Achieving climate goals will require transformational changes

April 4 2022, by Julie Chao

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The third and final installment of the Intergovernmental Panel on Climate Change's (IPCC's) Sixth Assessment Report calls for aggressive

and comprehensive actions if we are to achieve net zero emissions by mid-century. It finds we still need to reduce greenhouse gas emissions drastically, beyond what governments have pledged, and that this emissions gap is exacerbated by implementation gaps despite the mitigation efforts underway.

"Significant cuts in global greenhouse gas emissions, even getting close to net zero emissions, and even from energy-intensive industries such as iron and steel and plastic, can be achieved by 2050. But it will require a reorientation from the historic focus on incremental improvement, like energy efficiency, to transformational changes in energy and feedstock sourcing," said Stéphane de la Rue du Can, a researcher from Lawrence Berkeley National Laboratory (Berkeley Lab) who is a lead author of the industry chapter.

Berkeley Lab researchers were also leading contributors on a new chapter to evaluate climate mitigation pathways in the near- to mid-term and served as overall reviewers representing the U.S. Government. The first installment of this IPCC Assessment Report was released last summer (with contributions from several Berkeley Lab scientists) and the second installment was released earlier this year. This third and final part focuses on climate change mitigation, or ways to limit or prevent greenhouse gas emissions.

"Berkeley Lab researchers have a long history of participating in the IPCC, going back to the early 1990s," said Lynn Price, who served as a lead author on six previous IPCC reports and on the U.S. government review team for this report. "This was an exhaustive effort, with contributions by about 250 leading scientists from over 60 countries. They assessed recent trends in greenhouse gas emissions and analyzed emissions mitigation technologies, policies, scenarios to support the Paris Agreement's goal of holding 'the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels

and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels.'"

Strategies to mitigate climate change

For the chapter on mitigation pathways, the IPCC authors conducted an extensive review of published studies and evaluated government-submitted "nationally determined contributions," or NDCs, which are essentially the climate action plan each country submitted as part of the 2015 Paris Agreement. The literature identified an emissions gap of 14 to 23 gigatons of carbon dioxide-equivalent for limiting warming to 1.5 degrees Celsius in current country policies, including the NDCs. For context, global greenhouse gas emissions in 2019 were about 60 gigatons of carbon dioxide-equivalent.

"To get to our 2050 climate goals, there are differentiated pathways for different countries. Some countries are very rich in bioenergy, for example, such as in Latin America. Other countries may put more focus on other renewable energy, including India and China," said Nan Zhou, a Berkeley Lab senior staff scientist and a lead author on this IPCC chapter.

Looking at individual economic sectors, they found that decarbonization of the electricity sector is technically feasible and could be achieved sooner than other sectors. In fact, the development of renewable energy has "happened faster than we thought," Zhou said.

However, sectors such as transportation and buildings may need to find new strategies to quicken the pace of decarbonization. For example, besides the scale up of electric vehicles and trucks, emerging measures such as shared mobility systems could play an important role in the transport sector. "For some countries, digital or information technology can transform transport systems," said Nina Khanna, a Berkeley Lab

researcher and contributing author on the chapter. "Better urban planning can also be an effective strategy."

At the same time, reducing the demand will be critical. Designing buildings with advanced materials, for example, could reduce the need for iron, steel, and cement—all carbon-intensive to produce as well as to transport. "A lot of the needed technologies and measures exist today. We know how to do it. The question is, how we can accelerate their adoption?" Zhou said.

Lastly, the chapter looked at the human side of the equation—how to achieve our climate goals while ensuring that human health and wellness are not sacrificed or that some populations are not disproportionately affected.

"The issue of a just and equitable transition to clean energy must be addressed if we want to embark on that accelerated mitigation scenario," Zhou said. "In Germany, for example, the transition away from coal to cleaner forms of energy includes job training, education, and other measures to ensure that workers were not left behind."

Industry emissions growing fast

The industrial sector is not only the sector with the highest emissions of greenhouse gases—higher than the transport, agriculture, and buildings sectors—it also has the fastest-growing emissions. And about half of industrial emissions come from the production of just a few materials, namely, cement, chemicals (including plastic), iron and steel, aluminum, and paper and pulp. Of those, production of plastics is growing the fastest.

"What's interesting in this chapter is that we looked at the material intensity, meaning the production of materials compared to GDP [gross

domestic product] growth," said de la Rue du Can. "We found that material production is growing faster than the GDP, so we are becoming more material-intensive. I've worked my entire career in energy efficiency. We're now seeing energy intensity decreasing, but material intensity is actually growing."

It's becoming increasingly clear, the chapter notes, that our society needs to use less material, or find ways to reuse and recycle materials. "It's an area that has been overlooked sometimes, but it's really becoming more important—it will require material efficiency and a circular (recycling) economy to achieve our climate goals," she said.

Buildings can be designed to be lightweight and have longer life, lowering the amount of cement and steel required. Products such as home appliances can also be designed to have a longer life. "For example, just as we have energy performance standards, with energy efficiency standards and labeling, the European Union is looking at how to also include durability in their requirements," de la Rue du Can said. "They want to ensure that manufacturers have the replacement piece when, say, your washing machine breaks, so that you can repair it instead of throwing it away."

Such requirements might also include standards to use low carbon materials in infrastructure development. "For example, the state of California passed the Buy Clean California Act (AB 262) that establishes maximum acceptable global warming potentials for eligible steel and glass construction materials for public procurement," she said.

"The key message is that there's really no silver bullet, and it will take significant action using a combination of technologies, measures, and practices to address the world's growing greenhouse gas emissions if we are going to achieve carbon neutrality by mid-century," said Zhou.

Provided by Lawrence Berkeley National Laboratory