Panel on negative emissions technologies at COP23; ITER booth with pineapple

As Alex's previous blogpost states, there was a sense of urgency at this COP. Urgency had observable consequences all around the conference and was not only embraced but enhanced by Fiji's presidency. You could see this even in the COP's logo. Whereas the COP logo is usually a sleek and trendy design to look good on banners and t-shirts, Fiji's logo, though seemingly innocuous, is emblematic of the true stakes of negotiations coming out of the COP. The logo is a small green island with two palm trees, reminiscent of something out of a Pixar movie, being engulfed by a tidal wave and the ocean around it. This image is the first COP logo I can recall that has a clear message, namely that even a 2-degree goal, with all of the challenges it presents, will not suffice to stop climate change from presenting an existential threat to small island developing states.

Given the state of negotiations and the magnitude of the problems at hand, I followed a thread of discussions around innovative technologies that could provide solutions to climate change, some of which I was familiar with and some of which new were totally new to me. I attempted to learn more about these technologies and the legal and political challenges they may present. All of these technologies are beginning to look less like moonshots and more like conceivable realities. The political and legal actions to implement them will require proactive rather than reactive responses to get them "online" as they become available. An overly reactive stance, by contrast, will likely elongate the time it takes to deploy these technologies. When time is so critical, opting to prepare for rather than passively await these technologies might prove critical.

Negative Emissions Technology

Negative emissions technologies, or NETs, enable small-scale carbon capture that uses machines to pull carbon from the atmosphere. The methods can then put carbon underground through carbon storage, turn carbon into rocks, or even turn carbon into building materials through capture and conversion. On the same day in Bonn, I had the opportunity to hear from both Kevin Anderson, a climatologist skeptical of these technologies, and a panel moderated by the founders of the Center for Carbon Removal, a group working to promote these technologies. That panel included a representative of the California Governor's office and a number of professors and advocates studying these efforts. A recent New Yorker article profiled a number of these people and highlighted both the potential of these technologies and the difficulties and controversies in getting them to scale.

Kevin Anderson warns against relying on NETs in forecasts, pathways, and scoping plans because they seem to not be scalable in their current form and the resulting moral hazard will create more harm than benefits if people think there is no urgency to reduce emissions. Additionally, his research shows that meeting even the most modest of targets discussed at the COP will require large-scale changes to energy generation, and he fears that the hope of negative emissions technology would detract from these aims. Many of the issues with carbon capture that Kevin Anderson speaks of derive from the scalability of the different pathways currently available.

But at the panel, at least one set of panelists had optimism about rapid technological advancement for NETs. The specific pathways discussed at the panel were direct air capture, CO_2 conversion into roads and building materials, accelerated weathering which accelerates naturally occurring carbonization of silicate rocks, and bioenergy carbon capture combining geologic capture with bioenergy. The panel traced the development of these technologies, with one presenter stating that although he was told NETs were not possible at a scalable level, they were nevertheless becoming currently available commercially. The panel tracked a direct capture plant in Zurich by Climeworks, a restoration engine (turning CO_2 into stone) by CarbFix, a generation engine by Carbon Engineering + Greyrock, and accelerated weathering in the Shasta region. CalTrans might work with Blue Planet to make roads with captured CO_2 in the materials in a wider effort to use CO_2 for carbon tubes and raw building materials. For now, these processes seem prohibitively expensive, but as demand for them begins to grow, they become more scalable. Policies can affect how fast these new technologies develop by allocating resources to them, and once there is a critical mass, the processes become cheaper. This could create a positive feedback loop in innovation, making these processes more efficient and more economically feasible.

Fusion

Amongst the country pavilions in the conference center, one would find a booth for the ITER project, complete with pictures of the sun, a model of the tokamak reactor, and a pineapple on a pedestal. ITER is an international effort to build a large fusion reactor in the south of France. The models and diagrams show the process of turning hydrogen isotopes into helium and energy by replicating the conditions of the sun in the large donut-shaped reactor. The pineapple represents the size of tritium fuel (a hydrogen isotope) it would take to replace 10,000 tons of coal worth of energy production. Unlike fission, fusion has very little if not zero nuclear waste outputs, and one reactor can produce between 500MW and 5GW of power. Though that may sound ideal, little in the mothball fleet of solutions to climate change has more stigma attached to it than fusion energy. Fusion faces many problems which generally stem from a lack of knowledge—or, sometimes, from an abundance of knowledge of fusion and its history. To address the lack of knowledge, ITER is working to rebrand itself and to distance itself from much maligned nuclear fission. Even though it is a nuclear process, nowhere in the booth will you find the word “nuclear”. Still, apparently some NGOs at the COP declined to help the ITER crew show a documentary about fusion energy because it was associated with nuclear energy and fission. On the abundance of knowledge side, the scientific community sees fusion as a technology perpetually 10 years away. Yet despite all of these factors, I was greatly impressed by the grit of the scientists I met in the face of widespread criticism of fusion projects. Those that I spoke with fully believe it will soon be not only achievable, but economically feasible, saying “when” fusion becomes widely available rather than “if”.

Regardless of what one thinks about fusion as a technology, the agreement that created ITER is an interesting piece of international legislation. It is a mutual effort on the part of China, the EU, India, Russia, Korea, Japan, and the United States. The intellectual property that comes out of the project is shared with all of the countries involved. If a country decides to leave the effort, it will have to pay another member country to pick up the slack, and it won’t have access to any of the intellectual property when the project is finished. The intellectual property network amongst these specific countries in the development of advanced nuclear technology seems to be unprecedented.

Though this project is in the south of France using an older fusion method, the scientists I spoke to said there were also a number of novel fusion projects in Canada and the United

States. One scientist spoke somewhat critically of a new Lockheed project as a retread of a technology that was not shown to be scalable. However, he spoke very highly of Tri Alpha Energy and General Fusion citing them as novel and intriguing. Toward the end of the conversation, another scientist at the booth picked up her phone and described how far off this cellphone technology would have been in the 1990s. They then likened this progression to what could occur with fusion. Their vision is of fusion as a closer technology that could replace baseload natural gas plants, helping countries reach not only 2 degree pathways but 1.5 or even 1 degree pathways successfully. As these technologies get closer, it might be time to think about the potential roadblocks in implementing them. If these projects do create useable products, California's state ban on the construction of nuclear plants and various anti-nuclear municipal ordinances could pose barriers to implementation here. On top of educational outreach to help the public understand fusion as distinct from fission, perhaps it is time to look over these laws and policies to make sure that if or when these new technologies become available, we in California won't have to wait yet another 10 years to implement them.

Hydrogen Fuel Cells

Looking around Los Angeles or the Bay Area, it would be quite difficult to not see an electric vehicle (either HEV, PHEV, or EV) on the roads. To us in California it seems as though the technology battle for the future of passenger transportation already has its winners and losers, with electric vehicles being the proverbial (triumphant) VHS and hydrogen fuel cells being the proverbial (loser) Beta-max. Yet Toyota is investing in a hydrogen car called the Mirai, which is Japanese for future. Toyota was a major beneficiary of the movement towards electric vehicles with the Prius being emblematic of the eco-friendly passenger car, so why would it be allocating resources towards an entirely different technology? Well, it appears as though the California government will not be giving up on hydrogen either, as it is planning to expand the number of hydrogen fueling stations in the state to eighty, which it hopes will be a critical mass. Governor Brown's office has even made efforts to connect with east coast states like New York to begin creating hydrogen infrastructure there as well. Whereas one could imagine the east coast becoming full hydrogen very quickly because there is far less development of electric charging stations, there looks to be a battle coming in California. The beneficiary of this battle could be the environment because hydrogen technology offers a solution to those who have range anxiety, as the infrastructure for refueling is more or less the same as normal gas. Additionally, hydrogen offers an interesting solution to renewable energy overgeneration, because extra energy from renewable sources could be used to make hydrogen during times of the day when there is an abundance of energy from these sources potentially remedying issues caused by the notorious "Duck Curve". A company in Northern Sweden is already doing this, with a project called Hybrit. Whereas a BMW representative stated they are not taking their hydrogen cars to market anytime soon, Toyota is jumping on yet another low-carbon opportunity. It seems as though once again being the vanguard of low-emissions technology will give Toyota a massive first mover advantage. Whereas the Prius became the symbol of **low**-emissions vehicles, the Mirai might become the symbol of **zero**-emissions vehicles of the future.

Tracking these technologies was one of my favorite parts of having the opportunity to attend the COP. We are beginning to realize is that what is readily available now likely won't be enough to achieve even the 2 degree target. There has to be more, and there are certainly interesting innovations on the horizon. In order to protect the island nation that hosted this COP, innovation and its political and legal implementation will be invaluable to achieving the goals of the Paris Agreement. From attending these panels and discussions it seems as though these solutions are necessary to reaching a 2 or 1.5 degree goal. A world where we drive hydrogen powered cars with hydrogen separated by fusion energy on roads and materials made from carbon emitted from coal in the 1950s seems far-off, but it might just be closer than anyone thinks. Although it might not be wise to plan too rigidly on having these technologies now, as Kevin Anderson warns, we should at least prepare for these new technologies so that we may get to the future faster than we otherwise would because those few years will likely be critical to preserving a livable climate.

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