consumption thereby reducing the incidence of non-payment of electricity bills, while lifeline tariffs provide implicit subsidies to low consumption households. Subsidies for connection charges/fees, ready-boards for connecting low income households with low housing quality, distributed generation and mini-grids for rural communities are also examples of schemes that support inclusion in access to electricity (Blimpo and Cosgrove-Davies, 2019). The main indicators on inclusiveness in the database are shown in Table 4.

Table 4: Indicators on Inclusiveness

Indicators
Urban-rural access gap (% points)
Presence of block tariffs
Presence of time of day tariffs
Presence of fixed value prices
Presence of lifeline tariffs
Presence of pay-as-you-go (prepaid) metering systems
Presence of smart meters
Presence of subsides for connection charges
Presence of distributed generation
Presence of mini-grids

V. Sustainability

The concept of sustainable markets relates to how markets operate without exerting depleting the natural (environmental), social, and economic capital.

Environmental resources play an important role for the functioning of energy markets. Aside the sources power generation, the environment also acts as a receptor of emissions (waste) from power generation. Climate change and its associated socioeconomic impacts have reinforced calls for countries to lower emissions and chart a path of eco-friendly production and consumption. The power sector, which historically has been a carbon intensive sector, has a critical role to play by shifting towards clean generation technologies (renewables) thereby reducing the carbon footprints associated with electricity generation. To this end, increasing the share of renewables in the generation mix have become a key sustainability goal for most power markets. Aside emissions, construction of energy projects (eg. hydro-dams) can lead to significant biodiversity loss through destruction of natural habitats.

There are social issues associated with energy infrastructure. Factors such as resettlement of project affected people, health effects associated with pollution from ambient pollutants emanating from power projects, livelihood impacts, conflicts, etc., often result from construction of power infrastructure. Addressing these social issues are important considerations for sustainable power markets.

There are various approaches in towards achieving sustainability. First, the role of market instruments in achieving sustainable power markets cannot be overemphasized. Feed-in-tariffs (FiT), Feed-in-Premiums (FiP), Renewable Energy Auctions are some of the main instruments used around the world to support renewable energy generation. These instruments provide economic incentives to (large and small scale) renewable energy generators to participate in the electricity market as it provides a market for their output at attractive tariffs. In addition, the push for renewables coupled with low electricity access rate in developing countries as well as the relatively high cost for grid expansion in sparsely populated regions have spurred growth in distributed generation and off-grid solutions (Joskow 2019). These solutions offer countries the opportunity to harness their renewable energy potentials to expand access to electricity while reducing the carbon footprints of the sector.

Furthermore, the political, regulatory and institutional frameworks that support and incentivize players in the sector to transition to clean energy is crucial. For instance, under the UN Climate Change Conference in Paris (COP-21), countries made commitments to pursue low-carbon energy and climate policies, with decarbonization of the energy sector as a top priority in the short-medium term. As a result, transition to renewable energy features prominently among the Nationally Determined Contributions (NDCs) with over 150 countries committing to a substantial increase in the share of renewables in the energy mix (IRINA, 2017). Political support is particularly important given that the transition to clean energy often entail significant initial economic cost.

Ensuring that power companies minimize the social and environmental footprints of their activities however require efficient regulatory and institutional framework. For instance, (enforceable) regulations that establishes limits/penalties on pollution to firms in the sector will ensure that firms invest in technologies that reduce their impact on the environment. Similarly, enforceable social protection laws will ensure that the rights of local communities or people affected by (energy) projects are protected (eg. payment of adequate compensations, livelihood restoration plans). Companies also have economic and social incentives to operate sustainably. Increasing awareness on the benefits of sustainability have led consumers to demand companies to be more responsible and take action to address sustainability challenges in their operation.[3] As a result, sustainability certifications such as Rainforest Alliance[4], have become of economic value to companies. Development finance institutions such as IFC[5] and the World Bank[6] also have environment and social sustainability framework that its projects and clients must comply with. Thus, in the spirit of sustainability, (some) companies ascribe to environmental, social, and governance (ESG) performance standards to guide their operations.

Stemming from the above, there are several indicators that can be used to assess the sustainability of power markets, taking the various dimensions of sustainability into consideration. The current version of the Power Markets database however focuses on a

[3] https://www.businessinsider.com/sustainability-as-a-value-is-changing-how-consumers-shop
[4] https://www.rainforest-alliance.org/faqs/what-does-rainforest-alliance-certified-mean
[5] https://www.ifc.org/wps/wcm/connect/7141585d-c6fa-490b-a812-2ba87245115b/SP_English_2012.pdf?MOD=AJPERES&CVID=kiIrw0g
[6] https://www.worldbank.org/en/projects-operations/environmental-and-social-framework

subset of sustainability indicators as shown in Table 5. Future updates of the database will expand the indicators to sufficiently capture all dimensions of sustainability.

Table 5: Indicators on Sustainability

Indicators
Support for Renewable Energy
Feed-in-Tariffs/Premium
Energy auctions
Tax exemptions on renewable energy
Feed in tariff for solar (US $/kWh)
Feed in tariff for wind (US$/kWh)
Feed in tariff for biomass (US$/kWh)
Feed in tariff for hydro (US$/kWh)
Environmental Regulation and Institutional Framework
Presence of environmental laws
Presence of an agency responsible for environmental protection
Year the agency responsible for the environment was established
Does the agency have specific environmental requirements for the power sector?
Which body, other than a court, can overturn the decisions of the environmental agency?
Body with authority to appoint environmental agency's head/board members

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