Renewables may be the Future but are they the Present? Coal, Energy, and Development in India

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We would like to thank a number of colleagues who have, over the years, helped us think about many of these issues, including Nancy Birdsall, Navroz Dubash, Bill Gates, Ashok Lavasa, Dr. Ajay Mathur, Aaditya Mattoo, Partho Mukhopadhyay, Pratap Mehta, Lord Nicholas Stern, and Lord Adair Turner. For help with and comments on this paper, we thank Abhishek Acharya, Kapil Patidar, Parth Khare, Syed Zubair, Rohit Chandra, Josh Felman, Devesh Kapur, Todd Moss, M. Rahul, Rajshree Ray, and Justin Sandefur. Errors remain very much our own.

Respected Minister Suresh Prabhu, Chairman of the Board, Mr. Ashok Chawla, Director General, Dr. Ajay Mathur, and Distinguished Guests,

It is a great honour to be here at The Energy and Resources Institute (TERI) to deliver this 16th Darbari Seth Memorial Lecture. Mr. Seth was, of course, one of the Titans of the Tata Group and Indian industry, and a confidante of the legendary JRD Tata. He had a strong streak of public service—not to mention a sneaking soft corner for socialism—reflected in his founding of this terrific institution, TERI. It is also a great honor to follow in the footsteps of so many illustrious previous speakers.

At the outset, I want to emphasize that this is the joint product of deliberations with my two young colleagues, Rangeet Ghosh and Navneeraj Sharma. Almost all that I know about the power sector is due to Navneeraj.

Today, I want to speak about renewables and coal in the current Indian context. I believe there is inadequate understanding of the issues related to coal and renewables; In fact, I am myself confused about how to think about them jointly. So, today I want to think aloud, to clarify issues, hopefully for all of you but definitely for myself. My apologies in advance: I am not an energy expert, nor a climate change expert but someone who is trying to put it all together into a public policy framework.

II. Background

Three features define the background for having this discussion on renewables and coal.

First, under the leadership of Prime Minister Modi, India has become one of the leaders in the global effort to combat climate change. The PM, along with the then French President and other countries, led the initiative to launch the International Solar Alliance (ISA) at the Paris meeting (TERI and Dr. Mathur also deserve kudos for the terrific and constructive role they played at Paris).In turn, this was underpinned by a domestic effort to dramatically increase the role of renewables in the domestic energy equation. India is now committed to installing 175 Giga Watts (GW) of renewables by 2022 which would account for 20.4 percent of electricity generated from all sources.

Second, this emphasis on renewables come against the recent history of a dramatic expansion, even over-expansion, in thermal capacity, predominantly in the private sector (218 GW of total thermal capacity at the end of FY 17 with 8x increase in private sector capacity to 84 GW between 2007 and 2017). That over-expansion—fuelled by the growth optimism of the mid-2000s--combined with stresses in the discoms and slowdown in the economy has led to plummeting Plant Load Factors (PLFs), declining

profitability, and the spectre of large amounts of stranded power assets, and consequentially stranded coal assets as well. All this can have a detrimental effect on the health of the banking sector, especially the public sector banks, in the country, which in turn can adversely impact the health of the Indian economy, already afflicted by the Twin Balance Sheet challenge.

Figure 1: Declining Plant Load Factors

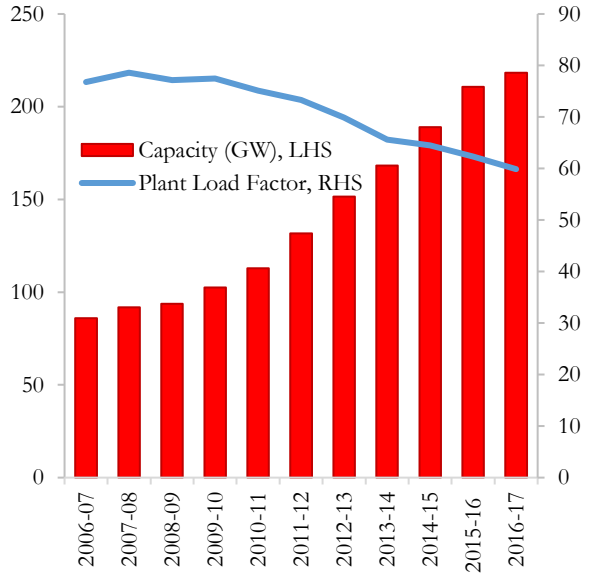
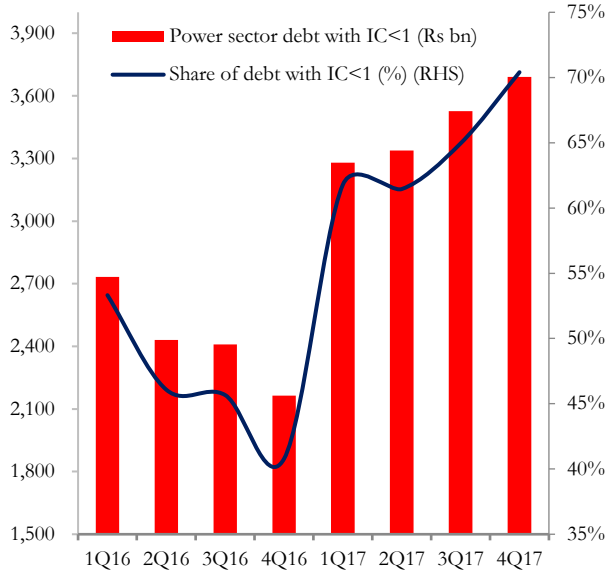


Figure 2: Increasing Power Sector Debt



Third, discussions of renewables and coal must take account of India's regional, development realities. Coal is located predominantly in the poor, eastern hinterland of India, while the potential of renewables is, with the exception of Rajasthan, in the richer, peninsular parts of India (Gujarat, Maharashtra, and Tamil Nadu). Coal is both the source of livelihoods for millions and the locus of many communities (Chandra, R., forthcoming) as well as an important source of fiscal revenues for many states. But coal is also the source of several development pathologies—corruption, crime, mafias, Maoist insurrection—captured in the term the "resource curse." (Economic Survey, 2016-17, Vol. 1). So, the rise of renewables poses both a threat to those livelihoods and communities but it may also afford an opportunity to escape from the attendant pathologies.

Figure 3: West vs East, Renewable Energy Potential[1] and Coal producing areas

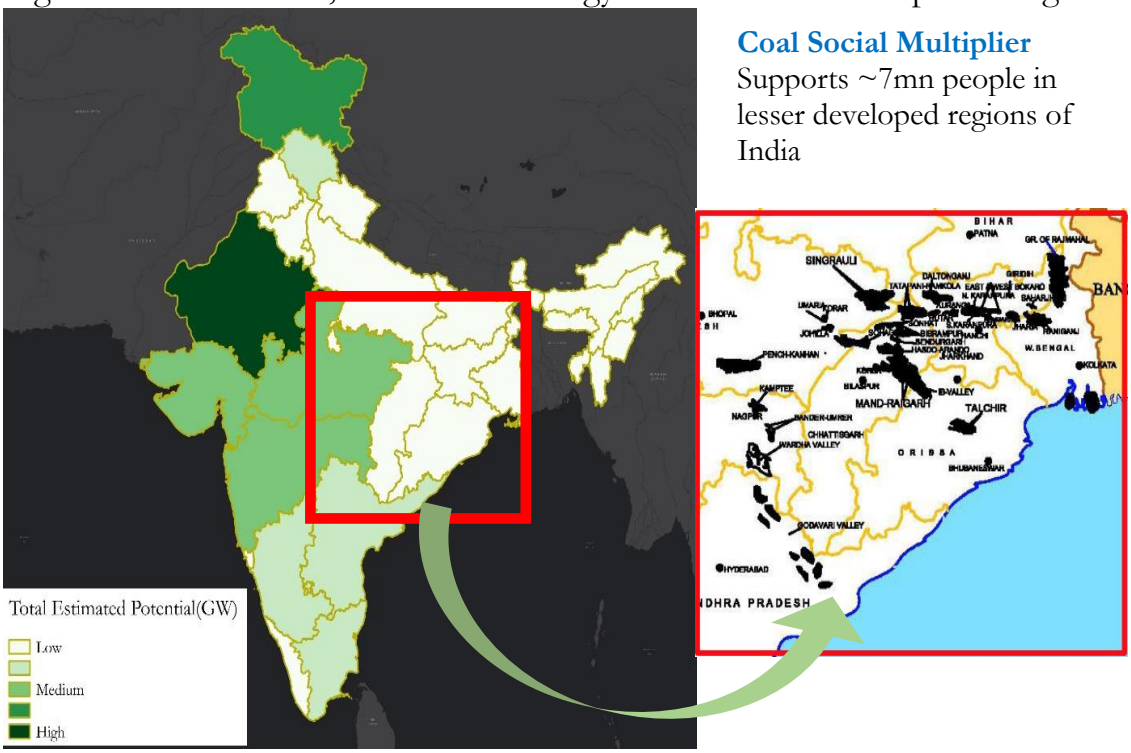
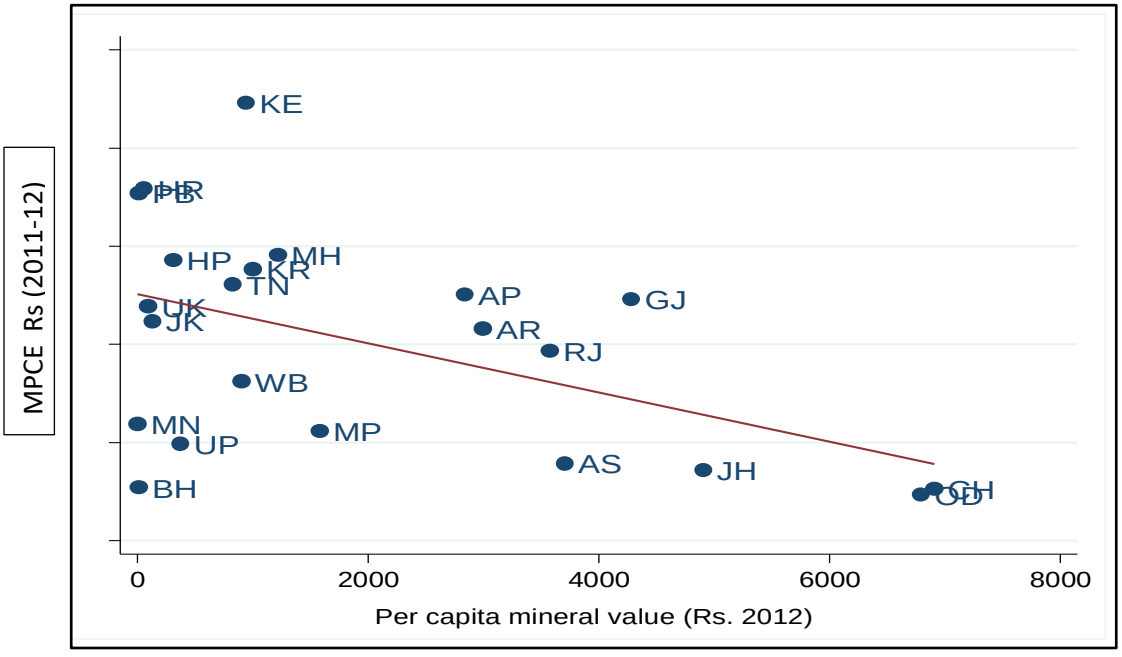


Figure 4: Resource Curse? Consumption is negatively correlated with mineral endowments



[1] MNRE estimates for Solar energy potential is 750 GW and 100 GW @ 80m height for Wind energy.

III. Ten Propositions in Brief

Let me summarize my talk in a few propositions which I will elaborate later on. The overall theme and message can be captured in that famous remark of St. Augustine, "Lord give me chastity and continence but not yet."

Proposition 1: Coal and renewables must be the joint focus of policy; they must be jointly decided not separately.

Proposition 2: The social costs of coal should include its domestic externalities, but at least for some time, not the international externalities.

Proposition 3: We must be abundantly cautious about claims on behalf of renewables. Properly costed, renewables will achieve true parity (in social terms) with coal only in the future.

Proposition 4: Beware "carbon imperialism" of advanced countries which risks biasing our judgments about energy.

Proposition 5: Because the economy is afflicted by the Twin Balance Sheet challenge and because coal is special, the social cost of renewables should include the costs of stranding thermal and coal assets.

Proposition 6: Current bids on renewables are not especially revealing or informative about the true costs of renewables because of extensive subsidies (implicit and overt, awarded by centre and states) and strategic behavior by renewables producers.

Proposition 7: There is a window, perhaps narrow, until renewables become truly viable, for accelerating expansion of coal, and driving up capacity utilization sharply in thermal power generation.

Proposition 8: Subsidizing renewables at a time when its social costs are above those of coal seems a double whammy for government which then also has to pick up the tab for the resulting stranded assets.

Proposition 9: This strategy will raise two dynamic implementation challenges, one on the political/social side and one on the economic/financial side, which will need to be addressed.

Proposition 10: Rapid, organic growth in energy demand and technological progress in cleaning coal—for which there must be a collective international effort--will help minimize the tensions between coal and renewables.

IV. Elaborating on the Propositions

Allow me, distinguished guests, to elaborate on each of these propositions, some more than others.

Proposition 1: Coal and renewables have aspects of both substitutability and complementarity. Hence, coal and renewables must be the joint focus of policy; they must be jointly decided not separately. And in some ways, by having a common Minister for clean and "dirty" energy—the dynamic Minister, Mr. Piyush Goel—we have institutionally recognized this Siamese-twins nature of the subject.

Proper costing

Propositions 2 and 3 relate to the costing of renewables and coal and here I mean their true social costs. First, some principles and then some tentative numbers.

Coal

For coal, the social costs must distinguish domestic and international costs. The former include, the negative impact on air pollution, disease, water contamination etc. These domestic costs must be added to the social costs of thermal generation. The most recent study[2] on India indicates that these costs are about Rs. 0.34 per kWh or $ 5.4 /ton of CO_2 (Total number converted into per unit number by dividing it by the total thermal electricity generation). It is worth emphasizing that the social costs of thermal power may be over-estimated to the extent that power will actually replace much worse forms of energy in large parts of India where households use kerosene and wood-fired stoves.

Now, social costs also include in principle the international externality in the form of contributing to global warming. My own view (consistent with Mattoo and Subramanian, 2012) is that India would be entitled not to incorporate these costs in its domestic policy calculations. Only over time, should India internalize, and progressively, the international marginal cost—the climate change impact.

That is how I think equity in combating climate change should be addressed, how development and carbon space should be afforded to countries such as India by advanced countries that have primarily and predominantly created the problem of climate change by occupying that space. If this is right, these international externalities would be small in magnitude for India—about $4 per ton or roughly Rs. 0.14 per kWh (2017 prices)—according to the estimates in Nordhaus (2017). Just for transparency, if

[2] https://www.scientificamerican.com/article/coal-fired-power-in-india-may-cause-more-than-100000-premature-deaths-annually/. A recent IMF study (IMF, 2017) based on Leileveld and others in Nature (2015) has a different set of estimates which are not strictly comparable. All these estimates are contingent on the tricky issue of valuing human life.

India were to fully externalize the global externality, the comparable magnitudes would be $31 per ton or about Rs. 2/kWh.

On the other hand, there are other externalities related to coal which must be incorporated. One such is water which is a scarce resource in India. For example, a 1000 MW coal-based power plant requires about (about) 84 million liters a day.[3] Another is the displacement of people that occurs when a new coal mine is exploited.

Renewables

Turning to the costing of renewables. It is fair to say that the world has become enamored with renewables, and for a lot of good reasons. It offers the chance to strike at the problem of climate change decisively. As important, technological improvements in this area have been striking. There is a Moore's Law counterpart to Solar PV costs known as Swanson's law which states that Solar PV module cost falls by 20 percent for every doubling in its capacity. These improvements are reflected in the dramatic decline in the price of photo-voltaic cells and in battery storage costs. The holy grail here, of course, is that renewables achieve "parity" with energy from fossil fuels.

Figure 5: Solar PV Price Index (in 2014 $/W)

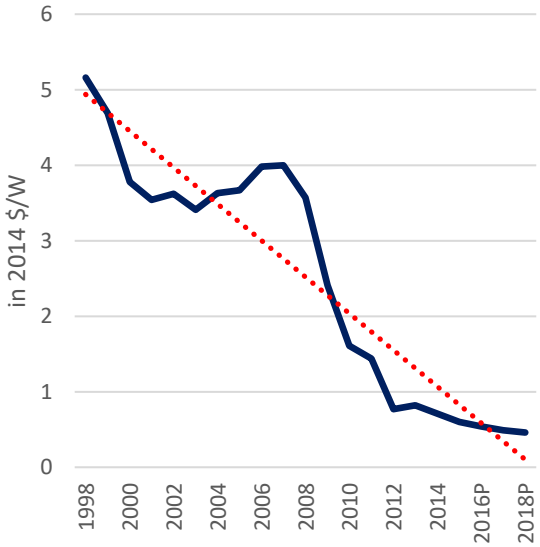
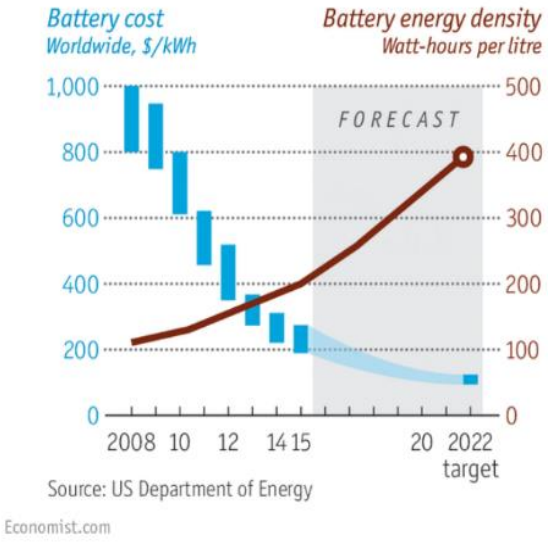


Figure 6: Battery Costs (in $/kWh)



But I think there are also claims about renewables that one has to be wary of (Gates, 2015). As a country that is abundant in coal and where the political economy of coal and

[3] https://thewire.in/116859/water-scarcity-behind-decline-thermal-power-generation-india/.

exiting gradually from it will be fiendishly difficult, a healthy skepticism about renewables would be in order.

A clarification is in order. For sure, once capacity is created, the social costs of renewables—taking into account just variable costs—are almost zero, and hence considerably below the social variable costs of thermal power.

But we are concerned here with long run decisions on solar which must take account of investments already incurred in thermal power. Renewables, in this situation, must be properly costed:

- for intermittency—the fact that solar and wind are not available all the time—and storage costs;
- for the fact that greater solar capacity has to be installed to generate a unit of power equivalent to conventional sources; put differently, renewables have lower (equilibrium) capacity utilization;
- for land acquisition costs which could be high in India if political, regulatory costs are also included;[4]
- for the costs of building and upgrading grids to equip them for renewables;[5]
- so that all the hidden subsidies—and there are many of them[6]—are taken out.

One overlooked point is that while the price of PV panels has been plummeting, they account for only a fraction of the total cost of solar energy.

Proper estimates of the full costs—not just levelized costs—of renewables are still elsuive. And one thing is clear: recent prices bid at solar auctions in India are not a true reflection of the true cost both because of the plethora of subsidies available and because there has been strategic under-bidding in the reverse auctions as in coal and telecommunications. (In fact, there is an important lesson here for renewables, namely, to avoid the experience of thermal power in creating excess capacity.)

[4] For a counter-view, see: http://www.livemint.com/Industry/UEJYwZQT5m3wNvGupBShZJ/How-the-worlds-largest-solar-park-is-shaping-up-in-Karnatak.html.

[5] There is a view that at least in rural India, decentralized solar is the way forward. Another view is that every Indian—rural or urban—must be on the grid to receive uninterrupted, high quality power. Until such time as decentralized can match this, calls for decentralization carry the whiff of "carbon imperialism." In any case, India has settled this for the moment by choosing to electrify every village by 2018.

[6] Renewable generation has fiscal and promotional incentives such as capital and/or interest subsidies, tax holidays on earnings for ten years, generation based incentives, accelerated depreciation, viability gap funding, financing rooftop solar as part of home loans, concessional customs duties, preferences for power generated from renewables, 25% capital subsidy for solar equipment production and implicit subsidies on land provided for siting of solar plants.

But there are some useful pointers. Two recent papers offer some suggestive numbers that confirms that at least for India, true parity is still far away.

One such is the updated paper by Charles Frank of the Brookings Institution (2016) who has a fuller analysis to take account of many of these costs for the US. His finding is that if emissions are valued at $50 per ton of CO2, solar is marginally competitive relative to thermal power. Recall that the social value of emissions in India is closer to $2.25 per ton, still far from the $50 suggested by the study. Recall too that India today has a tax ("cess") of Rs. 400 per ton of coal which is equivalent to about $10 per ton of CO2, still far from the true parity. And finally recall too that recent market data (from ICE, the intercontinental exchange) suggest that the current global valuation of CO2 emission is only about $6.5 per ton.

Another recent paper in the *Journal of Political Economy* (Gowrishankaran et al. 2017) is also instructive. Using the experience of Arizona, the authors calculate that solar achieves parity with coal if emissions are valued at $139 per ton of CO2 and if solar installation costs are $1.5 per watt. This study used data for 2011. Since then, solar costs must have declined but the broad relative assessment probably still holds.[7]

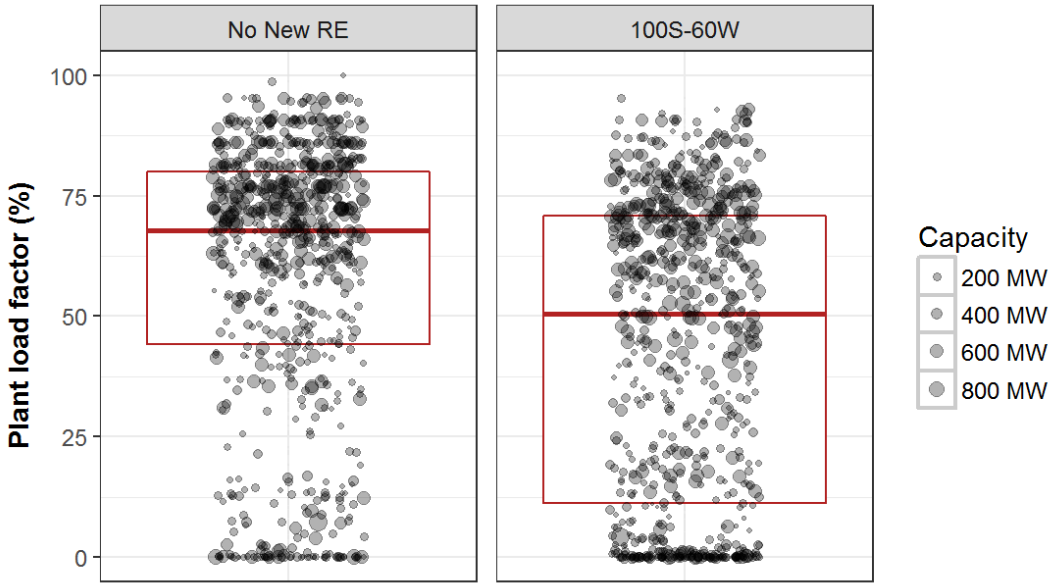
The other major and neglected social cost of renewables relates to the energy form it will displace—coal. Given the current macro-economic environment with India afflicted by the Twin Balance Sheet problem, any cost-benefit analysis of the impact of renewables must take account of the near-term impacts of the financial and economic costs of stranding assets in power and coal (and knock-on effects to sectors such as Railways). I cannot emphasize enough how important these costs are given the difficult nature of exit in India (documented in Chapter 2 of the Economic Survey, 2015-16)

And given the importance of coal from a regional and development perspective (discussed above), the social cost of renewables must include social costs of affecting and dislocating communities that derive their livelihoods from coal.

Based on a study commissioned by the Ministry of Power, Figure 7 below illustrates how much thermal generation might be displaced if renewables capacity rises sharply over time to reach 175 gigawatts by 2022. For example, median plant load factors decline from 63 percent to about 50 percent by 2022.

[7] The US experience may not travel easily to India in one sense because land costs—very low in the Arizona region—are potentially greater in India.

Figure 7: Impact of Renewables : Declining Capacity Utilization in thermal power



Source:- GREENING THE GRID: Pathways to Integrate 175 Gigawatts of Renewable Energy into India's Electric Grid, Vol. I—National Study

It is difficult to put precise numbers on the impacts of this declining PLFs but they could be substantial. For example, Economic Survey Volume 2 estimates that the cost of stranded assets in power alone is Rs. 0.7-0.8 per kWh. These would rise if the social costs are included.

Overall, the conclusion is that while there are considerable uncertainties about the social costs of renewables and power— and a lot more careful work is required, including by TERI—we can make two judgments in increasing order of confidence. First, for India, today and at least for some time, the social costs of renewables are likely to be greater than thermal power. Second, today and at least for some time, it is highly unlikely for the converse to be true.

Figure 8: Social costs of Coal vs. Renewables

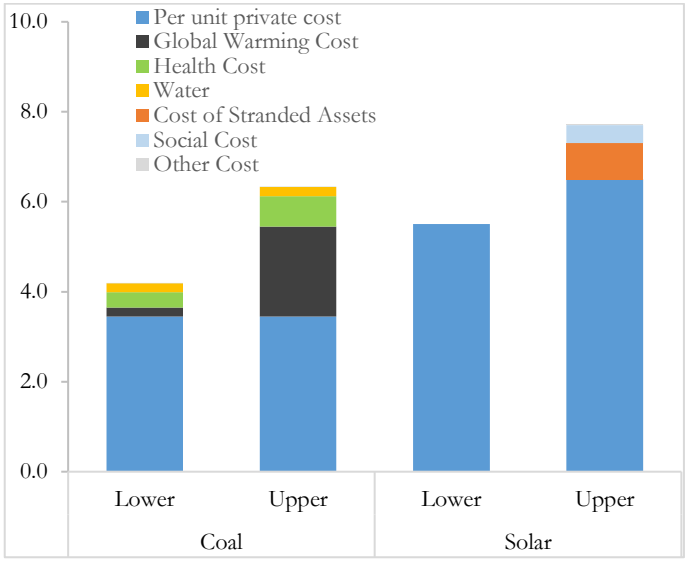
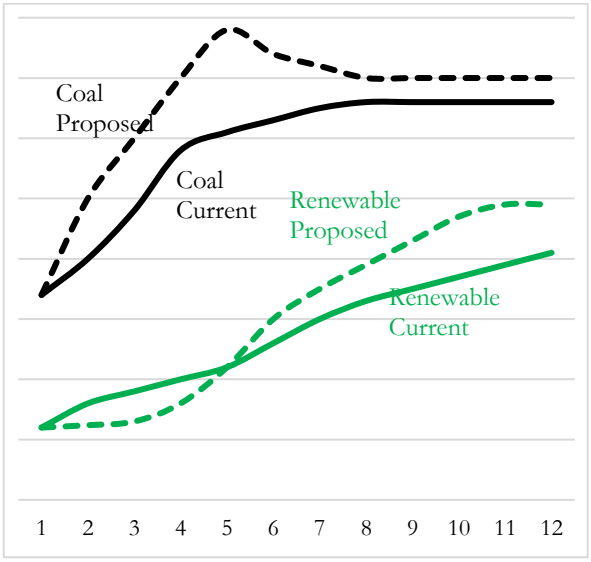


Figure 9: Implied Trajectory of Coal and Renewables



Carbon imperialism

If coal is critical for India's energy needs, we must beware and resist what I have called "carbon imperialism." This emanates from many sources and manifests itself in several forms. There have been recent shifts with the new Trump administration but broadly, the Group of Seven leading industrialised nations is committed to phasing out fossil fuels. The US and others had also vowed to vote against fossil fuel energy projects in developing countries when multilateral development banks are voting on them and when bilateral agencies are funding them. The President of the World Bank Jim Kim has said that new coal-fired plants would spell disaster for "us and the planet."

For India — a country struggling to provide basic electricity to about 25 per cent of the population—such carbon imperialism on the part of advanced nations could spell disaster for India and other developing countries. Under any plausible scenario, coal will provide about 60 percent of India's power needs until 2030. It will, and perhaps should, remain the country's primary energy source because it is the cheapest fuel available. We must shape the national and global narrative and not be stampeded by the rhetoric of carbon imperialism

Policy implications

If the discussion above is reasonable, a few policy conclusions follow.

A plausible strategy going forward must be to accelerate coal and thermal in that window and then phase down thereafter sufficient to provide at least the base load. The window before renewables become truly viable means that the reform of the coal sector and ramping up production and efficiency is vital.

[The intuition here is simple: maximize the use of national assets to the greatest extent possible and then gradually ramp up the use of the free global asset—sunlight and wind—when it becomes advantageous to do so.]

A corollary is to perhaps give consideration to drastically reduce subsidies for renewables because it seems odd for the government to subsidize renewables on the one hand and then also pick up the tab for the stranded assets in power and reduced coal consumption that result—the financial impact for the government arises from having to recapitalize the public sector banks that have lent to power companies and to the reduced profitability of the coal industry. This seems a double whammy for the government.

Advanced countries are seeing something similar, a perverse impact of the renewables revolution. As the Economist argued (February 25, 2017), conventional power utilities face the threat of a "death spiral" because their profitability declines from the scissors effect of falling demand and increasing renewables supply, some of it dictated by the "must run" status of renewables because of their zero marginal cost. Either the conventional utilities have to be subsidized (the same double whammy for governments or they have means that traditional utilities get wholesale electricity prices and hence decline in their profitability.

However, this proposed strategy raises two challenges of dynamic implementation, one on the political/social side and one on the economic/financial side, which will need to be addressed. On the former, the question is this: how do you ramp up coal in the short to medium term while simultaneously preparing for its phase-down beyond that? On the latter, how do you slow down renewables today while creating the right incentives for the private sector to preparing for its ramp-up later when it achieves true parity.

Clearly, the first challenge will require careful planning to manage the gradual importance in coal, the impacts of which will be concentrated in a few areas geographically. But in some ways, virtue can be made of necessity and in the form of a credible threat. Analysis in this year's Economic Survey shows (Figure 4) that coal and other natural resources do give rise to a form of natural resource curse. Exiting from, or rather phasing down gradually, these resources is a development necessity. The long term viability of renewables provides the credible threat to plan for this phase down. At

some point in the future, the incentives to use coal will diminish organically. Short of massive and indefinite support for coal—which will be inefficient domestically and counter-productive internationally—the sector will face existential threats.

Addressing the second implementation challenge would require some support for renewables even in the short run, if the sector is to be adequately prepared to take advantage of falling costs and become viable in the long run. There is also the argument that, because of learning-by-doing, costs themselves will be endogenous to scale of operations and hence to the support given today.

So, a via media is perhaps not to eliminate support for renewables today but rather to reduce it from current levels with the aim of achieving the time path of coal and renewables shown in Figure 9.

Minimizing tensions

Rapid growth in demand and technological progress in cleaning coal will help minimize the tensions between coal and renewables

A rapidly growing Indian economy—at close to double-digits—is the best guarantee of robust demand. But the move to electric cars offers another opportunity to shore up electricity demand in the long run.

On the second point. India is committed to curbing climate change and to promoting renewables, making coal clean is vital to the country's development. However, this cannot be done by India, or anyone else, alone. Technologies that are already available, such as carbon capture and storage, have proved prohibitively expensive. To discover truly effective techniques— i.e. to clean and green coal—the world collectively needs to embark on a programme akin to the Manhattan project that produced the first nuclear bomb. This would require investment from both public and private sectors, in advanced and developing nations, as well as a range of policy instruments.

But the rich world's preoccupation with phasing out fossil fuels creates a risk that the private sector — already lukewarm about investing in cleaning coal — will read the signals and abandon this project altogether. Remember that even in the medium term, coal will provide the base load for power in India; for example, under India's Nationally Determined Contribution (NDC), fossil fuels will provide about 60 percent of India's total power requirements. The time is ripe to create a global green and clean coal coalition. That, rather than unconscionable calls to phase out India's cheapest form of energy, would best serve the cause of fighting climate change.

Concluding Observations

Rapid changes in technology are promising to help realize the promise of renewables. This is an eminently desirable development and one that India is attempting both to benefit from and accelerate. At the same time, these changes need to be seen in the context of India's current economic situation and its enormous endowments of coal which is still a very cheap way of providing energy to hundreds of millions who are still energy-deprived.

If there are a few key messages I would like for you take away, they are the following: coal and renewables must be jointly decided because of their inter-connection, they are Siamese twins. For example, declining prices of renewables is threatening to upend the thermal power sector, and as prices are renegotiated because power buyers—the discoms—are themselves financially strapped, this threat will extend to renewables themselves.

Second, India needs coal in the short-medium term; renewables are part of the energy answer but they also come with hidden costs which must not be overlooked in our headlong embrace of renewables.

Third, India cannot allow the narrative of "carbon imperialism" to come in the way of rational, realistic planning for the future.

Finally, on behalf of, and as an emissary for, coal, I want to make a plea to policy-makers and research institutions such as TERI: as Tagore said in one of his great songs, "Bhoola Na" (don't forget or neglect me).

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