The power and promise of improved climate data infrastructure

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The announcement by the Biden Administration to reengage the Paris climate process and lower US greenhouse gas (GHG) emissions 50% by the end of this decade is an essential development in the global effort to avoid the worst impacts of climate change (1). However, promises to reduce US GHG emissions are not new and have thus far delivered little real and sustainable emissions reductions (2). The result? Climate change continues unabated, and we forgo the associated jobs and technological innovation that will fuel economic growth in climate friendly businesses. It must be different this time—pledges must lead to practical policy and quickly.

To meet the US emission pledge, practical policies will need to reach broadly across the US economy and mobilize new technologies, behavioral change, and private capital. Regardless of policy specifics, actionable GHG reduction policies will fundamentally rest on critical climate data infrastructure that comprehensively and reliably quantifies and tracks GHG emissions in the United States from the local to the national scale. Ideally, all citizens should be able to see a daily map of detailed emissions across the US landscape, much like viewing daily weather. In other words, we need a "US Greenhouse Gas Information Service." Such a service would provide local emission context to our daily lives and is essential to determine whether emission reduction claims are real, if they're targeting the best opportunities from neighborhoods to the

To mitigate greenhouse gas emissions, we need accurate and transparent emissions data infrastructure that maps when emissions are happening and where they're coming from. Image credit: Shutterstock/Tatiana Grozetskaya.

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nation, and whether they're establishing the trust necessary to mobilize and sustain reduction investment.

Problems with the Status Quo

Right now, however, US climate data collection and dissemination efforts are falling short. Measurement and tracking of GHG emissions reflect a collection of ad hoc mandates and voluntary interests. The measurement efforts are aimed at addressing a wide array of decision support needs with varying degrees of completeness and utility. For example, the US Environmental Protection Agency (EPA) produces the national GHG inventory as part of the ongoing obligation of the United States to the international treaty process (3). California has established a similar inventory of statewide emissions and is moving toward operational monitoring with surface measurements and even a constellation of satellites (4). Some cities across the United States have developed urban inventories with the assistance of environmental organizations (5). Many states, businesses, universities, and individuals are applying various methods to guide emission reduction efforts or estimate their carbon footprints. With a few exceptions, these disconnected efforts are inadequate for guiding and verifying emission reductions—and worse, they may actually hamper progress.

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Firstly, the individual estimates are not integrated across different spatial scales (e.g. city to metro to state) and hence are not internally consistent (e.g. adding up individual emitters in a state does not comport with state totals estimated by other means), which dramatically increases the likelihood of errors. With an array of methods and perspectives, attempts to compare or integrate estimates are impossible. Without checks using traceable and transparent, independent verification, gaps and errors go unnoticed. For example, a recent study examined 48 urban inventories in the United States and found that they underestimated emissions, on average, by almost 20% (6). Worse yet, individual cities had overestimates and underestimates greater than 60%. And accuracy is critically important. If we are to move from the mostly voluntary reduction effort to a path that achieves a 50% GHG reduction by decade's end, and in the process create an array of new markets and business opportunities, traceable accuracy will be essential for investors, brokers, and buyers/sellers of emissions or emission credits. Only by accurately tracing can we enter any form of market-based GHG emissions reduction approach.

Few of these self-generated inventories create information of sufficient resolution to inform or verify practical policy actions, which will increasingly be subnational. For example, knowing the total vehicular GHG emissions in a city or a state provides no direct insight into which roadways or which specific vehicle classes dominate the emissions or why. More specificity leads to greater efficiency and flexibility when, as is inevitable, we will have to choose which emissions to target first at lowest cost before tackling those that are smaller and more expensive to manage. Knowing who, where, and why emissions occur at local scales also assists in understanding emissions responsibility or ownership, which is key to any future policy that incorporates market mechanisms or trading of emission credits.

Furthermore, if emitters themselves are tasked with emissions measurement, the outcomes are open to internal bias, known to occur with "self-regulation" where emitters choose their emissions reduction target, decide which accounting methods to use, perform the pollution accounting, and report results that are difficult to check (7).

Finally, the patchwork of approaches and methods across the United States is a wildly inefficient means to perform GHG emissions quantification and stands in stark contrast to the way we have approached similar problems historically. Take weather forecasting, for example. Although local data and information are important to collect (with the assistance of local expertise), we would not expect businesses, cities, or states to gather and analyze data or create and run weather models to predict weather. The result would be far too costly, inefficient, and inaccurate. It's far better to perform these tasks at an apolitical institution with a centralized and common approach that adheres to scientific best practices and technical standards. The resulting GHG emissions information could be publicly available, opening up opportunities for the private sector to add value through analysis, interpretation, and visualization in a fashion similar to what is done with weather forecasting information.

A GHG Emission Information Service would free up emitters to focus on the aspect of the climate change problem they know best: how to reduce emissions given their individual emissions composition, financial status, political landscape, and governance conditions. With less than 9 years to achieve the 50% reduction, such a service needs development now.

From Prototype to a System

There is some good news, however. Numerous prototypes of a GHG emissions information service have been developed by the scientific community, with research funding already paid for by taxpayers. For example, an approach that quantifies CO_2 emissions down to every building and road segment across cities and states has been developed and has shown consistency with atmospheric CO_2 measurements (8–10). It avails of an integrated collection of data such as energy statistics, demographics, local pollution reporting, satellite remote sensing, utility data, and ground and aircraft-based CO_2 measurements. All of these data are crunched through a large computer modeling system to arrive at the best estimate of emissions across multiple scales in a continuous, near–real-time fashion. It maintains consistency from the building up to the nation (and even the globe) and can potentially obviate the need to do this for every business, city, or state. All Americans could see emissions and daily progress towards a more sustainable future.

But such prototypes, promising though they are, are not yet "operational" or fashioned as a service. A new institution will need to simultaneously coordinate with the scientific community on further testing and improvements, while also beginning the scaling-up process. Such an operational institution would most likely require federal leadership and considerable collaboration with other scales of governance (cities, counties, states), not to mention collaboration with the private sector, and the non-governmental sector, all of which have already made important advances on this topic. For example, Google has developed approaches to urban emissions using their extensive data streams. Non-governmental organizations such as ICLEI have worked with cities to build GHG emissions inventories, and environmental consulting firms have contracted with local governments to build GHG emissions inventories.

A Greenhouse Gas Emissions Information Service must knit together capacity across numerous existing government agencies that have purview over components of the problem such as the National Institute of Standards and Technology, the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the US Environmental Protection Agency, and the Department of Energy, among others. Each of these agencies collects data, runs models, or performs analysis essential to an operational GHG emissions information service.

Although standing up this capability will require resource investment, this new climate infrastructure has a myriad of co-benefits with significant financial return. Like all infrastructure investment, the development of this system not only generates jobs now but also requires a labor force indefinitely into the future. Jobs such as instrument development and manufacturing, data collection, data analysis, modeling, information distribution, and marketing will all be necessary. Such economic development could meet global demand for these products as other countries similarly face the need to plan, monitor, and track emissions with greater accuracy, granularity, and rapidity. Collaboration with the private sector or enablement of private sector value-added products would stimulate the emergence of a new economic sub-sector. One only has to look at the many businesses that add value to weather data or air quality information to see how basic underlying infrastructure on foundational GHG emissions information could lead to large commercial activity.

Next Steps

Making this vision a reality will require a roadmap. It should start with three critical elements:

1. A more detailed assessment of the existing intellectual, technical, and sociopolitical ingredients that are essential to the information system and its successful application. Gaps must be identified and solutions to those gaps prioritized with a notional development timeline;
2. The institutional/administrative home and the relationships among the many participants must be established. This will include both public and private entities;
3. A financial model or multiple compatible models (e.g., public versus private, hybrids) must be considered to sustain the system and allow for an initial estimate of costs and revenue opportunities for differing levels of ambition.

Such a roadmap could emerge from a series of workshops that include leaders from the many public and private entities listed here.

These steps must be taken now to realistically meet not only the 9 years to achieve the 50% GHG emissions reduction pledge made by the United States but also the zero or negative emissions that must be achieved globally to limit dangerous climate change. Without a 21st century GHG emissions information system, investment in mitigation and offsetting will be viewed as too risky, reduction policies will miss their mark, reduction claims will be mired in political acrimony, and it will not be clear whether the burden of GHGs in the atmosphere is consistent with emission reduction claims. This, in turn, will continue to sow cynicism about the climate change problem and miss another opportunity in the global race to capture the markets around climate friendly technology and solutions.

A US GHG Emissions Information Service will usher in real and sustainable emissions mitigation efforts supported by accurate, traceable, comprehensive, and standardized emissions information. Most importantly, it will reestablish US leadership internationally and unleash investment in GHG reductions, stimulating job growth and technological change in GHG information services.

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