As the ninth-largest economy in the world, California has the muscle to influence opinions beyond its borders. So it’s no surprise that all eyes are on the Golden State as it implements a relatively new approach to combatting greenhouse gas emissions: letting companies buy and sell the right to pollute.

Under California’s “cap-and-trade” program—the most expansive of its kind in the country—state regulators place a cap on the amount of carbon that oil refineries, power plants, and large factories may emit per unit of production. The cap decreases over time to rein in emissions. Companies that exceed the legal limit face a choice: clean up or buy extra allowances from companies that have some to spare.

It sounds simple, but assigning carbon emissions to individual products is anything but. “Assigning emissions is an especially complex problem in the manufacturing sector, where one facility can produce a lot of different products,” says Eric Masanet (MS ’96), associate professor of mechanical engineering and of chemical and biological engineering at McCormick. “To distribute carbon allowances fairly across an industry, we need to account for these differences in product outputs within an industry, as well as differences in their production processes.”

For the past year Masanet, Northwestern postdoctoral researcher Mike Walker, and partners from the University of California, Berkeley, and the Dutch consulting firm Ecofys have been working to design mathematical approaches to help the California Air Resources Board, the regulatory agency overseeing cap-and-trade, make credible, mathematically sound decisions about carbon allowances across California’s many industrial plants.

Masanet is focusing on California’s food processing industries, which include large companies like Morningstar, Frito-Lay, and Gallo, that can have massive operations that are complicated to analyze. In the tomato processing industry, for instance, numerous products, from ketchup to diced tomatoes to sauce, are made from one raw commodity. Any formula regulators use to assign carbon allowances must take all the products into account.

“Regulators can’t just say to a tomato processing plant, ‘You can emit X grams of carbon dioxide for each tomato you process,’ because the emission levels are different for each product,” Masanet says. “Our goal is to accurately assign emissions to a broad range of products—providing a calculation method to regulators so they can fairly distribute allowances and drive change across an industry.”

Driving change is the goal of all of Masanet’s work. He often employs life-cycle analysis to study the environmental impacts of the entire life cycle of a product, from manufacturing to consumption to disposal. By quantifying the energy usage, emissions, and environmental effects of current and potential technologies and behaviors, life-cycle analysis informs smarter manufacturing processes and policies.

“From a sustainability perspective, my research seeks to determine where we are today, where we could be, and the steps we can take to get
there," Masanet says. “Putting numbers on potential reduction opportuni-
ties is an important first step in designing policy, as these numbers illumi-
nate where design can make a difference, where manufacturing can make a
difference, and so on.”

Whether comparing the carbon footprints of tomato products or
researching the life cycle of computer equipment, Masanet is supplying the
cold, hard facts that have been lacking in his field. “You frequently hear that
a product or process is ‘green,’ but it takes good data to determine whether
that’s true,” Masanet says. “People want to know if they should use paper or
plastic, cloth diapers or disposable. While the answer might seem obvious, it
actually depends on a lot of factors, and we don’t know the answer until we
do these detailed analyses.”

Researchers like Masanet are beginning to close that knowledge gap
by making sustainability research available not just through publications
but also through open-source models that others can adapt and reuse.
Masanet currently has been funded to develop two open-source models: one,
funded by Google and in collaboration with Lawrence Berkeley National
Laboratory, to quantify the energy efficiency benefits of cloud computing,
and another, funded by the National Science Foundation, to minimize the
environmental footprints of complex manufacturing supply chains. “The
idea is to leave something behind so that other researchers can help move the
field forward,” he says.

Masanet’s big-picture analyses are also helping to guide economic
decisions. In a project for the US Department of Energy, Masanet and his
collaborators are assessing the societal and economic benefits of next-
generation manufacturing process technologies in the United States.

“We think industries like nanotechnology, clean energy technologies,
and additive manufacturing might create jobs, reduce carbon emissions, and
be a boon for our economy, but putting numbers to these claims is incredibly
important,” Masanet says. “There are thousands of technologies the govern-
ment could invest in. Having hard numbers on the potential benefits of each
technology helps in decision making.”

After only a year at McCormick, Masanet has already added three
sustainability courses to the curriculum, including Life-Cycle Analysis and
Sustainable Manufacturing Systems. In addition, he is working on a new
project, funded by McCormick’s Walter P. Murphy Society, that would enable
Northwestern students to provide no-cost life-cycle sustainability audits to
local manufacturers.

“The idea is to leave something behind so that other researchers can help move the field forward.”

Sarah Ostman