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Abstract

China, India, and South Africa have recognized the importance of renewable electricity for their future development. In this paper, we investigate the experience of the three countries in applying generation-based policies to promote renewable electricity. In contrast to the European experience, which proposes feed-in tariffs as the most successful policy to promote renewable electricity generation, emerging economies show strong interest in little acknowledged auction-based tariffs. We explore how and why different generation-based policies for solar photovoltaic (PV) are applied, as well as what their prospects are. Our comparison highlights the importance of policy objectives on policy choice and design. All three emerging economies need to promote electricity from renewables while keeping electricity prices low. Hence, they are experimenting with policies and design options and arriving at country specific solutions. Despite applying different policy instruments and designs that put strong emphasis on low-cost solutions, all three countries seem able to reach their ambitious deployment targets.

Abbreviations

ABT	Auction-based tariff
ESCOM	Electricity Supply Commission South Africa
FIT	Feed-in tariff
GW	Gigawatt
IPP	Independent Power Producer
KWh	Kilowatt-hour
INR	Indian Rupee
MNRE	Ministry of New and Renewable Energy (India)
MW	Megawatt
NDRC	National Development and Reform Commission (China)
NERSA	National Energy Regulator of South Africa
PV	Photovoltaic
RET	Renewable energy technology

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1 Introduction

Electricity generation in most countries today heavily relies on fossil fuels. This reliance on fossil fuels entails a number of risks. On the one hand, the earth's finite natural resources make countries increasingly vulnerable to volatile international markets. On the other, this dependence exposes them and everyone else to the risks of climate change. Fossil fuels continue to be used and promoted because they are said to be cheaper than renewables. However, the cost advantages of fossil fuels over renewables disappear as soon as the externalized risks are considered and a long-term perspective is taken. Markets are weak in doing this; hence, proactive government support is needed to promote renewables and the green electricity sector (Ellis / Baker / Lemma 2009, 55–57; WBGU 2011).

Greening the electricity sectors of emerging economies is particularly important and challenging. First, economic growth is strongly correlated with electricity demand (Yoo / Lee 2010), which entails the danger of greater fossil fuel dependence, but also the chance to instigate the deployment of renewable energy (WBGU 2011). Second, emerging countries have limited capacities to respond to major external shocks (Naudé / Santos-Paulino 2009). Risks from fossil-fuel dependence and climate change are therefore much more substantial for these countries. Hence, encouraging an early transition to electricity from renewable energy is decisive to exploit their mitigation potential and to contain climate and resource risks. For this purpose, massive amounts of renewable energy installations are needed. However, as electricity is central to development, additional costs from a transition to renewables are a socially and politically sensitive issue, which underscores the need for smart policies that encourage installations at reasonable prices.

Emerging economies are increasingly adopting policies to promote the deployment of renewable electricity technologies. In doing so, they seemingly ignore the alleged superiority of feed-in tariffs (FITs), the importance of investment security, and other lessons learned in Europe's two-decade experience with generation-based renewable policies. Why is this so, and are these policies doomed to fail? To answer this, we bring together theoretical considerations on the policies and the European experience, paying particular attention to two aspects, deployment success and policy costs. On basis of this conventional knowledge, we analyze three country cases, China, India, and South Africa, and compare their experience in promoting solar photovoltaic (PV).[1]

2 Generation-based policies for renewable electricity

This chapter provides a review of the two most prominent generation-based incentives: feed-in tariffs and their tender-based equivalent, which we refer to as auction-based tariffs (ABTs). Despite the popularity of FITs, no common understanding of what constitutes FITs can be found in the literature. We start by defining FITs and distinguishing them from ABTs. In a further step, we reflect on the theory and empirics of the two instruments with a focus on deployment success and policy costs.

1 Note that we focus on on-grid deployment rather than off-grid installations, for which solar PV technology is already competitive in many cases (Müller / Brown / Ölz 2011, 56; Thiam 2010).

Feed-in tariffs and auction-based tariffs

Existing definitions of FITs are at best vague and do not correspond with each other. There is little agreement of what the constituent features of a FIT are. The central characteristic present in all understandings is that FITs provide generation-based incentives for electricity generation from selected energy sources or technologies (e. g. Couture / Gagnon 2010; Kreycik / Couture / Cory 2011; Lipp, 2007; Mendonca / Jacobs / Sovacool 2010). Several authors have put forward additional criteria like technology-specificity, fixed payment periods, or purchase guarantees. However, from our point of view, such criteria artificially limit the analytical scope and should, therefore, not be included into the basic definition of FITs.

In addition to the diversity of FIT definitions, the relationship between FITs and auctions is often unclear. While auctions, in the form of tenders, are used to determine and allocate generation-based payments for generated electricity, they are generally not referred to as FITs (e. g. Couture / Gagnon 2010; Kreycik / Couture / Cory 2011; Mendonca / Jacobs / Sovacool 2010; Müller / Brown / Ölz 2011). However, the financial support schemes of FITs and their auction-based equivalents resemble each other. The two support schemes only differ in how payment rates or tariffs are determined. To be specific, policies with tariffs predetermined by policymakers via rules and regulations are commonly subsumed under the term FIT. Policies with tariffs determined through auctions are referred to as ABTs throughout this paper.

	Feed-in tariff	**Auction-based tariff**
Alternative terms	Standard Offer Contracts, Advanced Renewable Tariffs	Renewable tenders, tendering systems, competitive biddings
Definition	• Generation-based payment for electricity, • predetermined by policymakers and constantly available to project developers.	• Generation-based payment for electricity, • determined and allocated through auction-based tenders in which project developers compete.

Competing policy objectives

Accelerated deployment has been hailed as the success of policies applied in Germany, Spain, and other countries (Mendonca / Jacobs / Sovacool 2010). However, there is growing concern over the policy costs associated with accelerated deployment and whether these costs are above the levels needed to achieve the accelerated deployment (Batlle / Pérez / Zambrano-Barrangán 2012). Depending on the competitiveness of different Renewable energy technology (RETs), supporting electricity generation can be quite costly. These costs are borne either by the tax payer, if FITs function as subsidies, or by the electricity consumer, if costs are passed on via electricity bills. Consequently, we consider accelerated deployment of renewables and low electricity costs as competing policy objectives. Generation-based policies are to facilitate accelerated deployment of RETs while policy costs are to be limited (OECD / IEA 2008). The relative weight attributed to these competing objectives influences the choice and design of policy instruments.

Feed-in tariffs versus auction-based tariffs: theory and practice

Real-world policies for RET deployment often differ from recommendations based on economic theory. While the latter proposes that market mechanisms, and thus ABTs, are more efficient than regulatory approaches, such as FITs, the deployment success of FITs in Europe hints at their supremacy.

There is no theoretical argument why either FITs or ABTs should be more successful with respect to accelerating RET deployment, provided that FITs are set high enough to encourage investment and ABTs auction the necessary volume of installations. ABTs also guarantee that support is provided efficiently as tariffs emerge from a competitive bidding process amongst investors with full knowledge of their costs and risks (Kreycik / Couture / Cory 2011, 25 f.). Correspondingly, FITs are efficient if tariff-setting policymakers have full information about the investors' cost structures and set tariffs accordingly.

However, FITs involve risks for policymakers that ABTs do not due to informational asymmetry between principal (policymaker) and agent (investor) (Lesser / Su 2008, 985–988; Lipp 2007, 5483). In an urge to provide for sufficient incentives and in light of constantly falling RET costs, tariff rates can easily lead to an overcompensation of investors (Gupta et al. 2007, 762; Kreycik / Couture / Cory 2011, 1–2). If policymakers fail to adapt tariff rates timely and sufficiently, the number of projects and the payments they receive increase sharply, rendering FITs inefficient.

On the other hand, European countries have instituted different generation-based incentives and found FITs are superior to auction-based ones: Deployment levels in countries with auctions, such as France, Ireland, or the United Kingdom, lag behind those that have employed FITs, Germany and Spain being the prime examples (Mendonca 2007; Mendonca / Jacobs / Sovacool 2010; OECD / IEA 2008). Comparing the auction mechanism in the UK and Germany's FIT, Butler / Neuhoff (2008) show that the latter not only resulted in more deployment but also posed less costs to the customer.

What practical arguments are brought forward for FITs? First of all, FITs are praised for the investment security[2] they create and the resulting effectiveness in accelerating deployment (Haselip 2011; OECD / IEA 2008, 100–105). Support that is constantly accessible and not limited to specific bidding windows improves the investor's ability to plan ahead, thereby limiting investment risks. For FITs to be financially attractive, returns on investment just have to exceed opportunity costs (profits) of other investments. FITs are therefore likely to attract a large amount of investment and facilitate accelerated deployment of the targeted RETs.[3] In addition, the constant support and uninterrupted

2 Dinica (2006) argues that policies need to be assessed from an investor's perspective; reducing risks by creating investment security is essential. The risk premium investors ask for drops as a result, thus allowing deployment acceleration at the lowest cost possible. This view is now echoed in many discussions on generation-based incentives (e. g. Butler / Neuhoff 2008; Kreycik / Couture / Cory 2011; Mendonca / Jacobs / Sovacool 2010).

3 This particularly applies to cost-covering feed-in tariffs that factor in costs related to investment, administration, operation, and maintenance, and simultaneously provide for a 'reasonable' rate of return (Mendonca / Jacobs / Sovacool 2010, 19–25; Ragwitz / Huber 2004, 3–4).

investment flow are expected to have a lasting positive effect on innovation systems and attached industries.

The failure of ABTs to significantly accelerate deployment in several European countries has mainly been attributed to the auction mechanism itself. By appointing capacities only within specific time frames and by obliging investors to stick to defined milestones, ABTs distort the natural investment flow. This tidal support destabilizes the manufacturing industry and its innovative power (Butler / Neuhoff 2008, 1863; Kreycik / Couture / Cory 2011, 32–33). Also, competitive bidding can encourage adventurous bids that are financially not viable and lead to a large number of scheduled projects not being realized (Kreycik / Couture / Cory 2011, 25 f.; Mendonca 2007, 15). However, if investors seek to position themselves in growth markets and move their businesses along technological learning curves, auctions pressure investors to be moderate on their expected profits. In order to secure a move into the market, some might even consider a short-term loss and hence contribute to the high front-up costs needed to make renewable electricity technologies competitive. Last but not least, auctions advantage large companies, which are more capable than small ones to cross-subsidize low bids and to cope with high transaction costs that precede and accompany tenders (Kreycik / Couture / Cory 2011, 32). This also hinders new, potentially innovative firms from entering the market, and can thereby undermine the industry's long-term innovative capacity (Couture 2010).

The role of different policy design options

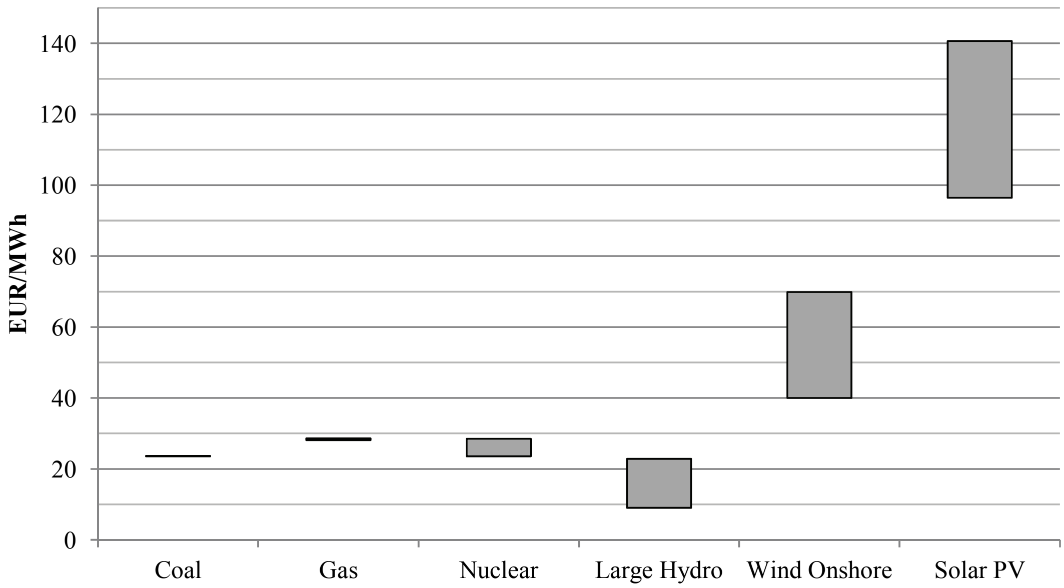
The success of generation-based policies does not exclusively depend on the way generation-based incentives are determined. The design of the support scheme itself is at least as important. In this, FITs and ABTs are very similar. They basically have the same design options. The most important ones are discussed here.

Guarantees are central to the functioning of generation-based policies. First, investors need to receive purchase guarantees to assure that all generated electricity will be bought. Without this, utilities are likely to continue using established, conventionally produced electricity (Mendonca / Jacobs / Sovacool 2010, 27–30). Second, in order to assess the long-term return on the investment, investors need to know for what time they can expect to receive favourable treatment. Guaranteed durations are thus a key component of generation-based policies that aim to enfold high investment security.

Caps and price ceilings can limit excessive policy costs. Quantity-based auctions, where capacities are necessarily predetermined, imply a ceiling for the otherwise flexible price. Such starting prices are common in auctions. For price-based FITs, the opposite can be done – the cap is put upon the offered capacity. This latter system has been proposed as cost-cutting option for developing countries (Kreycik / Couture / Cory 2011, 8–10; Mendonca / Jacobs / Sovacool 2010, 68–69). Once this capacity cap is reached, no additional projects are admitted to the scheme. However, capped feed-in tariffs, like ABTs, disrupt investment cycles, thereby limiting the investment security created.

The selection of supported RETs is decisive in many ways. Figure 1, with data for China, shows that electricity generation costs differ significantly from one technology to another. In order to promote a diverse electricity mix, it is necessary to support different renewable

Figure 1: Levelized costs of electricity generation in China



Source: IEA / NEA 2010

technologies separately (Mendonca / Jacobs / Sovacool 2010, 16–17). The World Bank (2010, 44) has argued that developing countries should appoint only one general tariff scheme for renewables in order to make sure that the cheapest RETs are brought in first. In contrast to this argument, the three countries discussed here – China, India, and South Africa – have opted for technology-specific schemes, seeking to support different RETs from early on. Later in this paper, we look at the promotion of solar PV, a technology that still depends decisively on targeted support due to its lack of competitiveness.

The eligibility of investors is often limited through financial, technological and other selection criteria. Financial criteria are to assure that developers have the means to execute their projects. Technology criteria may be invoked to exclude technologies that have not proven feasible. Last but not least, local content requirements promote the development of domestic industries. Financial and, to some extent, technological criteria can instigate policy effectiveness. The effects of selection criteria depend on the policy instrument. For ABTs, selection criteria imply a limitation of competition and can thereby negatively impact efficiency and the achievement of low-cost objectives. Serving as a safeguard against unviable offers, such criteria can, however, foster the accelerated RET deployment. Selection criteria naturally have no influence on the price level of FITs. Their effectiveness in accelerating deployment is, however, reduced if investors who would have otherwise participated in the scheme are not eligible anymore.

Sanctions are important features of auctions. While they can be applied to FITs, they are not common, as project developers usually only register when their installations are completed. Auctions naturally appoint limited capacities of support before installations are realised. In making sure winning projects are executed, sanctions and deadlines play a crucial role. They do, however, constitute an additional risk for developers and can thus make policies less attractive and/or more expensive.

Beyond Europe

What can countries make of the experience and knowledge gained on different generation-based incentives? The European experience proposes FITs as the most successful policy to promote renewable electricity generation. Emerging countries that have recently shown an increased interest in renewable electricity sources, however, are experimenting with different schemes. While predetermined FITs are applied, they do not appear to play a dominant role. In the following sections, we explore how and why different generation-based policies for solar PV are applied, and what their prospects are.

3 China: preparing for the great push?

China's fast industrialization and economic development has increased energy demand by more than 12 times within less than 20 years (Kahrl et al. 2011, 4033). In order to meet the growing needs of the economy, electricity production capacity was increased to 962 Gigawatt (GW) as of 2010 (CREIA / ERI 2011). Although the expanded capacity provides 99.4 % of China's population with access to electricity (IEA 2010), electricity shortages still occur regularly at peak times in summer. Further expansion of electricity supply to overcome this problem and to support further economic development is important; consequently, the IEA (2011, 594) anticipates that China's installed electricity capacity will rise to about 1,700 GW by 2020. The abundance of coal reserves within the country has facilitated the generation of affordable electricity; today, two thirds of China's electricity comes from coal-fired plants. Coal is thus a major contributor to the high levels of air pollution and green-house gas emissions within the country.

China's plans for future electricity generation increasingly emphasize the importance of RETs as a way of meeting additional demand without further environmental strain. Target levels for RET deployment underwent several upward revisions in recent years, and the latest target formulated in the 12th Five-Year Plan (2011–2015) raises the share of renewable electricity in total generation capacities to one third by 2020.[4] Solar PV installations are expected to grow to 10 GW by 2015 and 50 GW by 2020 (Martinot 2010; Fischer 2012). From 2010 to 2020, solar PV installations are thus expected to make up 6.8 % of total electricity capacity additions. Through these efforts, the Chinese government expects to reach grid parity for solar PV as early as 2015 (REM 2011).

The Chinese government continues to facilitate its economic development by capping retail prices for electricity, which averaged about 0.06€ / kilowatt-hour (kWh) in 2009 (SERC 2010). While cautious about rising electricity prices, the government is eager to exploit the benefits from the deployment of RETs in terms of environmental protection, energy security and climate change mitigation.

Solar PV, China's unwanted child

In contrast to wind turbines, solar PV did previously not play a major role in government plans to expand RET deployment. With a total of 160 Megawatt (MW) installed capacity

4 China includes conventional large hydro power in its definition of renewable energy.

in 2009, on-grid solar PV deployment was at a nascent stage (Martinot 2010, 8). Previously, the government had been reluctant to push solar PV installations for a number of reasons. First, solar PV was more expensive than other RETs. Second, solar PV relied on (at that time expensive) raw material input (purified silicon), machinery and other input technologies from abroad, and therefore was not attractive in terms of enhancing energy security.

The reluctance to expand solar PV deployment stood in sharp contrast with the development of China's manufacturing industry, which reached an annual solar PV cell production capacity of 13.5 GW in 2010 (Li / Wang 2011, 36). Due to the successful stimulation of solar PV installations in such markets as Germany, Spain, and the US, Chinese solar PV production almost exclusively focused on exports. Making use of cost advantages, process innovations and economies of scale, the country became, within less than ten years, the world's major supplier of solar PV panels (Rigter / Vidican 2010, 6990). In 2010, Chinese manufacturers managed to serve more than 50 % of the global market (EPIA 2011, 36).

Before 2011, China had only very modest support schemes for solar PV deployment in place, as scepticism prevailed whether comparatively expensive solar energy (see Figure 1) should be supported for on-grid electricity generation. Starting in 2007, the central government experimented with support schemes that differed with respect to eligible project sizes and in the way prices were determined (CREIA / ERI 2011). Two different support schemes were employed for large-scale solar PV plants. First, for some projects suggested by local governments and approved by the central government, the electricity price was set by China's National Development and Reform Commission (NDRC) at 0.445€/kWh[5] for projects approved in 2007. Projects approved by the NDRC in 2010 received only an average support of 0.128€/kWh. This lower support level partly reflected the fast decrease of solar PV cell and module production costs after 2008, but was also a signal to the industry that efficiency was a priority in RET deployment (The Climate Group 2011; CREIA / ERI 2011). Second, the government initiated tenders for solar PV plant investment and management licenses (25 years) with the electricity generation payment being determined on basis of a competitive bidding process. Two major tenders were organized in 2009 and 2010, which resulted in even lower tariffs, ranging from 0.081 to 0.121€/kWh. These low tariff rates were partly the result of the overproduction in the Chinese solar PV industry, which had been caused by the large number of manufacturers entering the market (RICCLCE 2011).

A feed-in tariff to compensate for a stagnating global market

Most support schemes for solar PV that emerged in 2009 or later were intended to compensate the domestic industry for the repercussions of the global financial crisis and the reduction of solar PV support in major foreign markets. However, against this backdrop, policies did not seek to encourage additional production and installations through extensive support schemes. Quite the contrary, the government put a lot of pressure on project developers to accept low price levels for on-grid solar PV (interview,

5 Annual exchange rate (2011), applied here and in the following: 1EUR = 8.9944CNY (European Central Bank 2012).

Chinese project developer 2011).[6] The generation prices resulting from tenders and those set by the NDRC were, however, deemed too low by the industry to be economically viable. Indeed, they were significantly lower than FITs already offered by some provincial support schemes. As a result, actual installations fell short of contractual volumes and frequently suffered low quality (interview information, different industry representatives 2011; The Climate Group 2011).

In 2011, the Chinese government finally introduced a nation-wide FIT for solar PV (NDRC 2011). Generation payments were set just above the level of previous tenders. Projects approved before July 2011 were to receive 0.128€/kWh for their generated electricity. All projects approved later are to obtain a generation price of 0.111€/kWh with the exception of projects in Tibet that are still eligible for the FIT's initial rate. While earlier regulation guarantees that all renewable electricity has to be purchased by utilities (SERC 2007), no guaranteed duration for the preferential FIT payment was specified in the policy document. Industry representatives, however, expect stable support for approved projects for 25 years (interview with Chinese project developer 2011). The policy stipulates that the FIT will be adjusted in the future in accordance with investment trends and technology developments. Project-specific tenders are allowed along the new scheme, but the scheme's tariff level serves as a general price ceiling. The FIT is financed by an additional fee paid by consumers through their electricity bill in accordance with the Renewable Energy Act. The FIT is not available for building-integrated and rooftop installations supported by other government programmes, which therefore already receive investment support from government budgets. Developers of building-integrated and rooftop installations hence have to rely on generation payments equalling the local aggregate price for electricity from desulphurized coal.

While the nationwide FIT was welcomed by the solar PV industry, the tariff level was criticized for a number of reasons. First, the FIT only provided sufficient incentives for solar PV installations in the western regions of China, where solar radiation is high and land prices low, but the FIT was too low for the eastern parts of the country, where electricity demand is highest. Second, the FIT does not create sufficient investment security as many details were left open – from the lack of a guaranteed tariff duration to the possibility of regional top-ups to the FITs, which industry experts expected after the publication of the FIT rules (Zhou 2011). Third, the low tariff rate tends to attract low quality installations mostly produced by state-owned enterprises. It does not provide an attractive alternative for most private, export-oriented enterprises that focus on markets offering high returns for high quality panels, mostly in Europe and the US.

The policy path in China reflects a conflict between low cost and rapid deployment. While the early auctions for solar PV generation support enabled low tariff levels, they were incompatible with the country's state-driven economic system and corresponding institutional weaknesses. Incomplete installations of low quality were the frequent outcome of projects appointed according to auctions. At first, the newly installed FIT appears to focus on rapidly compensating the weaker and often state-backed enterprises of the sector for a slowing global demand (Solarbuzz 2011). A high level of investor interest indicates that the FIT might indeed be able to accelerate deployment to meet defined

6 Interviews conducted by Doris Fischer in Shanghai, November 2011. Non-disclosure agreements do not allow for the publication of names of interviewees.

targets. In the long run, low FIT rates force firms to exploit economies of scale, and the size of China's domestic market enables them to do so. This approach is in line with industrial development in China in general (Zeng / Williamson 2007) and could thus prepare an effective and efficient roll-out of solar PV in the country.

4 India: transformation through competition

The expansion of India's strongly subsidized, coal-based electricity sector has provided the country with affordable electric power, thereby facilitating the country's social and economic development. Within a decade, installed capacity increased from 109 GW to over 176 GW in 2009 (EIA 2011; IEA 2011, 598). Hydro and wind energy have already come to play a more important role in the country's electricity portfolio, solar PV provided a mere 119 MW in 2011, most of it off-grid (MNRE 2011a). Fossil-fuel based technologies continue to constitute the lion's share – about 67 % – of the electricity system's capacity (IEA 2011, 598).

Electricity prices are a politically sensitive issue in India. About a quarter of the population still had no access to electricity in 2010 (IEA 2010). Maintaining and expanding access to affordable energy is, therefore, a primary strategy to alleviate poverty. Rising electricity prices would be a hard blow for politicians seeking re-election and for citizens, many of whom still suffer from widespread poverty. Poor households strongly depend on affordable electricity. Consequently, in order to avoid passing on increased costs of electricity generation to customers, tariffs are highly subsidized, with electricity prices averaging about 0.065€/kWh[7] in 2008 (Government of India 2011a, 262). At the same time, tight governmental budgets make it difficult to justify extensive support schemes for RETs. In addition, India's electricity system suffers from frequent power outages, and the steadily increasing demand is likely to aggravate this situation (Government of India 2011a, 262). To address these challenges, the Indian government is determined to tap the country's rich renewable resources, particularly the most abundant one, solar energy (Government of India 2010; Planning Commission 2008, 386).

A new focus on solar energy

To overcome the country's electricity challenge, the Indian government seeks to double installed RET capacity over the next decade, with solar PV playing a significant role in this. By 2022, the government aims for an on-grid electricity capacity of 465 GW (MNRE 2011b, 23). The *Jawaharlal Nehru National Solar Mission* (hereafter, Solar Mission), part of India's *National Action Plan on Climate Change* launched in 2008 (Singh 2008), set the target of an on-grid solar PV capacity of 10GW until 2022. The government expects these targets to be sufficient in making solar PV cost-competitive by the time the Solar Mission is completed (Government of India 2010, 1; MNRE 2010, 19). If these targets are achieved, solar PV would constitute about 4 % of the electricity generation capacity installed between 2008 and 2022.

7 Average domestic electricity tariffs vary between 3 and 6 INR/kWh; one state has an extremely low tariff of about 0.8 INR/kWh (Government of India 2011a, 262). Annual exchange rate (2011), applied here and in the following: 1EUR=64.8818INR (European Central Bank 2012).

Although deployment of solar panels is still at a low level, an export-oriented manufacturing sector has already emerged, and the government is eager to proactively support its development. In 2009, more than 1 GW of solar panels were produced in India (Arora et al. 2010, 43–44). Similar to China, this industry emerged despite negligible domestic demand. The industry also suffers a strong dependence on imports of raw materials and components, in particular silicon wafers, which are essential to produce solar panels (Government of India 2010, 5). While competition from Chinese manufacturers is stiff, advancing the solar PV industry and securing a larger share of the global market for solar panels is one of the declared objectives of India's Solar Mission (MNRE 2010, 19).

Failure of a feed-in tariff

Past policy endeavours, including a nation-wide FIT, have largely been unable to stimulate investment in solar PV projects. A range of policies were explored at the national and regional level before 2010. For example, the country's 10th Five-Year Plan (2002–2007) set a modest target of 5 MW in solar PV installations, but only 1 MW was attained (Planning Commission 2008, 387). As a reaction to the 11th Five-Year Plan (2007–2012), which prescribed a more ambitious target of 50 MW, the Ministry of New and Renewable Energy (MNRE) chose to establish its first FIT. The tariff was capped according to the set target (50 MW) and offered a compensation of 0.178€/kWh, which was to be paid for a period of 10 years (Government of India 2008). However, it provided too little incentive for private investors and led to no new installations (Arora et al. 2010, 40).

Determined to achieve the targets set out in the 11th Five-Year Plan and the Solar Mission, the MNRE prepared a new tariff scheme with stronger incentives in 2010. In comparison to the previous policy, the tariff offered was raised significantly to about 0.276€/kWh. In addition, the guaranteed duration for which all generated electricity would be bought was extended to 25 years (Arora et al. 2010, 40). At the same time, the MNRE in turn arranged to appoint limited capacities in different rounds, which if reached, as happened later, would be allocated according to the lowest bids (MNRE 2009, 7). This approach practically meant switching to an ABT. For a start, two bidding rounds were foreseen, one for 2010 (150 MW), the other for 2011 (350 MW).

Making tenders work for India

To increase the viability of supported solar PV projects and to discourage adventurous bids, the new policy includes various selection criteria, bidding fees and financial penalties. First, support is limited to commercially proven technologies, and bidders are obliged to submit a transmission agreement from the respective regional utility. Second, in order to discourage unviable bids, the potential project developers have to pay higher bidding fees the lower their offers are. For a 5 MW project, the fees range from about 800€ for projects more than 10 % below the ceiling price (0.276€/kWh) and up to about 4,000€ for projects offering more than a 25 % discount. Third, applicants to the scheme are required to provide considerable performance guarantees of approximately 232,000€ per 5 MW project, or 46,400€/MW. These guarantees are to be forfeited in parts or even fully in case accepted projects are not realized (MNRE 2009, 7–8).

In addition, the selection criteria of the ABT have important implications for the industry. For one thing, only projects of specific sizes are supported. In the first round, they must equal about 5 MW, and each applicant is allowed to apply only once. In the second round, this requirement is loosened. Project sizes must be multiples of 5 MW but can amount to up to 20 MW, with each applicant being allowed to apply for a number of projects up to a total sum of 50 MW. Local content requirements also oblige developers to source specific modules and appliances from Indian manufacturers. Projects approved in the first round are only obliged to attain crystalline silicon modules from domestic manufacturers. However, in the second round, developers must rely exclusively on appliances manufactured in India, with the exception of thin-film modules (MNRE 2009; MNRE 2011c, 7–8).

Project developers competing for support

The first two rounds for solar PV projects attracted wide-spread interest and resulted in offers significantly below the starting price, which generated concern that projects would not be financially viable. The overall volume of bids submitted in the first round amounted to 1,815 MW, way beyond the 150 MW on offer (MNRE 2011d, 12). Thus, the projects were selected on the basis of the offered generation prices, resulting in winning bids of 0.166 to 0.193€/kWh, discounts of between 30 and 40 % of the original ceiling price (Prabhu 2011). The second round, in 2011, which appointed another 350 MW, resulted in even lower tariffs. Ranging from 0.134 to 0.146€/kWh, these generation prices mirrored the quick decline of production costs of solar panels (Bridge to India 2011; Government of India 2011c). Doubts regarding the financial viability of projects due to the low tariffs (e. g. Prabhu 2011) have not been confirmed. In July 2011, the Indian government announced that 29 of the 30 projects selected in the first round had been able to secure the necessary financing (Government of India 2011b). The first solar PV projects funded under the Solar Mission have already been set up; the precise number, however, is not clear (Government of India 2011c; MNRE 2011e).

All of India's attempts to provide generation-based incentives for solar PV have been dominated by concerns over policy costs. The government's keen interest in solar PV became apparent with the institutionalization of a FIT in 2008. The cost concern was evident from the low rates and short duration the FIT offered. As policymakers realized the ineffectiveness of such low incentives, they increased them. To limit and minimize policy costs, this time capacity caps were put in place and potential project developers had to submit competitive bids to gain support. This ABT determination allowed policymakers to secure a high degree of policy efficiency. Indeed, the only policy-inherent trade-offs to efficiency are the safeguards against financially unviable bids and some strategic policy design options such as eligible project sizes or local content requirements. While policymakers were clearly eager to attain defined deployment targets, rapid deployment clearly did not dictate their efforts. Contrastingly, concerns over policy costs have led to the failure of the FIT and encouraged policymakers to shift to an ABT.

5 South Africa: the cost of development

South Africa's economy has benefited greatly from the exploitation of its rich domestic coal reserves, upon which it based its electricity production (IEA 2011, 439–440). Today, coal-fired plants contribute about 90 % to the country's electricity capacity, which totalled 44 GW in 2008 (DOE 2011a; EIA 2011). This reliance on domestic coal reserves has allowed for the low electricity prices commonly identified as a major driver of the country's rapid economic development (IEA 2011, 439; Pegels 2010, 4947–4949). At the same time, around 25 % of South Africans still have no access to electricity (IEA 2010). In addition, with access expanding and on-grid demand increasing due to economic growth, South Africa's electricity reserve margin fell below 10 % in 2008. The low reserve margin causes frequent power outages and impedes the conduct of necessary maintenance as only a small number of facilities can be taken from the grid simultaneously (Government of South Africa 2008). The government seeks to at least partly finance the upgrading of electricity generation and transmission facilities by increasing electricity prices. Having risen sharply, current prices amount to about 0.052€/kWh[8], a level which is, however, insufficient to cover incurred costs.

Getting away from coal

South Africa has identified renewable energy as a key element to satisfy its future energy needs. This strategy crystallizes in the country's second Integrated Resource Plan, which was published in 2010 and laid out a roadmap for the next 20 years (DOE 2011b). According to the plan, South Africa seeks to double its installed on-grid capacity by adding 45 GW of new installations, of which almost 20 % (8.4 GW) is expected to come from solar PV plants. Coal-based energy production is expected to contribute no more than 6.2 GW to the added capacity (DOE 2011b, 17). This plan constitutes a great shift in the country's energy mix as there are currently no on-grid PV power plants in place, and off-grid applications are estimated to contribute a small amount of about 21 MW (Edkins et al. 2010, 4–5).

The government recognizes the potential of solar PV to not only increase energy supply but also to support the country's socio-economic development, instigate environmentally sustainable growth and develop the domestic solar PV industry (DOE 2011c). The industry objective in particular has been of limited success so far. With a capacity of about 200 MW (Michaelson 2011), the country's solar PV manufacturing industry hardly contributes a significant share to the global market.

Renewable electricity in the political crossfire

South African policymakers were eager to promote solar panels through an extensive FIT, which however stumbled over institutional and legal hurdles, and was later replaced by an ABT. In 2009, the National Energy Regulator of South Africa (NERSA) introduced a FIT for several RETs. On-grid solar PV installations received the most extensive support,

8 On February 28, 2011, Eskom switched to the 2011/2012 energy tariff, realizing a 25.8 % increase from the previous year: 0.523 Rand/kWh (ESKOM 2011). The annual exchange rate (2011) applied here and in the following was 1EUR = 10.2035ZAR (European Central Bank 2012).

amounting to 0.426€/kWh (NERSA 2011, 14). The rates set were welcomed by the industry at first, but high expectations were soon dampened. The monopolistic, state-owned electricity provider Electricity Supply Commission (ESKOM), refused its support as it feared being burdened with the additional cost and thought its own monopolistic position might be undermined (Conrad / Fernandez / Houshyani 2011, 36–39). In addition, the national treasury objected to the policy as it felt that FITs would neither minimize the cost to the customer nor appoint capacities on a competitive basis. In the course of fierce, intra-governmental struggles that lasted for about two years, the tariff rates were first significantly reduced, and later the implementation of the FIT was put on hold. The introduction of a tendering system in 2011, known as Independent Power Producer (IPP) Procurement Programme, is broadly regarded as ousting the previous FIT initiative (Pegels 2011).

Auctions, but the price tag doesn't take centre stage

The auction-based IPP programme appoints capacities for renewable electricity projects in five batches from 2011 through 2016, whereby projects have to undergo a thorough selection process. Out of the policy's total volume of 3.7 GW, 1.45 GW are to come from solar PV. The winning bids, which have to be below the ceiling of 0.283€/kWh, then receive the tariff they offered for a guaranteed duration of 25 years (DOE 2011c).

Because electricity provision is a highly political issue in South Africa, policymakers place great store on the IPP policy's contribution to socio-economic development. Extensive selection criteria, which dilute the relevance of the price bids, are included to this end. The IPP selection process involves two rounds. Passing the first round requires bidders to prove that they have either a track-record in raising funds or sufficient financial means to conduct the proposed project. In addition, the technology intended to be used must have been utilized commercially at least twice. Applicants also need to submit an energy resource assessment of their chosen location along with a comprehensive generation forecast. Furthermore, a local content requirement has to be fulfilled, which demands a 40 % share of a South African entity, such as an enterprise, in the project. Eligible projects range in size anywhere between 1 and 75 MW. In the second round, projects are rated on their contribution to economic development according to a fixed process. This process builds on the Broad-Based Black Economic Empowerment Act, a response to the country's apartheid regime that lasted until 1994. Variables include the number of jobs created, the proportion of employees from formerly disadvantaged ethnic groups, and local community ownership. These criteria strengthen the local content requirements of the first round. A maximum of 30 points can be achieved for all non-price variables together, while up to 70 additional points are granted according to the generation price offered. Project bids with the highest point score win the tender (DOE 2011c).

South African policymakers use a similar strategy as India's regulators to deter adventurous bids and their consequences: bidders that pass the selection process have to provide a performance guarantee of about 20,000€/MW, and this guarantee is forfeited if developers do not comply with defined milestones or regulation (DOE 2011c).

Rome wasn't built in a day

Despite reduced expectations after the initial FIT was cancelled, investors showed great interest in the government's first IPP call for bids in early 2011. The government received a total of 53 bids out of which 28 were admitted to the scheme, including 18 solar PV projects worth almost 632 MW. With regards to the 2016 objective of 1.45 GW, more than 40 % of the targeted solar PV capacity was thus already assigned in the first of five scheduled bidding rounds. Government officials are confident that winning project developers will be successful in securing financing, for which they have until June 2012 (DOE 2011d; Flak 2011). A commitment by the state-owned Industrial Development Corporation, a development financier, to fund 12 of the 28 winning projects supports these expectations (Creamer 2011).

South African policymakers had to develop a comprehensive generation-based policy within the limitations of the country's legal and institutional framework. At first, government officials sought to put their country at the forefront in RET deployment with a well-resourced FIT scheme. However, the implementation of a scheme that does not pay primary attention to efficiency appeared to be legally and institutionally unfeasible. The consequent adoption of an ABT circumvented these difficulties. As in India, policymakers integrated local content requirements and safeguards against adventurous bids. While both can have an adverse effect on competition and efficiency, the latter facilitates the attainment of deployment targets. In addition, stringent social criteria, which make project implementation more costly, are part of the new ABT (Engineering News 2012). These politically prescribed selection-criteria limit policymakers' space for manoeuvring. Within this space, however, the policy choice is focused on reaching set targets at the lowest possible cost.

6 Promoting renewable electricity production under conditions of scarcity

With electricity as a key facilitator of development, all three countries face the challenge of an ever-increasing electricity demand and the need to overcome an unsustainable reliance on fossil fuels, which is intensified by the central role affordable electricity plays for economic and social development – and the goal of universal access to electricity, which in particular remains a substantial challenge in India and South Africa. Mature fossil-fuel based electricity technologies paired with domestic resource abundance and/or low resource prices have led the three countries to heavily rely on coal. However, a rising awareness of the non-sustainability of fossil-fuel based electricity systems and of the economic, environmental and social uncertainties they entail has led all three to reassess their electricity strategies.

So far, solar PV has contributed little to the electricity mix in China, India, and South Africa. In recent years, however, with an intensified focus on renewable energy, all three countries have defined ambitious objectives to increase the share of solar PV in their electricity mix. While India aims for 10 GW installed solar PVs until 2022, which constitutes 4 % of the capacity to be added, China targets 50 GW until 2020, and South Africa plans for 8.4 GW until 2016, equalling about 7 and 20 % of the planned capacity additions, respectively.

The role of priorities and experimenting in shaping renewable electricity policy

In their more recent eagerness to expand the deployment of solar PV, policymakers in China, India, and South Africa have experimented with different policy approaches to deal with the strong cost pressures in their electricity sectors. These pressures arise from a common understanding that affordable electricity is a cornerstone of economic and social development. This understanding makes it politically and economically difficult to burden electricity consumers with the additional costs of an early transition to renewable energy sources. In China, the government was convinced of the effectiveness of a FIT, but it would not implement the tariff on a national scale until the lowest feasible price was determined through a number of project-specific tenders. Similarly, India instituted a FIT for solar PV in 2007. However, the tariff level and duration that policymakers agreed upon were not sufficient to attract any significant investment. Indian policymakers accepted the need to increase incentives if they were to successfully foster investment in solar PV, so a more extensive ABT was introduced to minimize the policy's financial burden on tax payers. South African policymakers were determined to facilitate the rapid deployment of solar PV by introducing a FIT scheme with strong incentives in 2009. However, its introduction stumbled over institutional and legal hurdles, which require a scheme that minimizes costs to society. Consequentially, the FIT was switched to an ABT. The South African policy is unlikely, however, to attain a tariff as low as in China or India due the strong social objectives integrated into the policy to add to the deployment target. This effect thus cannot be considered a drawback of the scheme.

Even under different policy schemes, the strong focus on policy costs does not seem to be an inevitable pitfall to the effectiveness in reaching government-defined deployment targets. Generation-based policies with low tariffs, capacity caps and/or competitive bids limit the number of solar PV projects eligible and feasible in the three emerging economies. The policies are therefore unlikely to accelerate deployment as much as the successful FITs in several European countries. However, as the Indian example showed, FITs can very well fail when policymakers are not willing or able to commit to a sufficient tariff level. Or as in South Africa, legal frameworks might hinder their implementation. The two countries now have ABTs, which they successfully apply in ways that compensate for the risks of adventurous and unviable bids (i. e., through sanctions and bidding fees). They are thus on a good track to reaching their deployment targets. China, on the other hand, instituted a FIT for solar PVs that was regarded as too low to be financially attractive and in addition misses important design features, particularly a guaranteed duration. Nevertheless, it seems to be suited to the country's economic and political situation. Investors are eagerly taking up the Chinese government's offer and deployment numbers thus increase successfully.

Two major side-effects of the policy designs that strongly focus on low-cost deployment are worth mentioning here. First, the low FIT in China and the fierce competitive bidding in India and South Africa lead to a concentration of installations in sun-rich regions that may be far away from the main areas of electricity use. This outcome is not necessarily problematic; however, it is an issue that future research should look into. Second, all three policy schemes are favourable for large firms interested in investing in solar PV. This is realized through the choice of ABTs, low FIT rates and/or explicit selection criteria. There is indeed good reason for emerging economies to explicitly employ such a large-firm focus. For one thing, emerging countries have a competitive advantage in low labour costs, which facilitates the exploitation of economies of scale in production. For another, economies of scale in research and development constitute a strong argument for technological late-comer countries to encourage large investments and the participation of established firms. A strong industry focus is clearly visible in all country cases: China's FIT emerged as a response to export difficulties that solar PV manufacturers experienced due to a slowing global demand for solar PV. India's Solar Mission was clearly aimed at strengthening previously underdeveloped parts of the national solar PV value chain. South Africa, which has a rather small manufacturing industry, focused its efforts on the project level.

7 Conclusion and outlook

Following the country cases and the discussion, we draw two major conclusions.

First, the three examined countries engage in policy experimentation defined by high cost pressures and a strong industry focus, unlike the policies in many European countries, where climate change concerns and a subsequent focus on rapid deployment often dominates. As such, China, India, and South Africa reviewed FITs and ABTs and more or less gradually adapted them to their specific needs and objectives.

Second, despite sidestepping success factors of generation-based policies identified in Europe, the three emerging economies are effectively working towards their deployment targets. China's example shows how a policy that lacks elementary design features, particularly guaranteed durations, still works due to the specific structure of its economic system. In particular, the soft budget constraints that many government-related companies face undermined the feasibility of auctions in determining tariff rates. Like India, which adopted auctions to limit policy costs by fostering competition, South Africa managed to design auctions in ways that largely avoid financially unviable bids, thus allowing both countries to successfully support the deployment of RETs.

Altogether, we conclude that countries can experiment with different schemes, arrive at different solutions and still be effective in achieving defined targets. However, the experience of China, India, and South Africa in encouraging deployment of solar PV through generation-based policies is very recent. After a period of experimentation, signs are positive that the three countries have arrived at policies that are effective in reaching defined targets. It remains to be seen what capacity will eventually be installed and connected to the grid. Only then can policies be evaluated conclusively. As solar PV technology is still in a phase of fast-paced development, it will be of high interest to see how countries adapt policies to changing technological and economic conditions.

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