

Is Development the Price for 1.5°C and Net Zero 2050?

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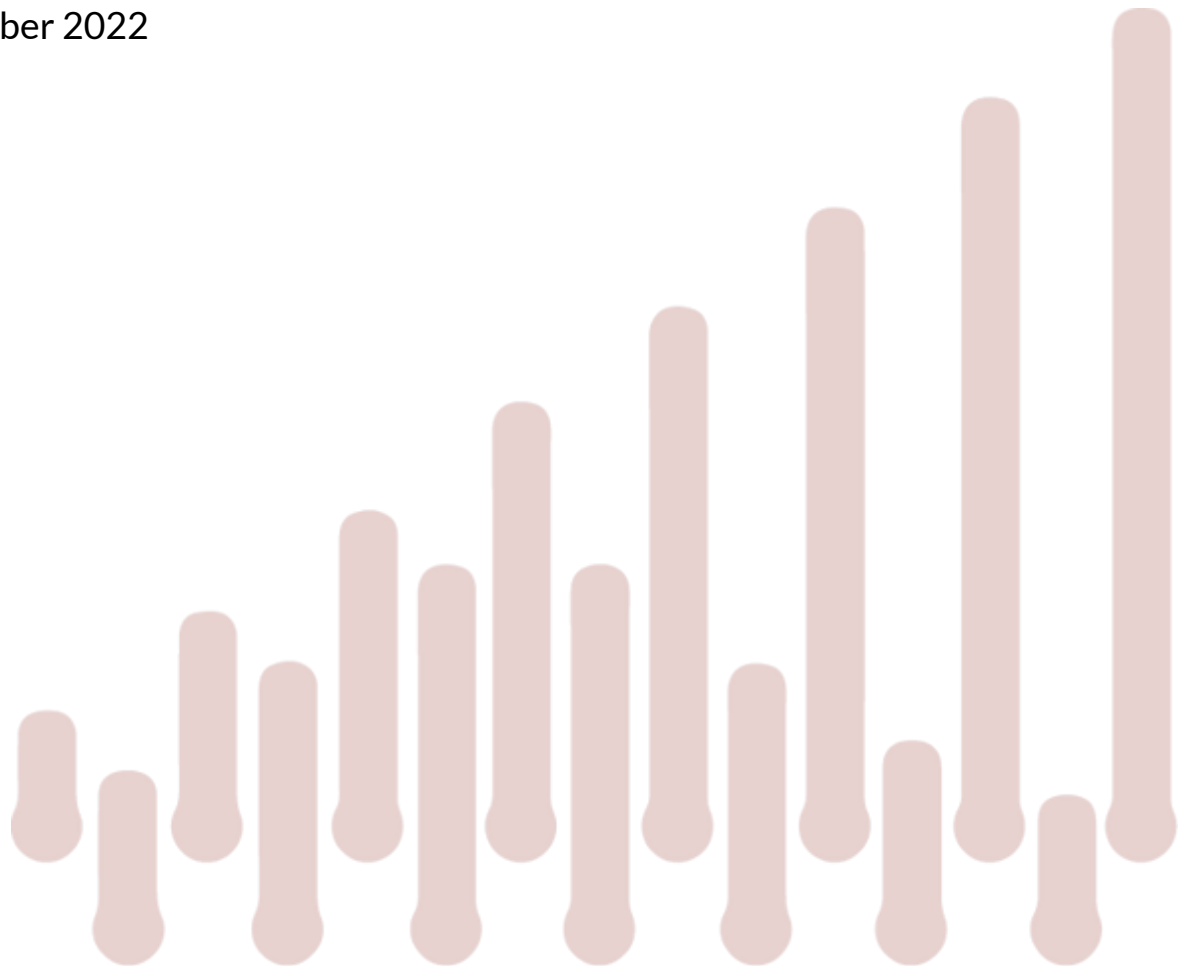
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The 2050 Global Target Framework needs to be reformulated and supplemented by Hard Intermediate Targets.

And two new global fiscal instruments are needed—neither of which is a carbon tax—to secure an efficient global strategy to deliver the temperature target.

I. Potential

Global climate policy treats “development” as steps toward **minimal near-term welfare** and as a floor, however holed under regress.

So poor countries are allowed a little longer to get to net zero and are the recipients of **token climate mitigation aid more promised than delivered**. But their **concerns are otherwise disregarded**.

By contrast, here “development” is considered neither as minimal nor incremental but as achievement of full potential by all, over a time span of perhaps a century.

Thus, as there is no inherent reason why such as Senegal or Malawi are not capable of realising the same GDP per capita as Luxembourg—proxy here for the output possibility frontier—the questions are whether 1.5° C and net zero for all by 2050 hinder realization of that full potential for all or render it impossible, why that matters, and what to do if so.

And not just “what to do”, but “how to do it right”.

The issue is the long-term inter-temporal and cumulative nature of the impact of carbon emissions on climate and the fact that almost all countries are far below Luxembourg levels of GDP per capita now.

Thus, while carbon dioxide emissions generally **partially dissipate over a century or so**, that dissipation diminishes as global temperatures rise. So with temperatures already markedly up relative to the mid-19th century, our collective impact on global temperature now is not set by emissions in any year eventually dissipating but simply by cumulative emissions over all time.

So given a global temperature target of 1.5° C above **the mid-19th Century level** by 2050 set at the 2015 Paris COP, emissions now cut global capacity for emissions later, even much later, one-for-one.

Thus, policy now may need to anticipate later emissions by others. By analogy, while raising infants, responsible parents will not target net zero savings but net surplus, anticipating much later college fees. Their net zero savings target refers to the life cycle and certainly not to such an early point in it.

Likewise, rich world climate policy now may need to anticipate full potential by all a century hence in order to reconcile the global net zero inter-temporal emissions budget constraint with that potential. To assess how much and how to deliver that, programming techniques developed at the IMF for their financial programs are applied here to a coherent goal—to address global warming efficiently.

So does global warming render development subject to the fallacy of composition? Do the goals of 1.5° C and net zero by 2050 address that matter? And should and how should they be changed if not?

II. Scalars

To begin to grasp the nature of this, consider—by concatenating the coming century’s global emissions life cycle into an instant, and thus scaling the phenomenon—that were all countries, tomorrow, to level up to the PPP GDP per capita of Luxembourg, global output would be 7 times larger than it is today.

Were that to occur with all countries using their current technologies—i.e., holding current emission-intensities-of-output constant—annual emissions would similarly be some 7 times their current annual volume.

Alternatively, were all countries tomorrow to level up just to the GDP per capita of the United States—with those now above, including Luxembourg, leveling down to it—global GDP would be 4 times larger than now.

And if instead all countries were to level just to the current GDP per capita of the People’s Republic of China—with all those now above leveling down—global GDP would remain at approximately its present level. And the world would still be on track—just—for 1.5° C by 2050.

And were countries to level up (and down) while applying the exceptionally low Swiss emission-intensity-of-output instead of their current emission intensities, the temperature target would still be breached at levels of GDP per capita well below those now realised in the US.

Thus, notwithstanding the great uncertainties in temperature projections, the only reason why 1.5° C degrees remains feasible at all now is because the overwhelming bulk of the global population is poor.

Such numbers reflect the intuition that far from Development constituting the price for 1.5° C and net zero for all 2050, those targets are essential for any significant development for the poorest at all.

But that scalar exercise, while illuminating to a point, is also misleading: global temperatures do not reflect annual but cumulative emissions; and full development will not be instantaneous.

III. Race

So can reductions in the emissions intensity of output outpace countries’ collective progress towards output potential—in order to reconcile full output potential with global temperature constraints?

Progress

The aggregate evidence on that—contrary to the tone of much discourse and **determined climate denialism**—has some surprisingly encouraging elements.

The **data on carbon dioxide emissions**, the main greenhouse gas, are not measured directly but are inferred from the physical output of oil, coal, and other industrial activities. The inferences are then added to others for the emissions-equivalent effects of changes in land use—destruction of forests (prosaically, the planet’s lungs) and of **natural stores of carbon**—to yield estimates for the total annual and cumulative man-made emissions of carbon dioxide.

These inferred annual numbers are available from 1960–2020 for industrial activities for all individual countries. But they are only available for country groupings for land use changes and only to 2010.

Though other gases such as methane and nitrous oxide may do more climate damage per unit, their relative quantities make carbon dioxide the overwhelming driver of global temperatures.

But to spotlight the relative speed of progress on emissions efficiency of output versus pace toward output potential, those data benefit from presentation in an atypical format.

First, the data on carbon dioxide emissions are aggregated into three country groups:

the 39 countries of the **OECD as currently constituted**;

- 16 non-OECD countries emitting over 200 million tons in industrial activities (excluding land use changes) in 2020 denoted “200 Plus”—Brazil, China, Egypt, India, Indonesia, Iran, Iraq, Kazakhstan, Malaysia, Pakistan, Russia, Saudi, South Africa, Taiwan, Ukraine, and Vietnam—and
- the 144 or so countries of the rest of the world (ROW).

The OECD and 200 Plus together comprise the “Global Emitters Core” (GEC).

This three-fold country aggregation is preferred to the typical individual country presentation—with the US as the big cumulative emitter villain—to avoid distractions due to border accidents. So had the US never united and had the EU done so back then, the given global emissions history would show the EU as principal villain and Texas irrelevant without changing anything temperature-determinant.

Then, and second, instead of the standard per capita emissions presentation, total carbon dioxide emissions in tons for these three groups including land use changes are calculated relative to US\$ 1,000 of real Purchasing Power Parity Gross Domestic Product (PPP GDP) for each group in 2017 International Dollars. This measure is abbreviated as Tons/K.

The PPP measure of output is preferred to correct for the impact of country income on non-tradable prices that is inherent in output measures at market rates, thus better reflecting the physical determinants of emissions. Backcasts are used for missing country PPP GDP, population data, and land use emissions-equivalents from 2011.

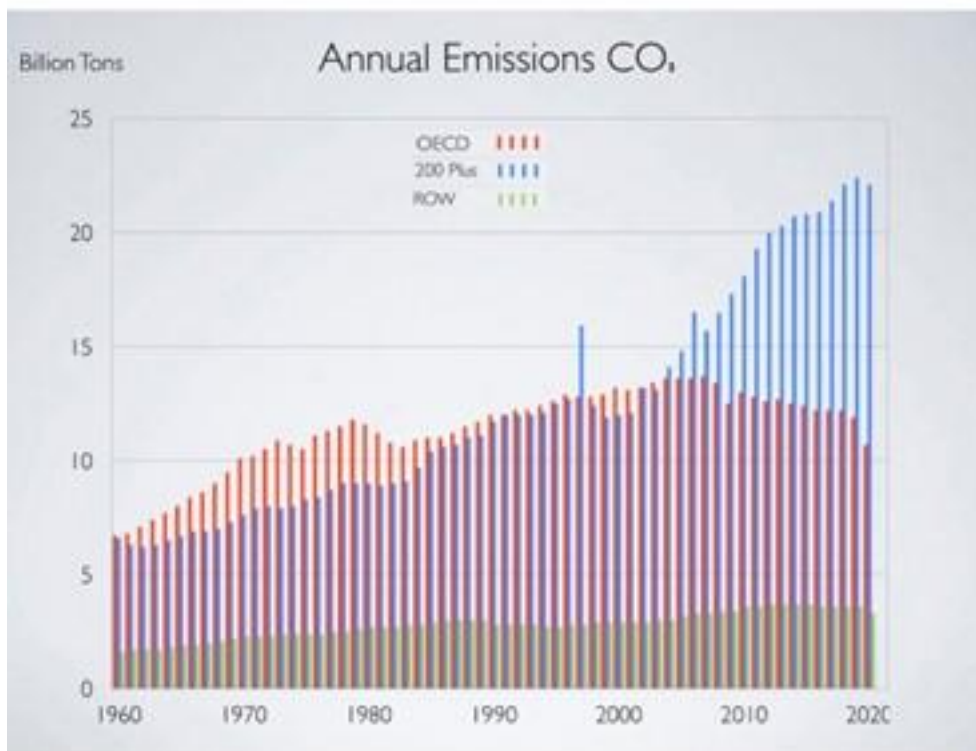
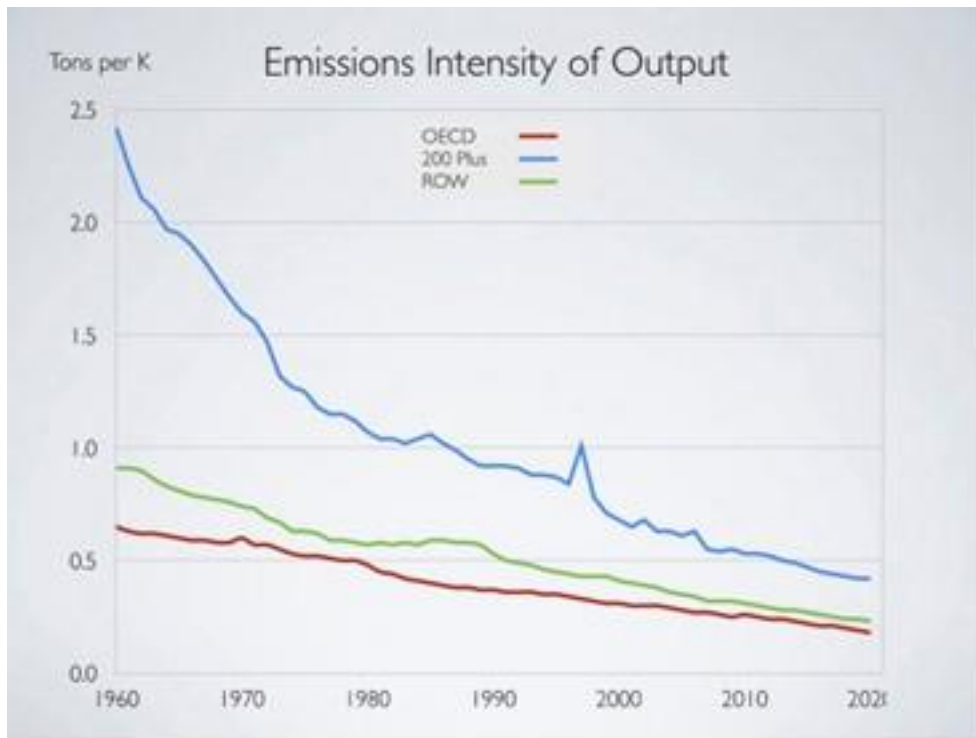
Normalization by GDP switches focus from individual country blame and onto emissions-efficiency.

Accordingly, the following charts summarise developments.

The main points to note are:

- from Figure 1, upper panel
 - the enormous improvements in emissions-efficiency since 1960, including in the most emissions-efficient group, the OECD;
 - that those improvements were steadily ongoing from 1960, well before elevated global oil prices, substantive climate activism, and **top political engagement with climate**, and have persisted steadily across several subsequent seismic global economic shocks;
 - that frequent assertions that 200 Plus—notably China, India, Brazil, and Russia—“do not pull their weight” are evidently and emphatically false, as the emissions intensity of output of that group has dropped by far more than any other;
- from Figure 1, lower panel

Figure 1.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

- but nevertheless, til the mid-2000s, the OECD and 200 Plus were neck-and neck on annual emissions due mainly to their economic output and relative emissions inefficiency respectively, with ROW negligible due to its poverty and relative emissions efficiency. After then, Chinese growth caused 200 Plus emissions to exceed OECD.

This clarifies, among other things, that US and EU per capita dominance of annual and cumulative emissions mostly reflects earlier industrialization and output rather than outlier emissions-inefficiency.

- from Figure 2, upper panel

these improvements in emissions-efficiency in the 1960s occurred in the context of rapid growth in all three groups and continued steadily in all three even in the volatile global economic conditions thereafter;

- from Figure 2, lower panel

but they occurred with the whole world—including the OECD—far below Luxembourg per-capita potential, with that gap narrowing moderately in the 200 Plus group to 2020, and widening sharply in ROW which stands now at just 6 percent of Luxembourg;

- from Figure 3, left panels

- in sectoral terms, this progress in emissions efficiency in the OECD since 1960 mainly reflected sharp cuts in coal use alongside small land use changes (tree planting etc) there which modestly shifted into recapture, while the gains in 200 Plus and ROW were totally dominated by less damage from changes in land use;
- there were sustained but moderate emissions efficiency gains from **more efficient use of oil** in all three country groups after 1980, partly reflecting elevated real prices relative to the pre-1970s-oil-shock levels;

- from Figure 3, right panels

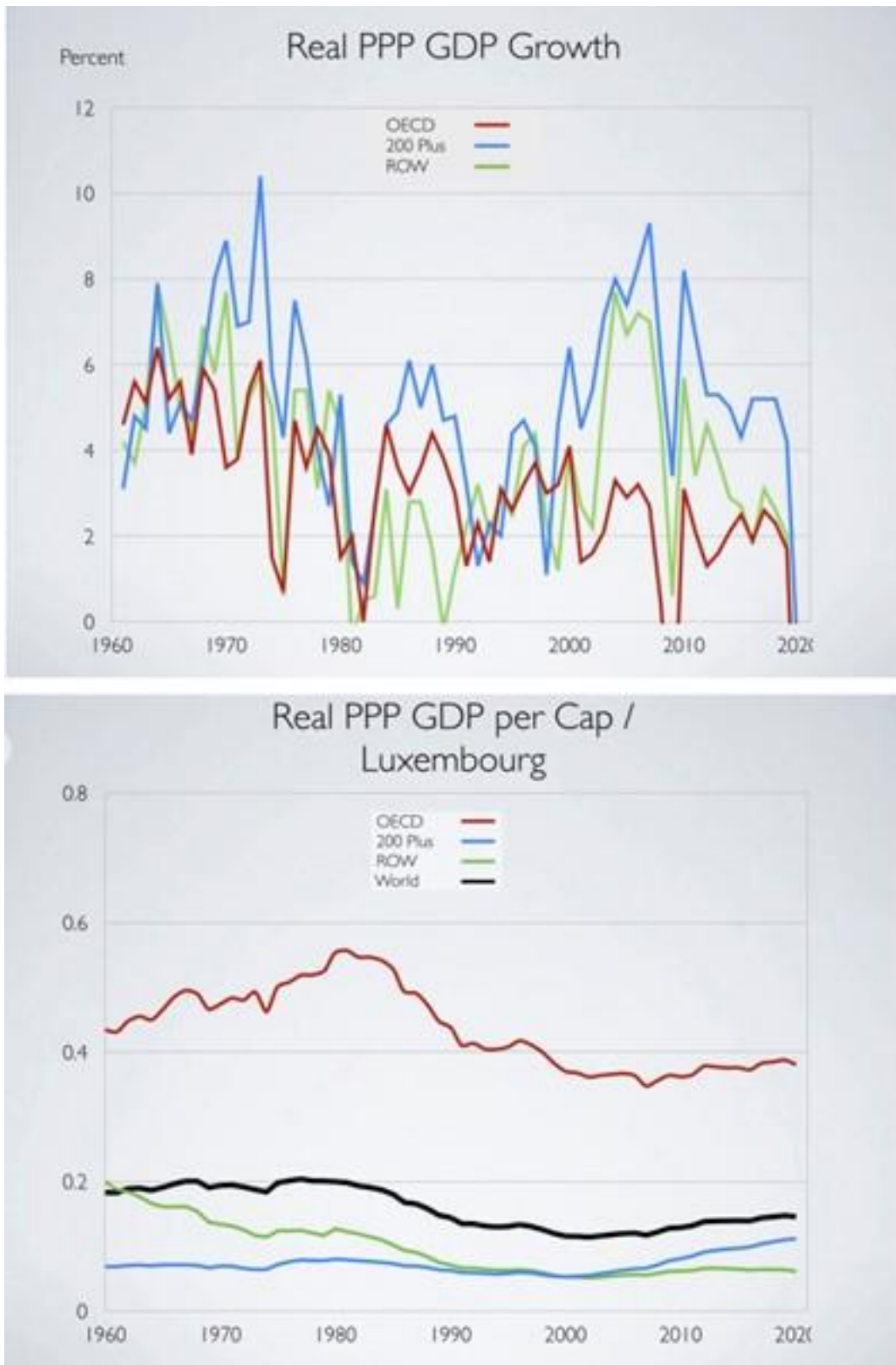
- but the big efficiency gains in coal in OECD were largely offset by growth there so total annual OECD emissions from coal were mostly unchanged before falling somewhat very recently;
- and the efficiency gains from coal in 200 Plus were totally overwhelmed by growth there so annual emissions there from coal quintupled;
- while, in sharp contrast, efficiency gains in 200 Plus in land use were so dramatic to 2010 and backcast thereafter that the total emissions implied from that source there fell sharply, by 4/5, despite rapid growth.

But all this remarkably good news on the pace, universality, and persistence of gains in emissions efficiency, led by 200 Plus, has been inadequate:

- from Figure 4, upper panel

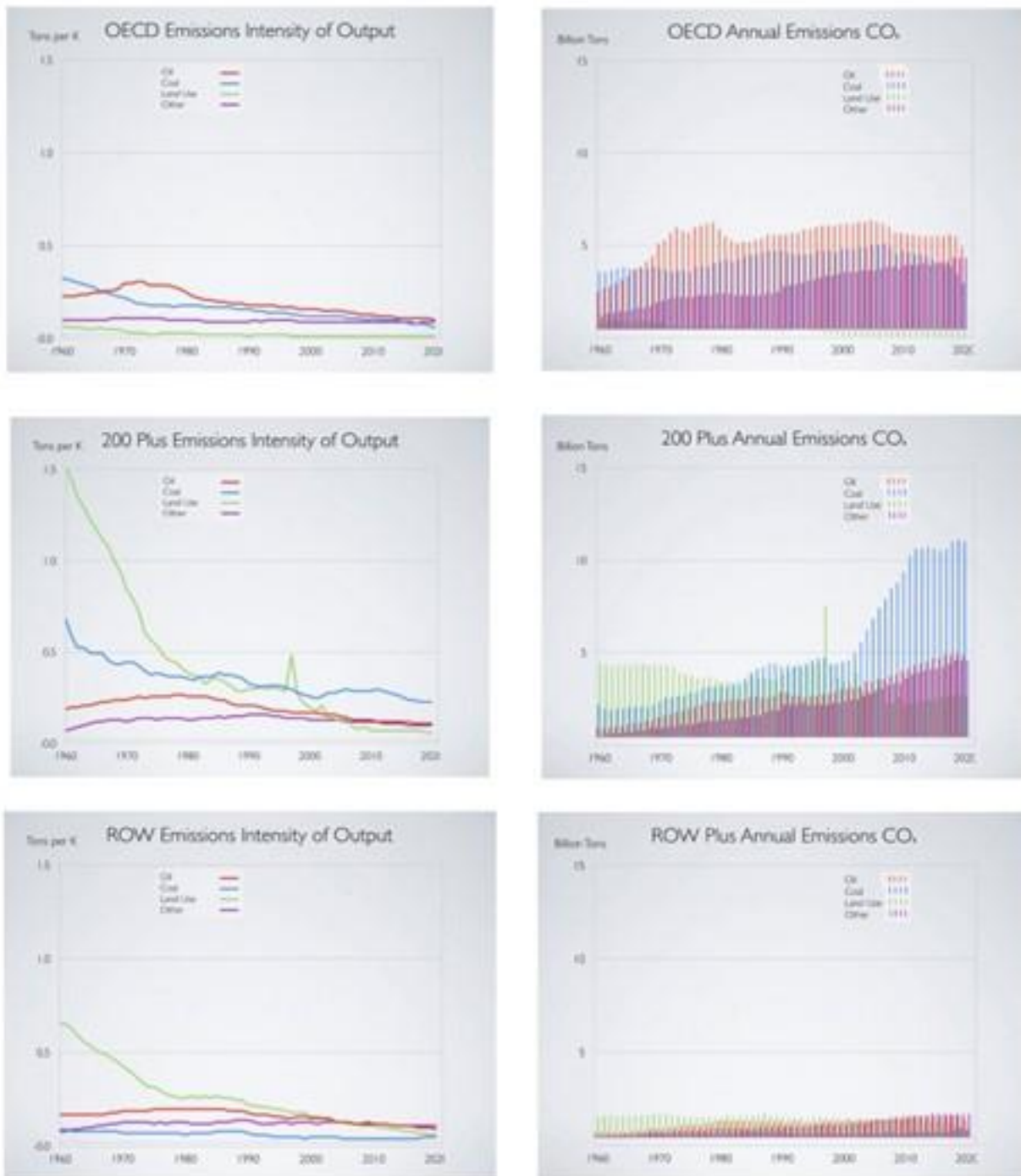
- cumulative emissions per capita in OECD remain far (some ten times) above either 200 Plus or ROW, so much so that ROW cumulative per capita emissions have fallen to 1/3 those of the Global Emissions Core (GEC);

Figure 2.



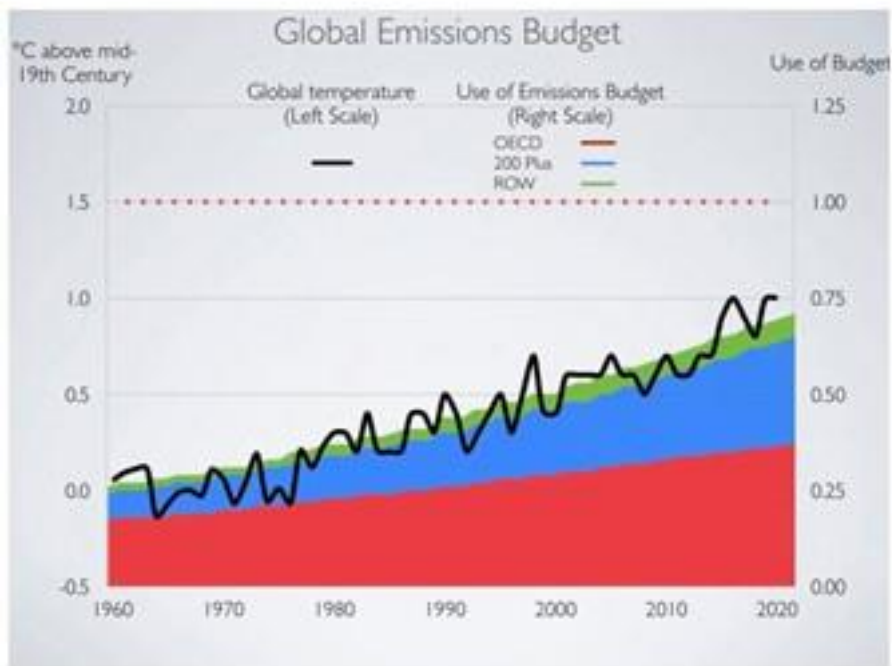
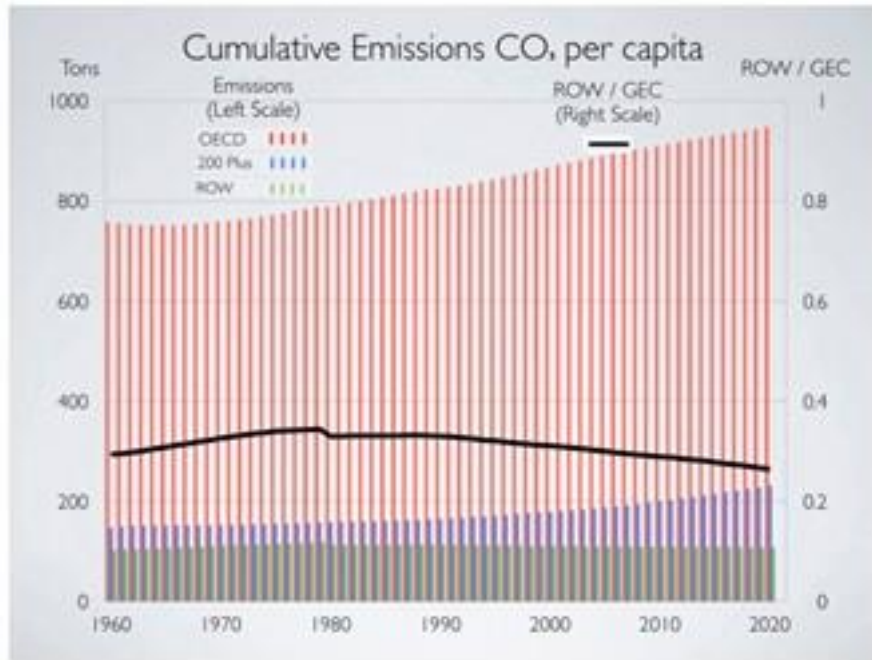
Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

Figure 3.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

Figure 4.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

- from Figure 4, lower panel
 - despite the huge efficiency gains on coal in OECD and in land use in 200 Plus, temperatures continue rising in linear lockstep with estimated global cumulative emissions;
 - with ROW negligible, OECD and 200 Plus dominate both emissions and temperatures;
 - the falls in total emissions in all three groups in 2020 are temporary, entirely reflecting the pandemic effect on output rather than any significant change in emissions efficiency, and as confirmed by the [latest global aggregate emissions data](#);

and so cumulative global emissions and temperatures remain on a strong upward trend.

Thus, since 1960, gains in emissions efficiency have been remarkable:

- in 1960, each ton of carbon dioxide emissions produced US\$ 1,600 in 2017 PPP International dollars of output; in 2020, a ton of emissions produced US\$ 3,700 of the same real output. Were this vehicle miles/kms per gallon/liter (and some is), mileage has considerably more than doubled;
- absent that dramatic global cut in the emissions intensity of output, global temperatures would not be up 1° C in 2020, but considerably more.

But all that has been inadequate: with global output in 2020 8 1/2 times its level in 1960, annual global emissions of carbon dioxide were 2 1/2 times their 1960 levels, and global temperatures were up 1° C.

So while progress in global emissions efficiency has been extraordinary, given growth, it is not enough.

And with global output per capita still only 15 percent of Luxembourg potential in 2020 with global temperatures still rising, it is not nearly enough.

Moreover, OECD cumulative emissions per capita are almost 10 times greater than those of ROW, with OECD's GDP per capita almost 9 times greater.

So, in short, the rich world took 200 years to 2000 to consume half of the total budget of 3.5 trillion tons of carbon dioxide emissions judged to be consistent with the 1.5° C temperature target, and along with 16 emergent nations, just the following 20 years to consume a further quarter of that budget.

Urgent is an understatement.

Prognosis

Despite its “follow-the-science” credentials and iconic status worldwide, the global policy framework underpinned by net zero and 1.5° C by 2050 is woefully inadequate to address this challenge.

Four simulations, based on the three-country-groups and emissions efficiency, begin to clarify.

Note that the simulations are neither forecasts nor conditional forecasts; instead, they are an expository device—notably simply extending the linear correlation between cumulative global emissions and temperature since 1960 to project temperatures—to highlight the core issues and orders of magnitude.

Those temperature projections accordingly reflect **only the human carbon dioxide contribution to global temperature** and abstract from issues of functional form, lags, out of sample parameter instability, measurement error, the error term in the underlying temperature processes, and potential changes in the composition of greenhouse emissions.

But given the minimal systematic variation in the global temperature and cumulative emissions data post-1850, this is about as good as econometric modeling of this can do. And the **attempts at more complex models suggest that this linear approximation is robust.**

Baseline

With that rubric emphasized, the baseline simulation assumptions for Figure 5 are:

- the emissions intensity of output remains on its post-1960 downward trend (upper LHS),
- as does output per capita and population growth worldwide.

These assumptions yield a temperature rise of 1.5° C by 2050—just on target (lower panel RHS).

That replicates and confirms the principal qualitative conclusion of the Glasgow COP—which was that if we go on as we are, we are collectively, at best, right on the temperature target edge.

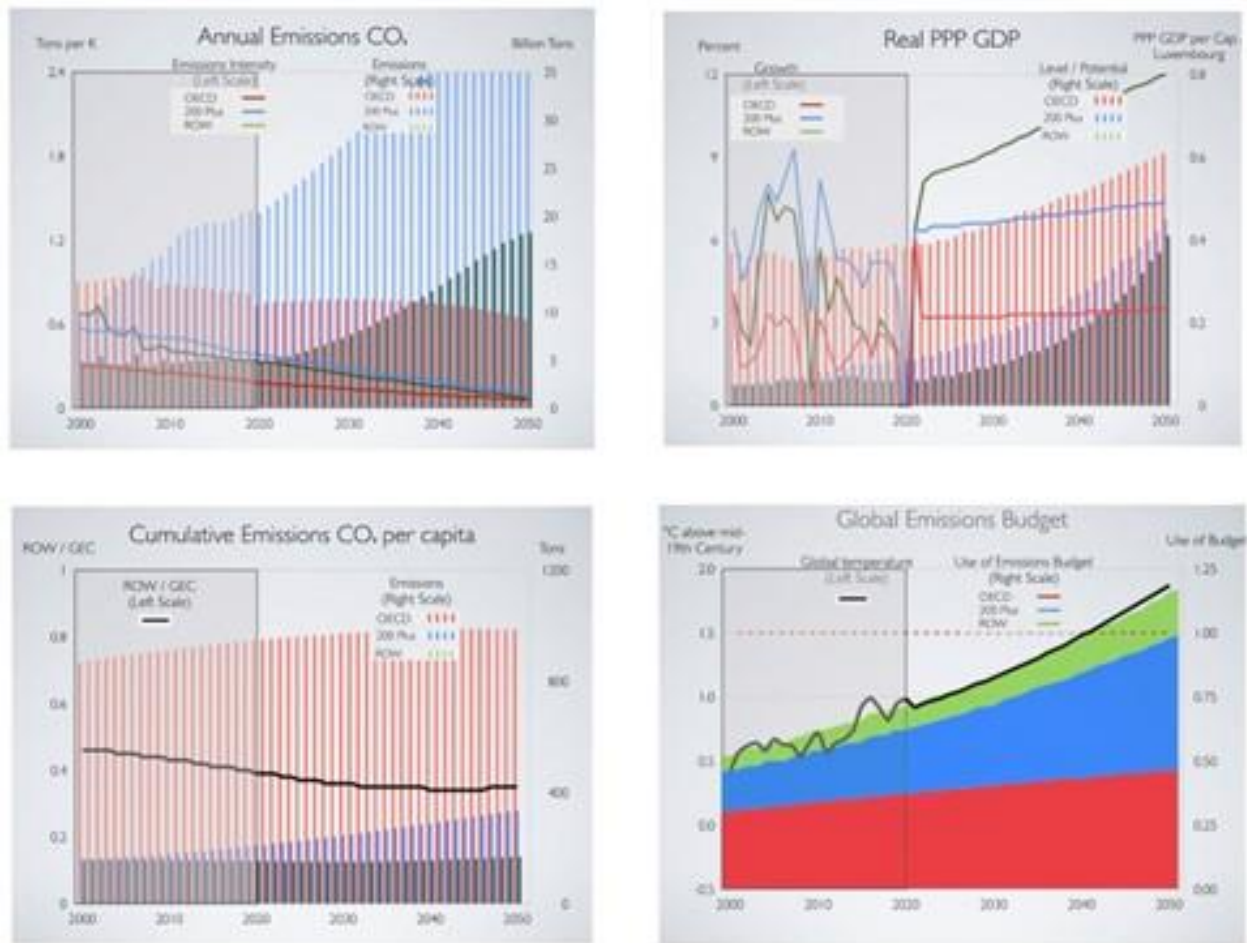
But as the Global Emitters Core (GEC) does not get to net zero by 2050 (Figure 5, upper LHS), cumulative emissions continue to rise as do global temperatures, thus breaching the global temperature target thereafter.

And with the global emissions budget fully exhausted by 2050 with output in ROW just 6 percent of Luxembourg, this scenario implies that effectively no allowance is made for global potential.

Thus, present trends represent the worst “deadbeat parents” scenario: the rich world living ostentatiously now and making no allowance for the global future in their temperature target framework, and by not reaching net zero, not even meeting their own inadequate targets.

On current trends and policies, with no progress by ROW to its Luxembourg potential, development is the price paid for almost attaining 1.5° C and net zero by 2050.

Figure 5. Baseline simulation



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

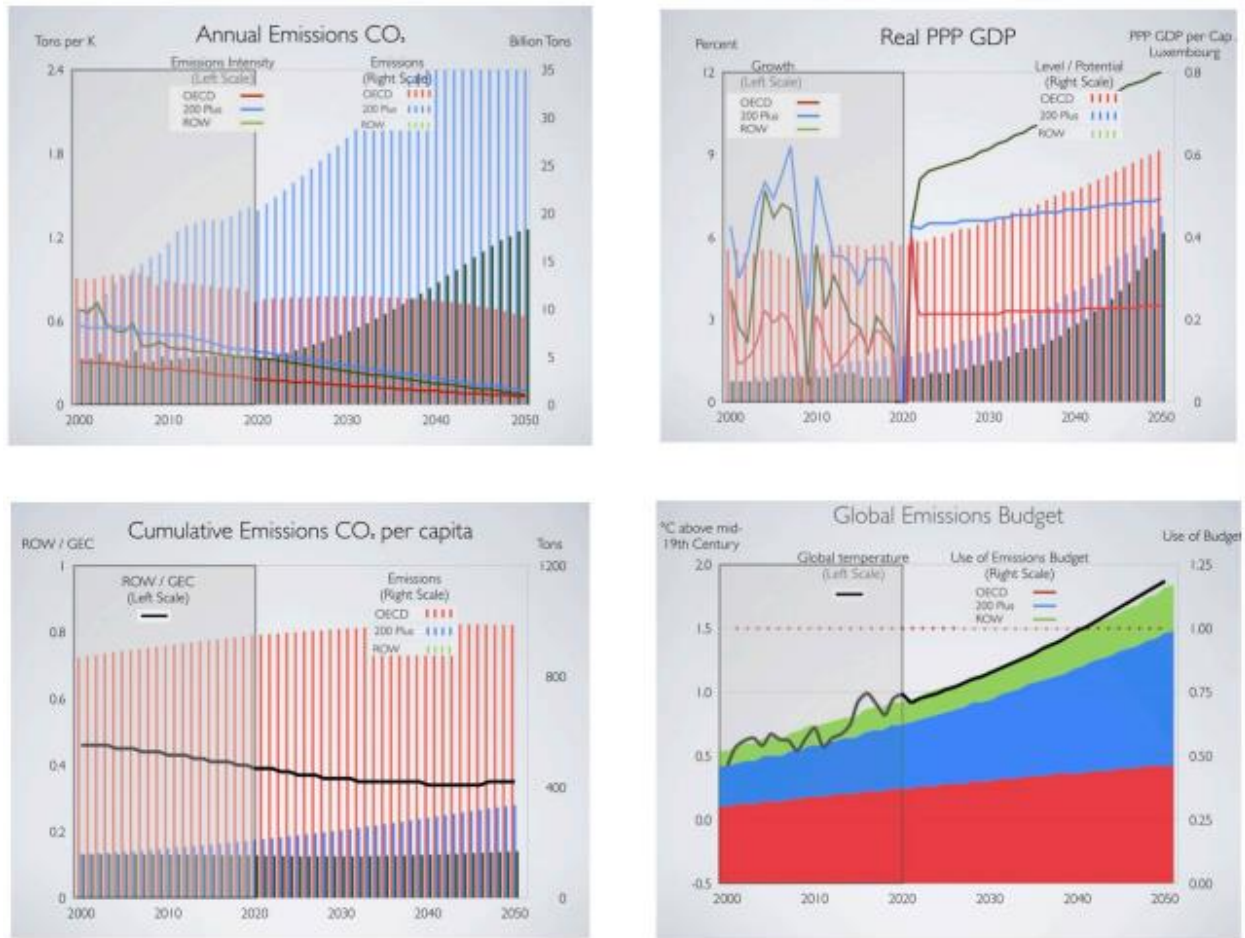
Luxembourg

This conclusion is underlined by rerunning the simulation—with the same paths for emissions intensity of output and population—but assuming that all countries attain the GDP per capita of Luxembourg a century from now, attaining 1/3 of that goal by 2050 with Luxembourg’s GDP per capita growing at just 1 1/2 percent till then (Figure 6).

In this simulation, OECD annual emissions rise through 2035 rather than falling as in the baseline, but even so they are dwarfed by those of 200 Plus (upper left panel) which literally go off the chart. That is because per capita growth for all three groups far exceeds recent trends (upper right panel) with the size and relative emissions-intensity of 200 Plus thus dominating emissions (upper left panel).

Consequently, with ROW per capita output rising to almost 40 percent of Luxembourg by 2050, global temperatures breach the 1.5° C target a decade or so before 2050. And as no group is at net zero even by 2050, global temperatures continue to rise thereafter.

Figure 6. Luxembourg simulation



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

Thus, were the world to advance towards output potential instead of remaining on baseline growth trends, the temperature target would be utterly unattainable given the assumed (baseline) paths for emissions intensities of output.

Front-loaded

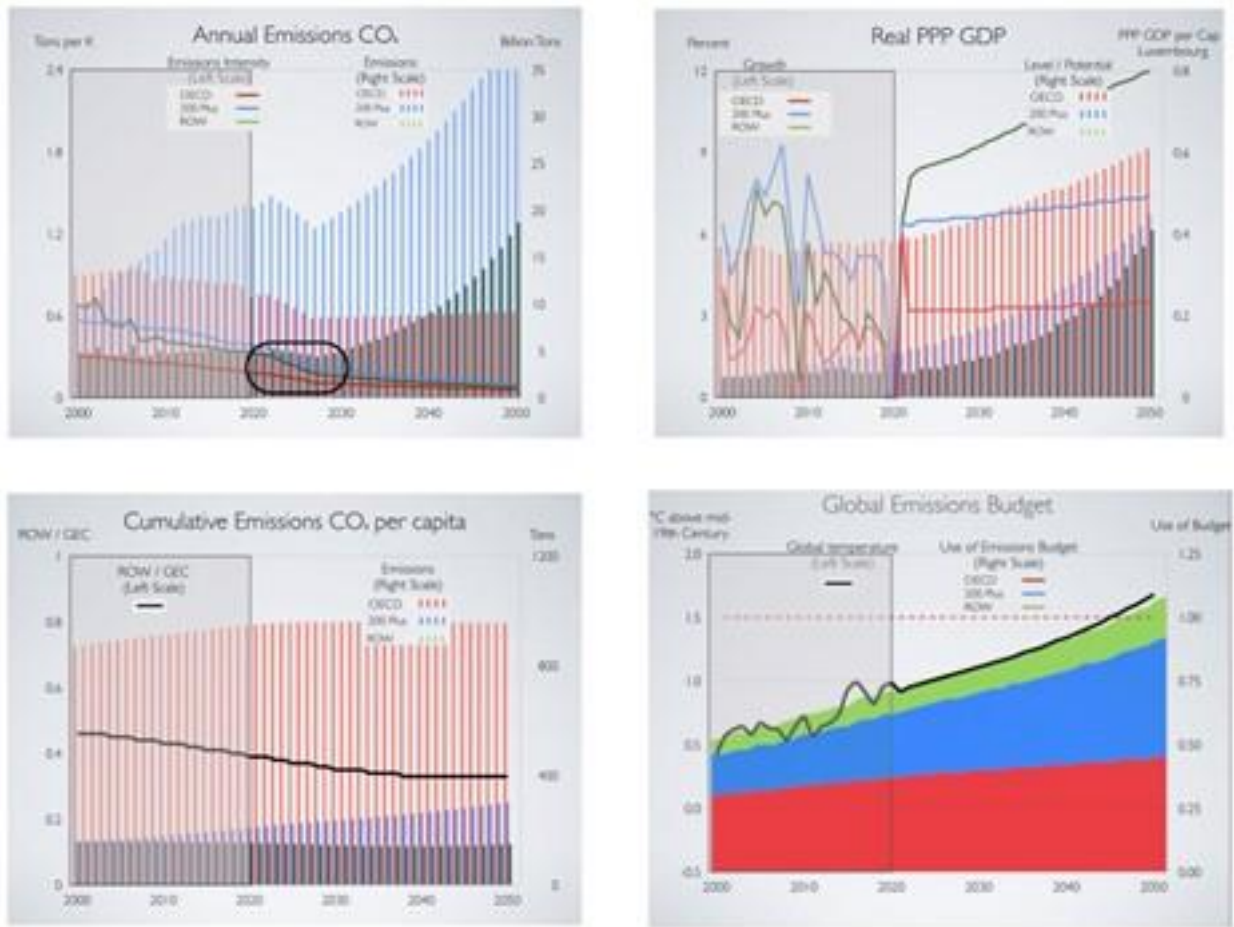
But even those two simulations fail to capture the full implicit sacrifice of development inherent in the current global target framework.

Because not only do the goals for 2050 matter; the path to get there is also critical.

The front-loaded simulation summarised in Figure 7 illustrates.

This retains the Luxembourg simulation assumptions. But it assumes that the pace of advance in emissions efficiency of output in all three groups doubles from 2023-27 before returning to paths delivering the same endpoints in 2050 for emissions efficiency as in the baseline (upper left panel).

Figure 7. Front-loaded simulation



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

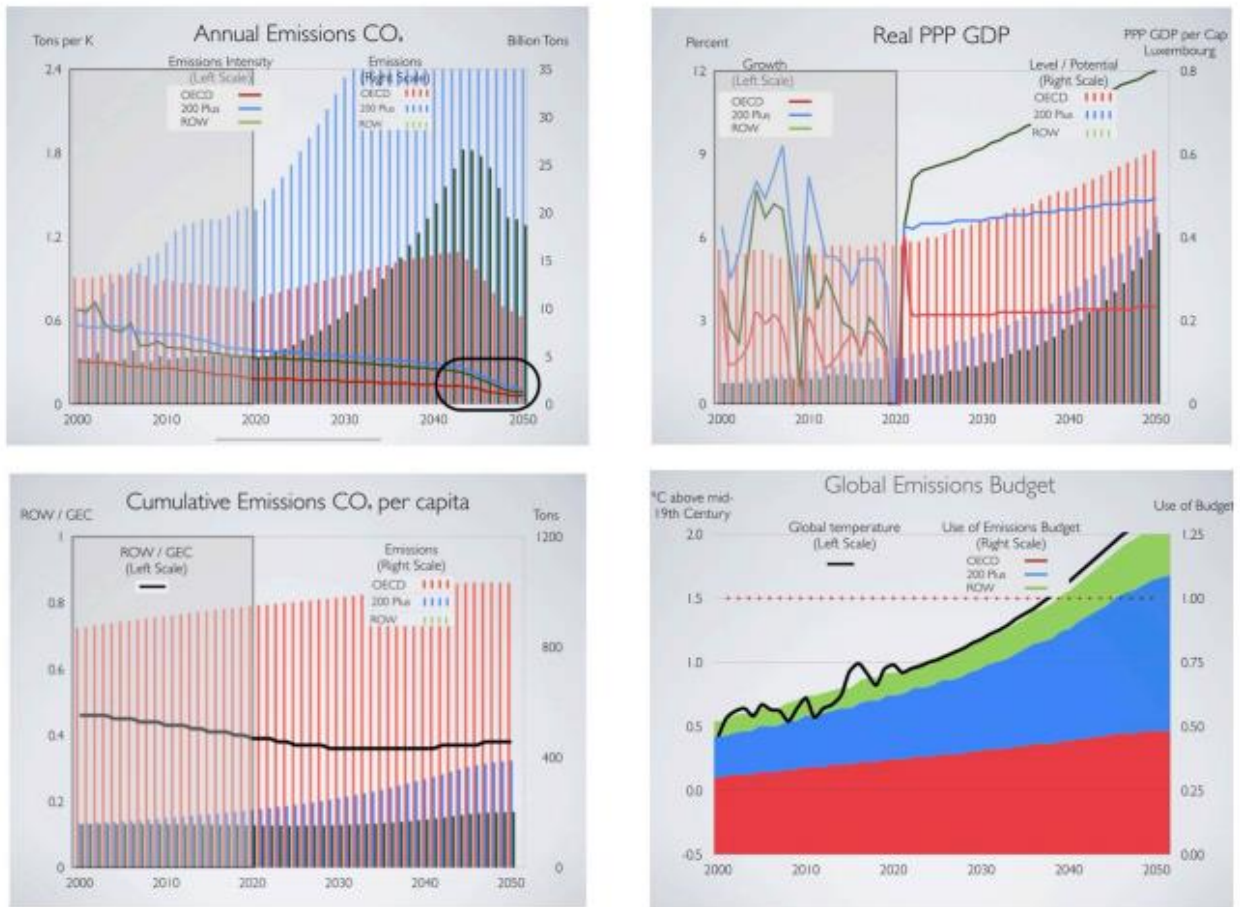
Remarkably, even with growth globally surging towards Luxembourg potential, the simple assumption of just a temporary 5-year acceleration in emissions efficiency with the end point unchanged is enough to keep the 2050 global temperature target just about within reach.

And were emissions efficiency to get to net zero by 2050, the 2050 temperature goal would be firmly back within reach, even with output surging towards Luxembourg potential.

Back-loaded

And to underscore path-importance for development, were that path for emissions intensity of output instead to be backloaded in the context of a surge of growth towards Luxembourg potential, the global outlook becomes temperature armageddon (Figure 8, lower right panel).

Figure 8. Back-loaded simulation.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

But this high sensitivity of temperatures to the specific path to 2050—front-loaded vs backloaded is entirely ignored in the global target framework.

Accordingly, and to summarise all of this, even if the current global target framework is met and no adverse solar system events aggravate temperatures, a good temperature outcome is far from a given:

- if the path to global net zero 2050 is backloaded, temperatures may stabilise thereafter but above—and possibly well above—target (Figure 8).
- if global net zero is not achieved by 2050 but cuts in emissions intensity of output are front-loaded, the 2050 temperature goal may be achieved but it will continue rising thereafter (Figure 7).
- and either way, if progress to cut the emissions intensity is slow or inadequate, even well-below-potential global output may not suffice to cap temperatures at target (Figure 5).

In short, the outlook for the emissions intensity of output across the three groups is the heart of the matter.

IV. Instruments

Technology is thus central.

But it does not magically resolve everything. The flippant techno-blasé mindset that dismisses the entire global warming challenge—“an App will come along to fix that too”—is flatly contradicted by the slow pace of reductions in the emissions intensity of output *relative* to output (Figure 1).

Furthermore, the relevant technology does not just concern machines and infrastructure because this is not about economic output. Instead, it concerns all factors determinant of global emissions.

So the instruments include **the distribution of income**—as **high per capita emissions of the top income quintile relative to the bottom** means that redistribution can cut emissions and emissions-intensity (and vice versa) just as dramatically, if not moreso, as changes in land usage and emissions-efficient machinery and **infrastructure**. And it includes the transition from planning to market mechanisms, **carbon levies of highly varied design and ambition**, and policy aimed at **happiness rather than GDP**.

This wide range of emission-control technologies—going well beyond **alternative energy sources**—is already reflected in aggregate data on emissions intensity.

And **contrary to the view of some**, the wide range also rules out a global “one-size-fits-all”—and in particular a global carbon pricing—policy. Carbon pricing **may play a role, even an important one**, but only as one menu item **among many**, and only for some.

The wide range of instruments also contradicts pervasive notions, as reflected in the **Glasgow Financial Alliance for Net Zero**, that **individual sectors**—**fossil fuels**, finance, **aviation**, vehicles, or **meat**—should be also be **emissions-vilified worldwide**. That approach ignores that such sectors may be macro- or micro-critical in some countries which are, because of their overall emissions efficiency and/or poverty and unlike others, more than fully pulling their climate weight.

So countries may **continue to reduce their emissions** making **different choices** from that **broad menu of instruments**, reflecting their individual **relative prices, incomes, preferences, and sectoral circumstances**. A “planetary problem requiring a planetary solution” does not mean a single solution.

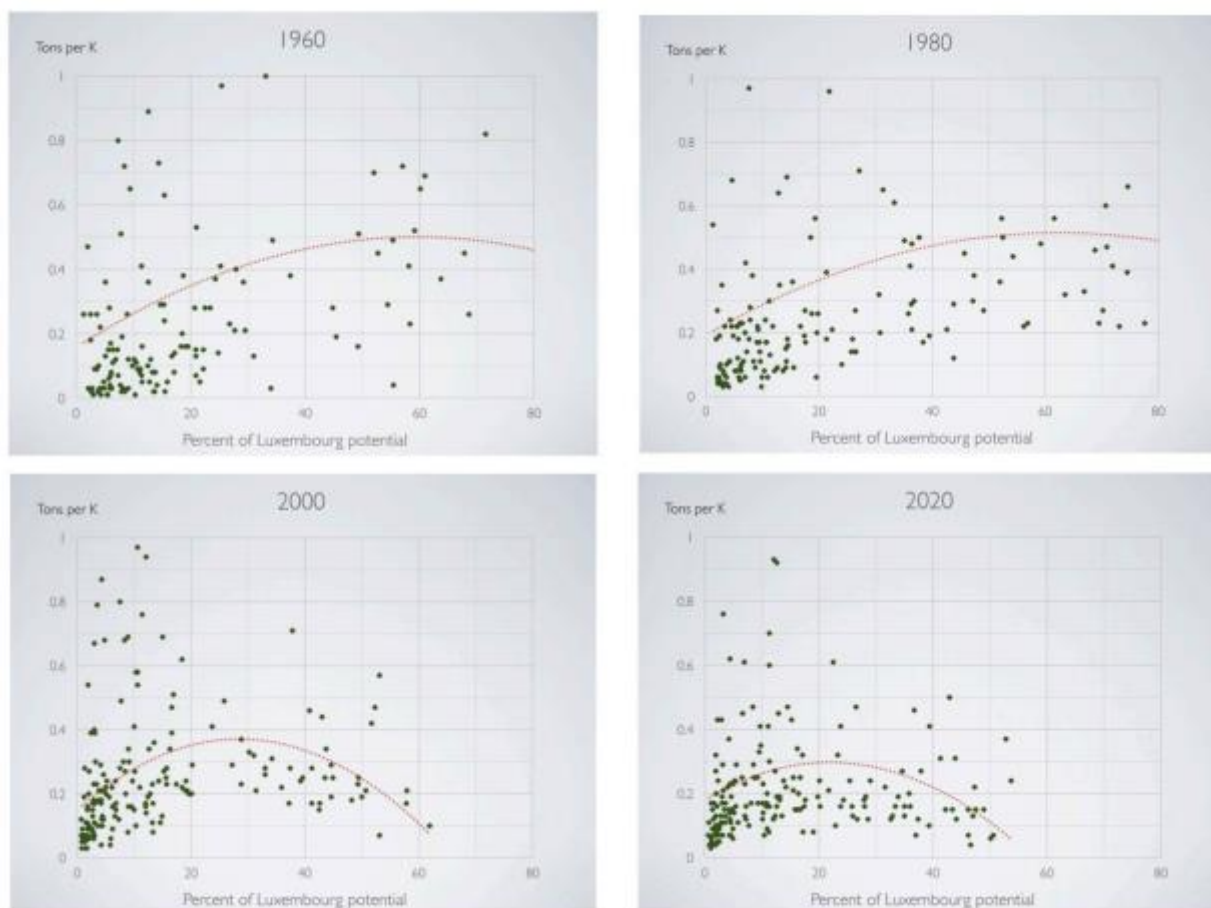
And the breadth of the menu is central to effective global policy now, not least as given the urgency, **full flexibility for countries is essential to maximise their cooperation to contain temperature**.

So this is not a matter of the future pace of technological productivity at the production possibility frontier—the **Gordon vs Brynjolfsson debate**. Instead, at issue is whether the full range of instruments can absorb, with just 1/4 of the total global emissions budget for 1.5° C remaining, the growth potential of the world.

In getting to an answer on that, note critically that not all choices from the menu are voluntary. For ROW, the primary—involuntary—option is their poverty. To date, that factor—with the shortfall in ROW per capita output relative to Luxembourg of 94 percent compared to just 60 percent for OECD (Figure 2) and consequently the cumulative per capita emissions in ROW barely 1/3 those of the GEC (Figure 4)—has been by far the greatest single global contributor to keeping global temperature within bounds. Without it, the temperature cap would long have bust.

And for the foreseeable future, ROW faces particular technological constraints on reconciling net zero even with just its incremental growth. In particular, with intensity and income outliers (above 1.45 Tons/K and US\$ 61,000 respectively) excluded, cross country data excluding land use changes from 1960-2020 consistently indicate that overall emissions intensity rises with income per capita at least up to around 30 percent of Luxembourg potential (Figure 9).

Figure 9. Emissions intensity and income.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

That remains even as more recently, declines in emissions intensity appear at higher incomes and the whole curve broadly shifts down somewhat.

Thus, incremental development at low income levels appears to be **relatively and inherently emissions-intensive**, even with the full range of menu options available.

And this relationship is particularly acute for those in ROW parts of whose resource endowment happens to be emissions-intensive, such as **Timor-Leste**, or **Senegal**, or **Uganda-Tanzania**, or **Angola**.

More broadly, the costs of the net zero requirement to development are only negated if, at some point, technology renders all potential ROW output emissions-free at zero cost relative to the counterfactual.

But just wishing that, or aspirational talk of “leap-frogging”, or hoping ROW will adopt OECD-appropriate green technology won’t make it so.

ROW, by definition, has **limited resources to pay for R&D specifically to enable low-income zero-emissions** or to purchase its products. And any such appropriate technology has a limited half-life—becoming obsolete when ROW approaches half of Luxembourg potential.

These economics stand in the way of the development of such appropriate zero emissions technology.

So the shape of the prospective unconstrained path for Africa's emissions efficiency as it advances from its present 4 percent of Luxembourg potential is likely to follow the shape though not the amplitude of that of the OECD after 1800—a long inverted U.

In contrast, the almost linear decline in emissions intensity by China from 2.2 Tons/K in 1980 (excluding land use) to 0.4 now in its rise from 2 to 15 percent of Luxembourg potential is atypical, reflecting for very specific historical reasons its unique starting point in 1980 as a high emissions-intensity outlier. And despite that huge improvement, China's partial advance towards Luxembourg has still consumed 6 percent of the total global emissions budget so far.

Thus, the challenge posed even just by Africa alone is that the continent is now home to 1.2 billion people, 1/3 more than China's in 1980 with no prospect of—or case for—anything like China's "one child" policy, that the OECD and 200 Plus have already consumed some 3/4 of the global emissions budget, and that both groups continue emitting heavily as they move to potential alongside.

All that is how, despite the broad menu of instruments available, past and ongoing consumption of the global emissions budget by OECD and 200 Plus means that development to potential globally now manifests the nature of a long-term zero-sum game—at the disproportionate expense of the poorest.

V. Recapture

All the more remarkable then is the total absence of global recapture of emissions from policy.

Not **token** virtue-signaling **recapture by some** to **slow net annual emissions marginally** (Figure 3), but recapture on a global scale sufficient to cut total cumulative emissions and thus to drive temperatures back down.

That "dog not barking" is telling—because "we prioritise net zero" is only part of the explanation.

The target of 1.5° C itself discourages R&D on global recapture by signaling that the globe is happy to live with those temperatures, even if at the expense of the poorest.

And implicit demand for global recapture is further suppressed because any eventual market for it is subject to free-riding, as it is the ultimate public good.

These economics stand in the way of the development of technology for global-scale recapture.

That and the associated/ consequent fact that **scientific research on this is not yet even in its infancy** are further rebuttals of blithe "techno-optimism" to resolve all these matters.

VI. Principles

Given the global emergency, an instinctive impulse is “just get new emissions to net zero now”.

But that “science-based” framing—zero annual net emissions, as soon as possible, by any means, with everyone doing “their bit”—has major shortcomings because science has nothing to say about the selection of instruments nor tradeoffs nor contingencies nor potential nor polluter-pays.

Yet these economic principles are all integral to the global challenge:

- Menu choice

The wide range of instruments, including poverty, gives many options to cut emissions but also complicates agreement, mutual surveillance, and assurance that plans suffice and are delivered;

- Tradeoffs

Cuts in emissions are unequal—as reflected in emissions intensities, some imply much heavier sacrifice of output and broader goals than others, and ability to bear them also varies greatly;

- Contingencies (1)

Policy on recapture has to address the possibility (likelihood?) that the given target will be overshoot;

- Contingencies (2)

1.5° C as target reflects OECD and 200 Plus politicians’ guesses about their populations’ **tolerance for it**—with all **incoming evidence** suggesting **that they will not** do so. So policy has to address the possibility that these core preferences might change and 1.5° C might come to be seen as **too high to live with**;

- Potential

Net zero for all 2050 might keep temperature capped while the bulk of the world remains poor, but it makes no accommodation for potential;

- Equity

Net zero for all ignores the dominant contribution the poorest have already made and are continuing to make to capping global emissions via their poverty;

- Polluter pays

Net zero for all also ignores that the classical “polluter-pays” principle applies to total cumulative net pollution/emissions, not just to **current net pollution/emissions**.

Unlike net zero for all, this full set of principles places the OECD and 200 Plus as principal and richest cumulative polluters into the hot seat.

So, with almost all climate scientists residing there with their work largely framed by its priorities, politicians there are only too happy to hide behind them with “science-based” net zero for all. Indeed, they **get very upset** when the economic inadequacies of their strategy surface, even elliptically.

All this is deliberate abuse of science by those politicians.

Science makes a pivotal contribution by establishing that there is a global problem and its causes, and by offering a host of technical options to address it.

But it does not—and makes no claim to—specify the solutions, only to establish the broad emissions constraints that must be satisfied to achieve any temperature target that is chosen by global policymakers, whichever means are chosen to satisfy that constraint.

OECD and 200 Plus policymakers have shown no shame in disregarding such distinctions.

And that's far from the end of the shamelessness. Polluters there continue gargantuan emissions daily; influential interests there **continue to delay correction** including by **exaggerating doubt** and **fatalism**; others there **unabashedly** exaggerate **advances**—including the **recent US climate actions**; and many use the climate issue to advance unrelated agendas, such as trade protectionism and anti-capitalism.

With all this incoherence in the target and strategy, the globe is barely on track to hit even 1.5° C—as reflected both in the baseline simulation and in many other formal studies.

Polluter Pays

But the most deafening silence of the great cumulative emitter-polluters in regard to these principles concerns polluter pays.

Even acknowledging that ROW has benefitted from imports from OECD and 200 Plus industrialization, it paid for those in full in cash, whereas the temperature cost to ROW of that industrialization has gone entirely unpaid.

And all that will remain even as some in ROW gain from **green demand for their minerals**.

So the simplicity in the name of science of “net zero for all equals net zero globally equals temperatures stabilise” is iconised in the rich world and by the **international financial agencies they control** precisely because it obliges countries to act regardless of cumulative malfeasance: polluter does *not* pay.

Moreover, that iconisation establishes in the minds of the general public there the notion that “**when we (individual countries/counties) get to zero, we're done**”, thus pitting the entire center of political gravity there on this matter against polluter pays.

Accordingly, the fact that cumulative emissions per capita in 2020 in OECD were almost ten times those in ROW—917 tons, as compared with US\$ 232 tons in 200 Plus and just 107 tons in ROW—is simply wafted away with shameless self-righteousness with zero “**for all**” (Figure 4 upper panel).

But the polluter-pays principle has been conventional economics for a century since Pigou first proposed its general “externalities” form—highlighting the wanton destruction of value when costs do not have to be paid.

Current warming strategy not only blatantly disregards that imperative, and it also ignores the related the core Pigovian proposition—that the correct redress is not to some weighted or coerced average of the preferences of externaliser and externalised, but full restoration of the externalised's status-ante.

That disregard of redress-to-status-ante is apparent in all three of the core elements of current strategy:

- the number, 1.5

The number has been set without concern with **what process is legitimate let alone economically coherent to do so**. A straightforward return to the status-ante for ROW would imply a global target of 0° C—a bald fact which dramatically underscores the import of total inaction on global scale recapture.

And if instead some average of global preferences were used to set the number, ROW constitutes some 1/3 of the global population to 2050. So given its negligible per capita cumulative emissions and so burden to correct, it would likely prefer a number **close to 0° C**. Alongside the OECD and Plus 200 preference for 1.5—that implies a global number of 1.0° C.

While some ROW governments have formally endorsed the 1.5° C target, it is with a gun placed to their collective heads (rejection out of hand by the biggest and richest global polluters of anything lower, with this coerced consent dubbed “realism”).

- the phrase “for all” after “net zero” and before “by mid-century”.

Even though its contribution to the global temperature rise since mid-19th Century is negligible, ROW also has to pay to secure 1.5° C—by advancing its current emissions-efficiency. That fact remains even with the “accommodation” that ROW gets to net zero a little later than others.

- Compensation for ROW by loans

Instead of full compensation for the climate damage above 0 degrees that ROW suffers as a result of OECD and 200 Plus cumulative emissions, it is offered loans, namely the **proposed \$100 billion annual fund for climate damage**. In order to be eligible for those loans, ROW must conform to the specifications OECD and 200 Plus set out for it to get to net zero. And funding under this heading may simply replace funding already envisaged.

Summarising these three breaches of Pigouvian Status-Ante-Redress by analogy—with “smoking in bed” representing carbon-based-industrialization by OECD and 200 Plus, and with “your house” representing the global temperature that ROW consequently has to live in:

I have burned down my house and yours by smoking in bed, so I have set a plan to quit my smoking in bed, at a pace of my choice, which may slip a lot, and if you protest, I will smoke in bed more and for longer before quitting, risking other properties you may own; you have to put up cash towards the damage I have done to your house; and I will not pay you to cover the rest but will instead lend you sums at times and for purposes and on terms of my choosing, possibly replacing funds I was extending to you anyway, equal to a small part of the damage I’ve caused, but only if you, as a lifetime non-smoker, commit never to smoke in bed.

Science says that this “net-zero-smoking-in-bed-for-all” program will solve the issue once and for all. So, all our future properties will be secure *and* I have helped to finance your development.

Disbelief at this reflects the strength of feeling about Status-Ante-Redress when it is taken off an abstract conceptual pedestal and is put concretely—with your house as casualty of my insouciance.

Yet remarkably, whereas any number of economics text books cite global warming as the iconic example of an externality, none go on to note how the core of current climate strategy—as reflected in that smoking metaphor—rejects the Pigouvian status ante remedy utterly.

Pigou and the International Economy

And even though emissions-intensive industrialization by OECD and 200 Plus is not going to repeat, the Pigouvian case that they should pay for past emissions at planetary expense still applies robustly.

That is because their emissions violation of Pigou is only one episode of a **multiplicity of such offenses** at international level. Precisely for **lack of an overarching authority to enforce it**, anarchic—Pigou violating—behavior all but defines international relations, quintessentially including military invasions.

And for the future, such violations include longstanding “international fallout” risks inherent in nuclear technology and more recent externalization challenges in space and the cyber world, as well as further threats coming from ongoing research on geo-engineering to redistribute global rainfall, reflecting its potential as a strategic weapon and its commercial uses.

And contrary to the implicit assumption in dismissive “techno-optimism” that more knowledge is benign, **galloping and spreading technology** also facilitates more such externalisation—by OECD, 200 Plus, or ROW or any of their parts against others.

So the **risk of being externalised** at international level is pervasive, repeating, and rising. It will be a dominant characteristic of—and challenge for—the international economy in the coming century,

So though technology means that the biggest polluters will not **industrialise similarly again**, it also implies that the boot may be on the other foot for some or all of them in future international externalisations, whatever form those may take and whomever may initiate them.

Thus the point is not to penalise to prevent a repeat of emissions industrialisation but is to do so to establish that any such future international externalisations will be penalised.

The only way to do that is by precedent.

This has partly been done before—for the Atlantic Trade in People from the 16th Century on.

For centuries, the historical “great” powers willfully defied Pigou by extracting value without compensation **in the form of People-Owning**, just as they are now doing via global warming—on the same scale and duration and with the same unblinking assertion of virtue, albeit now in the name (falsely) of Science rather than (falsely) of Christianity.

That Pigou-defying extraction of value without compensation was ended not by a Global **Leviathan**, but by means of universal renunciation by collective precedent—albeit **without reparations yet**—which now renders it unacceptable anywhere under any circumstances.

By contrast, uncompensated extraction via rising global temperatures goes on and on.

And though such uncompensated international externalisations cannot all be stopped, this one—global temperature—like People Owing, warrants priority due to its fundamental nature and global scale.

So concern for ROW on this basis is not mere bleeding-heart supplication, nor a reflection of vague notions of “climate justice”, nor of slurs like “neoliberalism”, nor another guilt trip to do “more”.

And nor is it backward-looking. Instead, like all sound policy, it concerns efficiency in the future. And not just any future, but fundamentally, on a global scale, and over a multi-era time scale.

Thus, it is the hardest-core concern of conventional economic principles—albeit expressed over an unfamiliar time horizon and across international boundaries—with wanton destruction of value when costs do not have to be paid for.

And perhaps to their surprise, just as with People Owing, setting such a Pigovian precedent on this matter is also in the self-referencing interest of the biggest cumulative polluters lest they find themselves similarly internationally externalised in future.

So 1.5° C and net zero for all may now be the choice of OECD and 200 Plus for themselves in their own myopic interest, and at a global level and with some fortune it may cap temperatures. But toothless as it is—and hence liable to failure—it violates a core tenet of economics; it is not even second- or third-best absent full Pigou Status-Ante-Redress for ROW.

As with People Ownership, in the absence of Pigou precedent-setting in the climate strategy, all that remains is anarchic brute force—a core reason People Ownership persisted and temperature warming persists for so long.

That is what makes an approach to warming which respects Pigou Status-Ante-Redress not just an imperative for ROW but a global imperative—to end to that global wanton destruction of value when costs do not have to be paid for.

And, so, though no climate protestors’ placards read “Follow the Economics!”, that is exactly what should be done.

So where do the economics delivering Status-Ante-Redress—in the first instance anchored by the target number of 1.5° C—lead?

VII. Action

Course Correction

The principles—and notably polluter pays—are not nice desiderata to be jettisoned in the exigencies of emergency, and certainly not in the self-righteous myopic comfortable self-interest of the great cumulative polluters under the aegis of “realism” and “necessity”.

Instead, alongside rising cumulative emissions, the principles collectively *describe* the global emergency.

Accordingly, **motivated by common humanity**, correction cannot consist of **wishful thinking** or denial, but must consist of action to ensure that the shortcomings in the global strategy relative to the Pigovian standard are corrected.

That means returning ROW to its status ante.

ROW Status Ante

The strategy could return ROW to its status-ante in three ways.

(i) Compensation

The standard Pigou remedy to restore the externalised to their status ante is via financial compensation paid by the offender.

That requires specification of exactly who, pays exactly how much, to exactly who, exactly how, and exactly when.

In the case of global warming, the “exactly who pays” is not difficult to determine. It could simply be based on relatively non-controversial estimates of the per capita cumulative emissions of each country.

But all the other requirements for Pigovian compensation—“exactly how much, to exactly who, exactly how, and exactly when” are technically all-but-insurmountable.

The “exactly how much and to exactly who” issues require establishment of precise costs in each ROW and 200 Plus country which can be ascribed to climate change and nothing else—eg, a general failure to plan ahead—and decisions on valuation of lives shortened or lost or never lived, and decisions on what to do about countries or parts thereof in ROW that may have gained from warming.

All that technical work would generate much creativity but little credibility. And even so decisions would be required as to whether to pay governments or affected individuals directly.

The “exactly how, and exactly when” are equally intractable. While compensation would have to be in form of grants, that still leaves fungibility—if “donor” countries making such grants correspondingly cut other financial flows (including grants) to recipients. And given that emissions are ongoing, this exercise may need to be ongoing.

And certainly, any compensation should not be **focussed only on the emissions-intensive members of ROW** in order to “buy” their non-exploitation of their particular resource endowments, especially if that might leave the Pigovian issues in the rest of ROW unaddressed.

This quagmire of problems with Pigouvian compensation has nothing to do with the political resistance to compensation within the OECD and 200 Plus Countries. They are pure economics.

So, anything remotely approaching full compensation to restore temperature status ante is all-but-infeasible. Any such financial arrangements, even if labeled “reparations”, are essentially **pre-labelling “aid” for various forms of climate disasters**. That is a band-aid—and **laudable accordingly**—but it is certainly not Pigovian restoration to status ante.

(ii) Temperature

Failing compensation, a second approach would be to target 0° C, rather than 1.5° C. That would literally restore the status ante for ROW and 200 Plus while diminishing the case for compensation.

While evidently ambitious, the main case against it is that there is a lower cost approach to restoring the status ante for ROW and 200 Plus.

(iii) **No Emissions Constraints**

A third approach is to allow ROW to grow without any emissions constraints on its own activities.

That would restore ROW to its status ante in terms of development potential. It would also put ROW on the same footing as OECD and 200 Plus when they began their respective growth take-offs—which were also unconstrained (de facto) by emissions constraints.

And it is feasible because even were ROW to grow rapidly, its cumulative contribution to the temperature challenge would **still be temperature-non-critical (Figure 3)**.

That last point is critical—because it does not apply to 200 Plus. Whatever the case for such status ante emissions-unconstrained growth for ROW, the same for 200 Plus is now infeasible—given the modesty of the remaining carbon budget and the annual scale of their emissions. Though 200 Plus warrant some special accommodation in this form of status-ante redress, it cannot be unlimited.

However, this form of Status-Ante-Redress secures a meta equality for ROW—equality of growth opportunity with OECD and 200 Plus unconstrained by own-emissions concerns.

And as an approach to delivering Status-Ante-Redress, it would end not when ROW has achieved per capita emissions parity with OECD, not its own Luxembourg potential, but when it has achieved OECD levels of GDP per capita.

At that point, whatever the remaining discrepancy between ROW and OECD cumulative emissions per capita, both would face the same overall constraints and opportunities for economic growth because, having equal per capita income, they would face the same relative factor prices and therefore the same technological options to grow consistent with global temperature objectives thereafter.

Thus, what this achieves is equality of growth opportunity across centuries for OECD and ROW—and Status-Ante-Redress in that sense and to that degree.

Combined with feasible compensation also paid to ROW for climate damage resulting from earlier OECD and 200 Plus emissions, that would get as close to full Status-Ante-Redress as possible.

Thus, this third approach is not to reset the global target to 0° C nor to compensate ROW financially in full for the difference between that and 1.5° C, either of which would be unnecessarily costly means of restoring the status ante for ROW.

Instead, alongside compensation for the direct harm ROW suffers from climate change that can be sensibly quantified, provided as grants and excluded from aid-to-GDP targets to ensure additivity, the correction is to free ROW entirely of any temperature constraints on its potential growth in the policy framework to 2050.

So while ROW has to **adapt to climate change, it should face no curbs on its emissions to fight it—**including no bans on fossil fuel financing or coercive **debt-for-temperature-control swap transactions**.

All that breaches a core tenet of net zero for all—that all further emissions anywhere should be curbed and eliminated as soon as possible.

But by adding yet another non temperature-critical constraint to the complex processes of growth and stabilization, that tenet violates the **principle of parsimony in conditionality** in ROW. So for **outsiders to insist that tiny Kosovo de-carbonise**, on top of the **thicket of issues there**, while **Germany reactivates its coal power stations** and **China extends its own**, is to descend into climate performative parody.

Instead, far from that breach of a core tenet of net zero for all constituting a heresy, it is the point—to focus the adjustment effort where it matters and at the appropriate locus of Pigovian responsibility.

To deliver that consistent with global temperature targets, relative to net zero for all OECD and 200 Plus would have to accelerate their own emissions efficiency so as to offset the added emissions from ROW—putting the burden where it belongs and setting the precedent that costs have to be paid for.

This approach also addresses those in ROW with emissions-intensive resource endowments more simply than any form of “**paying them to leave those resources in the ground**”, especially if such payments are at the expense of other members of ROW. Development of those resources in ROW would be climate unconstrained.

And remarkably, there is evidence that when the climate strategy reflects such fundamental economic imperatives, **public support for it grows in both the OECD and 200 Plus**.

Thus, the proposal is to free ROW entirely of any temperature constraints on its potential growth in the policy framework to 2050—it does not have to target net zero at all.

Headline Targets

But the global temperature target of 1.5° C still has to be met.

So, to derive the associated new emissions targets for OECD and 200 Plus, the following applies the conceptual techniques of financial programming of the IMF—which formally tie long-term complex objectives to current actions and measures in its lending to members.

The organizing question for this programming exercise is:

how much of the remaining global carbon budget should be set aside to accommodate ROW to OECD levels of GDP per capita, emissions unconstrained and for however long that may take?

One programming approach to answering that is to impose an assumption that ROW and 200 Plus grow to 2050 sufficiently rapidly that they reach OECD levels of GDP per capita on its baseline trajectory then (Figure 10), and to subtract the associated emissions from the global budget total, leaving the residual for OECD and 200 Plus.

That programming exercise also requires an assumption on how the emissions residual is split between 200 Plus and OECD. That is done by solving for the paths for emissions efficiency of 200 Plus and OECD which, given assumptions about their output, means that the globe hits 1.5° C in 2050.

In particular, the programming exercise toggles (raises) the annual percentage improvements in the baseline emissions efficiency for 200 Plus and OECD by the same percentage point amount until the 2050 temperature target is realised, consistent with the growth assumptions.

This approach to allocating the global residual between OECD and 200 Plus requires the OECD to adjust further to accommodate the faster programmed growth of 200 Plus—putting the overall

burden of adjustment to raise emissions efficiency where it belongs—on the greatest cumulative polluters.

A detailed illustration of the implications is set out in the “Status Ante” simulation in Figure 10.

That indicates that OECD should attain significant recapture by 2045 (Figure 10, upper left panel, circled).

However, this overall arrangement is maintained only until ROW and 200 Plus attain parity of income per capita with OECD (Figure 10, upper right panel, circled). Thereafter, given equality of productivity and relative factor prices, others can use OECD zero emissions technology without further relative disadvantage to their developmental potential.

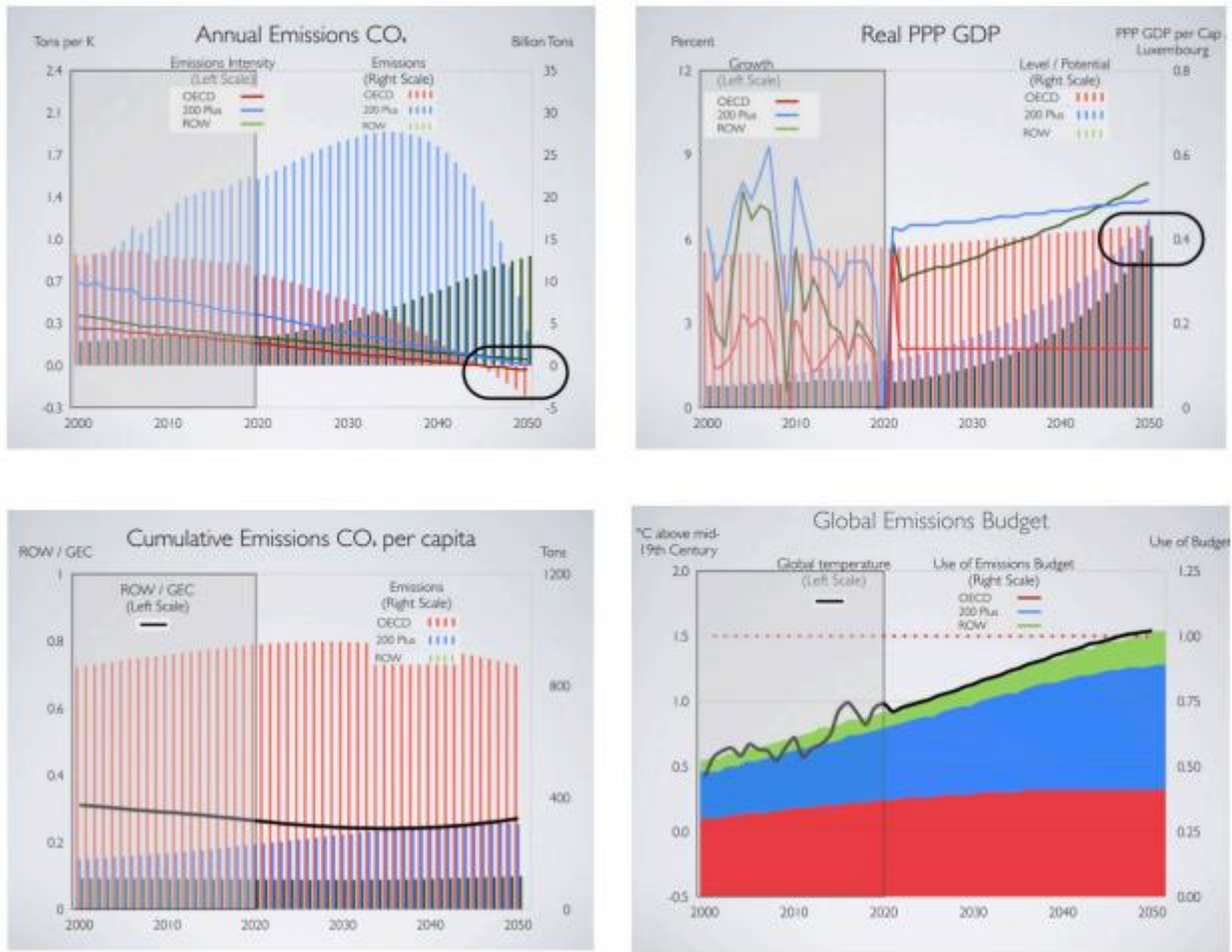
All this provides a measure of the “least required” adjustment effort for OECD consistent with Status-Ante-Redress because it takes no account of:

- the possibility that 1.5° C may, ex post, be viewed globally as too high;
- that compensation by OECD for climate damage to ROW cannot be possibly be complete;
- that ROW emissions intensity may rise with its GDP per capita before falling back;
- that ROW needs a bigger emissions budget if its ascent to OECD per capita is more protracted;
- that ROW in a pure Pigou sense can claim exemption from emissions constraints until its per capita cumulative emissions equal those of OECD, not just until its income per capita matches OECD;
- that if prospects for post-2050 global recapture are circumscribed—given the economics standing in its way—then more ambitious pre-emptive global action is required, led by OECD.

Yet, even with all these allowances, still the need is for OECD not to aim at net zero but decisively at significant net recapture for the group as a whole.

Clearly, the numerical 2050 recapture target for GEC for 2050 could be calibrated on less ambitious growth assumptions for ROW and 200 Plus to 2050 and correspondingly easier efficiency targets for OECD and 200 Plus. But that increases the burden on post 2050 recapture and/or appropriate zero-emissions technology in order to deliver full Status-Ante-Redress.

Figure 10. Status ante simulation.



Sources: IMF WEO Fall 2021, Maddison Project Database, and Global Carbon Atlas.

So, any case for that arises only if confidence in either or both of these is high, despite the economics impeding both.

Of course, other approaches to this financial programming exercise could be attempted.

Notably, rather than assuming ROW and 200 Plus grow to income per capita parity with OECD by 2050, another simulation could be run for ROW and 200 Plus to 3020 assuming it will take a century for ROW to reach OECD per capita income. Alongside assumptions for ROW emissions efficiency for that time, an estimate could be made of the remaining emissions budget to be set aside for ROW now to accommodate that, with the OECD and 200 Plus allocation again calculated as a residual.

However, such other approaches are less robust—requiring assumptions about activity and emissions efficiency a century hence.

So, even on the most accommodative assumptions for the greatest cumulative polluters under most-robust methodology, Status-Ante-Redress requires substantial changes for the greatest cumulative polluters from their current baseline.

The OECD should halve its anticipated total baseline 2023-50 net emissions (Table 1), sizeable but feasible without a discontinuity in its emissions-intensity path (Figure 10). Thus by 2050, the OECD will be annually net recovering from the atmosphere 1/3 of its annual net emissions now.

Table 1. Total net emissions 2024-2050 tons (billions)

	OECD	200 Plus	ROW	Total
Baseline	256	644	81	981
Pigou	120	644	222	987
Percentage Change	-53	0	173	0

Sources: IMF WEO Fall 2021, and Global Carbon Atlas.

Furthermore, were this framework adopted, if OECD and 200 Plus comply, and if 200 Plus and ROW take much longer to reach per capita parity with OECD than 2050, then the global target of 1.5° C will be undershot. In that event, that will not be cause for celebration (and accompanying policy relaxation); it only means that 200 Plus and ROW are taking longer to use up the carbon budget set aside for them.

For that reason and others, the headline target formulation needs to be recast.

The proposal is that the headline target be changed from 1.5° C and net zero for all by 2050 to net recapture by the Global Emissions Core at least by 2045, and an undated cap of 1.5° C.

Intermediate Targets

However, all that is meaningless without an effective framework of intermediate targets to deliver it.

Even the prevailing targets for OECD and 200 Plus for 2050—let alone beyond—are far too distant and susceptible to back-loading. And in that context, even the cycle of **country submission of climate plans anticipated since the 2015 Paris COP** is completely inadequate as a measure of progress.

Following the example of the IMF’s financial programming frameworks for its programs, such “future plans” must be anchored in hard numerical targets of ongoing performance, headlined by so-called **quantative performance criteria**—measuring recent performance to establish formally, and regardless of future promises, whether countries are “on track now or not”.

These are usually quarterly and are enforced by immediate cessation of IMF financing if corrections to any breaches of the quantative performance criteria are not forthcoming immediately. The greatest cumulative polluters insist that the IMF which they control imposes all this on countries—primarily in ROW—availing themselves of that institution’s lending to tie undertakings to delivery.

Accordingly, such hard quantitative intermediate annual targets need to be imposed on the world's biggest emissions polluters. Regardless of promises of future climate actions, these intermediate targets should be used to measure past progress in time to drive course correction by appropriate countries if necessary and to maintain the credibility of the ultimate undated goalpost of "Max 1.5° C (Figure 2).

Such formal intermediate targets should, however, not be defined on temperature or on chemical readings of the atmosphere. While these should and will continue to be intensively monitored, they are noisy, are affected by non-human factors, and are indeterminate about who is responsible for any necessary corrective action.

Nor should the intermediate targets be defined on individual country carbon emissions. That would overlook concerns that emissions cuts by the rich come at less cost than those by the poor given the marginal disutility of income, that cuts should focus on relatively emissions inefficient output in order to minimise the associated global output costs, and that an intermediate target should not be distorted by temporary output declines such as occurred in 2020 with covid or other recessions.

Thus, the intermediate targets should be defined on the annual emissions intensity of output.

And they should be set separately for both the OECD and 200 Plus aggregates. Were they set for the GEC group as a unit, this would also overlook that OECD per capita cumulative emissions of OECD far exceed those of 200 Plus (Figure 1 part 3, upper panel).

The annual numbers for emissions intensity should be calibrated—under the Pigouvian simulation—to be congruent with and to deliver the aggregate global objective to cap temperatures at 1.5° C.

Furthermore, using the Pigouvian simulation as the basis to set the two target paths for OECD and 200 Plus ensures that the paths are absolute minima. So, there is no question that breaches of such intermediate targets matter, even allowing for the technical challenges in assessing the human impact on temperatures on which underly that path.

These intermediate targets of course rest on assumptions for the unconstrained path of emissions intensity for ROW to 2050 and beyond. They would have to be reset in mid-stream if emissions shift from OECD to ROW more than assumed even if total global emissions remain on track—with weaker-than-assumed emissions efficiency in ROW automatically matched by stronger-than-assumed emissions efficiency in OECD.

Similarly, if ROW secures greater than assumed unconstrained emissions efficiency alongside rapid growth—so that the curve tracing the relation between emissions efficiency and GDP per capita continues to fall in the relevant range (Figure 9)—then this has to be reflected as well.

Hence, need for—in IMF programming terminology—a standard symmetric Performance Criterion Adjuster.

The symmetric adjuster approach to this matter is congruent with a Status Ante Redress strategy because it calibrates the adjustment path for the greatest cumulative polluters assuming that this decline does not happen and adjusts their path ex post if it does. By contrast, the current strategy implicitly sets the adjustment path for the greatest polluters assuming and coercing the further decline in the curve in the relevant range—regardless of the cost borne those who have polluted the least.

Accordingly, the Performance Criteria for the Emissions Intensity of output for 2021-26 for the OECD and 200 Plus aggregates, and indicative Performance Criteria thereafter, are presented as follows in Table 2.

Table 2. Status ante redress performance criteria 2021-2050 1/

Tons of CO2 emissions (or equivalent) per US\$ 100,000 PPP GDP (2017 International Dollars)																																
	Performance Criteria												Indicative Performance Criteria																			
	2020	2025						2030						2035					2040					2045					2050			
OECD	18	18	17	16	15	14	14	13	12	11	10	10	9	8	8	7	6	5	5	4	3	3	2	1	1	-0	-1	-1	-2	-3	-3	
200 Plus	42	40	39	37	36	34	33	31	30	29	27	26	24	23	22	20	19	17	16	15	14	12	11	10	8	7	6	5	3	2	1	
	1/ Before symmetric adjuster for ROW																															

The proposal is to set intermediate annual aggregate Performance Criteria paths for the OECD aggregate and the 200 Plus aggregate defined on their respective emissions intensity of output, with adjusters for emissions shifting to and efficiencies by ROW, and indicative Performance Criteria for 2026 onwards.

Enforcement

Such Status-Ante-Redress annual performance criteria are highly likely to require enforcement.

That is because the GEC has only committed to Pigou-inefficient targets with adverse consequences largely external to them in ROW. Further, their targets are subject to backloading. And the falls in emissions intensity of output so far were largely the coincident result of other things—notably economizing on oil and coal, so that **further progress will be increasingly difficult**.

Though OECD and 200 Plus have many technical options—ranging from the personal to the systemic—if the pace of decline in emissions intensity of output in those groups does not increase sharply and soon, a Status-Ante-Redress climate strategy become impossible. And regardless of what ROW does, human activity is set to drive global temperatures beyond—and possibly well beyond—1.5° C.

So, the first step is enforcement of the annual performance criteria that are proposed for the two groups—OECD and 200 Plus. The greater the deviation, the greater the corresponding corrective force.

Such corrections should be focussed on the worst individual country performers on emissions intensity of output in the two groups. In the first instance, these worst performers should be reported and publicised expressly to as to embarrass the offenders and laggards at the relevant COP meetings.

Amongst other benefits, that would break through the “Tower of Babel” melee of such meetings with clear headlines, thus rewarding front-runners and naming-and-shaming laggards.

That focusses the adjustment effort on the least emission efficient countries. And it also encourages other countries which are just outside the list of the worst three to do likewise—so as to avoid such embarrassment at future COPs.

It thus motivates a competitive force between Sovereigns focussed on the worse offenders in the OECD and 200 Plus to drive down the global emissions intensity of output at least expense to global output.

To illustrate, the upcoming COP in Egypt should be presented with table 3 and Figures 11 & 12, showing **Australia**, Canada, South Korea, Iran, Kazakstan, and South Africa the prime culprits, as well as the OECD and 200 Plus countries, including the US and China, nearby in their respective groups.

Table 3. Worst and best performers on emissions intensity of output 2020 (excl. land use)

	OECD			200 Plus	
	Worst	Best		Worst	Best
Levels 2020	Australia Canada South Korea	Switzerland Denmark Sweden		Iran Kazakstan South Africa	Brazil Indonesia India
Change 2015-20	Columbia Chile Costa Rica	Estonia Czech R Greece		Iran South Africa Malaysia	China Kazakstan India

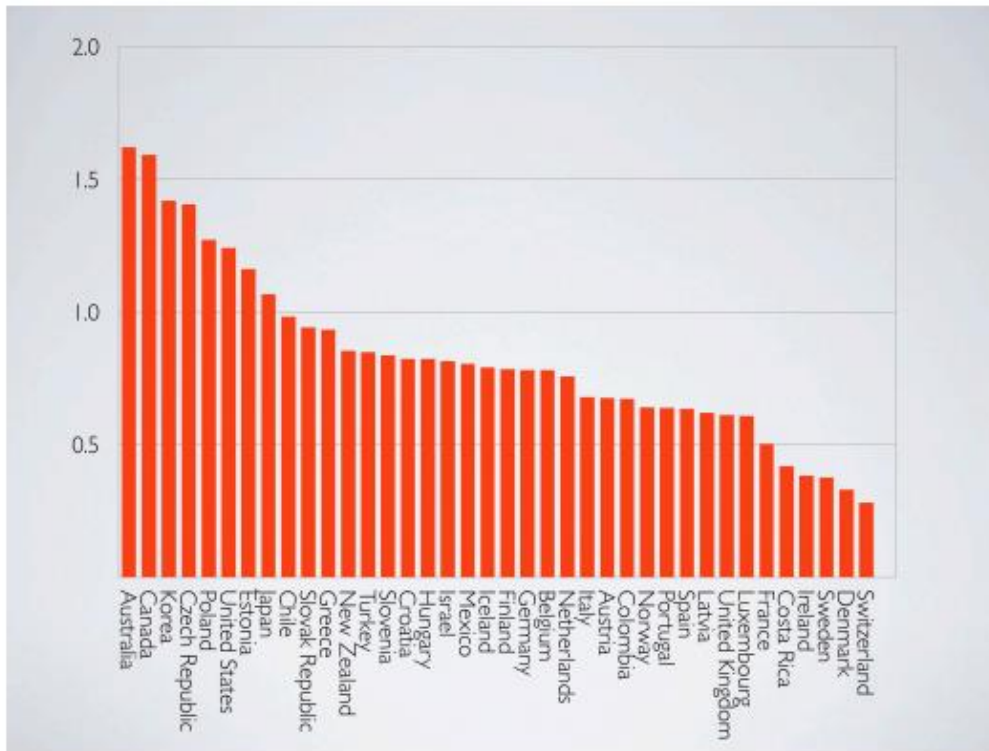
Sources: IMF WEO Fall 2021, and Global Carbon Atlas.

Table 3 also helps to diffuse the OECD excuse for inaction “due to China and India” because both appear on the 200 Plus “best” lists, India twice.

And when least emissions-efficient countries thus singled out protest that their “latest plans” will address everything, as doubtless the new Australian Government will do, participants should largely not engage with the substance of such protestations. Such assertions ignore that backloading itself undermines dated goals—here GEC recapture from 2045—and grand plans today typically disappear in smoke and mirrors tomorrow.

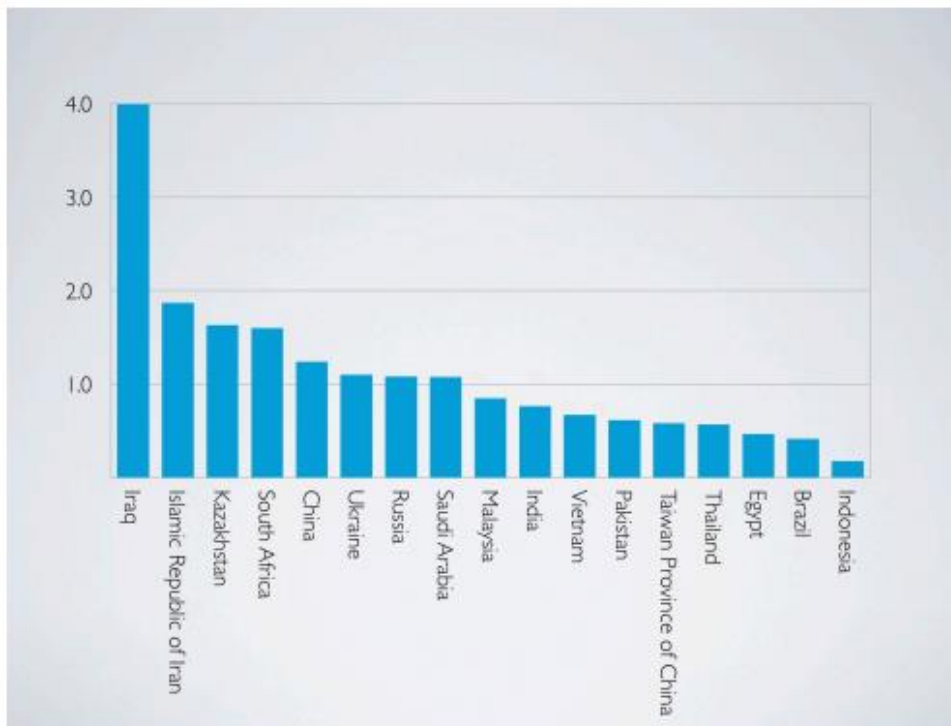
Instead, given the annual performance criteria, all that matters is delivery relative to emissions-inefficient peers, not indecipherable unenforceable complex promises.

Figure 11. OECD emissions intensity of output relative to the average, 2020 (excl. land use)



Sources: IMF WEO Fall 2021, and Global Carbon Atlas.

Figure 12. 200 plus emissions intensity of output relative to the average, 2020 (excl. land use)



Sources: IMF WEO Fall 2021, and Global Carbon Atlas.

The proposal is that enforcement should focus on the least emissions-efficient members of OECD and 200 Plus respectively—in the first instance by routinely and loudly naming and shaming them.

Emissions Inefficiency Tariffs

Of course, such a global competitive force operating via public embarrassment alone may need to be reinforced.

So, as in IMF programs, such indicators should be backed up by formal penalties.

If necessary, the least emissions-efficient countries in the GEC should face a tariff penalty levied on all their exports until they move themselves off the worst-performing lists.

To illustrate, for the offenders with the poorest emissions efficiency of output, a Pigou tariff rate calculated to apply globally to the offender's exports should be calibrated to yield in total 1 percent of the offender's annual GDP. EU members could levy an appropriately calibrated charge on VAT, consistent with its single market, if the offending countries are EU members.

The penalty for the worst offenders in 200 Plus would be considerably lower primarily because the group has a much lower per capita cumulative emissions—and hence an underlying claim to accommodation under Status Ante Redress—but also because it has a smaller number of members and thus greater probability for any individual member appearing on a “worst” list and a much lower GDP per capita.

Liability for this penalty in either group should be extinguished for any country on the “worst levels” list for its group which is also on the “most improved” list for its group and compounded if it is on both “worst” lists for its group.

The penalty tariff should not only be differentiated across OECD and 200 Plus as noted but the tariff set to achieve that penalty will also have to be set individually for each country on the worst lists taking into account the individual share of exports in GDP and estimates of the relevant trade elasticities.

Once the Emissions Inefficiency Tariffs are activated, individual country liability for this tariff at each COP should not end when the country concerned reaches and stays at zero emissions because the collective target for them all is to go into net recapture—on a significant scale.

Of course, setting the tax parameters requires some estimation of the strength of the competitive force thus unleashed in order to ensure it secures the global targets. That is challenging technically.

But thanks to the annual performance criteria, this is not a one-and-done exercise. If over a five year period after activation, the aggregate target for a group is missed, the penalty size should be increased for that group above 1 percent of GDP for the subsequent five years.

This approach respects that given the range of technical options, there can be no “one size fits all” policy in OECD and 200 Plus countries—focussing on “bad sectors” or anything else. The approach is also agnostic on **what instruments**—taxes, spending, regulation, voluntarism, or combination—are used to do so.

Instead, it minimises foreign interference and meddlesome coercion by focussing only on aggregate emissions intensity of output. This avoids any suspicion that other—and especially foreign ulterior—agendas are being advanced under cover of global temperatures.

And to avoid random allocation of the revenue collected according to the direction of exports of countries on the “worst” lists, that revenue could be pooled and distributed according to PPP GDP, perhaps with partial progressive and/or inverse cumulative emissions adjustments, maintaining the incentive for all countries to participate.

But, however the revenue arising is distributed, with ROW excluded from liability, the framework is globally progressive, sensibly differentiated, and focused appropriately on the Global Emissions Core, and within that, especially on OECD.

Furthermore, Emissions Inefficiency Tariffs do not rely on the consent of all.

In particular, if a large economy, say the EU, declines to apply the tariff, others can apply it to any member of the EU which is on the “worst” list. And the tariff rate levied by participants can be adjusted up for countries on that list, so the burden of their penalty is unaffected by non-participants.

Further, countries which facilitate evasion of these penalties by re-labelling and re-exporting on behalf of the “worst list culprits” should face heavy secondary sanctions on all of their exports.

And if the US at some time is on one of the “worst” lists, those countries which decline to impose the Emissions Inefficiency Tariff would forego the claim to their share of a very large sum of revenue.

So this structure may garner global consensus. The 140 or so countries in ROW, excluded from any liability for the Emissions Inefficiency Tariffs and principal beneficiaries of the Status Ante Strategy, will be well-disposed. So will those countries among the OECD 39 which are the most emissions efficient—and will thus not be liable to tariffs but are greatly offended by the free-riding of their less emissions efficient OECD confreres. And even 200 Plus may be encouraged to consent as their tax rates are lower than OECD and their collective performance criteria corresponds to their baseline.

That is a large body of potentially—or even likely—supportive sovereigns.

Only countries at the worst end of the spectrum, either on levels or changes, are likely to resist proposals for such penalties strongly.

And the framework has some prospect of surviving the emergent geo-strategic struggle between the US and China because, however desirable, unanimity is not required, non-participants incur significant revenue losses and have their own efforts free-ridden over, and because under these proposals, both the US and China are constrained by performance criteria but they do not compete head-to-head as they are in different groups—OECD and 200 Plus respectively.

This enforcement mechanism has greater impact than current approaches—which depend on good fortune, on commitments many years hence, and on rafts of scientific treatises and entreaties at each COP in all but incomprehensible prose.¹

This disciplining tax structure also establishes a search mechanism for OECD and 200 Plus to discover whether or not choices from the menu of options can secure the temperature goals without sacrificing output. If necessary emissions adjustments driven by the tax turn to secure Status Ante Redress for ROW turn out to be growth neutral, so be it. Alternatively if countries’ choices of instruments from the menu turn out to be growth harming, so be it.

¹ As an example of such prose, the 2013 IPCC executive summary states that it is “extremely likely that more than half of the observed increase in global average surface temperature from 1951 to 2010 was caused by human activity”. This phrasing was intended to convey that humans were responsible for around 110% of observed warming offset by some natural cooling.

Given this search mechanism, there is no need to design policies around an assertion of the balance of the debate between degrowth and the techno optimists ex ante.

In all these ways, this mechanism turns Hirschman's warnings of "trade entanglements" to the good.

And all this allows all countries maximum discretion to act according to their circumstances while avoiding "anything it takes policies" from descending into totally unfocused gestures and tokenism.

The proposal is to establish an Emissions Inefficiency Tariff to be applied as necessary to OECD and 200 Plus to secure delivery of the Status Ante Strategy.

Global Recapture Fund

But even if under the incentive of the EIT these performance criteria are observed, a Global Recapture Fund is required to address additional contingencies.

In particular, the financial programming exercise assumes a relationship between cumulative emissions and temperature which is subject to out-of-sample parameter instability—that the relationship between the two apparent from the data to date may change as total cumulative emissions rise further.

For that reason, even if the performance criteria are observed, the 1.5° C cap may be overshoot so that global-scale recapture is needed to get temperatures back down to that target.

And even absent that contingency, if scientific consensus on the implications of temperature rise for climate outcomes darkens or if as temperatures rise and the populations in OECD and 200 Plus become better acquainted with the actual physical and economic implications for them of 1.5° C, they may revise down their current preference for the global temperature target.

They may not go all the way to ROW's un-coerced preference for 0° C. But they may lower their target sufficiently so that when it is weighted with ROW's preference, the global target may fall to 1° C or less, requiring global-scale recapture to get temperatures back down to the reset target.

Carbon recapture technology, along with natural processes, in principle constitutes a means of driving excess cumulative emissions back down to target if overshoot or if the target is lowered ex post.

That would require technology on a global scale that completely dwarfs current token/PR recapture schemes even including ocean-based initiatives.

But its non-existence on the scale required is neither a given state of nature nor an accident. Incentives to scale up recapture technology to such global scale face two fundamental impediments: uncertainty over need for (and hence the size of the market for) it ex ante; and if it turns out to be needed, by doubt about who will pay for its deployment, as that technology, like carbon emissions, is also subject to free-riding.

These two impediments reinforce evidence that all R&D is becoming less productive.

Given these economics, glib "techno-optimism" is most definitely unwarranted on this matter. The longer these economics are unaddressed, the greater the delay to produce scaled recapture technology.

So, a second fiscal instrument is needed—a Global Recapture Fund.

That should not fund spending on global-scale-emissions-recapture R&D but expenditure on that associated technology—with the fund stimulating research by realizing an effective market for that R&D.

The Fund should be constituted by a wealth tax on dollar billionaires worldwide. It would have the same legal basis as envisaged for the global minimum corporation tax, but rather than accruing to the individual governments, the proceeds should be pooled into a single global fund dedicated solely and irrevocably to purchases such technology.

The tax would also be recurring as evidence comes in either of parameter instability in the projections causing temperature to overshoot the 1.5° C target, or that global preferences are revising down.

And the funds would be irrevocably hypothecated for this purpose—to provide assurance to potential researchers and investors that the market for their enterprise cannot subsequently be withdrawn.

All this would create a market now for the scaled technology if it turns out to be needed. It would place the burden for it on those global individuals most able to bear it and who most cause and benefit from excess emissions at the expense of potential. And thus at the margin it would also encourage them to reinforce global efforts to prevent temperature overshoots of any sort.

Box 1. Border Adjustment Taxes

Border Adjustment Taxes (BATs) have no place in a Status-Ante-Redress global temperature strategy driven by an Emissions Inefficiency Tax and a Global Recapture Tax.

The given motivation of BATs is to discourage emissions-intensive firms from shifting and is applied to select products and to all non-EU suppliers thereof, including ROW.

But the point here is to restore ROW to its status ante—where it's growth unconstrained by temperature considerations, even if that means that carbon emitting firms shift to ROW. It is up to OECD to raise its own emissions efficiency efforts to accommodate that, not to prevent it from happening. And such increased efforts are enforced via Emissions Inefficiency Tariffs.

Furthermore, a key benefit of the Status-Ante-Redress strategy is to avoidance of foreign diktat, anywhere, both in OECD and in ROW.

BATs breach that principle directly, producing obvious anomalies. In particular, EU countries with high emissions-intensity-of-output may thus penalise ROW countries with lower emissions intensities and lower emissions for the transfer of industries those countries need for their incremental development, whether or not those industries actually shift or whether or not such shifts reflect EU climate policy. And these penalties would apply to ROW even as the EU countries fail, without penalties, to move on other parts of the temperature menu—such as domestic income redistribution.

Such anomalies reflect that the BATs are no more than protectionism under the guise of climate policy.

All this is considerably less Utopian than the current strategy of imagining that humanity can simply carry on business as usual.

The proposal is for a recurring (as needed) tax on global billionaires strictly hypothecated to finance expenditure on global scale emissions recapture.

Triggers and Pre-Announcement

The forthcoming COPs provide immediate opportunities for this overall framework to be presented and advocated, including:

- to reset the headline goals;
- to name-and-shame the emissions-inefficient countries;
- to announce the numbers for the Performance Criteria for OECD and 200 Plus for 2021-26 and indicative targets thereafter; and
- to introduce the case for the Emissions Inefficient Tariffs and the Global Emissions Recapture Fund

with all these proposals to be monitored and followed up at all subsequent COPs.

The EIT should be activated every time the OECD and 200 Plus aggregate outturns on emissions-efficiency fall short of the performance criteria, and should be suspended again if those aggregates return to compliance.

This trigger is appropriate even even though full data on individual country emissions (excluding changes in land use) are only available with a lag—with full data beyond 2020 not yet available.

But given their centrality, accelerated collection of the necessary data (including on changes in land use) should be a global priority.

However, were the OECD and 200 Plus to adhere to the performance criteria, the EIT could remain contingent—only activated if the performance criteria are subsequently missed.

Even upon such a breach, the EIT does not require immediate activation. Upon the first breach, the EIT could be preannounced to begin five years after the first breach. That would allow all OECD and 200 Plus countries to accelerate their efforts relative to one another knowing that the EIT is coming.

That will mobilise the desired efficiencies in emissions intensity long before the tax is actually applied to any of them. That phase-in also lifts the political burden of actually paying the tax from the shoulders of any OECD policymakers accepting the contingent liability of their countries to do so.

And should such efforts put the OECD and 200 Plus back on track with the performance criteria before the effective date, then the EIT pre-announcement could be suspended until the next breach.

Thus, it is possible that the EIT would never be activated because the OECD and 200 Plus remain on track for with the Performance Criteria simply under threat of the tax.

By contrast, the GRF should be activated immediately given that the contingent risks it addresses are not dependent solely on observance of the performance criteria.

The proposal is to activate the EIT contingent on breaches of the Performance Criteria, and to pre-announce such activation, and to activate the GRF immediately.

Governance

Despite its foundation in completely conventional economics, the OECD and 200 Plus are clearly not going to advance this strategy—as the behavior of their **international organizations, scientists, and NGOs** there **demonstrate**.

So ROW should lead the global governance for a Status Ante Strategy.

Given that ROW bears the **primary burden of climate damage** and of developmental constraints under zero “for all”, rather than adopting its customary supplicant stance still less **exasperated** disengagement and delinking, ROW has particular cause to take up this function aggressively.

And not in general or emotive terms, but in these concrete, technical, and specific terms, collectively, whether or not some of the OECD and 200 Plus greatest cumulative emitters dismiss it.

Thus, in the first instance, ROW should leverage the fact that political leaders in OECD and 200 Plus now use the COP meetings largely as vehicles for domestic climate grandstanding. So, ROW should assert at each COP the case for a Status Ante Strategy, measure aggregate progress relative to the associated performance criteria, publicly shame the least emission efficient countries, and call for the immediate activation of the Global Recapture Tax.

If OECD and 200 Plus aggregate emissions efficiency continues to fall short of the performance criteria, then ROW should go on to call for activation of Emissions Inefficiency Tariffs.

Similarly, bearing the brunt of climate damage, ROW should also be pivotal in the governance of the Recapture Fund, perhaps modeled on the dominant uniform bloc-voting by EU members at the IMF.

In all this, ROW should also directly challenge the **heady climate optimism in some quarters** and the related notions of a “**climate club**” form of governance, instead emphasizing need for enforcement mechanisms with teeth. While mutual moral suasion can be productive in inter-personal relations, its prospects among sovereign states including the biggest cumulative polluters all ruthlessly pursuing their individual interests, are completely inadequate to the task—especially of a Status Ante Strategy.

ROW should underscore its commitment to this overall approach by establishing a small standing secretariat—mainly funded from its own collective fiscal with any OECD, 200 Plus, or foundations’ support fully transparent and limited.

The secretariat would update the underlying simulations, prepare technical inputs into ROW’s collective initiatives at COPs, estimate the EIT tariff rates for “worst offenders” and the rates and perimeter for GRF expenditures, drive fuller and faster collection of data on individual country changes in land use which are necessary for a fully-effective annual accounting of their progress, and given **Goodhart’s Law**, address any manipulation of emissions data if they become the basis for an EIT.

With its own technical underpinning, ROW could resist interference by OECD and 200 Plus in all the underlying analytical work and the associated headline announcements by ROW principals.

Unlike other elements of **global governance structures**, there are no treaties, norms, or power politics to block such assertive high-profile initiatives by ROW at the COPs.²

And indeed, regrettably, the IMF has vacated its intellectual integrity on climate—by parroting the preferences of the biggest cumulative emitters who are its biggest shareholders and thus endorsing net zero “for all”, by **enforcing it in ROW in its programs**, by relegating the role of redistribution and **backing carbon taxes as principal global instrument**, by its **silence on border adjustment taxes**, by omitting emissions intensity of output completely from its “**climate change dashboard**”, and by endorsing “club” governance, all in the face of these conventional economics to the contrary and against the interests of the bulk of its membership. And it has even failed to bring to bear its own financial programming and program apparatus on the matter.

So, it can play at most a limited role in advocacy or governance given the requirement for a Status Ante Strategy, leaving the field open for ROW to lead.

But the IMF could still play a role in administration of the EIT—if breaches of the Performance Criteria are not corrected and the EIT is activated—by serving as a clearing house for the revenue and by verifying all the underlying returns by all countries in all its annual Article IV consultations.

The proposal is that ROW, **perhaps catalyzed by the African Union**, assert this case for a Status Ante Strategy on global warming in upcoming COPs and all international fora.

Is Development the Price of 1.5° C and net zero for all 2050?

The core metric of an efficient Status Ante Redress strategy on global temperature is not annual emissions, nor Luxembourg potential, nor cumulative emissions per capita; it is OECD GDP per capita.

Once 200 Plus and ROW have reached income per capita parity with OECD, global inter-temporal efficiency dictates that they should thereafter carry the same burden to secure temperature goals as OECD—because they will then face the same relevant relative factor prices.

Alongside, full feasible compensation—in grants, and excluded from aid targets—should be paid to ROW for climate damage suffered.

All that achieves status-ante equivalence as best as possible, and at lowest cost.

That requires a portion of the remaining global Carbon Budget to be set aside, sufficient for ROW to grow to OECD GDP per capita, unconstrained by emissions restrictions, and for 200 Plus partly constrained by emissions restrictions, likewise.

The present strategy on global temperature fails to meet this Status Ante Redress standard and is anyway liable to serious slippage. Accordingly, it puts development fundamentally on a collision course with global temperature goals.

The immediate costs to ROW of this depend on how back-loaded emissions efficiencies are in OECD and 200 Plus are, on the coercion OECD can exert on ROW—including via the International Financial Institutions—to raise its emissions efficiency above unconstrained levels, and on the deadweight losses to ROW of being forced to adopt sub-optimal emissions efficient intermediate technology.

² Some Africans may balk at imposing penalties on South Africa, given that the main reason for its outlier emissions inefficiency is energy infrastructure built for Apartheid. They should consider that the South African Authorities now have at their disposal fiscal instruments—domestic energy tariffs—to place the bulk of any burden arising from any penalties on the formerly over-served communities there.

And the broader costs of all this to ROW and all others is the reassertion via this global strategy that costs do not have to be paid for—with all the attendant wanton destruction of value now and long into the future.

There is nothing inevitable about any of this.

A broad coalition of all ROW countries combined with the emissions efficient OECD and 200 Plus countries are, under the present global strategy, having their exceptional contributions to global goals free-ridden-over by rich OECD emissions-efficiency laggards.

Such a broad coalition in pursuit of global efficiency, if catalyzed by ROW, can advocate instead for a Status Ante Redress strategy designed around the target of 1.5° C, anchored by a revised set of headline targets and a corresponding set of annual performance criteria applied to OECD and 200 Plus aggregates, enforced as needed by an Emissions Inefficiency Tax focussed the least emissions efficient countries, and all backstopped for various contingencies—including possible downward revisions of the 1.5° C goal—by a Global Recapture Fund.

And there is nothing unrealistic or unreasonable about the consequent quantitative adjustments for OECD. And they are the means to global inter-temporal Pigovian efficiency.

*“First they ignore you, then they laugh at you, then they fight you, then you win.”
Mahatma Ghandi.*

Peter Doyle
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ROW* Status Ante Strategy for Global Warming.

The proposal is:

- to free ROW entirely of any temperature constraints on its potential growth in the policy framework to 2050—it does not have to target net zero at all.
- that the headline target be changed from 1.5° C and net zero for all by 2050 to net recapture by the Global Emissions Core at least by 2045, and to an undated cap of 1.5° C.
- to set intermediate annual aggregate Performance Criteria paths for the OECD aggregate and the 200 Plus aggregate defined on their respective emissions intensity of output, with adjusters for emissions shifting to and efficiencies by ROW, and indicative Performance Criteria for 2026 onwards.
- that enforcement should focus on the least emissions-efficient members of OECD and 200 Plus respectively—in the first instance by routinely and loudly naming and shaming them.
- to establish an Emissions Inefficiency Tariff to be applied as necessary to OECD and 200 Plus so as to drive delivery of the Status Ante Strategy.
- for a recurring (as needed) tax on global billionaires strictly hypothecated to finance expenditure on global scale emissions recapture by a Global Recapture Fund.
- to abolish and ban all border adjustment taxes.
- to activate the EIT contingent on breaches of the Performance Criteria, and to pre-announce such activation, and to activate the Global Recapture Fund immediately.
- that ROW, **perhaps catalyzed by the African Union**, assert this case for a Status Ante Strategy on global warming in upcoming COPs and in all international fora.

* ROW is all small developing countries, thus excluding OECD and 200 Plus, the large-carbon-emitting emerging markets.

