Special Interview II

Inspiring Future Generations: The Importance of Carbon Capture Storage and Understanding Human Environmental Impacts

Carbon Capture Storage (CCS)[1] and the exploration of how to reduce CO_2 emissions is a global issue of great importance. Professor Takeshi Tsuji, Lead Principal Investigator for the I^{2}CNER CO_2 Storage Division, interviewed Professor Michael Celia, the Director of the Princeton Environmental Institute at Princeton University, about the current state of CCS research and the potential future implications of the field. They also delved into the importance of guiding future generations to explore these problems in the hopes of finding lasting solutions.

Research as a Collaborative Effort

Takeshi Tsuji: Thank you very much for making time for this interview. Your talk at our Annual Symposium yesterday must have motivated I^{2}CNER members very much. Firstly, please tell us how you became involved with I^{2}CNER.

Michael Celia: When I^{2}CNER decided to include a significant CCS component, I^{2}CNER members contacted me to ask if I would join the external advisory board as the person who is involved in CCS activity. The first time I met you was when I went to my first I^{2}CNER meeting, three or four years ago. Then I wound up being really impressed with your work. I think the work that's going on here with CCS is really interesting and important.

Tsuji: Before I came to I^{2}CNER, my specialty was geophysics/geology. Specifically, large-scale geological formation investigations and large-scale CO_2 behavior monitoring using a geophysical approach.

Celia: It's an important point – the fact that you approach this with a seismology background. I think it gives a different perspective and you are thinking about one of the major issues with CCS which is: 'How should we think about the risk of creating earthquakes by injecting huge amounts of fluid underground?', You need expertise in earthquakes and seismology in order to think about that problem in the right way. If you just look at CCS in terms of research, 25 years ago there was no research in CCS because it didn't exist. People from hydrology, from petroleum engineering, and from other various backgrounds started working on the problem. Almost everybody who was working on the problem came at it from just the fluid flow perspective. However, the idea that we had to think about the mechanics of the rocks and whether or not there are going to be any possibilities of earthquakes at the surface came later. For me, one of the interesting parts about working on a relatively new area is to observe how the research itself

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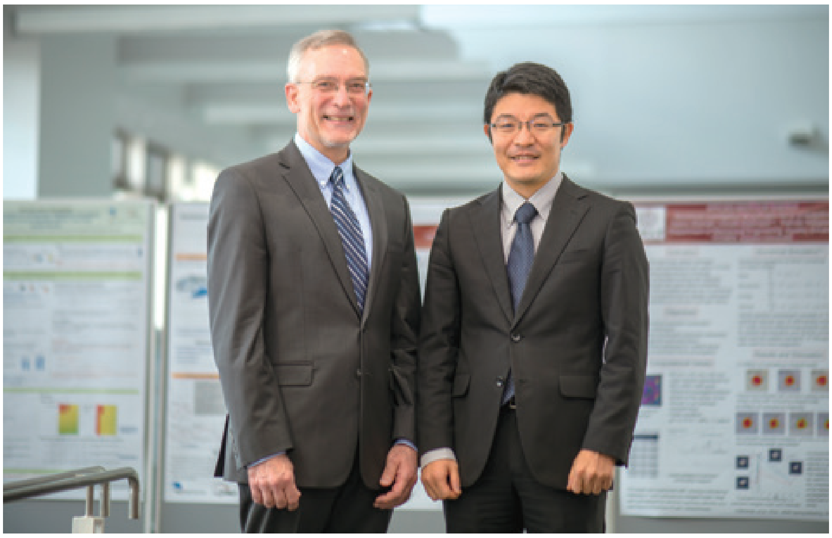
develops. It attracts people from these different groups that come in and make different contributions.

Tsuji: It's true, CCS is a very good chance to collaborate and gather many specialists, and our research can help other fields as well.



Considering CCS Projections

Tsuji: Could you please talk about the importance of CCS in view of the 2018 IPCC[2] Report that says that we are on track for a 3-4℃ temperature rise by the end of the century?

Celia: I think that every study that I have seen indicates that CCS needs to play a major role in serious carbon mitigation strategies. If you look at any projections for 2 degrees or 1.5 degrees, instead of the 3 to 4 degrees that you pointed out, you see that CCS is expected to ramp up between now and mid-century to significant levels – gigaton per year levels. If you look at the 1.5-degree report, for example, you can see that many scenarios will have net negative emissions[3] in the second half of this century. The major technology that is currently expected to be able to do that is the combination of bioenergy with CCS, that is an order of 10 gigatons a year ramping up. All of these scenarios for how we can realistically solve the carbon problem involve massive amounts of CCS. The challenge that we have is to go from where we are today, to what these future projections are assuming will happen. In all of these, CCS plays a central role and I think our responsibility is to figure out how we can ramp up the activity.

Achieving Negative Emissions

Tsuji: In your presentation at the I²CNER Annual Symposium yesterday, you talked about negative emissions. I think it is tough, but it is a very important concept for carbon reduction. Can you talk a bit about your views on negative emissions?

Celia: Yes, negative emissions means that either humans design a technology to take CO_2 out of the atmosphere and then do something with it to keep it out of the atmosphere (the likely thing to do is to put it underground) or we allow vegetation to take CO_2 out of the atmosphere (which happens by photosynthesis), and then we use the vegetation products as the fuel source, and then we capture those emissions and put them underground. In either case, we use those processes coupled with the carbon storage to basically have a net negative accounting for the amount of carbon that is going from the earth into the atmosphere. At the moment, there is no viable human-made technology that works at scale for the extraction of huge amounts of CO_2 from the atmosphere. That's why the technology that is referred to as 'BECCS'[4] (bio-energy with carbon captured storage) is what's pointed to in these reports. That's the technology that we know has some reasonable chance to work right now. Ideally, there will be a group of new technologies that can take carbon out of the atmosphere and redirect it in ways that will keep it out of the atmosphere. The thing that we have to remember is that the only way that any of these things makes a difference, is if the amount of carbon we're talking about is massive–gigatons of CO_2 per year. The scale of the problem really has to be emphasized because it's a massive undertaking and many different technologies are required. We also need to be thinking about the geological part of this, the underground part of this, at these scales because it is important to achieve those levels.

Exploring the Popularity of CCS

Tsuji: Yes, it is important to reduce large amounts of CO_2, and CCS could achieve the large-scale CO_2 emission reduction. Another question I have is: given the importance of CCS, what is its status in the U.S. and possibly worldwide?

Celia: In the U.S., CCS has not taken off as any sort of large industry so far. Whether that happens in the future remains to be seen. However, in the U.S., there are interesting possibilities at the moment. About a year ago in 2018, a new tax bill was passed. In that tax bill are tax credits for CCS. The tax credits are at a significant level, up to $50 per ton if you capture the CO_2 and use it for direct storage, and up to $35 a ton if you use it for enhanced oil recovery.

Tsuji: The general perception is that CCS has not gained traction worldwide toward decarbonizing the environment. Could you please elaborate on possible reasons? What are the main roadblocks for accelerated deployment of CCS projects?

Celia: I think the reason is largely economic. My

A scene from the interview

own opinion is that if there is a system in place where, at the large scale, there's profit to be made by putting CO_2 underground then a "CCS industry" will develop. The appropriate regulations will either be written or be modified in whatever ways are necessary to allow it to happen. Until that happens, I think that we spend a fair amount of time thinking about public perception and how negative perceptions might be the reason for the lack of large-scale development of CCS. I don't want to minimize its importance of public perception, but in most parts of the world there are all sorts of infrastructure projects that are built, including pipelines. In the U.S. we have pipelines that will take natural gas from the Gulf of Mexico region to where I live in the North East, and we've got natural gas storage sites for the seasonal storage of gas, and all sorts of things like that, that already exist. The idea that we wouldn't be able to build a similar pipeline for CO_2, I don't believe that is the case. My own sense, and perhaps this is just a hopeful statement, is that the idea that there is a negative perception about CCS, comes through in what we see in specific surveys. Instead of saying 'Do you want us to build a pipeline that will be operated by an oil company?' to which the answer is probably, 'Well, I think that's not a good thing,' the more reasonable question is, 'Will you work with us to solve the climate problem?' I think that in terms of gaining traction and public perception, it would be good if we could present this quite directly as an important green technology that will help to solve the climate change problem.

Motivating Future Generations

Tsuji: How do you view the role of CCS research in academic institutions like I²CNER?

Celia: At Princeton, we've offered a special topics course on CCS a couple of times. The thing about CCS is that the 'capture' part is really a problem of engineering technology. How do you build something to do gas separation or think about new materials? It's really a chemical engineering and material science question. The 'storage' part is earth science, geosciences, and some parts of civil engineering. Overall, there are so many different disciplines involved in CCS, so it helps to sometimes break it up into the 'capture' and the 'storage' parts. While we may not have a curriculum specifically for CCS, the tools that we need to do the work exist in many programs in many different universities. That gives me optimism that even if we don't develop specific CCS courses, there will be a number of students, both undergraduate and graduate, who are trained with the skill sets to allow them to contribute in important ways to solving these problems.

Tsuji: How can we motivate young scientists to carry out research in this area? Are there future opportunities for employment?

Celia: I think the best motivation is to invite them to come and save the world. In some sense, that's the advertisement because I think that's what we are actually trying to do in some grand sense. If you think that an uncontrolled warming planet is an existential threat to our species, and to several other species on the planet, then, it's not an exaggeration to say, 'Come and save the world, at least the world as we know it.' That's what solving the climate problem is, and if CCS is going to play a major role, then that's how we motivate students. Our job is to give our students the tools, the perspective, and the context to go out and make meaningful contributions no matter what they ultimately choose as a profession. I'm very optimistic about this cohort of young scientists and I am comfortable putting my faith in that group to go out and solve the problems that my generation created through the emission activities that we see going on today.

Tsuji: I agree that our works for CCS are directly related to the biggest problems for human beings. I continue our research activities for carbon emission reduction, and also try to educate young scientists to save our planet earth. I really enjoyed this talk with you. Thank you very much.

Notes

1 Carbon Capture and Storage (CCS): The process of separating and capturing CO_2 and then storing it underground.

2 IPCC: Intergovernmental Panel on Climate Change.

3 Negative emissions: A reduction in the amount of CO_2 that is in the atmosphere.

4 BECCS (bio-energy with carbon captured storage): A technology that has the potential to mitigate greenhouse gases.

Special Lecture by Prof. Michael Celia
(Feb. 1, 2019)

Prof. Celia delivered a special lecture to Prof. Tsuji's research group and those from the Department of Earth Resources Engineering at Kyushu University. He talked about the importance of understanding the basics of hydrology, including groundwater flow paths while referring to a groundwater contamination case depicted in "A Civil Action," a best-selling nonfiction book by Jonathan Harr.

Prof. Celia during his lecture