



Piecemeal cuts won't add up to radical reductions

To meet ambitious emissions targets will require systems thinking and massive breakthroughs in technology and fuels, says Jane C. S. Long.

In 2005, California threw down the gauntlet: by executive order, the state must reduce greenhouse-gas emissions to 80% below what they were in 1990, by 2050. Similar targets have been adopted in Europe, but the California goal is well beyond any federal policy taken on in the United States. Is it possible? What will it take to achieve it? For two years, I was part of a group of energy experts in California that tried to answer those questions. Our report, *California's Energy Future — The View to 2050*, was released by the California Council on Science and Technology earlier this year.

For smaller emissions-reduction targets, tactical approaches such as piecemeal reductions may look promising. But to ensure a radical decrease in emissions while also reliably meeting its energy needs, California must make strategic choices.

The difference may seem academic, but in fact it is hugely significant. For example, if your net emissions target is not near-zero, you might approach it by increasing the use of biofuels in cars. But biofuels are scarce. To achieve near-zero net emissions, you must electrify the cars so that you can reserve the biofuels for forms of transport that cannot be electrified — heavy-duty trucks and planes, for example. In a systems approach, using biofuels in cars is a dead end.

Similarly, it is popular to promote extensive use of wind power, with no worries about what to do when the wind doesn't blow. Somehow the problem just gets 'solved'. Some say that we can radically reduce emissions with only a major emphasis on efficiency, or just by changing our behaviour. But what if it doesn't add up?

In our report, the California's Energy Future Committee looked at the big picture, asking which technical strategies will achieve an energy system with near-zero emissions yet still meet society's needs. We estimated how much more efficient buildings, industry and transportation could become, and how quickly cars, buses, trains and heat production could be electrified. We looked at how to supply that electricity from near-zero-emissions sources: nuclear power, fuel-based power plants used with carbon capture and storage technology, and renewable energy. We also worried about emissions from 'load balancing', in which generators are used to meet peak loads or fill in for intermittent power from solar or wind sources. We assessed how much biomass might be sustainably available to meet the remaining demand for fuel, and how much it could help to cut emissions. We counted everything, but only once. It was hard, but it was honest.

Having done the maths, what did we discover? If California could very quickly replace cars, appliances, boilers, buildings and power plants with today's state-of-the-art technology, replace and expand current electricity generation with

non-emitting sources and produce as much biofuel as possible by 2050, the state could reduce emissions a lot — by perhaps 60% below 1990 levels. But it would have to replace or retrofit every building to very high efficiency standards. Electricity would have to replace natural gas for home and commercial heating. All buses and trains, virtually all cars, and some trucks would be electric or hybrid. And the state's entire electricity-generation capacity would have to be doubled, while simultaneously being replaced with emissions-free generation. Low-emissions fuels would have to be made from California's waste biomass plus some fuel crops grown on marginal lands without irrigation or fertilizer.

To reach an 80% cut will take new technology.

Emissions-free electricity is one hurdle. California has plenty of renewable resources, but they are intermittent. Energy-storage technology is not yet good enough to solve this problem, and no one knows

whether smart-grid technologies can. Using natural-gas generators to firm up the supply will mean falling short of the 80% goal.

A reliable reinvented energy system should provide base-load power without intermittency or emissions. California should exploit all the geothermal energy it can. Carbon-capture schemes should focus not on coal-fired plants, but on lower-cost natural-gas plants, which produce fewer emissions to sequester. And the state should rethink its opposition to nuclear power.

Even if the electricity problem can be solved, it won't address the needs of planes, trucks, ships and some industrial heating that cannot be electrified. The state will still need fuel — about three-quarters as much as today. California

would be lucky to get half of that from biofuels.

So there we are — a concerted effort to deploy known technology could cut emissions by more than half, but getting all the way down to 80% cuts will almost certainly require major advances in near-zero-emissions fuels. This is by far the biggest technology gap. The conclusion may seem obvious, but few have really given this the hardheaded look it deserves. California can't just spend or deploy its way to an 80% reduction or beyond — and neither can anywhere else.

We don't know precisely how economic and political factors will help or hinder progress towards the reduction target. But we are obliged to try to reach it, and we now know what it will take. This is not a small thing. We may not make the goal of radical emissions cuts by 2050, but it is important to get there eventually — or rather, as fast as we can. ■

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