Indo – German Energy Programme

Green Energy Corridors

Report on Market Design for Capacity Market in India

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List of Abbreviations

DISCOM	Distribution Company
EEX	European Energy Exchange
EFORp	Equivalent Peak Period Forced Outage Rate
EOM	Energy Only Market
OMC	Out of Management Control
OTC	Over the Counter
PLF	Plant Load Factor
RES	Renewable Energy Sources
TSO	Transmission System Operator

1 Traditional and Capacity Markets

1.1 Traditional Energy Market and it's Problems

Electricity is traditionally sold and purchased in KW/hrs or MW/hrs i.e. in terms of energy. Thus the traditional market is known as an 'energy only market'. On the other hand, the capability to generate the electricity is measured in terms of KW or MW. To create a capacity to generate power the producer makes investments and the annual cost of such investments is known as 'Capacity Charge'. An additional cost is incurred, including fuel, when the energy is produced. This additional cost is referred as 'Incremental Cost' or 'Marginal Cost'. In the traditional 'energy only market' (EOM) the producer is compensated for the 'capacity' by implicit means i.e. by margins over incremental cost of energy in the Over the Counter contracts (OTC or Bilateral contracts) as well as in the spot market. Even if OTC is in terms of MW capacity, the final billing is as per energy delivered. In an ideal situation, an electricity market with sufficient demand elasticity always clears. That is, there always exists a market price such that demand and supply are balanced. If supply gets scarce, the price goes up until there is sufficient voluntary load reduction to absorb the scarcity. This means that, with sufficient demand elasticity, there is no capacity adequacy problem.

However, the reality is very different from the ideal scenario described above. There are numerous drawbacks for the producer in the present energy only market. The most significant issue faced in the EOM's is loss of revenue when demand is low, especially if incremental cost is high. Capacity cost is not recovered in competitive market where margins are less. The conventional fuel plants get affected more and more if percentage of the RE increases. System Operator has to adjust/re-schedule the power generation in order to ensure safe grid operation. This also has commercial bearing on the generators. Due to these reasons, the producer is not incentivized to create capacity to balance the grid which is necessary for safe grid operation. A 'capacity market' is being suggested to create a market for capacity, which shall be rarely used but nevertheless necessary for grid operation and security. This market is proposed alongside EOM.

1.2 Need for Capacity Markets

Since more and more countries are switching to renewables, the consumer is willing to respond to intermittent electricity production and becoming flexible. Especially the large consumers are responding to 'Demand Side Management' for increasing their profitability. In view of the above, the market is switching from a system where controllable power plants used to follow the demand' to 'a system where flexible producers, flexible consumers and storage systems together manage the intermittent supplies from wind and solar'. The problem is to feed 'Residual Demand' i.e., a load that cannot be served by renewables and has to be served by conventional power plants. The power market has to perform two functions even in the extremes of high and low residual demands:

- To ensure availability of sufficient capacity at all times.
- To make sure that the capacity is utilized when required.

In other words, the most important function of Capacity Markets is '**generation resource adequacy'**, which, in power markets is the ability of the system to meet any level of power demand, and peak demand in particular, at all times. Electricity capacity markets work in tandem with electricity energy markets to ensure that investors build adequate capacity, in line with consumer preferences for reliability.
At the same time, seeing the current market trends and penetration of renewables, existing conventional power generators will have no incentive to stay in the market due to falling PLF's leading to losses. Therefore, a capacity market, where capacity can be explicitly traded will incentivize these producers to not exit the market and instead provide reserves.

It can therefore be summarised by saying that the need for a capacity market stems from an imbalance between demand and supply of power. In such events, there is inelastic demand and inadequate supply which contributes to blackouts. This in turn can result in considerable price volatility as demand-side management of the market is not fully functional. Therefore, capacity markets are a means to ensure resource adequacy while mitigating problems due to demand side flaws. Adequacy however differs from security, which is a system's capacity to cope with sudden disruptions (balancing and stability of the grid), enabling it to operate in real time. Adequacy, on the other hand, means there will always be enough supply available to match demand but it does not reduce the need for reserves in order to meet real-time demand.

1.3 Definition of Capacity Markets

A Capacity Market is an additional market created alongside the existing electricity market where only the maintenance of capacity is traded and explicitly remunerated. They are developed with an aim to balance generation and demand in the grid. Capacity markets provide an additional incentive, which price signals alone in electricity market do not provide for capacity developers (i.e. power plants or demand response providers who wish to participate in the capacity market) in order to make their capacity available. These capacity developers are paid on a kilowatt per year basis for the capacity generated or, in the case of demand response, the capacity that is regulated down. Capacity markets are introduced with the fundamental assumption that even an optimized electricity market does not provide sufficient incentive for the maintenance of capacity and that an additional market for the maintenance of capacity and adequate supply is imperative. The additional costs incurred for maintaining this capacity are passed on to the electricity customers as higher prices in the form of a **'capacity surcharge'**.

A capacity market can be implemented through various models; in a **central and focused capacity market**, the state directly determines the quantum of capacity required. In a **decentralized capacity market**, the state does not specify the quantity required but controls the level of capacity indirectly by imposing penalties on the power generators if they fail to provide their service at the time of contingency. Even with a capacity market in place, it is the responsibility of the market participants to contract sufficient capacities in order to meet their delivery commitments at any time. Regulators are responsible for ensuring all parties abide by the market rules and for overseeing the development of capacity through a continuous monitoring process.

The capacity market does not distinguish between generation types and, therefore, does not support any policy shift towards a particular generation type, such as renewables. It poses a challenge for independent system operators (ISOs) to induce the right amount of demand-side response — at the right time and location. At the same time, it can be an ideal target for industrial lobbying, looking to exploit the mechanism as a system of low-risk subsidy for existing generation. The development of capacity markets therefore requires a sound wholesale market for both spot and medium-term markets and does little to protect against the harm caused by politically-induced uncertainties.
Presently India does not have a capacity market, though Indian tariff system takes care of the need for capacity markets through its tariff determination process.

1.4 Role of capacity markets in resource adequacy design

The most appropriate market-based design for resource adequacy depends on a region's policy objectives and risk tolerance. There are two basic approaches to achieve adequacy:

- **Energy-only approach** - Relies purely on the market to incentivize needed capacity investments. Regulators rely on energy-only markets, through scarcity pricing, to ensure sufficient cost recovery for generators and, thus, maintain sufficient planning reserve margins.

- **Energy market and additional capacity mechanism approach** - Addresses perceived market failures due to imbalance in demand and supply and thereby provides additional capacity assurance. A capacity mechanism aims at providing market participants with a more certain stream of revenues than what is delivered by "energy-only" markets.

While free market proponents advocate an energy-only approach, some governments do not want to leave their generation capacity to the volatility of the free market, fearing that it could leave them at risk of having insufficient capacity.

1.4.1 Energy-only markets

In an energy-only market, the generator is remunerated solely through selling energy in the market (remuneration for MWh). The prices are set by the supply–demand mechanism while minimizing the use of administrative caps or other means that artificially suppress prices below competitive levels. These markets presume spot prices to reflect operating conditions and the price signals sent by the market to ensure future security of supply and provide the right incentives.
In theory, fixed costs are covered:

- By the infra-marginal rent for low- and mid-merit order units (i.e., generators receive higher price than bid)
- By scarcity rent (when the market price is higher than the marginal cost) for peak units

The goal of an energy-only market is to shift the risks and rewards of prudent investment from consumers to investors. This could be achieved by moving the primary responsibility for investment decision-making from regulated planning and centralized administrative processes to the decentralized, voluntary decisions made by market participants, responding to prices set by the market.

Resource adequacy is not assured in an energy-only market. However, increased occurrence of price spikes in the spot market give the signal to investors that new investment in peak units would be profitable. These market forces should ensure that the system achieves the desired level of reliability.

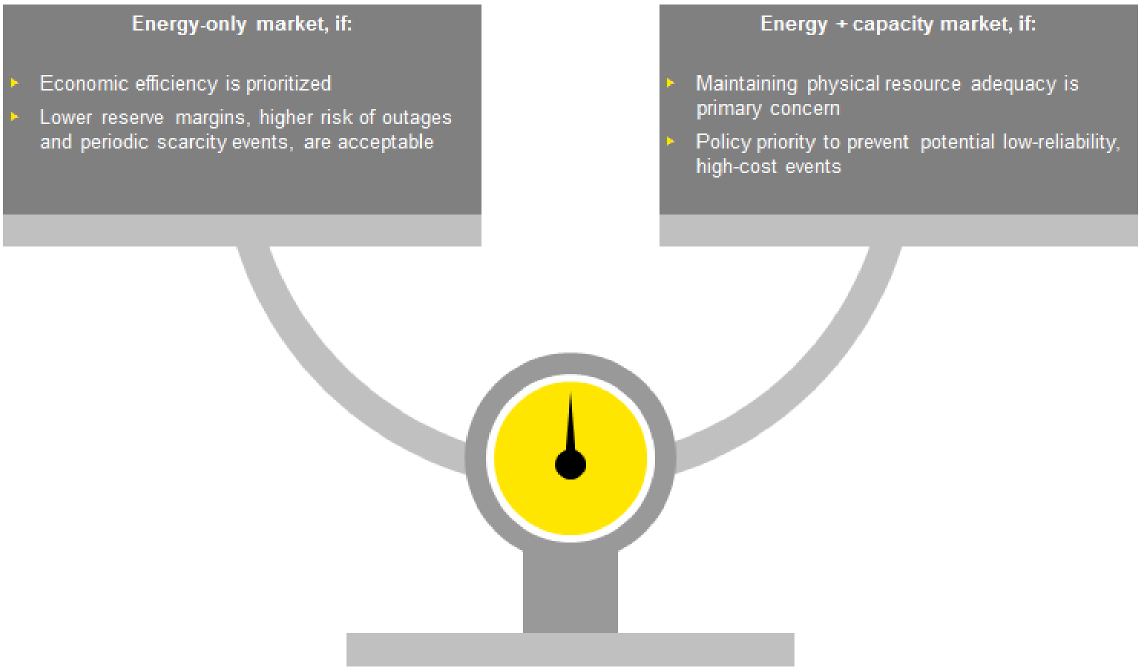
1.4.2 Energy and capacity market

A capacity market recognizes two market commodities, namely electricity (the output) and generation capacity (the means). Introducing capacity mechanisms imply that generators receive payments for the mere availability of capacity in addition to revenues obtained from the energy market.

In a market with a capacity mechanism, while the energy market remains the main instrument for short term resource optimization, long term resource adequacy is incentivized by some form of capacity payment to

- Address a situation when energy-only markets do not attract "adequate" investment, due to any reasons
- Incomplete or poorly-designed ancillary service markets
- Solve the problem of "missing money" (lack of sufficient dispatch over time to cover fixed costs)
- Manage intermittent renewable energy generation
- Manage an unusual or a specific consumption pattern (e.g., need for capacity markets in France stemmed from a substantial increase in peak demand (30% in the 11 years through the 2012–13 winter), and the increased sensitivity of that peak demand to temperature changes).

Figure 1- Approaches for Resource Adequacy



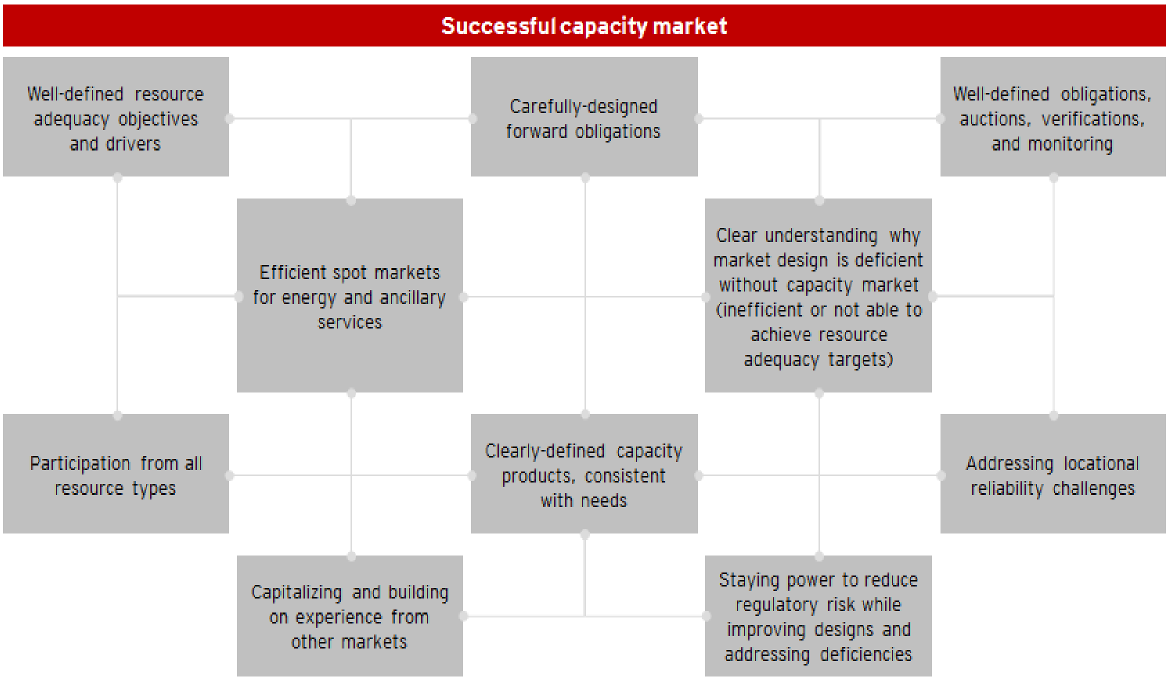
1.5 Prerequisites for the Introduction of Capacity Markets

Before adopting a capacity market design, caution should be exercised especially when

1. Capacity mechanisms explicitly
    - Discriminate between existing and new resources
    - Exclude participation by demand-side and renewable resources
    - Ignore locational constraints and transmission inertia
2. Capacity mechanisms are included just to add revenues for certain resources or to address a perceived lack of long-term contracting.
3. Out-of-market payments are also provided to some resources that oversupply the market and distort both short- and long-term investment signals.
4. Capacity mechanisms are added without understanding and addressing deficiencies in energy and ancillary service markets.

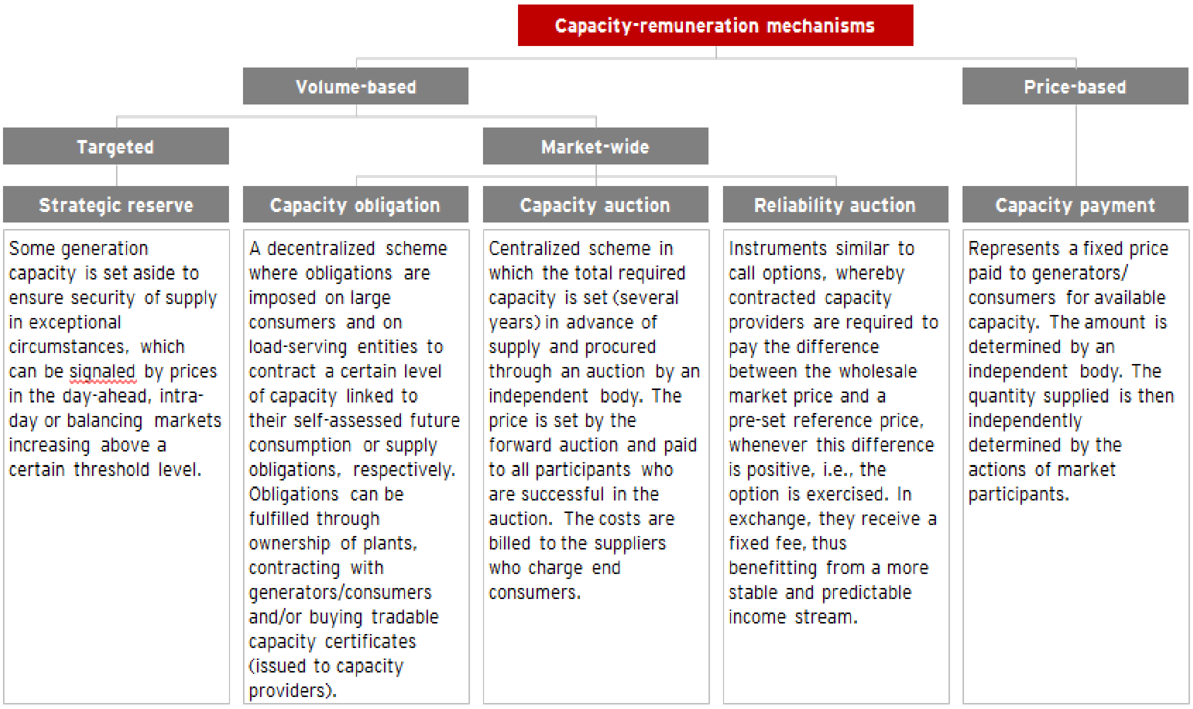
The following illustration summarises the prerequisites for developing a successful capacity market.

Figure 2 - Prerequisites for a successful capacity market



2 Implementation examples and lessons learned

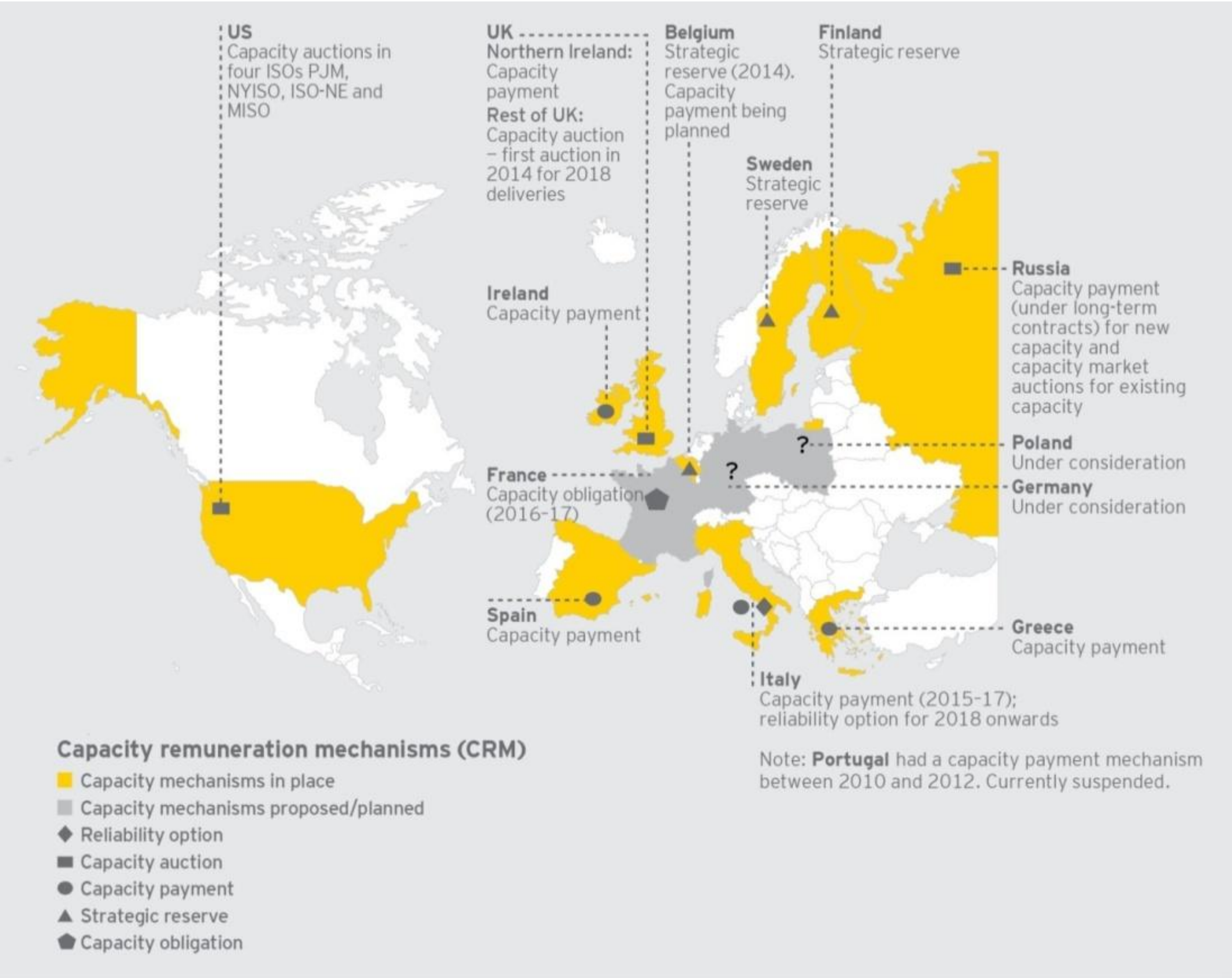
Figure 3 - Remuneration Options



The following illustration shows the various models of Capacity Markets being implemented across the globe and the capacity remuneration models used.[1]

[1]EY Analysis

Figure 4 - Examples of Capacity Market Models



Here we provide examples of various models being implemented in four different countries and the lessons that can be learnt from them.

- **USA (Independent System Operator – PJM) – Energy and Capacity Obligation**

In PJM currently, an ‘Energy and Capacity Obligation’ model is followed. Capacity obligations are calculated for selected peak load demands expected to be served by each customer serving entity. Generating units issue capacity certificates depending on available capacity, while each customer-serving entity has to demonstrate annually that they hold sufficient capacity certificates compared to its obligation. These capacity certificates are tradable in the market.

Many challenges were faced in the implementation of this model. Lessons that can be learnt are that insufficient peak period penalties in the current PJM tariff provide a disincentive to make investments in generation resources for low-probability, high-reliability impact events, which have increased after a transformation in the country’s power industry (shift from coal to gas and renewables). First, there is little risk of incurring a capacity market penalty for being unavailable during reliability critical events.

Second, there is an incentive to try and characterize outages as out of management control (OMC), since OMC is excused from the Equivalent Peak Period Forced Outage Rate (EFORp) calculation.

- **Great Britain - Energy and Capacity Payment**

In Great Britain, an 'Energy and Capacity Payment' is being implemented. Great Britain introduced capacity remuneration in 1990 in the England & Wales Pool, which was determined based on loss of load probability (LOLP). Two main generators were initially able to manipulate the market by making their plants unavailable when the bids were submitted one day ahead. This would often raise the LOLP, and hence the capacity payment. Once the capacity payment had been set, the generators would declare their plants to be available, and hence become eligible to receive the payment, which could not be reduced.

To prevent this market abuse, the regulator decided that LOLP would be calculated on the basis of each plant's highest availability over the previous eight days.

- **Western Australia - Energy and Capacity Obligation**

Demand-serving entities are obliged to buy capacity credits to cover their share of total system reserve requirements that are determined by the TSO annually. Capacity markets have proved to be an expensive way to meet forward demand. Customers in Western Australia now pay around $85 per megawatt-hour, substantially more than the $35/MWh typical in the NEM (energy-only market). Investment in peak demand capacity was identified as the main driver (contributing 17%) for the grid power cost increases.

- **Germany – Energy only**

Germany follows the 'Energy-only' where the generator is remunerated solely through selling energy in the market (remuneration for MWh). This model in Germany fails to adequately compensate backup power solutions needed to support the increasing portion of renewables in the country's generation mix. This is resulting in a decrease in the country's temporary strategic reserve capacity (at the current rate, the strategic reserve is expected to run out by the end of 2017). Agora Energiewende, a German think tank studying the energy transition, estimates that Germany could face a 5GW to 15GW supply shortage by the year 2022 if no precautionary measures are taken.

The following illustration summarises other capacity market mechanisms currently in use across the world.[2]

Figure 5 - Examples of Capacity Market Models

Market	Mechanism	Brief overview
Eastern USA markets (PJM, MISO, ISO-NE)	Energy market (EM) + capacity obligation	Capacity obligations are calculated for selected peak load demands expected to be served by each customer serving entity; generating units issue capacity certificates depending on available capacity, while each customer-serving entity has to demonstrate annually that they hold sufficient capacity certificates compared to its obligation; capacity certificates are tradable.
Colombia	EM + capacity auction	A driver for the capacity auction in Colombia was energy scarcity due to the seasonal variation in a hydro-dominated electricity market. The Colombian market imposes a firm energy obligation that fixes a price for 20 years. Generators have to supply the market with an amount of energy to cover demand when the market price exceeds the strike price set administratively.
Chile	EM + capacity payment	Chile has applied capacity payments since 1982. Capacity payments are an extra payment to all available capacities. Payments are made based on a plant's contribution to total required capacity needed for system reliability.
Argentina	EM + capacity payment	Since 1995, Argentina has had different payments for operating plants (using loss of load probability but applied only to operating plants) and for reserve plants; reformed after 2005 to unify remuneration to plants operating and plants available during peak demand.
ISO-New England (US)	EM + capacity auction	ISO-New England (US) has a new capacity regulation in place, which follows a scheme similar to that applied in Colombia; demand participation is expected (demand curtailment) to take part in the reliability auctions; locational price signals also introduced.
Brazil	EM + reliability auction	In Brazil, the system operator auctions reliability contracts on an ad hoc basis depending on forecasts about possible energy scarcity; the auctions are separate for existing and new plants and differ in terms of duration length.
Western Australia	EM + capacity obligation	Demand-serving entities are obliged to buy capacity credits to cover their share of total system reserve requirements that are determined by the TSO annually.
Guatemala	EM + capacity obligation	Obligation of retailers to hold capacity credits in sufficient amounts in comparison to expected future sales; capacity credits are determined by the regulator for each plant type.
South Korea	EM + capacity payment	Applying direct capacity payments (replaced by reliability charges)

[2] EY Analysis, 2015

3 German Electricity Market: A Case Study

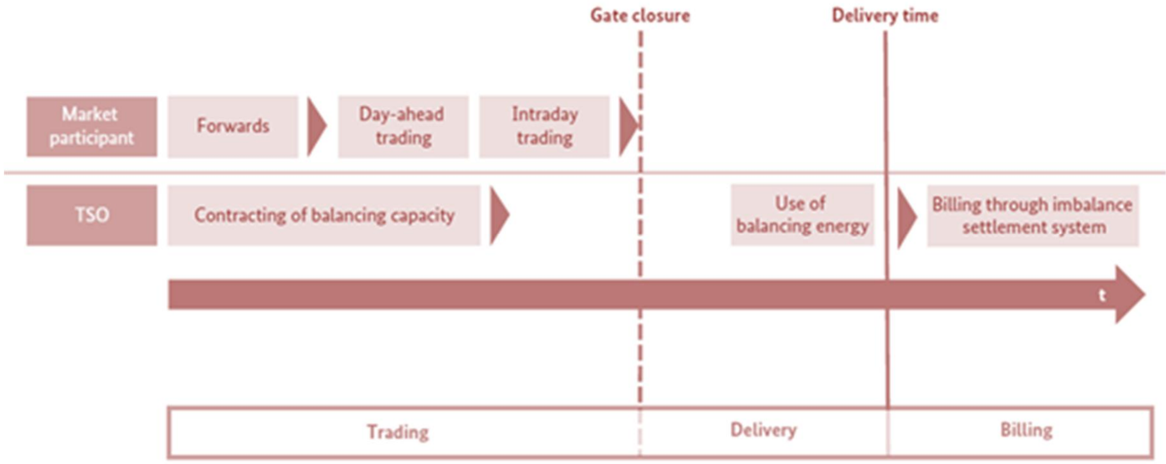
The German Energy Policy is driven by security of supply, economic viability and environmental compatibility. The aim is to make energy supply more environmentally friendly, while also ensuring it remains secure and cost-effective. By 2020, the goal is to reduce greenhouse gas emissions by 40 percent com-pared to 1990 levels, and cut primary energy consumption by 20 percent over rates for 2008. Renewables are to have a 40 – 45 percent share in electricity production by 2025, and a 55 – 60 percent share by 2035. (Federal Ministry for Economic Affairs and Energy, 2014)

In order to achieve these goals, there is a need to synchronize power production and power consumption efficiently and to ensure that sufficient capacity is available. This capacity has to be utilized in such a way that power generation and power consumption is always in equilibrium. There was a requirement to design a future market and regulatory framework for the power sector that guarantees a secure, cost-effective and environmentally sound power supply system taking into account an increasing share of wind and solar energy in electricity production The two options available to do so were - an optimized electricity market which would include restructuring of the present market design through different measures to increase is efficiency (electricity market 2.0) or the introduction of a second market, i.e. the 'capacity market' to hold capacity available.

3.1 German Market: Working

For restructuring of the electricity market and redesigning its architecture, it is imperative to understand the current working model of the German electricity market. In Germany, electricity can either be traded on the exchanges (European Energy Exchange (EEX) in Leipzig or the European Energy Exchange - EPEX SPOT in Paris or) or through. Over the Counter (OTC through bilateral contracts).As in India, in Germany trading takes place on forward, day-ahead and intraday markets.
On the forward market, companies can agree deliveries up to six years in advance, with trading for the next three years being particularly liquid i.e. for the next three years; it is easy to execute a trade quickly and at a desirable price because there are numerous buyers and sellers. The products that are traded in this way are referred to as "futures" on the exchange and "forwards" in OTC trading. The spot market encompasses the day-ahead market and the intra-day market. Electricity deliveries for the next day are auctioned on the day-ahead market, with suppliers and buyers having to submit their bids by 12pm on the previous day. The closer it gets to the agreed time of electricity delivery, the better the market participants can estimate the actual feed-in and real consumption. To keep shortfalls or surpluses to a minimum and ensure the cost-effective dispatch of the available power generation facilities, market participants can, after the day-ahead auction closure – have recourse to the intraday market and trade on a very short-term basis with electricity volumes for periods ranging from quarter hours to hour blocks. Intraday trading on the exchange closes 45 minutes before delivery (gate closure). Companies can engage in OTC trading up to 15 minutes before delivery.

Figure 6 - German Electricity Market



The above figure gives a chronological depiction of the German electricity market. The price quoted on the exchange is the point where supply and demand intersects which is also known as the clearing price. In the electricity market, the generation facilities with the lowest variable costs are the first in line to meet demand (as per the merit order). This helps minimize the cost of supplying electricity. As a general rule, the exchange price for electricity corresponds to the variable costs of the most expensive generation plant in use. This plant is known as the "marginal power plant". The exchange price is therefore also referred to as the marginal cost price.

3.2 Market Trends in Germany

In Germany, there exists an energy only market and it fails to adequately compensate backup power solutions needed to support the increasing portion of renewables in the country's generation mix. This is resulting in a decrease in the country's temporary strategic reserve capacity (at the current rate, the strategic reserve is expected to run out by the end of 2017).Agora Energiewende, a German think tank studying the energy transition, estimates that Germany could face a 5GW to 15GW supply shortage by the year 2022 if no precautionary measures are taken.(Federal Ministry for Economic Affairs and Energy, 2014)

It can be seen that the German electricity market is undergoing a period of transition. The German electricity market is liberalized and coupled with the electricity markets of neighboring countries. While this boosts the efficiency of the power supply system, it also contributes to the current overcapacity in the market, a situation which has been aggravated further by the addition of renewable energy facilities and the operation of new fossil-based power stations.

In addition to that, a temporarily lower demand for electricity in the wake of the financial crisis in Europe can currently be observed. This results in low electricity prices on the exchange, which are currently defining the market and reducing the economic viability of power stations. On the other hand, Germany plans to phase out nuclear energy by 2022. This will involve taking roughly 12 gigawatts of generation capacity offline. Further to this, renewable energy sources are increasingly playing a central role in the power supply and reduce the need for electricity production from fossil-fired power stations. They are transitioning from a power system in which controllable power stations follow electricity demand to a power system where flexible producers, flexible consumers and storage systems respond to the intermittent supply of wind and solar power. This transition will shape the electricity market in the years ahead.(Felix, Ben, Carsten, Hauke, & Christian, 2012)

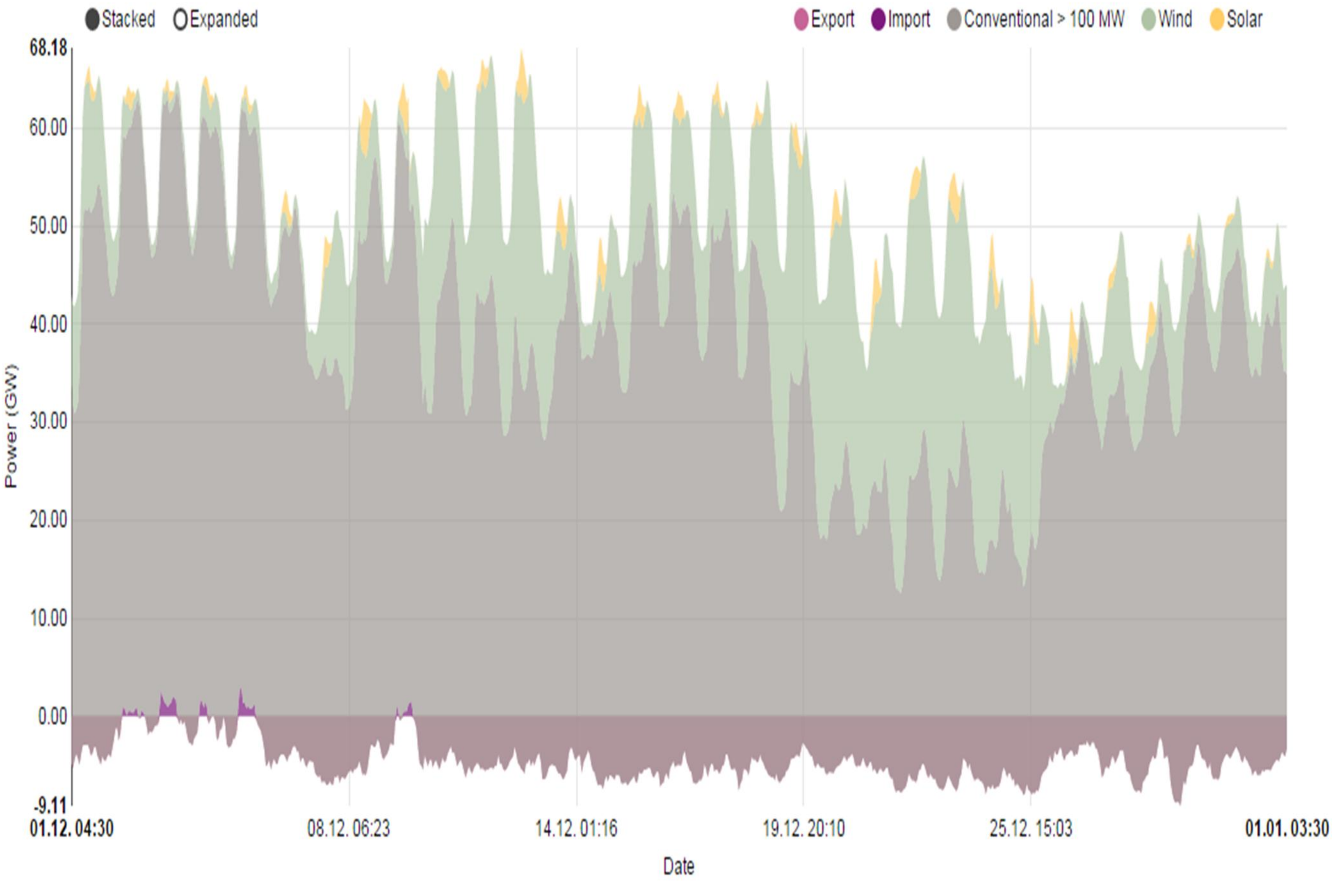
3.3 Need for Capacity Markets in Germany

The liberalized German energy market deals exclusively with volumes of electricity; this is why it is often referred to as an "energy-only" market. It is undisputed that the energy-only market will ensure that the cheapest power plants to satisfy a given demand. Such a market implicitly provides compensation for capacity on forward markets, spot markets and in power purchase agreements and adequate capacity is available on the short to medium term. However, whether or not the existing electricity market signals generate sufficient investment (both for new conventional power plants as well as for new RE plants) is still a major question.

In order to ensure security of supply in the few hours of peak load, sufficient capacity must always be available. This can be in the form of non-fluctuating RES, fossil backup capacity, power storage, and sliding loads. Since the energy-only market does not provide incentive for sufficient capacity to guarantee secure supply of electricity to consumers, a need for a capacity market is seen in Germany .In many countries and regions with liberalized markets (such as on the east coast of the United States, Brazil, Spain, Great Britain, Russia, and South Korea), electricity market regulators have introduced capacity market to ensure reserve capacity.

To be able to predict the need for Capacity Markets in Germany for the future, we must look at some statistics from 2014 to understand the present scenario of security of supply in Germany. The graph below depicts the Electricity production in Germany in December, 2014.

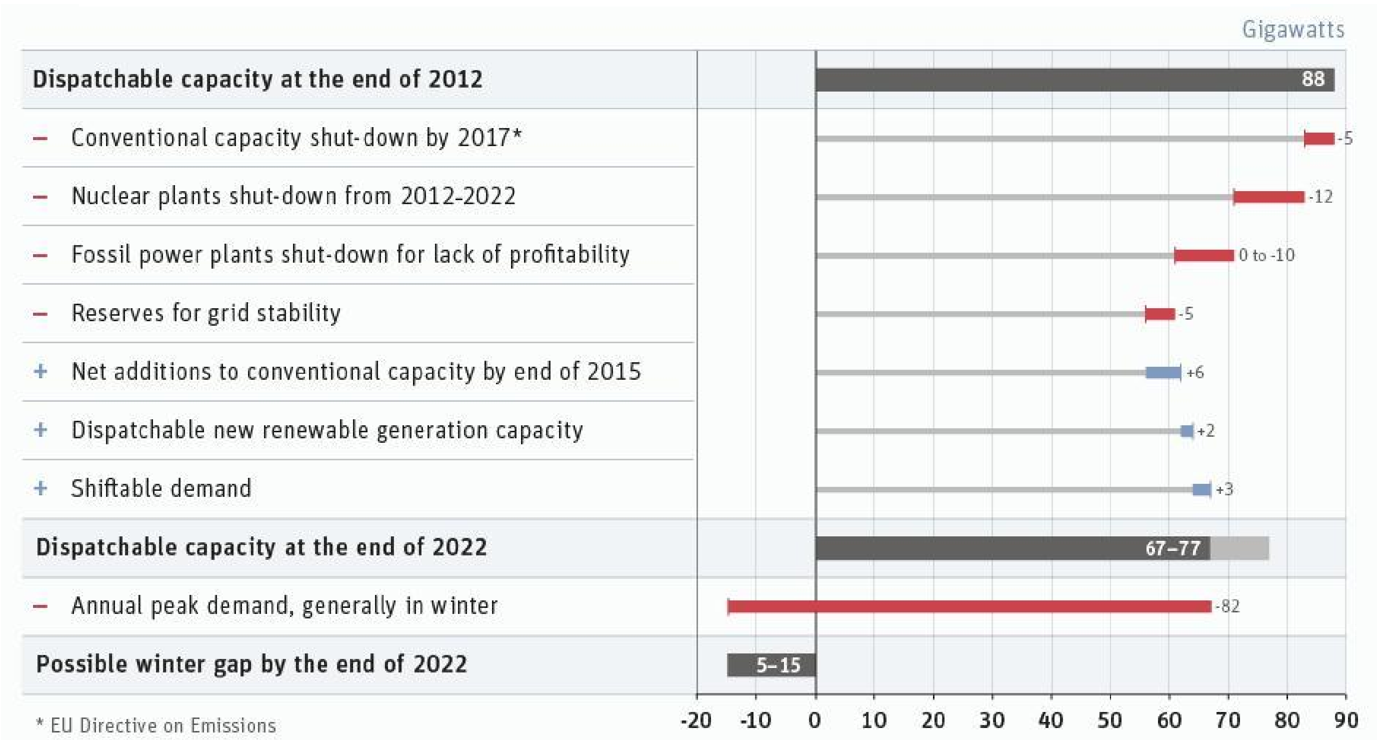
Figure 7 - Electricity production in Germany, December 2014[3]



In the third week of December, production of wind power (green area) was very high but was extremely low in the first week of the month. Domestic demand for conventional power (the large grey area) fell as low as 20 GW before Christmas, a level that is very close to the minimum production level to cover costs of Germany's conventional fleet. Exports (the area below the baseline) reached as high as 7 GW at those times, thereby rescuing these plants. Yet, demand at the beginning of the month regularly reached around 60 GW, three times higher.

In the third week of the month, power plant operators could only sell one third of their power, and prices were also much lower at the time. The result was unprofitable. But shutting down a lot of plants is not an option for Germany because they still have to cover the absolute peak for the year, which is close to 80 GW (including exports). This establishes a need to incentivize these power generators to stay online, without selling power. That is the idea behind capacity payments, but the concern is that these payments will prop up the very plants that need to be shut down, particularly coal plants.

The following illustration shows a net decrease in the dispatchable capacity in 2022 as compared to in 2012. [4]It can be seen that majorly owing to the shutting down of nuclear and fossil power plants, there will be huge reduction in Germany's dispatchable capacity in 2022. This level of capacity (67-77 GW) will not be able to cover its annual peak demand (82 GW) especially in winter. This would result in a winter gap of 5-15 GW which necessitates the introduction of a market with additional capacity. However, In January 2014, the Industry and Energy Ministry of Germany openly opposed the capacity market concept stating that the current market can take care of the challenges for the next few years with their strategic reserve.



[4]Energy Transition, The German Energiewende 2015 - http://energytransition.de/2015/02/capacity-reserve-or-strategic-reserve

German power companies cannot, however, simply shut down their generators that become unprofitable. In order to ensure this, the government has asked them to apply for permission for shutting down from the Federal Network Agency, which reviews the grid situation to determine whether that power plant is needed to prevent blackouts. The Agency only permits a few plants to shut down while the rest remain on a waiting list. Therefore, despite not having any incentive to stay, it is not easy for conventional power producers to exit the market due to restrictions from the government.

Germany currently has a “strategic reserve” of 2.6 GW. Statistically if we see, these power plants almost never run, but they are kept on standby just in case. In the past few years, they were only used for a day or two annually, and in 2013 they were unable to respond in time when four conventional power plants simultaneously failed in southern Germany – meaning they were actually not used at all that year.

To conclude, presently in the German case, they’re hoping to make do with this small capacity market which they call the strategic reserve (2.6 GW) as German government believes that there is no major capacity problem in the next five years. At the same time, since the Federal Network Agency is responsible to review the grid situation to determine which conventional power plant is needed to prevent blackouts, it is not so easy for existing power producers to exit the market, despite not having any incentive to stay.

In 2014, the experts advised Germany against capacity markets. According to the experts, capacity markets present considerable risks in terms of organisation and structure. Capacity markets only guarantee security of supply if they are designed and organised correctly. Practical experience from the United States, for example, demonstrates that arriving at the correct market design is a difficult undertaking that takes many years and may require many adjustments to rectify regulation errors. Capacity markets result in higher system costs and also present considerable risks (particularly in terms of over-complexity, mismanagement potential, inefficiency, less incentive for the development of flexibility, irreversibility, path dependency).

It must also be noted that capacities are necessary but not a sufficient condition to guarantee security of supply as depicted in the following case study:

United States, January 7th 2014.On the east coast of the US, a very critical supply situation was experienced in the power grid of energy provider PJM[5] even though more than enough generation capacity was held available by the capacity market there. On this particular day, over 40 gigawatts, or 22 percent of the generation capacity, was not available to the wholesale market when it was urgently needed. The reason was because these plants did not have sufficient incentive to be ready for operation and be actually dispatched. PJM therefore announced that it would revise its electricity market regulation (PJM 2014).

The German ministry of economics recommended in March 2015, that a modified energy-only market with a capacity reserve – but no set capacity market mechanism for compensating generation just for being available - would guarantee an income stream for capacity being on standby, whether it is called upon or not. Here Germany is choosing to diverge from the path of a national capacity market that the UK, France and Italy have already chosen to tread in order to safeguard security of supply for electricity systems with a high penetration of variable RES.

3.4 Challenges for Capacity Markets in Germany

This section discusses the key issues faced by Germany's electricity market that could potentially affect the effectiveness of a capacity market.**(Peter & Axel, 2011)**

- **Growth of RE Capacity**

The electricity market in Germany is characterized by a politically-induced strong growth of RE capacity. The RE generators are paid a subsidy for the electricity generated, which is independent of the electricity price. The sale of RE power in the market increases price volatility. Also, owing to the must run status of RE capacity, the degree of capacity utilization of conventional generation is significantly reduced. The gap between the cost of subsidy provided and the market clearing price of electricity is widening. A capacity market as described above can help to mitigate the various challenges for conventional generation in a system with a large share of renewables.

It can be argued that for a transition to a system with a large share of renewables, there does not seem to be any need for capacity markets as conventional generators are needed to meet the demand and do not have to be remunerated for making their capacity available as a reserve.

- **Politically-induced uncertainties**

One of the major risks faced by investors in electricity markets comes from political uncertainties regarding the demand for new capacity and the profitability of investments—regardless of whether there is a capacity market or not. There is also the risk of political and regulatory opportunism, when prices reach levels that are economically sound. A capacity market cannot avoid drastic risk premiums that need to be paid to investors who are unwilling to invest in unpredictable environments. That is, with or without capacity markets, politically-induced uncertainty makes reliability of electricity supply an impossible or expensive goal. In particular, any plant that provides reliability options, including the existing plants, would be paid large risk premiums, making reliability very expensive in times of profound political uncertainties.

So, complementary to considering a capacity market in India, one natural approach to address resource adequacy problems is to implement a stable political framework that takes into account its long-term effects on the electricity sector.

- **Regulatory Imperfections**

In Germany, new power capacity addition is subject to strong pressures from market, political, environmental and other lobby interest groups. It is likely that such interest groups will try to bias the design—e.g., the ratings of certain technologies and locations—towards their interests. One might hope that a transparent debate about how much capacity is actually needed may help to discipline the influence of interest groups. There is a danger that the parameters in the capacity market get distorted because of pressure from politics and lobbyists, or because the capacity level can be used as a strategic commitment device, to constrain the decisions of future policymakers and investors.

Thus, if a capacity market is going to be established in India, installing an independent group of experts to manage and supervise the process is a good idea.

3.5 Indian Scenario

The Indian power market is purely an Energy Only Market where the investments in building the capacity are implicitly recovered as one of the components of the two-part tariff structure. The 'Capacity Charge' is fully recoverable at a very high normative level of PLF (of about 80%), and there are incentives for higher PLF beyond normative level. Therefore there is a strong competition between the power producers for high PLF by maximizing energy sale.

With large scale penetration of renewables, existing conventional power generators shall find it difficult to maintain high PLF and will have less incentive to stay in the market due to losses they will incur owing to falling PLFs, especially those having higher incremental costs. In fact large number of power producers in Europe, where the RE penetration is high the conventional plants being de-commissioned. However, from point of view of system operation, these power producers need to be standby. A capacity market, where capacity can be explicitly traded will then be required to incentivize these producers to not exit the market and instead provide reserves.

In India, RE penetration is low at present and may not require an immediate 'capacity market', but it may be required for the future. The following are some pre-requisites for developing capacity market.

- To incentivise generators to make their capacity available, the capacity charge, a component in two part tariff structure, should be linked to availability rather actual PLF.
- The ancillary market for explicit payment of capacity needs to be developed.
- A strong SPOT market with large tradable power volume shall also be required.

As of March 2015, of the total 271.7 GW installed capacity in India, only 35.7 GW is from RES[5]. Looking at the power supply position of India in the year 2014-15, the annual peak demand was 148GW while the demand met was about 141 GW(Central Electricity Authority, 2015). Therefore in the current scenario, the conventional generators have to be run to meet the country's demand and there is no scope for them to provide standby capacity to support variable RE generation. The current penetration of must run RE generation is definitely not sufficient to necessitate capacity market development in the country.

For 2022, the projected annual peak demand for the country is 283 GW (Ministry of Power, 2014) and the planned RE installed capacity is 175 GW. The following scenarios can be envisaged for the situation in 2022.

- Scenario 1 - During low RE generation season - conventional generation capacity will be required to cater to the demand. In this scenario conventional power plants shall be required to meet the demand.
- Scenario 2 – During high RE generation and high demand season – Assuming a maximum PLF of 70% for the total RE installed capacity in 2022, 122 GW of available RE power will not be sufficient to meet the total demand in the country. In this scenario also the conventional power will be required to cater to the demand, however at lower PLF.
- Scenario 3 - During high RE generation and low demand season - Assuming a fall in demand by a maximum of 30 %, the demand of 198 GW cannot be met by RE power alone, even if 175 GW of RE power is available. In this scenario conventional power will be able to cater to a substantial portion of the demand, requiring conventional plants to standby.

The above mentioned scenarios may not be mutually exclusive and may occur in same year during different seasons. Therefore, we have to review our policies time to time and at least move towards pre-requisites for a capacity market.

[5] CEA, 2015 - http://www.cea.nic.in/reports/monthly/inst_capacity/mar15.pdf

As of June 2015, about 47% of the installed capacity in Germany is from RES[6]. Even with this level of RE penetration into the grid, Germany has decided to not opt for capacity markets. Understanding the current scenario and market trends of the Indian electricity market and also drawing a comparison with the German framework, it can be concluded that even with the ambitious target of 175 GW of RE penetrations into the grid in 2022, India's power market structure is premature for the introduction of capacity markets.

A precipitate and ill-conceived introduction of a capacity market could petrify current market inefficiencies, hampering innovation and providing economic rent to India's ailing utilities. Highest priority needs to be given to first build a stable and reliable political, and a sound market framework. This should include integrating renewables into the wholesale and reserve markets, developing new transmission lines, adjusting the design of power reserve products and markets, reducing regulatory uncertainties, strengthening real time demand response, real time price discovery, and real time dispatch flexibilities, as well as other measures. Most of these measures could substantially contribute to resource adequacy and reliability. In fact, given the current state of Germany's electricity market, the contribution from building a stable and more flexible market environment will likely exceed any contribution from well-designed capacity markets. That said, a capacity market, will be of important complementary value once the market operates on a stable political, regulatory and economic basis and it will also help incentivize existing conventional power generators in India to not exit the market and to instead provide reserves.

Before introducing capacity markets in India, a well-defined study of the resource adequacy, objectives and drivers needs to be carried out. There should be well-defined obligations, auctions, verifications, and monitoring and efficient spot markets for energy and ancillary services. There should be a clear understanding of why the market design is deficient without a capacity market. Locational reliability challenges should be addressed in the initial stages. The market should have staying power to reduce regulatory risk while improving designs and addressing deficiencies.

3.6 Steps to introduce capacity market in India

It is essential to maintain reliability of power at least-cost while the power sector shifts from being dominated by conventional power to renewables. This involves addressing both adequacies of resources i.e. access to enough power to be able to meet the highest expected level of demand and system quality i.e. the right mix of resource (consumers and generators) capabilities deployed to ensure that demand and supply are always balanced. Rising shares of variable renewables is making resource flexibility increasingly an investment consideration as well as an operational one.

Keeping the above factors in mind, for the Indian context, the following steps are proposed before a viable capacity market can be created. These steps should be undertaken to make sure that the system has effective access to all of the cost-effective flexibility available from the existing generation portfolio and untapped existing demand-side management potential in the short term. In the long term, these steps should ensure that the market supports investment in a portfolio of new and existing supply- and demand-side resources capable of efficiently and cost-effectively meeting the projected need for flexible resource capabilities over a longer time.

i) Before introducing flexibility in the generation portfolio, operational challenges posed by growing shares of variable RE can be substantially mitigated through a number of relatively low-cost measures.

[6] https://www.energy-charts.de/power_inst.htm

- Introduction of shorter scheduling intervals for increasing accuracy of schedule
- Creation of balancing groups balancing power flows at SLDC or Sub-SLDC level
- Investment in transmission to mitigate congestion and remove barriers to free flow of inter and intra state power
- Enable regional balancing of power
- More accurate forecasting of RE power and mandatory introduction of demand forecasting at DISCOM level
- Consumers (such as flexible industrial loads as well as large commercial buildings) to leverage their load as a reserve to be more responsive to uncontrollable changes in supply to manage unplanned imbalances to be included in balancing groups

ii) Ensure that existing power market is designed and operated to extract all cost-effective flexibility services available from all existing resources (consumers and generators).

- There should be sufficient capability to stop/start and ramp generation up and down (or in the case of consumption, down and up) fast enough
- A fully functional mechanism should be developed so that the above flexibility measures can be used in the necessary quantity and frequency over multiple scheduling intervals in a least-cost manner to ensure system reliability

iii) Ensure that all qualifying demand-side management options are fully able to participate in the market, both directly and through aggregators.

iv) Historically there has been investment in resource adequacy however, system quality is ensured in operational timescales (imbalances managed by xLDCs at their own levels). Going forward, large shares of variable and intermittent RE requires that investment is done to ensure system quality.

- The CERC regulation on ancillary services is a first step in this direction
- A fully functional control reserves market to ensure provision of ancillary and balancing service should be introduced

v) Establish a procedure for combining gross demand forecast with RE generation forecast to derive a net demand forecast. Use this net demand forecasts to assess on a periodic basis, the demand for critical flexibility services, taking into account the available dispatchable resources (consumers and generators) to provide these services.

vi) Establish a methodology for setting the maximum value to the upcoming generation (both conventional and RE) depending on expected future peak load forecast and system reliability requirements.

The following are the envisaged possible options to ensure system reliability in the Indian scenario.

Enhanced Services Market

This approach utilizes a long-term services market (essentially adaptation of existing ancillary services mechanisms, with new services added as necessary) to procure the target mix of resources (consumers and generators) derived from the net demand forecast. This would most likely include traditional system operator functions such as spinning and non-spinning reserves and operating reserves. Obligations to secure such services would remain with the system operator.

Required balancing services may include short-cycle stop-start and aggressive dispatch or ramping options, parameters meant to reflect how fast and how frequently, across multiple scheduling intervals, a resource can be turned off and on, as well as the up-ramp and down-ramp rates and ranges. For both traditional ancillary services as well as these less traditional balancing services, their value could be set by periodic "forward" auctions and paid to all new and existing resources capable of providing them.

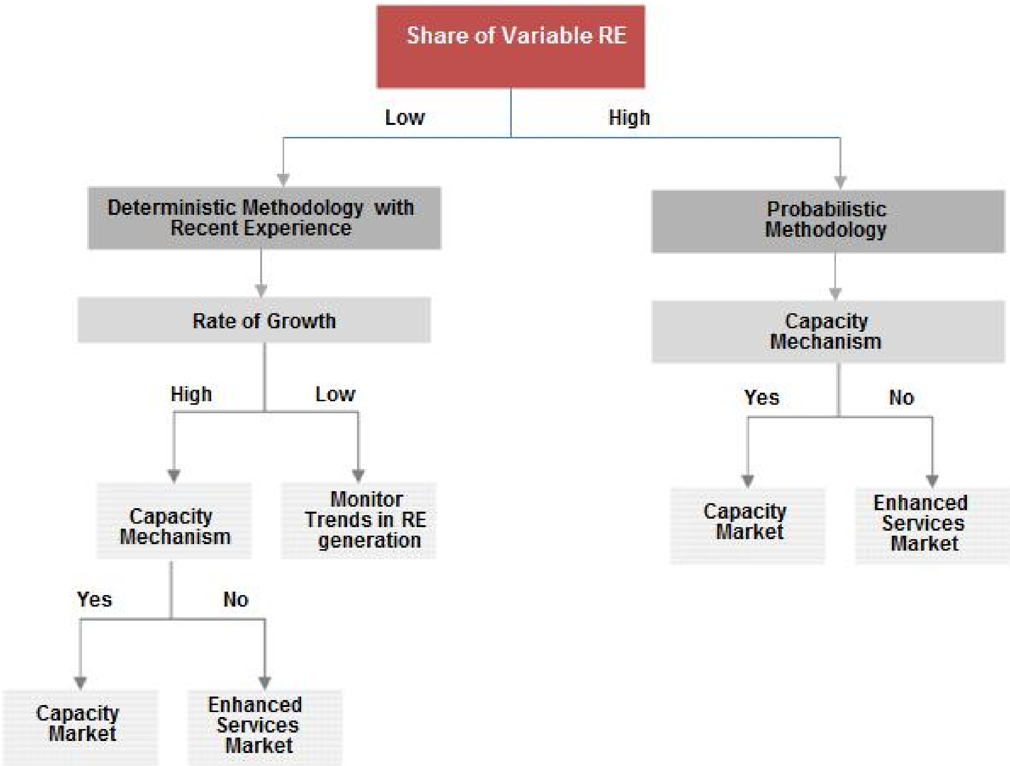
Investors may be slow to incorporate the relevant capabilities into long-term resource investment plans unless they have a more immediate motive to do so (such as the capacity mechanism described below). Therefore pursuing an enhanced services market may be more appropriate for markets where there is no perceived urgency to invest in a significant amount of new supply resources. Nonetheless, this approach represents a viable option for regions experiencing a growing share of variable renewables where creating a separate forward capacity payment mechanism may not be desirable.

Forward Capacity Market

An alternative approach, involves simply apportioning the capacity mechanism into products based on the target mix of resources (consumers and generators) based on the net demand forecast. All resources, including qualifying demand-response and end-use energy efficiency resources, would bid into the highest-value product for which they could qualify. The most flexible product is cleared first, followed by the next, and so on.

It is important to keep in mind that capacity mechanisms are not intended to provide additional revenues to system resources over and above what they would expect to earn in a properly functioning energy-only market. Rather they are designed to substitute a more stable, predictable stream of payments for capacity in place more variable, less predictable revenues that would otherwise have been earned through the sale of energy. As a result more flexible resources can realize a higher proportion of their earnings from stable, long-term, predictable capacity (or "capability") revenues, which should afford them an overall competitive advantage over less flexible resources in the energy, capacity and ancillary services markets.

Figure 8 - Decision Framework



Depending on the expected market condition, a simple deterministic approach based on recent experiences or a more complex probabilistic approach can be used to set up capacity markets for the Indian scenario. Following the decision framework as depicted in the figure above, the desired resource capabilities can be procured through either enhanced services markets or apportioned forward capacity mechanisms, depending on the market circumstances.

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