[SQUEAKING, RUSTLING, CLICKING]

DAVID HSU: And this is a shorter video lecture introducing my class on Cities and Climate Action. Or this is really kind of an exploration, or maybe a rationale, perhaps, of why you should take this class-- MIT 11.165 for undergraduates, or 11.477 for graduate students.

This video lecture is really-- I'm going to use this as an example of all the future video lectures that are to come. So, for example, I'm not going to go over this slide. This slide has all the readings that are on the syllabus for today. I'll generally start my lectures with a slide like this, but I won't go into it because first, all these things are on the syllabus.

Second, for all the students taking this class at MIT, you'll have the PDF slides available on the Canvas site. So you can go to the PDF slides and click on the links. You don't need to go click on the links for the ones on the syllabus because you already have the syllabus.

But if I bring in other reports or articles or sources or papers, I'll put those references into the slides. And so if you want to follow up on other topics, just go to the slide and click on the link in the PDF.

So why are we watching this short video today? I'm going to use the short videos in class to comment on or synthesize, but not recap the readings. So you do have to do the readings. But the point of watching the video lecture is to really set up our discussion, or to demonstrate something I want to highlight or explore.

Quite often in my lectures, I really like doing a deep dive in a particular aspect of the readings. But that might not be necessarily what we want to talk about together in class. So I'll highlight things or explore things that I want to focus on. We can discuss it more in class. And then for the student leaders of the discussions, you can highlight something you want to explore or highlight, and we talk about it in class.

What I'm hoping this is going to allow us to do is to allow you to watch or rewatch these videos on your own time or at your own pace. And hopefully, what it's going to allow us to do is to flip the classroom and enable us to have richer, longer discussions.

We have about three hours of class time together. Given the number of people in the room today, I'm hoping we can use all three hours so everyone can feel like they're getting something out of the discussions. And the fun thing is sometimes the discussions go to different places than we expect, or than I expect.

And ultimately, the reason why I'm making these short videos is that these videos are going to form the basis of a new digital course on Cities and Climate Action. Ultimately, I hope to make these videos available to faculty or students at other departments at other schools.

I would argue that actually as urban planners, we need to get involved in climate change. But also, at the same time, we may not have the faculty or staff or student bandwidth to take a new course or offer new class. So I'm hoping these video courses will enable people to do that.

At the same time, I think that a lot of other disciplines, like engineering and policy, could benefit from focusing on cities. Because cities, I'll argue to you in this next few slides, are a key scale or jurisdiction at which we can have a lot of opportunities to take climate action.

So one reading I just want to focus in on, just to demonstrate how I'm going to delve deeper into certain readings, I want to introduce the textbook for this class. It's a book by David MacKay. He was a British physicist. I think he was the royal astronomer or royal physicist at some point in the UK.

He wrote this book in 2009. And unfortunately, he passed away at a relatively young age in 2016. But this book is actually a fairly good legacy. It was wildly popular then. It's still fairly popular now, even 13 or 14 years later.

And it's popular for a lot of reasons. It's accessible-- David MacKay made this book free, actually. He put it as a PDF on the web. It's actually fairly funny. A lot of students find this book quite entertaining. The evaluations of the course always highlight this textbook. Students really enjoy reading this textbook, so I hope you do, too.

It actually uses a fairly simple but powerful back-of-the-envelope reasoning. Dave MacKay almost always starts with fairly basic physical principles, looks at empirical data, and uses simple reasoning or calculations or graphics to enable people to understand the key issues involved.

In the first chapter, David MacKay makes the point that there's no economics in this book. And we can talk about whether or not that's good or bad. The one thing that has wildly changed since 2009 is the cost of renewable energies and technologies,

renewable energy technologies, have all declined since 2009. That's become a huge advantage for renewable energy over fossil fuel energies. And that's why the energy transition is going to happen more and more rapidly in our lifetimes. So we can discuss whether it's good or bad that this textbook has no economics. It simply focuses on the technological issues involved, rather than the economic issues.

Similarly, it really doesn't focus on the political or policy aspects of some of these technologies. This is perhaps before-- well, climate change has always been fairly polarized in the US in a way that it's not polarized in other countries. But David MacKay makes an effort in this book basically not to focus on politics, as much as on the physical or technological solutions we need. He assumes that that will help drive the conversation, or help drive the policy changes needed.

Obviously, we haven't had the policy changes we needed in the US. And Europe is slightly ahead, but perhaps has not moved as quickly as we'd like it to also. So we can discuss in this class whether or not we think the kind of lack of emphasis on politics and policy is also appropriate.

But let me show you some of the strengths of the book. And I'll use one example I really like. I really-- let me-- before I do that, I'll just show you that because it's accessible, because he made the PDF free. You can download for free on the website. It shows you where to buy it in paper.

But this is actually a volunteer thing, that somebody read the book, liked it enough. And because the content was free, made a separate web page for every single chapter. So you can access this book through the PDF on Download.

You can buy a hard copy. I'll show you a hard copy in class today. Or you can simply look at the web pages. Or you can do some combination of all three to access the book. That's why it's quite accessible. And it's been translated into, it looks like, 10 or 12 other languages.

To show you one aspect of the book I really like, I like the use of graphics in all of David McKay's work. You can see this very simple graph on the vertical axis is carbon dioxide concentration in the atmosphere. On the horizontal axis is time, going all the way back to about 1,000 AD. He focuses on this little section, which is between 1600 and 2000.

And his puckish commentary in the caption here is, "I think something new may have happened between 1800 2000 AD. He marks the year 1769, which is when James Watt invented the steam engine. That's the beginning of the Industrial Revolution in the UK. And you can say-- you can see in the UK and countries like France, Germany, and the US, the Industrial Revolution begins, and carbon dioxide concentrations go straight up, almost exponentially.

If you look at this graph, it's only to 2000. I think in 2020, we're about 415 or 420 parts per million in the atmosphere. So we've fully exceeded-- this growth has continued unabated for the last 22 years. But if you look at how he examines the issues, what I really like in a lot of his work and this textbook is that he uses graphics to illustrate different issues.

For example, he takes world greenhouse gas emissions in his numbers from 2000-- about 34 gigatons of CO2 equivalent per year. And basically says that's the total area of greenhouse gas emissions. And if you compare that to the population of 2000 at six billion people with what is seven point something now, or almost eight billion people on the planet, that basically averages to about five tons of CO2 equivalent per year per person. So you multiply this axis times this axis, and you get this result-- resulting area of 34 gigatons of CO2 equivalent per year.

But we can also look at some of the numbers, and they've been updated. Our World in Data is a pretty useful website for looking at different sources of data. They use a slightly different definition of annual CO2 emissions. They exclude land use change. And so in 2000, they have about 25 billion tons of CO2 equivalent.

Well, you can see what happens is basically it has gone straight up over the last 22 years till this slight dip from COVID. So if you look at their definition in data, it's 25 billion tons in 2000, almost 37 billion tons in 2019, until it slowly declines with COVID. And what we're hoping after COVID is that as our energy transition continues, we aren't bouncing up back to the same upward trajectory, which is going to result in more climate change.

At the same time, you can use the original graphics. You can kind of drill down into the data little bit, as David MacKay does, and shows that these areas of greenhouse gas emissions are quite different.

Even though the total area of greenhouse gas emissions is what counts, if you average over, let's say, different populations of people in different regions, you can see that even if the total area of Asia might be slightly larger than North America, there's many fewer people in North America who are emitting much more greenhouse gas emissions per person. And this is starting to highlight some issues perhaps of equity across different regions of the world.

If you look at it by country, most of the people in North America are Americans, who are all in 2000 looks like emitting about 24 tons per person per year. Even though China has a larger population of nearly a billion people, those people on average are only emitting about four tons per person per year. So in 2000, by this measure, it looks like the average American is emitting about six times the average Chinese person.

Having said that, the average Chinese person is still emitting twice as much as the average Indian person here. And so the area of greenhouse gas emissions from India is consequently roughly less than half of what it is from China.

If we were to update this for 2019, you can see that's changed. In this graphic, China has become clearly the largest greenhouse emitter in the world, [INAUDIBLE] even emitting twice as much as the average Chinese person.

You can also see some changes over time. You can see that the US is now emitting it looks like around 15 tons per person per year. They might be slightly different measures, but greenhouse gas emissions have declined in the US. They've gone up in China. And now, China is above the world average-- about 4.4 tons per year per capita.

And if you look at India, India is still well below average. Sub-Saharan Africa is even smaller. And so what we're trying to do is look at how this might translate into national policy, or at least what we think the responsibility of different countries are to deal with climate change.

If you look at historical greenhouse gas emissions, if you average all the greenhouse gas emissions over the last 120 years, you see the United States is clearly responsible for the largest area of greenhouse gas emissions per person per year over that time period.

If you look at largest total historical or cumulative greenhouse gas emissions, again, the US really unfortunately number one here, double that of China, and looks like triple that of Russia. Having said that, this will change over time as annual emissions change. But what we're basically seeing here is the US is the largest-- has the largest responsibility for total historical greenhouse gas emissions over the last 170 years.

And what are we doing in this kind of reading? I'm only digging down into this particular issue because I want to highlight what I want to try to do in this class, which is first, develop your basic numerical literacy. In this case, we're looking at greenhouse gas emissions per capita over time.

I want to understand broad issues, like equity or climate action, which countries are responsible for climate action, by taking specific deep dives. So we looked a little bit at different data sources and different trends over time, or different ways to analyze the data. And ultimately, what we're trying to do is build a moral case for climate action.

I take a US focus in the US because the US is the largest historical emitter of greenhouse gas emissions, and still on a per capita basis one of the highest emissions emitting countries in the world. So I would argue that actually leads to a moral case or a moral responsibility for us to take more climate action than other countries.

If you look at countries like India or regions like sub-Saharan Africa, they are well below the global average. For them to develop or to even achieve a standard of living like our own, they really have nowhere to go but up, in terms of their greenhouse gas emissions. Honestly, if we want to achieve decarbonization, the US and other rich countries have nowhere to go but down. And that is the crux of our energy transition challenge going forward.

And so let's talk about why we focus on cities. Quite often at MIT-- this is courtesy of my terrible, terrible PowerPoint skills. But if you-- what we talk about at MIT quite often is technology, policy, and markets.

We talk about developing new technologies through our science and engineering research. We talk about trying to pass new policies through advocacy, or also based on our social science research. And we often talk about developing new markets for technologies through, let's say, commercialization or innovation or creating new technologies.

But I would argue with you that cities have a role at the intersection of all of these. And as a scale, is this-- is a underappreciated scale, or an opportunity for us to try to affect all three of these areas.

We know that technologies can be developed for certain situations or certain combinations of problems. Different cities are going to have different adaptation and mitigation needs that need to be met by technology. Cities are large enough to pass their own policies that can help shape the adoption of technology and how the markets develop in that particular region.

And cities are large enough themselves to constitute a market for new technologies. Cities are responsible for most of the GDP in the world. And so we have the ability at the local level to shape technology and policy also. So the intersection of technology policy markets in this Venn diagram, I would argue to you that cities are a key venue for climate action.

Another reason, quite simply, why we should look at cities is that's where all the people are. This is the graph of the percentage of urban and rural population as a proportion of the total population from the UN World Urbanization Prospects.

You can see, then, every region in the world, if the blue is the rural population and red is the urban population, every region in the world-- Africa, Asia, and Europe-- Europe is already quite urbanized at 75% now, but will become even more urbanized by 2050, which is our mid-century target for decarbonization.

Asia is right at 50%-- half and half between urban and rural population, but will become even more urban over the next 20 years. There will be mostly urbanization happening in Southeast Asia or India.

And Africa is 42% urbanized, but by 2050, is going to be about 60% urbanized. That's mostly urbanization that's going to occur in sub-Saharan Africa.

If you look at the Latin American Caribbean, already amazingly urbanized at 81%; North America at 82%. But both regions will be probably pushing 85% or 90% urbanized by 2050. And Oceania, which is Australia and New Zealand and the Pacific Islands, will probably stay roughly as urbanized as it is, which is already 68%.

So the argument for focusing on cities is simply that's where all the people are. That's where all the economic activity is. That's what we should focus on to try to reduce our consumption.

But we're going to focus on us studies in the class, partly simply because we're teaching in an American institution. Also, we've had recent climate developments, which are quite exciting to me. Here's an article by Miriam Wasser of WBUR, just simply saying what we need to know about the new Massachusetts climate law. That's going to affect our state energy policy quite a bit.

This is a blog post from Amy Turner at Columbia University, focusing on how cities will be affected by the Inflation Reduction Act, which is our first major piece of climate legislation ever passed by climate-- by Congress ever since Congress learned about climate change and the problem for the first time 30 years ago.

And so I welcome insights and comparisons with other countries. I've done work in a number of other countries on energy and energy transition. But we're going to focus mostly in this class on US cities, simply because we have the moral responsibility to take climate action. And also, because we're studying in a US institution.

But, again, I welcome your insights and comparisons with other countries. I'll try to bring in comparisons with other places I've worked or other regions as appropriate, to try to illustrate some of these energy and climate issues and how they work in other cities around the world.

And I also want to highlight that there's nothing in this class really should be off limits. And I just want to emphasize that different people will get different value from different readings.

For some people, Bill Gates was a ruthless monopolist in '90s, a successful philanthropist in the aughts, and the, let's say, early teens of the century. And you might have heard most recently he had a terrible, terrible divorce, and maybe his reputation is somewhat damaged by that.

But he's also known as somebody who's worked on child mortality and disease and climate change and pandemics. So he wrote an article in 2018 about "Climate Change and the 75% Problem," arguing that we need new technologies and innovation to solve large parts of climate change that we don't already know how to solve.

At the same time, we have this article by Nikayla Jefferson and Leah Stokes, who's one of our graduates from DUSP at MIT. And it's titled "Our Racist Fossil Fuel Energy System." And I actually think it gives a number of good arguments why the fossil fuel energy system disproportionately affects Black Americans.

This is an article that was written in July of 2020 right at the height of the Black Lives Matter protests. And it highlighted basically how the energy system affects different groups, especially Black Americans differently.

Having said that, people had very different reactions to this article. I had one student who came from the fossil fuel industry, and she was quite offended by this article that she called "Our Racist Fossil Fuel Industry," which wasn't actually the title of the article, but just shows you how this label-- of labeling the energy system as racist, she took quite personally.

And so I want to emphasize that you can look at both the articles by Bill Gates or Jefferson-Stokes, and you can have different reactions to them. But what I want us to do is try to read lots of different viewpoints and engage with them and think through what we agree with, what we don't agree with, and use that to shape our own viewpoints.

And this is just to emphasize that the point of your education with is to develop your own critically reasoned viewpoint. But to develop your own critically reasoned viewpoint, you have to engage with evidence. You have to engage other people's viewpoints. And you have to engage with other people.

So we're going to try to have nothing to be off limits this class, even as we try to engage things rationally and respectfully, respectful of other people's viewpoints, I want us to try to keep on working on developing our own critical reasoning, and trying to contrast how other people see some of the same issues, even if we don't agree with them. And so in our class, I want to emphasize that we're going to learn, question, and reason together.

Finally, I wrote this article this summer with a number of colleagues around the planning discipline, including Chris Zegras, who's here at MIT. The article is titled "Planning the Built Environment and Land Use Towards Deep Decarbonization of the United States." And I wrote this article with my colleagues because we argue that deep decarbonization is basically our net zero goal for 2050.

At the same time, we don't think that there's wide understanding of what we need to do to the built environment land use. And this is to say two things, that the built environment land use are going to be critical to realizing our energy transition goals. At the same time, if we don't address the built environment on land use, we may not reach those goals.

And we think that decarbonization has implications for cities and the planning in terms of the scale of how we plan cities, the scope of what planners look at, the speed with which planning occurs. We need to achieve a decarbonization goal, which is basically changing our entire energy system 28 years from now. That's going to require planners to operate much faster.

And we need to make sure that we remain relevant. If planners don't focus on mitigating greenhouse gas emissions, we will be left out of larger climate discussions happening in other disciplines or in government, which is much more focused on mitigation than adaptation. But planners have traditionally focused on adaptation.

And finally, there's an open question of what the role of land use and built environment planning is. We know there's lots of different ways that we can affect decarbonization. This is what this article argues. Having said that, that means planners have to reconceptualize our role in planning cities, and cities and their energy system.

So I hope you enjoyed this lecture. I hope you take this class, or I hope you watch the subsequent videos on why cities are a key venue for future climate action.