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## Demystifying the Carbon Markets | Episode 3

Professor Cameron Hepburn, Director of the Smith School of Enterprise and the Environment at the University of Oxford

**The net-zero commitments made by corporations and large institutions are foundational to the development of the voluntary carbon markets. Professor Cameron Hepburn, Director of the Smith School of Enterprise and the Environment at the University of Oxford, joins us to discuss the role of the voluntary carbon markets, what they need to succeed, and how to get net-zero right.**

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**Cameron Hepburn** (00s):

What we are stressing is that getting to net zero, isn't about doing nothing for the next decade and then starting to take some action and then gradually getting yourself there by 2040 or 2050. There's a reason we call this decade, the decisive decade and it's because we are a long way off track to where we need to be. If we're gonna hit the globally agreed goals at Paris.

**Announcer** (24s):

Welcome to Smarter Markets. A weekly podcast, featuring the icons and entrepreneurs of technology, commodities and finance ranting on the inadequacies of our systems and riffing on ideas for how to solve them. Together we examine the questions are we facing a crisis of information or a crisis of trust and will building Smarter Markets be the antidote.

**David Greely** (51s):

Welcome back to demystifying the carbon markets on Smarter Markets. I'm Dave Greely, Chief Economist at Abaxx Technologies. Today, I'll be speaking with Cameron Hepburn. Cameron is the Director of the Economics of Sustainability at the Smiths School for Enterprise and the Environment at the University of Oxford and a Professor of Environmental Economics. He's the perfect guest to help us better understand the voluntary carbon markets and how to get net zero right. Hi Cameron. Welcome to Smarter Markets. Thanks so much for joining us this week to discuss and demystify the voluntary carbon markets. Now the net zero commitments made by large corporations and institutions are really foundational to the development of the voluntary carbon markets. You and your colleagues at Oxford Net Zero have emphasized that net zero is both a scientific concept and a frame of reference through which we structure our response to climate change, whether it's at the corporate institutional or government level. Could you elaborate on these twin meetings of net zero for us?

**Cameron Hepburn** (01m 56s):

Yeah, sure. I mean, it's a scientific concept in the sense that if you take a long lived gas, like carbon dioxide, if we want to stop the effect of carbon dioxide trapping heat and warming up the planet, then we need to have net zero emissions of CO<sub>2</sub>, which is to say that any further emissions of CO<sub>2</sub> from humans have to be balanced by humans, taking CO<sub>2</sub> out of the atmosphere and preferably locking it up permanently because of course the CO<sub>2</sub> that we're taking out of the rocks out of the lithosphere is effectively on a permanent, you know, multimillion year sort of time scale. So the science tells us that we need net zero of carbon oxide, at least in order to stabilize global temperatures. So that's the scientific sense and that's true, no matter what the target is. So if we're aiming for well below two degrees or one and a half degrees of warming, then we need net zero.

**Cameron Hepburn** (02m 56s):

But it's also true that we need net zero if we're aiming to stabilize at 3 degrees or 4 degrees. So the first point to clarify is that a net zero pathway doesn't necessarily mean a 1.5 degree pathway or 2 degree pathway. These two things are not the same thing. We need net zero, irrespective of the amount of warming. So that's what we mean when we say it's a scientific concept. It's a question, not quite a theorem, but it's a question of atmospheric physics and the balance of different effects, meaning that, you know, once we net the CO<sub>2</sub> going up with the CO<sub>2</sub> going down, we make that zero, then we're, then we're likely to get, you know, roughly a stabilization of temperatures and of course we might want to be gently calling the planet at some point in time, if we've gone above a safe temperature range.

**Cameron Hepburn** (03m 45s):

So we may indeed wish to go net negative at some point, but, but net zero's a sensible thing to be shooting for scientifically and then in terms of, you know, we describe it as framework for organizing our approaches to addressing climate change and there, what we mean by that is that in addition to the scientific base, you have to think structurally economically from a governance and an institutional perspective about how to get to net zero and when to get to net zero. You know, so in principle, in theory, there'd be nothing wrong with emitting as much as we like and then once we hit, you know, 1.5 degrees suddenly stopping all emissions and going to net zero, but that's not the way the world works. I mean that wouldn't be a credible net zero pathway and be a theoretically acceptable net, zero pathway to omit like crazy until 2015, then suddenly stop, but it wouldn't be particularly credible. So our paper sets out the additional elements that you would want in a plan to get to net zero that makes it realistic. That makes it credible, that uses existing technology and or new technologies and business practices and just accounts for the full range of things that you need to be accounting for.

**David Greely** (04m 59s):

Right and I want to return to some of the specifics on that because it's so important, but before we get there, you know, it's interesting in that it's being used as a framework, both for corporations and institutions, making net zero commitments, that support voluntary markets, but also government policy makers and I'm curious because right now we have this interesting mix in the carbon markets of some compliance markets that are driven by government policy and then these voluntary markets that are driven by net zero commitments and moral suasion and stakeholder activism and I'm curious, you know, as an economist who study these markets and been active in them for a long time, you know, how do you see the relationship between the compliance and the voluntary markets of evolving, do you see the voluntary markets perhaps as like a transitional phase until we get to something like a global set of cap and trade systems or could we see a more sustainable market ecosystem where you have both voluntary and compliance markets existing side by side?

**Cameron Hepburn** (06m 01s):

It turns out that's a very complex question, actually. I mean, if you go back 20 years, when there weren't really the sorts of compliance markets, let alone kind of serious compliance action in place by governments, voluntary markets were where the action was and it was where we tested, what are our mainstream approaches and indeed some compliance approaches to removing and reducing greenhouse gas emissions. So in that sense, voluntary markets were the leading edge and they still are in some ways the leading edge. I mean, you, while we are having discussions around the inclusion of, you know, re-mineralization, for instance of CO2 in compliance markets, this is mainly a voluntary market sort of area. So the voluntary market tends to lead the compliance markets and they do, because companies are wanting to show that they're on the cutting edge, that they understand these issues that they're willing to put themselves out there and actually make a contribution to making progress on climate change.

**Cameron Hepburn** (07m 02s):

And that tend the companies who want to do that tend also to be companies who want to push the frontiers and not just do what everybody else is doing. So they've had that characteristic throughout. I think they'll continue, certainly continue voluntary markets continue to have that characteristic today and probably will continue for some time to look a little different and be bit more cutting edge than the compliance markets. Of course. I mean, the relationship between them is complex and evolving. I mean, when you had no government action and no kind of compliance markets, there was no doubt that what you were doing in the voluntary space was in some sense additional to what was happening, you know, what would've happened anyway and if you take government action as part of the, what would've happened anyway, if governments aren't acting, then, you know, producing a voluntary offset is you can be more comfortable that what you're doing is genuinely contributing.

**Cameron Hepburn** (07m 54s):

Once governments do start to act and once, I mean, if we were to have a global capped, comprehensive, beautiful, elegant, you know, economist dream of a carbon deal, then you're in a sense, in theory, there'd be no space for voluntary markets because the whole thing would be covered and any voluntarily reduced ton would need to have a corresponding adjustment on the compliance side, which of course you could do and governments may well want to do, but they would sit less comfortably together, but I think you, we aren't heading towards an elegant, beautiful globally harmonized deal. So there is currently still, but not just space for the voluntary carbon markets, but a really important role and a growing role for those markets in, in the decades to come, not without caveats and not without risks, which perhaps will come to.

**David Greely** (08m 48s):

Oh, absolutely and it is fascinating, you know, as you said that the voluntary markets have been more of the leading edge for much of this and there seems to be a real sense that with the urgency, that many feel about climate change and the need to act now, it was almost a bit like, well, maybe government policy makers can't move quickly enough, so we need to find other avenues, but of course, in order for that avenue to be successful, credibility is key and I think that's been a real core issue in the voluntary markets, really both for people who want to use them and for people who are skeptical about them. You know, I think the credibility of the net zero commitment itself and of the actions being taken to keep it are essential to their success and, you know, if you're a CEO of a large corporation, that's made a commitment to net zero, you want to make sure that what you're doing is gonna be acceptable to the stakeholders whose pressure may have led you to make that commitment in the first place. I mean, you've spent a lot of time thinking through and working through these issues as you've talked about and have developed some principles about designing institutional level net zero commitments and judging credibility of actions, I would just love if you could walk through some of those. I know there are, I think there are seven of them maybe, you know, pick the highlights or happy to hear all of them. I'm sure you, you pick the number because they're all important.

**Cameron Hepburn** (10m 10s):

Oh, it's a good, good, lucky number isn't it, seven? No, no. There are, there are seven principles cause that's logically what, what made sense, but yeah, I mean those of you listening in who want more detail, then I'm, I'm not gonna bore you with them all here, but there's a paper in, in nature, climate change from a group of Oxford authors led by Sam Fankhauser on the meaning of net zero and how to get it right and there's also a set of Oxford offsetting principles, which you can find with a quick Google online that starts to get to some of these questions about what a credible set of offsets and a credible plan for net zero looks like perhaps to just highlight, as you say, a few of those items. What we are stressing is that getting to net zero, isn't about doing nothing for the next decade.

**Cameron Hepburn** (10m 59s):

And then starting to take some action and then gradually getting yourself there by 2040 or 2050. there's A reason we call this decade, the decisive decade and it's because we are a long way off track to where we need to be. If we're gonna hit the globally agreed goals at Paris of well below two degrees of warming aiming for one and a half degrees of warming and whether we can get there at all or, or not depends upon how we go in the next, you know, 9, 8, 10 years. So the first principle we put in our set of seven is that if you are serious about getting to net zero, you should be front loading that pathway. So, you know, not, not taking it easy for this decade, but going hard now and I think that's a really important one. The other important kind of piece as you point to is the integrity, particularly the integrity of the net part of net zero.

**Cameron Hepburn** (11m 55s):

So if you are a company or fund or an entity listening in thinking, okay, I want to get to net zero and I want to do it today or tomorrow. Then you're probably gonna be using a lot of offsets because you can't suddenly reduce your missions to zero today or tomorrow, but then you've got to ask yourself the question, how am I going to be procuring those offsets, what sort of offsets are they, are they avoided emissions, are they carbon removals that will go into the biosphere, so trees and soil management that, you know, perhaps won't stay there forever. Do, am I confident in the standards and the buffers that are in place to and insurance mechanisms in place effectively or do I want to go really full on and buy myself an offset that I can completely guarantee is taking CO2 out of the air and locking it up underground or, or combining it with rocks in a way that's just never gonna be released again.

**Cameron Hepburn** (12m 49s):

But then of course the costs of that are considerably higher and even if you are buying forestry based offsets or soil based offsets, and you think, well, it's not gonna be forever 50 years is pretty valuable. You know, if you can lock up your carbon in a tree for 50 years, and that buys us 50 years of time, you know, some of my colleagues at Oxford would disagree. We have heated debates about this, but my sense is that that's pretty valuable. Like a 50 year lag will allow a lot of these other clean technologies to come down the cost curve and it's just, it's super important and then I guess the final piece I'd highlight, so make it three out of the seven is that it would be a shame to put it mildly. If we were to address climate change and to trash nature at the same time.

**Cameron Hepburn** (13m 38s):

Now some of your listeners might be thinking, well, how could we do that, surely if we sought climate change, we're, we're fine, but no, it's only one of the challenges, one of the SDGs, the central development goals, and only one of the environmental challenges that we face and you could comfortably destroy an awful lot of biodiversity on land and in the oceans in order to achieve the climate goals.

Now, we don't want to do that. You don't want to stabilize the climate, but make the world either uninhabitable or not worth living in. So having a pretty close eye on the other human and environmental dimensions of the path to net zero is really important.

**David Greely** (14m 15s):

And when you, when you think through the principles and you look at companies, you've worked with institutions, you've advised, how do you see them doing overall, relative to those principles, are there certain ones that people need to work a little harder at?

**Cameron Hepburn** (14m 33s):

Yeah, so I mean the striking thing has been the number of companies and indeed countries who've added net zero targets in the course of the last couple of years. I mean, we're now in a position where, well, over 80% of the global economy in terms of GDP is covered by a net zero target, which is hugely impressive. It's actually where we need to be, to get towards below two degrees of warming. So if everybody now delivers on their net zero promises, we are okay. The problem as we've been discussing is that a lot of these promises look like just that at the moment, just promises because they're not backed up by a detailed plan by reporting mechanism, by a clear and structured approach with limits on the amount of offsetting. Because obviously if everybody says, we're gonna get to net zero and we're gonna pay somebody else to do it well, who is the somebody else who is being paid to do it.

**Cameron Hepburn** (15m 32s):

And we've been pretty brutal at Oxford on this point tracking companies and those of you listening and want have a look at zerotracker.net, you can see there's literally thousands of entities listed there. There's the 2000 largest publicly traded companies in the world listed there. They're all rated on, you know, is their plan detailed enough, do they have the right sort of mechanisms in place, what does it cover, you can type in your own company and see how it measures up and so that sort of transparency and, you know, slightly obsessive focus on delivery and integrity is where the game is now and, you know, I actually have said to several people, I think these conferences, climate conferences that we have the big ones every five years and, and kind of these intermediate ones every year, I think we should have an arrangement where every second year countries and companies come together to lift their ambition. But every other year we say, no new pledges are allowed, no new promises, no new anything. We just want you to report on what you've actually done in the previous period. And we want the accounting to be tight and the oversight and the transparency, the scrutiny to be tight because otherwise, you know, we can keep promising ourselves that we're gonna do something about this for the next 20 years and not actually do it.

**David Greely** (17m 02s):

So transparency, accountability sound like two of the big issues and it sounds like there's a, a lot of interesting things there. And we'll try to get out the, the zero tracker.net. That sounds fascinating. I want to look that up myself, in addition to credibility, you know, are there other elements that you see that these markets might be needing, what do you see going, right, what do you see going wrong. I know you're, it sounds like you're a little skeptical, at least towards the attitude that, you know, someone can't just think this is gonna be easy and if a CEO sitting and saying, well, it's gonna be hard for us to get to net zero. I'll just go buy some offsets. That's not gonna work. It's gonna be challenging. It's gonna be challenging for the person you're buying the offsets from to do credible projects that don't do environmental harm, but do environmental good and are transparent and verified and accountable. So I'm just curious when you look at the, the markets themselves and that piece that they have, you know, maybe what do you see going, right and what are you worried about?

**Cameron Hepburn** (18m 00s):

Yeah, great question. I'll start by saying, I'm, I'm hugely in favor of these kind of markets. As I'm said, when I had had my most aggressive interview on these sort of topics, I didn't make the shirt that I'm wearing. I bought it from somebody who was better at making shirts than I am. I'm not very good at making shirts. I'm not very good at most things, actually, I'm good at few things that academics are good at, and that earns me, my living and then I use the money to pay other people who are good at things to do the things that I need them to do and so markets allow that and so there's absolutely nothing wrong with saying, well, I'm not, you know, my core business, isn't reduced to reduce emissions. I'm gonna pay somebody else to go and sort that out for me.

**Cameron Hepburn** (18m 41s):

But having said that there is it's not quite charity begins at home, but, but you do have to take responsibility for, you know, for your footprint and that means both reducing it as much as you can in-house and probably beyond what is kind of narrowly economically sensible you know, so if you can buy an offset at say, \$20 a ton or something you, you might think economically well, we'll, we'll reduce, we'll cut our emissions up to the point at which it costs, you know, less than \$20 a ton and beyond that, we'll just offset. Actually I don't

think that's good enough in the current climate. You have to do really quite a lot and probably quite a lot of expensive steps to maintain your credibility. And then you just offset the stuff that's really hard to do at the back end.

**Cameron Hepburn** (19m 25s):

So there's that side of the puzzle. The, the other side of the puzzle is that offsetting, it's a bit of a dangerous business in, in the sense, I mean, well, let's go back 10 years. So about, about 10 years ago, we had a kind of boom and a bust in the voluntary carbon markets. It was a unifying experience for all of us involved in it, at the markets at the time and what happened was that there was a, a bunch of different reasons, but the markets were exploding in interest, huge amounts of capital coming in lots of new buyers, lots of new projects, but in that rapid growth, I think you know, collectively the ball was dropped on integrity and it only takes a few dodgy projects on the front page of the New York times or the financial times or whatever around the world.

**Cameron Hepburn** (20m 17s):

And then, you know, this thing that CEOs are paying for, which is supposed to bolster their brand and maintain their reputation is now damaging their brand. At this point, you say, well, hang on, why am I paying for this stuff, that's just making me look pretty rubbish. I'm being accused of green washing, let's cut this program and that's kind of what happened and I think there is a risk right now in the coming year or two or three with the explosion of interest, the explosion of players on all sides on the supply side, the demand side, you know, there will be dodgy projects out there and they will be highlighted by journalists because that's their job and that's what they should do and, you know, there'll be big companies who get caught looking pretty shabby here and hopefully we are not facing a risk of market implosion this time around because we don't have the time.

**Cameron Hepburn** (21m 13s):

You know, we don't have the space in, in climatic terms to have this crash and burn a second time round. But I think there is a real risk of that. So, you know, those who are listening in on, on the buy side of the offsets market, you've got a lot of due diligence to do and those of you on the sell side, you should recognize that. I don't think it's in. I think it's quite an important and subtle point. It's actually in your interests to expose the dodgy players proactively before somebody else does before the press does. Because if the market participants who are on top of integrity, if the project development firms who are doing this properly, they have an interest in the market, not imploding and they therefore have an interest in exposing and weeding out the dodgy providers early to give confidence to everybody else that this market is real, it's serious and it's worth engaging in.

**David Greely** (22m 10s):

Yeah, we, you hear that concern so much the, the risk of ending up on the front page of the newspaper when you're trying to do something good and it turns out so wrong. And I'm curious to pick your mind on, you know, it seems like the, the folks who wholeheartedly have made and want to keep these net zero commitments like their, their intention is to do the right thing. They're really looking for a standard they're looking for, if I do this, that people will say you did the right thing and we haven't gotten to that type of standard yet. I don't think, you know, you've pointed out some ways that can get us there by having people point out the dodgy actors and, you know, doing the due diligence and managing the risk of the projects you're working with. Is there something more of, you know, an overall market level that we can be doing to help kind of create a set of standards that, you know, both people can meet if they're honestly trying to meet them and people who are more on the activist side of the conversation will accept as that's a good faith attempt in line with the scientific concept of getting an at zero and we're happy.

**Cameron Hepburn** (23m 29s):

I hear you, David and, I get asked this all the time, just tell me what I need to do make it easy and I'll do it and hopefully it won't be too expensive and then we're done. And of course, you know, if you had a bunch of the standards organizations in, on, on the program, maybe you should, they would tell you why their standards are great and that's all you need. The voluntary carbon standard does the job or the gold standard is what you need and in a sense, you know, those guys have been around for a long time. They're good at what they do and part of the challenge I guess, is that there are multiple standards here in this. So it's not, not the we're lacking our standard. It's that we've got quite a lot of them and the, what they, what the sorts of levels of assurance that they provide.

**Cameron Hepburn** (24m 11s):

They don't guarantee that you're not gonna end up on the front page of the times because they're what they're guaranteeing is that various processes and procedures have been followed that they've been independently verified, that they've met some criteria that the standard set deem to be adequate, to show that, you know, it, the action was additional compared to a counterfactual and the problem is not with those bodies or the people in them. They're very good people and they're good organizations. There's just a more

fundamental challenge, which is that if you are paying for an offset relative to what would've happened, otherwise that what would've happened otherwise is, is called a counterfactual and the counterfactual is by necessity, not always, but almost always by necessity constructed, which is to say that it's kind of made up it's not to denigrate it. You, you can have very conservative counterfactuals, you can have aggressive counterfactuals, but there's a certain level of art in the process of working out the counterfactual for an avoided emission reduction now, okay.

**Cameron Hepburn** (25m 16s):

I, if you are taking CO2 out of the air, then you might think there's less room for art, but even in some of the forestry sequestration or soil or land related based projects, you've still got the question of, well, okay, what are the second and third order effects of this use of land compared to what other use of land may have been occurring, these are complex questions on top of the whole scientific question. I mean, there's a whole bunch of questions that we don't yet fully understand. It's not to say it's not great science, perhaps even adequate science, but about the way in which the soils hold the carbon or the root systems, hold the carbon, because it's both above soil, carbon storage and below land, ground carbon storage and you know, it's, it's complex. So there's very good science there, but it is complex.

**Cameron Hepburn** (26m 05s):

This is tricky. It's fundamentally tricky and then in the areas where you can perhaps have more confidence, like, well, we, we literally sucked this amount of CO2 out of the air. We reacted with a rock. It's now bound to the rock in the lowest possible energy state for a carbon I mean, it's not going anywhere. You, you can feel good about that, but that's, you know, currently very expensive. So I'm not here to come on your program and give you simple answers and if there were simple answers, we would've had them and they would've dominated 10 or 15 years ago. So quite a lot of judgment, unfortunately is still required.

**David Greely** (26m 39s):

I want to switch gears a little bit with you because you've also studied the role of innovation, not just technological, but also innovation in our social political and financial systems and because this is a complex problem and not an easy problem, it seems like the answer will likely involve not only technology, but changes in our social systems, our political and our financial systems. I heard you speak once on how under the right conditions, small changes can make a big impact to these systems. Really enjoyed that and I think many of us hope and expect that innovation and technology will play a big role in helping us meet the demands of climate change and making this large energy transition to a low carbon energy system that we're attempting less painful. What can we be doing to try to create the right conditions to foster the change in innovation that's needed to let smaller changes make bigger impacts because we have to have a pretty big impact given what you're saying,

**Cameron Hepburn** (27m 40s):

The conditions that enable innovation to flourish, I think we're in a much better place now than we were a decade ago because part of the, you know, the essential input in innovation is human brain power and actually we have had far too little human brain power devoted to thinking about solutions in this space and what I've seen over my career, you know, 20 years ago is virtually the only person at Oxford work in this area. There's now literally hundreds and it's fantastic to see so many smart people coming up with innovative ideas, whether it's shift to the different chemical processes that could change them from being net emitters, internet sequestering type activities, or, you know, the, the work going on up the road in the labs on Perovskite solar panels that are much higher efficiency, potentially a lot cheaper. But as you say, it's not just on the tech side.

**Cameron Hepburn** (28m 45s):

A lot of, I mean this is a really, really, really big transition that involves the rewiring of our entire global economy and as a result, a restructuring of, of many of the institutions, I mean, geopolitics will be restructured by this transition as well for obvious reasons. I mean, you can't look at the current landscape and say that it's not strongly determined by energy based relations between nations and just the gas crisis right now to take one example, but there're multiple different oil based relations. All of them were gonna be reconfigured in the course of the next 30 years and that is probably going to lead to a much better, well, it is gonna lead to a much better world, but I, but I fear there's gonna be quite a few bumps along the way. So to answer your question perhaps more directly, how, how do we create the conditions that give rise to the portfolio of ideas that humanity needs to bring to bear to this question?

**Cameron Hepburn** (29m 42s):

Well, it is all about people. That's not to say it's not about money because smart people, even though they do it for love, also need to be paid. My sense is that you get far more value for money by investing cash in. I mean, I guess I would say this given what I do so sorry

for speaking my book now, but putting money into clever people, thinking about ideas in this space tends to pay dividends and these ideas, as I say, they can be a new form of solar panel, but earlier this morning, I've just been in a board meeting in a fund in central London. Who's been leading the way on rethinking the auditing industry, the financial audits and how, how we're going in shifting the pressure on the big auditing firms to make sure that their audits and their financial statements are consistent with a Paris aligned scenario.

**Cameron Hepburn** (30m 39s):

And you don't have companies reporting assets on their books that are based on prices and use of fossil fuels. That's simply incompatible with what the world's governments have signed up to. So those sorts of interventions are actually fairly modest, you know, changes in accounting, rules changes in auditing rules, but they can trigger really massive changes in behavior. I mean, another example is changing the remuneration structure of the leading executives. If a big enough component of their remuneration is about how they manage these, you know, non-financial but of course, you know, they are big in their economic impacts. Non-Financial issues like achievement of net zero targets and other ESG related things. Then you can change behavior in a very big way or another point is how you organize the institutional architecture to deliver net zero within your country. So it's having a chat with colleagues in China earlier this week about how the UK's committee on climate change means that there is a much more credible regime in place for getting the country to net zero, that isn't dependent upon, you know, the whims of any particular prime minister or cabinet it's more structured and hopefully will help us to deliver net zero in a, you know, reasonably sensible way on time here.

**Cameron Hepburn** (32m 07s):

And so the Chinese are interested in, I mean, they've got their own similar sorts of institutional architectures, but we need such institutions all around the world to be, to be bolstered and to be more powerful. So it's a rather long answer David, to a question about innovation, but, but it is innovation across the board in, in social systems as well as in technology.

**David Greely** (32m 28s):

Yeah. And I wanted to take a quick step back, you know, when you brought up how, when you started in this, it was kind of you by yourself, interested in some of these issues from the academic standpoint, you know, where you were and now you've got, you know, hundreds of colleagues and I'm sure lots of students and I think that gives some, you know, hope that this isn't a fad. You know, when you kind of look at the chance we had in the, in the two thousands and things didn't play out and as you said earlier, now we need, we needed to work this time. I guess failure is not an option. When you look at, you know, the students that you're working with and the, and the colleagues you're working with, what gives you the most hope that we've got the staying power and the solutions are gonna come very much agree with you. You know, we like to say that, you know, give engineers and people time and money and they find answers. I was just, you know, curious when you look around, what, what, what gives you hope that, that we'll be able to work this out?

**Cameron Hepburn** (33m 21s):

Well, I think if there's one thing and, and it's not one thing actually is many hundreds and thousands of things. I look at the cohort of our new masters students at the Smith School at Oxford, which has been the most popular course in Oxford actually, which tells you something. So, you know, each of them individually gives me hope. But if I was to highlight one thing, it's that the cost reductions in the key clean technologies have been very consistent and reliable, you know, year on, year out, they come down in cost and it's felt to some people as though there's been a sudden breakthrough, but if you go back and look at the data series, the time series over 30 years or 50 years, it's very, very steady. It's a kind of drip, drip, drip of innovation in these technologies. That means it's not gonna suddenly reverse itself.

**Cameron Hepburn** (34m 15s):

At least it doesn't look that way and that's because of the multitude of people making, in some cases minor, in some cases, more major improvements to what is a scale manufacturing business that is heavy on IP and that's very different to coal-fired energy generation or oil and gas. I mean, those technologies also have very smart people working in them, but they're big, they're lumpy. You're not building millions of units, so you're not getting the same learning and the same scale economies as you do in producing millions of wind turbines or millions of solar panels and those curves tell you some pretty exciting things. So if you believed the international energy agency a few years ago, then when it did indeed at any point for the last 20 years, you'd get to the point of us, not really having a particularly clean energy system by 2040 or 2050.

**Cameron Hepburn** (35m 14s):

You know, there's not a lot of wind and solar on the grid, but if you take the sorts of rates of progress that we've had, and you simply project them as a statistically valid way into the future, then you find that clean energy completely dominates the world's energy system within the next 20, 30 years on its own, you know, on purely narrow financial grounds, not including the cost of climate change that are valuable, not including the avoided millions of deaths from air pollution. So ignore all of that and just say, which is cheaper. The clean energy becomes the dominant force in the system. So that's the single biggest thing that gives me hope and then if I was to add a kind of coder to that, I'd say that it's, there are signs that those sorts of economic dynamics in what is the clean energy space may be applying in some of the other key clean technologies where, whether it's around the food system or around the storage system or clean molecules. So, and, and if those dynamics then also are replicated in the other parts of this system, then you actually, we can really do this.

**David Greely** (36m 26s):

Thanks again to Cameron Hepburn from Oxford University. We hope you enjoyed the episode. Join us next week with Peter Zaman, a Lawyer and Partner at HFW based in Singapore, as we discuss all things related to Article 6 of the Paris Agreement where the compliance and voluntary markets connect.

**Announcer** (36m 51s):

That concludes this week's episode of Smarter Markets by Abaxx. For episode transcripts and additional episode information, including research editorial and video content, please visit [smartermarkets.media](https://smartermarkets.media). Smarter Markets is 100% listener-driven. So please help more people discover the podcast by leaving a review on Apple Podcast, Spotify, YouTube, or your favorite podcast platform. Smarter markets is presented for informational and entertainment purposes. Only the information presented on Smarter Markets should not be construed as investment advice, always consultant licensed investment professional before making investment decisions. The views and opinions expressed on smarter markets are those of the participants and do not necessarily reflect those of the show's hosts or producer. Smarter Markets, it's hosts, guests, employees, and producer Abaxx Technologies shall not be held liable for losses resulting from investment decisions based on informational viewpoints presented on Smarter Markets. Thank you for listening and please join us again next week.