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Toward inverting environmental injustice in Delhi

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Abstract
We propose a carbon tax policy for Delhi—the most polluted capital globally—which will fundamentally change the energy mix of Delhi's economy toward clean, green energy and 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 redistributive program: Right to Food, Energy, and Travel (RFET). The policy is designed to advocate for the 'poor over the rich' to compensate for the 'rich hiding behind' the poor by emitting the majority of carbon and pollutants. Using input–output analysis, we estimate the class-wise distribution of carbon emissions in Delhi. We find that the necessary tax would be US$112.5 per metric ton of carbon dioxide in order for this program to work. 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 US$75 per person for use in public transport and an annual per capita availability of food of US$205.

JEL Codes: Q43, Q48, Q52, Q58

Keywords
Asia, carbon tax, climate change, Delhi, energy policy, inequality, right to energy, urban pollution

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Introduction

Delhi is in a deep environmental crisis. It is the most polluted capital globally and has, perhaps, the highest carbon emissions of any city in India. We propose a way out through a carbon tax that is used for changing the city's energy mix and partly for for an in-kind transfer from the rich to the poor of *free* electricity up to a specific limit, and *universal* travel passes to encourage the use of 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.

In advanced countries, especially the USA, there are currently many discussions on the Green New Deal. These countries are trying to figure out a mitigation strategy to avoid the catastrophic event of creating a 'Hothouse Earth,' the marker of the point beyond which any efforts made to reverse these warming will prove futile as a threshold limit will have been crossed (Steffen et al., 2018). However, this problem cannot be solved without a global coordination strategy involving both the North and the South, where both parts of the world, albeit in different proportions, need to share the cost of these transitions (Azad and Chakraborty, 2019). The reasons for the South to participate in this strategy are obvious. If the Intergovernmental Panel for Climate Change (IPCC) targets are not met, tropical regions of the world, which are both densely populated and predominantly in the global South, are likely to be most negatively affected because of their low altitudes and preexisting high temperatures (Martin, 2015; Mendelsohn et al., 2006). Moreover, at a local level, the cities in the tropical South like Delhi already bear some brunt of the change in high and increasing pollution levels.

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 1.9 million 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 due to rising pollution levels (Chhabra et al., 2016). It is nothing short of a public health emergency! The primary source of pollutants are fossil fuels—oil, coal, and natural gas—burned to produce energy for traffic and domestic heating along with construction activities (Hama et al., 2020).

Fortunately, there is awareness and concern about this among the residents of Delhi. In a recent survey conducted by a national daily in India (Sardesai, 2019), 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 global climate crisis, however. We believe that had the question been formulated instead in terms of carbon emissions and climate change, the concern may not have been as forthcoming. An earlier analysis showed that more than 65% of respondents in India had never heard of the term climate change (Lee et al., 2015). Therefore, it is more effective to formulate a response that tackles 'pollution' instead of 'climate change' per se, even though a well-drafted mitigation policy will address both the problems. It is high time that Delhi develops such a comprehensive plan for making this city healthier and more livable.

However, the million dollar question is: how? And the answer is, along with other pollution curbing measures, that we need to tax carbon! A 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 a universal carbon tax program. It is regressive; that is, it affects the poor more than the rich. But, thankfully, there is a solution. If the tax is distributed equally among individuals in the form of a carbon dividend, the regressiveness disappears because the rich pay higher taxes than the poor, while everyone receives the same dividend in return (Boyce, 2019b). Unlike the proposal of 'tax and distribute in cash' in the global North, we would like to argue for an in-kind transfer to adjust to the sociopolitical context of the global South.

A valid concern can be raised as to why we choose to focus on a specific city instead of looking at global or countrywide policy, especially since the problem is not local at all. The reason is that there have been multiple attempts to address the climate crisis globally as well as nationally, but unfortunately without much success. While these solutions are not mutually exclusive, perhaps a bottom-up approach may yield better results. Moreover, if we plan something concrete locally, which is implementable both politically and financially, potentially it can be scaled up to a national level. Some countries have had more success starting at the local level and scaling up to the national level (World Bank, 2020). Di Gregorio et al. (2019: 73) argue that such initiatives and 'innovative institutions need to be specifically designed and dedicated to integrate weaker local level interests in centrally dominated policy processes.' Focusing on the locals, we present a proposal for Delhi which can be a pilot project for the country if it is successful. Even if it is not scaled up, at least it will help improve the living conditions in the city.

A background

Major pollutants in Delhi

According to Boyce (2019a), one of the most dangerous air pollutants is particulate matter. To understand the nature of pollution in Delhi, we need to look at the sources from which these pollutants are generated (Amann et al., 2017; Bhanarkar et al., 2018; Hama et al., 2020). Delhi has grown across all sectors—industry, transport, and housing, each of which have contributed to an increase in city air pollution (Firdaus and Ahmad, 2011; Goswami and Baruah, 2008; Guttikunda, 2012; Guttikunda and Gurjar, 2012; Narain and Bell, 2006; Sahu et al., 2011). While disagreements stem from the use of different methodologies across studies on sources of pollutants, we use Amann et al. (2017) as a benchmark to summarise the sources and their contribution (see Table 1). The contribution of various sectors, not surprisingly, varies significantly across these gases. If we look at the particulate matter PM2.5 and PM10, the largest contributor is transportation, which generates about one-third of total pM2.5 and PM10 emissions. In terms of spatial contribution, more than half of PM2.5 enters Delhi from neighboring states like Uttar Pradesh and Haryana and other outlying regions. Any mitigation policy to significantly impact Delhi's air would require a similar implementation in these neighboring states.

Guttikunda and Calori (2013: 101) 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 that contribute the most to emissions in Delhi as

Table 1. Sources of emissions (in %).

Sources	Gases								
	PM_{10}	$PM_{2.5}$	SO_2	NOx	CO	VOC	CO_2	CH_4	N_2O
Power plants	16	19	89	43	3	4	49		4
Res & Com. Residential & commercial 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 and distribution						18		4	
Non-road mobile							2		
Agricultural 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).

power, transport, construction, and waste management. We look at these sectors closely in the rest of this subsection.

Prospective and past mitigation strategies in Delhi

A number of pollution mitigation strategies have been implemented in Delhi. First Over 15 years ago, some major industries were shifted out of Delhi to ensure a cleaner environment. A second major initiative between 1998 and 2002 mandated compressed natural gas (CNG) as a fuel for public vehicles, affecting more than 100,000 vehicles. This mandate was instituted even though there was an international understanding that it is better to mandate performance standards (in this case, exhaust standards) rather than technologies (in this case, CNG). The third initiative was the Delhi Metro network which has expanded to cover significant parts of the city. A fourth major initiative was converting the coal-based thermal power plants within Delhi to gas-based power plants (Government of NCT of Delhi, 2010) and the relocation of coal and fuel oil-based industries, including brick kilns, to the city's outskirts. These Supreme Court orders were attempts to control the problem (Narain and Bell, 2006), but other factors counteracted these achievements, such as the increase in the number of passenger vehicles, lack of enough public transport buses, the increase in freight movement and the expulsion of construction material and debris from trucks passing through the city, the lack of maintenance of trucks and buses, the growing demand for electricity including the use of in situ generator sets, and industrial growth.

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

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 emission sources in the province. A unique element of this carbon tax is its goal of revenue-neutrality, that is, the tax revenue was redistributed to the people, mainly in the form of tax cuts. The taxed fuels include liquid transportation fuels such as gasoline and diesel, and 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 a 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-intensive 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, that is, compensating the regressive impact of the tax (Beck et al., 2015a, 2015b; Lee and Sanger, 2008).

Climate injustice in Delhi

In Delhi, while the rich hide behind the poor in terms of emissions, the poor face the brunt of their devastating impact on their health and living conditions (Garg, 2011; Kathuria and Khan, 2007). 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 total consumption level. 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.

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

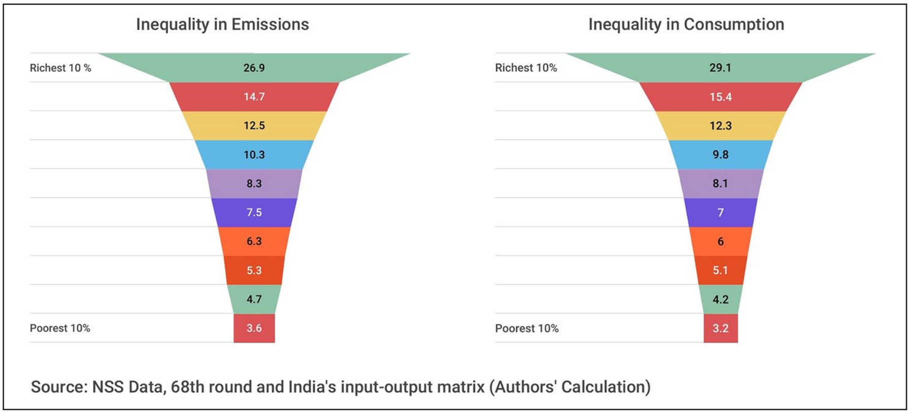

Figure 1. Delhi's climate injustice funnel.

Emissions: A class analysis

Before we go into the details of the 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 absolute consumption decrease as we go down the funnel, the composition of this consumption changes. For example, a higher proportion of the total consumption of the rich is spent on transport, mostly air travel, which has a higher carbon content.

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

To demonstrate the change in the composition of commodities across classes, we compare the relatively most equal commodity, that is, food, to the most unequal commodity consumed, that is, transportation. Food' being an absolute necessity, has an income elasticity of less than one. It shows a more equal distribution relative to transport (see Figure 2), with an income elasticity much higher than one, and so appears more like a funnel.

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 commodity 'x.' 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 National Sample Survey (NSS) data (see Table 3).

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Table 2. Share in total per capita expenditure in Delhi (in %).

Deciles	Commodities								
	Food	Clothing	Industrial goods	Housing	Fuel and electricity	Transport	Medical and education	Miscellaneous services	Decile's share 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	

NSS: National Sample Survey.
Source: Authors' calculation based on 68th Round of NSS.

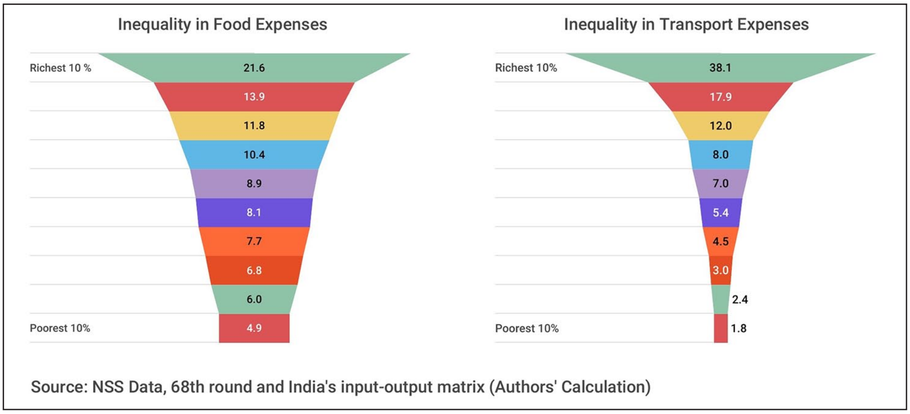

Figure 2. Inequality in food and travel expenses in Delhi.

Table 3. Carbon content of commodities of consumption.

Categories in terms of consumption	Current carbon content (in kgCO_2/US$)	New carbon content (after Green Energy Policy)
Food	0.3	0.2
Clothing and footwear	1.1	0.8
Manufactured goods	2.8	1.9
Housing	1.8	1.2
Fuel and electricity	13.5	9.0
Transport	2.7	1.8
Health and education	0.4	0.2
Miscellaneous services	0.4	0.2

Source: Authors' calculation (see text for details).

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 program, which translates into an increase from 1.8 trillion dollars in 2011–2012 (the year of NSS data available) to 6.1 trillion in 2035–2036. The emissions, however, do *not* grow at the same rate. They are modeled to increase from 2018 mmt of CO_2 to just 2200 mmt over the same period. This is because of both to the shift toward renewables and better efficiency in the usage of fossil fuels. Hence the carbon intensity, which is carbon emitted per unit of gross domestic product (GDP), decreases by almost 33 percentage points.

It is interesting to see from Tables 2 and 3 why, in spite of a higher share spent by the poor on low carbon embodied food, inequality in emissions is marginally less than in

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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 of less than one, that is, why expenditure on fuel and electricity rises more slowly with a rise in income. It turns out that there are two components within this category—liquefied petroleum gas (LPG) and informal sources of energy—the shares of which in total expenditure fall as we move up the income scale. This is not surprising because LPG, which is widely accessible across income categories in a city like Delhi, is used for cooking and the expenditure on it moves in tandem with food. The informal sources of energy like coke, firewood and chips, dung cakes, matches (box), charcoal, and candles are again mostly used for cooking and lighting among the poorer sections of the population.

Our proposal

A charge on pollution: The 'Robin Hood' carbon tax

We propose that carbon taxes are imposed at the site where carbon enters the economy. They are then passed on to the consumers according to the carbon content in each of the commodities they consume. Carbon taxes, generally, are regressive, as 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%) than the richest household (7.2%). Furthermore, these shares are all with respect to their total consumption expenditure and not households' income. The NSS does not survey the income of the households. Therefore, the extent of regressiveness of a carbon tax would be even greater when calculated as a share of households' income compared to our results based on their expenditure. It would be a gross injustice if the most significant burden of mitigating the climate crisis were to fall on those who contribute the least to it. Our policy proposal seeks to invert this injustice by shifting the burden to the rich, who compensate the poor in the process.

We address this injustice at two levels. First, the carbon revenue generated is partly spent on changing the energy mix at the production stage itself. This would mean that the emissions are much lower for the same levels of expenditure, thereby decreasing the effects of climate change and pollution that fall disproportionately on the poor. It would involve improving energy efficiency and expanding green, clean, renewable energy, which will slowly phase out the fossil fuel sector. Second, the other part of the revenue is spent on in-kind transfers at three levels—free rations of food up to a certain limit, free access to electricity up to a specific limit, and preloaded 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 that this compensation, in effect, is borne by the richest, who emit the most emissions.

However, one point needs to be clarified here. A carbon tax alone may not be sufficient to invert the environmental injustice and finance the rapid transition to renewable energy away from fossil fuels. The city also needs to implement other revenue-generating policies to curb pollution. There should be increased parking fees, tolls, congestion charges for cars entering cities, annual licensing fees for private vehicle owners (with

Table 4. Carbon footprint and the CIQ (Climate Injustice Quotient).

Deciles	Footprint per capita	Household size	Footprint per Household	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

CIQ: climate injustice quotient.
Source: Authors' calculation (see text for details).

families owning more than one vehicle), and also charges on luxury and sport vehicles. However, the detailed estimates of these fees and their revenue generation capacity are beyond this study's current scope.

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). Where the CIQ is less than 1, members of a decile contribute less than their share in the population, whereas those above contribute more. We take the seventh decile as the cutoff point for the energy and transport component of the Right to Food, Energy, and Travel (RFET). So, the free entitlement to electricity and travel passes is determined by the mean expenditure of the seventh decile under these categories. For the food component, we instead take the mean expenditure on food of the third decile and make that the universal right of all. With these benefits, the climate injustice quotient is in favor of the poor.

Free rations. 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 the economic uplifting of the poor and needy, it certainly is a necessary one. Moreover, if the state takes care of the food requirements, as we propose, it eases up the poorer households' budget to spend on education and health, which may help families get out of the poverty trap.

While setting a limit on how large a ration is sufficient for a family is difficult, both politically and ethically, we need an estimate for the policy details. The least that should be done is to give all families a right to that amount equivalent to the poverty line as defined by the government. As the third decile is considered to be the poverty line, we take the mean food consumption of a member of the third decile as the entitlement of every Indian citizen. The proposal then is for a *universal food ration program*. However, in all likelihood, there is a self-selection process here because the more affluent classes do not access the fair price shops. Thus, our calculations are overestimated, and the actual expenditure on this component will surely be lower than what we estimate. An alternative could be that this basic entitlement itself is increased, assuming the top 30% of the population will not access these rations, to keep the total food distribution within limits set by this policy.

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 too expensive. However, if this access is made more inclusive by providing certain units free to households that consume less than that limit, it might contribute to a democratic distribution of resources across different income classes. To be sure, the present Delhi government offers 200 units free to every household, regardless of their income level. However, we propose that it only be offered to those who consume less than that limit and not to all households. This will help reduce the overall consumption compared to the current scheme because those on the margin would try to reduce their consumption to stay within 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 government's current scheme, will increase electricity consumption and contribute to emissions and pollution. However, unlike the current scheme, there are two reasons why this may *reduce* emissions. First, from the demand side, taxing carbon increases electricity prices by 67%, which will induce people to consume less. Second, from the supply side, because a part of the revenue will be used to change the energy mix of electricity production in favour of renewable sources, emissions will be reduced to that extent.

Travel passes. 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 people to use public transport while dissuading them from using private transport. Regarding supply-side measures, we suggest creating well-planned and efficient mass transit infrastructure that includes, among other things, last mile connectivity to the subway rail, exclusive bicycle lanes, pedestrian sidewalks, and rapid bus corridors. All of this may discourage private transport. There is also a counteracting effect of an efficient mass transit system, particularly those transport modes that take the passenger load off the roads. Demand measures, however, can control this counteracting effect. Due to the relatively higher carbon content in the usage of private vehicles, a carbon tax will 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 for car pooling, and high registration fees on second cars complement 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 that can be used on any mode of public transport. There is already clear evidence that this works, with at least a 10 percentage point rise in women travellers' footfall in the Delhi Metro, which occurred after the Delhi government made travel free for women. It also provides an empowering and positive experience for women (Kumari and Banerjee, 2020). Unlike in the case of energy, the travel passes are universal, which gives a signal that the opportunities created to use public transport are class-neutral. It is the upper deciles that need to move to public transport because they are the biggest carbon emitters. Ideally, public transport should be free, but that would require an even higher carbon tax to finance it, which may not be politically viable to implement (Dellheim et al., 2018). However, once a carbon tax is implemented, Delhi should gradually move toward free public transport financed by increased taxes.

However, this policy will fail if people do not 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 first to overhaul the public transport infrastructure, discussed below, and then add a carbon tax to finance it.

Addressing the supply side: Changing the energy mix

The goal here is to decrease carbon emissions and pollutants. Since this depends on reducing the burning of fossil fuels whether directly, say driving motor vehicles, or indirectly, say in terms of electricity usage produced using these fossil fuels, the eventual goal is to decrease the fossil fuels' use.

Efficiency. An essential component in reducing fossil fuel usage is improving the efficiency of energy usage. India is not an energy-efficient country in the world, that is, a lot of energy gets wasted in production or consumption for a 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 less expensive—the 'rebound effect.' This is not an issue in our proposal for two reasons. First, we propose changing the energy mix of electricity production by moving away from fossil fuels toward renewable green energy. So, the emissions related to production are addressed at the production stage itself. Second, because, along with energy-saving techniques, we are also introducing carbon taxes that increase the price of electricity, there will be a net rise in prices instead of a fall in the absence of these taxes.

Power. If we look at the major polluting sectors, three stand out for Delhi: power, transport, and construction (Hama et al., 2020). Not all of Delhi's power is generated in Delhi. It buys power from neighbouring regions. Out of that total power usage, in 2020, 98% comes from Non-solar, non-renewable, polluting thermal sources, whereas the rest comes from non-polluting renewable energy, chiefly solar (Centre for Monitoring the Indian Economy (2021) database). The current inter-state power purchase agreements should be renegotiated in favor of renewables. We propose that 1.5% of Delhi's gross state domestic product (GSDP) be allocated to make this transition and also improve energy efficiency. Because this requires such a change not only for Delhi but also for power sources outside of Delhi, there should be a national approach toward such a change in power generation, which, as Pollin and Chakraborty (2015) have shown, requires spending 1.5% of India's GDP. This is an important step because, in this program, we are also proposing that free units of electricity up to a certain limit be given to address issues of energy inclusion. Such a proposal will undoubtedly lead to increased consumption by the households lower on the income distribution. It is, therefore, critical that the source of power generation moves as far away from fossil fuels 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 megacities like Delhi has to combine buses, metro, bicycles, and pedestrian pathways (eg Mohan et al., 2017). However, governments across the political spectrum have focused primarily on the metro subway (Guttikunda and Goel, 2013). While there are many positives of metro, including its large carrying capacity, its use of renewables for power (one-third of its base), and its extensive network, there are some downsides. One of the critical problems is that its ticket prices have skyrocketed in recent years, 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. Nevertheless, if it can be made accessible to the city's working class, those high costs are justified. Also, if the share of renewable energy can be increased further, emissions can be controlled to that extent.

However, aside from the metro, studies have shown that one of the most cost-effective ways of bringing emissions down is the other three modes of public transport: bus, exclusive bicycle lanes, and pedestrian pathways ([reference]). Moreover, these three complement the metro as they provide 'last mile connectivity.' Constructing bus corridors to address the unpredictability of bus timings and increasing the fleet of buses to improve their frequency, and creating bicycle lanes and pedestrian pathways would require significant public spending, some of which will be self-financed through energy savings. As for private cars (which, though lessened in number, will still be used no matter what), apart from the government-mandated eco-friendly models, there is a need for better road infrastructure because some of the highest vehicle emissions emanate from the friction of the tires, which increase as road conditions worsen.

As noted above, the changes in Delhi cannot be made independently of changes to the energy mix of India as a whole. The proposals made in this section should be read alongside the detailed proposal for decreasing dependence on fossil fuels and increasing the efficiency of India's energy usage that has been presented in Pollin and Chakraborty (2015).

Results

We first present a summary of the fiscal expenditure required to implement the proposal (see Table 5). As discussed earlier, there are two components on the supply-side intervention: investment in renewables and improving the efficiency of energy usage. As a proportion of Delhi's GSDP, we propose that the expenditures required under these two

Table 5. Summary of the policy proposal for Delhi.

	2011–2012 Amount (in million US$)
Supply side	
Renewables	1505.5
Efficiency	752.7
Demand side	
Food	3435.5
Electricity	1423.9
Travel passes	1261.1
Administrative costs	84.6
Total expenditures [*a*]	8463.4
Total carbon emissions ($MMTCO_2$) [*b*]	75.2
Carbon taxes (per $MTCO_2$) [*a*/*b*]	US$112.5
Carbon revenue	8463.4
Net balance	0

heads are 1% and 0.5%, respectively. The annual figures under these categories are given in the upper half of Table 5.

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, and the procedure of arriving at each is presented below. The level of carbon tax required is US$112.5 per metric ton per year for the 20 years when this policy is under effect. We suggest that the implementation of the carbon tax itself should 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. First, a sudden high carbon tax will lead to high inflation and may kill the policy before it has seen the light of the day, as was the case with France's Yellow Vest Movement. Second, the people will start receiving the benefits, including the development of infrastructure like better public transport system, roads, and highways, a long way ahead of when the taxies used to pay for these are levied, which will make the carbon tax more 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 understand how these benefits and 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.

The 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, Supplemental file) as arrived at in Table 3. The last row in Table 6 presents the extent of the rise in expenditure across the commodities as a result of the carbon tax imposed on the population.

As discussed above the third decile's food consumption acts as the benchmark for food. For electricity and travel passes, we need to find the class that acts as the dividing line between the beneficiaries, who are at the receiving end, and the payers, who are the primary producers of emissions. A just way of dividing the population into these two

Table 6. Total annual per capita expenditure in India (in US$).

Deciles	Commodities									
	HH size	Total expenses	Food	Clothing	Industrial goods	Housing	Fuel and electricity	Transport	Medical and education	Miscellaneous services
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

NSS: National Sample Survey.
Source: Authors' calculation based on 68th Round of NSS.

Table 7. Potential per capita distributional incidence of Delhi's green energy program (in US$).

Decile	Carbon dividend									Percentage of expenditures		
	Total expenses	HH size	Carbon charge	Energy	Transport	Food	Total benefit	Net benefit	Net benefit per household	Charge (in %)	Benefit (in %)	Net benefit (in %)
	[*a*]	[*b*]	[*c*]	[*d*]	[e]	[*f*]	[*g* = *d* + e + *f*]	[*h* = *g* − *c*]	[*i* = *h* × *b*]	[*c*/*a*]	[*g*/*a*]	[*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

groups would be to find the decile that contributes just as much as their share in the population—the so-called benchmark, 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 pass—levels that need to be determined. The results are presented in Table 7.

Carbon charge

Based on each decile's carbon footprint 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%. 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 US$204.6. We use that figure as an entitlement for the entire population of Delhi. As it will be available for free to all, it will surely alleviate food poverty for the bottom three 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 that consume equal to or less than 170 kWh (the consumption level of the seventh decile) per year. All those consuming more than that will not be eligible for this policy, unlike the Delhi government's current scheme. 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 because there is a basic entitlement to electricity, the common practice of electricity theft may decline significantly. For the policy to work correctly, the government will have to provide electricity connection at the household level, including in temporary settlement colonies and to 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 across the deciles because the provision of resources is uniform at the household level. Because the number of household members decreases as we move up the income scale, the per capita entitlement rises to the seventh decile and then drops to zero for the top three deciles based on their monthly consumption.

Travel passes

As for the travel passes, because 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 city residents. These preloaded passes would come with a value of US$75.1 per person per year, the amount that each member of the seventh decile currently spends on transport on average. This travel pass will be usable on all public modes of transport—DTC (Delhi Transport Corpotation) buses, Delhi Metro, and feeder buses for the Metro. The 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. The travel pass will need to be indexed to inflation (at least to the rate of rise in the price of tickets across these modes of transport) in order 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 will have to be brought down. This is a reasonable proposal because public transport should be for everyone and not just those who belong to the society's higher strata.

Net benefits

The overall benefits per capita are the sum of the three benefits, and it is evident that it more than compensates for the carbon charge for all the deciles except the very top. The poorest Delhiite gains US$324.9 every year, while the richest loses US$20.2 due to 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 discussed earlier. Our findings for Delhi conform with results from other studies, which show 'a significantly increased likelihood of progressive study outcomes within lower income countries and for transport policies' (Ohlendorf et al., 2021: 18).

Conclusion

We are on 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 been addressed by government fiscal policies. This article aims to provide a green alternative to Delhi—the most polluted capital city in the world and a city with a looming health crisis. We have proposed a city-level plan instead of a broader, national-level plan because smaller pilot projects have, in the past, had a higher success rate. Moreover, if such a policy can be implemented in Delhi, it can provide a political incentive to be scaled up.

The purpose of this policy is twofold: to bring emissions under control and to provide relief to the people who are at the receiving end of this climate crisis. We have proposed a carbon tax that finances both a green energy transition to fulfill the first goal and a benefits program in the form of the right to food, energy, and public transport travel passes to achieve the second goal. The level of carbon tax comes out to be US$112.5 per $MTCO_2$.

A carbon tax addresses both the demand and supply sides. On the demand side, increasing all commodities' prices according to their carbon content acts as a disincentive to consume high carbon embodied commodities. On the supply side, it changes the energy mix of the economy.

We want to suggest the implementation of carbon tax to be staggered and the balance amount deficit-financed during the initial 5 to 6 years. This is for two reasons. The onset of a sudden high carbon tax may not be acceptable to most people—as was the case in France with the Yellow Vest Movement. Second, if people immediately receive benefits, including infrastructural development, and then are presented with a gradual tax burden, they will be more likely to buy into the program.

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

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Supplemental material

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