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Delhi Green Deal

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Abstract

In this paper, we propose a carbon tax policy for Delhi, the most polluted capital in the world, which will fundamentally change the energy mix of Delhi's economy toward clean, green energy and will guarantee universal access to electricity, transport and food, up to a certain amount. Any carbon mitigation strategy needs to alter our dependence on fossil fuels, requiring a systemic overhaul of its energy mix. Implementing a carbon tax will mitigate emissions and mobilise revenue for our proposed re-distributive program of Right to Food, Energy and Travel (RFET). The policy is designed to prefer 'the poor over the rich' as a way of compensating for 'rich hiding behind the poor' in terms of emissions and polluting the environment. Using the input-output analysis, we estimate the class-wise distribution of carbon emissions in Delhi. We find that in order to implement this programme, the necessary estimated tax would be $112.5 per metric ton of carbon dioxide. The free entitlement of fuel and electricity per household comes out to be 2040 kWh per annum and there is an annual universal travel pass of $75 per person for use in public transport, and annual per capita availability of food of $205. The purpose of this proposed policy is two fold in the context of Delhi: bring the emissions under control and provide relief to the people who are at the receiving end of this climate crisis.

Keywords: carbon tax; right to energy; energy policy; inequality; Asia; Delhi.
JEL Classification: Q43, Q48, Q52, Q58

1 Introduction

Delhi is in a deep climate crisis.

It is the most polluted capital in the world and has perhaps the highest carbon emission of any city in India. We propose a way out through a carbon tax which is partly used for changing the energy mix of the city and partly for an in-kind transfer from the rich to the poor in the form of free electricity, upto a certain limit, to the latter and universal travel passes to encourage public transport. We also allocate a fraction of the carbon revenue for universal access to food, up to a certain limit. Instead of either a proposal of 'tax and spend' or 'tax and distribute' argued for in the Global North of late, we propose a middle path of 'tax, spend and distribute' where the distribution is an in-kind transfer unlike carbon dividends in cash.

The implications of pollution are many but just two will suffice here. A report of the Lancet Commission on Health and Pollution states that around 19 lakh people die prematurely every year due to outdoor and indoor air pollution in India (Balakrishnan et al. [2019]). A study by the Indian Journal of Pediatrics shows that the lungs of children in India are 10% smaller as a result of rising pollution levels [Chhabra et al., 2016]. It's nothing short of a public health emergency! The main source of pollutants are fossil fuels – oil, coal and natural gas – burned to produce energy.

Fortunately, there is awareness and concern about this within the residents of Delhi. In a recent survey conducted by a national daily in India, Indian Express, and CSDS, Delhiites feel that the biggest problem facing them is pollution. This awareness may not necessarily extend to the issue of carbon emissions and the impending climate crisis that our planet is faced with. We believe that had the question been formulated instead in terms of carbon emissions and climate change, the response may not have been as forthcoming. A recent analysis shows that more than 65 per cent of respondents in India had never heard of the term climate change [Lee et al., 2015]. This is because the ill effects of pollution is felt directly at the local level. Therefore, it is easier to formulate a response which tackles pollution instead of climate change per se even as a properly drafted mitigation policy can address both the problems. It's high time that Delhi thinks of such a comprehensive plan for making this city healthier and liveable. Many big cities in the world, like London, New York or Beijing, had to act on a war footing to drastically reduce their pollution levels, from conditions under which, much like Delhi, you could not see the sky above. Unless we act proactively, we would have mortgaged the lives of future generations without any fault of theirs.

Hence there is a need for Delhi to reduce its carbon footprint, which will also improve the air quality of the city. An additional component is the fact that the carbon footprint is extremely skewed with the 'rich hiding behind the poor' i.e. high emissions by the rich and the wealthy hide behind the overall low per capita emissions for the country as a whole [Azad and Chakraborty, 2020]. Any policy to curb emissions will also simultaneously improve justice, particularly in resource usage.

But the million dollar question is how? And the answer is to tax carbon, period! The carbon tax addresses both the demand side (by increasing prices of carbon-intensive products) and the supply side (by changing the energy mix and improving energy efficiency) of emissions in the economy. There is, however, a problem with carbon tax. It's regressive in nature, i.e. it affects the poor more than the rich. But thankfully there's a way out. If the tax is distributed equally across individuals in the form of a carbon dividend, the regressiveness disappears since the rich pay higher taxes than the poor but all get the same amount of dividend in return [Brenner et al., 2007]. Unlike the proposal of 'tax and distribute in cash' in the global North, we would like to argue an in-kind transfer to adjust to the sociopolitical milieu of the global South.

We propose that a part of the tax revenue can be used for an in-kind carbon dividend with three components. One, food dividend is distributed to all at a level which can pull the poorest out of the poverty. This level can be determined by the official definition of the poverty line. Our recommendation sits well with 'Right to Food' campaign in India which has been arguing for ration upto a certain limit to be distributed to the poor [Drèze, 2004]. Two, 'free electricity dividend' to the population who contribute less carbon than the economy average. Anything above this limit will be charged in full to control misuse of this policy. Three, to compensate for the rise in transport costs and to encourage the use of green public transport, universal metro/bus passes with a preloaded amount will be issued to every citizen of Delhi. With these three compensations, the policy of Right to Food, Energy and Travel (RFET) prefers 'the poor over the rich' as a way of compensating for 'rich hiding behind the poor' in terms of emissions and polluting the environment.

The other part of the carbon revenue can be used for a systemic overhaul of the energy mix within Delhi, which to a large extent addresses the pressing problem of environmental degradation. We call the energy transition the Green Energy Policy (GEP) component of the overall programme. Since the expenditure side is financed by the revenue side in the form of carbon tax, it will be a revenue neutral policy with no implications on the fiscal deficit of the Delhi government. Not only is the policy comprehensive, it also addresses the criticism that the Delhi government attempts firefighting every winter instead of looking for a systemic solution to this chronic problem in Delhi.

Taxing commodities which emit the most, like electricity and private transport, would incentivise self-regulation of consumption practices. On the other hand, change in the energy mix towards renewables and better efficiency usage of energy will also reduce total emissions in Delhi. This paper attempts to present a detailed proposal in this regard. A valid question can be asked as to why we are choosing a specific city instead of a global or a country-wide policy especially since the problem is not local at all.

The reason is that there have been multiple attempts to address climate crisis globally as well as nationally but unfortunately not to much avail. While global and local solutions are not mutually exclusive, perhaps a bottom up approach may yield better results given the political deadlock global solutions are often faced with. Moreover, if we plan something concrete locally which is implementable both politically and financially, it can also be scaled up at least nationally. This has been the experience of most countries where climate policies started at the state/city levels were later scaled up. Focussing on the local, we present a proposal for Delhi which can be a pilot project for the country if it's successful. Even if it's not scaled up, at least it will help improve the living conditions in the city.

2 A background

2.1 Major pollutants in Delhi

According to Boyce [2019], one of the most dangerous air pollutants is particulate matter. But there are other greenhouse gases (GHGs) that need to be looked at. All the polluting activities also produce carbon, which means that a policy which targets these activities will simultaneously, with a few exceptions, bring carbon emissions and pollution down. In the rest of the paper, therefore, the term 'emissions' encompasses both pollutants and carbon.

To understand the nature of pollution in Delhi, we need to look at the source from which these pollutants are generated (Amann et al. [2017], Bhanarkar et al. [2018]). Delhi has grown across all sectors—industry, transport, and housing, all of which have contributed to an increase in city air pollution (Narain and Bell [2006], Goswami and Baruah [2008], Firdaus and Ahmad [2011], Guttikunda [2012], Sahu et al. [2011], Guttikunda and Gurjar [2012]). While there are

Table 1: Sources of Emissions (in %)

				Gases					
Sources	PM10	PM2.5	SO2	NOx	CO	VOC	CO2	CH4	N2O
Power Plants	16	19	89	43	3	4	49		4
Res & Com. Combustion	9	20	1	3	17	4	13	5	
Industrial Combustion	1		10	1	1		8		
Industrial Processes	3	3							
Road Transport	9	22							
Transport Non exhaust	46	17							
Road Vehicle				52	71	54	28	2	5
Solvent Use						19			2
Fuel Production & Distribution						18		4	
Non-road Mobile							2		
Agriculture Activity		1		1				89	60
Waste/Other	16	18			8	1			29
Total	100	100	100	100	100	100	100	100	100

Source: Bhanarkar et al. [2018]

disagreements, based on the differences in methodologies, across studies on sources of pollutants, we take Amann et al. [2017] as a benchmark to summarize, in table 1, the sources and their contribution in emissions of these pollutants along with the GHGs. The contribution of various sectors, not surprisingly, vary significantly across these gases. If we look at the particulate matter PM2.5 and PM10 in particular, the biggest contributor is (about one third of the total) transport. In terms of spatial contribution, more than half of PM2.5 enters Delhi from neighbouring states like Uttar Pradesh and Haryana as well as other outlying regions. This means that any mitigation policy to have a significant impact on Delhi's air would require a similar implementation, or at least controlling the specific polluting activities, in these neighbouring states.

Guttikunda and Calori [2013] argue that 'the bulk of the pollution [in Delhi] is due to motorization, power generation, and construction activities'. Also based on table 1, one could broadly classify the sectors which contribute the most to emissions in Delhi as power, transport, construction and waste management. We look at these sectors closely in the rest of this subsection.

Transport: There is a large literature on the role of transport on emissions in Delhi. The attempt here is to provide the readers with a broad overview, which is by no means exhaustive. Contrary to the argument of very high contribution of transport in emissions in studies like Badami [2005], Gurjar et al. [2010], transport contributes only one third to PM2.5 in Delhi (Bhanarkar et al. [2018]). And of that, a little more than half is contributed by exhaust gas emissions while the rest by non exhaust emissions like road dust and tire and brake wear (Bhanarkar et al. [2018]). Therefore, a policy like the implementation of the Bharat VI standards in Delhi, which targets just exhaust emissions, may at best address just one sixth of the problem and that too is likely to be overshadowed by higher non-exhaust emissions that follow the anticipated growth in traffic volumes. So, tackling emissions from the transport sector needs to address both the technological side of the problem as well as controlling the demand for vehicles, something that carbon tax can seemingly address.

Power: There are six major power plants located in the vicinity of Delhi, all of which contribute to pollution, though to varying degrees depending on whether they are coal-based (more polluting) or gas based (relatively less polluting). More importantly, due to frequent power cuts and blackouts, large capacity generators in hotels, hospitals, malls, markets, large institutions, apartment complexes, cinemas, telecom towers, and farm houses are used indiscrimately which are all sources of emissions and contribute to the growing PM10 ambient pollution levels (Guttikunda [2012], Guttikunda and Calori [2013]).

Construction: The construction sector is rapidly growing in India. This includes brick and cement manufacturing. The brick kilns located along the borders of Delhi, most of which operate conventional fixed-chimney bull-trench technology, contribute significantly to pollution in the city (Guttikunda [2012]). Another major source of pollution in most Indian cities is road dust (CPCB [2008]), including that from the construction activities.

Waste Management: Waste management and garbage burning contribute to local air pollution – especially because most waste burning is decentralised close to the area of disposal – which means that residents are exposed to burning fumes of plastic, rubber, and soot (Guttikunda and Calori [2013]). Burning of uncontrolled waste emits several compounds. Treatment of municipal solid waste (MSW) and wastewater leads to CH4 emission from landfills and anaerobic wastewater treatment, and NH3 emission from composting (Gurjar et al. [2004]).

2.2 Impacts of Pollution

Air pollution was the second largest risk factor contributing to disease burden in India after malnutrition in 2016, with an increasing trend in exposure to ambient particulate matter pollution and a decreasing trend in household air pollution (Dandona et al. [2017], ICMR [2017], WHO [2016]). In 2017, 1·24 million (95% UI 1·09–1·39) deaths in India were attributable to air pollution. Delhi has the highest DALY among the high socio-demographic index (SDI) states, and all of it is attributable to outdoor air pollution. If the exposure to ambient particulate matter pollution had been lower than the minimum levels associated with health loss, the average life expectancy would have increased in India by 0·9 years (0·8–1·1), with the highest increase in Delhi (1·5 years [1·3–1·7]) (Balakrishnan et al. [2019]).

The Class Divide: While the rich hide behind the poor in terms of emissions, the poor face the brunt of its devastating impact on their health and living conditions (Kathuria and Khan [2007], Garg [2011]). Monbiot [2007] puts it succinctly,

> The effort to tackle climate change suffers from the problem of split incentives: those who are least responsible for it are the most likely to suffer its effects.

Garg [2011] shows that nearly 3/4th of the poor population are exposed to annual 24-hourly average PM10 concentration levels above 150 lg/m3 as opposed to a little over half each in the medium and high income categories. This has to do with, among other things, the parts of the city that the poor live in which have a significantly higher concentration of PM10 (North and Central Delhi districts). This heavy exposure to pollution is componded by an unequal access to health care facilities, which increases the morbidity rates among the poor. Any just transition to a better future would require the access to quality health care to tilt in favour of the poor.

Children the Worst Sufferers Monbiot's quote could not have been more apt to show the unequal effect pollution has on the children. According to CPCB [2008], Delhi's children, as compared to children from other parts, had 1.8- times more upper respiratory symptoms and 2-times more lower respiratory symptoms suggesting higher prevalence of underlying respiratory diseases. And even here, there is a class divide. More children in the low income group are exposed to higher pollution than the medium and high income counterparts (Garg [2011]).

2.3 Prospective and Past Mitigation Strategies in Delhi

Most of the existing literature has focussed on supply side measures to tackle the problem of pollution in Delhi (or India).

Over 15 years ago we shifted some of the major industries out of Delhi to ensure a cleaner environment. The second major initiative in 1998-2002 was to mandate compressed natural gas (CNG) as a fuel for public vehicles, which led to switching for more than 1,00,000 vehicles, in face of international understanding that it is better to mandate performance standards (in this case exhaust standards) and not technologies (in this case CNG). The third initiative was the Delhi Metro network which has expanded over the years to cover major parts of the city. Four, conversion of coal-based thermal power plants within Delhi to gas-based power plants (SoE-Delhi, 2010) and relocation of the coal and fuel oil-based industries, including brick kilns, to the city outskirts, following Supreme Court orders (Narain and Bell [2006]) were attempts to controlling the problem. But there were other counteracting factors, which outdid these achievements such as increasing number of passenger vehicles, lack of enough public transport buses, the increase in freight movement and construction material and debris by trucks passing through the city, the lack of maintenance of trucks and buses, growing demand for electricity including the use of insitu generator sets, and industrial growth.

In terms of prospective measures, Boyce [2019] proposes, in the short run, expanded pollution monitoring, health advisories, provision of particulate-grade masks as measures of adaptation especially to those whose livelihoods depends on the streets of Delhi. In the long run, he proposes measures, much in line with Garg [2011], to phase out diesel vehicles and replacing them with cleaner ones, building bypasses around Delhi to keep heavy transport vehicles out of the city, expansion of public transport with a cap on private automobiles, control on coal-fired power plants, rapid expansion of renewables and ban on waste burning.

Bhanarkar et al. [2018] propose three prospective scenarios — advanced control technology (ACT), low carbon intensity (LCI) and clean air strategy (CAS) — to compare with the baseline business as usual (BAU) scenario to see which of these would be most effective in the long run. The extent of reduction of emissions increases as we move from ACT to LCI to CAS scenarios. In 2030, as opposed to a dramatic rise in emissions, the range of reduction under the three scenarios varies between approximately 15–64% for PM10 emissions, 28–68% for PM2.5 emissions.

As can be noticed, all the measures noted above are some sort of a supply side push to change the quality of air in Delhi. There are a few papers which discuss policies which affect the demand for carbon intensive goods and services. Polluter pay policy and stricter penalties for industrial and commercial sector emissions, incentives for carpooling, and steps such as increase in parking fees, higher registration tax, disincentives for buying second cars, introduction of congestion tax are the additional measures that may be considered [Goel et al., 2015].

2.4 Filling the missing gap

What's missing in the existing literature? While most of the existing literature focuses on the supply side measures, there are some which address the demand side as well but those are few and far between (Azad and Chakraborty [2020]). Moreover, a comprehensive policy comprising of *both* the elements is sorely missing. Emissions are after all a demand *and* a supply side phenomenon. After all, if there is no demand for carbon emitting commodities, they will not be supplied. Similarly, if there are no low carbon emitting techniques, the demand will be met by high carbon emitting processes. So, any mitigation strategy should address both the sides of the problem.

How can it be done? Tax carbon, which increases the prices of commodities according to the carbon embodied in them, thereby signalling the consumers to shift towards low carbon emitting commodities. And use that tax revenue to overhaul the energy mix of the economy. A policy of ‘tax and spend’, therefore, is better than just ‘spend’ on cleaner technologies. A standalone spending policy for greening the economy means running significant fiscal deficits. According to Pollin and Chakraborty [2015], 1.5% of the GDP is required for the next 20 years to make that transition, which would mean a fiscal deficit of exactly that amount over these years unless taxes are increased *pari passu*. That’s a big commitment given that the governments are increasingly obsessed, often incorrectly so, with keeping the deficit under 3% of the GDP as mandated by the Fiscal Responsibility Budgetary Management (FRBM) Act of the parliament. And if the governments want to stick to these fiscal targets *and* implement the green energy policy that Pollin and Chakraborty [2015] recommend, it will have to come at the cost of spending on other social sectors, like health and education, which are already underfunded. Our comprehensive policy of ‘tax, spend and distribute’, in contrast, is a revenue neutral policy with no increase in the fiscal deficit.

Is there such a well functioning tax system which comes close to our proposal, which we can draw lessons from? Fortunately, yes and it is British Columbia. Let us look at their experience briefly before we present a detailed proposal.

2.5 Carbon Tax: What can we learn from British Columbia?

The Canadian province of British Columbia (BC) instituted in 2008 a stand-alone carbon tax that covered about three quarters of all emissions sources in the province. Among the unique elements of the BC carbon tax is its goal of revenue-neutrality i.e. the tax revenue was redistributed to the people, largely in the form of tax cuts. The taxed fuels include liquid transportation fuels such as gasoline and diesel, as well as natural gas or coal used to power electric plants, along with other types of fuels (Murray and Rivers [2015]).

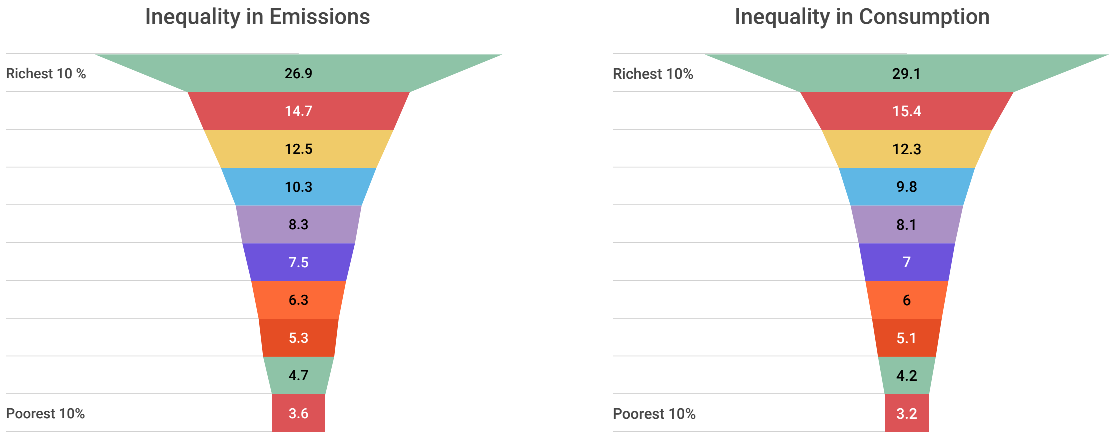
The target tax rate was achieved gradually and not in the first year itself. It was redistributed in the form of cut in low income personal taxes, cash transfers to rural households and corporate taxes. It led to roughly a 19% reduction in per capita fuel sales relative to other Canadian provinces (Elgie and McClay [2013]). It had a positive effect on employment with a shift taking place from emission-intesive and trade-intensive (EITE) to non-EITE sectors because of a higher employment elasticity in the latter (Yamazaki [2015]). The distributional impacts too were along the expected lines i.e. compensating the regressive impact of the tax (Lee and Sanger [2008], Beck et al. [2015b,a]). In terms of public acceptability, the young (under 30) were particularly in favour of the tax even as the incumbent party got reelected after the introduction of the tax.

3 Our proposal

3.1 Climate Injustice in Delhi

As noted earlier, while the rich hide behind the poor in terms of emissions, the poor face the brunt of its devastating impact on their health and living conditions. To what extent do the rich hide behind the poor in emissions? To find out, we divide the population of Delhi into deciles according to their level of total consumption. We construct a distribution ‘funnel’ where each decile’s share in total carbon emission is plotted with the richest at the top. The two funnels for Delhi are shown in figure 1. The details of data analysis are given in the methodology section below. Two datasets have been used to calculate these figures — the national sample survey (NSS) in combination with India’s input-output matrix.

Added to what can justifiably be called the ‘pollution capital of the world’ is this stark inequality in emissions in Delhi, both of which need to be simultaneously addressed to compensate



Source: NSS Data, 68th round and India's input-output matrix (Authors' Calculation)

Figure 1: Delhi's Climate Injustice Funnel

those who are least responsible for it. In other words, we need a policy which can simultaneously bring the pollution level down and invert the climate injustice funnel and create a pyramid of benefits, so to speak, where the poorest classes benefit the most and the richest in effect pay for this benefit by paying higher taxes.

Based on this funnel, we create a climate injustice quotient (CIQ), which measures the share of a class in total emissions as against its share in total population. Those whose share in emissions is more than their share in population, will have a CIQ of greater than one and those with lesser a CIQ of smaller than one. This CIQ plays a critical role in our policy. We design a policy where those with CIQ greater than one (those who inflict injustice on the others) pay for the benefits accruing to those with a CIQ smaller than one. So, the break-even point happens at the seventh decile whose CIQ is almost one. The top three deciles hide behind the bottom seven, so to speak, in emissions (see Table 4 below).

3.2 Emissions: A Class Analysis

Before we go into such a policy, we need to understand *why* we get a funnel-like structure in emissions. This has to do with the consumption pattern of these classes. Not only does the absolute consumption decrease as we go down the funnel, the composition of this consumption changes where for the same rupee spent, the poor emits less. So, for eg., a higher proportion of the total consumption of the rich is spent on transport, mostly air travel, which has a high carbon content (the reasons for which are discussed below).

To facilitate the discussion, we divide total consumption into eight categories — food, clothing, medical, housing, electricity, transport, industrial goods, and miscellaneous items. As the income rises, the composition of consumption moves away from food towards other categories, such as clothing, transport, medical, housing (see table 2). The only exception to this rule is the expenditure on fuel and electricity, which behaves more like food i.e. its share in total household expenditure declines as we move from the poorer to the richer classes. This is a significant result since it will have an impact on the incidence of carbon tax on the poor.

To demonstrate the change in composition of commodities across classes, we take the relatively most equal, i.e. food, to the most unequal commodity consumed, i.e transport. Food being an

Table 2: Share in Total Per Capita Expenditure in Delhi (in %)

	Commodities								Decile's Share
Deciles	Food	Clothing	Indus. Goods	Housing	Fuel & Elec.	Trans.	Med. & Educ.	Misc	in total consumption
1	61.7	1.6	5.7	1.7	12.4	6.2	3.3	7.5	3.2
2	56.9	3.9	5.5	3.5	11.9	6.0	5.7	6.6	4.2
3	53.5	3.4	6.6	4.6	10.4	6.3	7.8	7.3	5.1
4	51.5	3.5	6.9	2.3	10.4	8.0	9.4	8.2	6.0
5	46.5	6.0	6.5	6.2	10.2	8.2	7.4	9.0	7.0
6	43.8	4.8	6.1	7.1	9.3	9.2	10.5	9.0	8.1
7	42.3	3.6	7.3	7.6	9.7	8.7	9.7	11.1	9.8
8	38.5	3.5	6.3	13.4	8.4	10.4	9.1	10.3	12.3
9	36.2	3.6	7.2	5.7	7.7	12.3	13.5	13.8	15.4
10	29.8	3.4	4.6	8.2	7.2	13.9	12.4	20.5	29.1
Average	40.0	3.7	6.0	7.2	8.8	10.6	10.4	13.2	

Source: Authors' Calculation based on 68th Round of NSS

absolute necessity, the income elasticity of which is less than one, shows a more equal distribution relative to transport (see figure 2), with an income elasticity much higher than one, which resembles more like a funnel.

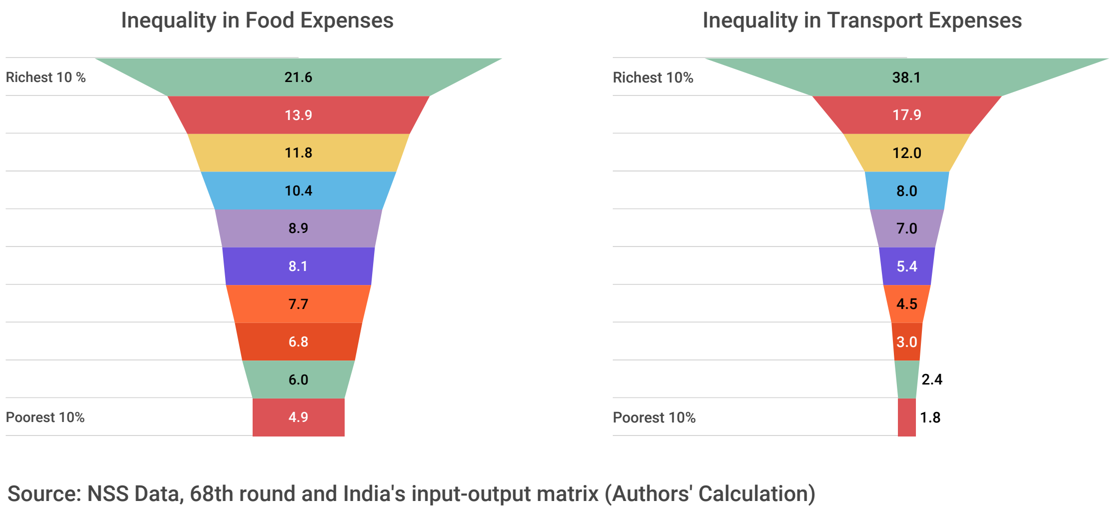


Figure 2: Inequality in Food and Travel Expenses in Delhi

We also estimate the carbon content of these commodities. We combine the consumption data of Delhi with the input output matrix for the Indian economy to arrive at these carbon figures. The input output matrix tells us the amount of an input that has gone into production, directly as well as indirectly, of a unit of output of a commodity 'x'. So, we have calculated the amount of carbon (as an input) that goes into the production of the commodities under the eight categories arrived at from the NSS data (see table 3). More details of calculation are given in the methodology section and appendix.

There are two columns of carbon content in the table and they stand for 'before and after' scenarios of the green energy policy component. Current carbon content represents what the current input output matrix of India tells us about how much carbon is embodied in each of these commodities. We assume an average real rate of growth of 6% over the two decades of the programme, which translates into an increase from 1.8 trillion dollars in 2011-12 (the year of NSS data available) to 6.1 trillion in 2035-36. The emissions, however, do *not* grow at the same rate, which increases from 2018 mmt of CO2 to 2200 mmt over the same period, because of both the shift towards renewables and better efficiency in the usage of fossil fuels. Hence, the carbon intensity, which is carbon emitted per unit of the GDP, decreases by 33 percentage points. [1]

Table 3: Carbon Content of Commodities of Consumption

Categories in terms of Consumption	Current Carbon Content (in mtCO2/$)	New Carbon Content (after GEP)
Food	0.0003	0.0002
Clothing & Footwear	0.0011	0.0008
Manufactured Goods	0.0028	0.0019
Housing	0.0018	0.0012
Fuel and Electricity	0.0135	0.0090
Transport	0.0027	0.0018
Health and Education	0.0004	0.0002
Misc Services	0.0004	0.0002

Source: Authors' Calculation (see text for details)

It is interesting to see from tables 2 and 3 why, in spite of a higher share spent on a low carbon embodied food by the poor, inequality in emissions is marginally *less* than consumption. This is because low carbon food is more than compensated by high carbon fuel and electricity in the budget of the poor. We dig deeper into why the expenditure on fuel and electricity has an income elasticity less than one i.e the expenditure on which rises slower with a rise in income. It turns out that there are two components within this category – LPG and informal sources of energy – the shares of which in total expenditure falls as we move up the income scale. This is not surprising since LPG, the accessibility of which in a city like Delhi is extensive across income categories, is used for cooking and the expenditure on that would move in tandem with food. As for the informal sources of energy like coke, firewood and chips, dung cake, matches (box), charcoal and candle, they are again mostly used for cooking among the poorer sections of the population.

3.3 A Charge on Pollution: The 'Robinhood' Carbon Tax

We propose that carbon taxes are imposed at the site where carbon enters into the economy, which are then passed on to the consumers according to the carbon content in each of the commodities they consume. Carbon taxes, like any indirect tax, are regressive in nature i.e. the poor have to shell out more as a proportion of their income than the rich. This regressiveness is further compounded by the fact that the poorest household spends a higher share of its budget on fuel and electricity (12.4%) as compared to the richest class (7.2%). And these shares are all with respect to their total consumption expenditure and not their income. The NSS does not survey the income of the households. The extent of regressiveness of a carbon tax, therefore, would be even greater when calculated as a share of their income as compared to our results based on their expenditure. It will be gross injustice if the greatest burden of mitigation of the climate crisis falls on those who contribute the least to it. Our policy proposal seeks to invert this injustice by shifting the burden on the rich who compensate the poor in the process.

We address this injustice at two levels.

One, the carbon revenue so generated is partly spent on changing the energy mix at the production stage itself. This would mean that for the same levels of expenditure, the emissions are much lower, thereby, decreasing the effects of climate crisis and pollution which fall disproportionately on the poor. Two, the other part of the revenue is spent on in-kind transfers at three levels - free rations of food upto a limit; free access to electricity upto a certain limit; and pre-loaded transport passes. We will show that these transfers more than compensate for the loss that the poor will incur as a result of the carbon tax and this compensation in effect is borne by the richest, who emit the most.

3.3.1 Inverting the Climate Injustice Funnel

The basic entitlement to electricity, transport passes and food is determined by the climate injustice quotient (CIQ), which measures the share of the carbon footprint of classes as a proportion of their share in the population (see table 4). It can be seen that it is the seventh decile below where the CIQ is less than 1, which means they contribute less than their share in the population, whereas those above it contribute more. We take the seventh decile as the cutoff point for the energy and transport component of the RFET. So, the free entitlement of electricity and travel passes is determined by the mean expenditure of the seventh decile under these categories. For the food component, we take the mean expenditure on food of the third decile and make that as the universal right of all. The third decile is decided by the official poverty line of India, according to which the bottom 30 percent of the population lives under poverty. With these benefits, the climate injustice is sought to be inverted in favour of the poor.

Table 4: Carbon Footprint and the Climate Injustice Quotient

Deciles	Footprint per capita	HH Size	Footprint per HH	Share in Footprint	CIQ
1	0.5	6.9	3.687	0.054	0.54
2	0.7	6	4.181	0.061	0.61
3	0.8	6.2	4.901	0.072	0.72
4	0.9	5.4	5.051	0.074	0.74
5	1.1	5.6	6.232	0.091	0.91
6	1.2	4.7	5.807	0.085	0.85
7	1.5	4.2	6.475	0.095	0.95
8	1.9	3.8	7.101	0.104	1.04
9	2.2	4.4	9.654	0.141	1.41
10	4.0	3.8	15.275	0.223	2.23

Source: Authors' Calculations (see text for details)

Free rations: India has had a universal public distribution system (PDS) in the past according to which every Indian was entitled to a certain ration which was distributed through government ration shops. With the economic reforms in 1991, however, this approach was abandoned in favour of a targeted public distribution system, where the population is divided into the below povery line (BPL) and above poverty line (APL) categories. BPL category level households have a certain entitlement to rations. It has been argued in the literature that this targeted system has generated more problems of false exclusions than solving the problems of so-called leakage and inefficiency of the universal system. On the issue of corruption in the public distribution system (PDS), Somanathan [2015] shows through field studies that leakages are miscalculated in government documents. Moreover, if the coverage is universal, there is no incentive for leakage since everyone has access to the same ration. Study of one of the states in India, Tamil Nadu, which continues to have a universal PDS, shows that the leakage is neglibile as compared to the other states which have gone the targeted way [Swaminathan, 2008].

Food poverty, which, among other things, leads to malnutrition among children, is the biggest hurdle to any social or income mobility. It affects every decision of the household, including the amount spent on health and education. While addressing food poverty may not be a sufficient condition for economic upliftment of the poor and the needy, it surely is a necessary condition. Moreover, if the State takes care of the food requirements, as we propose, it eases up the budget of the poorer households to spend on education and health, which may help the families get out of the poverty trap.

While setting a limit to how much ration is sufficient for a family is a difficult judgement to make both politically and ethically, we need to have an estimate to work out the policy details. The least that should be done is giving all families a right to that amount which is equivalent to the poverty line as defined by the government. Since the third decile is considered to be the poverty line, we take their mean food consumption as the entitlement of all. In all likelihood, there is a self selection here as the richer classes (even the middle class) do not access ration shops. So, our calculations are overestimates and the actual expenditure on this component will surely be lower than what we account for. An alternative could be that this basic entitlement itself is increased, assuming the top 30% of the population will not access these rations, so as to keep the total food distribution within the limits set by this policy.

There is a special policy advantage, unlike the following two components, that free rations provide. Since it has the least carbon content (see table 3), its provisioning post the carbon tax does not rise all that much (only by 2.3%).

Free Electricity: While Delhi, unlike most other Indian cities, may have provided near universal access to electricity to its population, it remains out of reach for many because it is expensive. If, however, this access is made more inclusive by providing certain units free to those households which consume less than that limit, it might contribute towards a democratic distribution of resources across different income classes. To be sure, the present Delhi govt has a scheme of providing 200 units free to every household. However, our proposal is it should be provided only to those who consume less than that limit and not to all households. This will help reduce the overall consumption as compared to the current scheme since those on the margin would try to reduce their consumption to stay within the limits whereas those who consume more gain nothing from this policy and hence have no incentive to increase their power usage.

We are aware that this scheme, much like the Delhi govt's current scheme, will increase the total consumption of electricity and hence contribute to emissions and pollution. However, unlike the current scheme, there are two reasons why this may *reduce* emissions. One, from the demand side, taxing carbon increases the price of electricity by 67%, which will induce people to consume less. Two, from the supply side, since a part of the revenue is going to be used to changing the energy mix of electricity production in favour of renewable sources, emissions will be reduced to that extent.

Travel Passes: As discussed in the background section above, one of the highest contributors to emissions in Delhi is transport, public as well as private. By public transport we mean mass public transport like the Delhi Transport Corporation (DTC) buses and Delhi Metro. Cabs or autorickshaws do not count as public transport even though they emit relatively less than other modes of private transport owing to their mandatory CNG requirements. Mass public transport emits far less than other modes of transport both because it carries more people for an equivalent use of fuel and their source of fuel used is, in the case of DTC, gas-based instead of oil, and in the case of Metro, more than one third of the electricity drawn from solar based power plant.[2] Delhi's experiment with free travel passes for women holds a lot promise as it shows that the footfall of women rose by a significant 10 percentage points. Our travel proposal attempts to increase the footfall of all.

Controlling emissions from the transport sector, much like any other sector, requires a combination of demand and supply measures. The basic objective of both these measures is to create incentives for the people to use public transport while dissuading them to use private transport. By supply side measures, one is suggesting creating well planned and efficient mass transit infrastructure which includes, among others, last mile connectivity to the metro, exclusive bicycle lanes, pedestrian sidewalks, rapid bus corridors. All of this may discourage private transport. To be sure, there is also a counteracting effect of efficient mass transit system, particularly of modes which take the passenger load off the roads, for eg. the Delhi metro, since it leaves greater space for cars and motorbikes to ply. Demand measures, however, can control this counteracting effect. Carbon tax, owing to relatively higher carbon content in usage of private vehicles, is going to increase the relative price of private versus public transport, thereby, helping us address the demand side of our problem. Other fees like parking charges, yearly registration, incentives of car pooling, high registration fees on second cars etc. can be complemented with a universal carbon tax.

Apart from disincentivising private transport, our policy proposal includes an extra incentive for people to shift to public transport, which decreases the relative price of public transport even further. Free travel passes financed by the carbon tax can be used on any mode of public transport. There is already clear evidence on at least a 10 percentage point rise in the footfall of women travellers in the Delhi Metro after the Delhi government made travel free for women. Unlike the case of energy, here the travel passes are universal, which means a signal is being given that the opportunities created to use public transport is class-neutral. In fact it is the upper deciles which need to move to public transport since they are the biggest emitters. Ideally public transort should be free but that would mean an even higher carbon tax to finance it, which may not be politically viable to implement [Dellheim et al., 2018]. But once carbon tax is implemented, Delhi should gradually move towards free public transport financed by increased taxes.

However, this policy will fail if people don't have alternatives to essential services such as transport. The bus rapid transport (BRT) or the odd-even experiment in Delhi failed, in part, because they were not accompanied by a comprehensive plan for enhancing public transport[Mohan et al., 2017]. Therefore, the sequencing of this policy should be to first overhaul the public transport infrastructure, discussed below, and then tax carbon to finance it.

3.3.2 Addressing the Supply side: Changing the Energy Mix

The idea here is to decrease carbon emissions and pollutants. Since this is dependent on burning of fossil fuels whether directly, say driving motor vehicles, or indirectly, say in terms of electricity usage which is produced using these fossil fuels.

Efficiency: An important component of fossil fuel is the efficiency of energy usage. India is one of the most energy inefficient countries in the world i.e a lot of energy gets wasted in production or consumption for an unit of output [Pollin, 2015]. So, on this count alone, a lot of energy saving, and emission reduction, can be done. It is often argued that this may not necessarily decrease energy consumption but may even increase it because energy becomes cheaper, what is known as the 'rebound effect'. This is not an issue in our proposal for two reasons. One, we are proposing to change the energy mix of electricity production by moving away from fossil fuels towards renewable green energy. So, the emissions related to production are addressed at the production stage itself. Two, because along with energy saving techniques we are also introducing carbon taxes which increase the price of electricity, so, there will be a net rise in prices as opposed to a fall in the absence of these taxes.

Power: Since taxes have been elaborated upon, we discuss now the process of changing the energy mix of a city like Delhi. If we look at the fossil fuel intensive sectors, three stand out for Delhi — power, transport and construction. All of Delhi's power is not generated in Delhi. It buys power from neighbouring regions. Out of that total power usage, 98% come from thermal sources whereas the rest come from renewable energy (CMIE database). While what matters for Delhi's pollution levels are those power stations located within the city and a very narrow city-specific approach would mean to just target the power plants located in Delhi itself. A more inclusive approach, however, would be to change the composition of power altogether, Delhi or outside Delhi alike. The current inter-state power purchase agreements should be renegotiated in favour of renewables. The fact that Delhi Metro can do it means this could be done for the entire consumption of Delhi provided there are no supply constraints in the renewable energy production sector. We propose 1.5% of Delhi's gross state domestic product (GSDP) allocated to make this transition. Since this requires such a change not just for Delhi but also for power sources outside of Delhi, there should be a national approach towards such a change in power generation, which, as Pollin and Chakraborty [2015] have shown, requires 1.5% of India's GDP to be spent on this transition. This is an important step since we are proposing free units of electricity upto a certain limit be given to address energy inclusion. Such a proposal will surely lead to an increase in consumption by the households lower on the income distribution. It is, therefore, critical that the source of power generation moves away from fossil fuels as far as possible so that the net effect of such a policy is at least neutral if not a reduction in emissions.

Transport: As for transport, a lot has been written but little done in praxis. Studies have shown that mass transit in dense mega cities like Delhi has to be a combination of buses, metro, bicycles and pedestrian pathways but the focus of governments across the political spectrum has primarily been on the metro. While there are many positives of metro given its large carrying capacity, one-third dependence on renewables for power, extensive network, there are some flipsides too. One of the most important problems is that its ticket prices has skyrocketed in recent times making it out of the reach even of the lower middle classes. The other problem of course is the huge infrastructural costs in building the network. But if it can be made accessible to the working class of the city, those high costs are justified. Also, if the share of renewable energy can be increased further, emissions can be controlled to that extent. But quite aside from the metro, studies have shown that, one of the most cost effective ways of bringing the emissions down are the other three modes — bus, exclusive bicycle lanes and pedestrian pathways. Moreover, the role of these three as complementing the metro is also important in its own right as they provide the last mile connectivity that the Delhi Metro is struggling to deal with. Constructing bus corridors to address the unpredictability of bus timings and increasing the fleet of buses to improve their frequency, bicycle lanes and pedestrian pathways would require significant public spending, some of which will be self financed through energy savings. As for the private cars (which, though lesser in number, will still be plying no matter what), apart from the government mandated eco-friendly models, there is a need for better road infrastructure since one of the highest vehicle emissions emanate from the friction of the tyres, which is greater the worse is the road condition.

Summary of the supply side measures: A detailed proposal on decreasing the dependence on fossil fuel and increasing the efficiency of energy usage for India has been presented in Pollin and Chakraborty [2015]. We present here some of the salient features of that proposal:

1. Raise the economy's level of energy efficiency through the operations of buildings, industry and transportation systems.
2. Among fossil fuel energy sources, increase the proportion of natural gas consumption relative to coal, because carbon emissions from burning natural gas are about one-half those from coal.
3. Invest in the development and commercialisation of some combination of the following technologies:
   (a) Clean renewables, including solar, wind, hydro, geothermal and low-emissions bioenergy,
   (b) Nuclear power,
   (c) Carbon Capture and Sequestration (CCS) processes in generating coal, oil, and natural gas-powered energy.

Of these three, the primary focus should be on 1 and 3 (a) above as Pollin et al. [2015] and Pollin [2015] have argued.

3.4 Broad Contours of the Fiscal Policy

The fiscal policy we have proposed above is revenue neutral, which means the carbon taxes are calculated endogenously. Let us look at the steps of arriving at the appropriate tax rate. There are four categories of expenditure — changing the energy mix G_f, free rations (in nominal terms) F free electricity upto a certain unit (in real terms) $\bar{e}$, and travel passes (in nominal terms) T. We propose, like Boyce and Riddle [2007, 2011], Fremstad and Paul [2017], that the tax is collected 'upstream' instead of the messy commodity wise carbon taxes because the former has lower administrative costs while preventing leakage on account of multiple layers of administration. These taxes will get passed on to the consumers by the producers in tandem with the rise in cost of production as a result of these taxes. The administrative cost of this collection has been assumed to be 1% of the tax revenue in the literature, so, we make the same assumption. Let us call this total net revenue R, which, with $\bar{C}$ as the total carbon emissions in Delhi and t as the carbon tax, is given by:

$$R = t\bar{C} - 0.01t\bar{C} = 0.99t\bar{C} \tag{1}$$

For the supply side measures, we take the expenditure required to change the energy mix in Delhi to be 1.5% of the GSDP. So, the total expenditure on this count would be $G_f = 0.015 \cdot Y$, where Y is Delhi's GSDP. For the demand side measures, if the tax rate is t per unit of carbon, the prices of each of these three entitlements increase according to their respective carbon content. Denoting the new carbon content (resulting from the implementation of the policy) as c_f, c_e, c_t (the figures for each are given in the last column of table 3), the price rise, assuming the old price of electricity to be p_e will be $1 + c_f \cdot t, p_e + c_e \cdot t, 1 + c_t \cdot t$ for food, electricity and transport respectively[3]. We can now calculate the total costs that the Delhi government has to bear for the proposed policy. The carbon tax rate t is, therefore, calculated endogenously in the following manner.

$$0.99t\bar{C} = 0.015Y + (1 + tc_f)F + (p_e + tc_e)\bar{e} + (1 + tc_t)T$$
$$t = \frac{0.015Y + F + p_e\bar{e} + T}{0.99\bar{C} - c_f F - c_e\bar{e} - c_t T} \tag{2}$$

4 Methodology and Data

4.1 Methodology

The methodology used in the paper is similar to the existing literature [Fremstad and Paul, 2019]. To calculate the carbon content in individual commodities, as well as the employment potential of a given sector in the economy, the input-output tables for India, have been used. The Right to Energy programme requires two steps: calculating the carbon content and determining its impact on the household budget. For the former, IO data is used. And for the latter, the national sample survey (NSS) data is used to estimate the consumption of different deciles of the households. Commodities of consumption in the NSS have been recategorised to match with the IO specification available for India.

Step 1: To calculate the effect of a carbon tax on the price of a commodity, we borrow the methodology used in Brenner et al. [2007], and we use Fremstad and Paul [2017] to estimate the carbon content. The *direct* content dc_{ej} is simply the amount of the energy sector going into producing one unit of that commodity (e and j in dc_{ej} represent the energy sector and the sector which produces the commodity under consideration respectively). There is an *indirect* carbon content too, which enters a commodity through the other commodities that have gone into its production. The sum of these gives us the total content (tc_{ej}) of carbon of a commodity, which can be calculated from the Leontief inverse matrix in the following manner, where **DC** and **TC** are respectively the matrices of direct and total content of commodities as inputs to commodities as outputs and, **I** is the identity matrix.

$$\mathbf{TC} = (\mathbf{I} - \mathbf{DC})^{-1} \tag{3}$$

Each of the elements tc_{ij} in **TC** represent the amount of commodity i entering as an input for production of a unit of commodity j. By implication the tc_{ej} represents the amount of energy embodied in each commodity j, so, the energy row of the **TC** matrix gives us the total content of energy in each of the commodities. To find out the carbon content in commodity j, we multiply it by the amount of carbon (c_e) emitted by a unit of energy,

$$c_j = tc_{ej} \cdot c_e \tag{4}$$

The increase in price of a commodity j as a result of a tax t imposed on carbon can then be calculated by multiplying this tax rate with the total carbon embodied in a commodity,

$$p_j^{new} = p_j^{old} + c_j \cdot t \tag{5}$$

This increase in prices can then be used to calculate its adverse impact on the budget of a household.

Step 2: The budget of the household is derived from the NSS survey. The NSS survey gives details of expenditures for a household across a whole range of commodities defined at a very detailed level. Since our attempt is to find the carbon content of these commodities, we have recategorised them in a way that is commensurate with the IO level of disaggregation. We have divided the commodities into eight categories and found the respective industries in the IO table and the commodities in the NSS survey to match that. The exact codes used for this match from the respective sources is provided in table 1 of the appendix.

With this match, the carbon content and the price rise can now be calculated across these eight consumption categories based on equations 4 and 5. The total carbon content of these eight categories of commodities has been reported in table 3.

The effect of a carbon tax varies across income categories of households, so, we divide the NSS population in deciles and study the effect of this tax on their budget and then compensate both for free energy and travel passes to see the net impact of our programme on these deciles. We also report the overlap between class and caste to show the progressive effects of our policy on the socio-economic fabric of India.

4.2 Data Sources

We use the latest NSS 68th round unit level data (survey done in 2011-12), and the corresponding source for the Input-Output table is OECD database. NSS schedule 1.0 has been used for consumption related data. For carbon consumption of Delhi, we use the estimates from the web resource (http://citycarbonfootprints.info/) and extrapolate it using the World Development Indicators, World Bank database.

5 Results

We first present a summary of the fiscal expenditure required for the proposal to come into being (see table 5). As discussed earlier on the supply side intervention, there are two components — investment in renewables and improving efficiency of energy usage. We propose that the expenditure required, as a proportion of Delhi's Gross State Domestic Product (GSDP), under these two heads are 1%, 0.5% respectively. The annual figures under these categories are given in the upper half of table 5. All the calculations here are for 2011-12 and the reason why it is dated is because this is the latest round of data publicly available from NSSO.

In the lower half of table 5, we present the figures relevant for the demand side measures of this policy — free rations and electricity and travel passes. We present the total figures here, the procedure of arriving at each is presented below. The level of carbon tax required is USD 112.5 per metric tonne per year for the 20 year period when this policy is under effect. We would like to suggest that the implementation of the carbon tax itself could be gradual so that in the initial years, it will be deficit financed which will be compensated for in the later years by higher than average taxes. This is for two reasons. One, a sudden high tax of carbon will lead to high inflation and may kill the policy before it has seen the light of the day as was the case with yellow vest movement in France. Two, the people will start receiving the benefits, including of infrastructure, way ahead of when are taxed for these, which will make the carbon tax acceptable.

Before we go into the details of the benefits under each of these three categories, we need to discuss the pattern of expenditure of different income classes to be able to understand how these benefits as well as the tax burden are going to accrue to these classes. Table 6 presents the per capita annual expenditure on different consumption categories for each decile in Delhi.

Table 5: Summary of the Policy Proposal for Delhi

	2011-12 Amount (in million $)
Supply side	
Renewables	1505.5
Efficiency	752.7
Demand Side	
Food	3435.5
Electricity	1423.9
Travel Passes	1261.1
Administrative costs	84.6
Total Expenditure [a]	8463.4
Total Carbon Emissions (MMTCO2) [b]	75.2
Carbon Taxes (per MTCO2) [a/b]	$112.5
Carbon Revenue	8463.4
Net Balance	0

Rise in expenditure under each category of commodities is determined by taxes based on the total carbon embodied in these commodities (c_j in equation 4) as arrived at in table 3. The last row in table 6 presents the extent of rise in expenditure across the commodities as a result of the carbon tax imposed on the population.

As discussed in section 3.3, for food, the third decile's food consumption acts as the benchmark. For electricity and travel passes, we need to find the class which acts as the dividing line between the beneficiaries, who are at the receiving end, and the payers, who are the primary inflictors of emissions. And a just way of dividing the population into these two groups would be to find the decile which contributes just as much as their share in the population, the so called benchmark, i.e. who have a CIQ of 1. For the data we have, that group happens to be the seventh decile.

There is one charge, the carbon charge, and three benefits distributed as a part of the program — rations, electricity and travel passes — levels of which need to be determined. The results are presented in table 7.[4].

Table 6: Total Annual Per Capita Expenditure in India (in $)

			Commodities							
Deciles	HH Size	Total Expenses	Food	Clothing	Indus. Goods	Housing	Fuel & Elec.	Trans.	Med. & Educ.	Misc
1	6.9	144.7	3.7	13.4	3.9	29.1	14.4	7.8	17.6	234.4
2	6	176.3	12.2	17.1	10.9	36.8	18.5	17.8	20.5	310.1
3	6.2	200.9	12.7	24.9	17.5	39.1	23.8	29.3	27.6	375.7
4	5.4	227.7	15.6	30.4	10.1	45.9	35.2	41.4	36.2	442.5
5	5.6	239.0	30.9	33.3	32.1	52.5	42.3	37.9	46.4	514.4
6	4.7	262.0	28.8	36.4	42.7	55.7	55.2	62.9	53.9	597.7
7	4.2	306.6	26.4	52.6	55.2	70.1	62.7	70.1	80.4	724.2
8	3.8	349.2	31.4	57.5	121.9	76.3	94.2	82.8	93.6	906.9
9	4.4	412.5	41.0	81.6	65.5	87.7	140.3	154.5	157.1	1140.2
10	3.8	640.8	74.2	99.8	175.8	154.4	299.1	267.4	440.4	2151.9
Average	5.1	296.0	27.7	44.7	53.6	64.7	78.6	77.2	97.4	739.8
Post Tax Rise (%)			2.3	8.5	20.9	13.2	101.0	19.8	2.8	2.7

Source: Authors' Calculation based on 68th Round of NSS

Table 7: Potential Per Capita Distributional Incidence of Delhi's Green Energy Program (in USD)

				Carbon Dividend						Percentage of Expenditures		
Decile	Total Expenses [a]	HH Size [b]	Carbon Charge [c]	Energy [d]	Transport [e]	Food [f]	Total Benefit [g=d+e+f]	Net Benefit [h=g-c]	Net Benefit per Household [i=h x b]	Charge (in %) [c/a]	Benefit (in %) [g/a]	Net Benefit (in %) [h/a]
1	234.4	6.9	39.9	84.98	75.1	204.6	364.7	324.9	2241.6	17.0	155.6	138.6
2	310.1	6.0	52.0	97.73	75.1	204.6	377.5	325.5	1952.9	16.8	121.7	105.0
3	375.7	6.2	59.0	94.58	75.1	204.6	374.3	315.3	1955.2	15.7	99.6	83.9
4	442.5	5.4	69.8	108.59	75.1	204.6	388.3	318.6	1720.2	15.8	87.8	72.0
5	514.4	5.6	83.0	104.71	75.1	204.6	384.5	301.4	1688.0	16.1	74.7	58.6
6	597.7	4.7	92.2	124.76	75.1	204.6	404.5	312.3	1467.9	15.4	67.7	52.3
7	724.2	4.2	115.0	139.61	75.1	204.6	419.4	304.3	1278.2	15.9	57.9	42.0
8	906.9	3.8	139.4	0.00	75.1	204.6	279.8	140.3	533.2	15.4	30.8	15.5
9	1140.2	4.4	163.7	0.00	75.1	204.6	279.8	116.0	510.6	14.4	24.5	10.2
10	2151.9	3.8	299.9	0.00	75.1	204.6	279.8	-20.2	-76.7	13.9	13.0	-0.9

Carbon charge: Based on the carbon footprint of each decile and the carbon tax per unit of carbon, we calculate the per capita carbon charge for each decile. The regressiveness is visible in the decreasing percentage of carbon charge as we move up the expenditure scale where the poorest have to shell out 17% of their total expenditure and the richest 13.9%. A better indicator of the extent of regressiveness would have been the charge as a share of their incomes instead of just their expenditures. If taken as a proportion of their income, the regressiveness would have been worse since the poor consume a higher share of their income as compared to the richest. In the absence of the incomes data, however, we would have to make do with the expenditure data itself. Our policy seeks to address this regressiveness of the carbon tax with the three in-kind benefits discussed below.

Free Rations: Mean yearly per capita food consumption of the third decile in Delhi is worth USD 204.6. We use that figure as an entitlement to the entire population of Delhi. Since it will be available for free to all, it will surely alleviate food poverty of the bottom 3 deciles. Food rations of this value constitute one of the three in-kind benefits in table 7.

Equitable Access to Electricity: As discussed earlier, the benefit of electricity goes only to those households which consume equal to or less than 170 units (the consumption level of the seventh decile). All those consuming more than that will not be eligible for this policy unlike the current scheme of the Delhi government. Giving it to all gives the richest classes a license to pollute more *and* get rewarded for doing that. Another benefit of this policy is that since there is a basic entitlement to electricity, its stealing too may decline signficantly. For the policy to work properly, the government will have to provide electricity connection at the level of households, including in temporary settlement colonies as also for both owners and tenants. Benefits under the electricity and cooking category in table 7 give us the per capita values across the deciles. Unlike the other two benefits, the benefits under this category are not uniform because they are uniform at the level of the household since distribution of electricity at an individual level cannot be administered practically. Since the numbers of members per household decreases as we move up the income scale, the per capita entitlement rises up to the seventh decile and then drops to zero for the top three deciles because their monthly consumption.

Travel Passes: As for the travel passes, since we want to encourage all commuters to shift to public transport instead of using low capacity and heavy-polluting private transport, the passes are given to all the residents of the city. These pre-loaded passes would come with a value of USD 75.1 per person per year, the amount that the seventh decile on an average currently spends on transport. This travel pass will be applicable on all public modes of transport i.e. DTC buses, Delhi Metro as well as feeder buses for the Metro. This amount is low compared to the high costs of public transport in Delhi but this is what an average person in the seventh decile spends in Delhi. It goes without saying that this travel pass should be indexed to inflation (at least to the rate of rise in price of tickets across these modes of transport) to be able to provide for the same level of benefits in real terms. For this pass to be practically usable in the Delhi Metro, its exorbitant ticket prices have to be brought down. It's only fair that they are because public transport should be for all and not just for those who belong to the higher strata in the society.

Net Benefits: The overall benefits per capita is the sum of the three benefits and it can be seen that it more than compensates for the carbon charge for all the deciles except the topmost. The poorest Delhiite gains $324.9 every year while the richest loses 20.2 as a result of this policy. In terms of percentage of expenditure, the regressiveness of the carbon charge changes significantly in the progressive direction (last column of table 7), thereby, inverting the climate injustice funnel we started the discussion with.

6 Conclusion

We are at the brink of an irreversible climate crisis. The time to act is now or never! Across the world, progressive movements are, therefore, demanding accountability of their (and other) governments on the issue of carbon emissions. Some of these demands have made their way to the fiscal policy of the governments. Our attempt in this paper is to provide a green alternative to Delhi, which is the most polluted capital city in the world with a looming health emergency as a result. Our idea of focussing on a city instead of a national analysis is that smaller pilot projects have a higher success rate. Moreover, if such a policy can be implemented in Delhi, it can provide a political incentive to be scaled up for the country.

The purpose of this policy is two fold: bring the emissions under control and provide relief to the people who are at the receiving end of this climate crisis. We have proposed a carbon tax which finances both a green energy transition to fulfil the first goal and a benefits programme in the form of right to food, energy and public transport travel passes to achieve the second goal. The level of carbon tax comes out to be $112.5 per mtCO2.

A carbon tax acts on both the demand and supply sides. On the demand side, by increasing the prices of all commodities according to their carbon content, it acts as a disincentive to consume high carbon embodied commodities. On the supply side, it changes the energy mix of the economy. It is true that just a city implementing it will not check the climate crisis but a city can surely lead by example.

We would like to suggest that the implementation of the carbon tax be staggered and the balance amount deficit financed during the initial 5-6 years. This is for two reasons. One, a sudden high tax of carbon may not find acceptability among the people as was the case with yellow vest movement in France. Two, the people will start receiving the benefits, including of infrastructure, from year 1 while they are taxed in entirety only a few years down the line, which will make the gradual tax increase acceptable.

Delhi residents, including the rich and the wealthy, need to be convinced that the current and future inhabitants of the city, which includes their children, will have a healthier life with such a green and egalitarian policy. No one wants to carry an air purifier or a face mask around the city and no one should, whether you can afford one or not.

Appendix

While we use Delhi specific consumption data, the underlying production structure is taken at a country level. One of the reasons to do so is that there is no state-specific IO matrix and the other reason is that the production of commodities can be broadly assumed to have a similar process across the country. In most commodities, such as cars, clothing and other industrial goods, fuel, medical, this is most likely to be the case. In some others, which are not standardised across the country, such as food, the production processes could vary. Nothwithstanding these differences, given the paucity of data at the state level, we believe taking the IO matrix of India as representative of Delhi is a close approximation to reality.

Table 1: Code Matching from Input Output Tables to NSS Categories

Consumption Categories	**IO Codes***	**NSS Codes****
Food	C01T05+C15T16	1 to 17
Clothing and Footwear	C17t19	29+30+31
Manufactured Goods	C20+C21T22+C24+C25+ +C26+C27+C28+C29+ +C30T33X+C31+C34+C35+C36T37	21+22+23+34
Housing	C45+C70+C71	26
Fuel and Electricity	C10T14+C23+C40T41	18
Transport	C60T63	25
Health and Education	C80+C85	19+32+33
Misc Services	C50T52+C55+C64+C65T67 +C72+C73T74+C75+C90T93	20+24+27

*Codes are taken from OECD Input-Output Tables (IOT), 2015
**Codes are serial numbers of items in the Summary of Consumer Expenditure (Level 12) of Schedule 1.0 (NSS 68th round)
Source: Compiled by authors from IO, NSS

Table 2: Macro Level Estimations

2011-12 (actual)	
Average Carbon content	
GDP (US$) [a]	1827637859135.7
Carbon emissions (mmt CO2) [b]	2018.503
Carbon intensity (mtco2/USD [b/a]	0.0011044327
2035-36 (estimated)	
Average Carbon content	
GDP estimated (US$) [c]	6100000000000
Carbon emissions (mmt CO2 [d]	2200
Carbon intensity (mtco2/USD) [d/c]	0.000360655737704918
Midrange of carbon content	0.663276468
Reduction in carbon content	0.336723532

Source: Authors' Calculation (see text for details)

Table 3: Mimimum Per Capita Distributional Incidence of Delhi's Green Energy Program (in USD)

				Carbon Dividend						Percentage of Expe		
Decile	Total Expenses [a]	HH Size [b]	Carbon Charge [c]	Energy [d]	Transport [e]	Food [f]	Total Benefit [g=d+e+f]	Net Benefit [h=g-c]	Net Benefit per Household [i=h x b]	Charge (in %) [c/a]	Benefit (in %) [g/a]	N
1	234.4	6.9	39.9	8.14	17.3	148.0	173.47	133.60	921.8	17.0	74.0	
2	310.1	6.0	52.0	11.86	22.1	180.4	214.40	162.40	974.4	16.8	69.1	
3	375.7	6.2	59.0	12.19	28.5	204.6	245.30	186.31	1155.1	15.7	65.3	
4	442.5	5.4	69.8	16.45	42.2	204.6	263.26	193.47	1044.7	15.8	59.5	
5	514.4	5.6	83.0	18.11	50.7	204.6	273.42	190.38	1066.1	16.1	53.2	
6	597.7	4.7	92.2	22.91	66.2	204.6	293.72	201.53	947.2	15.4	49.1	
7	724.2	4.2	115.0	32.28	75.1	204.6	312.04	197.01	827.4	15.9	43.1	
8	906.9	3.8	139.4	0.00	75.1	204.6	279.76	140.32	533.2	15.4	30.8	
9	1140.2	4.4	163.7	0.00	75.1	204.6	279.76	116.04	510.6	14.4	24.5	
10	2151.9	3.8	299.9	0.00	75.1	204.6	279.76	-20.18	-76.7	13.9	13.0	

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