The Carbon Numbers Game

Scientists who test the air are discovering pollution figures that companies and countries report for climate treaties and global emissions trading don’t add up.

Euan Nisbet, a University of London earth sciences professor who has traveled the world testing the air for greenhouse-gas pollution, makes his way to a rocky outcropping on the eastern coast of Hong Kong Island on this sunny November afternoon. He takes out a battery-operated pump connected to a thin tube and a plastic bag to capture traces of the wind. “This is a good day for collecting samples,” says Nisbet, 61, looking out to sea. “There’s a good, strong breeze blowing in from the mainland. It’s the breath of China.”

Hooking up his air-sucking device, Nisbet says the world puts too much faith in government estimates of carbon dioxide, methane and other heat-trapping gases blamed for climate change. That’s because companies and...
Countries base emissions calculations on the raw materials that go into a factory or power plant; they don’t check the pollution that comes out. “It’s like going on a diet without weighing yourself,” explains Ray Weiss, a geochemistry professor at the Scripps Institution of Oceanography in California, whose article with Nisbet in the June issue of Science argues for measuring the atmosphere. “We’re counting all the calories, believing the bottom-up calculations are right and not making any effort to test by getting on the scale.”

As the world turns to climate treaties and emissions-trading markets to tame global warming, scientists and regulators are clashing over a key question: How do we measure the pollution we’re trying to reduce?

**Measurement Dispute**

Emissions levels can vary widely based on whether they’re monitored in the air or calculated on the ground.

**TOP DOWN**

**Monitoring:** People, balloons and airplanes gather air samples. Satellites are proposed.

**Processing:** Researchers send the samples to labs to determine greenhouse-gas concentrations.

**Analysis:** Analysts feed the results, weather patterns and other data into computer models.

**Conclusion:** Computers run the models backward to trace what is being emitted from where.

**BOTTOM UP**

**Delivery and storage:** Plants weigh and test coal for type, quality, moisture, ash and carbon content.

**Burning:** Officials check whether coal is fully or partially burned.

**Final calculations:** Companies use an equation to estimate emissions; auditors check figures.

**Nationwide numbers:** Countries tally company figures, vehicle miles and other national data.

Source: AEA Group, EPRI, Intergovernmental Panel on Climate Change, World Coal Institute, World Meteorological Organization

Companies use bottom-up calculations and report their emissions estimates based on inputs: how much coal a plant burns; how much oil a factory consumes; how much lime is added to cement. Countries tabulate these estimates and add nationwide figures: how many vehicles drive within their borders; how much waste people plow into landfills; even how many methane-belching sheep graze in pastures.

Nisbet, Weiss and dozens of researchers say this bottom-up approach doesn’t reveal what we really need to know—what’s happening in the air. They’re sounding an alarm that greenhouse gases measured in the atmosphere can be double what companies and nations estimate on the ground. In the case of one heat-trapping gas called sulfur hexafluoride, countries report that output has plummeted since 1995 based on their counts of military radar systems, electrical equipment and factories that use it to soundproof windows, all of which can release the gas. Scientists say measuring the air shows levels have surged since at least 2000. Getting the measurement right is crucial because SF6 traps 23,900 times more heat per molecule than carbon dioxide and lingers for up to 3,200 years, the U.S. Environmental Protection Agency says. “These gases lead to climate change for centuries or millennia, so there’s a finite amount you can ever put in the atmosphere,” says Stephen Pacala, director of Princeton University’s environmental institute. “For every release, you’re taking something from some subsequent person.”

**MAKING SURE the numbers add up is important for a more immediate reason: They underpin the only international climate treaty that sets mandatory limits for greenhouse gases—the 1997 Kyoto Protocol, which went into effect in 2005 and sets emissions targets for 38 of the countries that signed on. Today, $141 billion worth of credits that help countries meet their Kyoto goals are changing hands in global emissions markets. And business is booming in offsets—the right for countries and companies that still pollute too much to claim credit for green projects elsewhere. All of these efforts are based on bottom-up calculations being accurate.**

“Over time, the emissions numbers right early on,” says Shakeel Afsah, a former World Bank environmental economist who founded data-analysis company Performex LLC. “We’ve seen how the cumulative effect of small errors that accumulate in the financial markets have blown up as little cracks turned into fault lines.”

Traders and regulators say Europe’s carbon market, called the Emissions Trading System, and the United Nations’ offset market, called the Clean Development Mechanism, are making a real dent in greenhouse emissions. From $570 million a year in 2004, the global carbon market may surge to as much as $1.4 trillion worth of transactions by the end of the decade, Bloomberg New Energy Finance says. Trade in carbon options contracts alone soared to about $106.6 billion in 2009. Traders looking to profit from buying or selling options on EU credits or UN offsets accounted for more activity than buyers actually trying to meet Kyoto caps, the World Bank says.

The European Union is betting on cap and trade. The 15 countries who were EU members at the time the pact was adopted in Kyoto say the system has already helped them: They’ve surpassed their goal of trimming emissions in the five years to 2008 by an average of 8 percent compared with 1990 levels. As of 2008, the now-27-nation EU reported to the UN that emissions had dropped 11.3 percent below 1990 amounts. Endesa SA, Spain’s second-biggest utility and the top user of UN offsets in the EU market in 2008, says it has cut emissions at its Spanish plants by 5 percent annually since 2005. The EU has set internal targets in addition to Kyoto goals.

“It is working,” says James Cameron, vice chairman of Climate Change Capital Ltd., a London fund manager that has invested more than $1 billion in carbon credits. “This system is only there to take tons of carbon out of the atmosphere; it has no other purpose,” says Cameron, who declines to say how much the fund has profited. “It has propelled some very, very good investments.” Wind farms in China are among them, Bloomberg data show.

Jean-Pascal van Ypersele, vice chairman of the Intergovernmental Panel on Climate Change, a UN-led network of scientists, says companies and countries use trial-and-error formulas to calculate emissions. Carbon dioxide is the main
greenhouse gas traded in the EU market and burning coal, oil and other fuels accounts for most of the emissions from human activities. CO₂ is relatively simple to calculate, he says. Auditors and expert panels review and sign off on the numbers companies and countries report.

"Emissions from burning fossil fuels are quite easy to monitor and quantify because burning 1 kilogram of carbon is going to produce 3.7 kilograms of CO₂; that's the law of chemistry," van Ypersele says. "As long as you know how much carbon is present in the fossil fuel you burn, you automatically know the amount of CO₂."}

F THERE ARE discrepancies between emissions reduction figures, it may be because countries that calculate them don't all follow one set of rules, van Ypersele says. The Kyoto Protocol requires just 38 developed countries of the 191 in the pact to submit emissions numbers using stringent guidelines. The U.S. has refused to ratify Kyoto. Fast-growing polluters such as China and India can use looser calculations that aren't audited, the treaty's terms say. "That's not a technical problem," van Ypersele says. "It's a political problem."

India, the second-biggest earner of UN offsets, claims more than 550 green projects—from methane-trapping landfills to bricks made without coal-fired kilns. The UN says these projects have eliminated the equivalent of 80 million tons of CO₂ from the air. India isn’t required to verify those calculations: Nobody takes a measurement device to a plant or assesses the air across polluted cities to say CO₂ levels have come down. Countries at global climate talks in Copenhagen in 2009 failed to make any progress toward setting universal standards, and the issue is likely to remain a stumbling block at the UN Climate Change Conference in Cancun scheduled to start at the end of November 2010.

Matthias Jonas, a physicist at Austria's International Institute for Applied Systems Analysis, has studied emissions numbers that do adhere to UN guidelines. He says he's skeptical about the gains European countries are claiming. Estimates based on fuel consumption, forest cover and other bottom-up factors are riddled with inaccuracies, and the margins of error are too wide to be useful, Jonas says.

"All the emissions we're accounting for so far under the Kyoto Protocol are built on what we think the atmosphere sees by standing on the ground," Jonas says. "Real verification would be with a measurement device sitting in the atmosphere and saying, yes, what you have estimated is true and we can confirm by measuring what the atmosphere has received."

With billions of dollars riding on markets that are literally based on thin air, emissions trading has to be especially transparent, says Pieter Tans, a Boulder, Colorado-based senior scientist with the National Oceanic and Atmospheric Administration. A metric ton of CO₂ was trading at €14.24 on London's European Climate Exchange on Nov. 8, after recovering from a record low of €1.40 in mid-April 2008; amid oversupply.

The EU's climate commissioner, Connie Hedegaard, said in May that the bloc should set stricter emissions targets to boost the price to €10 to encourage a faster low-carbon shift. In the UN offset market, a company that can claim it cuts one ton of CO₂ out of the atmosphere can get credits worth €33.40 at the Nov. 8 price. Goldman Sachs Group Inc., Electricité de France SA, the Spanish government and several hundred others have bought offsets to counter their own emissions or profit from trading them.

## Battling Carbon

As countries commit to reducing emissions under the Kyoto Protocol, carbon trading has increased.

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<tr>
<th>Country</th>
<th>Year</th>
<th>Projected Value</th>
<th>Emissions Targets</th>
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<tbody>
<tr>
<td>EU-5</td>
<td>2008</td>
<td>€128.76m</td>
<td>6%</td>
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<tr>
<td>Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Luxembourg, Mexico, Romania, Slovakia, Slovenia, Switzerland</td>
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<td>Canada, Hungary, Japan, Poland</td>
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<td>Greece</td>
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These ETFs have an objective (target) for a single day. Due to the compounding of daily returns, returns for these ETFs over periods other than one day will likely differ in amount and possibly direction from the target return for the same period. Investors should monitor their holdings consistent with their strategies, as frequently as daily. These ETFs are not regulated under the Investment Company Act of 1940. Investing in ETFs involves a substantial risk of loss. There is no guarantee any ProShares ETF will achieve its daily objectives. These ETFs use leverage and may invest in financial instruments such as swap agreements, forward contracts, and futures and options, resulting in greater volatility than investments in traditional securities and which may cause large losses. These ETFs are not suitable for all investors.

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Source: Ipper based on a worldwide analysis of all of the known providers of funds in these categories. The analysis covered ETFs, ETNs, and mutual funds by the number of funds and assets as of 6/30/2010.

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‘AS SOON AS EMISSIONS BECOME WORTH A LOT OF MONEY, I START LOSING FAITH IN SELF-REPORTED NUMBERS REGARDLESS OF WHO SIGNS OFF ON THEM,’ PIETER TANS SAYS.

If the U.S. creates a nationwide cap-and-trade market, carbon could become the world’s most widely traded commodity, says Bart Chilton, a commissioner at the U.S. Commodity Futures Trading Commission. Results of the November midterm elections may have killed federal cap-and-trade for at least two years, says Ethan Zindler, who heads clean-energy policy at Bloomberg New Energy Finance. Still, 10 states, including New York, New Jersey and Massachusetts, run a mandatory cap-and-trade system to cut CO2 emissions from the power industry.

If you’re selling oil, you’re actually transferring something tangible,” says Gregg Marland, a staff scientist at the U.S. Department of Energy’s Oak Ridge National Laboratory. “If somebody lies, somebody loses,” he says. “In a CO2 transaction, you can lie and both win.” The seller gets paid, and the buyer has his credit for compliance. “We’re going to create a situation where both sides can win by cheating,” Marland says.

U.S. success in reducing acid rain shows how tracking what comes out of a factory—along with what goes in—can pay off. The EPA began requiring companies to continuously measure the sulfur dioxide and nitrogen oxides coming from their smokestacks in 1995. They reported as often as every hour in the world’s first large-scale emissions-trading effort. By 2006, the U.S. had cut sulfur dioxide emissions by 40 percent and nitrogen oxides by almost 50 percent, a 2007 EPA assessment found. The smokestack measurements proved the most-accurate and comprehensive data collected by any U.S. agency.

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GREEN MATH

Calculated by the Netherlands Environmental Assessment Agency along with others calculated by BP PLC. Both collect energy data and supply it to the public. The difference between the two sets of estimates for 23 nations added up to 2 billion metric tons of CO₂—more than what Russia, the world’s third-largest emitter, spews from burning fossil fuels in 2008. The gap shows how widely results can vary depending on how calculations are tweaked and what statistics go into

around China, Japan, the Korea and Taiwan found that levels of the gas, emitted in making aluminum and semiconductors, may be 97 percent higher than calculations from bottom-up approaches. Ingeborg Levin at Germany’s Heidelberg University and 13 international researchers compiled airborne measurements of SF₆ from 1978 to 2009. The data from Antarctica, Sweden and other far-flung locales show 80 percent of emissions in the past decade can’t be accounted for.

Top Emitters

China doesn’t regularly report emissions as part of the Kyoto Protocol, and the U.S. has refused to ratify it.

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<thead>
<tr>
<th>Country</th>
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<tr>
<td>CHINA</td>
<td>4.5</td>
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<tr>
<td>U.S.</td>
<td>4.1</td>
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<tr>
<td>RUSSIA</td>
<td>2.2</td>
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<tr>
<td>INDIA</td>
<td>1.1</td>
</tr>
<tr>
<td>JAPAN</td>
<td>1.0</td>
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</tbody>
</table>

Source: International emissions data from the U.S. Energy Information Administration

Even an early supporter of bottom-up calculations says he now sees the drawbacks. "When it comes down to it, these estimates are all guess," says John Bosch, who retired from the EPA in 2009 after 38 years. Bosch’s team designed ways to estimate pollution from oil refineries and petrochemical plants. He says he left to become a consultant because he was frustrated regulators didn’t require precise measurements. New laser-based instruments make policing emissions possible, he says. "In the real world, there are huge motivations for everyone to low-ball emissions," Bosch says. "Regulators want to report progress, and polluters want to pay less for permits, he says. "Everybody is in the game."

Scientists say studies published in 2010 support their call for better verification of bottom-up figures. Measurements of methane, the most common greenhouse gas after CO₂, gathered in Los Angeles with a laser-based analyzer were a third greater than estimates the California Air Resources Board calculated using UN guidelines, according to the January 2010 Journal of Atmospheric Environment. Bottom-up calculations may underestimate natural gas pipeline leaks and miss other sources entirely, the study found.

Researchers who looked at perfluorocarbons in the air

This suggests a "strong underestimation" in what developed countries report to the UN, a March study in Atmospheric Chemistry and Physics, the journal of the European Geosciences Union, said. "My suspicion is that the companies and accounting people are too optimistic," says Levin, who has a doctorate in physics. "There can be unknown leakages and pathways. But the atmosphere sees everything."

Mark Lewis, managing director of global carbon research at Deutsche Bank AG, says traders don’t have the expertise to second-guess how emissions markets have been designed. They have to believe experts have set up a system that achieves real pollution cuts. "I assume the scientists are doing their job correctly and the market can then get on and do its job, which is to deliver emissions reductions at the least cost," Lewis says. "There’s no reason why you need to understand the science or even believe in it to trade in the market."

The EU and UN markets are audited by experts who inspect logbooks, cross-check production data against fuel invoices and interview workers. Auditing doesn’t guarantee accuracy, Afshar says. When he worked at the World Bank, Afshar examined environmental data at thousands of factories. He found air measurements always deviated from bottom-up estimates—no matter how rigorously they were audited. “Every auditor audited Enron’s accounts, and it still blew up,” he says, likening estimates of what goes into a

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Nisbet, the professor sampling air in Hong Kong, has seen how testing the atmosphere can make a difference. His data on methane were used in an early study that detected discrepancies between air-based measurements and bottom-up estimates. That study found that methane from human activities in France, Germany, and the U.K. in 2001 was 50 percent to 90 percent higher in the air than what the countries had first reported to the UN. Germany, in the meantime, increased its estimate by 66.5 percent, which more closely matched what the air showed.

Nisbet says the bottom-up calculations that underpin today’s emissions markets and climate pacts have one big selling point: They’re consistent. “You can do the paperwork again and again and again and you’ll get the same thing,” he says. “It’s like if you ask someone again and again for their tax return, it’ll be the same. It might be true, it might be not. Who knows?”

Measuring the air has its flaws. It’s not easy and it’s not as precise. “You don’t always get the same results,” Nisbet says. “But it’s what’s really there. It’s there because we can measure it.”

Natalie Obri Pearson covers renewable energy at Bloomberg News in Mumbai. She can be reached via e-mail at natalie.pearson@bloomberg.net or through BloombergMag@bloomberg.net or via M/A/D +<Go>.

Bloomberg Tips

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