Issues And Challenges In The Solar Energy Sector For Its Development And Utilization Globally With A Comparative Analysis Between India And German

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Abstract:

In the late 20th-century deregulation and opening of the power market to private players were done in several regions of the world. This was a necessity due to a plethora of reports globally, which suggests that the availability of Conventional source of energy is an all-time favourite but due to availability in a limited capacity, their shift from conventional sources to non-conventional sources should be more important. Government is more focused toward to harness non-conventional sources and those smart policies may be introduced. Smart policies for the smart grid are one of the key elements in developing and harnessing the solar energy sector in India and other countries. FIT is one of its which is responsible for setting up energy prices and the tariff related. The best part of FIT is to create a balance between green energy producers and consumers. Fit is most prominent in Germany, U.S., Spain, and Italy. However, this study is to check the FIT status quo and its prospects to develop the solar energy sector in India and Germany. Moreover, the existing literature underestimates the potential impact of FIT. In India, this FIT is a fixed payment given by Discoms to Producers under long-duration contracts and decided by the central and state-level authorities. The current study checks the effectiveness of FIT in the Indian Legal system and reflects its future growth along with its non-compliance which leads to creating hindrance in the evolution of the Solar sector.

Keywords: FIT, Renewable Energy, Solar Energy, Policy Regime, one solar one grid.

INTRODUCTION

India Imports its major portion of crude oil to fulfil the consumption of Oil and Gas. Current oil reserves in India are not sufficient to meet their demands. And Hydropower generation plants are not easy to install and have to face a lot of hurdles like regulatory compliance, necessary permissions, Land, etc. But the other non-conventional methods like solar and wind are easily available in ample amounts which is a basic Raw to generate electricity because of India's geographical conditions. India's geographical condition is blessed with 365 days of sun throughout the year which makes it stand different from the other countries. Recently India has adopted policies for procurement of electricity through renewables and cleaner sources of electricity likewise solar Energy.

Though the industries are mostly privatized and have a high rate of consumption of electricity, their demands must be fulfilled by electricity generated from conventional sources and non-Conventional sources both for continuous production. Government has the scope to purchase electricity through the required energy source. These public procurement policies are of two standard forms.

1. Feed-in-tariff- for a fixed price.
2. Certain percentage which is market-based.

The primary premise of FIT programs is to ensure financial assistance for power generation from RES for specific time. This assistance is provided to everyone without any discrimination for every kilowatt hour of electricity generated and can be segregated depends on the type of technology, the area of the installed plant, the quality of the raw, the location of plant, and an information related to project-specific "(Mendonc-a, 2007; Fouquet and Johansson, 2008; Langniss et al., 2009)".

This program helps others likewise homeowners, small- and large-scale investors, farmers, and local municipalities to join the programs and also expand renewable energy transmission deployment across a wide range of technology classes "(Klein et al., 2008; IEA, 2008; Lipp, 2007; REN21, 2009)".

The steep fall in the cost of solar photovoltaics has ignited a shift from non-renewables to renewables. Policies initiatives like Jawaharlal Nehru National Solar Mission sets up a goal of 100 Gigawatt of electricity generation by the year 2022, through Solar (*Feed-In Tariffs vs Reverse Auctions: Setting the Right Subsidy Rates,* 2022). The common feed-in tariff rule was propagated for all to promote and fasten up the speculation in the Solar energy sector. These policies' initiatives veil the speculation in Solar Rooftop Plants in cities. Gujarat is the only state who reached the set limits of Production (*Feed-In Tariffs vs Reverse Auctions: Setting the Right Subsidy Rates,* 2022).

These fast developments in solar technology abridged generation costs and fasten up the supply of electricity to such an extent resulting in a lower cost of generation.

This paper is structured as firstly, it was started with the introduction which includes a background of the solar energy policy feed-in tariff system in India. Secondly, the impact of this tariff on two major states Gujarat and Tamilnadu are discussed. Next, the feed-in tariff in Germany and its effective and efficient execution is being discussed in solar-related policies along with Renewable Energy Resources Act, 2000, and the recent amendments that happened in the year 2021. Finally, the paper ends with some concluding remarks and Tariff implications in India by taking Germany as a role model.

REVIEW OF LITERATURE

The following are the primary reasons for the effectiveness of FIT policies, according to (Ayoub & Yuji, 2012) provides investors with long-term security by guaranteeing and fixing tariffs at a relatively high level for a long time (high price per kilowatt-hour); the existence of well-designed financial subsidy programmes; regional investments in economic and social welfare; technology-specific and location-dependent differentiation; and stable governmental regulations.

FIT programmes have been the most often used policy to encourage the deployment of PV systems around the world. The FIT regulations provide set prices and long contract terms, lowering investors' perceived risks. FIT policies are more efficient at increasing capacity and stimulating R&D input to reduce costs than other policy instruments such as the renewable portfolio standard (PRS). FIT policies, on the other hand, may stifle healthy market competition by favouring certain technologies and raising the financial burden on taxpayers.

However, in earlier studies, of (Hoppmann et al., 2014) researched the development of Germany's FIT policies and concluded the factors integrating socio-technical systems which deflects policy interventions. Gao et al. prepared step-by-step process to those who entered late and prospective FIT comers to set their scheme. For the evaluation of the FIT

policies, the economic approaches had been widely adopted. In addition, the learning curve is frequently used to describe technical advancement, which is an important component of optimal FIT models.

Kayser highlighted the risk component that hinder demand-driven PV market growth. High electricity generation costs and insufficient grid transmission capacity, according to Hui et al., 2017, are obstruct the steady growth of clean electricity generation equipment. For evaluating PV investment under uncertainty, Zhang et al., 2016 suggested a real options model. Ouyang et al. computed the cost of electricity of PV and compared it to similar feed-in tariffs for FIT regulations. Lin and colleagues showed how to integrate FIT policies with an emissions trading programme to create a cost-effective climate policy package. The annual return on investment and payback period of integrated PV greenhouses systems were calculated by Li et al., 2017. The Author in this paper tries to check the effectiveness of FIT policies.

FEED-IN-TARIFFS (FITs) IN INDIAN STATES.

These are the fixed payments by Discoms to Electricity generators through Solar power under long-term contracts. This word was first reiterated in "Germany Renewable Energy Sources Act", 2000 (Couture, 2010). The main feature that is they are set by the central and state regulatory authority. These regulatory authorities set the tariff as per their mechanism and it varies from state to state.

Earlier Gujarat has led in the terms of generation of electricity through solar in India. It is located on the western coast of India and gets benefits due to that but after the construction of Bhadla solar park in Rajasthan, which is the world's biggest Solar Park in generation and second in terms of area till March 2020.

Gujarat's model of generating electricity has a taste of success because of the FIT process that provides a fixed rate of tariff to the generators of electricity through solar and also supplied to the grid if required. This tariff applies to all projects and is fixed for 25 years. Apart from that, it was levelized into two categories one is of higher many prices i.e., runs for 12 years (from 2010-2022), and the other is for much lower prices for the succeeding 13 years (from 2023-2036). This model indicated the steep declines in the tariff set by Gujarat Electricity Regulatory Commission. A tariff will be lessen from it earlier status by 7 %.

A rooftop rate is computed in Tamilnadu based on the rooftop solar tariff, much more than what users pay for grid power. "Consumers receive subsidies from the grid, which the government pays to Tangedco on an annual basis. For example, all domestic consumers are entitled to free delivery of the first 100 units, and since 2014, the government has cancelled the charge for consumers who use fewer than 500 units each month (B, 2017)

Domestic consumers receive two sorts of incentives for consuming grid power, but Tangedco pays them the full tariff when they sell solar energy. Several domestic customers in high-end apartment complexes have installed rooftop solar projects with capacities ranging from 2KW to 15KW (B, 2017).

Depending on the size of the terrace, several places have rooftop solar generating systems of varying capacities. However, because most of them lack a net meter, they are unable to send extra electricity to the grid.

Installation of Each KW of plant requires an investment of approximately 80,000 INR-1,00,000 INR. There is off-grid (without transferring the generated electricity to the Grids) installation by the consumers by using lithium-ion Batteries and with the converter. But this type of installation requires a further cost of maintaining the batteries which also increases the 30% cost of the solar power project, which is also one of the major drawbacks of this type of plant.
All states decide their tariff as per their own choice and standards, central electricity regulatory commissions also set standards for the same.

Feed-in Tariff data in India from 2015-to 19(OECD, n.d.)

Source	2015	2016	2017	2018	2019
Solar PV	0.117	0.084	0.000	0.000	0.000
Wind	0.083	0.080	0.000	0.000	0.000
Small Hydro	0.079	0.076	0.079	0.081	0.081
Biomass	0.113	0.115	0.119	0.104	0.114
Waste	0.123	0.114	0.116	0.114	0.111
Geothermal	0.000	0.000	0.000	0.000	0.000
Marine	0.000	0.000	0.000	0.000	0.000

All Units are in US Dollars

The above-mentioned data reflect the Feed-in tariff status of India from 2015-to 2019 afterward the pandemic hits globally and affected all the manufacturing industries and the installation of new plants electricity Generation plants in India. We can see that only small hydro, biomass, and electricity generation from waste is fulfilling the feed-in tariff and the rest is not fulfilling the same. The issue with this tariff is being discussed in this paper and what are the preventive measures should be taken to improvise that.

Issues with Tariffs need to fix.

In India, there are two types of power generation tariffs. The first half is a fixed cost - the cost of running a generator. This has nothing to do with the amount of energy produced. The second portion varies depending on the generation quantum. Since 1992, the two-part tariff has been popular. It applies to both thermal and hydroelectric power generation. It excludes renewable energy sources such as solar, wind, and nuclear power. The variable price is estimated using a two-part formula that follows the regulatory commissions' guidelines. This is determined by the cost of fuel, which can be coal, gas, or lignite, depending on the situation.
In the case of hydropower generation, we don't have a valuation for water as we do for coal or gas, hence there is no variable cost of generation for hydro generators. A hydro station's entire cost is a fixed cost, with half of that cost being treated as a variable cost.
Solar and wind power, as well as nuclear power, are still subject to a single-part tariff. The single-part tariff applies to nuclear power plants for a variety of reasons, including the fact that, due to the technology, nuclear generators typically do not increase or decrease generation at a rapid rate, but rather maintain a steady stream.
In any event, nuclear power accounts alone for about 2% of total generation. Solar and wind energy, on the other hand, currently account for around 10% of total generation,

and according to the statement made at COP26 in Glasgow, we would want to raise this to 50% by 2030.

There are a few factors to consider here. The renewable energy sector has been designated as a "must-run." This means that any renewable energy generation must be dispatched first. The idea is that if we don't use the sun's rays or the wind velocity for that matter, it will be lost forever. The state load dispatch centres (SLDCs) are required to follow this approach.

The dilemma is that "must-run" goes against basic economic theory, which states that to reduce overall cost, dispatch should begin at the lowest marginal revenue source and work higher. Herein is the issue.

The full cost of renewable generation is changeable with a single part rate, and solar generation is not the cheapest source at Rs 2.5 per unit. Simhadri (Rs 1.36), Korba (Rs 1.36), Sipat (Rs 1.43), Vindhyachal (Rs 1.70), and Talcher (Rs 1.70) are only a few of the NTPC coal-fired pit head plants with reduced variable costs (Rs 2.00). This is merely an example and not an exhaustive list. Only solar generators of modern manufacture are charged Rs 2.5 per unit.

The tariff for older solar facilities might be well over Rs 3 per unit, and it could be considerably higher for wind-based energy, averaging over Rs 4.5 per unit. It's no wonder, then, that SLDCs frequently disregard the "must-run" concept, because the distribution firms would save money by ordering the renewable generator to shut down while keeping the coal-fired generator running.

The solution to this dilemma is to use multiple tariffs for solar and wind producers, similar to what we do now for hydro plants. But, while 50% of the entire cost is allocated as a variable cost in hydro, what should the concept be for sustainable generation plants? The overarching premise is that the proportion given as a cost factor must assure that power generation has the lowest cost, so the “Must-Run” criterion is not violated. Simultaneously, the total fixed element must not be maintained so excessively that it does people harm. It will be necessary to maintain a fine line between fixed and variable costs. There are further advantages to implementing a two-tier renewable energy pricing. It would guarantee developers a steady income even if the facilities are not producing during specific hours, as is the case with fossil and hydroelectric plants.

When a renewable generator is required to back down for grid balance, it is paid nothing under a single-part tariff. If we are serious about reaching a renewable generating capacity of 450-500 GW by 2030, we must establish the right climate and provide appropriate returns to encourage new investments in renewables. It's vital to remember that, while the government may set targets, private players must carry them out, therefore market signals are crucial.

We need to convert from a single to a two-part tariff structure for renewables right now because we are on the verge of ramping up our renewable capacity, and as we have seen in the past, things take time to get streamlined.

FEED-IN-TARIFFS (FITs) IN GERMANY

Germany has used FIT to great effect in its solar energy collection. The Electricity Feed-in Tariff Act of 1991 has accelerated the transition to 100 percent renewable energies, with more than 60 percent of the generation coming from rooftops. The first German Feed-in Tariff Renewable Energy Act (EEG) went into effect in 2000 to encourage the generation of RE (Jaeger, 2021). It has been changed multiple times since then. The EEG serves the goal of increasing renewable energy's proportion in the electrical mix while

producing zero greenhouse gas emissions (GHG) for a healthy environment and long-term wealth development for future generations.

This approach has shown to be quite effective in boosting the market share of renewable energy. In 2000, Germany produced only 6.2 percent of its electricity from renewable sources, rising to 23.7 percent by 2012 and nearly 28 percent in 2014. If current rates of growth continue, Germany might be powered entirely by renewable energy by 2035 (Reuters, 2022).

With a growing global interest in encouraging renewable energy, the German Feed-in-Tariff is widely referenced as a transferable model and has acted as an exemplar for similar laws in over 80 nations worldwide, particularly in China.

The German Feed-in Tariff (EEG) went into effect in 2000 to encourage the production of renewable energy (RE) through encouraging market development. In 2004, 2009, 2012, 2014, and 2021, the EEG was modified to reflect the continued good development of renewable energy in all industries.

Key features of the EEG include:

- Priority access to the electricity grid for renewable energy sources.
- For a set term, a fixed price for each kWh of electricity derived from natural energy (generally 20 years). This fixed price is sufficiently high to assure a profit.
- All sources of renewable energy are evaluated, with rates varying depending on the source, size of the plant, and year of installation.
- The EEG surcharge distributes the additional cost to all energy users so that end-users of energy can expect to pay a set amount for each kWh consumed.
- The government reduces the fixed tariff in response to market conditions.

This policy offers financial certainty and economic assistance for all types of renewables, allowing Germany to raise its share of renewable energy in its power consumption dramatically.

In 2004, 2009, 2012, 2014, and 2021, the EEG was modified to reflect the continued good development of renewable energy in all industries.

Major amendments in 2021

On January 1, 2021, the amended Renewable Energies Act (EEG 2021) came into force. With the amendment to the EEG, the German government aims to further endorse the expansion of renewable energies. For the first time, the goal of greenhouse gas neutrality for electricity supply before the year 2050 is enshrined in law. The amendment contains a whole bundle of individual measures – from the possibility of financial participation by municipalities in the expansion of onshore wind energy to the facilitation of self-supply to the regulation of the smart meter gateway obligation (Weingart, 2021).

It is already foreseeable that there will be readjustments to the EEG 2021 this year. In the resolution proposal of the government factions of December 15, 2020, it was stated, among other things, that in the first quarter of 2021, a more far-reaching expansion path for renewable energies is to be defined that sufficiently takes into account the European climate target of 55% by 2030. The further strengthening of long-term Power Purchase Agreements (PPAs) is also reserved for a future amendment to the EEG.

This policy sparked a decentralized, underside movement, allowing people to invest in renewable energy initiatives. Because most RE infrastructure in Germany is owned by private persons and cooperatives, this community-based strategy encourages widespread citizen participation.

The objective of this Act is to enable the long-term expansion of energy supply, mainly for protecting our environment and mitigating the climate change, to diminish energy supply charges to the economy, including by factoring in peripheral continuing things, to save fossil, and to indorse the additional expansion of machinery for the production of electricity from non-conventional sources.

To achieve the purpose stated in the subsection above, and to integrate these quantities of electricity into the electricity supply system, this Act aims to increase the share of renewable energy sources in the electricity supply to at least: 35 percent by no later than 2020; 50 percent by no later than 2030; 65 percent by no later than 2040; and 80 percent by no later than 2050.

By mid-2015, these targets will almost certainly be exceeded, with renewable electricity accounting for more than 30% of total electricity generation. According to a 2009 coalition agreement between the CDU/CSU and the FDP, the legislative goals are to:

Reduce GHG emissions in Germany by 40% below 1990 levels by 2040; Increase renewable energy and energy efficiency, with renewables accounting for most energy production.

Push the energy transition forward and make Germany the home with one of the most modern energy industries, making it a desirable business place and ensuring energy supplies cost and availability.

Feed-in Tariff data of Germany (OECD, n.d.)

Source	2015	2016	2017	2018	2019
Solar PV	0.097	0.097	0.000	0.000	0.000
Wind	0.099	0.098	0.095	0.114	0.108
Small Hydro	0.091	0.091	0.090	0.094	0.089
Biomass	0.065	0.065	0.105	0.112	0.106
Waste	0.000	0.000	0.162	0.121	0.115
Geothermal	0.280	0.279	0.285	0.298	0.282
Marine	0.000	0.000	0.000	0.000	0.000

All units are in US Dollars.

These numbers illustrate the charges that are required by law and are further stated in power purchase agreements (PPAs). Values given in this section are typically averages f or a year and nation across various classes within a single technology thread. Different s ub sectors' values are constantly segregated. Payments are always the value for a new

installation in a particular term, and do not include current values from past years' contracts. The few relevant feed-in premiums (FIPs) are recorded as if they were feed-in tariffs in this dataset. The current US / kWh is used to calculate the FITs.

CONCLUSION

Most Discoms all over the world provide FITs as an inducement to motivate the consumers to setup Solar rooftop PV by making the investment-worthy for the consumers. The main important step to investing more and more in Solar rooftop PV is to provide decent Feed-in-Tariff to the consumers. The majority of existing FIT's are based on the original capital cost and the spot price of power; however some studies have adapted a particular feed-in pricing for clients in remote areas. Many existing feed-in prices are based on the original investment and the instant price of power, though some studies have reflected special feed-in pricing for their clients in far-flung areas. This article reflected that in Germany, feed-in-tariff already shows us its success where the geographical conditions are not in favour to generate electricity through solar rooftops, whereas in India the geographical condition is fully in favour of generating the electricity.

EEGs have been a major success in Germany, and the EEG is widely recognised as one of the best instances of a successful EEG law. Because democratic support for a shift away from fossil fuels and toward renewables is substantial, well-designed EEGs are expected to outperform alternative regulatory support mechanisms, particularly in the early stages of renewable technology development.

This strategy has very much strength to be used as a template for promoting renewable energy. The German EEG has served as a model for renewable energy expansion in more than 80 other countries. The EEG ensures that renewable energy installations are profitable, and that renewable energy is promoted effectively.

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Conflict of Interest

The authors further declare that they have no conflicts of interest to declare that are relevant to the content of this article.

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