Renewable deployment in India: Financing costs and implications for policy

Gireesh Shrimali *, David Nelson [1], Shobhit Goel, Charith Konda, Raj Kumar

CPI-ISB Energy and Environment Program, Indian School of Business, Hyderabad 500032, India

HIGHLIGHTS

- We examine impact of policy on financing costs of renewables in India.
- The high cost of debt – the most pressing problem – adds about 24–32% to the cost.
- An interest rate subsidy can actually reduce the overall subsidy burden by 13–16%.
- Loan terms – debt tenor and variable rate debt – add about 13–14% to the cost.
- Finer policy instruments are not as effective, given that they add 3–11% to the cost.

ARTICLE INFO

ABSTRACT

India's ambitious goals for renewable energy raise many questions regarding the nature of investment required. We conduct financial modeling of actual renewable projects in India; and derive the following insights. First, the high cost of debt is the most pressing problem: higher cost and inferior terms of debt in India may raise the cost of renewable energy by 24–32% compared to the U.S. Second, even if cost of debt goes down, loan terms – including short tenors and variable interest rates – will become significant impediments, given that they add 13–14% to the cost of renewable energy in India compared to the U.S. Finally, due to the high cost of debt, policy lessons from the U.S. and Europe; which focus on finer instruments such as duration of revenue-support, revenue-certainty, investor-risk-perception, and completion/cost-certainty; are not likely to be as effective, with potential impacts on the cost of renewable energy in the 3–11% range. In fact, we find that an interest-rate subsidy, which reduces the cost of debt, reduces the overall subsidy burden by 13–16%. This suggests that Indian policymakers need to prioritize the provision of low-cost, long-term debt and take a closer look at the successful efforts by China and Brazil.

1. Introduction

1.1. Motivation

India's power sector has two overlapping, historic challenges—one that has grabbed international headlines and another that has largely flown below the radar. The widespread blackouts that brought much of India to a sputtering halt in 2012 were a dramatic signal of a power sector that requires attention (NY Times, 2012). But a challenge no less central to India's future, and arguably much more so, is that of the country's goals for renewable energy. As India wrestles with the historic challenge of providing enough electricity for its huge population and booming economy (Madan, 2009), the national government

is pursuing another equally difficult and impressive goal—markedly expanding the share of renewable sources in its energy supply mix (NAPCC, 2008).

The government has embarked upon an ambitious plan, Jawaharlal Nehru National Solar Mission (JNNSM),[2] to build 20,000 MW of solar

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* Corresponding author. +1 650 353 8221.
E-mail addresses: gireesh.shrimali@cpihyd.org, gireesh_shrimali@isb.edu, gireesh_shrimali@yahoo.com (G. Shrimali).
[1] David Nelson is at the San Francisco office of Climate Policy Initiative.

[2] The commonly used abbreviation are as follows: Accelerated Depreciation (AD); Average Power Procurement Cost (APPC); Basic Points (bps); Brazil National Development Bank (BNDES); Capacity Factor (CF); Capital Expenditure (CAPEX); Central Electricity Regulatory Commission (CERC); Certified Emission Reduction (CER); Clean Development Mechanism (CDM); Debt Service Coverage Ratio (DSCR); Feed-in Tariff (FIT); Generation Based Incentive (GBI); Indian Renewable Energy Developing Agency (IREDA); Indian Rupees (INR); Jawaharlal Nehru National Solar Mission (JNNSM); Levelized Cost of Electricity (LCOE); London Interbank Borrowing Rate (LIBOR); Ministry of New and Renewable Energy (MNRE); National Action Plan on Climate Change (NAPCC); Net Present Value (NPV); NTPC Vidyut Vyapar Nigam (NVVN); Operating Expenditure (OPEX); Private Equity (PE); Power Load Factor (PLF); Power Purchase Agreement (PPA); Reserve Bank of India (RBI); Renewable Energy Certificates (RECs); Renewable Purchase Obligation (RPO); Return on Equity

power nationwide by 2022 (MNRE, 2009a), with an intermediate target for 4000–10,000 MW by 2017. As a result, under JNNSM, grid-connected solar PV capacity increased by 165% in 2011 to reach 427 MW (CPI, 2012a). Likewise, with 16 GW installed, India had already become the world′s fifth largest market for wind by 2011 (BP, 2012), with ambitious plans for a further expansion to 31 GW by 2017.

These policy goals, coupled with the country′s rapid progress in developing renewable energy, demonstrate the seriousness of India′s intentions, resulting in India being ranked fourth world-wide in terms of renewable energy attractiveness (E&Y, 2012). But the scale of these ambitions, and the financial resources required— e.g., the USD 20 billion required for JNNSM (MNRE, 2009a), raise many questions regarding the sources and costs of the needed investment, about the adequacy of the investment to reach these goals, the efficacy of that investment in reaching the most suitable projects, and the role of policies in enabling cost-effective diffusion of renewables (NRDC, 2012).

The challenges of the renewable energy sector cannot be completely divorced from India′s overall infrastructure financing challenges, however. According to the Planning Commission of India,[3] infrastructure investment will need to increase from about 8% of GDP in 2011–2012 to approximately 10% of GDP by 2016–2017. The total investment in infrastructure is required to be over USD 1 trillion during the 12th Five Year Plan period—i.e., 2012–2017 (Planning Commission, 2011). However, the Indian government estimates a 30%, or USD 300 billion, gap in the targeted infrastructure investments by 2017, largely due to the lack of long-term finance (Infrastructure Investor, 2011).

Given the emerging nature of renewable energy technologies and business models, financial and regulatory sectors must adapt quickly—a task that has been carried out somewhat unevenly in India (Herd et al., 2011). For this reason, the India renewable energy sector′s current challenges are especially acute—in particular, due to the issues facing its power sector (Victor and Heller, 2007). The question of whether India′s financial system is adequately financing the renewable energy sector – and if not, why – is especially poignant in light of the differences between India′s financing system and those of Europe and North America as well as developing nations such as China and Brazil.

In order to understand how India′s renewable energy goals can be reached in an effective manner, in particular in the Indian policy-making context, there is a need not only to better understand the impact of policy on the financing of renewable projects in India but also to learn from experiences world-wide. This requires understanding not only the direct impact of policies – i.e., via subsidies – but also the indirect impact of policies – i.e., via cost of capital – in reducing the delivered cost of electricity (UNDP, 2012).

1.2. Our work

Renewable energy is not competitive with energy produced with conventional sources. This requires policy support. The policy support comes in two forms (UNDP, 2012). First, policies bridge the gap between the delivered cost of renewable energy and the market price of electricity, by providing subsidies. An understanding of how different policies help bridge this gap is essential in understanding the effectiveness and contribution of these policies. Second, policies can influence the financial markets which, in turn, influence the cost of capital and, therefore, the delivered cost of renewable electricity.[4] An understanding of how different features of policies impact the delivered cost of renewable electricity via cost of capital can help policy makers design policies that can bridge the cost gap.

In this paper, we use detailed financial modeling of actual Indian renewable projects for two dominant technologies – wind and solar – as a key element of this analysis. In particular, we are interested in the following questions:

1. What are the *direct* impacts – via subsidies – of existing policies on the delivered cost of electricity through renewable sources (Section 4.1)? The answer to this question sheds light on how crucial the current policies are in making renewable energy viable.
2. What are the *indirect* impacts – through cost-of-capital – of old (and new) policies on the delivered cost of electricity through renewable sources (Sections 4.2 and 4.3)? The answer to this question sheds light on how future policies can help make renewable energy more competitive.

In this process, we examine the delivered cost of electricity through renewable energy in more detail, while comparing different components of this cost with projects elsewhere (in particular, the U.S.), and explore the role of financial costs, the main theme of this paper (Section 4.2). We note that, though we compare and contrast with projects elsewhere, the focus is on India and, therefore, we do not go into too much details related to these projects, as these details are available elsewhere (e.g., CPI, 2011a).

We believe that the unique contributions of our paper are as follows. First, our paper is the first of its kind – in terms of answering the questions above, which have been addressed in other contexts (Wiser, 1997; Wiser and Pickle, 1998; CPI, 2011a; CPI 2012c; BPC 2011; Bolinger et al., 2010; Mendelsohn et al., 2012; USPREF, 2012) – in the Indian context. Second, our paper provides an in-depth comparison of insights obtained by our work with insights obtained by similar work in other, developed-world contexts (CPI, 2011a), and demonstrates that lessons learned in the developed-world context are not directly applicable in India.

1.3. Prior work

In this sub-section, we examine only studies that are closest to our analysis, given that they focus on project-level financial modeling of renewable projects, and examine various policy pathways. After a brief discussion of each we contrast these studies with our work. In Appendix A, we provide a broader review of literature that examines the impact of policy on financing of renewable energy, including how policies influence investor behavior.

Wiser (1997) and Wiser and Pickle (1998) were pioneering works in the area of impact of policy on renewable financing. Using project-level case studies in the U.S., they showed that (a) the costs of these projects are highly sensitive to financing terms that effective policies must take into account—in particular,

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(*footnote continued*)
(ROE); State Electricity Regulatory Commission (SERC); State Owner Enterprises (SOEs); Venture Capital (VC).

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[3] The Planning Commission is a think tank that advises the Government of India on how to reach its long-term growth targets. This process is broken down into 5-year plans. The 11th plan was during 2007–2012.

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[4] Note that many of supposedly "non direct policy" factors – in particular, financing costs – are dependent on policy, demonstrating an indirect impact of policy. A clear example of this is the ROE in the US. In the U.S., since equity is primarily tax equity, which is typically supply constrained, the ROE could potentially be high (BNEF, 2011; BPC, 2011; Mormann and Reicher, 2012). This is why it is important to have a distinction between "direct" and "indirect" impacts.

Table 1
Policy framework in India (technology specific), 2012
Source: Various news sources and government documents.

Policy framework[a]	Wind	Solar
Accelerated depreciation (AD) The Government of India allows renewable (including wind and solar) projects to depreciate 80% in the first year	Introduced in the mid-1990s; discontinued in April 2012 (MNRE, 2009b)	Introduced in mid 1990s
Generation based incentive (GBI) The Government of India offered GBI as an alternative to AD	Introduced in 2009; lapsed in March 2012[b] (The GBI of USD 0.01/kW h[c] (INR 0.50/kW h) for wind power is in addition to the feed-in tariffs provided by the respective state governments)	Introduced in 2008; not available anymore (A GBI for solar was available for the first 50 MW of installed capacity, subject to a maximum of 10 MW per state)
Feed-in (or preferential) tariffs (FIT) FITs are determined in a cost plus manner; and involve long contracts (20–25 years), priority purchase, and priority access to the grid. With the exception of JNNSM, FITs are declared by State Electricity Regulatory Commissions (SERCs)	Introduced at the state level since early 2000	Introduced at the central level (through JNNSM) in 2010 and at the state level in 2011
Renewable energy certificates (RECs) RECs are market-based instruments to address the mismatch between availability and requirement of the obligated entities to meet their state-level renewable purchase obligation (RPO). Developers have a choice between using FITs or RECs	Introduced in 2011	Introduced in 2011
Income tax exemption The Government of India allows a 100% tax waiver on profits for any single 10-year period during the first 15 years of the operational life of a power generation project	Introduced in 2002; will expire in March 2013	Introduced in 2002; will expire in March 2013
Other benefits (excise, wheeling charges) The Government of India provides concessional rates for excise (reduced from 8% to 0%) and customs duty (reduced by 2.5–5%) for specific renewable sources of energy including wind, solar, and biomass. Several states in India levy relatively lower wheeling or transmission charges for renewable energy	Introduced in 2002 (Rotors and wind turbine controllers are fully exempted from excise duty.)	Introduced in 2002 (Transmission equipment used in the initial setup of solar power generation projects is exempted from excise duty.)
Clean Development Mechanism (CDM) Project developers are free to get their project registered with Ministry of Environment and Forests to participate in certified emission reduction (CER) credits markets	Introduced in 2005	Introduced in 2005

[a] The states have their own renewable energy policies in addition to the central-level policies. For example, Gujarat's solar power policy has certain advantages compared to JNNSM in terms of investment-friendly off-take price and no domestic content clause for solar power equipment.

[b] It appears that GBI has been re-instated in the 2013 budget—see http://economictimes.indiatimes.com/news/news-by-industry/energy/power/budget-2013-fm-says-to-reintroduce-generation-based-incentive-for-wind-power-projects/articleshow/18732589.cms.

[c] Indian rupee (INR) was converted to USD at an exchange rate of USD 1=INR 50 throughout the paper.

by providing revenue certainty; and (b) the utility model provides a lower cost than private ownership.

CPI (2011a), via detailed project-level financial models, examined the cost of renewable energy projects in the U.S. and the EU. They first showed that these projects would not have attracted investors without policy support, which provided 36–81% of the cost of these projects. They then examined the impact of various policy pathways on financing costs and found that: the duration of revenue support had the largest impact (11–15%); followed by revenue certainty (4–11%), investor risk perception (3–9%), etc. In a follow up study using the same framework, CPI (2012c) demonstrated that a cash grant half the size of the current investment tax credit would deliver the same benefit, a finding that has also been reported previously in BPC (2011) as well as in Bolinger et al. (2010).

Mendelsohn et al. (2012), via detailed project-level financial models, examined the impact of U.S. federal government policies targeted at reducing taxes for eligible investors – the investment tax credit, the production tax credit, and accelerated depreciation – on energy costs for utility-scale solar projects. The analysis demonstrated that: debt associated with the loan guarantee program can reduce cost by approximately 20%; the termination of the 1603 Treasury grant program would increase the cost of tax equity capital by 2–4 percentage points, raising the Levelized cost of Energy (LCOE)

from utility-scale solar projects by 3–20%; and delaying the IRR target year by one can improve the LCOE by 7–27%.

USPREF (2012), via project-level financial models, examined the impact of the investment tax credit on the eventual tax-returns to the government. They found that these projects, via lease and power purchase agreements (PPAs), can deliver a 10% rate of return on the investment tax credit for residential and commercial solar projects. Thus, they show these policies are financially sound, even without counting the additional benefits of solar projects, namely job creation, energy independence, and environmental benefits.

However, these studies are based on developed economies, such as the U.S. and the EU. Our study, in contrast, focuses on financing issues in India. Another major difference, as we show later (Section 4.2.2), is that our study shows that cost of debt is the major factor influencing the cost of renewable energy, and the nuanced policy pathways explored in these papers may not be very effective in the Indian context.

1.4. Paper organization

The rest of the paper is organized as follows. Section 2 provides background information on the Indian renewable energy sector. Section 3 provides the methodology and data used for our analysis.

Section 4 presents the results of our analysis and accompanying discussion. Section 5 concludes with a summary of our results and avenues for future research.

2. Background

In order to understand how policies would impact the financing of renewable energy as well as the delivered cost of renewable energy in India, it is necessary to understand: (a) the renewable energy policies that we are interested in; and (b) the renewable energy industry itself, including the investment climate for renewable energy.

This section provides background information necessary for understanding the impact of policy on financing renewable energy in India, including: major renewable energy polices (Section 2.1); the renewable energy industry (Section 2.2), which includes the cost and terms of capital (Section 2.2.2). A detailed version of Section 2.2.2 is provided as an Online Appendix A for the interested reader.

2.1. Renewable energy policies in India

The Electricity Act of 2003 transformed the power sector in India by driving changes such as the deregulation of power generation, opening access in transmission, and allowing the state electricity regulatory commissions to fix the level of renewable energy procurement. The National Electricity Policy (in 2005) and Tariff Policy (in 2006) followed, with the goal of increasing the share of renewable energy in the total energy supply mix.

Currently, the Indian government supports the deployment of renewable energy through a variety of incentives and mandates (Table 1). Some of these policies are mutually exclusive (e.g., FITs and RECs; AD and GBI; etc.) of each other whereas some others are complementary (e.g., income tax exemptions, wheeling charges, CDM, etc.) to other policies (e.g., to FITs, AD, GBI, etc.).

2.2. Renewable energy industry in India

In this sub-section, we examine the growth of the renewable energy sector in India (Section 2.2.1), focusing on deployment and related investment;[5] followed by a closer look at factors driving cost and availability of this investment (Section 2.2.2), including debt as well as equity.

2.2.1. Renewable energy sector growth

We now examine the trends in the deployment of renewable energy (Section 2.2.1.1) as well as related investments (Section 2.2.1.2), given that they are correlated. We will show later in the paper how this growth is supported by existing policies (Section 4.1), and how the future (expected) growth can be achieved in a cost-effective manner (Section 4.3).

2.2.1.1. Renewable energy deployment. Historically, the growth of wind power in India was primarily driven by state-level incentives in conjunction with AD benefit extended by the national Government of India beginning in 1995. Wind power installed capacity increased from 230 MW in 1994–1995 to 16,078 MW by 2011, reaching approximately 94% of the 11th Plan target (Fig. 1).

During 2007–2011, wind capacity installations increased at a compound annual growth rate of 19.7% as the Government of India introduced additional incentives such as the GBI as well as FITs (BP,
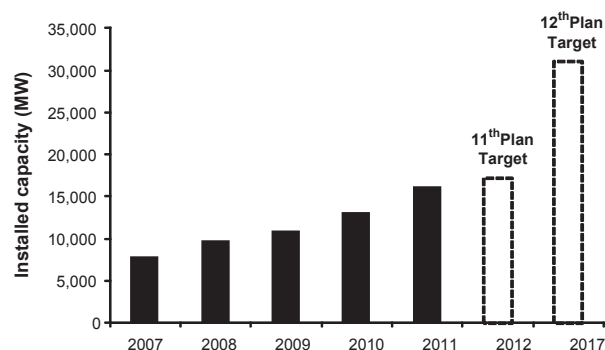

Fig. 1. India wind power installed capacity and future targets, 2006–2017. *Source*: BP, 2012; Central Electricity Authority; Ministry of New and Renewable Energy; India Infoline. *Note*: Yearly data is at the end of December every year.
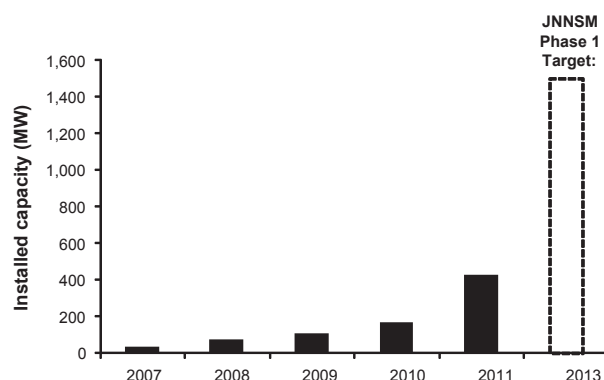

Fig. 2. India grid-connected solar PV installed capacity vs. Phase 1 target, 2007–2013. *Note*: Yearly data is at the end of December every year. JNNSM's Phase 1 target is to reach anywhere between 1000 and 2000 MW of installed capacity; mid-point of the target is plotted. *Source*: BP, 2012.

2012). However, both the AD and the GBI incentives expired in March 2012. Reaching India's ambitious target of total wind installed capacity of 31,078 MW by 2017 will now depend upon new mechanisms, including the REC market (Section 2.1).

India's solar power industry experienced significant growth only in 2010 (Fig. 2), when the JNNSM was announced. After the announcement of JNNSM, grid-connected solar PV capacity increased by 165% in 2011 alone to reach 427 MW (CPI, 2012). However, a failure to address the remaining financing challenges, as outlined in this paper, will make the targets set under JNNSM – Phase 2 (4000–10,000 MW by 2017) and Phase 3 (20,000 MW by 2022) – difficult to achieve.

2.2.1.2. Renewable energy investment. A variety of investors finance renewable energy projects in India, including institutions, banks, and registered companies (Table 2). Institutional investors are either state-owned or bilateral and multilateral institutions. Among banks, both private sector and public sector banks are involved. In addition to registered companies, venture capital (VC) and private equity (PE) investors contribute equity investment.[6]

The renewable energy deployment in India is directly correlated with renewable energy investment. During 2006–2009, India's annual total renewable energy investment remained between

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[5] We specifically focus on deployment as opposed to development, which would include R&D. In general, India does not focus much on R&D of any kind and particularly on renewable energy R&D. Thus, the R&D related numbers are very small (WWF, 2011).

[6] Note that the lines between private equity and venture capital are somewhat blurred in India. For example, venture capital in India typically does not invest in R&D, and most are the investments are deployment related, similar to private equity (WWF, 2011).

Table 2
Domestic renewable energy investors (number of institutions), 2012.
Source: Various news sources and IREDA, IFCI, and SIDBI websites.

Type of investor	Category	Total registered in India	Active in renewables sector
Commercial banks	Public sector banks	26	9
	Private sector banks	30	6
	Foreign banks	37	—
Equity investors	Private equity	51	16
	Venture capital	180	21
Institutional investors	Insurance funds	24	11
Development banks	Development financial institutions[a]	3	3

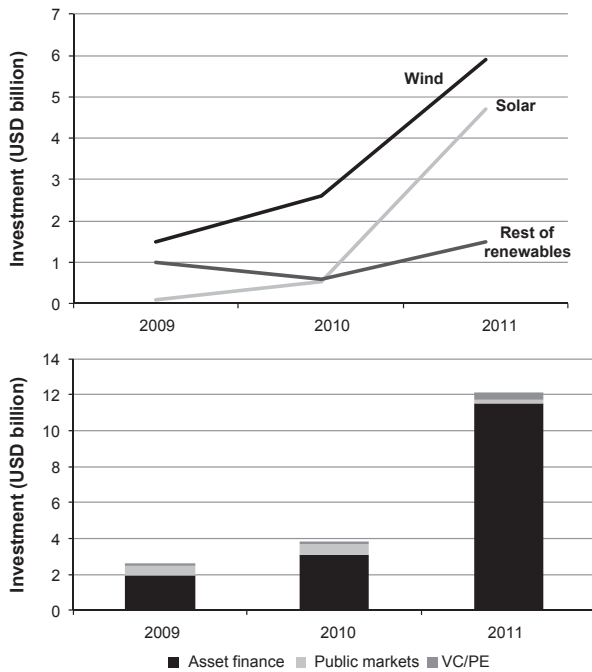[a] DFIs include national-level institutions IREDA, IFCI, and SIDBI.

Fig. 3. Renewable energy investments in India by technology and investment type (USD billion), 2009–2011.
Source: Bloomberg NEF-UNEP Reports, (i) Global trends in sustainable energy investment, 2010; (ii) Global trends in RE investment, 2011; and (iii) Global trends in RE investment 2012.

USD 4 billion and USD 5 billion (UNEP, 2012). Investment has risen rapidly since then, from USD 2.6 billion in 2009 to USD 12.1 billion in 2011. While wind continues to receive the majority of investment, solar has seen the highest growth, and the gap between the two is falling rapidly (Fig. 3).

Asset finance continues to be the largest investment class, growing from USD 1.9 billion in 2009 to USD 11.5 billion in 2011 (Fig. 3).[7] Among other investment classes, public market investments sharply reduced from USD 0.6 billion in 2010 to USD 0.2 billion in 2011 whereas venture capital (VC)/private equity (PE) investments increased to from USD 0.1 billion to USD 0.4 billion. Return expectations of the investors vary according to the sources of their funds and the risk attached to specific projects (see Section 4.2.2).

2.2.2. The cost and terms of capital deployed

Conditions for financing renewable energy projects vary depending on many factors, including: the technology, the developer, the size of the project, or the geography. The most important distinction is between investors in the debt and equity markets. In general, debt investors are more conservative, accepting lower returns in exchange for lower risk; whereas equity investors are willing to take more risk in exchange for higher returns. Typically, a project will be least expensive when it is funded by a mix of debt and equity.[8]

Renewable energy financing can become costly when either debt or equity investors demand too high a return or when either is simply unavailable. Thus, in this sub-section, in order to describe the enabling environment for both debt and equity, we pose two sets of questions:

- **Cost and terms:** Are the returns investors are demanding and the conditions they are placing on their investment so onerous as to make the project economically unattractive?
- **Availability:** Is adequate debt or equity available? That is, are there enough investors willing to invest in or lend to renewable energy projects in India?

Policy makers need to be aware that the availability and cost of capital are inter-related. If not enough capital is available (i.e., the supply is restricted) it may raise the cost of capital due to supply-demand mismatch. On the other hand, if the capital is too costly, enough cheap capital may not be available for deploying projects in a cost-effective manner. Thus, the key over-arching question is whether enough low-cost capital is available for renewable energy projects and, if not, how policy can make it happen?

While policy can influence the returns required by equity and debt investors and the availability of equity and debt capital, different policies are likely to be important to different classes of investors. We next examine factors driving the cost and availability of two main sources of capital: debt (Section 2.2.2.1) as well as equity (Section 2.2.2.2).

2.2.2.1. Cost and availability of debt.

The cost of debt is high in India, primarily due to high benchmark rates. Benchmark interest rates in India are significantly higher than in developed countries (Fig. 4). This is due to a rapidly growing economy coupled with high government borrowing (Ambit, 2010). The roughly 7–8 percentage points difference between benchmark interest rates in India and the U.S. and Europe account for nearly all of the 5–7 percentage point difference in debt costs between renewable energy projects (see Section 4.2.2).

Further, long-term debt is not easily available in India for several reasons, including diminished role of development financial institutions (Bhandari et al., 2003); asset-liability mismatches

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[7] According to UNEP (2012): asset finance is all money invested in renewable energy projects; VC/PE is equity investments by corresponding funds; and public markets is equity investments in publicly traded companies.

[8] Debt and equity are not the only options. Intermediate or mezzanine securities exist that may have limited but greater risk than debt, in exchange for a slightly higher return; that is, they have some characteristics of debt and some of equity. For simplicity, in this paper we address the general concepts of debt and equity, but other options can easily be characterized as a mix between the two.
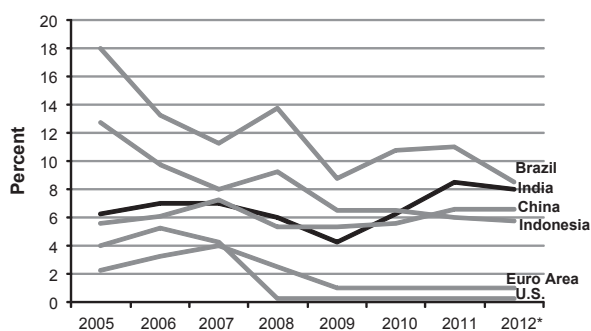
Fig. 4. Benchmark interest rates (%), 2005–2012.
*Until May 2012.
Source: Trading Economics.

for commercial banks (Business Standard, 2011); weak bond markets (World Bank, 2006; Kawai et al., 2011); and absence of long-term hedging instruments (VENATOR, 2011). Banks dominate infrastructure financing,[9] and given that a large fraction of bank deposits have an average maturity of below three years (Business Standard, 2011), they are not comfortable lending for tenors (i.e., duration) longer than 5–7 years, as opposed to long-term loans (20–25 years) required for renewable energy projects.

Due to these reasons, domestic loans commonly have variable, rather than fixed, interest rates. Variable rate debt makes cash flows to equity holders, which include project cash flows minus the debt payments to due debt holders, less certain as they are subject to changing interest expenses, thus increasing risks and required returns. This makes it harder to increase leverage (i.e., proportion of debt, which is cheaper than equity) to reduce cost of capital and hence reduce the cost of the project (Brealey et al., 2007). As we will see in Section 4.2.2, the high cost of debt, combined with the variable/short-term nature, is a major issue which needs to be resolved before finer policy measures can be effective.

In general, availability of (any) debt for renewable energy projects is somewhat limited. In India, less than one third of public sector banks lend to renewable energy projects (Table 2). The situation is worse for private sector banks where less than one fifth lend to renewable projects. Banks cite non-familiarity with the renewable energy sector as well as the perceived riskiness as reasons (CPI, 2011b). Even for banks that lend to these projects, the amount is restricted due to (self-enforced) limits on power-sector lending which, to some extent, is driven by the poor financial health of the state distribution companies (ET, 2012), the primary off-takers (i.e., entities buying renewable power).

Finally, the flow of foreign debt may also be constrained due to interest rate ceilings – currently 500 basis points (bps) or 5 percentage points over the London Interbank Rate (LIBOR)[10] – imposed by the government of India on foreign loans (Business Standard, 2012). This could also increase the cost of renewable energy projects if the ceilings restrict foreign loans cheaper than available domestic loans. The flow of foreign funds may be further constrained due to the limits on the total amount of foreign loans – currently less than USD 1 billion per year – allowed per company (RBI, 2012).[11]

2.2.2.2. Cost and availability of equity. The spread between equity costs and debt costs represents the allocation of risks and required returns between debt and equity (CPI, 2011b). For wind projects in India, we see spreads of 4–7 percentage points that are similar to those found in other jurisdictions, such as the U.S. and the EU (see Fig. 8 in Section 4.2.2). For solar, however, the observed spreads appear to be low (0–3 percentage points). This is surprising since, given solar is a less mature technology compared to wind and therefore riskier, one would expect higher spreads. Based on our conversations with developers and investors, equity investors seem to be taking on more risk for strategic reasons, such as to gain a first mover advantage (CPI, 2011b). See the online Appendix A for more details.

The availability of equity from both domestic and foreign sources is comparatively better than the availability of debt (CPI, 2011b). In fact, international equity may be more readily available than domestic equity. However, the lack of availability of debt to refinance a project may actually force equity to be kept in a project for too long, and hence restrict the equity available for recycling.

3. Methodology and data

3.1. Basic algorithm and assumptions

We develop project-level cash flow models to examine impact of policy pathways on the key financial metric: the LCOE (Campbell, 2009; Reichelstein, 2010). The inputs required were project-related costs, revenues, and financing characteristics.

3.1.1. Base model

For given project financial parameters, we calculate the "minimum revenue per kW h" (i.e., LCOE) that the developer would need to meet the required return on equity (ROE)[12] – or hurdle rate – objective for equity stakeholders, while ensuring that the debt payments are honored at the same time. LCOE is also referred to as the minimum PPA price or levelized tariff that the project developer would accept. We are interested in LCOE since, from the policymakers' perspective, paying for expensive renewable energy projects at corresponding LCOEs ensures that the policymakers' goals of cost-effective renewable deployment are accomplished (Lipp, 2007).

Essentially, if the project per unit revenue is LCOE, the project has a zero net present value (NPV) (Brealey et al., 2007). That is, LCOE represents the average (or levelized) cost of generating electricity from the project. Given the intricacies of project cash flow modeling, it is hard to establish formulas for the LCOE; however, a representative formula that provides intuition for the LCOE for a project that lasts T years is as follows (Shrimali, 2011):

$$lc = \frac{C - \alpha \sum_{t=1}^{T} (D_t/(1+r)^t) + (1-\alpha) \sum_{t=1}^{T} (W_t/(1+r)^t) - (1-\alpha)(C_T/(1+r)^T)}{(1-\alpha) \times 8760 \times \sum_{t=1}^{T} (CF_t \times x_t/(1+r)^t)}$$

where C is the initial capital expenditure (or CAPEX); D is the depreciation; W is the operating expenditure (or OPEX); CT is the terminal value of the plant; α is the tax rate; CF is the capacity factor (i.e., PLF); x is the degradation factor (of the technology); and r is the cost of capital.

In comparison to conventional power generation sources such as coal or gas, renewable energy is characterized by a relatively high CAPEX, followed by low OPEX given that there are no fuel requirements (IRENA, 2012). Further, the output of a renewable

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[9] According to the Planning Commission banks are estimated to contribute nearly 51% of the total debt finance requirement of the infrastructure sector in India during the 11th plan period (2007–2012).
[10] The London Interbank Offered Rate (LIBOR) is the average interest rate estimated by leading banks in London that they would be charged if borrowing from other banks.
[11] Our analysis (Online Appendix) shows that these limits are not binding yet; however, they can be binding in future.

[12] The required return on equity (or hurdle rate) in the project can be different from the actual return. The hurdle rate simply specified the "minimum" return that the equity investors are willing to accept. The actual return is typically higher than the hurdle rate.

energy plant is highly dependent on the availability of the resource being utilized, such as wind or solar. Given that initial capital expenditure (C) represents most of the cost of a renewable energy power plant, a higher cost of capital would reduce the NPV of project revenues more than the NPV of project costs, thus reducing the project NPV (Brealey et al., 2007), and it is straightforward to see that a higher cost of capital implies a higher LCOE.

Noting that leverage is defined as the percentage of project investment serviced by debt, the cost of capital r is defined as the leverage-weighted average of the cost of debt and cost of equity (Brealey et al., 2007). That is,

$$r = \frac{D}{D+E}r_D + \frac{E}{D+E}r_E$$

where D and E represent the amount of debt and equity, respectively, with $D/(D+E)$ as the leverage; and r_D and r_E are the costs of debt and equity (i.e., ROE), respectively. This shows that higher costs of debt or equity translate into a higher cost of capital and, given that cost of debt is cheaper than cost of equity, so does a lower leverage.

Since debt is typically cheaper than equity, we assume that, given fixed ROE and debt-rate, in order to maximize actual equity returns from the project – given by the difference between actual project cash flows and debt payments – given *any* PPA price, a rational developer would maximize leverage, therefore minimizing the cost of capital (Brealey et al., 2007). Given this insight, given any fixed debt-rate and required-ROE, we calculate the *optimized* LCOE assuming maximum leverage, which is typically constrained by terms of debt. Leverage (i.e., debt) is maximized so that debt-service-coverage-ratio (DSCR) – a condition that puts a margin on project cash flows to reduce the probability of default on debt payments – is met with equality at most once during the lifetime of the project. In general, a higher DSCR means that less project cash flows are available for debt-service, and a lower debt-tenor means that the debt has to be paid off sooner, both resulting in lower leverage, which results in a higher cost of capital and a higher LCOE.

The models use our best estimates of future cash flows for the lifetime of the project, considering the prevailing capital investment tax laws, depreciation schedules, etc. (see Table 1). For example, the income tax calculations are based on prevailing tax laws in India, with a 10-year tax holiday for renewable energy projects. Similarly, for projects using the AD benefit, a depreciation of 80% was used in the first year.

Finally, given that there is inherent variability in renewable energy generation due to intermittency of underlying sources, based on established standards (S&P, 2009), we use two different power load factors (PLFs), which define the percentage of time the renewable source is providing energy, in our analysis. For calculating actual ROEs, we use the P50 PLF, the value that the plant PLF exceeds by a greater than 50% probability (i.e., the average), given that it represents the most probable output of the plant. However, for calculating debt and leverage, we use the P90 PLF, the value that the plant PLF exceeds by a greater than 90% probability, as required by the banks, which tend to be more risk-averse. Leverage (i.e., debt) is maximized so that DSCR condition on the P90 level project cash flows is met with equality at most once during the lifetime of the project.[13]

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[13] Our calculations also assume that the PLF is determined by resource availability only. This ignores the case where PLFs could be reduced due to dispatch priority and curtailment by the grid operator. This assumption is justified given that the latter is not only small but also very hard to predict. Further, in the power starved country like India, it is likely that all the generated power would be consumed.

3.1.2. The algorithm

The basic model results in an iterative leverage optimization procedure for calculating the minimum LCOE.

1. We start with a reasonable (high) value of the PPA price.
2. Given the PPA price, project revenues at P90 PLF level are calculated, and debt – and hence leverage – is maximized while ensuring that the DSCR requirements are met. Basically, the DSCR condition does not bind for low leverage values. As leverage is increased, the solution is found when the DSCR requirement binds in exactly one of the time periods.
3. Given debt payments corresponding to maximized-leverage in step #2, the actual ROE is calculated from equity cash flows, which are equal to project revenues at P50 PLF level minus debt payments.
4. If the solution doesn't converge – i.e., actual ROE is higher than the project hurdle rate – the PPA price is adjusted downwards, and the process in steps 2–3 is repeated.

This process is guaranteed to converge, given that the PPA price levels are continuously adjusted downwards whereas the actual ROE is decreasing towards the hurdle rate. The result is the optimized LCOE, where the twin conditions of maximizing leverage while meeting required ROE are satisfied.

3.1.3. Sensitivity analysis

Once we obtain the LCOE from the base model, we perform sensitivity analysis for the key parameters (see Section 4.3 for more detail) – debt-rate, debt-duration, debt-variation, ROE, and technology cost – based on realistic ranges gathered from conversations with various stakeholders as well as secondary research. The leverage-optimization algorithm described above (in Section 3.1.2) is applied to each case. That is, the implicit (optimal) leverage is different for each usage case.

3.1.4. Limitations of the model

The most crucial limitation of our analysis is that the actual PPA price for the modeled project can be different from the LCOE derived from our model. This may happen due to many reasons. First, the actual (or realized) ROE from the project may be different from the stated required ROE (or hurdle rate) by the developer. Second, as mentioned earlier, in absence of real project data, we have used generic data based on data available from Central Electricity Regulatory Commission of India, and there may be divergence between the two. However, given that our focus is on the sensitivity (i.e., variation) of project financials to key financial parameters, ballpark values of these financial parameters should suffice for deriving meaningful conclusions.

3.2. Data

In India, we studied three projects in detail (Table 3). These projects were chosen based on the following criteria: First, the projects had to be large enough so as to allow scale benefits, typically available in utility-scale projects. These are the projects that would result in the lowest LCOEs and hence minimize the subsidy cost for the government. Second, the projects had to belong to different technologies in India—wind, a close-to-competitive technology; solar PV, a demonstrated yet not-competitive technology; and solar thermal, a novel technology. Third, project-level information had to be available from secondary and primary sources.

For the rest of the paper, the wind, solar PV and solar thermal projects are also referenced as Acciona-Tuppadahalli, Reliance-Dahanu, and Lanco-Chinnu, respectively. Detailed interviews with

Table 3
India case study project descriptions.
Source: UNFCCC, interviews with developers, and various news sources.

Project	Description
Acciona's Tuppadahalli Wind power project	• An estimated USD 67.9 million (INR 3.394 billion), 56.1 MW wind farm • Financed through domestic debt, probably for one of the longest debt tenors (14 years) in India at an interest rate of ~11.8% • Signed a 20-year PPA (subject to revision in the 11th year) with a state-owned transmission company at a tariff of USD 0.068/kW h (INR 3.39/kW h). In addition to this FIT, this project used GBI as well as CDM revenues • This project was selected due to the combination of foreign equity and domestic debt, coupled with high disclosure in public domain
Reliance Power's Dahanu Solar PV project	• An estimated USD 112 million (INR 5.60 billion), 40 MW solar PV project • Debt financing by US EXIM bank and ADB for debt tenors of 16.5 and 17.5 years, respectively, at an average interest rate of 12% • Signed a 25-year PPA with Reliance's distribution utility at a tariff of USD 0.299/kW h (INR 14.95/kW h). In addition to this FIT, this project availed of AD as well as CDM revenues • This project was selected as it was the largest solar PV project in India at the time of selection and offered unique perspective on combination debt financing by bi-lateral and multi-lateral lending agencies
LANCO's Chinnu Solar Thermal project	• An estimated USD 360 million (INR 18 billion), 100 MW solar thermal project equipped with molten salt storage technology • Debt financing received from a domestic lender at an interest rate of ~11% for a debt tenor of 13–14 years • Signed a 25-year PPA with NVVN (a government sponsored nodal agency) at a tariff of USD 0.210/kW h (INR 10.50/kW h). In addition to this FIT, this project availed of AD as well as CDM revenues • The project is one of the seven winners and one of the largest solar thermal projects selected under phase one of the central government's JNNSM

developers provided the financial parameters (e.g., required ROE, debt-rate, debt-tenor, DSCR, etc.), expenditures (e.g., capital, operations and maintenance costs, etc.) as well as other sources of revenue (e.g., CDM revenue) (CPI, 2011b). Any missing information was either collected via secondary research or via generic project-level information provided by the Central Electricity Regulatory Commission (CERC) (CERC, 2012).

4. Results and discussion

In this section, we start by discussing the direct impact of policies (Section 4.1). We then move toward examining the indirect impact of policies (Section 4.3), and identify the key role of the provision of low-cost, long-term debt. In the process, we examine the role of cost-of-capital in determining the delivered cost of electricity (Section 4.2). Finally, based on experience world-wide, we explore some options for the provision of low-cost, long-term debt (Section 4.4).

4.1. Direct impact of policy

We start by assessing the direct impact of policies (see Section 2.1) – i.e., how much of the cost gap between the delivered cost of electricity for renewable energy and the market price of electricity is supported by policies – on the delivered cost of electricity for actual wind and solar projects (Fig. 5). We focus on the following projects in India (Table 3):

• Solar PV—Reliance Powers' 40 MW project in Dahanu, Rajasthan.
• Wind—Acciona's 56.1 MW project in Tuppadahalli, Karnataka.

Using the algorithm in Section 3.1.1, we first calculate a pre-policy LCOE in absence of any incentives using underlying project-level parameters (e.g., debt-rate, debt-tenor, and ROE). This *pre-policy* LCOE, referred to as the LCOE in the remainder of this sub-section, represents the lowest revenue per kW h that would make a particular project viable (see Section 3.1.1) in *absence* of policies. We then add various policy measures in a sequential manner and calculate their contribution towards the LCOE by determining the per unit revenue support required in presence of the incentives, using the same method—i.e., leverage maximization.

Given that we have focused on actual projects (see Table 3), we account for corresponding policies availed. We start with AD for solar PV and the GBI for wind. We observe that these policies contribute 21% and 11% towards the LCOE of the solar PV and wind projects, respectively. Next, the approximate contribution of CDM towards the LCOE turns out to be 2% for solar PV and 6% for wind. Finally, the support of average power procurement cost (i.e., the average cost of grid-connected power) towards LCOE is 16% and 48% for solar PV and wind, respectively. The rest of the LCOE – 61% and 35% for solar PV and wind, respectively – is supported by the FITs. Thus, the direct support of policies accounts for 84% and 52% of the pre-policy LCOE of solar PV and wind, respectively. This demonstrates, without doubt, that policy support is essential for the viability of renewable energy projects in India.

4.2. Cost of renewable energy

Having established the direct impact of policies, we now move toward assessing the indirect impacts of policy measures. This requires getting a deeper understanding of what constitutes the cost of renewable energy, and how these costs are different in India compared to other developed economies, such as the U.S. and the EU.

4.2.1. A comparison with the U.S.

In some ways, India has a cost advantage. For example, labor and construction costs, which are included in CAPEX, are significantly lower in India than in countries such as the U.S. or Germany (RE, 2012). Furthermore, India is blessed with renewable resources (e.g., sun) that are comparable to good locations in other countries. Yet, despite these advantages, the cost of renewable energy can be as high in India (or higher) compared to the U.S.

The difference is often due to financing costs, an indirect impact of policy. Since a much greater share of the cost of energy is determined by the initial investment, and NPV calculations discount initial costs less than costs incurred later in the project (Brealey et al., 2007), higher financing costs (i.e., high discount factor) have a disproportionate impact on the LCOE of renewable energy.

To illustrate this issue, we compare two typical large-scale installations in the U.S. against similar projects – i.e., projects using the same
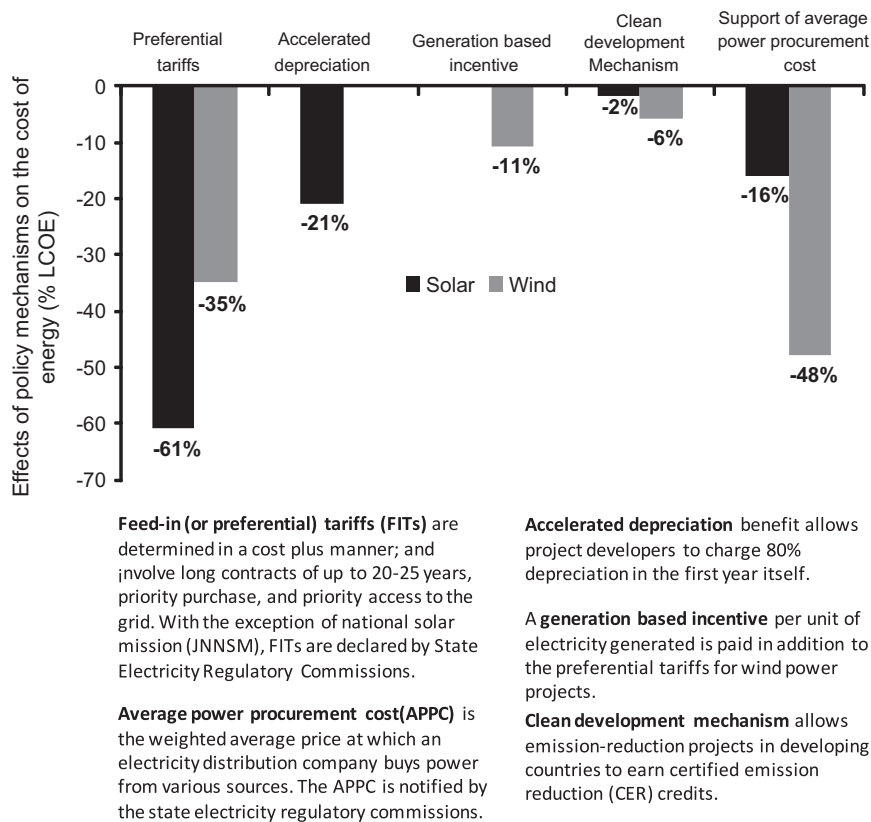
Fig. 5. Contribution of policies and market prices to overall renewable energy remuneration.
Source: Climate Policy Initiative Analysis.

Feed-in (or preferential) tariffs (FITs) are determined in a cost plus manner; and involve long contracts of up to 20-25 years, priority purchase, and priority access to the grid. With the exception of national solar mission (JNNSM), FITs are declared by State Electricity Regulatory Commissions.

Average power procurement cost (APPC) is the weighted average price at which an electricity distribution company buys power from various sources. The APPC is notified by the state electricity regulatory commissions.

Accelerated depreciation benefit allows project developers to charge 80% depreciation in the first year itself.

A **generation based incentive** per unit of electricity generated is paid in addition to the preferential tariffs for wind power projects.

Clean development mechanism allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits.

Table 4
Key project parameters for India and U.S. projects.
Source: Interviews with developers and various news sources.

	U.S. wind (First wind Milford)	Indian wind (Acciona Tuppadahalli)	U.S. solar PV (Sunpower greater Sandhill)	Indian solar PV (Reliance Dahanu)
Project size (MW)	203.5	56	18.5	40
Capital cost (MN USD/MW)	2.2	1.2	5.1	2.8
Plant load factor (PLF)	25%	28%	30%	21%
Debt rate	7%	12%	7%	12%
Return on equity (ROE)	11%	16%	15%	16%
Debt tenor (Years)	20	14	20	18
LCOE (USD/kW h)	0.09	0.08	0.19	0.24
Debt-service (DSCR)	1.3	1.3	1.4	1.3

technology around the same time – in India. For example, a solar PV project in the US is compared with a solar PV project in India.

This comparison is not easy, however, given that the policy regimes are different in these countries, which impact the project economics directly as well as indirectly. For example, the U.S. wind project may use production tax credits (Barradale, 2010), whereas the India wind project may be availing GBI, CDM revenues and FITs. This may result in the *post-policy* LCOE, defined as the revenue required per kW h *after* all the direct policy related adjustments have been made, to be different. Since we would now like to focus on the indirect impacts of policy, it is desirable to adjust for variations resulting due to the direct impacts.

To avoid complications due to the direct impact of different policy regimes in these countries, and to isolate the indirect impacts of policies from the direct impacts, we model the projects under Indian policies. For example, we model both the wind projects under the Indian policy – i.e., GBI, CDM revenues and FITs. We then focus on differences in the post- policy LCOE, referred to as the LCOE for the rest of this sub-section, due to the following factors (see Table 4): (1) capital expenditures, (2) power load factors, and (3) financing costs.

The Indian projects are already described in Table 3, and we focus on the following projects, which were modeled in detail in CPI (2011a), in the U.S.:[14]

- Solar PV—Sunpower's 19 MW project in Greater Sandhill, Colorado, referred to as Sun Power-Greater Sandhill;
- Wind—First Wind's 204 MW project in Milford, Utah, referred to as First Wind-Milford.

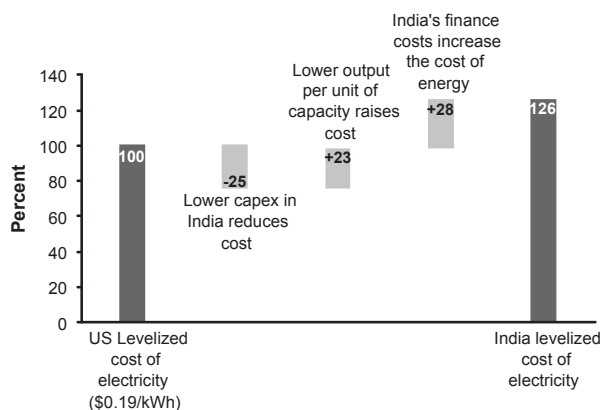[14] More detail on these projects is provided in CPI (2011a).

Fig. 6. Solar PV energy cost in India.
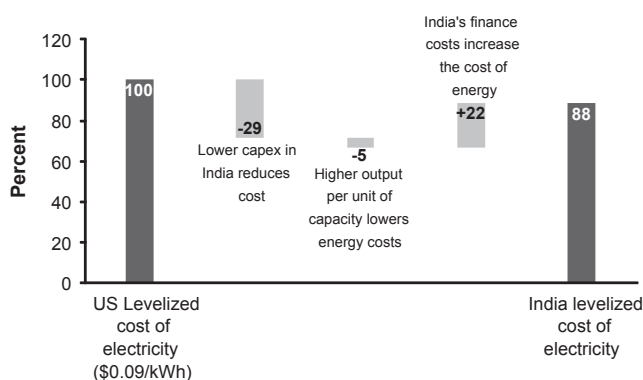*Sources*: Discussions with developers; Climate Policy Initiative Analysis.

Fig. 7. Onshore wind energy cost in India.
Sources: Discussions with developers; Climate Policy Initiative Analysis.

Fig. 8. Range of returns on equity and debt costs for renewable energy projects—India versus U.S. and Europe. *Data not available for solar thermal in Europe.
Note: Equity is levered equity.
Source: Projects in India and CPI (2011a).

In Figs. 6 and 7, we compare the cost of solar and wind power between India and the U.S. It is illustrative to examine the solar PV projects first. The LCOE for the Sun Power-Greater Sandhill project is estimated to be USD 0.19/kW h. We normalize this to 100% and sequentially consider the impact of changes in capital expenditure (CAPEX), PLF and financing costs for the Reliance-Dahanu project. We also adjust the CAPEX for differences in timing of these projects. We find that:

- The CAPEX for Reliance-Dahanu is lower, resulting in a reduction in the LCOE by 25%.
- The PLF for Reliance-Dahanu is lower, resulting in an increase in LCOE by 23%.
- The financing costs for Reliance-Dahanu are higher, increasing the LCOE by 28%.

In summary, capital costs in India were 25% lower than those in the U.S. However, most of this cost advantage was eliminated by the lower expected output per MW, which was likely the result of lower insolation and higher levels of dust in Rajasthan (RSPCB, 2012), where the Indian plant was built, or, possibly the use of less expensive, but less reliable, equipment. With these two factors nearly offsetting each other, the Indian solar PV facility was nevertheless 26% more expensive due entirely to the higher return requirements for investors in India, that is, the more expensive cost of financing the project.

Similar trends are shown for wind (Fig. 7). The capital costs are lower, which reduce the LCOE by 29%. The PLF is higher, which reduces the LCOE by a further 5% to bring the overall reduction to
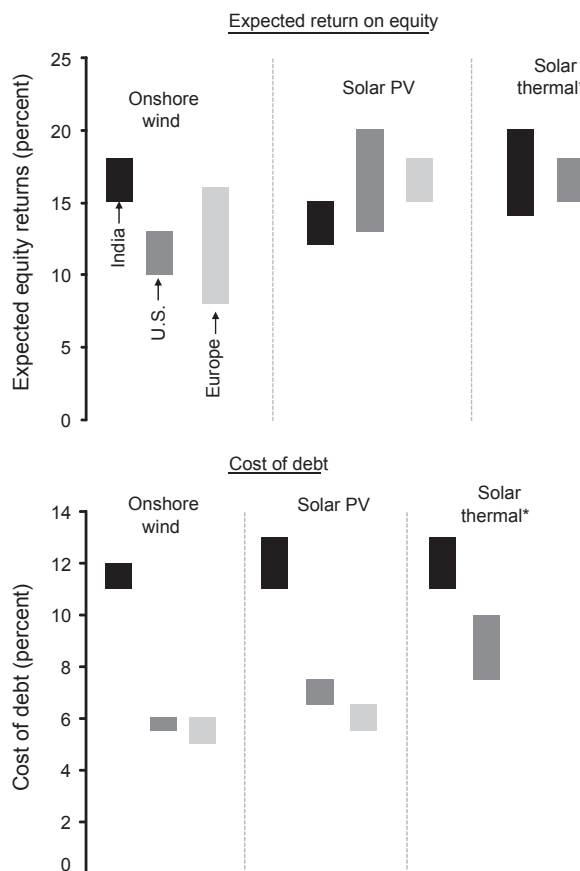
about 34%. However, higher financing costs push up the LCOE by 22%, leaving the overall reduction to be about 12%. Thus, the two wind projects depict a similar story, although the wind project in India is still cheaper, despite the higher financing costs.

While these projects do not represent all U.S. or Indian renewable projects, and rapid changes to cost and performance lead to constantly changing figures, the comparison itself is indicative of the substantial impact of financing costs on renewable energy in India. The key takeaway is that the renewable projects could be much less expensive if not for the higher financing costs, which add about 22–28% to the cost of projects in India compared to similar projects in the U.S.[15]

4.2.2. The role of financing costs

We now take a deeper look at the issue of financing costs, and break it down into its components. In India, the differences between debt and equity are particularly striking. Fig. 8 highlights the differences between renewable energy debt and equity markets in India and developed markets (see Section 2.2.2.1). Note how equity returns in India are similar to those in the U.S. and Europe, despite the higher underlying country risks, but interest rates on debt are significantly higher. As a result, the cost of debt to a renewable energy project in India is typically in the 10–14% range, as compared to the 5–7% range typical in the United States.

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[15] This difference would be even higher if the equity cost in the U.S. were not inflated due to the restricted supply of tax-equity capital (BPC, 2011; Mormann and Reicher, 2012).
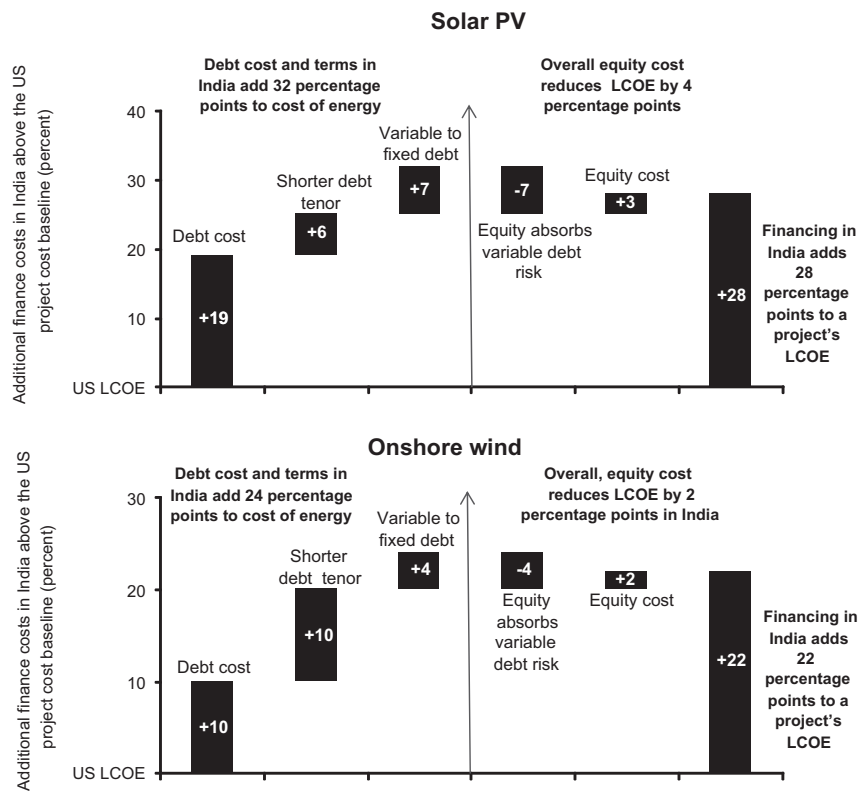
Solar PV

Onshore wind

Fig. 9. The impact of debt and equity costs and terms in India on overall financing costs compared to a U.S. baseline.
Source: Discussions with developers and financial institutions; Climate Policy Initiative Analysis.

Despite the higher cost, debt in India also suffers from inferior terms, including shorter tenors and variable rather than fixed interest rates.

Figs. 6 and 7 demonstrate that the financing costs added 28% and 22% to the cost of solar PV and wind projects, respectively, in India. In Fig. 9, we take a closer look at the financing component.

We begin by noting that there are many factors that influence the total finance cost: (1) the cost of debt; (2) the tenor of debt—that is, the length of time over which the debt is repaid; (3) whether the debt is variable or fixed; (4) extra risk that will be taken on by equity in the event that debt rates are variable; and (5) the cost of equity, or the required ROE. We find that:

First, in the case of the solar PV projects, the higher interest rate (by about 5 percentage points) on the debt, due to a higher cost of capital, alone added 19% to the project cost, while it added 10% to the wind project.

Second, the shorter debt tenors in India (by about 6 years) than in the U.S. or Europe, by forcing more rapid amortization of the loan and, therefore, reducing the effective leverage over the life of the project and increasing the cost of capital, add between 6% and 10% to the cost of the solar and wind projects, respectively.[16] With shorter-term debt, due to lower leverage, project debt has a relatively smaller influence on bringing finance costs down. Furthermore, debt tenors are relatively less important in India given that the spread between the cost of debt and equity is smaller, and the value of maintaining a higher level of debt throughout the life of the project decreases. Conversely, if the cost of debt decreases and, therefore, the spread between debt and

equity expands, we would expect the impact of shorter debt tenors to increase significantly.

Third, the variable interest rate can adds approximately 7% to the cost of solar PV and 4% to the cost of wind, as follows. Project developers typically seek fixed interest debt which, when combined with long-term PPAs with a fixed price that does not have an in-built adjustment for interest-rate variation,[17] leads to a high degree of certainty around cash flows. An investment with well-defined cash flows is less risky and, therefore, attracts lower cost finance. Developers will typically use interest rate swaps to convert variable rate debt into fixed rate debt. However, in India there is no liquid swap market and, therefore, to calculate the cost of the greater uncertainty, we have used the current interest swap rates – at 2 percentage points (Federal Reserve, 2012) – in the U.S. This swap cost increases the cost of debt (i.e., the cost of capital), and results in a higher LCOE.

Fourth, the corollary to the lower value of the variable rate debt is that equity is actually taking on more risk in India. With a fixed price PPA, an unexpected rise in the interest rates could consume all of the cash flow from a project and wipe out the equity investor. While we have no accurate way of measuring the cost of the additional risk assumed by the equity investors, we assume that the risk they take on is equal to the value of the variable-to-fixed swap used earlier. The result is an exact offset between debt and equity.

Finally, the (slightly) higher cost of equity (i.e., a higher cost of capital) in India adds only 3% and 2%, respectively, to the total cost of financing the solar and wind projects. When all of the

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[16] The solar project used for our analysis had an uncharacteristically long tenor. Therefore, we have adjusted the debt tenor down to 13 years, which would be much more typical of Indian PV projects.

[17] This is key—the PPA for renewable energy projects has a fixed price over the duration of the projects. That is, there are no in-built adjustments for variable factors, such as the variable PLF or the variable rate of debt. Then, in case of increasing debt rate, the risk of reduced equity cash flows is completely borne by the developer.

adjustments are made to account for the differences in terms and tenors, equity ends up being less expensive than in the U.S. or Europe, despite the higher country risks. Meanwhile, the total impact of debt, including terms and costs, is 24–32% added to the cost of the projects compared to similar project in the U.S.

It is significant that the ROES of projects in India are lower than the ROEs of projects in the U.S. This implies that investors are buying into the market and accepting below rational returns in short-term for strategic reasons (see Section 2.2.2.2)—thus suggesting that ROEs may rise once the market matures, increasing the delivered cost of electricity further.

4.3. Indirect impact of policy

Finally, we examine the potential impact of finer policy instruments, where policy impacts the cost of electricity via the cost of capital. CPI (2011a) studied a series of renewable projects in Europe and the U.S. to evaluate the way policy can impact the cost of financing – as measured though the change in post-policy LCOE (see Section 4.2) – renewable energy through different "pathways." In this context, CPI (2011a) defined pathways as general characteristics of policy that could affect investor cash flows or perceptions. Specifically the pathways included the following:

- **Duration of revenue support**—That is, how long a FIT, PPA, or other financial support mechanism would last. Generally, a longer support mechanism allows debt to be amortized more slowly with the result of higher effective leverage (i.e., lower cost of capital) and lower financing costs across the project life. We compare LCOEs under 10 and 20 year PPAs.
- **Revenue certainty**—Here we looked specifically at the impact of having a fixed level of support or one that varied as a function of markets or commodity prices. A fixed level of support offers more certainty of cash flows and allows greater leverage (i.e., lower cost of capital). We compare LCOEs under REC vs. FIT.
- **Risk perceptions**—We looked at the range of risk premium applied to different renewable projects to ascertain the financial costs associated with riskier perceptions. We compare LCOEs under normal and reduced – by 300 bps – ROE expectations (i.e., lower cost of capital).
- **Completion certainty**—Here we looked at the cost of delays to a project caused by policy or regulatory hurdles delaying project completion. A project delay increases financing costs due to the delay in receiving the financial return, which reduces the effective leverage (i.e., higher cost of capital). We compare LCOEs under normal and increased – by 1 year – completion times.
- **Cost certainty**—Policy could also lead to uncertainty in costs; for example, by imposing additional requirements during the construction phase. We compare LCOEs under normal and increased – by 5% – cost projections.

CPI (2011a) analyzed each of these pathways through detailed financial modeling of representative onshore wind, solar PV, and a more innovative technology each in Europe and the U.S. and modeled alternative policy scenarios for each of the projects to determine the impact that changes to key policy pathways would have had to project financing costs. Fig. 10 summarizes the results in CPI (2011a).

This analysis indicated that in the U.S. and Europe, extending the length of a support policy could lower costs. It also found that mechanisms such as FITs offering constant, stable prices could also lower costs, as could mechanisms with variable support, but appropriate and well-designed price floors, such as feed-in premium with floor prices. Meanwhile, cost and completion certainty

Fig. 10. A comparison of the range of impact of policy pathways on renewable financing cost in U.S./Europe and India.
Source: Climate Policy Initiative Analysis.

could be solved mainly through already commercially available contracting arrangements.

Fig. 10 also contains corresponding results for India, where the sensitivity analysis for the policy pathways is applied to the post-policy LCOE, defined in Section 4.2.[18] We add two India specific pathways: debt-cost reduction (by 5 percentage points) as well as debt-tenor increase (by 6-years).

Two points emerge from the analysis: First, differences between the policy impact pathways are smaller in India. This is because one important mechanism for reducing financing costs is reducing risks to allow increased debt and project leverage. With debt costs so high in India, and the difference between debt and equity costs low,[19] the value of leverage (and therefore reducing risks) is lower. In addition, some of the commercial contract mechanisms to reduce construction risk may not be as reliable in India. Second, and more significantly, all of the policy pathways here are dwarfed by the potential impact of reducing debt costs. In this analysis, we have reduced debt interest rates by 5 percentage points, enough to cover most, but by no means all, of the interest rate gap with developed countries.

A key take away is that the higher interest rates, and shorter debt tenors, may reduce some of the effectiveness of developed world renewable policies. Our findings are similar to Becker and Fischer (2013) who, in analyzing the popular developed world policies, find that these policies do not provide similar results in developing economies, such as India. For Indian policy makers, a key lesson is that, before focusing on finer policy mechanisms, they should explore methods of reducing the cost of debt to renewable energy projects.

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[18] Essentially, for India, the sensitivity analysis indicated the following impact: duration of revenue support (7–11%); revenue certainty (3–8%); risk (ROE) reduction (5–8%); risk (DSCR) reduction (3–3%); completion certainty (4–8%); cost certainty; debt-rate reduction (12–19%); debt-tenor increase (4–6%).

[19] This implies that many of (larger) impacts of these policy levers are due to the gap in the debt and equity costs in the U.S. This gap itself is not independent of policy, however, given that the cost of equity could be high in the U.S., due to the tax equity nature of the equity capital (BPC, 2011; Mormann and Reicher, 2012).
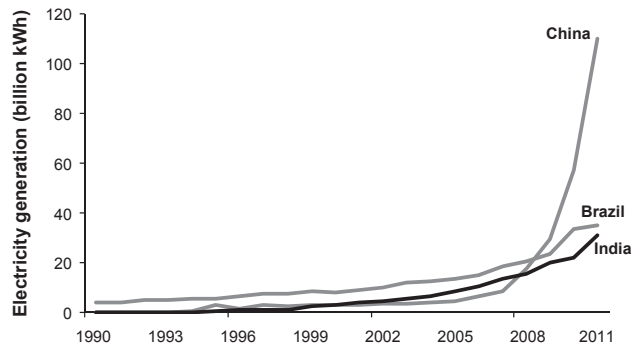
Fig. 11. Non-hydro renewable energy production in Brazil, China, and India, 1990–2011. *Source*: US Energy Information Administration.

4.4. Provision of low-cost, long-tenor debt for renewable energy

In order to provide low-cost, long-tenor debt, policy makers may explore two related avenues. First, they might look to countries with similar growth and interest rate environments (see Fig. 5), and particularly Brazil and China as inspiration for policy solutions to India's renewable energy dilemma. Second, they may want to explore ways for providing low-cost, long-tenor debt, and perform a cost–benefit analysis. In this paper, we provide brief examinations of both: we note that these examinations are by no means comprehensive, and are just the starting points for further detailed analysis to be performed in future (and ongoing) work.

4.4.1. The experience of Brazil and China

Brazil and China face similar renewable energy financing issues and both have enjoyed significant growth in renewable energy. As shown in Fig. 11, Brazil has been developing non-hydro renewable energy resources since well before 1990. While much of this generation is biomass, wind energy has recently become a significant component. Brazil continues to have more renewable generation than India, and this gap widened in 2010, with strong growth also in 2011. China's growth is more recent, with a strong growth in wind generation since 2008, resulting in China moving ahead of India.

Yet these countries have taken different paths to incentivizing renewable energy deployment. In China, more than 80% of the country's renewable energy capacity has been built by State Owned Enterprises (SOEs) and their subsidiaries (RE, 2009). As such, these companies enjoy financing through government guarantees on debt and access to low-cost government funding through related SOEs. Manufacturers, provincially-owned companies, and foreign joint ventures represent much of the remaining renewable energy deployment. However, the differences between China's and India's political and economic systems limit the potential applicability of any Chinese success stories.

Brazil's market-based, democratic system is analogous to India's, and Brazil's success in promoting renewable energy investment is potentially very relevant for Indian policymakers. Brazil has been successfully encouraging renewable energy investment through low-cost, long-term debt financing at large-scale. A large public institution, the National Social Economic Development Bank (BNDES), has dominated the overall long-term debt market. BNDES has exclusive access to low-cost, risk-free funding from a workers' welfare fund, and the bank sets a long-term interest rate which is 5.5%, with tenors of 16 years (Reuters, 2012). This is well below the market rate of interest (30%) and central bank's interest rate (8.5%) (OECD, 2011). The availability of BNDES low-cost, long-term loans cut renewable energy costs in Brazil by as much as one

fifth, and has made wind energy competitive with conventional energy solutions (DB, 2012).

This indicates that the policymakers in India should take a critical look at the mechanisms behind BNDES' success, and examine whether some of the best practices can be adopted in the Indian context. In this context, sourcing of low-cost, long-term debt would be crucial, and policy makers may find it instructive to examine Mathews et al. (2010) and Tang et al. (2012), who discuss ways in which private financing for renewable energy can be mobilized—for example, via floating of green or carbon bonds that are similar to infrastructure bonds used for conventional energy projects and are facilitated by multi-lateral organizations and governments.

4.4.2. Cost–benefit analysis of providing interest-rate subsidy

We have shown that the high-cost and unfavorable-terms of debt add 24–32% to the cost of renewable projects in India. Given that renewable energy is not cost-competitive, this means that the direct subsidy costs – defined as the difference between FITs and the average price of electricity – are higher than they could have been under favorable debt terms.

One potential policy intervention is to provide an interest-rate subsidy, where the government provides subsidized loans via the Indian Renewable Energy Development Agency (IREDA), which already focuses on prioritized lending to renewable energy projects (Bakthavatsalam, 2001).[20] This would result in reducing (though not eliminating) the direct subsidy; however, there is now an added cost to the government, due to the low-interest loan. Thus, a natural question to ask is: is providing an interest-subsidy any better than providing a direct subsidy?

In this sub-section, we compare the subsidy cost for the two cases: (a) direct-subsidy in the absence of any interest-subsidy and (b) the sum of (reduced) direct-subsidy in presence of an interest subsidy and the interest-subsidy itself. The direct subsidies are calculated as the difference between the post-policy LCOE (defined in Section 4.2) and the average purchase price of electricity. The interest rate subsidy is calculated as the interest payments paid by the government. Each of these subsidies is then discounted at the government's cost of capital, which is assumed to be the risk-free rate—i.e., 10 year Government bond rate at 8%.[21]

We find that, in general, providing an interest-rate subsidy is cheaper for the government (Table 5):

- For wind (i.e., the Acciona Tuppadahalli project), an interest rate subsidy of 2 percentage points results in a 5.3% reduction in the overall subsidy; whereas an interest rate subsidy of 5 percentage points results in a 16.2% reduction.
- For solar-PV (i.e., the Reliance Dahanu project), an interest rate subsidy of 2 percentage points results in a 5.5% reduction in overall subsidy; whereas an interest rate subsidy of 5 percentage points results in a 13.7% reduction.

Most of these gains come from an increased leverage due to the availability of cheaper debt: the project cash flows can now service a larger debt, given reduced per-period payments. In summary, our results prove that providing interest-rate subsidies may allow more cost-effective deployment of renewable energy.

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[20] We are already under discussion with policy makers in India regarding the actual details of a program that would provide interest-rate subsidies. This program will initially be funded by the National Clean Energy Fund, which itself is funded by a coal tax of USD 1/t, and implemented by IREDA.

[21] See http://www.bloomberg.com/quote/GIND10YR:IND.

Table 5
Impact on subsidy due to lower interest rates.
Source: Climate policy initiative analysis.

Case	Wind				Solar			
	LCOE USD (INR)	Leverage (%)	NPV of total subsidy in USD million (INR million)	% Change in NPV from base case	LCOE USD (INR)	Leverage (%)	NPV of total subsidy in USD million (INR million)	% Change in NPV from base case
Interest rate: no subsidy	0.088 (4.41)	65	51.1 (2557.4)	–	0.285 (14.24)	73	184.4 (9221.7)	–
Interest rate: 200 bps subsidy	0.082 (4.11)	68	48.4 (2420.9)	− 5.3	0.262 (13.12)	75	174.4 (8717.9)	− 5.5
Interest rate: 500 bps subsidy	0.074 (3.68)	71	42.9 (2143.4)	− 16.2	0.228 (11.39)	80	159.2 (7960.1)	− 13.7

5. Conclusions

This paper examines the potential role of policy in providing cost-effective renewable deployment via detailed project-level financial modeling based on actual projects on ground. The main conclusions of our analysis can be summarized as follows:

First, the high cost of debt, that is, high interest rates, is the most pressing problem facing renewable energy financing in India and has significant impact on the LCOE. In our analysis, the cost and terms of debt add about 24–32% to the cost of renewable projects in India when compared to similar projects in the West. As of now, neither the cost nor the availability of equity is a major problem, but this could change, particularly if debt becomes less available.

Second, general Indian financial market conditions are the main cause of high interest rates for renewable energy. Growth, high inflation, and country risks all contribute. A shallow bond market and regulatory restrictions on capital flows also adds to the problem. Continued high government borrowing keeps the risk-free rate elevated.

Third, regulation and the structure of the India power sector also raise significant issues. Many state-level policies are created to support renewable energy and decrease project-level risk (Atteridge et al., 2012). However, renewable energy is just a small fraction of the overall mix for the power sector, which is not in a good shape. Thus, some state-level policies – in particular, the weak and ad-hoc management of the financial failure of the state electricity boards – increase project risk. National policies designed to weave state policies together – e.g., the REC mechanism (CPI, 2012b) – do not adequately reflect the realities of financial markets or state-level risks.

Fourth, differences in national financial markets impact renewable energy policy design and effectiveness. As noted elsewhere in this paper, policy itself may impact the financial market requirements in a country—the U.S. equity returns being driven by the tax equity markets being one example (BNEF, 2011; BPC, 2011; Mormann, 2012). Thus, lessons learned from, and policies developed by, developed economies may not be particularly useful given these differences in financial markets. Our analysis shows that finer policy mechanisms, such as providing revenue certainty, reduce the costs of renewable projects in India by about 3–11%, a much lower impact than similar projects in the West.

Finally, we show that an interest-rate subsidy reduces the overall subsidy burden on the government. Our preliminary analysis shows that an interest rate subsidy of 5 percentage points reduces the subsidy burden by 13–16%. Other developing countries have bridged the financing gap in unorthodox but successful ways. Brazil's BNDES is an especially promising example that deserves further study and consideration by Indian policymakers.

Our intent is to further extend this paper's lines of inquiry in directions that will assist policymakers in identifying the most effective policy options. Several areas of immediate interest for future research include the following. First, examining the design and

implementation of funding mechanisms that would provide long-term, low-cost debt—for example, by examining best practices worldwide, including Brazil and China; Second, expanding the scope to include projects in different Indian states – to cover policy as well as institutional variations – and other technologies, such as small hydro or biomass; Third, extending the analysis to compare renewable energy markets and corresponding design features—for example, how sensitive are financing costs to a price band that is intended to provide stable price signals? Fourth, understanding how financiers and developers will alter their financial requirements when investing in portfolios of projects—for example, how does the cost of increasing development uncertainty impact willingness to invest?

Further, this study does not address the subject of off-grid renewable energy projects, which present different financing challenges and require different policy solutions than on-grid renewable energy projects. Nor does it discuss in depth the overlap between the financing of renewable energy and conventional power generation. Finally, though we briefly look at global experiences in financing of renewable energy, we do not perform a detailed analysis. We will address these topics in future research as well.

Appendix A. Impact of policy on financing

In this appendix, we examine studies that, though based on techniques fundamentally different from project-level modeling, examine various aspects of the impact of policies on the financing of renewable energy projects, and provide valuable context on how policy impacts investors' views on renewable energy—in particular, in terms of investors' risk-return perceptions (Kamandotova et al., 2012).[22] However, it should be kept in mind that these studies differ from our work in two important aspects: they do not focus on project-level financial modeling; and they are mostly focused on developed economies.

Sardosky (2012) emphasized that the investments in renewable energy are driven by a risk-return tradeoff. Masini and Menichetti (2012) as well as Wustenhagen and Menichetti (2012), while disentangling the role of risk-return perceptions, portfolio effects, and path dependence suggested that the heterogeneity of investors requires diverse policies. This finding was further supported by Bergek et al. (2013), who emphasized that policies must take into account four main investor-related factors: motives, background, resources, and personal characteristics.

Kalamova et al. (2011), using plant-level data, examined the impact of key policy features – transparency, predictability, and longevity – on investor risk-return expectations in Germany, the U.S., and Australia, and showed that predictability is a necessary condition for clean energy investments. This finding is further supported by Kahn (2009) who, in examining project finance in

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[22] As we identify later, reduction of investor risk perception may be an important policy pathways, but only after the high cost of debt issue identified in our paper is addressed.

Australia, found lack of revenue certainty to be the biggest barrier; and Barradale (2010) who, in examining the production tax credits (PTC) in the U.S., showed that the uncertainty over the return of PTC negatively influences investment.

Luthi and Prassler (2011) and Mormann (2012) further argued that, apart from remuneration level, regulatory risks and project finance-ability play a critical role in determining deployment effectiveness. For example, in Europe, a shortening of administrative process duration may yield the highest gains, whereas, in the US, improvements in grid access regulation and an increase in remuneration levels may be more effective (Luthi and Prassler, 2011). On the other hand, the observed weak correlation between policy performance and remuneration can be explained using a framework that assumes an investor perspective to explore how investment-based, market-based, and behavioral "soft-cost" factors determine a policy's ability to spur investment in renewable energy (Mormann, 2012).

Some literature has focused on specific policies, such as FITs and market based mechanisms, such as quota/auctions and certificates. Mitchell et al. (2006) examined the impact of policy on risk and financing costs of renewable projects, and showed that the German FIT is more effective in reducing investor risk compared to the English renewable obligation. This finding was supported by Burer and Wustengagen (2009) who, through survey techniques, established that FITs to be the most preferred policy for investors in Europe. On the other hand, Dinica (2006) showed that the risk-return characteristics of a mechanism influences investor behavior and that poorly designed FITs may do worse than well designed quota systems. This was further supported in Fagiani et al. (2013) who showed that, while a FIT could obtain better results than a certificate market, its performance is dependent on regulator choices; and the latter would obtain desired level of cost-effective renewable deployment as long as investors' risk aversion is moderate.

Appendix B. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.enpol.2013.07.071.

References

Ambit, 2010. The inimical cost of debt in India. Available at ⟨http://www.cityo flondon.gov.uk/business/support-promotion-and-advice/promoting-the-city-in ternationally/india/Documents/BC_RS_COLAmbitCOCpositionpaperFINAL.pdf⟩.

Atteridge, A., Shrivastava, M.K., Pahuja, N., Upadhyay, H., 2012. Climate policy in India: what shapes international, national and state policy? Ambio 41 (1), 68–77.

Bakthavatsalam, V., 2001. Windows of opportunity: IREDA and the role of renewable energy in India. Refocus 2 (4), 12–15.

Barradale, M., 2010. Impact of public policy uncertainty on renewable energy investment: wind power and the production tax credit. Energy Policy 38 (12), 7698–7709.

Bergek, A., Mignon, I., Sundberg, G., 2013. Who invests in renewable electricity production? Empirical evidence and suggestions for further research. Energy Policy 56, 568–581.

Bhandari L., Dasgupta, S. Gangopadhyay, S. 2003. Development Financial Institutions, Financial Constraints and Growth: Evidence from the Indian Corporate Sector. Available at ⟨http://emf.sagepub.com/content/2/1/83.short⟩.

Becker, B., Fischer, D., 2013. Promoting renewable energy in renewable economies. Energy Policy 56, 446–455.

BNEF, 2011. The return – and returns – of tax equity for US renewable projects. Bloomberg New Energy Finance White Paper. Available at ⟨www.bnef.com/ WhitePapers/download/54⟩.

Bolinger, M.; Wiser, R., Darghouth, N., 2010. Preliminary Evaluation of the Impact of the Section 1603 Treasury Grant Program on Renewable Energy Deployment in 2009. Lawrence Berkeley National Laboratory.

BP, 2012. BP statistical review of World energy, 2012. Available at ⟨http://www.bp. com/sectionbodycopy.do?categoryId=7500&contentId=7068481⟩.

BPC, 2011. Subsidies, Tax Credits, Grants: Reassessing Renewable Energy Subsidies. Bipartisan Policy Center Issue Brief. Available at ⟨http://bipartisanpolicy.org/ sites/default/files/BPC_RE%20Issue%20Brief_3-22.pdf⟩.

Brealey, R., Myers, S., Allen, F., 2007. Principles of Corporate Finance, ninth ed. McGraw-Hill.

Burer, M.J., Wustengagen, R., 2009. Which renewable energy policy is a venture capitalist's best friend? Empirical evidence from a survey of international cleantech investors. Energy Policy 37 (12), 4997–5006.

Business Standard, 2011. RBI again Warns Banks on Asset–Liability Mismatch. Available at ⟨http://www.business-standard.com/india/news/rbi-again-warns-banksasset-liability-mismatch/423227/⟩.

Business Standard, 2012. ECB Limits for HFCs Should be Reasonable. ⟨http://www. business-standard.com/india/news/ecb-limits-for-hfcs-should-be-reasona ble-nhb/489965/⟩.

Campbell M., 2009. Minimizing Utility Scale PV Power Plant Levelized Cost of Energy Using High-Capacity Factor Configurations. In: Proceedings of 34th IEEE Photovoltaic Specialists Conference, 7–12 June, Philadelphia.

CERC, 2012. CERC Tariff Order, March, available at ⟨http://cercind.gov.in/2012/ orders/RE_35_2012.pdf⟩.

CPI, 2011a. The Impacts of Policy on the Financing of Renewable Projects: A Case Study Analysis. Available at ⟨http://climatepolicyinitiative.org/publication/the-im pacts-of-policy-on-the-financing-of-renewable-projects-a-case-study-analysis/⟩.

CPI, 2011b. Authors Conversations with Leading Financial Institutions, Project Developers, and Policy Makers.

CPI, 2012a. Meeting India's Renewable Energy Targets: The Financing Challenges. Available at ⟨http://climatepolicyinitiative.org/publication/meeting-indias-rene wable-energy-targets-the-financing-challenge/⟩.

CPI, 2012b. Falling Short: An Evaluation of the Indian Renewable Energy Certificate Markets. Available at ⟨http://climatepolicyinitiative.org/publication/falling-shor t-an-evaluation-of-the-indian-renewable-certificate-market/⟩.

CPI, 2012c. Supporting Renewables While Saving Taxpayers Money. Available at ⟨http://climatepolicyinitiative.org/publication/supporting-renewables-while-sa ving-taxpayers-money/⟩.

DB, 2012. Attractive Price Discovery? Or the Discovery of Attractively-Priced Debt with High Capacity Projects? Unpublished Draft, Frankfurt, Germany.

Dinica, V., 2006. Support systems for the diffusion of renewable energy: an investor perspective. Energy Policy 34 (4), 461–480.

ET, 2012. Power distribution companies' losses cross Rs. 2 lakh crore. Available at ⟨http://articles.economictimes.indiatimes.com/2012-05-07/news/ 31610764_1_power-tariffs-hike-in-electricity-tariff-discoms⟩.

E&Y, 2012. Renewable Energy Country Attractiveness Indices. Available at ⟨http:// www.ey.com/Publication/vwLUAssets/Renewable_energy_country_attractive ness_indices_-_Issue_33/$FILE/EY_RECAI_issue_33.pdf⟩.

Fagiani, R., Barquin, J., Haakvoort, R., 2013. Risk-based assessment of the cost-efficiency and the effectivity of renewable energy support schemes: certificate markets versus feed-in tariffs. Energy Policy 55, 648–661.

Federal Reserve, 2012. 10-Year Swap Rate. Available at ⟨http://research.stlouisfed. org/fred2/series/DSWP10⟩.

Herd, R., Koen, V., Patnaik, I., Shah, A. 2011. Financial Sector Reforms in India: Time for a Second Wave? OECD Working Paper 879. Available at ⟨http://www. oecd-ilibrary.org/docserver/download/5kg8ghvzr2jk.pdf?expir es=1356650809&id=id&accname=guest&checksum=C6DDBB7225F61668E2 F084509F9F5EAB⟩.

Infrastructure Investor, 2011. India Estimates a $300 Billion Infrastructure Funding Gap. Available at ⟨http://www.infrastructureinvestor.com/Article.aspx? article=56727&hashID=27214BD8B6BBF7DBD9290CC120A5B25C2965933B⟩.

IRENA, 2012. Renewable Energy Technologies: Cost Analysis Series, vol. 1, Issue 4/5. Available at ⟨http://www.irena.org/DocumentDownloads/Publications/RE_Tech nologies_Cost_Analysis-SOLAR_PV.pdf⟩.

Kahn, S., 2009. Overcoming barriers to wind project finance in Australia. Energy Policy 37 (8), 3139–3148.

Kalamova, M., Kaminker, C. Johnstone, N. 2011. Sources of Finance, Investment Policies and Plant Entry in the Renewable Energy Sector. IDEAS Working paper. Available at ⟨http://ideas.repec.org/p/oec/envaaa/37-en.html⟩.

Kamandotova, N., Patt, A., Barras, L., Battaglini, A., 2012. Perception of risks in renewable energy projects: the case of concentrated solar power in North Africa. Energy Policy 40, 103–109.

Kawai et al. 2011. Asian Bond Market Development and Regional Financial Cooperation. Available at ⟨http://asianbondsonline.adb.org/publications/exter nal/2011/Asian_Bond_Markets_Development_and_Regional_Financial_Coopera tion.pdf⟩.

Lipp, J., 2007. Lessons from effective renewable electricity policy from Denmark, Germany, and the United Kingdom. Energy Policy 35 (11), 5481–5495.

Luthi, S., Prassler, T., 2011. Analyzing policy support instruments and regulatory risk factors for wind energy deployment—a developers' perspective. Energy Policy 39 (9), 4876–4892.

Madan T., 2009. India. Brookings Institute Energy Security Series. Available at ⟨http://dspace.cigilibrary.org/jspui/handle/123456789/5661⟩.

Masini, A., Menichetti, E., 2012. The impact of behavioral factors in the renewable energy investment decision making process: conceptual framework and empirical findings. Energy Policy 40, 28–38.

Mathews, J.A., Kidney, S., Mallon, K., Hughes, M., 2010. Mobilizing private finance to drive an energy industrial revolution. Energy Policy 38 (7), 3263–3265.

Mendelsohn M., Kreycick, C., Bird, L., Schwabe, P., Cory, K. 2012. The Impact of Financial Structure on the Cost of Renewable Energy. NREL Technical Report NREL-TP-6A20-53086. Available at ⟨http://www.nrel.gov/docs/fy12osti/53086.pdf⟩.

Mitchell, C., Bauknecht, D., Connor, P.M., 2006. Effectiveness through risk reduction: a comparison of the renewable obligation in England and Wales and the feed-in system in Germany. Energy Policy 34 (3). (297-205).

MNRE, 2009a. National Solar Plan, Final Draft, 29th April, 2009, Available at ⟨www.indiaenvironmentportal.org.in/files/national-solar-plan.pdf⟩.

MNRE, 2009b. Wind Energy Incentives. Available at ⟨http://pib.nic.in/archieve/others/2009/dec/f2009122102.pdf⟩.

Mormann, F., 2012. Enhancing the investor appeal of renewable energy. Environmental Law 42, 3.

Mormann F., Reicher, D. 2012. Smarter Finance for Cleaner Energy. Brookings Remaking Federalism/Renewing the Economy Series. Available at ⟨http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2174650⟩.

NAPCC 2008. National Action Plan on Climate Change. Government of India Prime Minister's Council on Climate Change. Available at ⟨http://pmindia.nic.in/Climate%20Change.doc⟩.

NRDC, 2012. Laying the Foundation for a Bright Future. Available at ⟨http://www.nrdc.org/international/india/files/layingthefoundation.pdf⟩.

NY Times, 2012. As Power Is Restored in India, the 'Blame Game' Over Blackouts Heats Up. Available at ⟨http://www.nytimes.com/2012/08/02/world/asia/power-restored-after-india-blackout.html?pagewanted=all&_r=0⟩.

OECD, 2011. OECD Economic Surveys: Brazil. Available at ⟨http://www.oecd.org/eco/surveys/48930900.pdf⟩.

Planning Commission, 2011. An Approach to the Twelfth Five Year Plan, Government of India, Planning Commission, October. Available at ⟨http://planningcommission.nic.in/plans/planrel/12appdrft/appraoch_12plan.pdf⟩.

RBI, 2012. External Commercial Borrowings. Available at ⟨http://rbidocs.rbi.org.in/rdocs/notification/PDFs/APD05012012.pdf⟩.

RE, 2009. China's New Generation: Driving Domestic Development. Available at ⟨http://www.renewableenergyworld.com/rea/news/article/2009/03/chinas-new-generation-driving-domestic-development⟩.

RE, 2012. As Grid Parity nears, India Prepares for Solar Revolution. Available at ⟨http://reneweconomy.com.au/2012/as-grid-parity-nears-india-prepares-for-a-solar-revolution-19850⟩.

Reuters, 2012. Brazil unveils stimulus, cuts BNDES lending rate. Available at ⟨http://www.reuters.com/article/2012/06/27/brazil-economy-measures-idUSL2E8HR5DM20120627⟩.

Reichelstein S., 2010. The Levelized Cost of Electricity. Working Paper.

RSPCB, 2012. Determinants of Success for Promoting Solar Energy in India. Available at ⟨http://210.212.96.131/rpcb/ReportsAndPaper/solarEnergy_14_12_2011.pdf⟩.

Sardosky, P., 2012. Modeling renewable energy company risk. Energy Policy 40, 39–48.

S&P, 2009. Key Credit Factors: Methodology and Assumptions on Risks for Utility-Scale Solar Photovoltaic Projects. S&P Rating Criteria. Available at ⟨http://www.researchandmarkets.com/reports/2153374/criteria__corporates__project_finance_key⟩.

Shrimali G., 2011. The levelized cost of electricity: a reconciliation of definitions. Unpublished manuscript.

Tang, A., Chiara, N., Taylor, J., 2012. Financing renewable energy infrastructure: formulation, pricing, and impact of a carbon revenue fund. Energy Policy 45, 691–703.

UNDP, 2012. Derisking Renewable Energy Investments. Available at ⟨http://www.undp.org/content/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/derisking-renewable-energy-investment/⟩.

UNEP, 2012. Global Trends in Renewable Energy Investment. Available at ⟨http://fs-unep-centre.org/sites/default/files/publications/globaltrendsreport2012final.pdf⟩.

USPREF, 2012. Paid in Full. Available at ⟨http://www.uspref.org/images/docs/SC_ITC-Payback_July_12_2012.pdf⟩.

VENATOR, 2011. Indian Debt Capital Market. Available at ⟨http://www.venatorsearch.com/web/attachments/dcm.pdf⟩.

Victor, D., Heller, T., 2007. The Political Economy of Power Sector Reform: The Experience of Five Major Developing Countries. Cambridge University Press.

Wiser, R.H., 1997. Renewable energy finance and project ownership: the impact of alternative development structures on the cost of wind power. Energy Policy 25 (1), 15–27.

Wiser, R.H., Pickle, S.J., 1998. Financing investments in renewable energy: the impacts of policy design. Renewable and Sustainable Energy Reviews 2 (4), 361–386.

World Bank, 2006. Financing Infrastructure: Addressing constraints and challenges. Available at ⟨http://164.100.52.24/pdf/india_financing_infrastructure_addressing_constraints_and_challenges_june2006.pdf⟩.

Wustenhagen, R., Menichetti, E., 2012. Strategic choices for renewable energy investment: conceptual framework and opportunities for further research. Energy Policy 40, 1–10.

WWF, 2011. Enabling the Transition: Climate Innovation Systems for a Low-Carbon Future. Available at ⟨http://wwf.fi/mediabank/1552.pdf⟩.