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Abstract

According to India's Third Biennial Update Report to the United Nations Framework Convention on Climate Change, electricity production contributes half of India's total carbon dioxide (CO_2) emission (without LULUCF) and 40 per cent of CO_{2e} (CO_2 equivalent) emission in 2016. Coal and lignite based thermal power sector is the predominant source of electricity generation in India and contributes 74 per cent in 2019-20. In COP26, India has committed to achieve net-zero (in CO_{2e} emission) target by 2070. Therefore, any strategy to reduce total CO_{2e} emission in India cannot spare emission reductions from coal and lignite based thermal power plants (TPPs).

To accelerate achieving India's emission intensity reduction target to 45 per cent, we explore a design of carbon tax for coal and lignite based TPPs. Given the constraints involved to design a carbon tax based on Pigouvian tradition, we estimate a revenue neutral rate of tax on CO_{2e} emission by converting taxes on coal and lignite. To make the proposed carbon tax system less disrupting for tax administrations, we propose adjustments of input tax credits with carbon tax liability. The proposed carbon tax will be incentive-compatible, as carbon efficient TPPs will face lower carbon tax burden.

Key Words: Emissions of Green House Gases (GHGs), Carbon Tax, Revenue Neutrality, Thermal Power Generation, Coal and Lignite, India.

JEL Codes: H23, Q54, Q4, P43

1. Introduction

According to India's *Third Biennial Update Report to the United Nations Framework Convention on Climate Change* (MoEFCC 2021), electricity production contributes half of total carbon dioxide (CO_2) emission (without LULUCF) and 40 per cent of CO_{2e} (CO_2 equivalent) emission in 2016 (Table 1).[1] Coal and lignite based thermal power sector is the predominant source of electricity generation in India and contributes 74 per cent of total electricity generated in 2019-20 of 16,22,983 Giga Watt hour (GWh) (MoSPI 2022). Therefore, India's any strategy to reduce total CO_{2e} emission cannot spare emission reductions from electricity production in general and coal and lignite based thermal electricity sector in particular.

Table 1: Emissions of Green House Gases in India – 2016 (in Gigagram)

	CO_2 Emission		CO_2 Equivalent (CO_{2e})	
TOTAL without LULUCF* (1+2+3+5)	**2,231,067.52**		**2,838,888.58**	
TOTAL with LULUCF (1+2+3+4+5)	**2,252,356.39**		**2,531,069.02**	
1. ENERGY (A.1+B.1)	2,064,840.50	(92.5)	2,129,428.48	(75.0)
A.1 Fuel Combustion Activities (1.1+2.1+3.1+4.1)	2,064,840.50	(92.5)	2,092,249.93	(73.7)
1.1 Energy Industries (a.1+b.1+c.1)	1,200,735.63	(53.8)	1,206,586.83	(42.5)
a.1 Electricity Production	1,122,229.67	(50.3)	1,127,732.23	(39.7)
b.1 Refinery	71,823.97	(3.2)	71,931.17	(2.5)
c.1 Manufacturing of Solid Fuel	6,681.99	(0.3)	6,923.43	(0.2)
2.1 Manufacturing Industries & Construction	395,893.24	(17.7)	397,739.15	(14.0)
3.1 Transport	269,975.76	(12.1)	274,433.69	(9.7)
4.1 Other Sectors	198,235.86	(8.9)	213,490.26	(7.5)
B.1 Fugitive Emission from Fuels (1.2+2.2)			37,178.55	(1.3)
1.2 Solid Fuels (a.2+b.2)			17,120.52	(0.6)
a.2 Above Ground Mining			11,742.03	(0.4)
b.2 Underground Mining			5,378.48	(0.2)
2.2 Oil and Natural Gas			20,058.04	(0.7)
2. INDUSTRIAL PROCESSES AND PRODUCT USE	166,227.02	(7.5)	226,406.78	(8.0)
3. AGRICULTURE			407,820.88	(14.4)
4. LULUCF	21,288.87		-307819.56	
5. WASTE			75,232.44	(2.7)

Note: Figures in the parenthesis show the percentage share in Total Emissions without LULUCF
*-LULUCF is abbreviation of Land Use and Land-Use Change and Forestry Sector
Source: Compiled from Ministry of Environment, Forest and Climate Change (MoEFCC 2021)

[1] "Carbon dioxide equivalent" or "CO2e" is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO2 which would have the equivalent global warming impact.

In recently concluded 26th Conference of Parties (COP26) of the United Nations Framework Convention on Climate Change (UNFCC), India has committed to achieve net-zero (in CO_{2e} emission) target by 2070. India is aiming to achieve the target by increasing the share of non-fossil fuels in total installed electricity generation capacity to 50 per cent and enhancing the emission intensity reduction target to 45 per cent. At COP26, there is an agreement among nations for market mechanism to support transfer of emission reductions between countries.[2] This is expected to help countries to meet their intended reductions as captured in their national climate action plans under the Paris Agreement (i.e., Nationally Determined Contributions, or NDCs). If the bilateral cooperation evolves among countries, the transfer of mitigation of emission between countries may help in the emergence of emission trading systems (ETS). However, it requires bilateral arrangements between countries to recognise the transfer of emission reductions. There is also need for the emergence of rules, modalities and procedures in emission trading within the framework of UNFCCC which will enable cross-country emission trading. Therefore, India's goal to achieve net-zero could help Indian businesses if they adopt aggressive emission mitigation targets and generate carbon credits which could be traded internationally.

Being the single largest contributor in total emission of CO_{2e}, Indian coal and lignite based thermal power plants (TPPs) could generate carbon credit if they adopt emission mitigation targets without compromising on net generation of electricity. This will also help to reduce India's objective of reduction of emission intensity by 40 per cent to achieve net zero target by 2070.

Putting a price on carbon – either by charging a carbon tax or by establishing an emissions trading system (ETS) – provides incentives to opt for less carbon-intensive alternatives while still leaving it to markets to determine the best and most cost-effective technologies and solutions (Steinebach et. al. 2020). Increasing tax on high carbon fuels may reduce consumption of the same, provided alternative fuels (e.g., hydrogen from renewable sources) and technologies are available at affordable prices. In recent years, carbon pricing policies (CPPs) have been adopted by several countries. In 2020, there are 61 subnational, national and supranational carbon pricing initiatives in place or scheduled for implementation, consisting of 31 ETSs and 30 carbon taxes (World Bank 2020). A well-designed carbon tax could reduce the risk of climate change, minimise the cost of emissions reductions, encourage innovation in low-carbon technologies, and raise new public resources/ revenue (Marron and Toder 2014).

In setting the carbon tax, the first best solution is to follow Pigouvian tradition to internalise the negative externality associated with CO_{2e} emission. According to Pigou, optimal tax should be equal to marginal social cost of CO_{2e} emission on output of polluting industry which is equal to the marginal abatement cost or marginal damage value at the social optimum. However, estimation of social cost of CO_{2e} emission is difficult given the fact that CO_{2e} gases accumulates in the atmosphere for decades and there is worldwide impacts of global warming and climate change. Moreover, environmental and economic impacts CO_{2e} emission also depends on stock of Green House Gases (GHGs) and therefore

[2] https://unfccc.int/process-and-meetings/the-paris-agreement/the-glasgow-climate-pact/cop26-outcomes-market-mechanisms-and-non-market-approaches-article-6 (last accessed on 11 April 2022).

it is not only related to current economic activities but also past and future economic activities, domestic climate policies and policies elsewhere in the world.

Social Cost of Carbon (SCC) estimates the monetary costs associated with health damages due to high level of carbon emissions, impact of climate change on agricultural productivity, property damages from natural disasters, extinction of species due to loss of ecosystem, etc. Hence, estimating SCC involves a complex procedure as it has to account for the full range of impacts from emissions (Nordhaus 2017). Beside this, estimation of SCC also depends on several other factors such as level of emissions, concentration of GHGs in the environment, discount rate, valuation of social damages (Ernst and Young 2018), the rate of time preference, elasticity of marginal utility of consumption, per capita consumption growth (projected) (Stern 2007), trajectory path of carbon emissions, climate sensitivity and the climate change impacts (Marron and Toder, 2014) etc.

Since estimates of SCC depend critically on several assumptions, there exists wide variety of SCC estimates in literature (Nordhaus 2017, Stern 2007, and Tol 2013). For example, a series of papers by Tol (2008, 2009, and 2013) provides meta-analysis of published estimates of SSC, of which the most recent study includes a survey of 75 studies with 588 estimates of SCC (Tol 2013). According to Tol (2013), mean SCC at 3 per cent real discount rate is US$25 per tonne with the standard deviation of US$22. With the help of Dynamic Integrated model for Climate and Economy (DICE),[3] Nordhaus (2017) estimates global SCC of US$31 per tonne of CO_2 emission in 2010 US$ for 2015. Similarly, Ernst and Young (2018) estimates SCC for India with the help of DICE model and it is US$10 per tonne of CO_2 emissions. Stern (2007) with the help of Policy Analysis of Greenhouse Effect (PAGE) model estimates global SCC along the business as usual trajectory at US$85 per tonne of CO_2 emissions which is higher than the values estimated in other studies. Stern (2007) also reports a wide range of SCC estimates from less than US$0 per tonne of CO_2 emission to over US$400 per tonne of CO_2 emission. This suggests that estimates of SCC are not conclusive as there exists wide range of values. Hence, given the uncertainties of SCC estimates, one can also opt for second best solution i.e. minimising the abatement cost of emission (Sankar 2012). However, marginal abatement costs (MACs) which estimate the cost of reducing one more unit of pollution also depend upon several factors such as level of targeted emissions, baseline scenarios, current and future climate policies, or developments in the carbon mitigation technologies etc. (Sankar 2012). Kuik et al. (2008) carried out a meta-analysis of MACs estimates and also argues that estimates of MACs are sensitive to assumption of baseline scenario, stabilization target, intertemporal optimization, assumptions for future technologies, choice of greenhouse gases, etc. Hence, there exist several issues in determining carbon tax rates as many damages are unknown or uncertain, values of SCCs or MACs depend upon several assumptions and also possibility of climate catastrophes are not well handled by cost-benefit or Integrated Assessment Models (IAMs) approach (Weitzman 2009). Therefore, a well design

[3] The most common and globally accepted model to estimate social cost of carbon is the Integrated Assessment Model (IAM) which comprised of three models i.e. Dynamic Integrated model for Climate and Economy (DICE), Climate Framework for Uncertainty, Negotiation, and Distribution (FUND), and Policy Analysis of Greenhouse Effect (PAGE). IAM's models are extensively used in the literature to determine the SCCs and hence corresponding carbon price (Nordhaus 2017, Ernst and Young 2018).

carbon tax policy will depend upon how policymakers address such issues of structuring or designing real-world carbon tax rates.

Given the constraints involved to design a carbon tax based on Pigouvian tradition, we estimate a revenue neutral rate (RNR) of tax on CO_{2e} emission from coal and lignite based thermal power plants (TPPs). In other words, given the energy and emission intensity of coal and lignite used in Indian power sector, we estimate tax rate on CO_{2e} emission which will help to achieve revenue neutrality with reference to prevalent taxes on coal and lignite used in TPPs. Literature on carbon tax proposes high tax on fossil fuels to discourage consumption. Unless India adds capacity in electricity generation from alternative low carbon fuels, increasing tax on high carbon fuels may not result in emission reductions. In the present paper, we propose tax on CO_{2e} emissions from coal and lignite based TPPs to incentivize TPPs to reduce CO_{2e} emissions and therefore reducing emission intensity per unit of electricity generation. This alone may not help India to achieve net-zero target by 2070 but it will help TPPs to reduce CO_{2e} emission intensity. To make the proposed carbon tax system less disrupting administratively, we propose adjustments of input tax credits against taxes on coal and lignite with carbon tax liability. In this case carbon tax will be on per tonne emission of CO_{2e} from coal and lignite based TPPs. Since India has introduced Goods and Services Tax (GST) on 1 July 2017 by replacing multiple indirect taxes from the Union and State tax bases, we assess RNRs on CO_{2e} emissions for two years – 2016-17 (pre-GST regime) and 2019-20 (GST regime) – to see whether tax regime change has any impact on tax rates on CO_{2e} emission from coal and lignite based TPPs.

In the next section we discuss on methodology and data sources to assess the consumption of coal and lignite in thermal power sector, CO_{2e} emission from coal and lignite based TPPs, taxes on coal, lignite and electricity. This is followed by discussion on results in section 3. We draw our conclusions in section 4.

2. Methodology and Data Sources

Based on available sources of information from published reports of the Government of India, we first assess the coal and lignite consumption in thermal power sector. Apart from indigenous coal, Indian thermal power plants also consume imported coals. Therefore, we also assess the consumption of imported coal in Indian thermal power sector for 2016-17 and 2019-20. We estimate CO_{2e} emission from Indian coal and lignite based electricity sector, based on the methodology presented in "*India: Third Biennial Update Report to the United Nations Framework Convention on Climate Change*" (hereafter BUR.3) by the Ministry of Environment, Forest and Climate Change (MoEFCC 2021). We also estimate fugitive emission of CO_{2e} from coal mining and post mining operations based on methodology presented in MoEFCC (2021) and Singh and Kumar (2016). However, we only report the estimated value of fugitive emission from coal mining and post mining operations for 2019-20 and avoid presenting the methodology to save the space of the present paper.[4] We assume that both energy factor (calorific value) and emission factor of coal and lignite remain same in 2019 as in 2016. We estimate taxes on per tonne of coal and lignite both for pre-GST

[4] Detailed estimations are available with author to share over personal communication.

and GST regime based on information available from Annual Reports of Coal India Limited (for coal) and NLC India Limited (for lignite). For Imported coal we estimate total taxes based on value of imported non-coking coal as available from publications of Coal Controller's Organisation. For taxes and duties on electricity, we rely on Finance Accounts and Budget Documents of the Union and State governments.

2.1 Consumptions of Coal and Lignite in Thermal Power Sector

Estimates of consumption of coal and lignite in thermal power sector vary across sources and even within a source across tables. According to *Energy Statistics of India 2022*, total consumptions of coal and lignite in electricity sector are presented in Table 2 (MoSPI 2022).

Table 2: Production, Availability and Sector-wise Consumption of Coal and Lignite in India

Particular	2016-17		2019-20	
	Coal	Lignite	Coal	Lignite
a) Production (million tonne)	657.87	45.23	730.87	42.10
b) Import (million tonne)	190.95	0.019	248.54	0.054
c) Export (million tonne)	1.77	0.005	1.02	0.093
d) Change of Vendible Stock (Closing Stock - Opening Stock)	11.53	2.074	23.79	-0.177
e) Availability (million tonne) (a+b-c+d)	**858.58**	**47.318**	**1002.15**	**41.89**
f) Consumption (million tonne)	837.22	43.16	955.93	42.26
Of which				
i) Electricity	***535.04***	***38.82***	***626.15***	***36.33***
*ii) Steel & Washery**	*51.98*	*0.04*	*63.74*	*0.02*
iii) Cement	*6.36*	*0.29*	*8.57*	*0.77*
iv) Paper	*1.18*	*0.53*	*1.33*	*0.55*
v) Textile	*0.24*	*1.29*	*0.1*	*0.12*
vi) Sponge Iron	*5.56*		*10.53*	
vii) Fertilisers & Chemicals	*2.45*		*1.76*	
viii) Bricks	*0.1*		*0.03*	
*ix) Others***	*234.31*	*2.19*	*243.72*	*4.47*
x) Total	**837.22**	**43.16**	**955.93**	**42.26**

Notes: *-includes import of coking coal
**-includes Sponge Iron, Colliery Consumption, Jute, Bricks, Coal for Soft Coke, Fertilisers & other industries, import of non-coking coal
Source: *Energy Statistics of India 2022* (MoSPI 2022)

Unlike *Energy Statistics of India*, *Coal Directory of India* presents coal consumption in power sector by type of coal. Identification of coal consumption in power sector by types (i.e., coking and non-coking coal) is important, as energy factor (calorific values) and carbon emission factor differ across type of coal (MoEFCC 2021). According to Table 3, coal consumption in power sector differs from the data presented in *Energy Statistics of India 2022*.

Table 3: Off-take of Coal and Lignite by Power Sector (million tonne)

2016-17	**Company-wise Off-take [a]**			**State-wise Off-take**	
Particular	Coking Coal	Non-Coking Coal	Total Coal	Total Coal[b1]	Lignite[b2]
Power Sector - Total	**43.455**	**490.244**	**533.699**	**538.597**	**38.824**
Power (Utility)*	41.013	438.645	479.658	480.843	24.284
Power (Captive)**	2.442	51.599	54.041	57.754	14.54
Total Despatches	**57.702**	**582.178**	**639.88**	**644.235**	**43.155**
Total Off-take#	**57.702**	**582.42**	**640.122**	**644.524**	**43.155**
2019-20	**Off-take from Companies[c]**			**Off-take from States[d]**	
Particular	Coking Coal	Non-Coking Coal	Total Coal	Total Coal	Lignite
Power Sector - Total	**39.056**	**585.100**	**624.156**	**625.498**	**36.332**
Power (Utility)*	36.726	499.239	535.965	536.892	9.887
Power (Captive)**	2.33	85.861	88.191	88.606	26.445
Total Despatches	**48.851**	**651.276**	700.127	**701.355**	**42.267**
Total Off-take	**48.851**	**651.469**	700.32	**701.566**	**42.267**

Notes: *-Power which is generated and used for commercial purpose is considered as Power (Utility)
**-Power which is generated and utilised/ consumed for own use is considered as under Power (Captive)
- Total Off-take = Total Despatch + Colliery Consumption
Sources: (a) Table 4.19 & Table 4.20 of *Coal Directory of India 2016-17* (CCO 2018)
(b1) Table 4.21 of *Coal Directory of India 2016-17* (CCO 2018)
(b2) Company-wise Off-take of Lignite to Different Priority Sectors, Table 4.17 of *Coal Directory of India 2016-17* (CCO 2018)
(c) Table 4.20 & Table 4.23 of *Coal Directory of India 2019-20* (CCO 2021)
(d) Table 4.24 of *Coal Directory of India 2019-20* (CCO 2021)

Publications of Central Electricity Authority provide thermal plant-wise consumption of indigenous and imported coal. Similar information is not available from either *Energy Statistics of India* or *Coal Directory of India*. According to CEA (2019), total consumption of indigenous coal in Indian power sector is 529.07 million tonne and imported coal is 45.19 million tonne in 2016-17 (Table 4). For 2019-20, the consumption of indigenous coal is 554.11 million tonne and imported coal is 68.11 million tonne in Indian TPPs (CEA 2020).

Table 4: Region-wise Consumption of Indigenous and Imported Coal in Power Sector

Region	2016-17	2019-20					
	Consumption ('000 tonne)	Receipts ('000 tonne)			Consumption ('000 tonne)		
		Indigenous	Imported	Total	Total	Indigenous*	Imported*
i) Northern Region	123,491	121,818	2,724	124,542	119,313	116,703	2,610
ii) Western Region	184,924	230,092	7,629	237,721	231,773	224,335	7,438
iii) Southern Region	100,447	90,927	13,710	104,637	103,172	89,654	13,518
iv) Eastern Region	119,618	123,961	912	124,873	122,016	121,125	891
v) North-Eastern Region	592	2,654	39	2,693	2,325	2,291	34
Sub-Total	**529,072**	**569,452**	**25,014**	**594,466**	**578,599**	**554,108**	**24,491**
Total All India (Imported Coal Based TPPs)	**45,187**	**-**	**44,203**	**44,203**	**43,623**	**-**	**43,623**
All India - Total	**574,259**	**569,452**	**69,217**	**638,669**	**622,222**	**554,108**	**68,114**

Note: *- estimated by using respective share in Total Receipts
Source: Compiled from Annexure 9.1 of *Review of Performance of Thermal Power Stations 2016-17* (CEA 2019) and Annex-2A *Annual Report 2019-20* of Central Electricity Authority (CEA 2020)

Based on figures presented in Tables 2 to 4, we compile coal and lignite consumption in Indian thermal power sector in Table 5. We validate our estimates of consumption of solid fuels (i.e., coal and lignite) with the category-wise fuel consumption in the Indian energy industries for 2016 as presented in BUR.3 (Table 6). Please note that consumption of coal and lignite as presented in Table 6 also includes consumption in 'manufacture of solid fuels and other energy industries'. Therefore, overall consumption of coal and lignite in Indian power sector cannot be different from the estimates we present in Table 5.

Table 5: Coal & Lignite Consumption in Indian Thermal Power Sector (in Million Tonne)

Fuel Category		2016-17	2019-20	Data Source
Coking Coal		43.455	39.056	Table 3
Non Coking Coal	Indigenous	490.244	585.100	Table 3
	Imported	45.187	68.114	Table 4
	Total	535.431	653.214	
All Coal		**578.886**	**692.270**	
Lignite		38.824	36.332	Table 3

Source: As Shown in Last Column of this Table.

Table 6: Category Wise Fuel Consumption in the Indian Energy Industries: 2016

Fuel Category	Electricity & Heat Production (Terra Joule or TJ)	Petroleum Refining (Terra Joule or TJ)	Manufacture of Solid Fuels and Other Energy Industries (Terra Joule or TJ)	Total Fuels Consumption in Energy Industries (Terra Joule or TJ)
Liquid Fuels	144,706			144,706
Gaseous Fuels	529,086	1,254,148		1,783,234
Solid Fuels	11,226,259		496,792	11,723,051
All	**11,900,051**	**1,254,148**	**496,792**	**13,650,991**
Share of Fuels in Total Fuel Consumption in Energy Industries		**% Share**	**TJ***	**Million Tonne****
Liquid Fuels	Naphtha	0.02	2,730	
	Gas/Diesel Oil	0.12	16,381	
	Residual Fuel Oil	0.12	16,381	
	LPG	0.8	109,208	
	Total	**1.06**	**144,701**	
Gaseous Fuels	Refinery Gas	7.32	999,253	
	Natural Gas (Dry)	5.74	783,567	
	Total	**13.06**	**1,782,819**	
Solid Fuels	Non Coking Coal	72.75	9,931,096	579.38
	Coking Coal	10.37	1,415,608	59.83
	Lignite	2.76	376,767	38.45
	Total	**85.88**	**11,723,471**	
All Fuels	**Total**	**100.00**	**13,650,991**	

Notes: *- Estimated by applying the share in Total Fuels Consumption in Energy Industries. It is to be noted total Fuel Consumption (in TJ) by each Fuel Category does not match with the Figures presented in the upper part of the Table. This may be due to rounding of share (in %) under each category of fuel.
** -Estimated by applying the Net Calorific Value (TJ/Kt) factor as presented in Table 7. We apply weighted average of Net Calorific Value (TJ/Kt) for Non Coking Coal (i.e., 17.14 TJ/Kt) where weights are estimated by using share of Solid Fuels consumption (in TJ) in 'Electricity and Heat Production' and 'Manufacture of Solid Fuels and Other Energy Industries' in total Solid Fuels consumption in Energy Industries.
Source: Compiled and Estimated by using Table 2.5, Table 2.6 and Figure 2.9 of BUR.3

2.2 CO_{2e} Emission from Coal & Lignite Based Thermal Power Sector

Based on emission and other factors as available from BUR.3 (as presented in Table 7), we estimate CO_{2e} emission from coal and lignite based thermal power sector in India for 2016-17 and 2019-20 (Table 8). We assume that for 2019-20 calorific values (energy factors) and emission factors of solid fuels will remain same as in 2016. The estimated total calorific value of solid fuels consumed in Indian electricity sector is 10,559,133 Terra Joule (or TJ) in 2016 and it is 667,126 TJ (or 5.94%) lower than the estimate presented in BUR.3 (i.e. 11,226,259 TJ). One possible reason for the shortfall in energy

consumption presented in Table 8 could be due to rounding off the energy factors across fuel types. Similarly, our estimate of CO_2 emission from electricity production (excluding fugitive emission from coal mining and post mining operations) is 1,023,001 Gigagram (Gg) in 2016 which is 99,229 Giggram (or 8.84%) lower than CO_2 emission from electricity production as presented in BUR.3 (i.e., 1,122,229.67 Gg).[5] Possible reasons for shortfall in estimated CO_2 emission could be related to shortfall in energy consumption in Indian electricity sector by 5.94 per cent (according to our estimate) and rounding off the emission factors across fuels. Shortfalls in energy consumption as well as CO_2 emission are also expected for 2019-20 in our estimates. However, shortfalls in our estimates for 2016 are less than 10 per cent of estimates presented in BUR.3.

Table 7: CO_{2e} Emission from Electricity and Heat Production in India

Sector	**Electricity and Heat Production**		**Manufacture of Solid Fuels and Other Energy Industries**
Fuel Consumption – Solid Fuels (Terra Joule or TJ): 2016		11,226,259	
Net Calorific Value (Terra Joule per Kilo Tonne or TJ/Kt): 2016	Coking Coal	23.66	23.66
	Non-Coking Coal	17.09	18.26
	Lignite	9.8	--
Carbon Emission Factor (Tonne of Carbon per Terra Joule or tC/TJ)	Coking Coal	25.55	25.55
	Non-Coking Coal	26.39	26.28
	Lignite	28.9	--
Green House Gas Emission from **Fuel Combustion Activitie**s – Energy Industries (Gigagram): 2016	CO_2 Emission	12,000,735.63	
	CH_4	15.94	
	N_2O	17.80	
	CO_2 equivalent	12,06,586.83	
Green House Gas Emission from **Fugitive Emission from Fuels** – Solid Fuels (Gigagram): 2016	CH4	815.26	
	CO_2 equivalent	17,120.52	
GHG Emission from **Electricity Production** (Gigagram)	CO_2 equivalent	11,27,732	(of which CO_2 emission only is 11,22,229.67 Gg)[(a)]

Note: (a) Emission of Methane (CH_4) and Nitrous Oxide (N_2O) from Electricity production is 12.19 Gigagram (or 255.99 Gg of CO_{2e}, as GWP of CH_4 is 21) and 16.92 Gigagram (or 5245.2 Gg of CO_{2e}, as GWP of N_2O is 310) respectively.
Source: Table 2.5, Table 2.6 and Appendix (Page No. 190-193) of *Chapter 2 - National Greenhouse Gas Inventory* of BUR.3.

[5] CO_{2e} Emission from Coal and Lignite based TPPs in 2016-17 (in Gg) = Carbon Emission from Coal and Lignite based TPPs in 2016-17 (in Gg) x 3.67 (see Table 8 note for details)

Table 8: CO_{2e} Emission from Coal and Lignite based Indian Electricity Sector

Particular	2016-17				2019-20			
	Coking Coal	Non-Coking Coal	Lignite	Total	Coking Coal	Non-Coking Coal	Lignite	Total
A. Solid Fuel Consumption in Electricity Sector (million tonne)	43.455	535.431	38.824		39.056	653.214	36.332	
B. Solid Fuel Consumption in Electricity Sector (Kilo tonne or Kt) (A*10^3)	43,455	535,431	38,824		39,056	653,214	36,332	
C. Energy Factor - Net Calorific Value (TJ/Kt)	23.66	17.09	9.8		23.66	17.09	9.8	
D. Emission Factor - Carbon Emission Factor (tC/TJ)	25.55	26.39	28.9		25.55	26.39	28.9	
E. Calorific Value of Solid Fuel Consumed in Electricity Sector (TJ) (B*C)	1,028,145	9,150,512	380,475	**10,559,133**	924,065	11,163,427	356,054	**12,443,546**
F. Carbon Emission from Solid Fuel Consumption in Electricity Sector (in tonne) (B*C*D or E*D)	26,269,112	241,482,021	10,995,733	278,746,867	23,609,860	294,602,845	10,289,949	328,502,654
G. Carbon Emission (in Gigagram) (F/10^3)#	26,269	241,482	10,996	278,747	23,610	294,603	10,290	328,503
H. Fugitive emission from coal mining and post mining operations (Gigagram of CO_{2e})				17,120.52[(a)]				16,445.62[(b)]
I. CO_{2e} Emission from Coal & Lignite Based Thermal Power Sector including Fugitive Emission (Gigagram of CO_{2e}) [(G*3.67)+H]*	**96,408**	**886,239**	**40,354**	**1,040,122**	**86,648**	**1,081,192**	**37,764**	**1,222,050**

Notes: # 1 Gigagram = 10^6 Kilogram = 10^3 Tonne. *-Molecular Weight of CO_2 is 44 [as atomic weight of Carbon (C) is 12 and Oxygen (O) is 16] and therefore Ratio of Molecular Weight of CO_2 and C is 3.67 (i.e., 44/12).
(a) As Available Appendix (Page No. 190-193) of *Chapter 2 - National Greenhouse Gas Inventory* of BUR.3 and (b) Estimated by Author.
Source: Estimated by Author

2.3 Taxes on Coal, Lignite and Electricity

In addition to royalty, coal and lignite attract various taxes and cesses. Introduction of GST has consolidated the taxes by subsuming taxes from the Union tax base (Union Excise Duty, Stowing Excise Duty, Clean Energy Cess) as well as State tax base (State Sales Tax/VAT, Central Sales Tax,[6] Entry Tax). In the GST regime, intra-State supplies attract Central-cum-State GST and inter-state supplies attract Integrated GST (or IGST). In addition coal and lignite (both indigenous and imported) attract GST Compensation Cess of Rs. 400 per tonne. Prior to GST, coal and lignite (both domestic and imported) used to attract Clean Energy Cess of Rs. 400 per tonne. Though inputs (coal and lignite) of thermal power sector attract GST, output (i.e., electricity) of power sector attracts 'electricity duty' and the date of introduction of GST on electricity is not yet decided by the GST council. Therefore, power sector cannot adjust input tax credit against input taxes with electricity duty payable to State governments.

Present rate of royalty on coal is 14 per cent (except in the state of West Bengal) on price of coal, as reflected in the invoice, excluding taxes, levies and other charges. In West Bengal royalty rates on coal ranges from Rs. 7 to Rs. 2.5 per tonne based on quality of coal.[7] The rate of royalty on lignite is 6 per cent and it is applicable for both captive mines and sales to other consumers. Royalty rates on coal and lignite are notified by the Union government under the Mines and Minerals (Development and Regulation) Act 1957 but it is collected and retained by the states.

There is additional royalty on account of District Mineral Foundation (DMF) which accrues to State government exchequer and National Mineral Exploration Trust (NMET) which accrues to the Union government exchequer.

The Section 9B of the MMDR Act, 1957 prescribes establishment of District Mineral Foundation (DMF) in any district affected by mining related operations. The objective of the DMF is to work for the interest and benefit of persons, and areas, affected by mining related operations. The Ministry of Mines has notified the Mines and Minerals (Contribution to District Mineral Foundation) Rules, 2015 with DMF collection rates of 10 per cent of royalty for auctioned mines (leases granted on or after 12 January 2015) and 30 per cent of royalty for mines allocated prior to 12 January 2015. According to MMDR Amendment 2015, State government requires to establish DMF that will be used for development of people and areas affected by mining operation. In September 2017, Government of India has launched *Pradhan Mantri Khanij Khsetra Kalyana Yojna* (PMKKKY) which will be implemented by using funds accruing to the DMF from miners. Directions were issued under section 20A of MMDR Act to incorporate PMKKKY into rule framed for DMF.

In pursuance of subsection (1) of Section 9C of the Mines and Minerals (Development and Regulation) Act, 1957, with the objective to expedite mineral exploration in the country, the National Mineral Exploration Trust (NMET) was established by the Government of India vide Gazette Notification G.S.R.633 (E) of 14 August 2015. The Trust supports regional and detailed mineral exploration in the country and other activities approved by the Governing Body, to achieve its objectives. To implement

[6] Though CST is the Union Tax, right from the inception it is collected and retained by the origin states.
[7] Please see https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=101253 (last accessed on 22 February 2022).

mandated activities an NMET Fund has been established and it receives money from holders of mining lease or a prospecting licence-cum-mining lease. Present rate of additional royalty on account of NMET is 2 per cent of royalty paid in terms of the Second Schedule of the MMDR Act.

In addition to royalties, some states collect various cesses under Land Revenue (e.g., Assam, West Bengal). For example West Bengal collects *West Bengal Rural Employment Cess on Coal Mines* and *West Bengal Education Cess on Coal Mines* under Land Revenue.

Royalties and associated cesses on coal and lignite are rent on natural resources and therefore in our carbon tax proposal we have not included them to estimate rate of carbon tax. Moreover, royalties on coal and lignite are origin based levy and an important source of revenue for state governments where mines are located.

Both in the GST regime and pre-GST regime, collection of all taxes from coal and lignite are not available from published documents of the Union and state governments. In the pre-GST regime, the Union Budget Documents and Union Finance Accounts used to publish three specific information pertaining to coal and lignite sector - collection of 'Clean Energy Cess' from coal and lignite, collection of 'Cess on coal and coke' under Union Excise Duty[8] and royalty collection from coal and lignite. In the GST regime, except royalty collection from coal and lignite, there is no information pertaining coal and lignite from the Union Budget as well as Union Finance Accounts. For states, except royalty collection from coal and lignite there is no specific information on coal and lignite from State Budget as well as State Finance Accounts (except collection of cesses from lands under coal mines in Assam and West Bengal). Even in royalty collection from coal and lignite, information is available for only three coal and lignite producing states (Assam, Odisha and Telangana). Lack of revenue information specific to coal and lignite from published government sources compels us to adopt alternative approach. We consider Coal India Limited (including all ancillaries) as representative of coal sector and NLC India Limited as representative of lignite sector in India. To support our consideration we present the share of CIL and NLC India Ltd. in total off-takes of coal and lignite respectively for 2016-17 and 2019-20 in Table 9. The share of CIL in total off-take of coal is 83 per cent in 2019-20 and the share of NLC India Ltd. in total off-take of lignite is 59 per cent in 2019-20. We estimate total taxes on coal and lignite (in Rs. per tonne) based on information available from annual reports of CIL and NLC India and apply the tax on total consumption of coal and lignite in India's thermal power sector in our study.

[8] This is Stowing Excise Duty and it used to be collected by Coal Controller's Organisation.

Table 9: Share of Coal India Limited (CIL) and NLC India Limited in Total Off-Takes of Coal and Lignite in India (million tonne)

		Coking	**Non Coking**	**Total Coal**
2016-17	Coal India Limited	51.41 (89.1)	489.658 (84.1)	541.068 (84.5)
	Grand Total	57.702	582.42	640.122
2019-20	Coal India Limited	43.318 (88.7)	537.452 (82.5)	580.77 (82.9)
	Grand Total	48.851	651.469	700.32
				Lignite
2016-17	NLC India Limited			25.578 (59.3)
	Grand Total			43.155
2019-20	NLC India Limited			25.123 (59.4)
	Grand Total			42.267

Note: Figures in the parenthesis show the percentage share in total off-take from all sources
Source: Tables 4.19, 4.22 & 4.23 of *Coal Directory of India 2019-20* and Tables 4.17, 4.19 & 4.20 of *Coal Directory of India 2016-17*

2.3.1 Taxes on Indigenous Coal and Lignite

Total tax on per tonne of coal and lignite is lower in the GST regime as compared to the pre-GST regime (Table 10). This is irrespective of increase in average pit-head value of coal from Rs. 1269 per tonne in 2016-17 to Rs. 1519 per tonne in 2019-20.[9] However, average pit-head value of lignite has gone down from Rs. 1668 per tonne in 2016-17 to Rs. 1584 per tonne in 2019-20. GST rate on coal and lignite is 5 per cent (Central GST 2.5% and State GST 2.5%) and it is lower than earlier Union Excise Duty rate of 6 per cent. However, State Sales Tax/VAT rate was 5 per cent on coal and lignite. In the pre-GST regime, there was Stowing Excise Duty on coal (@Rs. 10/ tonne), Central Sales Tax (CST, on inter-state sales of coal) and entry tax. In the pre-GST regime inter-state sales used to attract 2 per cent CST, in the GST regime inter-state supplies attract 5 per cent IGST. With the introduction of GST, entry tax has been rolled back.

Total tax on indigenous coal has gone down from Rs. 541.68 per tonne in 2016-17 to Rs. 467.06 per tonne in 2019-20. For lignite, total tax has gone down from Rs. 433.58 per tonne in 2016-17 to Rs. 404.87 per tonne in 2019-20 (Table 10).

[9] Pit-head value of coal is the value of coal at pit-head of the colliery. It is computed on the basis of base price and therefore it does not include any cost of loading, transportation from pit-head, cess, royalty, sales tax, Stowing excise duty etc.

Table 10: Taxes on Indigenous Coal and Lignite

Particulars	Coal (Coal India Limited)		Lignite (NLC India Limited)	
	2016-17	2019-20	2016-17	2019-20
Production (million tonne)	554.14	602.138	27.617	24.864
Off-take (million tonne)	543.319	581.926		
Statutory Levies (in Rs. 10 million)				
a) Royalty	8,745.84	10,682.04	478.38	489
b) Additional Royalty under MMDR Act				
b1) District Mineral Foundation (DMF)	3,964.47	3,123.36		
b2) National Mineral Exploration Trust (NMET)	221.16	214.31		
c) Cess on Coal#	1,706.37	1,859.45		
d) State Sales Tax/ VAT	2,787.91	12.00		
e) Central Sales Tax (CST)	1,200.09	20.36		
f) Stowing Excise Duty	538.00			
g) Union Excise Duty (UED)	2,617.56	20.93	91.36	
h) Clean Energy Cess	21,062.06		1103.02	994.56*
i) Entry Tax	283.82			
j) Others	941.00	1,064.15	3.05	12.12
k) Goods and Services Tax (GST)				
k1) Central GST (CGST)		1,364.60		
k2) State GST (SGST)		1,363.90		
k3) Integrated GST (IGST)		167.55		
l) GST Compensation Cess		23,166.07		
m) Total	**44,068.28**	**43,058.72**	**1675.81**	**1495.68**
n) Statutory Levies without Royalties and associated Cesses [m-(a+b1+b2+c)]	**29,430.44**	**27,179.56**	**1,197.43**	**1,006.68**
o) Total Tax Per Tonne of Off-take (Rs. /Tonne)*(n/off-take of coal)	**541.68**	**467.06**	**433.58**	**404.87**

Note: # - Of Total Cess on Coal of Rs. 1,706.37 crore in 2016-17, Rs. 1,690.74 crore paid to West Bengal and Rs. 3 Crore to Assam. For 2019-20, out of Total Cess on Coal paid of Rs. 1,859.45 crore, Rs. 1,856.87 crore paid to West Bengal and Rs. 2.58 crore paid to Assam.
*-Estimated [(Production in Million Tonne *Rs. 400/tonne)/10]
Source: Compiled from *Operational Statistics* (Page No. 21) and *Annexure 9* (Page No. 97-99) of Annual Report & Accounts 2019-2020 of Coal India Limited, Annexure 12 (Page No. 113-115) of Annual Report & Accounts 2016-2017 of Coal India Limited. *10 Years Performance at a Glance – Physical* (Page No. 11) and Notes to Standalone Financial Statements (Note No. 29, Page No. 117) of Annual Report 2019-20 of NLC India Limited. Notes to Standalone Financial Statements (Note No. 28, Page No. 107) Annual Report 2017-18 of NLC India Limited.

2.3.2 Taxes on Imported Coal and Lignite

Collection of customs duty and associated taxes from imported coal is not available from the published documents of the Union government. Therefore, we estimate customs duty collections from non-coking coal based on CIF (Cost, Insurance and Freight) value of imported coal as available

from *Provisional Coal Statistics* of Coal Controller's Organization (Table 11). Since thermal power plants use imported non-coking coal, we estimate total tax on imported non-coking coal only in Table 11. We exclude Basic Customs Duty (BCD) and Social Welfare Surcharge (SWS) from estimation of total taxes on imported coal in Table 11. In other words, in our carbon tax proposal we exclude basic taxes on imports (BCD & SWS). Total tax on imported coal (in Rs. per tonne) has gone down marginally in the GST regime as compared to the pre-GST regime (Table 11).

Table 11: Estimation of Taxes on Imported Coal

Particular	Unit	**Pre-GST Regime (2016-17)**	**GST Regime (2019-20)**
a) Import of Non Coking Coal*	Million Tonne	149.309	196.70383
b) CIF Value of Imported Non Coking Coal	Rs. Million	590,013.33	914,652.23
c) Assessment Value (includes 1% of CIF Value as landing charges) (b*1.01)	Rs. Million	595,913.46	923,798.75
d) Basic Customs Duty (BCD @10% of Assessment Value) (c*0.10)	Rs. Million	59,591.35	92,379.88
e) Social Welfare Surcharge (SWS) (@10% of BCD) (d*0.10)**	Rs. Million		9,237.99
f) Assessment Value+ BCD + SWS (c+d+e)	Rs. Million	655,504.81	1,025,416.62
g) Countervailing Duty (CVD @ 6%) (f*0.06)	Rs. Million	39,330.29	
h) Integrated GST (IGST @5%) (f*0.05)	Rs. Million		51,270.83
i) Clean Environment Cess (CEC @Rs. 400/tonne) (a*400)	Rs. Million	59,723.60	
j) GST Compensation Cess (GSTCC @Rs. 400/ tonne) (a*400)	Rs. Million		78,681.53
k) Total Value of Imported Non Coking Coal (f+g+i) or ((f+h+j)	Rs. Million	754,558.70	1,155,368.98
l) Value of Imported Non Coking Coal (k/a)	Rs./tonne	5,053.67	5,873.65
m) Taxes on Imported Non Coking Coal (excluding Basic Customs Duty & Social Welfare Surcharge) (g+i) or (h+j)	Rs. Million	99,053.89	129,952.36
n) Taxes on Imported Non Coking Coal (m/a)	Rs./tonne	663.42	660.65
o) Imported Non Coking Coal consumed in Thermal Power Sector	Million Tonne	45.187	68.114
p) Estimated Tax on Imported Non Coking Coal Consumed in Thermal Power Sector (n*o)	Rs. Million	29,977.75	44,999.51

Notes: *- Total Coal (Coking and Non-Coking Coal)
**- Social Welfare Surcharge (SWS) is a surcharge levied u/s 110 of the Finance Act, 2018. It is levied as a duty of Customs on the goods imported into India, to fulfil the commitment of the government to provide and finance education, health and social security.
Source: Compiled and estimated by author using Table 5.5 (Page No. 63 for 2019-20 and Page No. 63 for 2016-17) of *Provisional Coal Statistics* of Coal Controller's Organization.

2.3.3 Taxes on Electricity

States collect electricity duty on sales of electricity. Electricity duty is also collected from captive power plants. Electricity duty rate varies across states. Revenue on account of electricity duty is compiled from Finance Accounts and Budget Documents of State and Union governments (Appendix Table A1). We assume that the share in total generation of electricity by sources reciprocates the share in total sales of electricity (Table 12). Therefore, we consider that 76.85 per cent of electricity duty collection in 2016-17 (i.e., Rs. 288,500.96 million) and 73.92 per cent of electricity duty collection in 2019-20 (i.e., Rs. 410,814.13 million) may be considered to subsume under carbon tax. However, operationalising a differential tax regime on electricity based on source of generation may be difficult at this tume. Moreover, electricity duty is borne by consumers; and in absence of any alternative tax on electricity there will be no incentives for consumers to conserve electricity. Therefore, we postpone our proposal to include electricity duty into the proposed carbon tax on coal and lignite based TPPs.

Table 12: Source-wise Gross Generation of Electricity (Giga Watt Hour = 10^6 Kilo Watt Hour)

Source		2016-17				2019-20			
		Utility	Non-Utility	Total	% Share	Utility	Non-Utility	Total	% Share
Thermal	Steam	**944,022**	**137,588**	**1,081,610**	**76.85**	**994,197**	**205,546**	**1,199,743**	**73.92**
	Diesel	401	9,182	9,583	0.68	199	1,919	2,118	0.13
	Gas	49,094	22,855	71,949	5.11	48,443	25,443	73,886	4.55
	Total	993,516	169,625	1,163,141	82.64	1,042,839	232,908	1,275,747	78.61
Hydro		122,378	144	122,522	8.71	155,769	348	156,117	9.62
Nuclear		37,916		37,916	2.69	46,472		46,472	2.86
RES*		81,548	2,277	83,825	5.96	138,337	6,310	144,647	8.91
Total		**1,235,358**	**172,046**	**1,407,404**	**100.00**	**1,383,417**	**239,567**	**1,622,984**	**100.00**

Note: *RES: Renewable Energy Sources Excluding hydro
Source: Table 3.6(A & B) of *Energy Statistics of India 2022*

3. Results and Discussion

We estimate revenue neutral tax rate on CO_{2e} emission from coal and lignite based thermal power plants (TPPs) for both pre-GST regime (2016-17) and GST regime (2019-20). Table 13 shows that a tax of Rs. 328 per tonne of CO_{2e} emission would have been revenue neutral in the pre-GST regime (i.e., 2016-17). In the GST regime (i.e., 2019-20), a tax of Rs. 291 per tonne of CO_{2e} emission is estimated to be revenue neutral (Table 14). Given the energy and emission intensity of coal and lignite used in Indian power sector, we estimate tax rate on CO_{2e} emission which will help to achieve revenue neutrality with reference to prevalent taxes on coal and lignite used in TPPs. Any carbon tax rate higher than the estimated RNR may accelerate reductions of CO_{2e} emission from coal and lignite based TPPs.

In this exercise we consider subsummation of taxes on coal and lignite (excluding royalties, Basic Customs Duty and Social Welfare Surcharge on imports) into carbon tax. We have not considered levying emission tax on fugitive emission of CO_{2e} from coal mining and post mining activities, as real-time monitoring of CO_{2e} emission from surface and underground mines may be difficult. Moreover, TPPs cannot be hold responsible for fugitive emissions from coal mines and post-mining operations. Therefore, fugitive emission may be treated separately when broad-based carbon tax is levied on mining sector. We also keep aside electricity duty from inclusion under the proposed carbon tax. As implementing source-specific electricity duty may be difficult at this time and in absence of electricity duty or any other tax on electricity consumption, there will be no incentive for consumers to conserve electricity.

Table 13: Possible Rate of Tax on CO_{2e} Emission from Coal and Lignite based Thermal Power Plants – Pre-GST Regime (2016-17)

Description	Pre-GST Regime (2016-17)						
	Fuel Category						Total
	Coking Coal	Non Coking Coal			All Coal	Lignite	
		Indigenous	Imported	Total			
Solid Fuel Consumption in Electricity Sector (million tonne) (A)	43.455	490.244	45.187	535.431	578.886	38.824	
CO_{2e} Emission from Coal & Lignite Based Thermal Power Sector(million tonne of CO_{2e}) (B)	96.41			886.24		40.35	1,023.00
Tax on Fuels (Rs./tonne) (C)	**541.68**	**541.68**	**663.42**			**433.58**	
Total Tax on Solid Fuels Consumed in Electricity Sector (Rs. Million) (D=A*C)	23,539	265,555	29,978	295,533	319,071	16,833	335,905
Electricity Duty Collection from Coal Based Thermal Power (Rs. Million) (E)							221,717
Total Tax on Coal, Lignite and Electricity (Rs. Million) (F)							557,622
Tax on CO_{2e} emission (excluding Fugitive Emission & Electricity Duty) in Electricity Sector (Rs./ tonne) (G=D/B)*							**328.35**

Source: Estimated by Author

Table 14: Possible Rate of Tax on CO_{2e} Emission from Coal and Lignite based Power Plants –GST Regime (2019-20)

Description	GST Regime (2019-20)						
	Fuel Category						Total
	Coking Coal	Non Coking Coal			All Coal	Lignite	
		Indigenous	Imported	Total			
Solid Fuel Consumption in Electricity Sector (million tonne) (A)	39.056	585.1	68.114	653.214	692.27	36.332	
CO_{2e} Emission from Coal & Lignite Based Thermal Power Sector(million tonne of CO_{2e}) (B)	86.65			1,081.19		37.76	1,205.60
Tax on Fuels (Rs./tonne) (C)	**467.06**	**467.6**	**660.65**			**404.87**	
Total Tax on Solid Fuels Consumed in Electricity Sector (Rs. Million) (D=C*A)	18,242	273,278	45,000	318,278	336,519	14,710	351,229
Electricity Duty Collection from Coal Based Thermal Power Sector (Rs. Million) (E)							303,682
Total Tax on Coal, Lignite and Electricity (Rs. Million) (F)							654,911
Tax on CO_{2e} emission (excluding Fugitive Emission & Electricity Duty) in Electricity Sector (Rs./ tonne) (G=D/B)*							**291.33**

Note: *-Electricity Sector implies Coal and Lignite based Thermal Power Generation
Source: Estimated by Author

3.1 Operationalisation of Carbon Tax

To implement carbon tax, upfront tax exemptions on coal and lignite from existing taxes may be avoided. This will help to stop any possible diversion of coals and lignite allocated to power sector to other uses. Therefore, in the proposed carbon tax regime present taxes on coal and lignite (including taxes on imported coal) may continue. It is to be also noted that differential tax treatments of coal and lignite allocated to TPPs may be difficult to implement. In other words, higher tax on coal and lignite allocated to TPPs may be difficult to operationalize as it may encourage emergence of alternative markets of coal and lignite, at least for captive power plants. Like in Value Added Tax (VAT) or GST, input tax credits against taxes on coal and lignite may be adjusted with carbon tax liability. In this framework, carbon tax liability of each TPPs will be based on actual emission of CO_{2e}. The proposed regime will be less disrupting in terms of administrative changes. In the present GST regime, adjustment of input tax credit with carbon tax liability would be easier as both coal and lignite attract GST and the Union and State tax bases are consolidated and on the consolidated tax base either CGST-cum-SGST (for intra-state transactions) or IGST (for inter-state transactions) is levied. Exclusion of royalties, Basic Customs Duty, Social Welfare Surcharge (on imports) and electricity duty from the proposed carbon tax would be easier as they are also kept outside the GST system.

The proposed carbon tax will be incentive-compatible as efficient TPPs (based on low CO_{2e} emission) may face lower carbon tax burden as compared to inefficient TPPs. To accelerate the reduction of CO_{2e} from TPPs, carbon tax rate may be revised every regular intervals, keeping in mind total

emission reduction as well as revenue targets from coal and lignite based TPPs. Higher carbon tax may induce TPPs to reduce their CO_{2e} emission intensity. Implementation of the proposed carbon tax system may not create any additional burden on tax administration. However, to operationalise this system, real-time monitoring of CO_{2e} emissions from each TPPs (including captive power plants) will be important. In this context the Central Electricity Authority (CEA) could play an important role along with Central and State Pollution Control Boards. The CEA compiles database containing the necessary data on CO_2 emissions for all grid-connected power stations in India (CEA 2021). The CEA's annual database provides information on net generation of electricity (in GWh), absolute carbon dioxide emissions in metric tonnes, and specific carbon dioxide emissions in t CO_2/MWh. Therefore, joint-monitoring of CO_{2e} emission from power plants by State Pollution Control Boards and the CEA may help to implement the proposed carbon tax. As on 20 August 2020, there are 933 steam-based (coal / lignite) captive thermal power plants with installed capacity of 47,694 MW in India.[10] Monitoring of CO_{2e} emission from captive power plants (not connected to power grid) may be initiated with the help of State Pollution Control Boards. Since, there are only 173 power plants (as on 2019-20) in India in the utility sector;[11] monitoring emission from these plants may not be an administrative challenge. Alternatively, like in the GST regime, each TPP shall self-assess carbon tax liability and furnish a return for each tax period. A third party audit/certification of energy and emission may be mandated for large TPPs or captive power plants.

The carbon tax will be a regulatory levy (cascading type) and there may not have any provision to pass on the burden of carbon tax to consumers of electricity. This policy design may induce TPPs to reduce CO_{2e} emission as the burden of carbon tax will be borne by TPPs from their operating margin.

In line with the present GST regime, the proposed carbon tax may be considered as concurrent tax with equal taxation power between the Union and State governments. In the long-run, carbon tax may be extended to all sectors which are lifting coal and lignite for various industrial uses. Revenue neutral carbon tax structure may differ across sectors depending on end use of coal and lignite and associated CO_{2e} emission potential/ factors.

4. Conclusions and Policy Suggestions

In this paper we explore a revenue neutral rate (RNR) of tax on CO_{2e} emission from coal and lignite based thermal power plants (TPPs) by converting taxes on coal and lignite. The objective of this exercise is to accelerate achieving India's goal of net zero CO_{2e} emission target by 2070. Since coal and lignite based TPPs is the single largest source of India's total emission of Green House Gases (GHGs), mitigation emission of GHGs from TPPs naturally will be highest priority in India.

Based on available published reports of the Government of India, we assess the coal and lignite consumption in thermal power sector. Apart from indigenous coal, Indian TPPs also consume imported coals. Therefore, we also assess the consumption of imported coal in Indian thermal power sector for 2016-17 and 2019-20. We estimate CO_{2e} emission from Indian coal and lignite based electricity sector, based on the methodology available in "*India: Third Biennial Update Report to the*

[10] https://cea.nic.in/old/reports/others/planning/pslf/list_CPP_2018-19.pdf (last accessed on 23 February 2022).
[11] Annex-2A Annual Report 2019-20 of Central Electricity Authority (CEA 2020)

United Nations Framework Convention on Climate Change" for 2016 (MoEFCC 2021). We assume that both energy factor (calorific value) and emission factor of coal and lignite will be the same in 2019 as in 2016. We estimate taxes on per tonne of coal and lignite both for pre-GST (2016-17) and GST regime (2019-20) based on information available from Annual Reports of Coal India Limited (for coal) and NLC India Limited (for lignite). For Imported coal we estimate total taxes based on CIF value of imported non-coking coal as available from publications of Coal Controller's Organisation.

In 2019-20 total tax on coal is Rs. 467.06 per tonne for indigenous coal and Rs. 660.65 per tonne for imported coal. For lignite it is Rs. 404.87 per tonne. In the carbon tax proposal, we exclude royalties, Basic Customs Duty, Social Welfare Surcharge (as applicable for imported coal). We also keep electricity duty outside the proposed carbon tax. We estimate RNR tax rate on CO_{2e} emission from coal and lignite based thermal power plants (TPPs) for both pre-GST regime (2016-17) and GST regime (2019-20). We find that a tax of Rs. 328 per tonne of CO_{2e} emission would have been revenue neutral in the pre-GST regime. In the GST regime, a tax of Rs. 291 per tonne of CO_{2e} emission is revenue neutral. Any tax rate higher than the estimated RNR is expected to induce coal and lignite based TPPs to accelerate emission reductions.

To avoid any possibility of diversions of coals and lignite allocated to power sector to other uses, upfront tax exemptions from existing taxes may be avoided. Therefore, in the proposed carbon tax regime present taxes on coal and lignite (including taxes on imported coal) may continue. Like in Value Added Tax (VAT) or GST, input tax credits against taxes paid on inputs (coal and lignite) will be adjusted with carbon tax liability for coal and lignite based TPPs. In this framework, carbon tax liability of each TPP will be based on actual emission of CO_{2e}. The proposed regime will be less disrupting in terms of administrative changes. In the present GST regime, adjustment of input tax credit with carbon tax liability would be easier as both coal and lignite attract GST and the Union and State tax bases are consolidated and on the consolidated tax base either CGST-cum-SGST (for intra-state transactions) or IGST (for inter-state transactions) is levied. Exclusion of royalties, Basic Customs Duty, Social Welfare Surcharge (on imports) and electricity duty from the proposed carbon tax would be easier as they are also kept outside the GST system at this time.

The proposed carbon tax will be incentive-compatible as efficient TPPs (based on low CO_{2e} emission) may face lower carbon tax burden as compared to inefficient TPPs. To accelerate the reduction of CO_{2e} from TPPs, carbon tax rate may be revised every regular intervals, keeping in mind total emission reduction target from coal and lignite based TPPs. Higher carbon tax may induce TPPs to reduce their CO_{2e} emission intensity which will help to achieve India's emission intensity reduction target to 45 per cent. Implementation of the proposed carbon tax system may not create any additional burden on tax administration. However, to operationalise this system, real-time monitoring of CO_{2e} emissions from each TPPs (including captive power plants) will be important. In this context the Central Electricity Authority (CEA) could play an important role along with State Pollution Control Boards. Alternatively, like in the GST regime, each TPP shall self-assess carbon tax liability and furnish a return for each tax period. A third party audit/certification of energy and emission may be mandated for large TPPs or captive power plants.

The proposed carbon tax will be a regulatory levy (cascading type) and there may not have any provision to pass on the burden of carbon tax to consumers of electricity. This policy design may induce TPPs to reduce CO_{2e} emission as the burden of carbon tax will be borne by TPPs from their operating margin.

In line with the present GST regime, the proposed carbon tax may be considered as concurrent tax with equal taxation power between the Union and State governments. In the long-run, carbon tax may be extended to all sectors which are lifting coal and lignite for various industrial uses. Revenue neutral carbon tax structure may differ across sectors depending on end use of coal and lignite and associated CO_{2e} emission potential/ factors.

Literature on carbon tax proposes high tax on fossil fuels to discourage consumption. Unless India adds capacity in electricity generation from alternative low carbon fuels, increasing tax on high carbon fuels may not result in emission reductions. In the present paper, we propose tax on CO_{2e} emissions from coal and lignite based TPPs to incentivize TPPs to control emissions and therefore reducing emission intensity per unit of electricity generation. This alone may not help India to achieve net-zero target by 2070 but it will help TPPs to reduce CO_{2e} emission intensity.

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Appendix

Table A1: Collection of Taxes and Duties on Electricity (Rs. Million)

State	2016-17	2019-20
Andhra Pradesh	3,333.92	112.57
Assam	494.43	1,945.64
Bihar	2,238.98	4,395.38
Chhattisgarh	14,954.78	18,370.04
Gujarat	58,330.98	87,743.50
Haryana	2,756.92	2,620.09
Himachal Pradesh	3,716.68	1,008.64
Jammu Kashmir	899.42	2,351.17
Jharkhand	1,518.88	2,362.41
Karnataka	14,515.02	26,934.92
Kerala	633.04	679.20
Madhya Pradesh	26,205.29	22,679.97
Maharashtra	66,695.59	96,190.57
Manipur	0.06	0.04
Meghalaya	23.37	14.95
Nagaland	0.63	0.77
Odisha	16,371.41	28,196.70
Punjab	19,930.12	26,965.59
Rajasthan	7,382.38	22,627.65
Tamil Nadu	12,424.73	5,742.02
Telangana	5,140.15	170.69
Tripura	0.18	305.42
Uttar Pradesh	15,558.31	34,525.02
Uttarakhand	1,885.57	393.98
West Bengal	13,188.73	24,214.18
Union Government*	301.42	263.03
Total	**288,500.96**	**410,814.13**

Note: *-Collection on account of United Territories
Source: State and Union Finance Accounts and Budget Documents

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