The promise and peril of carbon neutrality goals

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Introduction

The carbon neutrality goal has emerged as the most popular way for institutions of all types and scales to frame policy responses to climate change. Ninety percent of global carbon dioxide emissions are now covered by national goals for neutrality (Climate Action Tracker 2022), and there are roughly 7,500 companies (Boehm et al. 2022) and 400 colleges and universities (NewClimate Institute et al. 2022) with pledges of carbon neutrality. The popularity of carbon neutrality stems in large part from its flexibility as a *net*-zero emissions target: rather than requiring the complete elimination of an institution's own greenhouse gas (GHG) emissions, it allows for counterbalancing of one's own GHG emissions with the elimination (or capture) of emissions elsewhere ("non-local action"[1]). However, GHG accounting is often complex and opaque (Bowen 2014); verifying additionality is difficult; and non-local action may be viewed unfavorably on political or ethical grounds. There is ongoing debate over the merits of carbon neutrality goals and the means to achieve them.

Carbon neutrality goals may serve different purposes across institutions and, in particular, at different scales. In international negotiation, net-zero targets provide an actionable roadmap to help countries credibly commit to the objective of the Paris Agreement to limit warming to well below 2°C. National and state level goals also help set expectations for firms, thereby making long-run decision-making easier for these constituents. Smaller institutional goals may not have these same effects, but there are other reasons to set a carbon neutrality goal at this scale. Firms, universities, and local governments alike may be driven by social responsibility or leadership obligations; they may be responding to demand from their customers and stakeholders; or they may see value in environmental marketing, whether transparently or not. At any scale, however, institutions may hope their carbon neutrality goals act as social pressure on their peers and others more generally, with the ultimate aim of causing more emissions reduction.

In this Policy Brief, we highlight key elements of the promise and peril of carbon neutrality goals. We begin by describing two desirable features of non-local action: the potential for abatement cost savings (the traditional economic logic); and the potential for a preferred *distribution* of outcomes. Next, we describe the primary concerns with non-local action – namely, issues with additionality and ethics. Finally, we discuss several implications for carbon neutrality planning.

Promise of carbon neutrality goals

The climate-science rationale for net-zero goals is strong: GHG emissions mix uniformly in the atmosphere before realizing their effect on the climate; consequently, the climate-related benefits of emissions reduction do not depend on the location or source of the reduction. Other impacts of emissions-reduction projects, however – including abatement cost, air quality, and employment effects, among others – vary widely across space and type. We describe the ways in which non-local action can facilitate improved social outcomes along two dimensions.

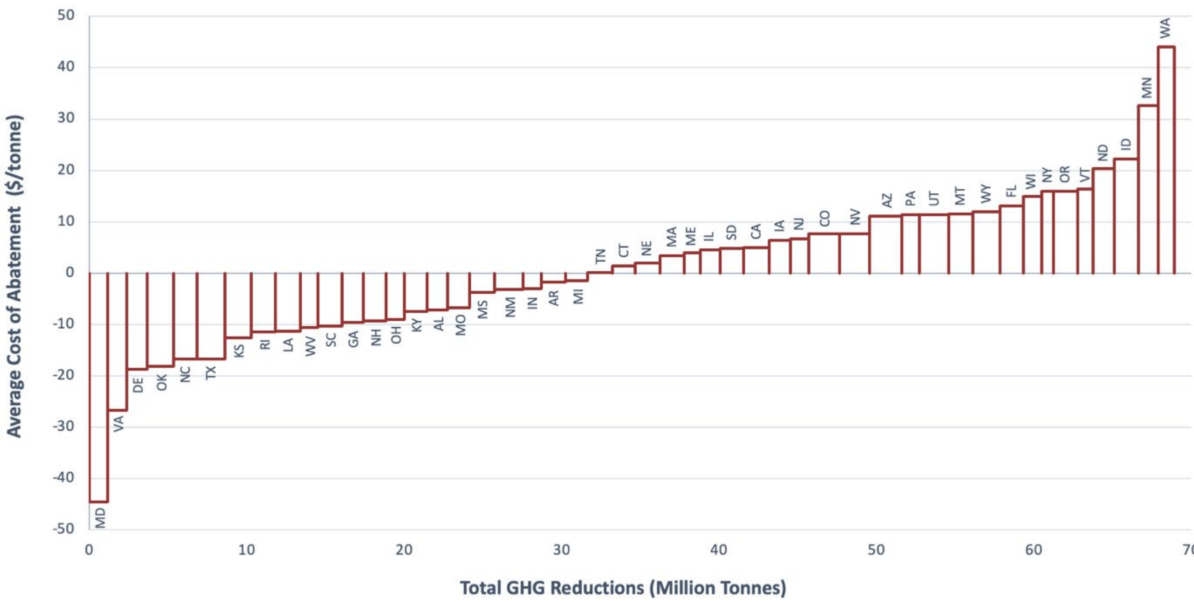
Cost-effectiveness

There is ample evidence that the average cost of abatement of available technologies and policies varies widely (Gillingham and Stock 2018). Can non-local climate actions produce meaningful savings relative

[1] "Non-local action" is pursued to *offset* emissions from one's own activities. But it is broader than the subset of "offsets" that can be purchased off-the-shelf in offset markets today. It includes, for instance, investing in new renewable energy capacity, paying for forest conservation in place of planned timber harvesting, and purchase and retirement of cap-and-trade permits.

to local ones? Economic logic and empirical evidence suggest that the answer is unambiguously "yes."[2] We illustrate this by comparing the average abatement cost of large-scale solar power generation across the US.[3] Figure 1 displays, ordered by state from lowest to highest, the estimated average abatement cost of a 200-megawatt (MW) solar array sited at the point of median solar generation in each state (see the Supplemental Material for methods[4]). It also indicates – with the thickness of each state's bar – our corresponding estimate of the total emissions reduction from each site over a 25-year lifetime.

Figure 1: Abatement Cost Curve for Utility Scale Solar Projects by State



Note. The average abatement costs are estimated for 200-megawatt solar arrays sited at the point of median solar generation in each state. The thickness of each state's bar shows the estimated total GHG emissions reduction for each site over a 25-year lifetime. Source: authors' calculations (see Supplemental Material).

Estimates of average abatement cost vary considerably across states: six states have cost estimates below -$15/tonne, while seven states have estimates exceeding $15/tonne.[5,6] A 200-MW solar array may

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[2] Here we rely on the same theoretical argument for cost-effective abatement that is used for market-based environmental policies, such as a carbon tax.

[3] This exercise takes a static perspective on costs. From a dynamic perspective, learning through research, development, and deployment of renewable energy technologies can result in sector-wide production and installation cost reductions. Germany's large subsidies for solar installation, for example, are credited with a large amount of solar adoption *outside* Germany, because the substantial investment in German solar power drove significant cost reductions from which other countries now benefit (Gerarden 2023). It is possible that some learning from renewable energy construction is concentrated locally, which suggests the potential to improve dynamic efficiency and/or equity through the choice of where to target learning spillovers.

[4] We calculate abatement cost excluding any subsidy for which a solar array may be eligible. There is a social cost of raising public funds to pay for the subsidy; otherwise, the subsidy is a transfer from taxpayers to renewables developers and any other entities that capture a part of the subsidy value. In the Supplemental Material, we report two alternative quantitative exercises: one showing the value of the solar subsidy, by state, embodied in the 30% federal Investment Tax Credit; and one showing average abatement cost when the solar projects are sited at the point of *maximum* solar generation in each state.

[5] Our methods for estimating abatement cost of utility-scale solar facilities are similar to those of Callaway, Fowlie, and McCormick (2018), who similarly find substantial variation in such costs between 2010 and 2012 in the US. Sexton et al. (2021) also estimate variable benefits of solar across the US, focusing on rooftop installations.

[6] While projects with negative abatement costs are profitable over the lifetime of the array, credit constraints on developers, among other factors, can prevent such projects from being built. Institutions can play a role in a developer

achieve as few as 750,000 tonnes of avoided GHG emissions (CO2e) (New York) or as many as 2 million (Arizona), depending on the site.[7] These wide ranges are driven by variation in each of four factors: wholesale electricity prices, solar irradiance across the US, upfront costs of solar construction, and emission intensities of marginal power generators. The potential monetary savings from building non-locally are large: siting an array in the median state for average abatement cost (Connecticut) is projected to save nearly $42 million over the lifetime of the array (using a discount rate of 3%) relative to siting in the most expensive state (Washington). Cost savings can be significant even over relatively small differences in geography; for example, a Pennsylvania institution could save an estimated $65 million by siting its array in neighboring Maryland.

Distributive justice

While an institution has many potential socially beneficial uses of the savings from cost-effective emissions reduction, one prominent candidate is to increase ambition in its climate action – that is, to accelerate the timeline of its emissions reduction (Mehling, Metcalf, and Stavins 2018). Since climate damages are regressive – disproportionately burdening poorer countries and poorer people within countries (Dell, Jones, and Olken 2012; Hsiang et al. 2017) – the global impact of each additional tonne of emissions reduction tends to be progressive. In this way, non-local action, by promoting an accelerated timeline, can also promote distributive justice.

An institution may also pursue distributive justice by choosing climate action based on the distribution of its environmental and economic co-benefits. A new source of renewable power generation, for example, may improve air quality by crowding out an incumbent polluting power source – and these benefits may not accrue to the hosting community (Sexton et al. 2021). The renewable project may also bring tax revenues to the government in the hosting location, which may be used in any number of ways to raise local welfare. And the project will provide jobs to some through construction and operation of the renewable facility.[8] On the other hand, the project may bring visual or noise disamenities that reduce the net benefits received by the hosting community (e.g., Jarvis, 2022). Knowledge of the spatial pattern of these co-benefits enables the choice of projects (whether local or non-local) that direct co-benefits to specific areas or groups of people. For example, the history of disproportionate environmental burdens borne by low-income communities and communities of color in the US (Banzhaf, Ma, and Timmins 2019) motivates the pursuit of climate actions that would benefit these groups in particular.[9]

Renewable power development in partnership with Indigenous nations in the US offers an example with both precedent and potential. Indigenous peoples in the US have experienced centuries of land dispossession, violence, and discrimination. Coal power generation hosted on Indigenous lands has brought jobs and tax revenues as well as air and water pollution, and many Indigenous households are unconnected to the electric grid (Basnet 2021). Renewable energy can bring jobs and tax revenues *without* pollution, as well as provide off-grid access to electricity and promote energy independence. The 55 MW

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securing financing for construction of a solar array – which, depending on the state, costs between $97 and $113 million for a 200-MWh capacity – by assuring a fixed payment from a credit-worthy entity for every unit of power produced.

[7] Importantly, when a project's total cost is negative, its abatement cost becomes *more* negative the *less* emissions reduction it achieves. This partially explains, for example, the high magnitude of negative cost estimates for Maryland and Virginia.

[8] Jobs are considered a cost, not a benefit, in a typical cost-benefit analysis; we are highlighting here the *gross* benefit of a job to the person who takes it. We note that jobs can be a net benefit in a cost-benefit analysis provided the right set of distributional weights (Stiglitz, 1988).

[9] Full partnerships are essential when siting a new project to ensure that the hosting community is not being exploited, i.e., the community buys in to the project with full knowledge of all its potential positive and negative impacts. Best practices of participatory planning can rebalance power among stakeholders and ensure hosting communities are afforded procedural justice.

Kayenta Solar Farm, for example, sits in the Navajo Nation in Arizona, where solar irradiance is very high. It was constructed with an estimated 87% Navajo Nation labor and is projected to generate 13 million dollars in tax revenues over its lifetime (Navajo Nation Utility Authority 2022). As for future potential, the City of Los Angeles is currently exploring a partnership with the Navajo Nation to produce renewable power on the site of an old coal power plant, taking advantage of existing transmission lines connecting the two parties directly (Donahue 2020). Such a project would return jobs and tax revenues to Navajo Nation while helping Los Angeles achieve its goal of city-wide carbon neutrality by 2030 (City News Service Los Angeles 2021).

Peril of carbon neutrality goals

The most widely-held concern about net-zero targets is that the claimed non-local emissions reductions are unlikely to be "additional." Additionality occurs when an agent takes an action beyond a business-as-usual baseline that results in CO_2 emissions reduction or carbon sequestration. This poses a conceptual challenge, as it is difficult to know the long-term counterfactual land use and behavior at prospective sites of emissions reduction or sequestration (Haya et al. 2020). Two studies now provide empirical evidence on the potential gravity of the additionality problem. Calel et al. (2021) find that, of 472 wind farms in India with offsets certified under the Clean Development Mechanism, 265 are inframarginal and thus unlikely to be additional, i.e., 56% of the projects do not need the revenue generated by carbon offsets to be profitable. Coffield et al. (2022) show that, of 37 forestry projects in California with offsets certified under the state's CO_2 cap-and-trade program, none have sequestered carbon above baseline rates and thus they have likely not been additional during the program's first decade. These two studies, notably, develop control groups to establish counterfactual conditions for the offset projects.

Carbon accounting presents further challenges to the monitoring and verification of claimed non-local emissions reductions. As part of carbon neutrality programs, many institutions obtain their non-local reductions from the avoided emissions of renewable electricity projects. Proof of having paid for renewable power generation is presented in the form of renewable energy certificates (RECs).[10] But RECs are ill-suited for verification of emissions reductions. Many of them are sourced from *existing* (rather than new) renewable capacity, in which case they are not additional. Construction of new capacity is thus necessary (though not sufficient) for authentic reductions. Organizations increasingly are using power purchase agreements – in which they agree to buy RECs and (sometimes) power from renewable capacity yet to be constructed – to accomplish this (Barron et al. 2021; Sallee 2022).

The denomination of RECs, in megawatt-hours, is also incompatible with carbon neutrality goals, which target emissions reductions. It is easy to monitor renewable power generation, but it is much harder to accurately measure the avoided CO_2 emissions; the latter depends on rapidly-changing demand and supply conditions corresponding to the intermittent generation pattern of renewable capacity in a particular regional grid. Research has identified significant temporal and spatial heterogeneity in avoided emissions from marginal solar and wind power capacity in the United States (Callaway, Fowlie, and McCormick 2018; Sexton et al. 2021), and at least one online platform, WattTime, is providing a tool (the "emissionality" tool) and offering services for making high-resolution spatiotemporal estimates of avoided emissions from marginal renewable capacity. A tool such as this should be disseminated for use as a standard practice in the sector.[11]

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[10] RECs are a commodity that represents the environmental attributes of electricity generated from renewable resources. RECs originated to facilitate compliance by electricity generators with state renewable portfolio standards in the United States; a utility can purchase RECs in lieu of building its own renewable capacity.

[11] A related carbon accounting issue arises when institutions buy RECs to offset their estimated Scope 2 emissions (where Scope 2 represents the emissions embodied in retail electricity purchases). With RECs denominated in megawatt-

Recent international developments under the Paris Agreement illustrate the above challenges. For instance, as countries such as Switzerland seek to count carbon credits toward their nationally determined contributions under Article 6.2, new rules to limit double counting of emissions reductions will be tested (Tabuchi 2022). Under Article 6.4, a new supervisory body charged with evaluating additionality and maintaining a centralized registry of non-local projects has potential to bring much-needed oversight to the mechanism. Yet, an ongoing concern relates to the transition of credits issued for likely non-additional projects under the Clean Development Mechanism, which can remain viable through 2025. And low-quality voluntary credits bought by companies continue to proliferate beyond the scope of Article 6. Improvements to accounting and standards for additionality are essential for the basic integrity of carbon markets of all types, markets that will play an increasingly important role as institutions endeavor to achieve net-zero emissions targets.

Lastly, non-local action has been criticized on ethical grounds. Such action is sometimes described as "buying one's way out" of responsibility. While this description applies equally well to local and non-local action (in both cases, spending is required), it nonetheless signals a belief that reducing emissions from one's own activities is preferable to reducing emissions elsewhere. Relatedly, many institutions have local constituencies and values-based missions or mandates to improve those constituencies' welfare. Beyond clashing with local preferences, non-local action has the potential to undermine an ethic of voluntary restraint and shared sacrifice (Sandel 2012).[12] At the level of the individual consumer, carbon offsets have been compared to religious indulgences: a monetary payment to absolve individual sins (Kotchen 2009). For institutions – including governments, corporations, and universities – the concern is that, through the commodification of carbon, non-local action will crowd-out local reduction of carbon emissions.

Implications

The advantages and risks of non-local action suggest several opportunities in carbon neutrality planning. The existence of social benefits of non-local action does not guarantee that such benefits will be realized. Too many institutions buy offsets and RECs to claim emissions reductions without scrutiny. Instead, they should assess options for emissions reduction along the dimensions highlighted here: total abatement cost, the distribution of co-benefits, and the likelihood of additionality. For instance, an institution could solicit proposals for new renewable power projects that fit desired criteria. This would leverage competition and could allow for a wide spatial distribution of projects, including local as well as non-local ones. The institution could then compare the different proposals and identify ones that optimize over institutional preferences and constraints. Alternatively, an institution could approach specific entities that it has identified as potential hosts of projects with the desired impacts.

To allay concerns about non-local action crowding out local action, institutions can "stage" carbon neutrality ahead of full local decarbonization. Establishing both types of targets can promote faster emissions reduction while still committing to the local reductions that will eventually be needed (Barron et al. 2021). Lastly, and urgently, institutions and governments alike should adopt rigorous analytical

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hours, an organization can implement the offset by simply expressing its Scope 2 emissions as the megawatt-hours of purchased electricity. The resulting carbon accounting is weak on both sides: by relying on electrical units, the actual emissions of purchased electricity and the avoided emissions of RECs are never estimated accurately.

[12] Sandel's treatise (Sandel 2012) addresses the tension between commodification via market rationality and non-market social norms, i.e., what are "the moral limits of markets," as stated in the book's subtitle. He includes carbon offsets as an example of the expansion of market rationality with the potential "to confer a moral license to pollute" (Sandel 2012 78).

procedures for predicting and verifying emissions reduction and carbon sequestration. State-of-the-art emissions impact evaluation should be streamlined for wide use. A profession of carbon accounting, akin to the certified public accounting of financial reporting, would help secure the integrity of carbon markets. Seizing these opportunities has the potential to substantially improve the social impacts of non-local action pursued to satisfy net-zero emissions goals.

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