Averting Pollution-Caused Harm in Lower-Income Countries: An Ecological Impact Fund

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Summary

Climate-changing carbon emissions are a key component of a larger problem that also includes non-carbon greenhouse gases (such as N_2O, SF_6 and NF_3) and other anthropogenic pollutants such as particulate matter (PM2.5) in the atmosphere, heavy metals (mercury, cadmium, lead, arsenic) and plastics accumulating in soil, water, and food, persistent organic pollutants (such as DDT, PCBs, dioxins, furans), as well as many other harmful industrial chemicals (PAHs, VOCs, phthalates), pesticides, and herbicides. Human activities, especially those involving consumption of fossil fuels (mineral oil, coal, and gas), are rapidly degrading our natural environment and climate, thereby triggering large present and future losses in human health and biodiversity. To give just one example of how massive these losses are: air pollution from the burning of fossil fuels is estimated to have caused 10.2 million excess deaths in 2012 and 8.7 million in 2018, $^1/_6$ to $^1/_7$ of all human deaths, mainly by increasing the incidence of respiratory ailments, heart disease, stroke, and cancer (Vohra et al. 2021; cf. Roser 2021).

Human pollution is tied to a wide variety of innovations that have produced many protections and conveniences of modern life, thereby greatly improving human health and longevity. It being neither realistic nor desirable to solve pollution problems by rolling back human progress, we must tackle them through more and better innovation. We must replace, refine, and complement existing technologies through "greenovations" that preserve and enhance human progress while reducing the associated harmful pollution and its destructive effects.

Such greenovations are indeed being developed—at least 30,000 each year, judging by the number of green and low-carbon patents granted in China in the 2016-22 period (CNIPA 2024, 4).[1] But these worldwide efforts at greenovation have clearly not been sufficient to solve the problems: harmful pollutants continue to rise in our environment—many at an accelerating rate. To preserve a livable planet, we need a better understanding of why humanity's existing efforts fall short and, based thereon, a reform program that can turn the tide.

The Ecological Impact Fund is one freestanding component of such a reform program. Its purpose is to promote the uptake of effective greenovations in the lower-income countries (LICs) and thereby also to incentivise the development of locally appropriate greenovations by and for their people. While these populations, due to severe poverty, have only minimally contributed to the existing pollution problems, their contributions are rising steeply and are on track to causing devastating harm to our planet. If the 4 billion Africans projected for the end of the 21st century were to live like the residents of the United States do now, they would produce 12 times as much pollution!

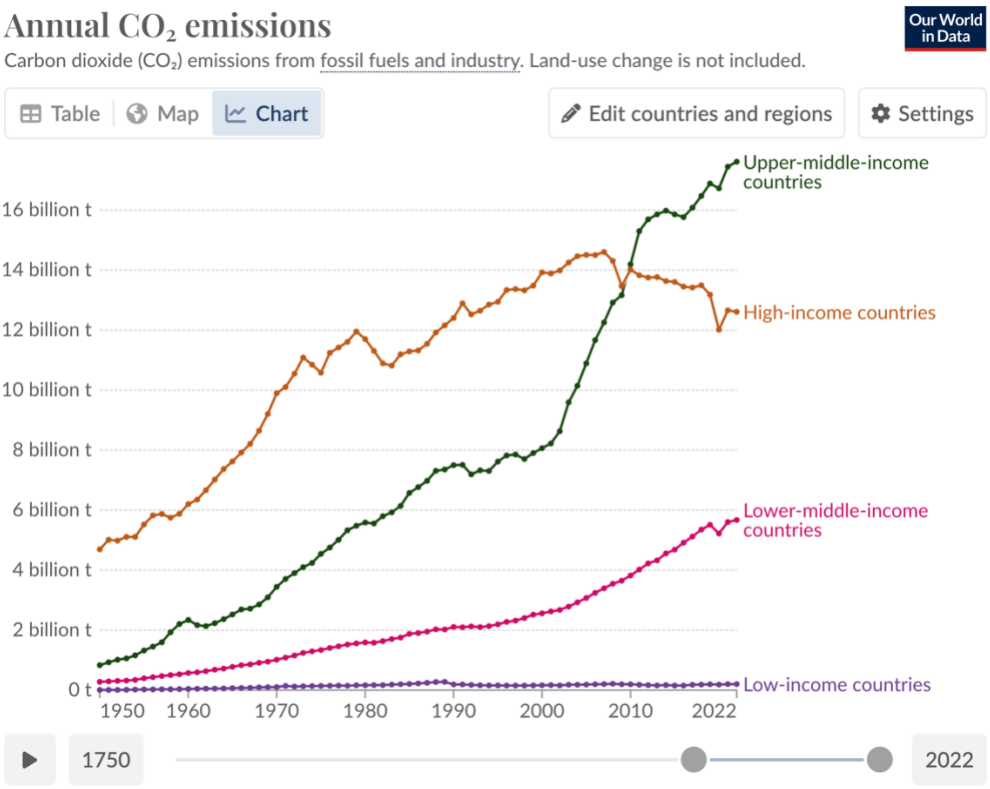

Figure 1: Emission Trends by Per-Capita Income, from Ritchie & Roser 2020/2024

In the remainder of this 21st century, many LICs are likely to undergo massive economic growth, intensified by large population increases. The technologies they will use, the practices and habits they will form, the roles they will be prepared to play in the fight for a livable planet will matter far more than any choices today's affluent nations will make within their borders. Rapid pollution reduction requires that highly effective and locally appropriate green technologies—many of them yet to be developed—be widely and rapidly deployed throughout the developing world.

The Ecological Impact Fund (EIF) would promote this goal by inviting originators to register any new green technology, with two legal effects in the LICs (the "EIF-Zone"):

- the EIF rewards the originator for the pollution-caused harm averted through deployments of its registered greenovation in the EIF-Zone which are completed within a five-year period; and
- the originator permanently forgoes, throughout the EIF-Zone, any monopoly rents it might earn from patents on its registered greenovation.

The EIF would assess harm on a single scale that takes account of contributions to global warming, to the global disease burden, and (possibly) to biodiversity loss. The measurement of such harms, for example in terms of CO_2eq and lost QALYs, is well established and confirmed to be practicable.[2]

The EIF should be financed by high-income countries (HICs), which have contributed most to the global ecological crisis and have, over many decades, accumulated great wealth through highly

polluting activities. Additional funds might come from international offset markets and ideally from a capital endowment built over time from treaty-based contributions, donations, and bequests.

EIF rewards would be paid through preannounced annual disbursements that might be scaled up over time. Any patentable new green technology could be registered for participation in five consecutive such disbursements, each divided among registered greenovations according to pollution-caused harm averted through their deployments in the EIF-Zone in the preceding year.

Because registration is optional, the EIF's reward rate emerges endogenously and predictably equilibrates to a stable level that satisfies both registering greenovators and EIF funders: when originators find it unattractive, registrations dry up and the reward rate rises; when the reward rate is seen as generous, registrations multiply and the reward rate declines.

The EIF would doubly support diffusion of green technologies in the EIF-Zone: through the tailwind of augmenting sales proceeds with impact rewards; and by eliminating the usual headwind from monopoly markups.

This switch in remuneration, from monopoly rents to impact rewards, would transform originator motivations: instead of exerting much effort to find, stop, prevent, and deter patent infringements, originators would actively promote the rapid, widespread, and beneficial deployment of their greenovation for increased impact earnings. Even without profiting from its sales price, such originators would promote its efficient use by providing technical support, maintenance, discounts — insofar as they expect the increase in impact rewards earned through such promotional investments to exceed their cost.

Full Text

The purpose of the proposed EIF is to reduce pollution-caused harm in a way that is cost-effective and advances global justice. It is based on the idea that the protections and conveniences of modern life, which have produced immense pollution problems, should be preserved in altered form and even be extended to that majority of human beings who are still largely excluded from them. With the right green technologies, we can give all human beings access to a high standard of living while also maintaining our planet in a condition that ensures a healthy future for humanity and the many other species we share this planet with.

To realize this vision, we need substantial improvement in both dimensions of human progress: *innovation* and *diffusion*. We need to lift the pace and quality of greenovations developed and to ensure the fast, wide, and effective deployment of cutting-edge green technology products.

To meet this challenge, we should start from a reflection on the main factors that impede the uptake of greenovations and thereby also weaken the incentives to invest into developing new green technologies in the first place. There are *five such main factors* that, together, have greatly weakened humanity's response to our self-made ecological crisis.

Many actors make choices about what technologies to deploy. These are often choices between a technology that is better and another than is worse for the environment. Buyers are generally quite willing to pay more for a better product, for a better car, for example, because they expect to derive substantial benefits from the extra expenditure. But *the typical green technology is exceptional in that its relative benefits* (the harm averted when it, rather than a dirtier alternative is deployed) *overwhelmingly go to third parties*. If you buy a safer and more comfortable car, nearly all the benefits of this choice go to you and your passengers. If you buy a less polluting car, nearly all the benefits of your decision go beyond people you know, to present and future living beings all over the planet. Indeed, few decision makers are wholly indifferent to the health and wellbeing of unknown others. But they give vastly less weight to the interests of such distant strangers than to those of themselves, their friends, family, neighbours, and employees. This is especially true of profit-focused corporations which are rarely willing and able to take full account of the cost their decisions impose on the wider world, future generations included.

This deficiency in altruism is reinforced by the second main factor: that *many technology decisions are made in a context of competition*. For example, firms incurring extra costs for the sake of a lower ecological footprint tend to lose ground against their rivals. A similar competition is felt among households: those spending more on limiting their pollution fall behind otherwise similar households in terms of savings and/or quality-of-life expenditures. And such a competition is also at work among states which, if they constrain the emissions of their firms and households more than other states do, must expect lower economic growth. Of course, such collective action problems can be solved by agreements on a fair sharing of burdens. But such agreements are difficult to achieve, difficult to police to all parties' satisfaction, and (partly for this reason) difficult to preserve against defection.

These first two factors underscore the importance of price—more exactly, of the difference in price between green technologies and their dirtier rivals. The first two factors make it unlikely that decision makers choose the environmentally superior option when it is considerably more expensive than some dirtier alternative. This is where factors 3 and 4 come into play.

The choice of dirty technologies is greatly supported by the gigantic subsidies that states are providing to the producers and consumers of fossil fuels. Such subsidies fall under two headings. States provide explicit subsidies when they absorb some of the cost of fossil-fuel extraction and delivery or when they lower the sales price of fossil fuels through supplementary subventions. States provide indirect or implicit subsidies when they shield producers and consumers of fossil fuels from responsibility for the damage they cause, such as excess medical bills and the cost of environmental clean-ups and additional (not so) "natural" disasters: floods, droughts, mudslides, heat waves, rising sea levels, failed crops, spreading tropical disease vectors, and so on. Under the auspices of the International Monetary Fund, researchers have produced several careful studies of these subsidies, estimating them to amount to a staggering $7 trillion *per annum* globally or about 7% of the gross world product (Figure 2).

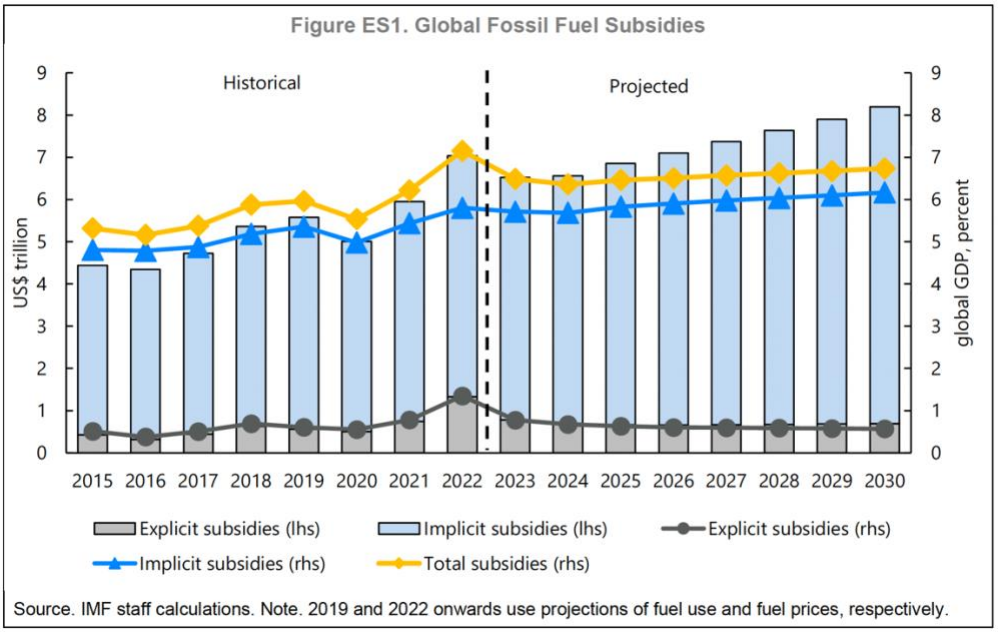

Figure 2: Global Fossil Fuel Subsidies, from Black et al. 2023

This is a monumental amount that greatly reduces the cost of using dirtier technologies, far below its true cost to the world. Why do states facilitate these enormous subsidies? In response, social reasons are often emphasized: transportation is essential to economic activity, and cheap transportation enhances the availability and affordability of goods and services to poor people and allows them to take advantage of distant opportunities for medical care, education, employment, shopping, and recreation. Poor people also need light in the dark hours and heating in winter. Moving as they are, these are bad reasons because the same purpose could be much better served by giving poor people in cash the equivalent of what they now receive in subsidies tied to fossil fuel consumption. The poor would gain the freedom to choose how to spend their subvention; and states would save vast amounts by not subsidizing the much greater fossil-fuel consumption of the more affluent (including fuel for yachts and private jets). Moreover, with the prices of fossil fuels reflecting their true cost, all fossil fuel consumers would shift their consumption away from fossil fuels, thereby reducing harm to our shared environment.

The true reason (using this word now in its causal rather than its normative sense) for the enormous fossil fuel subsidies is political lobbying by those who have most to gain from them. The market value of known fossil fuel reserves is in the hundreds of trillions. These reserves have owners: corporations and governments; and these owners want to reap as much profit from

their mineral resources as possible. Even if they accept that some fossil fuel reserves will have to stay in the ground, private owners of fossil fuel reserves are highly motivated to ensure that their own underground wealth will be spared such a fate. And the kind of political lobbying they engage in is known to be extremely effective.[3] We should of course support existing efforts to reduce fossil fuel subsidies and to "put a price on carbon"; but we must also realize that such efforts have so far not amounted to much (Twidale 2024). Fossil fuel subsidies are deeply entrenched politically, and the EIF proposal is formulated to work despite their foreseeable continuation. Moreover, as fossil fuel use is, perhaps partly through the EIF, diminished, fossil lobbies lose (and green lobbies gain) strength—though the problem of fossil fuel reserves remains.

Having discussed the third factor, which greatly lowers the cost of choosing and using dirtier technologies far below the true cost, let us now turn to the fourth factor which substantially raises the cost of choosing their cleaner, greener alternatives. Mostly of recent origin, state-of-the-art green products typically involve patented technologies. The exclusivity that patents confer gives their owners the opportunity to earn monopoly rents—by collecting royalties or licensing fees from those making use of the patented innovation or by themselves selling such products at elevated prices. Either way, the resulting *monopoly markups raise the price of green products*[4] *and thereby disadvantage them further vis-a-vis their dirtier competitors which are typically using older, off-patent technologies*.

Though they impede the uptake of innovative green technologies, monopoly rents also serve a very important purpose by motivating investment into developing these technologies in the first place. Globalized to a uniform standard in 1995, patents are the main engine of human progress. Annex 1C of the founding treaty of the World Trade Organization requires WTO members to issue patents of at least 20-year duration on eligible innovations (World Trade Organization 2005: esp. Articles 27, 28 and 33). Under this regime, some 558,000 green and low-carbon technology patents have been awarded globally in the recent seven-years period of 2016-2022 (CNIPA 2024). The world desperately needs greenovations, and the patent regime mobilizes billions for their development.

It is tempting to think that the patent regime manifests a rational trade-off between the aims of incentivizing innovations and facilitating their diffusion. In fact, however, this trade-off is not an efficient one. Monopoly markups entail deadweight losses, as many who would have bought the product at a competitive price will not buy it at a monopoly price. It would benefit both parties if these mutually advantageous sales could be consummated. But they generally cannot be realized because, if the patentee sold to some at lower prices, then those prepared to pay the monopoly price would also seek to pay less, leaving the patentee worse off.

Additional inefficiency arises from the fact that what matters for diffusion is the monopoly markup (increase in the unit price) whereas what matters for innovation is the monopoly rent (monopoly markup multiplied by sales volume). The patent holder is motivated by the monopoly rent and therefore prefers selling, say, 100 licenses at $250,000 each (earning $25 million) over selling 160 licenses at $150,000 each (earning $24 million). This example illustrates how the patent regime routinely sacrifices large increments in diffusion (and hence environmental impact) for tiny increments in incentivizing innovation.

Here is a real-world example of such inefficiencies involving coal-fired power generation. Mitsui Babcock charged manufacturers of steam boilers a licensing fee of about $1.5 million per 600 MW boiler for using its patented “ultrasupercritical” technology—a fee that Chinese producers such as Harbin Electric were willing to pay (Tan & Seligsohn 2010, 7). But many plants in India

and other LICs decided instead to deploy less efficient subcritical or supercritical technologies (Barnes 2016, 4) that will generate up to 30% higher emissions for decades.[5] Using technologies that were obsolete when installed, these Indian power plants are burning megatonnes of extra coal for zero gain in either electricity or incentivizing innovation.

The costs and inefficiencies of monopolies have been understood since Adam Smith:

> All monopolies in particular are extremely detrimental. The wealth of a state consists in the cheapness of provisions and all other necessaries and conveniences of life …. Its poverty again consists in the uncomeatibleness or difficulty with which the severall necessarys of life are procured. Now all monopolies evidently tend to promote the poverty or, which comes to the same thing, the uncomeatibleness of the thing so monopolized (Smith 1978, 83).

But he also allows an exception for temporary patent monopolies:

> [T]he inventor of a new machine or any other invention has the exclusive priviledge of making and vending that invention for the space of 14 years by the law of this country, as a reward for his ingenuity, and it is probable that this is as equall an one as could be fallen upon. For if the legislature should appoint pecuniary rewards for the inventors of new machines, etc., they would hardly ever be so precisely proportiond to the merit of the invention as this is. For here, if the invention be good and such as is profitable to mankind, he will probably make a fortune by it; but if it be of no value he also will reap no benefit (Smith 1978, 83).

So Smith believed, as many still do today, that, despite their serious drawbacks, patents are the best feasible way of incentivizing innovation. The above discussion of the first and fourth factors poses a challenge to Smith's conclusion. Greenovations can have great merit, can have the potential to be extremely profitable to humanity, and yet afford no decent prospect of income from monopoly rent. This is the case when the benefits of using the greenovation overwhelmingly go to third parties and therefore provide at best a very weak motive for paying the monopoly markup. And even where patent incentives do induce the development of greenovations, they depress their diffusion to a much lower level than would be socially optimal.

This diagnosis suggests that, to improve the present system, we must reform it to better align the incentives it provides with the true benefits produced by greenovation deployments. There are two pure options for doing so: carrots and sticks. The former approach seeks adequately to reward the positive externalities of green-technology deployments in order sufficiently to induce such deployments and thereby also to motivate investments in developing relevant greenovations in the first place. The EIF is a crucial step in this direction: toward incentivising greenovations through "pecuniary rewards" that are "proportioned to their merit," that is, to the good they do for the whole world.

The alternative approach induces adoption of green technologies by prohibiting or penalizing the use of their dirtier alternatives. Pollution levies, as proposed by Nobel laureate William Nordhaus (2021), are an especially elegant solution insofar as they internalize the negative externalities of polluting activities and thereby tend to reduce these activities to those whose benefits exceed even their true cost (externalities included). If we could institute and effectively enforce such pollution levies worldwide, the people deciding about technology deployments would become sensitive to the full cost of choosing the dirtier option and would, far more often, prudently choose the greener alternative.

In theory, the penalty approach is superior. If we could put appropriate prices on the various kinds of harmful pollution, we could reduce them to tolerable levels. And we could do so without any risk of non-polluters being unfairly made to contribute to rewards meant to induce polluters to reduce their emissions. Appropriate pollution levies deserve our support. But they will fall far short of solving the problem in our world as it is. The reward approach exemplified by the EIF can make a major contribution toward filling this gap.

An agreement to institute pollution levies globally is hard to reach against heavy political resistance from fossil fuel owners, producers, and consumers in some 200 sovereign states. Even if it could be reached, states would have many ways of undermining its effect through a variety of fossil fuel subsidies, as observed. Since any state in which the cost of polluting is lower than in others gains an advantage, there is a competitive pull toward reducing this cost, which deters leadership by example and makes achieved agreements vulnerable to unravelling into a race to the bottom. This helps explain why the total amount charged as emission levies worldwide—$105 billion in 2023 (Twidale 2024), offset by said $7 trillion in fossil fuel subsidies—is still woefully inadequate to the great harms at stake. Only 24% of all emissions worldwide are subject to any levy, and rates are often far too low to affect investment decisions (ibid.). Universal levies on our actual 40+ billion tonnes of CO_2eq of anthropogenic emissions, at more fitting rates of $60–120 per tonne, would have raised ca. $3.5 trillion in 2023, 33 times more than the actual amount.

Note also that globally uniform pollution levies would be grossly unfair to the LICs and thereby provoke their strong and justified resistance. This is the fifth and final of the main factors impeding the uptake of greenovations. This factor arises from the fact that—originating in the colonial period—our world is deeply divided into a group of HICs, comprising about 14% of the world's population, and the LICs—with China now occupying an intermediate position (Figure 3).

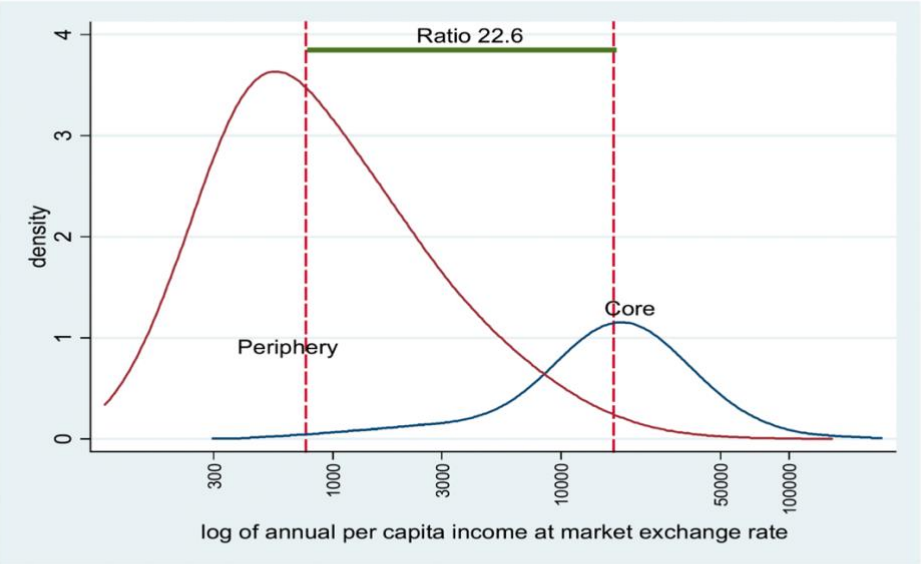

Fig. 11b. Distribution of income in the core and periphery countries in 2018 (incomes in dollars at market exchange rate). Note: Core is defined as Western Europe, North America, Oceania and Japan. Periphery is defined as all other countries except China. The vertical dashed lines are drawn at the points of median incomes. The areas under the curves reflect population sizes.

Figure 3: The Global Income Distribution, from Milanovic 2024, 14

This enormous economic inequality entails a great inequality in opportunities to play a leading role in human progress. HICs have the capital to maintain well-staffed and well-equipped universities, which produce highly trained researchers, to conduct and fund basic research for the benefit of their technology firms, and to support these firms through grants, subsidies, and government contracts. Poorer countries cannot match any of these efforts; and most of their firms and citizens could ill afford the cost of obtaining and maintaining patents in the most important jurisdictions anyway. It is not surprising, then, that the vast majority of green and low-carbon patent applications originate in the HICs, with 89.3% coming from just these five: China, Japan, United States, South Korea, and Germany (CNIPA 2024, 5; covering the 7-year period 2016-22). *Nearly all patent income generated by deploying greenovations in LICs flows to much more affluent countries.*

It is understandable that, as the above example of coal-fired power plants in India illustrates, decision makers in LICs are reluctant, for the sake of reducing their pollution (e.g., through pollution levies or through regulations or prohibitions of dirty technologies), to divert scarce funds to patentees in the HICs. This reluctance is driven not merely by an acute shortage of funds but also by three justice considerations. The moral claim on the LICs to contribute to rewarding and thereby incentivising greenovation is much weakened

- by the realisation that the HICs did not shoulder any such costs for the sake of a healthier planet when they passed through similar phases of development;[6]
- by the HICs' crushing advantage in human and financial capital, which deprives innovators in the LICs of a fair chance to score wins in the race to file patent claims on the next steps in human innovation;
- by the fact that the enormous gap between HICs and LICs has emerged from a historical process that was pervaded by massive grievous wrongs (including colonialism, slavery, and genocide) and is perpetuated through a structuring of the world economy that is dominated by, and highly favourable to, the HICs.

One might argue that, because they are much poorer and mostly located in the Earth's warmer regions, the LICs are much more vulnerable to the harmful effects of pollution and can therefore be pressured into accepting global pollution levies. Maybe so. But there is not much evidence of such acceptance so far. More importantly, we should prefer a solution that the poorer countries can *reasonably* accept, that is, can accept as fair among equals rather than as an inescapable imposition in a context of duress.

The EIF is part of such a fair solution in at least three respects. First, it is to be started with funds drawn from the excess wealth that the high-income countries (HICs) have, over many decades, accumulated through highly polluting activities that have also been inflicting severe, enduring, and uncompensated harms on LIC populations.[7] This belated-compensation rationale does not presuppose fault: even if prior populations of the HICs were unaware of the harms their activities were setting in motion, their successors should still compensate for these harms when they can comfortably do so out of the wealth surplus they have derived from those same harmful activities. Second, the EIF would diminish an existing innovation bias by facilitating the development and deployment of greenovations specifically suited to the needs of LIC populations, thereby making available and affordable to them a greener path of development than the HICs had used before them. Third, the EIF would thereby also mitigate the existing unfairness in the greenovation race: in working to develop and deploy greenovations for the LICs, innovators in the HICs would not enjoy the same crushing advantage they have in the competition to develop and deploy greenovations for those who can afford high-value products with substantial monopoly markups.

The EIF would therefore also help build, in lower-income countries, capacities in R&D, manufacturing, distribution, installation, operation, and maintenance of green technologies.

Let us pause for orientation. Here is where we started: "The purpose of the proposed EIF is to reduce pollution-caused harm in a way that is cost-effective and advances global justice." In regard to cost-effectiveness, we have seen that the existing incentives governing development and deployment of greenovations are very poorly aligned with their supposed end: the reduction of pollution-caused harm. Five main factors collaborate to ensure that worldwide investment in deploying and developing greenovations falls far short of what would be socially optimal. This is true not merely quantitatively, but also qualitatively: whole domains of highly effective greenovation are neglected because their potential users are poor or their potential beneficiaries are remote. We don't miss these unsought greenovations because we don't even know what they are. To reduce pollution around the world, we must urgently align the incentives of decision makers with the effects of their technology-related decisions: decision makers must be made to feel through their wallet the impact of their decisions on our environment.

Here cost-effectiveness is achieved through proportionality. The more is at stake ecologically for our planet and its human inhabitants, the more should be at stake financially for the decision maker. In this way, investment in development and deployment of greenovations is drawn to where it will have the greatest effect in reducing human pollution, *maximizing impact relative to cost*. Pollution levies meet this desideratum of optimal impact even more broadly than the EIF approach (for example, by also rewarding consumers for refraining from certain polluting activities altogether). But we have seen that, easily offset by subsidies, pollution levies have over many years made little progress, and we have illuminated some of the political obstacles explaining this delay. Important among these are moral obstacles. Arm-twisting the LICs into participating, without adequate compensation, in globally uniform pollution levies would not be fair to their populations. Here the EIF approach is superior because it reduces pollution-caused harm in a way that advances global justice.

We have found (p. 9) three ways in which the EIF would, as a fair solution, advance global justice. An important forth way must be added. Boosting greenovation development in and for, and greenovation deployment in, the LICs, the EIF would have its environmental impact mainly in the poorer countries, whose populations currently face vastly higher pollution than their HICs counterparts, despite their much lower per capita GNIs.[8] To illustrate this claim by reference to two important and broadly representative pollutants: average PM2.5 levels in South Asia (with many other LICs not far behind) exceed the relevant WHO guideline by well over 10 times,[9] entailing lifelong health burdens for children growing up there. And lead pollution, too, is much higher in LICs, again with children worst affected through permanent deficits in mental development.[10]

By incentivising development and dissemination of appropriate green technologies, the EIF would reduce pollution specifically in EIF-Zone countries and thereby reduce the pollution gap between LICs and HICs. The incentives it provides implicitly assign equal value to the health and survival of all human beings. In striving for maximum cost effectiveness (impact/$), the EIF assigns the same weight to QALYs lost by the poor as to QALYs lost by the affluent. You may think this goes without saying. It does not. The idea of a cost-effective health intervention can, and often is, defined in a country-specific way, entailing huge differences: to be considered cost-effective, a health intervention in the United States may cost up to $95,958 per QALY—in the Democratic Republic of the Congo up to $87 (Pichon-Riviere et al. 2023).

Having discussed the moral and factual foundation of the EIF—the values it is meant to advance and the challenges it is meant to address—this paper will proceed to argue that the EIF is feasible in two senses:

- if it were to be established, it would work well and would, in particular, have a large positive impact (relative to cost) on human health, environmental protection, and beyond;
- there is a realistic path to its establishment.

The EIF differs from existing international funds, such as the Global Fund to Fight AIDS, Tuberculosis and Malaria, by primarily working through incentives. Rather than using money on hand to purchase specific beneficial goods or services, it provides "pull funding," promising actors that they will be rewarded based on actual achievement. This creates the challenge of assuring potential registrants that the rewards promised for future years will really be there. Insofar as this assurance were less than fully convincing, potential registrants would discount future rewards or stay away altogether, thereby reducing the EIF's effectiveness. It would also be unfair, of course, to first create and then disappoint legitimate expectations of registrants who develop and register a greenovation in anticipation of partaking in five annual disbursements.

If a group of willing states agreed to create the EIF, they would understand this challenge and ensure that their contributions will not be so discounted. They could readily achieve this aim by contributing appropriate financial instruments, such as zero-coupon bonds maturing in each of the next ten years. Drawing additional funds from offset markets, donations, and bequests, the EIF should, in parallel, seek to build an endowment that would provide a cushion of additional assurance as well as a supplementary income stream that would help in expanding, in a gradual and orderly manner, the pre-announced size of the annual EIF disbursements.

Another distinctive feature of the EIF is that it defines achievement in very general terms. It operates with a single scale of achievement based on a weighted sum of averted pollution-caused health burdens and averted greenhouse gas emissions. The former can be measured in QALYs, the latter in metric tonnes of carbon dioxide equivalent (tCO_2eq), with equivalency defined in terms of global warming potential over 20 years.[2]

There is no purely scientific answer to what the weights of the two components should be. Moral considerations come into play, such as the relative moral weights we assign to present and future human beings, non-human animals, plants, and ecosystems. Scientific considerations also matter, for example estimates about the diverse long-term effects of current emissions. The founders of the EIF will fix the QALY ~ tCO_2eq "exchange rate" with expert and stakeholder input. Gains in the two dimensions would then be aggregated into a single impact "currency" which, for the moment, we might call ecological merit points (EMP).

The EIF will invite originators of green technologies to register them for rewards. Registration involves establishing a credible claim to the technology, for example by reference to a patent received (which could be one awarded by a HIC patent office), and proposal of a methodology for assessing the relevant impact of the registered greenovation in the EIF-Zone. Such a methodology, which would be subject to discussion and possible revision before EIF acceptance, involves identification of a—possibly dynamic—state-of-the-art baseline prevailing as the greenovation is introduced into the EIF-Zone and estimation of any QALY and/or tCO_2eq gains in the years following introduction, based on sales data, measurements, statistical sampling, and the like, as appropriate to the particular greenovation in question. It is true that these assessments would require work from registrants and the EIF's technical personnel. But this work would also produce important insights into the various kinds of pollution produced in the

LICs, their adverse impacts, and the most effective ways of reducing pollution-caused health burdens. Tackling the problem of pollution-caused harm in the LICs requires a solid understanding of this problem in its diverse dimensions.

The EIF will credit only gains achieved through deployments in the EIF-Zone within a five-year window. But credited gains could extend beyond this frame. For example, a pollution-reducing technology might be EIF-registered in 2028. It would then be rewarded for deployments in the EIF-Zone during the 2028-33 period. If such deployments—perhaps by averting pollution with long-term adverse health effects—entail predictable health gains after 2033 (such as a reduced cancer incidence in the 2040s), even outside the EIF-Zone, these should be credited to the registrant in the years in which they are caused.

There is nothing sacrosanct about setting the length of the reward period at five years. Like the QALY ~ tCO_2eq exchange rate and indeed the QALY metric itself, this length can be adjusted by the EIF founders with expert input. Two key considerations are that the reward period should be long enough for registrants to have a real chance to introduce and widely market their greenovation ... and not be so long that many greenovations will still receive substantial rewards even after they will have become obsolete. The former consideration can also be served, to some extent, by giving registrants the option to delay the reward period, for example by up to one year after the first EIF-Zone deployment.[11] The latter consideration can also be served by updating the state-of-the-art baseline, if needed, midway through the reward period.

EIF registration entitles the registrant to a share in five annual disbursements of pre-announced size.[12] Each disbursement is to be distributed over the registered greenovations according to the rewardable impact achieved through their deployments in the preceding year, thus rewarding all registrants at the same endogenous rate ($/EMP). Here, again, impact may transcend the period of rewardable deployments by including, for example, predictable future health gains (averted future disease burdens of pollution) even outside the EIF-Zone.

Paying rewards through fixed disbursements has the desirable consequence that registrants cannot conspire to cheat the EIF by exaggerating their achievements. On the contrary, such attempts at overstatement would provoke resistance from the other registrants, who would be short-changed by their success. The EIF gives registrants wholesome incentives to keep an eye out for one another's possible deceptions. Of course, the EIF should discourage cheating also through penalties and adjudication procedures specified in the registration contract and by mobilising the reputational damage that comes from abusing a jointly financed public good devoted to promoting shared ends of great moral importance: the health of poorer populations and the preservation of a liveable planet.

To be eligible to partake in EIF disbursements, the registrant must participate in formulating a suitable methodology and must help apply this methodology to track the impact of qualified deployments of its greenovation. The registrant must also relinquish potential monopoly rents in the EIF-Zone, most plausibly by forgoing patents (with all the associated hassles and expenses) in EIF-Zone countries. The registrant could then rely on competing manufacturers to maintain low prices there. Alternatively, a registrant might aim to meet most EIF-Zone demand itself with even lower prices achieved through a combination of discounting and economies of scale (with the registrant manufacturing in-house or outsourcing production to a single supplier through a tender process).

(Note that this discussion is simplified by focusing on green products that involve exactly one eligible greenovation. In fact, a green product may involve several patentable innovations whose originators would wish to partake in any EIF reward payments. In such cases, the EIF should simply let the originators arrange themselves. One of them might act as registrant while licensing the additional patents it needs. Or they might register as a team based on a mutually acceptable schedule for sharing tasks, expenses, and pay-outs.)

Because registration is optional, the EIF's reward rate emerges endogenously and predictably equilibrates to a stable level that satisfies both registrants and EIF funders: when the former find it unattractive, registrations dry up and the reward rate rises; when the reward rate is seen as generous, registrations multiply and the reward rate declines.

The EIF should be designed so that its reward rate equilibrates to a low level, making it as efficient as possible. For this reason, the EIF asks registrants to forgo their patent privileges only in LICs, where demand for green technologies at monopoly prices is weak. This limitation greatly diminishes the opportunity cost of EIF registration and hence the EIF's endogenous reward rate ($/EMP), while correspondingly increasing the EIF's efficiency (EMP/$).

Other design question can be approached with the same guideline. For example, should the registrant have the option to patent its registered technology in EIF-Zone countries while selling it there at a non-profit price? If it turned out that many potential registrants strongly value this option, then this would be a reason to offer it, thereby decreasing their reservation price and achieving a lower EIF reward rate.

The endogenously evolving reward rate would be indicative of the EIF's efficiency—but would also understate it substantially because the EIF's full impact greatly exceeds the sum of the assessed and rewarded impacts of all EIF-registered greenovations. This is so not only because the EIF confines the rewardable impact of a registered innovation to deployments during the first five years. A more important reason is that, by accelerating the pace of innovation, the EIF raises the standard against which newly registered innovations will be assessed. Over time, this effect will become quite large. A greenovation registered in 2040 will be rewarded for the reduction in pollution-caused harm it achieves relative to the alternatives being deployed in that year. But this 2040 state-of-the-art will be far superior to what it would have been had the EIF not existed for the preceding decade or more. This acceleration of greenovation is an achievement the EIF need not pay for. It is likely to be especially significant in classes of green technologies that, under the current regime, suffer neglect because they are suitable only for poor populations, are more expensive to manufacture and deploy than their dirtier alternatives, or bring widely diffused benefits that potential buyers care little about. This acceleration will also achieve accumulating cost and price reductions pursuant to Wright's Law (Roser 2023).

The EIF has no optimal size. The larger its pre-announced annual disbursements, the more registrations it will attract, the more harm it will avert, and the more strongly it will accelerate technological progress. A larger EIF would tend to engender a higher reward rate by attracting additional registrations of somewhat less efficient greenovations. But it would also enjoy enhanced operational efficiencies (in impact assessment and administration) and greater influence on the pace of green innovation, which increases that part of its beneficial impact that the EIF need not pay for. A meaningful EIF might have an annual budget around $5 billion—comparable to the Global Fund and easily accommodated within the HICs' 2009 promise to devote $100 billion annually to climate change mitigation and adaptation in the developing world

(Timperley 2021). But, depending on mobilizable funding support (or lack thereof), it could commence with a substantially smaller annual budget.

The pull funding the EIF offers is unusually generic. The EIF is open to a large diversity of registrants and greenovations, befitting the diversity of conditions in the LICs with their various political, economic, and health-care systems. The EIF organizes a wide competition across the entire EIF-Zone and the entire greenovation sector, including electricity generation, traffic, residential and office heating and cooling, construction, meat production, agriculture, forestry, industrial manufacture of steel, cement, and other commodities. Within this large space, the EIF creates an artificial competitive market geared toward the single goal of averting pollution-caused harm, thereby training originators to holistically organize their research, development, marketing, and delivery operations toward realizing the most cost-effective benefits. In this competition, some registrants will earn much more than others. But registrants with lower EIF earnings may still be very successful, if their earnings are high relative to their investment.

The EIF's highly generic pull funding avoids the prejudices, biases, and outright corruption that often blight push funding, which tries to pick winners in advance, and likewise pull funding employing prizes and advance market commitments, which tries to specify the best research targets in advance. This genericism renders the EIF distinctive in five key ways. The EIF

- constitutes a structural reform, establishing stable and predictable long-term innovation incentives;
- lets innovators, who know their own capacities best, decide which greenovations to pursue across the whole range of potential remedies against pollution-caused harms;
- avoids having to specify a precise research target, which is difficult to get right in advance, and instead rewards each registered greenovation according to the pollution-caused harm averted with its EIF-Zone deployments;
- avoids the tricky task of fixing a reward rate and instead lets this rate evolve endogenously through market forces revealing the true cost of optimal greenovation;
- gives innovators strong incentives also to promote (through information, training, technical assistance, discounts, and so on) the fast, wide, and effective diffusion of their registered greenovations.

The EIF would *raise the efficiency of greenovation* by attracting effort to prospective high-impact innovations that are neglected under the current regime because their potential users are poor or because their buyers and users barely partake in their large benefits. The EIF would do so by supplementing sales proceeds with impact rewards that are sensitive to the full benefit of use of the product. With this supplement, even sales to very poor people at very low prices can be profitable. The EIF would then also vastly *extend the reach of registered greenovations*—by ensuring that prices are low, profits are nonetheless attractive, and registrants are therefore motivated to invest in fast, wide, and impactful dissemination. As a further bonus, the EIF would *avert the expenses associated with the patent system* (patenting, lawyering, and litigation) *and the waste patents entail* through deadweight losses, investments in kickbacks, heavy promotion of non-beneficial sales, evergreening of exclusivity, and regulatory capture.

The fact that the EIF promises substantial gains not merely for justice but also for efficiency should help the effort to get it accepted and established. The EIF is likely to find support from

- ecology and social justice movements, as it serves their key goals with high efficiency;

- potential buyers and users in the EIF-Zone, as it gives them more affordable access to a much wider range of greenovations;
- governments and populations in the EIF-Zone, who would benefit from better and cheaper options for greening their activities, from domestic capacity building, from substantial declines in pollution, and from a slowing of climate change.
- potential greenovators, including firms with significant green technology patent portfolios, who would gain new opportunities to earn money by developing greenovations for sale into the EIF-Zone while retaining the choice, in each case, whether to choose EIF-registration or not;
- defenders of intellectual property rights, who would find it palatable that the EIF applies only to LICs and moreover leaves successful innovators the choice, for each of their greenovations, to forgo EIF rewards for the sake of claiming their monopoly privileges in the EIF-Zone.

The EIF would, as intended, reduce the use of dirty technologies throughout the EIF-Zone but would also give the firms selling them ample new opportunities to supply state-of-the-art green substitutes.

The crucial question then is whether HICs and their populations, enough of them, would be willing to create the EIF. We have seen already that there is a strong moral case for doing so. This case can be further buttressed by reference to the many unkept promises the HICs have made over the years: promises to abolish poverty, to promote global health and development, to slow climate change, and so on. Prominent examples include the already mentioned 2009 promise of the HICs to devote $100 billion annually to climate change mitigation and adaptation in the developing world (Timperley 2021) as well as Sustainable Development Goals 13 and 17: to “take urgent action to combat climate change and its impacts” and to “strengthen the means of implementation and revitalize the global partnership for sustainable development” (UNGA 2015, 14).

If some or all HICs agreed to inaugurate the EIF, they could readily do so, for instance under the auspices of the already existing UNFCCC's Green Climate Fund—mandated to “promote the paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions” (Green Climate Fund 2011: 2).

The key obstacles to the establishment of the EIF are political. We are living through a period of high international tension in which states are, even more than usually, obsessed with their national interest and their power position relative to one another. Even recognizing that the EIF would be overall beneficial to itself, a state might worry that the EIF would be even more beneficial to its rival and might therefore try to scuttle the project. It may seem impossible to design the EIF in such a way that it predictably benefits all its potential funders to exactly the same degree (does not affect their power position relative to one another at all) and also to convince all of them that this is in fact the case.

This predicament has an upside. Insofar as states understand the grave dangers inherent in the present period—dangers not merely of ecological destruction but also of proliferating arms races and wars—they may see reason to work toward a more amicable international climate and may then come to see a shared project like the EIF as a good step. This is a key reason for regarding China as an essential member of the funding partnership. China is a top polluter as well as a

leader in developing greenovations. Many HICs would reject the EIF if it paid rewards to Chinese greenovators even while their government made no contribution to it.

To be sure, some HICs might also be unhappy with China's inclusion as a funder. They might prefer an EIF that receives no financial support from China and also bars registrations by Chinese greenovators. But such an EIF would be much less cost-effective and would also frustrate the hope that the EIF will help ease international tension.

A fair division of funding burdens should be based on a combination of ability to pay (taking account perhaps of GNI exceeding a certain per capita threshold) as well as present and recent past rates of pollution. The HICs plus China would have to negotiate such a formula, and it is quite possible that the best formula they could come up with would leave some of them dissatisfied and unwilling to join. This would not block the path forward. In the context of HIC government budgets, an annual expense of $5 billion is comparatively minor—in fact, many national development assistance budgets are considerably larger (and there are even some individuals who could get the EIF going single-handedly). The OECD reports that, in 2023, the HICs that are members of the Development Assistance Committee (DAC) collectively provided $223.7 billion in official development assistance (ODA).[13] These figures should also put to rest any lingering national-security concerns: the EIF's annual cost is too small for its distribution to have an appreciable effect on the international balance of power.

Now, to be sure, HICs like to focus their development assistance on agents capable of reciprocation, firms in their own country, for example, or foreign governments from whom they have received, or hope to receive, favours. This is why more than $^3/_4$ of DAC development assistance is bilateral. Even so, HICs do give some multinational assistance. And it is not unrealistic to hope that many or at least some of them will be prepared to spend something in the order of 3% of their existing ODA on a joint enterprise that is likely to bring large gains in cost-effectiveness and international cooperation. Optionality of participation for funders, just like optionality of participation for greenovators, is essential to the prospects of the EIF.

Another thorny, albeit less thorny, matter is the definition of the EIF-Zone. It should probably be defined in terms of a GNI-per-capita ceiling whose value might be fixed in light of two considerations. It should include countries in which pollution is high and uptake of green technologies is poor. And it should be defined more narrowly if the annual budget of the EIF turns out to be smaller. With an annual disbursement of around $5 billion, a GNI-per-capita ceiling of ca. $7,000 might be appropriate—including the world's poorest 100 or so countries.[14] An educated trade-off will need to be made: a smaller EIF-Zone has the advantage of focusing on the poorest countries where more cost-effective gains are likely to be obtainable; a larger EIF-Zone has the advantage of affording greenovators better economies of scale. Here we can, once more, draw on the guideline instructing us to try to minimize the endogenous reward rate ($/EMP).

To help overcome HIC reluctance, an experimental pilot could test and refine the EIF idea and thereby make its adoption more likely. This pilot might involve a single reward pool of, say, $100 million, to be split among three to five preselected greenovations in proportion to the pollution reductions achieved with their deployments, competitively priced, in a self-selected region of the EIF-Zone over a two-year period. The pilot would show concretely how greenovators respond to competitive impact rewards and how impact can be estimated in a reliable and timely manner. It would help refine impact assessment and provide an indication of the cost-effectiveness of the

new impact rewards. The EIF pilot would also yield its own ecological benefits and policy insights through the pilot projects it monitors and rewards.

The last few pages have been uncomfortably specific about a few important parameters of EIF design. They should be read in a constructive spirit, asking not: "is this exactly right?" but rather: "is there some such specification that could work?" Here "working" involves two very different issues: a good design must make the EIF productive relative to its intended purpose and must also make the EIF attractive to its potential founders and funders which, most likely, must be HICs. Evidently, the EIF proposal is not yet ready to be cast in stone. It needs feedback and support from experts in several disciplines as well as a critical vetting from policy veterans. The question is whether it deserves such attention and support.

In conclusion, let us highlight three important points about the potential impact of the EIF project.

In contrast to many other schemes that pay money for ecological impact, the EIF would have very substantial secondary benefits that, over time, would expand exponentially. This is so because the EIF would increase the speed of greenovation, especially in certain areas in which greenovation currently proceeds only slowly (cf. p. 13 supra). If, for 20 years, we pay for an activity that removes pollution, then we will have eliminated a certain fixed amount of pollution for all future time. If we operate the EIF for 20 years, then we will end up with a stronger arsenal of greenovations that will permanently put us on a higher progress curve. Speaking metaphorically, in the former case we merely cover distance, in the latter we also gather speed.

The EIF is highly generic: it does not favour specific technologies nor specific innovators nor specific beneficiaries. This genericism makes the EIF more cost-effective, of course, attracting and rewarding the very best greenovations within a large option space. This genericism also makes the EIF especially suitable for an international cooperation that focuses its participants on a sharable purpose rather than on their respective self-interests. If successful, the EIF could help build mutual appreciation and trust toward spawning similar collaborations subsequently.

The EIF would pioneer highly generic impact rewards as a new kind of complement to patent incentives. This kind of complement, if successful, might be replicated in other economic sectors in which (i) there is an important role played by innovations that (ii) have large benefits beyond buyers and users, (iii) which benefits can be assessed and rewarded on a single scale (such as EMP in the greenovation sector). Sectors likely to satisfy these three conditions include pharmaceuticals, agriculture, and education. On this path we might proceed to avoid and mitigate more of the (well-known) inefficiencies and injustices of the patent regime.

4) References

Alexander, Raquel M., Stephen W. Mazza, & Susan Scholz (2009): “Measuring Rates of Return on Lobbying Expenditures: An Empirical Case Study of Tax Breaks for Multinational Corporations.” *Journal of Law and Policy* 25, 401–57.

Barnes, Ian (2016). "The Prospect for HELE Power Plant Uptake in India." London. https://usea.org/sites/default/files/The prospects for HELE power plant uptake in India - ccc271.pdf.

Black, Simon, Antung Liu, Ian Parry, & Nate Vernon (2023). “IMF Fossil Fuel Subsidies Data: 2023 Update.” Working paper, IMF, Washington, DC.

https://www.imf.org/en/Publications/WP/Issues/2023/08/22/IMF-Fossil-Fuel-Subsidies-Data-2023-Update-537281.

CNIPA (China National Intellectual Property Administration) (2024): *2023 Report on Statistical Analysis of Green and Low-carbon Technology Patents Worldwide*. https://english.cnipa.gov.cn/art/2023/7/6/art_3262_186148.html.

Green Climate Fund (2011): *Governing Instrument*. Incheon. https://www.greenclimate.fund/sites/default/files/document/governing-instrument.pdf.

Milanovic, Branko (2024): "The Three Eras of Global Inequality, 1820–2020 with the Focus on the Past Thirty Years." *World Development*, 177, no. 106516, pp. 1–24.

Milman, Oliver (2022): "Nearly $2tn of Damage Inflicted on other Countries by US Emissions." *The Guardian*, July 12, 2022. https://www.theguardian.com/environment/2022/jul/12/us-carbon-emissions-greenhouse-gases-climate-crisis.

Murray, Christopher J. L., & Arnap K. Acharya (1995): "Understanding DALYs," *Journal of Health Economics* 16 (6), 703–730. https://www.sciencedirect.com/science/article/abs/pii/S0167629697000040.

Nordhaus, William (2021): "Dynamic Climate Clubs: on the Effectiveness of Incentives in Global Climate Agreements." *PNAS* 118 (45), https://doi.org/10.1073/pnas.2109988118.

Pearce, Rosamund, & Tom Prater (2020): "Mapped: the World's Coal Power Plants." London. https://www.carbonbrief.org/mapped-worlds-coal-power-plants.

Pichon-Riviere, Andres, Michael Drummond, Alfredo Palacios, Sebastián Garcia-Marti, & Federico Augustovski (2023): "Determining the Efficiency Path to Universal Health Coverage: cost-effectiveness thresholds for 174 countries based on growth in life expectancy and health expenditures," *Lancet Global Health* 11: e833–42. https://www.thelancet.com/pdfs/journals/langlo/PIIS2214-109X(23)00162-6.pdf.

de Rassenfosse, Gaétan, & Ling Zhou (2020): "Patents and Supra-competitive Prices: Evidence from Consumer Products." https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3756359.

Ritchie, Hannah, & Max Roser (2020/2024): "CO_2 Emissions." Last revised in January 2024. https://ourworldindata.org/co2-emissions.

Roser, Max (2021): "Data Review: How Many People Die from Air Pollution?," Our World in Data. https://ourworldindata.org/data-review-air-pollution-deaths.

Roser, Max (2023): "Learning Curves: What Does It Mean for a Technology to Follow Wright's Law?," Our World in Data. https://ourworldindata.org/learning-curve.

Smith, Adam (1978): *Lectures on Jurisprudence*, edited by Ronald Lindley Meek, David Daiches Raphael, & Peter Gonville Stein. Oxford: Oxford University Press.

Tan, Xiaomei, & Deborah Seligsohn (2010): "Scaling up Low-Carbon Technology Deployment: Lessons from China." World Resources Institute. http://pdf.wri.org/scaling_up_low_carbon_technology_deployment.pdf.

Timperley, Jocelyn (2021): "The Broken $100-Billion Promise of Climate Finance — and How to Fix it." *Nature* 598, 400–402. https://www.nature.com/articles/d41586-021-02846-3.

Twidale, Susanna (2024): "Global Carbon Emissions Pricing Raised Record $104 Bln in 2023." Reuters. https://www.reuters.com/sustainability/climate-energy/global-carbon-emissions-pricing-raised-record-104-bln-2023-2024-05-21/.

UNGA (2015): *Transforming our World: the 2030 Sustainable Development Agenda*. United Nations General Assembly, 70th Session, UN Doc, A/Res/70/1, https://sdgs.un.org/2030agenda.

Vohra, Karn, Alina Vodonos, Joel Schwartz, Eloise A. Marais, Melissa P. Sulprizio, & Loretta J. Mickley (2021): "Global Mortality from Outdoor Fine Particle Pollution Generated by Fossil Fuel Combustion: Results from GEOS-Chem," *Environmental Research* 195, 110754, https://www.sciencedirect.com/science/article/abs/pii/S0013935121000487.

World Trade Organization (2005): *Agreement on Trade-Related Aspects of Intellectual Property Rights as Amended by the 2005 Protocol Amending the TRIPS Agreement*. Annex 1C. Geneva. https://www.wto.org/english/docs_e/legal_e/trips_e.htm.

Zucman, Gabriel (2024): *A Blueprint for a Coordinated Minimum Effective Taxation Standard for Ultra-High-Net-Worth Individuals*. Commissioned by the Brazilian G20 Presidency. https://gabriel-zucman.eu/files/report-g20.pdf.

5) Endnotes

[1] As CNIPA (2024) documents, more patents are granted in China than in any other jurisdiction. Referencing the total number of patents granted around the world is not meaningful because the same greenovation is often patented in multiple jurisdictions. The figure provided misses greenovations that receive a patent in some jurisdiction but not in China.

[2] 'CO_2eq' stands for carbon dioxide equivalent, expressing the global warming potential of any greenhouse gas release in terms of an equivalent amount of CO_2. Because greenhouse gases disappear from the atmosphere at different rates, equivalency calculations require a time frame. Methane (CH_4), for example, has 81 times the global warming potential of CO_2 over the next 20 years, 28 times the global warming potential of CO_2 over the next 100 years, and eight times the global warming potential of CO_2 over the next 500 years. Here use of a shorter time frame seems more appropriate because it is so crucial to prevent triggering crucial tipping points that could severely reinforce climate change and may never be reversed—for example: thawing of permafrost (with massive methane release), melting of glaciers and ice sheets (reducing Earth's albedo), change of ocean currents, destruction of rain forests and coral reefs.
'QALY' stands for quality-adjusted life years, a measure that aggregates the length and quality of life into a single measure. Thus, three years of healthy life would be 3 QALYs, as would be four years of diminished health (0.75), or three years of poor health (0.7) followed by two years of very serious illness (0.45). There is a similar methodology involving disability-adjusted life years (DALYs). Detailed discussion of these methodologies here is premature. What matters is that they are available and well-established and that one of them, possibly modified, could be used by the EIF. The QALY/DALY approach owes much to the pioneering work of Christopher Murray (Murray & Acharya 1995), who still directs the Gates-funded Institute of Health Metrics and Evaluation which publishes the widely read Global Burden of Disease reports (https://www.healthdata.org/research-analysis/gbd-research-library).

[3] Political lobbying takes different forms in different countries. In the U.S., contributions to political parties, candidates, and political action committees ("Super-PACs") dominate. Such contributions are extremely profitable: the 93 corporations that lobbied for the 2004 *American Jobs Creation Act* spent $282.7 million on their effort and harvested $62.5 billion in tax savings (Alexander et al. 2009, 404)—a 221-fold return on their investment. Fossil fuel interests spend about $125 million annually at the federal level (https://www.opensecrets.org/news/2023/02/oil-and-gas-industry-spent-124-4-million-on-federal-lobbying-amid-record-profits-in-2022) and even much more at the state level (over $400 million just in California, see https://calmatters.org/politics/capitol/2023/11/lobbying-california-2023).

[4] The magnitude of supra-competitive markups in the green-tech space varies across products and is difficult to quantify. Typical estimates cluster around 10% (de Rassenfosse & Zhou 2020)—certainly large enough to frequently tip the scales in favour of a more-polluting technology.

[5] If only 35% rather than 45% of the coal's energy content is converted into energy, then one must burn 30% more coal to generate the same amount of electricity — Pearce & Prater 2020.

[6] Here the LICs are, as it were, saying to the HICs: "you say that you did nothing wrong when your economic development imposed heavy losses and damages on the rest of the world (cf. Milman 2022) and that you owe us no part of your accumulated riches as compensation. How then can you demand that we refrain from pursuing a similar development path, unhampered by ecological restraints?" But then the people most vulnerable to air pollution and climate change are in the LICs. Constituting an ever-increasing share of the global total, pollution

originating there is harming and killing mostly people in the LICs (Vohra et al. 2021, Roser 2021). Also disproportionally affecting people in the LICs are the other negative effects of human emissions such as extreme weather events, the expanded reach of tropical diseases, and the increasing scarcity of food and water.

[7] The "billionaire tax" currently being debated at the G20/G21 might be a good source of EIF funding. The ultra-rich notoriously pay hardly any tax on their income because they can arrange their affairs so that their income takes the form of (non-taxable) unrealized capital gains. If they need liquid funds, they can borrow them while using their assets as collateral. And if they find their concentrated investments too risky, they can hedge them with derivatives such as swaps or options. To address this unfairness, the Independent Commission for the Reform of International Corporate Taxation (ICRICT) has set forth the proposal that all states should impute to their billionaires annual income in the amount of 2% of their assets. Insofar as billionaires currently report less that this amount in taxable income, their taxes would rise. Gabriel Zucman estimates that this billionaire tax would globally raise $200-$250 billion each year—mainly in the HICs, of course, where most billionaires are domiciled (Zucman 2024, 6; extending the tax to centi-millionaires would generate an additional $100-$140 billion). A mere 2% of this flow would be sufficient to secure a solid launch for the EIF.

[8] This is partly due to multinational corporations exporting polluting activities and hazardous waste materials to countries in which regulations and penalties are absent, less demanding, or poorly enforced.

[9] For country figures on PM2.5 pollution, see https://www.iqair.com/world-most-polluted-countries.

[10] For country figures on lead pollution, see https://epi.yale.edu/epi-results/2020/component/pbd.

[11] It is assumed in the text that the five-year reward periods of registered greenovations may commence at diverse times during the year. This seems unproblematic as a registrant might be reward in 2029 for deployments in June and later, and then in 2034 for deployment up to and including May. The model of annual disbursements is consistent with each registrant getting its own 5-year time window.

[12] Or more likely six, if the greenovation's reward period commences within a reward cycle. A greenovation might, for example, earn a share of the EIF's 2033 disbursement for deployments in the last seven months of 2033 and a share of the EIF's 2038 disbursement for deployments in the first five months of 2038.

[13] https://data-explorer.oecd.org/vis?fs[0]=Topic%2C0%7CDevelopment%23DEV%23&pg=0&fc=Topic&bp=true&snb=38&vw=tb&df[ds]=dsDisseminateFinalDMZ&df[id]=DSD_DAC1%40DF_DAC1&df[ag]=OECD.DCD.FSD&df[vs]=1.2&dq=GBR%2BDAC.11010..1140%2B1160.USD.V%2BQ.&pd=2020%2C2023&to.

[14] According to the World Bank https://data.worldbank.org/indicator/NY.GNP.PCAP.CD. This definition of the EIF-Zone would leave out the more affluent half of the countries that the World Bank classifies as "upper middle income"—countries like Turkiye, Mexico, Argentina, and Costa Rica.