Solving India's Renewable Energy Financing Challenge: Which Federal Policies can be Most Effective?

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Executive Summary

The Government of India has set ambitious targets for renewable energy — a doubling of existing renewable energy capacity to 55,000 MW by 2017. However, unsubsidized renewable energy is still 52-129% more expensive than conventional power, and requires policy support. This policy support is currently provided through a combination of state-level feed-in tariffs and federal subsidies in the form of a generation based incentive, viability gap funding, and accelerated depreciation.

Given the ambitious goals, but limited budgets, the cost-effectiveness of these policies becomes an important criterion for policymakers. In our previous work, we demonstrated that unfavorable debt terms add 24-32% to the cost of renewable energy in India. In this report, we show that if cost-effectiveness were the only criterion of interest, a class of debt-related federal policies that provide low-cost, long-term debt are more cost-effective than the existing federal policies.

However, cost-effectiveness is only one of the many criteria federal policymakers use. In our conversations with policymakers, the following questions emerged as important drivers of federal policy choice: How much of the gap between the unsubsidized cost of renewable energy and the wholesale price of electricity could the federal government cover without state support, i.e. what is the *viability gap coverage potential*? How much of the budgetary allocation would the government be able to recover over time, i.e. what is the *subsidy-recovery potential*? How does it ensure that the *production of renewable energy* is incentivized and not just capacity installation? Given a fixed annual federal budgetary allocation, how much renewable capacity can it support, i.e. what is the *one-year budget efficiency*?

The eventual decision for the policymaker would depend on a combination of these criteria. In this paper, we provide a framework to compare the existing federal policies for onshore wind and solar photovoltaic (PV) technologies with a proposed class of debt-related federal policies, using project-level cash-flow models. We considered three debt-related subsidies: extended-tenor debt, where the tenor of government debt would exceed commercial debt tenor; reduced cost debt, where the government would provide debt below the commercial rate of interest; and interest subsidy, where the government would subsidize the interest on commercial loans.

The figure on the next page presents a summary of our results for wind energy, assuming that the federal policies are used in combination with state-level feed-in tariffs and that federal support is optimized for cost-effectiveness. The results are similar for solar energy, with slight differences primarily due to the higher capital cost, which results in a larger viability gap. Although there is no single policy that performs better than the others across all criteria, our analysis presents policymakers with crucial tradeoffs that would enable them to choose appropriate federal policies based on relevant policy goals. In particular, there exist combinations of policies that could satisfy multiple policy priorities.

Our main finding is that, **in the long-term, debt-related policies are more cost-effective than the existing policies**. In particular, the combination of reduced cost, extended-tenor debt is the most cost-effective policy. With a tenor extension of 10 years, for wind energy, a 5.9% loan could reduce the total – i.e., the sum of federal, state, and tax — subsidies by 78% compared to the most cost-effective version of the generation based incentive (i.e., at INR 2.03/kWh). For solar energy, for the same tenor extension, a 1.2% loan could reduce total subsidies by 28% compared to the most cost-effective version of the existing policy, viability gap funding (i.e., at 56%). Furthermore, this policy combination would allow for a high degree of subsidy-recovery — i.e., 76% for wind and 49% for solar.

We also find that **reduced cost, extended-tenor debt is more cost-effective than the primary existing policies at current support levels**: for wind energy, the generation based incentive of INR 0.5/kWh, with a cap of INR 10 million per MW, to be utilized over 4-10 years; and, for solar energy, the viability gap funding of up to 30% of project cost. For wind energy, we find that an 18-year loan at the commercial rate of interest (i.e., at 12.3%) would reduce the total subsidy by 35%. Similarly, for solar energy, we find that a loan at 6.6% with a tenor increase of 10 years would reduce total subsidies by 18%.

However, reduced-cost, extended-tenor debt may not be the preferred policy in the short-run due to its high capital outlay. For wind energy, compared to this policy, the current generation based incentive can support 83% more deployment in one year, and for solar energy, the current viability gap funding can support 60% more deployment. Thus, although reduced-cost, extended-tenor debt is clearly attractive from a long-term perspective, in the near-term the federal government may have insufficient funds to provide support solely through this policy.
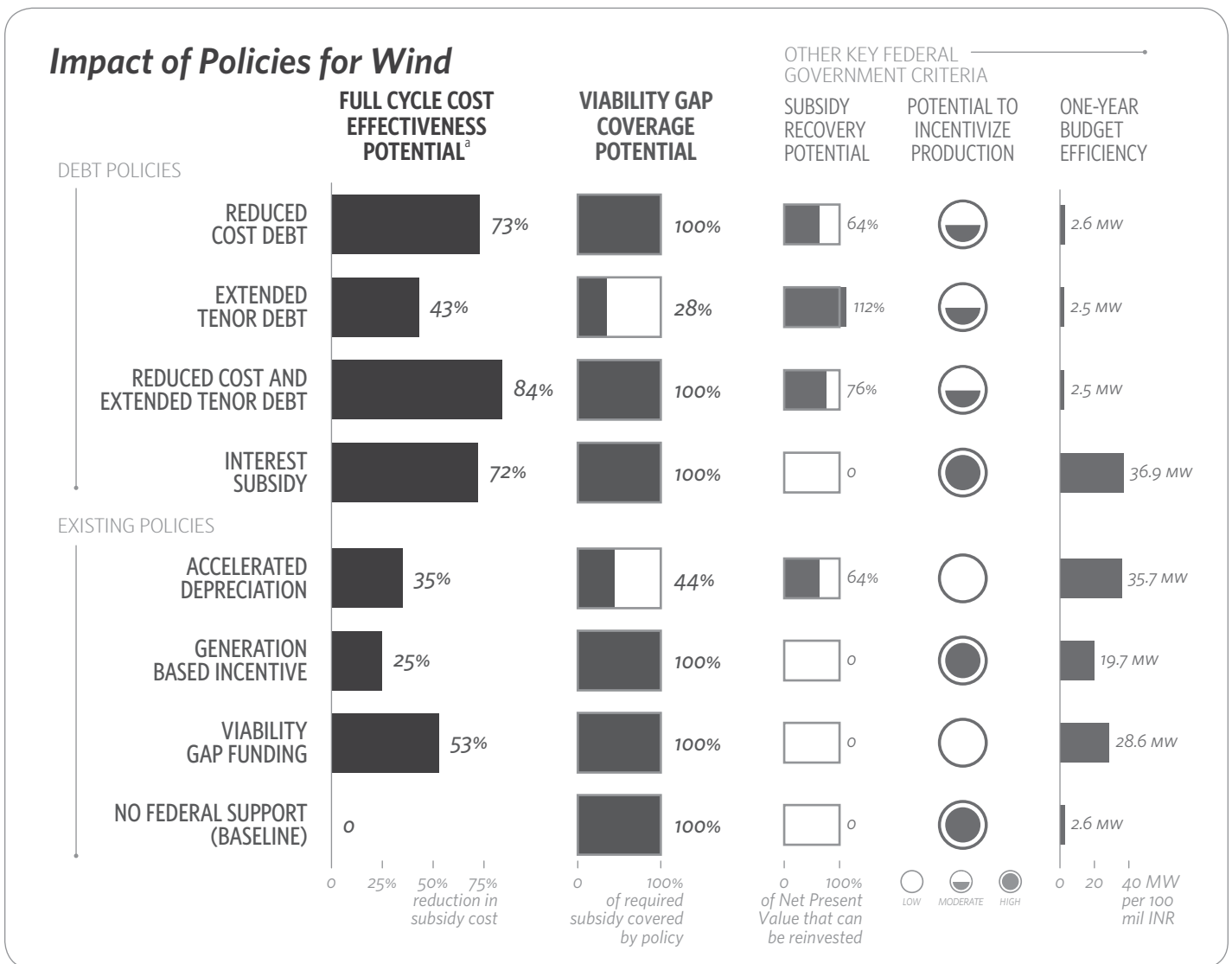
Nevertheless, **there are other policy options in the short-term that are more attractive than existing policies at current support levels**. For wind energy, for the same state-level support of INR 4.9/kWh, we find that the following policies have advantages over the generation based incentive:

- An interest subsidy of 3.4% would result in a total subsidy reduction of 11% and would support 83% more deployment in one year.

- An accelerated depreciation of 38% — i.e., less than the typical 80% — would result in a total subsidy reduction of 17% and would support 87% more deployment in one year. However, accelerated depreciation may not incentivize production as well as the generation based incentive.

Similarly, for solar energy, we find that, compared to a viability gap funding of 30%, for the same state-level support of INR 5.6/kWh, an interest subsidy of 10.2% would result in a total subsidy reduction of 11% and would support 30% more deployment in one year

Based on policymaker feedback, our work can be extended to include appropriate policy design for debt-related policies to ensure alignment with policy objectives. We recommend that the following questions be investigated in more detail: How can federal policies be designed to incentivize production? How could the design of accelerated depreciation be modified to better incentivize independent power producers? How could the government's cost of lending, including administrative/transaction costs and project risk premium, be better estimated? How should a more comprehensive, long-term measure of capital efficiency be designed? Answering these questions can help India meet its renewable energy goals in the most efficient way possible.

Impact of Policies for Wind

	FULL CYCLE COST EFFECTIVENESS POTENTIAL[a]	VIABILITY GAP COVERAGE POTENTIAL	SUBSIDY RECOVERY POTENTIAL	POTENTIAL TO INCENTIVIZE PRODUCTION	ONE-YEAR BUDGET EFFICIENCY
DEBT POLICIES					
REDUCED COST DEBT	73%	100%	64%		2.6 MW
EXTENDED TENOR DEBT	43%	28%	112%		2.5 MW
REDUCED COST AND EXTENDED TENOR DEBT	84%	100%	76%		2.5 MW
INTEREST SUBSIDY	72%	100%	0		36.9 MW
EXISTING POLICIES					
ACCELERATED DEPRECIATION	35%	44%	64%		35.7 MW
GENERATION BASED INCENTIVE	25%	100%	0		19.7 MW
VIABILITY GAP FUNDING	53%	100%	0		28.6 MW
NO FEDERAL SUPPORT (BASELINE)	0	100%	0		2.6 MW

OTHER KEY FEDERAL GOVERNMENT CRITERIA

Scale: 0 25% 50% 75% — reduction in subsidy cost

0 100% — of required subsidy covered by policy

0 100% — of Net Present Value that can be reinvested

LOW MODERATE HIGH

0 20 40 MW — per 100 mil INR

a   Full cycle cost effectiveness potential is measured over the full life cycle of the project.

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1. Introduction

Renewable energy can help provide energy security and mitigate climate change with adequate policy support.

As India tries to reduce its dependence on conventional energy and mitigate climate change, the role of renewable energy has become increasingly prominent. The Government of India aims to incentivize the use of clean energy, create a competitive domestic production base for renewables, and double the existing renewable energy capacity to 55,000 MW by 2017 (MNRE, 2012a).

However, renewable energy continues to be significantly more expensive than conventional power. Unsubsidized renewable energy is 52-129% more expensive than the average wholesale price, also known as the average pooled purchase cost (APPC), of electricity.[1] Therefore, it still requires policy support in order to compete with conventional sources of power.

A number of policies are in place to support the growth of renewable energy, but their cost-effectiveness has not been studied in detail.

Policy support for renewable energy in India is usually provided through a combination of federal and state policies.

The federal government provides policy support through the Ministry of New and Renewable Energy (MNRE). The federal policies currently offered are: a generation based incentive of INR 0.5/kWh for grid-connected wind projects, viability gap funding up to 30% of project cost, and accelerated depreciation of 80% for solar projects under the National Solar Mission (MNRE, 2013).

The federal policies typically cover only some of the viability gap – that is, the difference between the cost of unsubsidized renewable energy and the APPC. The rest is eventually supported by state governments entering Power Purchase Agreements with renewable energy developers, agreeing to pay feed-in tariffs for 20-25 years.

However, this raises an obvious question: *Are these policy mechanisms cost-effective?* In other words, are these policies the best use of finite public resources?

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1   Average pooled purchase cost is the weighted average pooled price at which the power distribution companies purchased electricity in the previous year from all energy suppliers, except renewable energy sources.

In our previous work, we examined the impact of policy on the cost of financing renewable energy projects (Nelson et al, 2012). We found that the high cost of debt is the most pressing problem currently faced by Indian renewable energy developers. High interest rates are not unique to the renewable energy sector; rather, they are the result of systemic factors such as high inflation, heavy government borrowing and competing investment needs in the economy. This limits the impact of policies such as feed-in tariffs, since financing cannot be optimized in response to policy changes. Lack of availability of long-term debt and variable interest rates also contribute towards the high cost of financing. Together, these three factors – high interest rates, short tenor and variable rate of interest, raise the cost of renewable energy by 24-32%, compared to similar projects in the U.S.

In this paper, we extend our previous work to analyze various policies for their cost effectiveness as well as other government criteria.

We focus on the two dominant renewable technologies – onshore wind and solar photovoltaic (PV), and use project-level cash flow models to investigate the impact of various policies. We examine *federally administered debt-related policies* that directly address the issues of high cost and short tenor of debt and compare them against *existing federal policies*, viz. the generation based incentive, viability gap funding and accelerated depreciation. We compare and contrast the impact of these policy mechanisms across five key criteria, identified in our conversations with policymakers:

1. **What is the cheapest way to subsidize renewables?** The total cost of a policy to the government determines its *cost-effectiveness*. This is measured by the net present value (NPV) of the total subsidy, which is the sum of state, federal and tax subsidies.

2. **Is it possible for the federal government to support renewable energy in the absence of state-level support?** *Viability gap coverage potential* assesses the extent to which a policy could be used by the federal government to bridge the difference between the cost of renewable energy and the APPC without depending on state-level support.

3. **How much of the budgetary allocation could the government recover over time?** The *subsidy-recovery potential* is the percentage of the federal subsidy cost that could be recovered by the government over time. This enables the government to assess

whether the funds deployed under a particular federal policy could be reused.

4. **How do we ensure that a policy mechanism incentivizes production, and not just capacity installation?** This criterion examines whether the policy incentivizes installation of capacity or the production of power. The purpose is to identify a policy that best supports the government's objective of reaching 15% of electricity generation through renewables by 2020 (NAPCC, 2008).

5. **Given a fixed annual federal budgetary allocation, how much capacity could be funded under each policy?** *One-year budget efficiency* indicates the amount of capacity that could be funded by the federal government in one year using a fixed annual budgetary allocation. This enables the government to identify federal policies that would have the highest deployment potential in the short-term.

The outline of this paper is as follows: Section 2 describes the policies studied in this paper; Section 3 details the data and methodology used for analysis; Section 4 presents and discusses our results; and Section 5 provides conclusions and policy implications.

2. Policies

In this section, we discuss state-level policy support and two categories of federal policies: the existing federal policies in the Indian renewable energy sector, and a new class of proposed debt-related federal policies that address the lack of availability of low cost, long-term debt.

2.1 State-Level Policy

A feed-in tariff is a long-term contract, usually 20-25 years, for the state government to buy the power produced by a renewable project at a pre-determined tariff. This tariff, which is based on the cost of power production, is higher than the APPC. Therefore, a feed-in tariff includes an implicit subsidy from the state government in the form of a feed-in premium.

2.2 Existing Federal Policies

We now describe the federal government's existing policies for renewable energy. At present, each of these federal policies is applicable to only one of the technologies, as mentioned below. However, for the purpose of comparison, we examine the impact of these policies on both technologies in our models.

2.2.1 Accelerated Depreciation

Accelerated depreciation allows a developer to write off the asset value in the initial years of the project. This benefits the developer by reducing its taxable income, and therefore, its tax liability. However, after the value of the asset has completely depreciated, taxes are higher in later years, enabling the government to recover some part of the subsidy.[2]

The government currently provides accelerated depreciation of up to 80% for solar projects. The incentive was also offered to wind projects earlier, but was withdrawn in April 2012 (MNRE, 2012b).

2.2.2 Generation Based Incentive

The generation based incentive is a policy that is directly linked to the amount of power generated, which incentivizes higher production. Under this scheme, the government provides INR 0.5/ kWh supplied to the grid by wind energy developers, subject to a cumulative maximum of INR 10 million per MW. The incentive must be drawn over a minimum of 4 years and a maximum of 10 years.[3]

2.2.3 Viability Gap Funding

Viability gap funding is a capital grant from the government that bridges the gap between project cost under the prevailing electricity rate and the price quoted by the developer. It has been introduced for solar projects under Phase 2, Batch 1 of the National Solar Mission (MNRE, 2013a).[4]

In viability gap funding, tariffs are pre-determined feed-in tariffs; to support these tariffs, the government provides a capital subsidy in installments with an upper limit of 30% of the project cost or INR 25 million per MW. The exact amount of viability gap funding is determined through reverse bidding where projects bid down on the viability gap funding required per MW (MNRE, 2013b).

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2   In India, depreciation is calculated using the written down value method, whereby the asset is depreciated by a fixed percentage of the remaining balance every year.

3   The generation based incentive can only be used for electricity supplied to the grid, and not for third party sales with merchant power plants.

4   The allocation process, signing of Power Purchase Agreements and disbursement of viability gap funding is being handled by the Solar Energy Corporation of India. According to the policy, a fixed tariff of INR 5.45/kWh will be provided to projects that are not using accelerated depreciation, and a fixed tariff of INR 4.95/kWh will be provided for projects using accelerated depreciation.

The funds may be disbursed at one time or deferred, depending on the physical and financial progress of the projects. Since the interval between these installments may vary for different projects, for most of this paper, we assume that viability gap funding is provided as a one-time grant the beginning of the project.

2.3 Debt-Related Federal Policies

2.3.1 Interest Rate Subsidy

Under this policy, the federal government would service a part of the interest obligation of a project, reducing the effective rate of interest payable by the developer for a commercial loan. However, the tenor of the loan would remain the unchanged. For example, if the government wants to reduce the cost of borrowing from 13% to 10% for a 10-year commercial loan, it would pay 3% interest (only) directly to the bank for 10 years, while the developer would pay the bank the remaining 10% interest in addition to the principal.

Although no such policy currently exists for power generation, the Ministry of Power offers interest subsidies of 3% for 14 years under the National Electricity Fund to public and private power distribution utilities in order to help improve their financial health (Ministry of Power, 2012).

2.3.2 Reduced Cost Loan

Under this policy, the federal government would lend funds for renewable energy projects at a lower rate of interest than the commercial interest rate, while keeping the tenor of the loan unchanged. For example, if the government provides a loan to project developers at its cost of borrowing of 7.83%, the interest on loan would be nearly 4.5% lower than the rate of interest on commercial debt (RBI, 2013).[5]

Plans to provide reduced cost loans through the National Clean Energy Fund have been discussed by the Ministry of Finance and the Ministry for New and Renewable Energy. An international example is the Brazilian Development Bank's (BNDES) low-cost loans for renewable energy projects. (IEA, 2012).

2.3.3 Extended-Tenor Debt

In this case, the federal government would directly provide loans to renewable energy projects at the commercial rate of interest, but for a longer tenor. For example, the government may provide a loan at 12.3% (the commercial rate of interest) for 18 years to the project developer, which amounts to an increase in tenor of 8 years compared to a commercial loan.

Extended-tenor debt has been under discussion in policy circles, by the Ministry of Finance, the Ministry of New and Renewable Energy, and the Planning Commission. In particular, it has been raised as a desired policy under the proposed National Wind Mission (MNRE, 2014).

In our analysis, we compare the policies based on three different perspectives.

We compare the current support levels of the existing policies with other policies, to assess whether more attractive policy alternatives exist in the short-term (Section 4.4).

However, these current support levels are not equivalent in terms of state-level policy support – e.g., for wind, the generation based incentive of INR 0.5/kWh (Section 2.2.2) requires a state-level support of INR 4.9/kWh whereas 80% accelerated depreciation (Section 2.2.1) would require a state-level support of INR4.6/kWh. The absence of a fixed reference makes it difficult to compare policies. Therefore, we also compare all federal policies, given a fixed state-level support – e.g., a feed-in tariff of INR 5/kWh for wind (Sections 4.2 and 4.3).

Finally, both of these analyses do not inform us of the best possible outcome – e.g., how cost-effective can a policy really be if there were no constraints on the federal support – that can be achieved with federal policies; therefore, we compare all federal policies at their best performance as well (Sections 4.1 and 4.3).

For the latter two analyses, all policies, including existing ones, are allowed to vary the federal support in order to facilitate comparison. We compare policies to a baseline case is when there is no federal policy support, i.e. the only policy support available to renewable projects is a feed-in tariff from the state government. This allows us to examine the impact of each of the federal policies against a common reference – i.e., the zero federal support case.

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5   Benchmark borrowing rate for a 10-month government security.

3. Data and Methodology

We collected project-level information on costs, revenues, and expenditures for wind and solar projects using median values for a representative sample of onshore wind and solar PV projects from the Bloomberg New Energy Finance database (BNEF, 2013). Since capital costs have changed significantly over the past few years, we selected recently commissioned, grid-scale projects, ensuring adequate geographic dispersion in terms of project location. Further, we validated these figures through conversations with developers, secondary research, and the Central Electricity Regulatory Commission's project level information (CERC, 2012).

The assumptions used for the financial models are presented in Table 3.1. Using these assumptions, we developed estimates for future cash flows in accordance with existing tax laws and depreciation schedules. Due to the inherent variability in renewable energy generation, we use two different plant load

Table 3.1: Project-level Assumptions

| ASSUMPTIONS	WIND	SOLAR
POWER GENERATION		
Installed capacity	50 MW	50 MW
Capacity Utilizations (P50 PLF)	24.7%	20.5%
Useful Life	20 yrs	25 yrs
CAPITAL COST		
Capital Cost[i] (in INR million/MW)	61.6	80.0
Total Capital Cost (in INR million)	3080	4000
FINANCIAL ASSUMPTIONS		
Debt (for fixed leverage)	60%	60%
Minimum Debt Service Coverage Ratio[ii]	1.3	1.3
P90 PLF (Debt condition)[iii]	22.7%	18.5%
DEBT		
Repayment Period	10 yrs	11 yrs
Interest Rate	12.3%	12.3%
EQUITY		
Expected Return on Equity	17.9%	17.3%

i Capital cost includes turbine/module cost, land, civil and general works, and evacuation cost.
ii Ratio of cash flows available for debt servicing to interest and principal.
iii P50 PLF or plant load factor represents the most likely output of the plant, while P90 PLF is a conservative estimate of the plant load factor.
Source: CPI analysis based on Bloomberg New Energy Finance data, Central Electricity Regulatory Commission benchmarks and interviews with project developers

Figure 3.1: Unsubsidized Levelized Cost of Electricity for Onshore Wind and Solar PV Projects
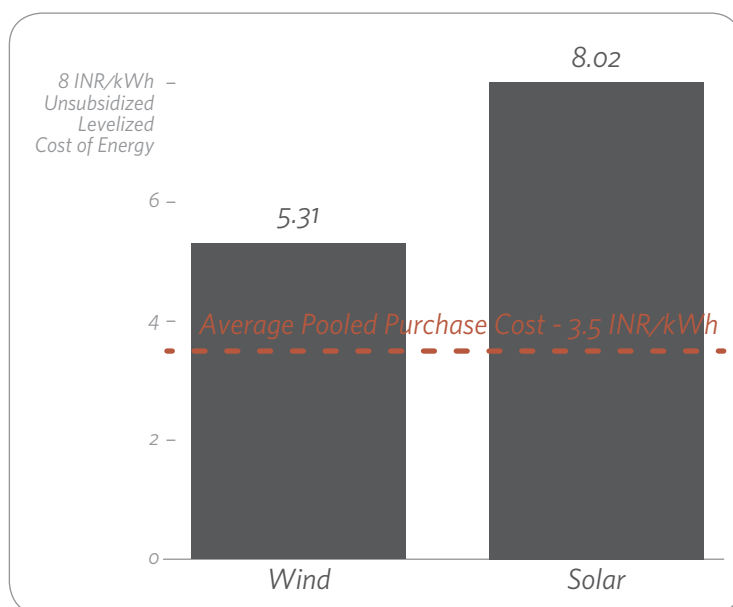
Source: CPI Analysis

factors (PLFs): we computed the return on equity on the basis of the P50 plant load factor, which represents the most likely output of the plant; and we calculated debt-leverage using the P90 plant load factor, a more conservative estimate required by banks.[6]

For each policy, we computed the amount of subsidy corresponding to different levels of state-level feed-in tariffs.

Figure 3.1 shows the unsubsidized levelized cost of electricity (LCOE) – i.e., the cost of renewable energy in absence of any policy support — for wind and solar projects.[7] In this case, in the absence of any federal policy support, the state-level feed-in tariffs would be INR 5.31/kWh for wind energy and INR 8.02/kWh for solar energy; and the implied feed-in premium would be INR 1.81/kWh and INR 4.52/kWh, respectively. Thus, in the absence of any policy support, renewable energy is 52-129% more expensive than conventional power.

In our analysis, we compared individual policies from three perspectives (Section 2):

1. **Maximum potential benefit** (Sections 4.1 and 4.3):

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6   There is a 50% likelihood that the plant output will be greater than the P50 PLF, whereas there is a 90% likelihood that the actual generation will exceed the P90 PLF. P50 PLF is, therefore, higher than the P90 PLF.
7   Levelized cost of electricity or LCOE is the average cost of electricity that helps to break even in terms of the return expected by the developer. It represents the minimum unit revenue required to meet the return on equity, given the project's financial parameters.

In this case, we compared the best performance of each policy across different criteria. This benefit is achieved at different *subsidized LCOEs* – i.e. the cost of renewable energy with federal policy support, eventually supported via state-level feed-in tariffs – for different policies, based on the corresponding viability gap reduction potentials.

2. **Fixed state-level feed-in tariff** (Sections 4.2 and 4.3): To explain the relative performance of each federal policy and why they may lead to a reduction in total subsidies, we compared all the policies holding the level of state support fixed. This allows a comparison of all policies with respect to a common, reference, subsidized LCOE.

3. **Current support levels of existing policies** (Section 4.4): We also compared the current support levels of existing federal policies – i.e., the generation based incentive of INR 0.5/kWh (with a cap of INR 10 million per MW on cumulative disbursement), 30% viability gap funding, and 80% accelerated depreciation — against alternative policies.

For evaluating the maximum potential benefit – i.e., the first perspective – we also considered two combinations of policies: reduced cost, extended-tenor debt, which emerged as the most cost-effective policy, and accelerated depreciation with viability gap funding, which the federal government currently offers under the National Solar Mission.

For the first two perspectives (Sections 4.1-4.3), we developed a baseline case for each of the technologies, where there is zero federal policy support, and the only policy used by the developer is a feed-in tariff from the state government, which would be equal to the unsubsidized LCOE. These baseline cases served as the starting points for measuring the amount of subsidy required under each individual federal policy at various levels of subsidized LCOE, supported by state-level feed-in tariffs. As federal support increases, the subsidized LCOE would reduce, leading to a reduction in the level of state support. We computed subsidized LCOEs at discrete intervals of INR 0.5/kWh. For example, for wind,

starting with the unsubsidized LCOE of INR 5.31/kWh in the baseline case, we obtained subsidized LCOEs of INR 5/kWh, INR 4.5/kWh, and so on.

To facilitate unbiased comparison, where necessary, we allowed federal policy support to vary, and assumed that all the federal policies were uncapped, or not limited to a maximum level of federal support. For the first two perspectives (Sections 4.1-4.3), therefore, we relaxed the constraints on the existing policies — 80% accelerated depreciation, cumulative payout of INR 10 million under the INR 0.5/kWh generation based incentive,[8] and a viability gap funding of 30% of project cost. Thus, accelerated depreciation of up to 100% and uncapped amounts of the generation based incentive and viability gap funding were allowed. For debt-related policies, for all perspectives, we allowed tenor extensions of up to 10 years and the eventual cost of debt to be as low as 0%.

We assumed that developers would optimize debt-leverage.

Given a fixed rate of interest, we assumed that the project developer would maximize debt to minimize the weighted average cost of capital and, therefore, maximize the returns on equity. This optimization is typically subject to a minimum debt service coverage ratio condition of 1.3 for the entire course of the project.[9] We included the effect of federal policies in computing the debt service coverage ratio. With the exception of accelerated depreciation, which affects equity cash flows rather than debt, all the policies have an impact on debt-leverage.

For reference purposes, to isolate the direct effect of a policy from the indirect effect of leverage, we also modeled scenarios with fixed leverage, where project developers kept debt at a constant percentage rather than adjusting debt-equity ratios to maximize benefits from lower debt costs. We held fixed leverage at 60%, rounding off the level of optimized debt in the baseline case. In Section 4.2.4, we discuss the implications of using optimized leverage against fixed leverage.

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8   We refer to this policy as the capped generation based incentive. In this paper, we also consider an uncapped generation based incentive as a reference case, where there is no cumulative maximum to the amount of subsidy that can be accessed. However, we assume that it is drawn within 10 years.

9   The debt service coverage ratio assesses cash availability for debt servicing relative to total debt, which includes principal and interest. A ratio of 1.3 is a realistic estimate based on our interactions with financiers and bankers.

4. Impact of Policies

In this section, we compare the existing policies and the proposed debt-related policies across the five identified criteria from three perspectives: (a) maximum potential benefit of each policy (Section 4.1), (b) relative performance of each federal policy assuming a fixed level of subsidized LCOE, supported by state-level feed-in tariffs (Section 4.2), and (c) comparisons with the existing federal policies with current support levels (Section 4.4). In Sections 4.1 and 4.2, we discuss all results in the context of wind energy. The results for solar energy are quite similar, and the key differences are discussed in Section 4.3.

4.1 Maximum Potential Benefit from Federal Policies

In this section, we discuss the maximum potential benefit of each policy along four criteria (see figure, below): (a) cost-effectiveness potential, which is the maximum reduction in total subsidies that could theoretically be achieved under each federal policy; (b) viability gap coverage potential, which is the maximum reduction in unsubsidized LCOE, that could be achieved under each federal policy; (c) subsidy-recovery potential, which estimates the percentage of subsidy cost that could be recovered by the federal government; and (d) the potential to incentivize production.

We discuss one-year budget efficiency in Section 4.2, since it is based on the relative performance of each federal policy when state-level support is fixed, rather than the maximum potential benefit under each policy.
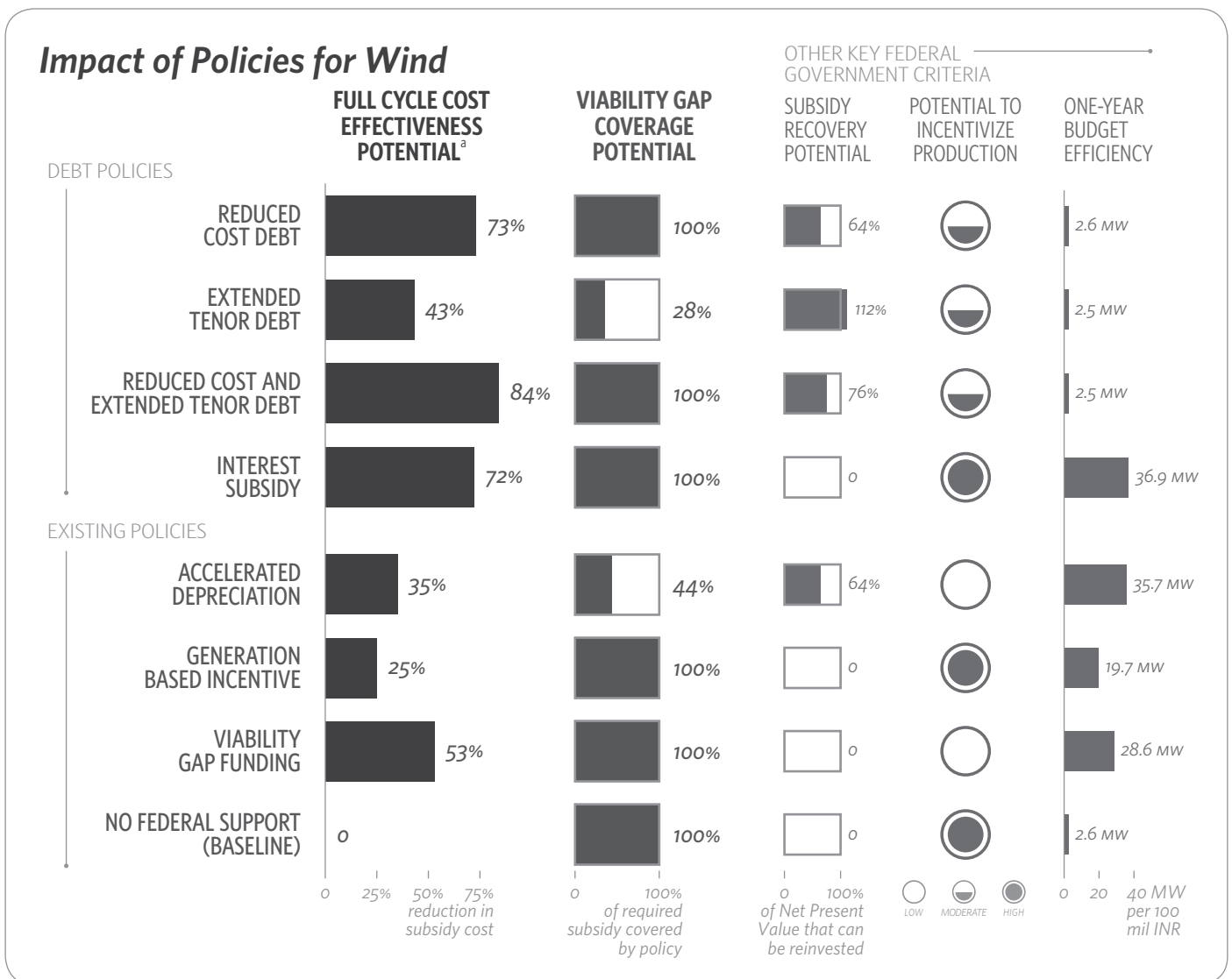
Impact of Policies for Wind

a   Full cycle cost effectiveness potential is measured over the full life cycle of the project.

We start with a discussion of the viability gap coverage potential because it affects how well policies meet other criteria such as cost-effectiveness and subsidy-recovery potential.

4.1.1 Viability Gap Coverage Potential: To what extent could various federal policies support renewable energy in the absence of state support?

We evaluated the potential of the federal policies to bridge the gap between the unsubsidized LCOE and the APPC, in order to assess the extent to which federal government policy can reduce subsidy spending by the state governments. We calculated viability gap coverage potential by comparing the maximum reduction in state-level feed-in tariff under each federal policy to the baseline case with no federal policy support.

Most federal policies have 100% viability gap coverage potential.

Starting from an unsubsidized LCOE of INR 5.31/kWh in the baseline case of no federal support, many federal policies – i.e., reduced cost debt, interest subsidy, viability gap funding, the generation based incentive and the combination of reduced cost, extended-tenor debt — can achieve the APPC level — a subsidized LCOE of INR 3.5/kWh – with no state-level support, indicating 100% viability gap coverage. Since the absence of federal support is the least cost-effective policy option (see 4.1.2 below), complete substitution through federal policies reduces the total subsidies to the maximum extent possible under the corresponding federal policy. Table 4.1 presents the level of federal policy support that would be required under each of these policies to achieve 100% viability gap coverage.

Extended-tenor debt and accelerated depreciation have low viability gap coverage potential.

For wind power, the lowest subsidized LCOE, supported by state-level feed-in tariffs, that can be achieved with accelerated depreciation is INR 4.57/kWh, indicating viability gap coverage of 44%, while the viability gap coverage for extended-tenor debt is 28% at a subsidized LCOE of INR 4.8/kWh. This creates a higher

Table 4.1: Amount of Subsidy Required for 100% Viability Gap Coverage (Wind Energy)

FEDERAL POLICY	SUPPORT LEVEL
Reduced cost, extended-tenor debt	5.9% loan for 20 years
Reduced cost debt	0.6% loan for 10 years
Interest subsidy	11.70%
Viability gap funding	33.6% of capital cost
Generation based incentive	INR 2.03/kWh for 10 years with no cap on cumulative amount drawn

Source: CPI analysis

dependence on state-level feed-in tariffs to bridge the viability gap, limiting the maximum cost-effectiveness under these federal policies.

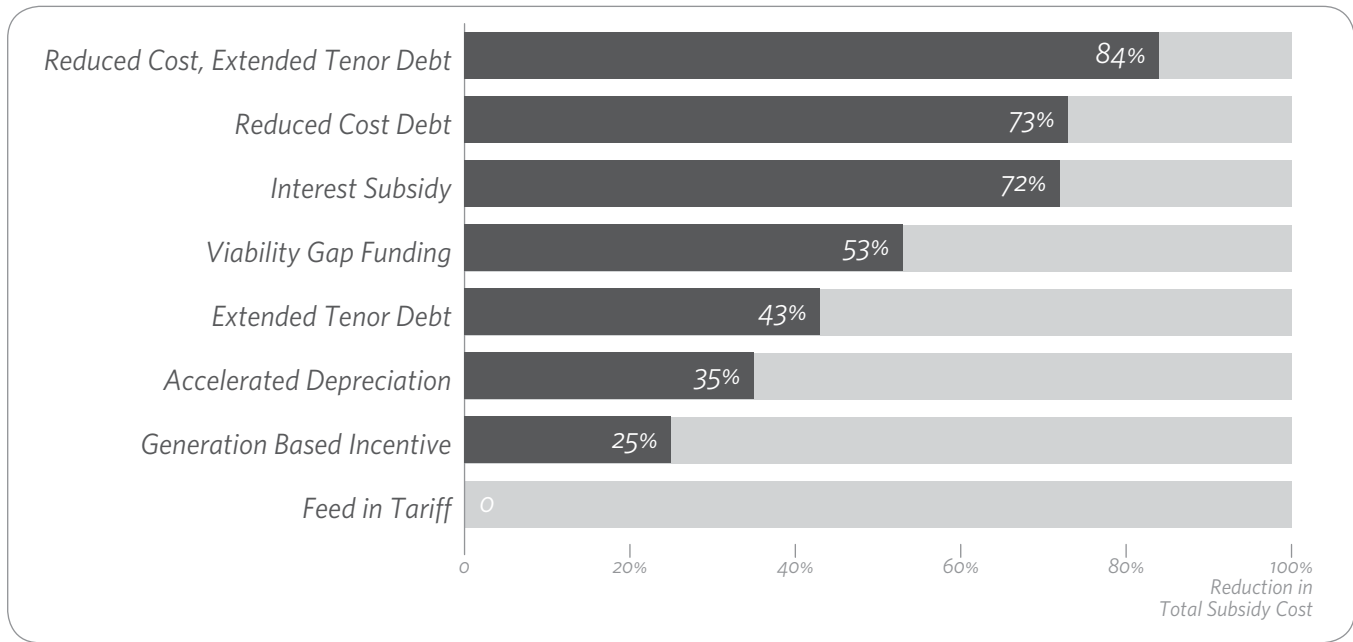### 4.1.2 Cost-Effectiveness: What is the cheapest method to support renewable energy?

Given India's ambitious renewable energy goals, the cost-effectiveness of policies becomes an important criterion for policymakers. To measure the relative cost-effectiveness of these federal policies, we use the baseline case where all the policy support is provided through state-level feed-in tariffs. The reason for doing so is explained below. Figure 4.1 shows the reduction in total subsidies with each federal policy.

Cost-effectiveness is measured by the percentage reduction in total subsidies – which we also refer to as the *value of policy* — compared to the baseline, when there is no federal policy support. For each policy, we evaluated the NPV (or value) total subsidy cash flows – which we refer to as the *total subsidies* — for the government.[10] This has three components:

1. **Federal subsidy,** which refers to the cost of the policy in question and is provided by the federal government;

2. **State subsidy,** which refers to the cost to the state government of providing the requisite level of feed-in tariff to bridge the viability gap between the subsidized LCOE and the APPC;

3. **Tax subsidy,** which measures the change in tax revenues for the exchequer after the introduction of a federal policy.

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10   The rate of discount for calculating net present value is the government's cost of borrowing: 7.83%. However, for reduced cost loan and extended-tenor debt, cash flows are discounted at 9.83%, accounting for a project default risk premium of 2% (based on conversations with project developers).

Figure 4.1: Cost-effectiveness Potential of Federal Policies (Wind Energy)

Policy	Reduction in Total Subsidy Cost
Reduced Cost, Extended Tenor Debt	84%
Reduced Cost Debt	73%
Interest Subsidy	72%
Viability Gap Funding	53%
Extended Tenor Debt	43%
Accelerated Depreciation	35%
Generation Based Incentive	25%
Feed in Tariff	0

Reduction in Total Subsidy Cost

Source: CPI Analysis

Compared to the baseline case with no federal support and only state-level feed-in tariff support, all the federal policies would be more cost-effective.

Our analysis shows that the absence of federal support – i.e., when all the support is via state-level feed-in tariffs – would be the least cost-effective federal-state policy combination and, therefore, we compare the cost-effectiveness potential of each federal policy to this as a reference case. Further, the value of any federal policy increases as it bridges more of the viability gap. Thus, each federal policy would achieve its maximum cost-effectiveness potential when it can reduce state-level support the most.

All federal policies are more cost-effective than the reference case of absence of federal support due to the phenomenon of front-loading: a feed-in tariff is provided by the state government throughout the lifetime of the project, while the federal policies are front-loaded and disbursed in the first few years of the project, creating value for the government. We discuss this phenomenon in the context of the generation based incentive below.

Even though a generation based incentive appears similar to a feed-in premium implied by a feed-in tariff, there is a major difference. A feed-in tariff is provided at a fixed value throughout the working life of a project, whereas a generation based incentive is front-loaded in the first few years (e.g., 4—10 years). Given that feed-in tariff (state-level support) cash flows are calculated on

the basis of the project cost of capital, which is much higher than the government discount rate used to calculate the value of total subsidies, it is always beneficial for the government to subsidize earlier rather than later.

Figure 4.2 compares the yearly subsidies (excluding tax subsidy) for the federal government under the generation based incentive and the state government's feed-in premium at 100% viability gap coverage. The generation based incentive, a front-loaded policy, achieves the APPC of INR 3.5/kWh (i.e., no state-level support) with a lower total subsidy compared to the case where all the policy support is through state-level feed-in tariffs. Similarly, viability gap funding, the most front-loaded policy, is cost-effective compared to the generation based incentive.

For the policymaker, front-loading presents a trade-off between cost-effectiveness and incentivizing production. A completely front-loaded federal policy like viability gap funding ranks high in terms of cost-effectiveness, but does not provide incentives for producing power. A uniformly distributed policy like 100% support via state-level feed-in tariff is the least cost-effective policy, but provides a strong incentive for production since it is always conditional on the supply of power.

Further, actual value creation for consumers through these policies is possible only if the reduced subsidy costs are passed on to electricity prices for consumers. Therefore, there is a need for an effective project selection methodology, such as auctions, that applies

Figure 4.2: A Comparison of Generation Based Incentive with No Federal Policy Support (Wind Energy)
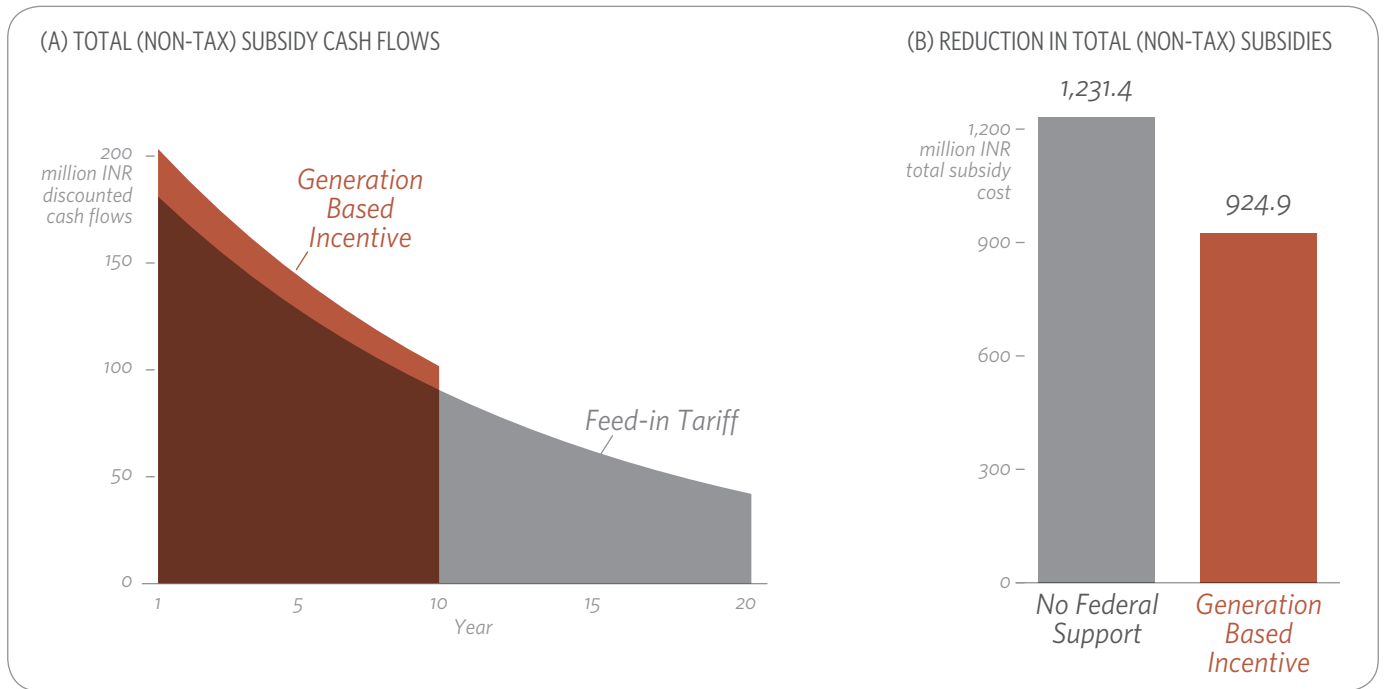
Source: CPI Analysis

downward pressure on prices. We discuss the potential of each federal policy to incentivize production in more detail in Section 4.1.4, and balancing multiple policy objectives in Section 5.

Debt-related federal policies are more cost-effective than existing federal policies.

The combination of reduced cost, extended-tenor debt is the most cost-effective federal policy. Compared to the baseline with no federal policy support, a government loan at 5.9% for 20 years not only achieves viability gap coverage (Section 4.1.1) of 100% — i.e., does not require state support — but also reduces the total subsidy by 84%.

Reduced cost debt is the second most cost-effective federal policy due to 100% viability gap coverage potential and subsidy-recovery (Section 4.1.3). A reduced cost loan at 0.6% leads to a 73% reduction in total subsidies. Interest subsidy is almost as cost-effective, reducing total subsidy by 72% with an interest subsidy of 11.7%.

Viability gap funding is the only existing policy that performs better than a debt-related policy: it is more cost-effective than extended-tenor debt due to its high viability gap coverage potential. Extended-tenor debt, on the other hand, has a high subsidy-recovery potential but a low viability gap coverage potential, leading to a high dependence on state-level feed-in tariffs. When combined with reduced cost debt, however, the viability

gap coverage potential increases to 100%, indicating that the policy combination can achieve the APPC without any state support.

Although reduced cost debt and interest subsidy appear similar, even for a given cost of debt for the project, the size of these subsidies is different due to the different reference points – 9.8% and 12.3%, respectively (Figure 4.3). For a subsidized LCOE of INR 3.5/kWh, supported via state-level feed-in tariffs, the reduced cost of debt to the developer is 0.6%. In the case of an interest subsidy, the government has to subsidize the difference between the commercial interest rate of 12.3% and the subsidized interest rate, which implies an interest subsidy of 11.7%, provided directly by the government. On the other hand, for reduced cost debt the government only has to subsidize the difference — i.e., 9.2% — between the government cost of capital of 9.8% and the final cost of debt to the developer. Thus, looking at the components of total subsidy (Section 4.1), given a lower federal subsidy and equal state and tax subsidies, the total subsidy is lower for reduced cost debt.

However, reduced cost debt involves higher capital outlay for the government relative to an interest subsidy, indicating lower budget efficiency (Section 4.2.3). Although the principal is recovered, due to the time value of money, the high capital outlay offsets the gains from the lower interest rate differential to some extent. An interest subsidy is more cost-effective than the existing subsidies due to the lower capital outlay.

Among the existing federal policies, viability gap funding is the most cost-effective, followed by accelerated depreciation and the generation based incentive.

Viability gap funding is more front-loaded than the generation based incentive and has a higher viability gap reduction potential relative to accelerated depreciation, making it the most cost-effective policy among the existing federal policies. Accelerated depreciation is more cost-effective than the generation based incentive due to subsidy-recovery and low capital outlay. At a subsidized LCOE of INR 4.6/kWh, supported by state-level feed-in tariffs, the reduction in total subsidies through 100% accelerated depreciation is 35%. A generation based incentive of INR 2.03/kWh has 100% viability gap coverage potential, but reduces total subsidies by only 25%.

However, the benefit of accelerated depreciation depends on whether it can be offset against tax revenue. In India, accelerated depreciation cannot be passed on from a special purpose vehicle to the equity investor and, therefore, is mainly useful for projects that are balance-sheet financed.[11] To fully account for the impact of this policy, we assume that this is the case, and potential corporate tax from other sources can be offset through accelerated depreciation from the renewable energy project.

4.1.3 Subsidy-Recovery Potential: How much of the budgetary allocation could the government recover over time?

Subsidy-recovery refers to the government's ability to reuse the funds allocated to a project under a particular federal policy. For example, viability gap funding is provided in the form of a grant to the project developer and cannot be recouped at a later date. The same is true for the generation based incentive and interest subsidy. In the case of reduced cost debt, however, the government recovers the principal after 10 years, making it possible to reuse this capital at a later date. Our

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11   We assume that the renewable project is balance sheet financed, i.e. it is shown on the books of the holding company (rather than being set up as a special purpose vehicle) and that the holding company has potential tax on the income from other sources, which can be offset by the accelerated depreciation generated from the project.

Figure 4.3: A Comparison of Interest Subsidy and Reduced Cost Debt
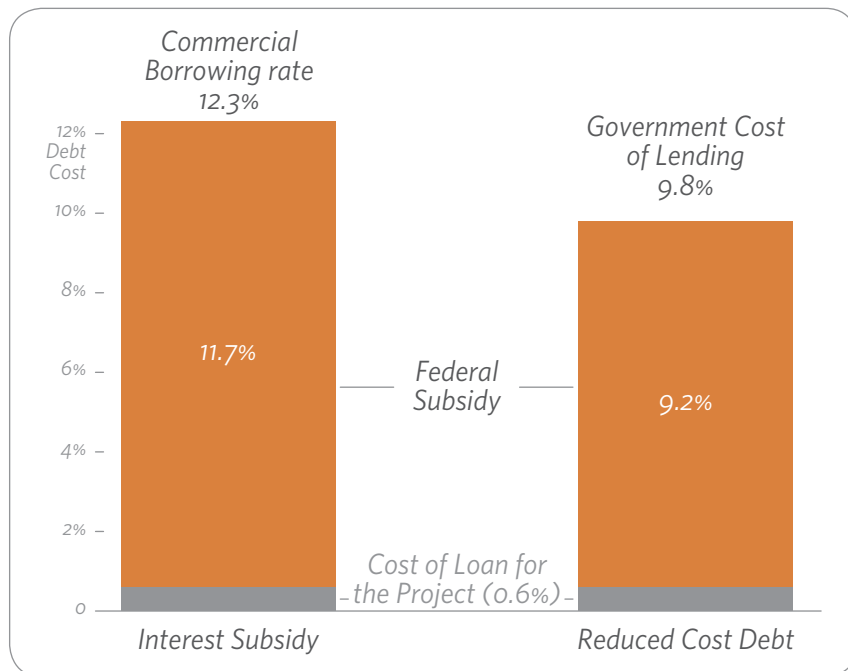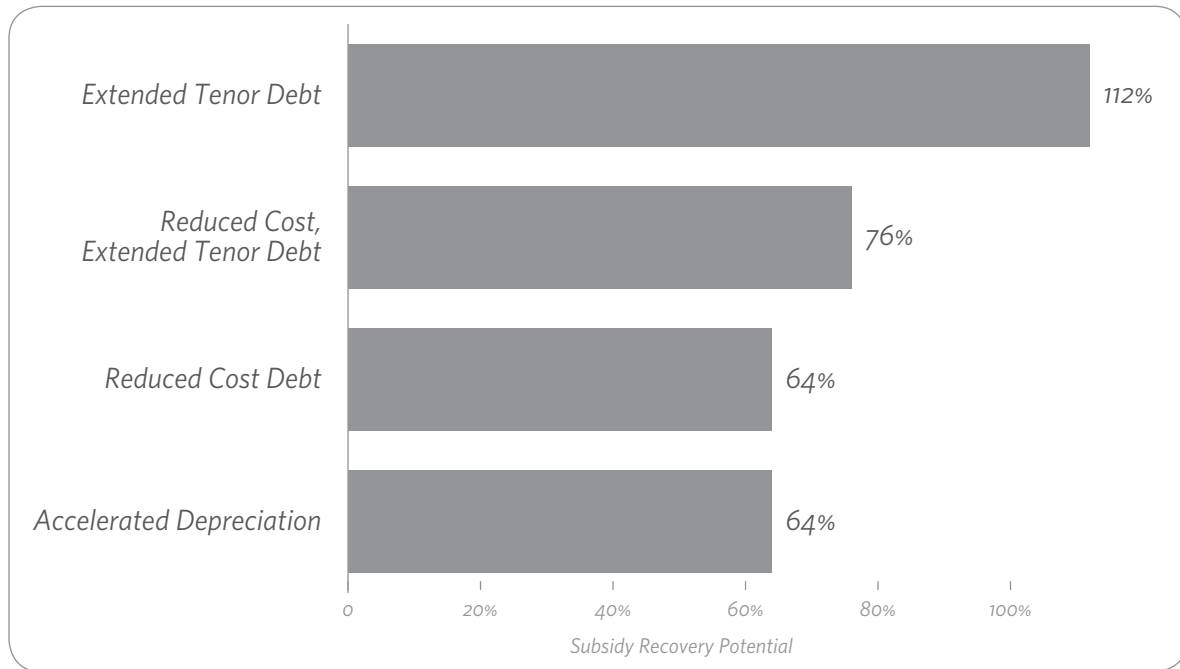

Source: CPI Analysis

analysis indicates that extended-tenor debt offers the highest potential for principal recovery. Finally, accelerated depreciation, which is a reallocation of federal tax revenues, also allows for subsidy-recovery.

Subsidy-recovery potential is calculated as the ratio of the federal subsidy cash inflows to the federal subsidy cash outflows for the case where the federal policy achieves its viability gap coverage potential. Figure 4.4 shows the level of subsidy-recovery for four federal policies. Subsidy-recovery is not possible under interest subsidy, the generation based incentive and viability gap funding, since they are provided in the form of grants from the government.

Extended-tenor debt has the highest subsidy-recovery potential.

The subsidy-recovery under extended-tenor debt is 112% — higher than 100% — primarily due to *interest-arbitrage*. The government borrows at 7.8% while on-lending the funds at the commercial lending rate of 12.3%. Accounting for a project risk premium of 2%, the government earns a margin of 2.5% — i.e., actually makes a profit on its investment — which leads to a lower federal subsidy for extended-tenor debt. This offsets the higher cost of state support (due to its low viability gap coverage potential, as discussed in Section 4.1.2) to some extent, leading to a lower total subsidy.

Figure 4.4: Subsidy-Recovery Potential for Federal Policies (Wind Energy)
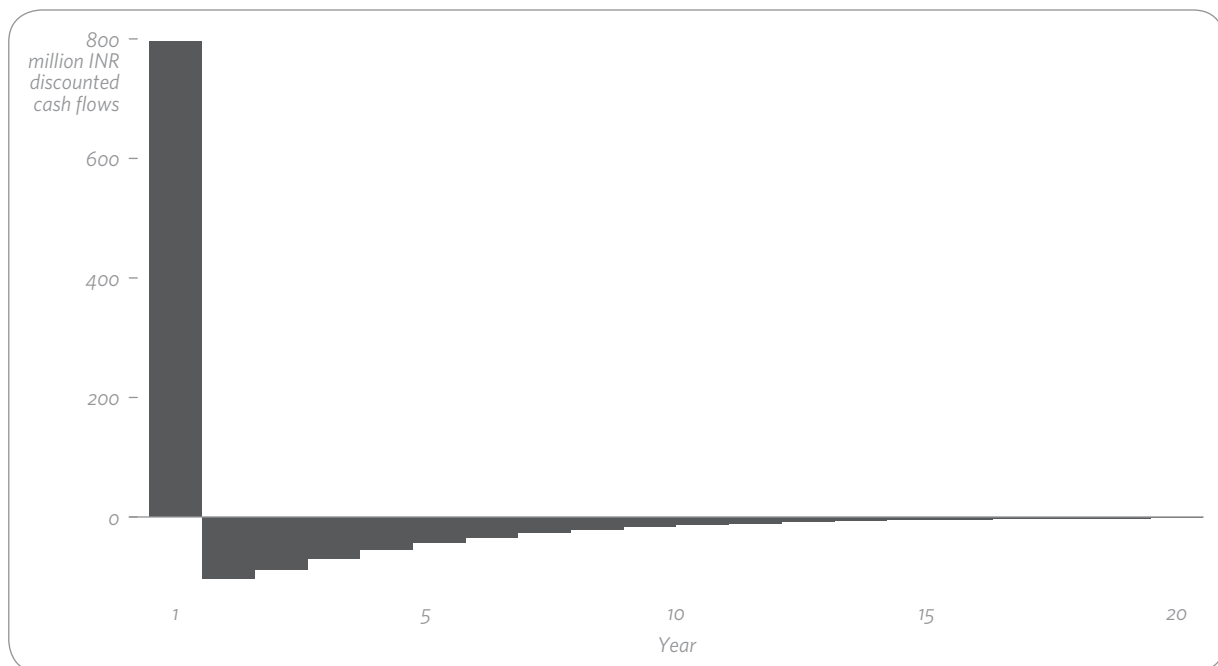

Source: CPI Analysis

Reduced cost debt, accelerated depreciation and the combination of reduced cost, extended-tenor debt have moderate subsidy-recovery potential.

With reduced cost debt, the federal government recovers 64% of the subsidy in the form of principal repayments over 10 years. The rate of interest is 0.6%, much lower than the government cost of capital of 9.8%. Although the government recovers the principal, it still loses on interest due to the implied interest subsidy, leading to a subsidy-recovery of less than 100%. Similarly, the combination of extended-tenor, reduced cost debt (at 5.9%) has a subsidy-recovery potential of 76%.

Figure 4.5 shows the federal subsidy (Section 4.1.1) cash flows with 100% accelerated depreciation. The cash flow

Figure 4.5: Federal Subsidy Yearly Cash Flows with 100% Accelerated Depreciation (Wind Energy)

Source: CPI Analysis

is positive for the developer in the first year, when the entire asset value is written off and the benefit of the federal policy is rapidly exhausted. In subsequent years, however, the subsidy cash flows are negative for the developer (and therefore, positive for the federal government) due to higher taxes, enabling the government to recover 64% of the federal subsidy.

4.1.4 Potential to Incentivize Production: Does the policy incentivize electricity production and not just capacity installation?

The structure of incentives under various renewable policies is an area of concern for federal policymakers. In new industries, capacity creation is the focus, and production incentives have relatively low uptake due to low production in the early years of the project. However, once there is adequate capacity, production takes precedence. In particular, if existing capacity is underutilized, policymakers try to create incentives for higher production. A policy that only incentivizes capacity creation can be misused, as observed in the case of accelerated depreciation (The Hindu Business Line, 2013).

In this section, therefore, we examine whether the design of the policy incentivizes the production of power. The prerequisites for accessing the benefits of a policy and the pattern of disbursement determine the incentives. Our analysis finds that the generation based incentive is the only policy that directly incentivizes production; however, debt-related policies, if designed appropriately, show potential for incentivizing production. Table 4.2 categorizes policies on the basis of their potential to incentivize production.

Among the existing federal policies, only the generation based incentive has a high potential for incentivizing production.

Since a generation based incentive is disbursed on the basis of the number of units of power supplied to

Table 4.2: Federal Policy Potential to Incentivize Production

POTENTIAL TO INCENTIVIZE PRODUCTION	FEDERAL POLICIES
High	Generation Based Incentive, Interest Subsidy
Moderate	Reduced Cost Debt, Extended-Tenor Debt, Reduced Cost Extended-Tenor Debt
Low	Accelerated Depreciation, Viability Gap Funding

Source: CPI analysis

the grid, it directly incentivizes power production. The policy design precludes the possibility of a developer installing capacity and using the policy support without producing power. Of the other existing federal policies, accelerated depreciation and viability gap funding are more likely to incentivize capacity creation, since they are not linked to power production.

The pressure to service debt creates a production incentive for debt-related subsidies.

An interest subsidy is not provided in a single period; rather it is spread out over the loan period of 10 years. Hence, it shows high potential for incentivizing production. The government would directly pay the interest subsidy to the bank, and could use the bank to apply pressure on the project. Since the project has to service debt, there is a strong incentive to produce according to expectations. It is further possible to link this policy to production by ceasing interest subsidy payments to the bank if the project does not supply power to the grid according to a pre-specified performance contract.

Reduced cost debt, extended-tenor debt and a combination of the two show moderate potential for incentivizing production. As opposed to an interest subsidy, the loan is sanctioned by the government in a single period, which reduces the potential to incentivize production. However, the need to generate cash flows for debt servicing is likely to incentivize power production. Eligibility criteria and monitoring systems for the proposed policies must be carefully designed on the basis of the desired incentive structure.

Viability gap funding shows low to moderate potential for incentivizing production.

The version of viability gap funding used in this paper is completely front-loaded, provided as a capital grant at the beginning of the project. In this form, the policy is more likely to incentivize capacity creation rather than production. However, under Phase II of the National Solar Mission, viability gap funding is provided in installments, making it possible to monitor project performance before sanctioning additional funds, thereby creating a moderate production incentive.

4.2 Effect of Federal Policies with Fixed State Support

While the previous section outlined the maximum possible benefit that each federal policy could provide, it does not compare policies against a common reference

point, which raises the question of how these policies would compare if the state-level support were fixed, a scenario that is perhaps more realistic in the current policy environment.

We now compare the performance of federal policies assuming a fixed level of state-level support through INR 5/kWh, which is the lowest possible level of subsidized LCOE, supported by state-level feed-in tariffs, that can be achieved with all of the federal policies. This essentially corresponds to the viability gap reduction potential of extended-tenor debt and accelerated depreciation. Thus, we calculate the amount of subsidy required under each federal policy to reduce the state-level feed-in tariff from INR 5.31/kWh in the absence of federal subsidies to INR 5/kWh. Table 4.3 provides a summary of the results discussed below.

Note that we do not discuss combinations of policies – in particular, reduced-cost extended-tenor debt — in this section. This is due to the fact that until the viability gap coverage potential of extended-tenor debt is reached, it is the most cost-effective policy. A state-level feed-in tariff of INR 5/kWh is within the viability gap coverage potential of extended-tenor debt.

4.2.1   Cost-Effectiveness: What is the cheapest federal policy for renewable energy given fixed state support?

Our analysis shows that extended-tenor debt is the most cost-effective federal policy, followed by reduced cost debt.

Although debt-related federal policies continue to perform better than the existing policies, there is a change in the relative performance of the policies compared to Section 4.1, where cost-effectiveness was measured at the corresponding viability gap coverage potentials, and policies with lower viability gap coverage potentials were at a disadvantage compared to policies with higher potentials. In particular, now extended-tenor debt and accelerated depreciation show much higher cost-effectiveness, while viability gap funding shows a much lower level of cost-effectiveness. Table 4.4

Table 4.3: Impact of Federal Policies at a State-level Feed-in Tariff of INR 5/kWh (Wind Energy)

POLICY TYPE	POLICY	COST-EFFECTIVENESS POTENTIAL (% REDUCTION IN SUBSIDY COST)	SUBSIDY-RECOVERY POTENTIAL	ONE-YEAR BUDGET EFFICIENCY (MW PER INR 100 MILLION)
EXISTING	Accelerated Depreciation	18%	42%	35.7
	Viability Gap Funding	9%	0%	28.6
	Generation Based Incentive	3%	0%	19.7
DEBT	Extended-Tenor Debt	30%	110%	2.5
	Reduced Cost Debt	20%	98%	2.6
	Interest Subsidy	12%	0%	36.9
BASELINE	Zero Federal Support	0%	0%	2.6

Source: CPI analysis

explores sources of relative cost-effectiveness in the absence of the viability gap coverage effect.[12]

Debt-related federal policies are more cost-effective than existing federal policies.

Debt-related federal policies continue to be more cost-effective relative to the existing federal policies. Extended-tenor debt for 15 years reduces total subsidies by 30%, primarily due to the effect of interest-arbitrage (see Section 4.1.3). The government actually has *positive* cash flows – i.e., it is making a profit – from the provision of the subsidy since its cost of capital is lower than the rate of lending.

A reduced cost loan at 9.8% reduces the total subsidies by 20%. Reduced cost debt is cost-effective due to subsidy-recovery (Section 4.1.3) and the *higher-leverage effect*. Since we assume that the level of debt in the project is optimized, a decrease in the cost of debt reduces the cash flows required for debt servicing, making it possible to use a higher level of leverage while allowing for the servicing of debt. The substitution of expensive equity with reduced cost debt also improves cost-effectiveness. We discuss the impact of leverage in greater detail in Section 4.2.4.

Accelerated depreciation at 29% is more cost-effective compared to an interest subsidy of 2.5%. While there is no subsidy-recovery under interest subsidy, accelerated depreciation allows the government to recover some proportion of the subsidy through higher taxes after the asset is completely written off. Accelerated

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12   Viability gap coverage effect refers to a difference in the maximum cost-effectiveness potential of federal policies on account of a mismatch in their potential to bridge the gap between the unsubsidized LCOE and the APPC.

depreciation is also more front-loaded compared to an interest subsidy, since it is exhausted in the first 4 years, while interest subsidy is provided for 10-11 years.

Interest subsidy is cost-effective compared to viability gap funding, even though the latter is more front-loaded, due to the leverage-effect: the level of debt-leverage increases from 58% in the baseline case to 62%. This contributes significantly towards the reduction of total subsidies by 12%.

Viability gap funding and the generation based incentive lead to a reduction in total subsidies due to front-loading.

Relative to the baseline with no federal policy support, viability gap funding is cost-effective since it is completely front-loaded. Viability gap funding at 5.7% of capital cost reduces the total subsidies by 9%. A generation based incentive of INR 0.35/kWh is required for a subsidized LCOE of INR 5/kWh, supported by state-level feed-in tariffs. Since the generation based incentive is drawn within the first 10 years, it is more front-loaded than a feed-in tariff, leading to a reduction of 3% in total subsidies.

4.2.2 Subsidy-Recovery Potential: How much of the federal policy spending could the government recover over time?

Subsidy-recovery is high for extended-tenor debt and reduced cost debt, and moderate for accelerated depreciation. Due to the effect of interest-arbitrage, extended-tenor debt has the highest subsidy-recovery potential among the federal policies. 110% of the subsidy is recovered under a 15 year loan at 12.3%, indicating a net cash inflow for the government from providing the policy. Reduced cost debt at 9.8% has a subsidy-recovery potential of 98%, nearly covering the entire capital cost for the government.[13] Accelerated depreciation has a moderate subsidy-recovery potential of 42% through higher taxes in later years.

Table 4.4: Sources of Cost-effectiveness of Federal Policies

FEDERAL POLICY	COST-EFFECTIVENESS POTENTIAL (% REDUCTION IN SUBSIDY COST)	SOURCE OF COST-EFFECTIVENESS
Extended-Tenor Debt	30%	Interest-arbitrage (Section 4.1.3)
Reduced Cost Debt	20%	Subsidy-recovery (Section 4.1.3) and Higher-leverage (Section 4.2.4)
Accelerated Depreciation	18%	Front-loading (Section 4.1.2) and Subsidy-recovery (Section 4.1.3)
Interest Subsidy	12%	Higher-leverage (Section 4.2.4)
Viability Gap Funding	9%	Front-loading (Section 4.1.2)
Generation Based Incentive	3%	Front-loading (Section 4.1.2)
Zero Federal Support	0%	

Source: CPI analysis

4.2.3 One-Year Budget Efficiency: How much capacity could be funded under each policy using a fixed annual federal budget?

In our conversations with policymakers, the following question emerged as an important driver of policy choice: given a fixed annual federal budgetary allocation, how much renewable capacity could the federal government support, i.e. what is the one-year budget efficiency? We found that interest subsidy demonstrates the highest one-year budget efficiency, followed by accelerated depreciation and viability gap funding.

In our analysis, we evaluated one-year budget efficiency on the basis of the number of MW of renewable capacity that can be supported in one year using a fixed federal budget. It is computed by dividing a fixed capital investment (in this case, INR 100 million) by the federal policy capital outlay required per MW. Since the amount of state-level feed-in tariff is fixed for all federal policies, it is excluded from the calculations.

In the case of viability gap funding, the capital outlay is simply the amount of subsidy provided. For reduced cost debt and extended-tenor debt, we consider the loan amount to be the capital outlay. For interest subsidy, a generation based incentive and accelerated depreciation, we considered the federal subsidy cost (Section 4.1.2) to assess one-year budget efficiency. Since interest subsidy and the generation based incentive involve the commitment of funds for a specified

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13   Subsidy-recovery is less than 100% because the government's precise cost of capital is 9.83%, while the reduced cost debt in this example is provided at 9.80%.

Figure 4.6: One-Year Budget Efficiency of Federal Policies at a State-level Feed-in Tariff on INR 5/kWh (Wind Energy)
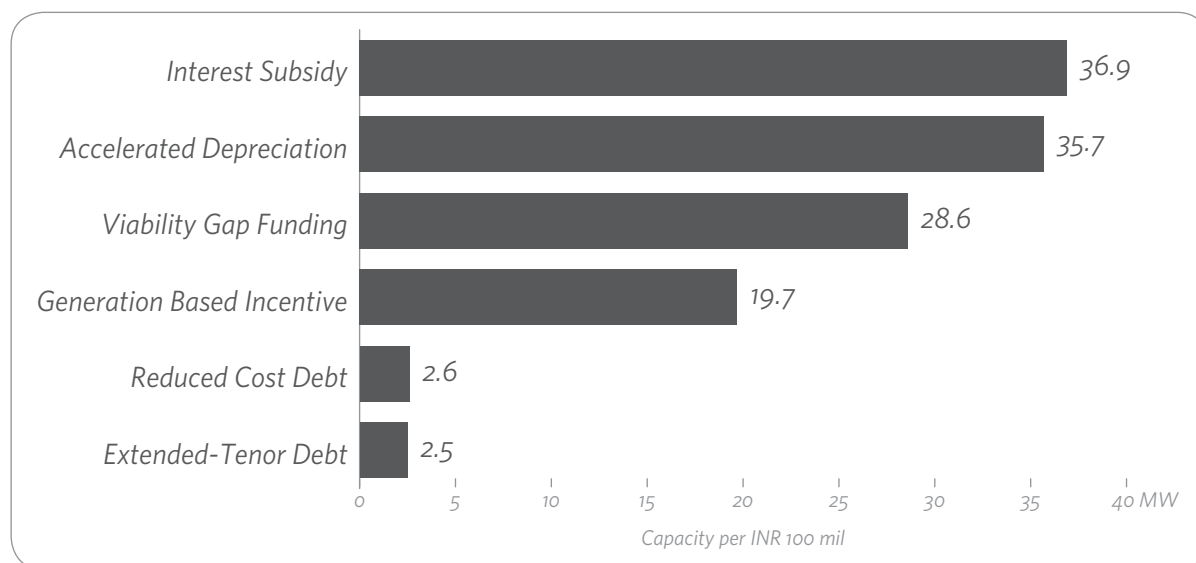
Source: CPI Analysis

period of time, this provides a realistic measure of the capital outlay required to provide policy support for the specified duration. In the case of accelerated depreciation, there is no outflow of cash from the government to the developer; rather, the tax revenue to be paid by the developer is deferred. To the extent that we seek to capture the cost of such revenue deferment to the government, the cost of federal subsidy is an accurate measure. However, this means that the one-year budget efficiency for accelerated depreciation relative to reduced cost debt and extended-tenor debt is overstated, since we have not considered the subsidy-recovery for them.

Interest subsidy, accelerated depreciation and viability gap funding allow high leverage of federal resources due to low commitment of funds.

Figure 4.6 shows that interest subsidy has the highest budget efficiency: assuming a subsidized LCOE of INR 5/kWh, supported by state-level feed-in tariffs, it is possible to support nearly 37 MW of wind capacity with INR 100 million of interest subsidy. Accelerated depreciation is nearly as efficient, and can support 96.7% of the wind capacity supported by an interest subsidy with the same capital outlay. Viability gap funding is slightly less efficient, with the potential to support 77.5% of the wind capacity supported by an interest subsidy.[14]

The generation based incentive offers moderate budget efficiency.

Due to the relatively high capital outlay under the generation based incentive, it shows moderate short-term budget efficiency. It can support 53.4% of the capacity supported under an interest subsidy.

Reduced cost debt and extended-tenor debt have the lowest budget efficiency.

Both federal policies involve a high capital outlay in the form of loan principal amounting to 58%—75% of the total capital cost of the project. The capacity creation with an allocation of INR 100 million is only about 7% of the capacity creation with an interest subsidy. Although the capital is recovered over time, in the short-term, this severely restricts capacity creation by the government.

One-year budget efficiency does not reflect long-term deployment potential.

One-year budget efficiency captures the impact of a policy only for the federal government, unlike cost-effectiveness, which considers the impact of a policy based on the total cost to the federal government, state government and the exchequer. One-year budget efficiency is a limited indicator of policy performance since it only examines capital outlay for one year. A more comprehensive measure would take a long-term consideration of capacity commitment, subsidy-recovery, and budgetary requirements. Developing a long-term indicator of capital efficiency could be an area for future research.
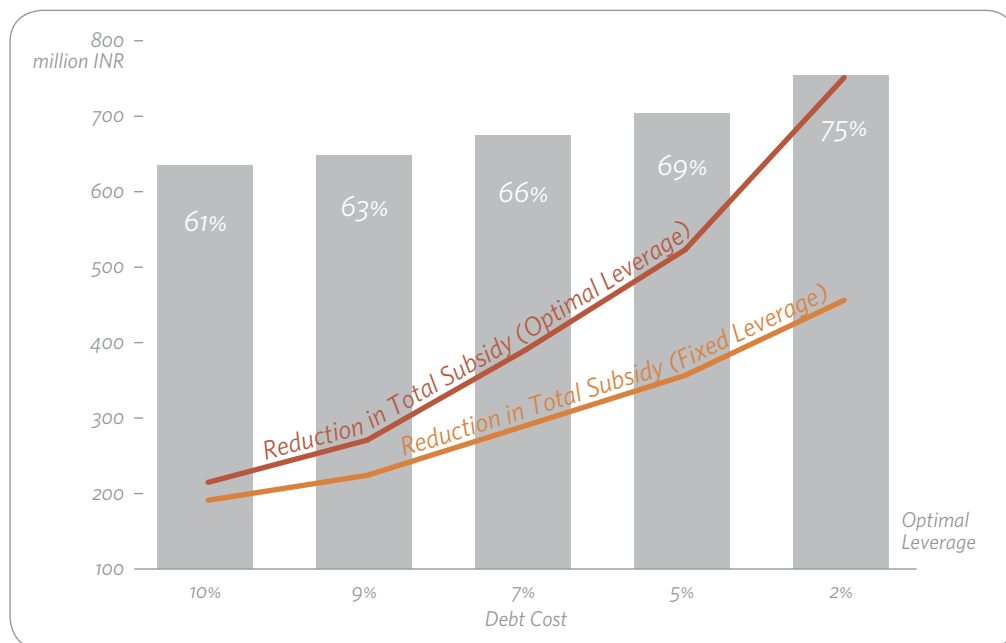
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14   One-year budget efficiency is high if the capacity creation is equivalent to 75-100% of the maximum capacity creation under a federal subsidy (i.e. 36.9 MW with an interest subsidy), moderate if capacity creation is 50-75%, low if it is between 25-50% and very low for 0-25%.

4.2.4 Are debt subsidies cost-effective with fixed leverage of 60%?

So far, we have assessed the impact of the federal policies assuming that projects optimize debt-leverage, i.e. the amount of leverage increases as the cost of debt falls. As a reference case, we now assess the impact of policies on cost-effectiveness, assuming the level of debt in the project to be fixed at 60%, and compare it with the optimized leverage model. The rationale for examining the fixed leverage example is to eliminate the effect of *equity substitution* (see below) – by holding the level of debt-leverage for the project fixed, we ensure that the impact of the policy is not distorted by excess gains from equity substitution. We restrict the analysis to debt-related subsidies in this subsection since the existing subsidies have a much lower impact on leverage.[15]

Figure 4.7: Effect of Leverage for Reduced Cost Loans

Source: CPI Analysis

Debt-related policies lead to equity substitution in the presence of optimized debt.

The reduction in the cost of debt is the direct impact of a debt-related policy, where commercial debt is replaced with subsidized debt. Further, the lower cost of debt reduces the cash outflows for debt servicing, making it possible to assume a higher level of debt-leverage. In this case, since the expected return on equity is 17.9%, expensive equity is substituted with subsidized debt (equity substitution), which further reduces the cost of capital. Therefore, we observe a much higher reduction in total subsidy with optimized leverage compared to the fixed leverage case.

Debt-related policies continue to be more cost-effective than existing policies even with fixed leverage, but the benefit of policy is much lower.

This means that the reduction in total subsidies with optimized leverage is not entirely the result of equity substitution. In the case of reduced cost debt, given that the federal subsidy is only provided for the first 10 years of the project, front-loading also plays a role.[16] Figure 4.7 illustrates the difference in total subsidy reduction under the two types of leverage for reduced cost debt: for a low interest loan at 10%, the benefit of policy with fixed leverage is INR 191.1 million against INR 214.8 million with optimized leverage. As the subsidy amount increases, so does the level of optimized debt, leading to a wider difference in the reduction of total subsidies. We observe similar trends for interest subsidy and extended-tenor debt.

The leverage-effect significantly contributes to the reduction in total subsidies for debt-related policies.

Consider an interest subsidy of 3% for wind energy. The debt-leverage in the baseline case with no federal policy support is 58% and the unsubsidized LCOE is

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15   An increase in generation based incentive leads to a small increase in leverage, while an increase in viability gap funding causes a gradual decrease in leverage by reducing the need for debt. Accelerated depreciation does not impact leverage, since it affects equity rather than debt.

16   For the baseline case with no federal policy support, the state-level feed-in tariff is INR 5.25 with fixed leverage compared to INR 5.31 with optimized leverage. Due to this difference in the state-level feed-in tariffs, we consider the reduction in total subsidies in absolute terms rather than percentages.

INR 5.31/kWh. Holding leverage fixed at this level, an interest subsidy of 3% leads to a subsidized LCOE of INR 5.03/kWh, supported by state-level feed-in tariffs, and reduces total subsidies by 5.2%. Since leverage is fixed, this reduction in total subsidies can be attributed the fact that an interest subsidy is more front-loaded than any support provided via feed-in tariffs.

However, starting with the baseline case, if we provide an interest subsidy of 3% assuming optimized leverage, the reduction in total subsidies is 14.6%, corresponding to a subsidized LCOE of INR 4.94/kWh. The reduction in total subsidies with optimized leverage is 9.4% higher than the fixed leverage case – this difference can be attributed to the leverage-effect.

It should be noted that the above example is an illustration of the importance of the leverage-effect. The actual impact of the leverage-effect for each policy would vary depending on the amount of subsidy.

4.3 How are the results for solar different from those for wind?

Our analysis shows that the results for solar energy are quite similar to those for wind energy. In this section, we highlight and discuss key differences in the results. The figure below provides an overview of the effectiveness of different policies for solar energy.

We see that the main differences from the results for wind energy are in terms of cost-effectiveness and viability gap coverage potential. We discuss these in greater detail below.
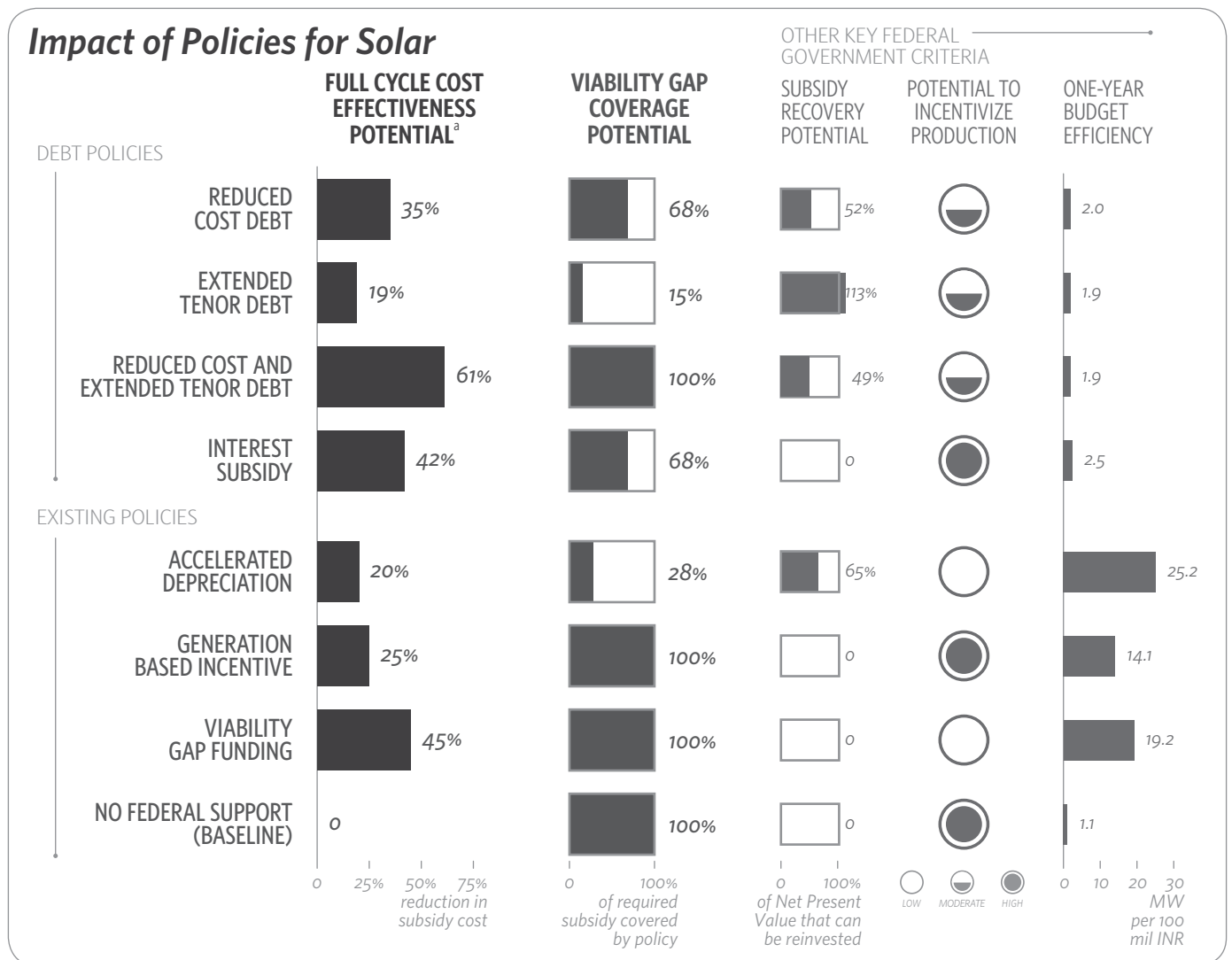
Impact of Policies for Solar

a   Full cycle cost effectiveness potential is measured over the full life cycle of the project.

4.3.1 Viability Gap Coverage Potential: To what extent can the federal government support solar energy in the absence of state support?

Viability gap funding and generation based incentive have 100% viability gap coverage potential.

While combinations of federal policies are able to achieve 100% viability gap coverage, among the individual policies, a generation based incentive of INR 5.17/kWh and viability gap funding at 56.3% of capital cost are the only policies that can achieve the APPC in the absence of state-level support.

Interest subsidy and reduced cost debt have moderate viability gap coverage potential.

An interest subsidy of 12.25% and reduced cost debt at 0.05%, both have an identical viability gap coverage potential of 68% at a subsidized LCOE of INR 4.94/kWh, supported by state-level feed-in tariffs. This is in contrast to the wind case, where both policies have 100% viability gap coverage. The lower viability gap coverage potential limits their cost-effectiveness potential: the corresponding reduction in total subsidies is 35% for reduced cost debt and 42% for interest subsidy.

4.3.2 Cost-effectiveness potential: What is the cheapest way to support solar energy?

The reduction in total subsidies is lower for solar energy compared to wind due to higher capital costs.

The effects of the policies on cost-effectiveness are less pronounced due to the high capital cost. The state-level feed-in tariff for the baseline case with no federal support – i.e., the unsubsidized LCOE — is INR 8.02/kWh for solar energy, much higher than INR 5.31/kWh for wind, primarily due to the difference in capital costs (INR 80 million per MW for solar against INR 61.6 million per MW for wind). Therefore, even after the introduction of a federal policy, the dependence on state support continues to be high due to the large viability gap between the unsubsidized LCOE and the APPC.

The combination of reduced cost and extended-tenor debt continues to be the most cost-effective policy, followed by the combination of accelerated depreciation and viability gap funding.

A reduced cost, extended-tenor debt at 1.21% for 21 years leads to a reduction in total subsidies of 61%. We also considered the combination of accelerated depreciation and viability gap funding, since it is available for projects under the National Solar Mission. We found that the combination of 100% accelerated depreciation with 49% viability gap funding is the second most cost-effective federal policy, reducing total subsidies by 47%. However, this combination has a relatively low potential for incentivizing production, given that neither of these policies are linked to production.

Viability gap funding is more cost-effective than individual debt-related policies due to its high viability gap coverage potential.

Viability gap funding at 56.3% of capital cost reduces total subsidies by 45%. Due to its high viability gap coverage potential, viability gap funding performs better than other debt-related subsidies, which continue to require high state-level feed-in tariffs, since the difference between the unsubsidized LCOE and the APPC is much higher for solar energy compared to wind.

4.3.3 Cost-effectiveness with fixed state support: Given a fixed state-level feed-in tariff of INR 7.5/kWh, which policy is the most cost-effective?

Table 4.5 shows that for a fixed state-level feed-in tariff, the results for solar energy are similar to wind, although the reduction in subsidy cost and one-year budget efficiency are much lower due to the high capital cost.

Accelerated depreciation is more cost-effective than reduced cost debt for solar energy.

The case of solar power differs from the case of wind power in one major way. Accelerated depreciation is marginally more cost-effective than reduced cost debt for solar energy. At a fixed subsidized LCOE of INR 7.5/kWh, supported by state-level feed-in tariffs, the required cost of debt for the project is 9.6%, which is lower than the government's cost of capital of 9.8% and, therefore, the government does not get the advantage of interest-arbitrage. The subsidy-recovery potential for reduced cost debt is 52%, compared to 64% for wind

Table 4.5: Impact of Federal Policies at a State-level Feed-in Tariff of INR 7.5/kWh (Solar Energy)

FEDERAL POLICY TYPE	FEDERAL POLICY	COST-EFFECTIVENESS POTENTIAL (% REDUCTION IN SUBSIDY COST)	SUBSIDY-RECOVERY POTENTIAL	ONE-YEAR BUDGET EFFICIENCY (MW PER INR 100 MILLION)
EXISTING	Accelerated Depreciation	13%	45%	25.2
	Viability Gap Funding	5%	0%	19.2
	Generation Based Incentive	2%	0%	14.1
DEBT	Extended-Tenor Debt	17%	111%	1.9
	Reduced Cost Debt	11%	97%	2
	Interest Subsidy	7%	0%	25
BASELINE	Zero Federal Support	0%	0%	1.1

Source: CPI analysis

energy. Accelerated depreciation, on the other hand, performs well due to the subsidy-recovery through higher taxes. However, at 2%, the difference in cost-effectiveness of the two subsidies is not very large.

Figure 4.8 shows that the ranking of the remaining policies remains unchanged, but their cost-effectiveness is much lower for solar energy due to the high level of state support even after the introduction of federal policies. This also lowers one-year budget efficiency since the capital outlay per MW for each policy is much higher.

4.4 Comparisons of Existing Federal Policies at Current Support Levels with Alternative Policies

As discussed in Section 2, there are three federal policies currently offered for renewable energy projects in India – a generation based incentive of INR 0.5/kWh for wind energy subject to a maximum cumulative payout of INR 10 million per MW, accelerated depreciation of 80% for solar energy and viability gap funding up to 30% of capital cost for solar energy. A combination of accelerated depreciation and viability gap funding may also be used. In this section, we examine "equivalent" federal policy alternatives that are more attractive than the

existing policies at their current support levels, while requiring the corresponding existing state-level supports.

For wind energy, extended-tenor debt is more cost-effective but has lower one-year budget efficiency compared to the generation based incentive at its current support level of INR 0.5/kWh.

For the existing (capped) generation based incentive of INR 0.5/kWh, the corresponding state-level feed-in tariff (i.e., subsidized LCOE) is INR 4.9/kWh, compared to INR 5.31/kWh in the baseline case. This is within the viability gap coverage potential of extended-tenor debt, which would be the most cost-effective federal policy.

Holding the state-level feed-in tariff fixed at INR 4.9/kWh, we find that an extended-tenor debt for 18 years reduces the total subsidy cost by 35% compared to the generation based incentive. Extended-tenor debt also has a subsidy-recovery potential exceeding 100%, while there is no subsidy-recovery under the generation based incentive.

An advantage offered by the generation based incentive is its high potential to incentivize production. However, with appropriate policy design, extended-tenor debt could also be designed to incentivize production

Figure 4.8: Reduction in Total Subsidies at a State-level Feed-in Tariff of INR 7.5/kWH (Solar Energy)
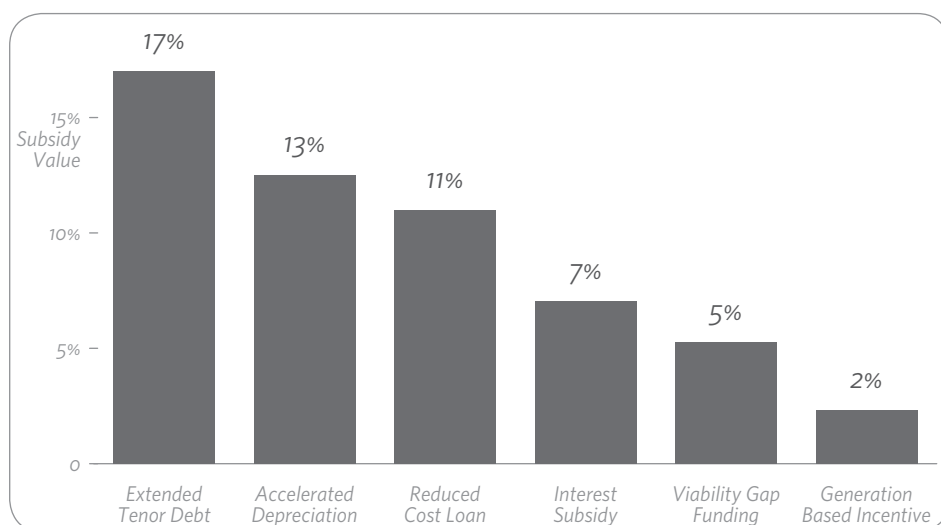
Source: CPI Analysis

through the pressure of debt-servicing. In the long-term, therefore, extended-tenor debt is clearly a better policy than the generation based incentive.

However, extended-tenor debt has much lower one-year budget efficiency: capacity creation is 83% lower. Although one-year budget efficiency does not indicate long-term policy performance, due to its high capital outlay, extended-tenor debt may not be a suitable policy alternative to the generation based incentive in the short-run.

For wind energy, interest subsidy and accelerated depreciation are better short-term policy alternatives compared to the existing generation based incentive.

We find that an interest subsidy of 3.4% or an accelerated depreciation of 38% achieves the same state-level support – i.e., INR 4.9/kWh – as the generation based incentive at the current support level of INR 0.5/kWh.

An interest subsidy of 3.4% is 11% more cost-effective and can support 83% more deployment compared to the existing generation based incentive. Further, with appropriate design, an interest subsidy shows high potential for incentivizing production. Hence, an interest subsidy performs better than the generation based incentive across all criteria and is clearly a better policy due to its higher cost-effectiveness and one-year budget efficiency.

For the same level of state subsidy, accelerated depreciation at 38% is 17% more cost-effective than the existing generation based incentive of INR 0.5/kWh. At 27.2 MW of capacity per INR 100 million, this level of accelerated depreciation can support nearly twice the capacity that can be supported with the generation based incentive at the current support level. Therefore, in the short-term, accelerated depreciation is a more efficient alternative to the generation based incentive with the potential to support higher capacity at a lower cost.

For solar energy, debt-related federal policies are more effective than the current viability gap funding with a support level of 30% in the long-term as well as the short-term.

Viability gap funding at 30% leads to a steep reduction in the state-level feed-in tariff, from INR 8.02/kWh in the baseline case with no federal policy support to INR 5.6/kWh. Extended-tenor debt cannot achieve such a large reduction in feed-in tariffs.

The combination of extended-tenor, reduced cost debt – a loan at 6.6% with a tenor increase of 10 years – is equivalent to the viability gap funding of 30% and reduces total subsidies by 18%. In the long-term, viability gap funding is less cost-effective compared to debt-related federal policies (Section 4.2) since it has a low leverage-effect and no subsidy-recovery potential. Therefore, reduced cost, extended-tenor debt is a better policy alternative in the long-term.

However, the one-year budget efficiency with reduced cost, extended-tenor debt is 60% lower compared to the viability gap funding at its current support level of 30%, making it less attractive in the short-term.

But, an interest subsidy of 10.2% can achieve a state-level feed-in tariff of INR 5.6/kWh. Further, an interest subsidy is 11% more cost-effective and supports 30% more deployment compared to 30% viability gap funding. Therefore, since they would enable the government to deploy its resources more effectively, there is a strong case for exploring debt-related policy alternatives to viability gap funding.

Accelerated depreciation is more cost-effective than viability gap funding.

It is also instructive to compare the two existing policies for solar energy – accelerated depreciation and viability gap funding. Since accelerated depreciation has a limited viability gap coverage potential, the state-level feed-in tariff of INR 5.6/kWh cannot be attained using accelerated depreciation as an individual federal policy. The accelerated depreciation at its current level of 80% achieves a state-level feed-in tariff of INR 7.02/kWh and is equivalent to a viability gap funding of 12.4%. This equivalent accelerated depreciation is 10% more cost-effective and supports 44% more deployment compared to 12.4% viability gap funding. Thus, in the short-term, accelerated depreciation is the most effective policy among the existing policies along all parameters except the potential to incentivize production. There is a need to investigate the design of the policy in greater detail to create stronger production incentives.

The combination of reduced cost debt and accelerated depreciation is more effective than the existing combination of accelerated depreciation with viability gap funding.

The existing combination of 80% accelerated depreciation and 30% viability gap funding reduces the state-level feed-in tariff from INR 8.02/kWh in the baseline case to INR 4.9/kWh. This provides the same

level of state-level support as the combination of 80% accelerated depreciation with reduced cost debt at 2%. Compared to the combination with viability gap funding, the combination of accelerated depreciation and reduced cost loan reduces total subsidies by 27%, and has a subsidy-recovery potential of 61% as compared to 10% for the combination of 80% accelerated depreciation with 30% viability gap funding. However, accelerated depreciation with viability gap funding has 27% higher short-term budget efficiency.

Accelerated depreciation is a cost-effective policy, but limited in its overall potential to reduce total subsidies due to its low viability gap coverage potential. Reduced cost debt has moderate viability gap potential, is more cost-effective than viability gap funding and has higher subsidy-recovery potential. While the combination of reduced cost, extended-tenor debt is clearly the most cost-effective policy in the long-term, replacing viability gap funding with reduced cost debt in the existing policy mix with accelerated depreciation would be the next best alternative, and should be explored further.

5. Conclusions

Our analysis shows that there is no single policy that performs better than the others on all parameters: reduced cost, extended-tenor debt is the most cost-effective policy; interest subsidy makes the most efficient use of capital; subsidy-recovery potential is highest for extended-tenor debt; interest subsidy and generation based incentive show the maximum potential to incentivize production; and reduced cost, extended-tenor debt, viability gap funding, and uncapped generation based incentive show the highest viability gap coverage potential.

In general, debt-related policies are more cost-effective than the existing policies and can be designed to meet the objectives of capacity creation or generation. However, policymakers are often required to make decisions by balancing multiple objectives rather than comparing on a single metric. In particular, among the criteria examined in this paper, policymakers would face a tradeoff between cost-effectiveness and the potential to incentivize production.

Front-loaded policies are clearly more cost-effective than those policies that provide a uniform level of policy support throughout the project life. However, front-loaded policies, such as accelerated depreciation, are less likely to incentivize production, given that their benefits are exhausted earlier in the project lifetime.

Complete support via state-level feed-in tariffs (i.e., in absence of federal support), on the other hand, is the least cost-effective policy, but has the highest potential to incentivize production, given that it is conditional on the supply of power to the grid for the entire duration of the project.

Policymakers are also likely to prioritize different criteria in the short-term and the long-term. For example, one-year budget efficiency is an indicator of short-term policy performance, while subsidy-recovery is only relevant in the long-term. So the question remains: how do we make policy decisions?

Long-term policy implications: Reduced cost, extended-tenor debt is an attractive policy

We believe that, in the long-term, a combination of reduced cost debt and extended-tenor debt is a very attractive policy for both wind and solar energy. This combination is clearly the best policy if cost-effectiveness and subsidy-recovery are the most important objectives for decision-making. For example, compared to the baseline of unsubsidized LCOE, a reduction of 3% in the cost of debt and an increase in tenor of 10 years reduces the total subsidy burden by 29-61%. This combination also performs well along the criterion of viability gap coverage potential and shows moderate potential to incentivize production.

By providing low-cost, long-term loans, the federal government's resources can be deployed effectively while reducing the need for state support. Since the government can mobilize funds at a lower cost compared to private developers due to its much higher credit (i.e., AAA) rating, it is possible to pass on the benefit of this borrowing capacity to renewable project developers at a relatively low cost compared to the existing policy mechanisms.

Though this combination appears to do less well in terms of one-year budget efficiency, in the long-term, its performance would improve considerably due to subsidy-recovery. Thus, it can be argued that one-year budget efficiency is not indicative of long-term policy performance. We plan to investigate long-term capital efficiency in future work.

Short-term policy implications: Interest subsidy and accelerated depreciation hold promise

In the short-term, there are a number of alternative policy options for the federal government. In particular,

interest subsidy and accelerated depreciation are more attractive than the existing capped generation based incentive at its current support level of INR 0.5/kWh for wind energy and the viability gap funding at its current support level of 30% for solar energy across most criteria.

Interest Subsidy:

- Wind: An interest subsidy outperforms the existing (capped) generation based incentive across all criteria. It is approximately 1.8 times as efficient in its use of capital, significantly more cost-effective, and has much higher viability gap coverage potential. For example, for the same state-level support, an interest subsidy of 3.4% is equivalent to the existing generation based incentive of INR 0.5/kWh; and, compared to this generation based incentive, would result in a total subsidy reduction of 11% and would support 83% more deployment.

- Solar: For the same state-level support, an interest subsidy of 10.2% is equivalent to a viability gap funding of 30%; and, compared to this viability gap funding, would result in a total subsidy reduction of 11% and would support 30% more deployment.

In general, an interest subsidy is an attractive policy since it directly addresses the lack of availability of low cost, long-term debt with a relatively low capital outlay by the government. It has high a potential for incentivizing production and a moderate potential for viability gap coverage. The only potential drawback is that subsidy-recovery is not possible; however, since the capital outlay is not very large, this may eventually not be a major issue.

Accelerated Depreciation:

- Wind: For the same state-level support, an accelerated depreciation of 38% — i.e., less than the typical 80% — is equivalent to a generation based incentive of INR 0.5/kWh; and, compared to the existing generation based incentive, would result in a total subsidy reduction of 17% and would support 87% more wind power.

- Solar: For the same state-level support, an accelerated depreciation of 80% is equivalent to a viability gap funding of 12.4%; and, compared to the viability gap funding, would result in a total subsidy reduction of 10% and would

support 44% more deployment. Though both of these are existing policies, the comparison is instructive given that it is not easy for independent power producers to avail of accelerated depreciation.

In the short-term, although accelerated depreciation is clearly the most cost-effective among the existing policies, it has been opposed as a policy mechanism because it encourages the setting up of a plant to yield tax benefits without incentivizing energy production. However, from the government's perspective, it is also one of the easiest policies to manage since it requires no cash disbursement. There is no direct capital invested by the government and the reduction in tax revenue is partly recovered in later years. Its advantages as a policy may eventually outweigh its drawbacks.

The only advantage that the existing generation based incentive offers over interest subsidy and accelerated depreciation is that it has the highest potential for incentivizing production. However, all the proposed debt-related policies, which include interest subsidy, if designed appropriately, show potential for incentivizing production.

In the case of accelerated depreciation, we recommend modifying the design of the policy or combining it with debt-related policies that could improve the incentive to produce through the pressure of debt-servicing. For example, for solar energy, for the same state-level support of INR 4.9/kWh, the combination of 80% accelerated depreciation with reduced cost debt at 2% reduces total subsidies by 27% compared to the existing policy combination of 80% accelerated depreciation and 30% viability gap funding. Furthermore, the combination of accelerated depreciation with reduced cost debt would have a moderate potential for incentivizing production, enabling the policymaker to improve cost-effectiveness without compromising on incentivizing production.

The advantage that viability gap funding offers over interest subsidy and accelerated depreciation is that it has the highest potential for standalone support of renewable energy, without state support. However, it can be argued that, given that electricity is a concurrent subject (concerning both, the federal and the state governments), in the long-run, a sustainable policy would include both federal and state support; and, therefore, viability gap reduction up to a certain level – e.g., equivalent to an 80% accelerated depreciation, which has a viability gap coverage of 27% – is what should be required of federal policies.

To summarize, if the policymakers' priority is to identify a policy mechanism that ensures capital efficiency, interest subsidy performs the best. However, if the government is interested in upfront cash disbursement rather than a long-term commitment to subsidizing a project, accelerated depreciation is more cost-effective and more capital efficient.

FUTURE RESEARCH

Our future work is likely to focus on the design of debt-related policies to ensure alignment with policy objectives. In particular, we may examine how debt-related policies can be designed to ensure that they incentivize production rather than capacity. We also recommend exploring financial instruments through which such policies could be made available – preliminary qualitative research in this regard has already been conducted (Shrimali et al, 2014).

Although all the policies discussed in this paper are cost-effective compared to the baseline case of no federal support, the benefits can be realized only if they translate to lower electricity prices for consumers. Therefore, an appropriate project selection methodology that applies price pressure on the developers is required. In this regard, it is important to explore the role of auctions in price discovery and suitable mechanism design to avoid non-serious bids.

Other aspects of existing policies also need to be explored in greater detail. Accelerated depreciation clearly offers a number of advantages, but has been regarded unfavorably on account of the incentives being skewed towards capacity addition and the potential for misuse of the policy. Further research is required to design the policy better to improve the incentive structure.

Furthermore, refining our estimates of the government's cost of lending to account for transaction costs and risk to arrive at a more accurate estimate of policy cost is a potential area for future research. Lastly, there is a need to develop a comprehensive, long-term measure of capital efficiency accounting for capital recovery.

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Appendix

Methodology and assumptions

We developed project cash flow models to examine impact of policy pathways on the key financial metric: the levelized cost of electricity (LCOE). The inputs required were the project-related costs, revenues, and financing characteristics.

Base model: The basic idea is as follows. Given the project financial parameters, we calculated the "minimum revenue" (i.e., LCOE) that the developer would need to meet the ROE objective. We assume that, given fixed return on equity (ROE) and debt-rate, a rational developer would attempt to maximize leverage so as to minimize the cost of capital. Leverage is optimized so that the debt service coverage ratio (DSCR) condition is met throughout the project.

The model uses our best estimates of future cash flows for the lifetime of the project, considering the prevailing capital investment tax laws and depreciation schedules. For example, the income tax calculations are based on prevailing tax laws in India, with the 10-year tax holiday for renewable energy projects. Financial parameters (such as ROE, debt-rate, debt-tenor) were collected on the basis of a sample of representative projects from the Bloomberg New Energy Finance database. Other project information such as expenditures (capital, operations & maintenance costs) as well as other sources of revenue (e.g., CER revenue) was collected through detailed interviews with developers. Any missing information was either collected via secondary research or via generic project-level information used by the Central Electricity Regulatory Commission (CERC).

Finally, given that there is inherent variability in renewable energy generation due to intermittency of underlying sources, we use two different plant load factors (PLFs) in our analysis. For calculating ROE, the P50 PLF is used, given that it represents the most probable output of the plant. However, for calculating leverage, the P90 PLF is used, as required by banks.

LCOE Calculation

The algorithm used for calculating the LCOE uses an iterative optimization procedure for arriving at the Power Purchase Agreement (PPA) price (or LCOE).

1. We start with a reasonable (high) value of LCOE.

2. Given the LCOE, the leverage is maximized while ensuring that the DSCR requirements are met.

3. Given the leverage, the LCOE is adjusted so that the ROE requirement is met.

4. If the solution doesn't converge, the process in 2-3 is repeated.

This process is guaranteed to converge. The result is the optimized LCOE, where the twin conditions of maximizing leverage while meeting ROE are satisfied.

NPV Calculations

To assess cost-effectiveness, we estimated the net present value (NPV) of the total subsidy (federal subsidy, state subsidy and tax subsidy) to the government. As value of policy, we define the percentage reduction in the NPV of total subsidy to the government, compared to the baseline where no federal support is provided.

The rate of discount for all subsidy cash flows is equivalent to the government's cost of borrowing, which is 7.83%. However, in our conversations with developers, it emerged that the project default risk premium for renewable projects is typically 2%. Therefore, in the case of extended-tenor debt and reduced cost loan, the NPV of instrument subsidy was calculated using a discount rate of 9.83%, including the 2% project risk premium.[17]

Limitations

The most crucial limitation of our cash flow analysis is that the actual PPA price for the project may be different from the LCOE derived by our model. This may be due to many the actual (or realized) ROE from the project being different from the stated ROE (or hurdle rate) by the developer; or because we used generic data based on CERC data when project-level data was unavailable.

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17   Value at risk calculations typically account for project risk within the cash flow models. However, the impact of project risk on NPV varies significantly with changes in the rate of interest and tenor of the loan. For example, the impact of the inclusion of project risk on NPV for a 12 year loan would be INR 150 million against INR 300 million in the case of a 20 year loan. To ensure that the NPV correctly reflects the variation in project risk for in each case, we assumed a higher discount rate, thereby accounting for project risk when discounting cash flows from the loan.

Glossary

Average Pooled Purchase Cost (APPC): The weighted average pooled price at which the power distribution companies purchased electricity in the previous year from all energy suppliers, except renewable energy sources.

Equity substitution: Substitution of high cost equity with low cost debt, leading to a higher reduction in total subsidies.

Existing federal policies: The federal government's policies for renewable energy, viz. accelerated depreciation, generation based incentive and viability gap funding.

Federally administered debt-related policies: Proposed policy support mechanisms that would directly reduce the cost of debt for renewable energy projects, viz. extended-tenor debt, reduced cost debt and interest subsidy.

Feed-in premium: An implicit subsidy from the state government under state-level feed-in tariffs, equivalent to the difference between the feed-in tariff and the average pooled purchase cost of electricity.

Front-loading: The allocation of a higher proportion of the subsidy at the beginning of the project.

Interest-arbitrage: When the government profits from lending at a rate of interest higher than its own cost of capital.

Levelized cost of electricity (LCOE): The average cost of electricity that helps to break even in terms of the return expected by developer. It represents the minimum unit revenue required to meet the return on equity, given the project's financial parameters.

Leverage-effect: A reduction in the total subsidy cost due to an increase in the amount of leverage in the project.

One-year budget efficiency: The amount of capacity that could be funded under a federal policy in one year using a fixed budgetary allocation.

Subsidized LCOE: The cost of renewable energy with federal policy support, eventually supported via state-level feed-in tariffs.

Subsidy-recovery potential: The percentage of subsidy cost that could be recovered by the government over time for each policy mechanism.

Total subsidies: The sum of the net present values of federal, state and tax subsidies under a particular policy mechanism.

Unsubsidized LCOE: The levelized cost of electricity for renewable energy in the absence of federal policy support.

Value of policy: Percentage reduction in the net present value of total subsidy cash flows under each federal policy compared to the baseline, when there is no federal policy support.

Viability gap coverage effect: A difference in the maximum cost-effectiveness potential of federal policies on account of the difference in their potential to bridge the gap between the cost of renewable energy and the average pooled purchase cost.

Viability gap coverage potential: The extent to which a federal policy can bridge the difference between the cost of renewable energy and the wholesale price of energy in the absence of state-level support.

Viability gap: The difference between the cost of electricity and the grid price of electricity.