Achieving a net zero economy in Japan and across the world

Speech by Adair Turner to the 4th Hitachi-Utokyo Lab Energy Forum

December 1st 2021

It's a great pleasure to speak at this fourth Hitachi - University of Tokyo Lab Energy Forum,

The theme of my talk today is "Achieving a net zero economy in Japan and across the world " and I would like to set out why at the global Energy Transitions Commission which I chair, we believe that achieving a net zero economy by mid-century is undoubtedly technically and economically feasible.

It is certainly vital, and the final agreed declaration of the COP26 conference which concluded in Glasgow 12 days ago, explained why.

The climate science, set out by the International Panel on Climate Change, tells us that we must limit global warming to well below 2°C and ideally to 1.5°C if we are to avoid potentially catastrophic harm to human welfare in many countries.

And the climate models show that to stay within those temperature limits, we will have to reduce CO2 and other greenhouse gas emissions to net zero by 2050 at the latest in all rich developed countries and by 2060 at the latest in all developing countries.

It is therefore extremely welcome that over the year running up to the Glasgow conference, almost all developed countries – including Japan – committed to achieving that 2050 net zero objective.

The challenge for Japan is now to determine the precise technologies and policies which will achieve that objective in Japan, taking into account Japan's specific national circumstances.

At the global level the key technologies which will get us to net zero are now clear. They do include a role for bioenergy, and a role for carbon capture and storage, but all major analyses – including both the work of the Energy Transitions Commission and the excellent Net Zero report published by the International Energy Agency earlier this year – make it clear that two technologies will be by far the most important – electricity and green hydrogen made from electricity.

The single most important priority, on average across the world, is to electrify as much of the economy as possible and to decarbonise electricity generation as rapidly and totally as possible – ideally by 2035 in all rich developed economies.

And in many sectors of the economy – in particular road transport and residential building heat – electrification will in itself deliver a huge increase in energy efficiency. An internal combustion engine inevitably wastes about 75% of all its energy input in the production of wasted heat, with only 25% converted into the kinetic energy which drives the vehicle: an electric engine by contrast can achieve over 90% efficiency

So we should electrify as much as possible, and at the Energy Transitions Commission we believe that on average across the world, the direct use of electricity will grow from today's 20% of final energy demand to as much as 60% or more by 2050 – with total global electricity use probably growing from today's 27,000 TW hours to 70,000 TW hours or more by 2050.

All that electricity must of course be produced in a zero carbon fashion ; and if 13 years ago, when I was the first chair of the U.K.'s official government Climate Change Committee, you had asked me how to decarbonise our electricity system, I would have talked equally about three technologies – renewables, nuclear and carbon capture and storage.

But since then the relative costs of these three different technologies have diverged quite dramatically.

- Solar photovoltaic electricity production costs have fallen about 90% in 12 years
- The cost of wind power , both onshore and offshore, is down about by 70%
- And batteries for use in electric vehicles or as a storage mechanism within the power system, now cost 85% less than just a decade ago, and will undoubtedly fall another 50% and probably much more in the next 10 years .

By contrast estimated costs for adding CCS – carbon capture and storage to fossil fuel power plants have not fallen at all and the estimated cost of new nuclear plants have increased .

The technology progress has been super rapid : the relative costs have changed dramatically: the facts have changed and I believe that when the facts change you should change your conclusions . Indeed over a longer period the change is even more dramatic. In the year 2000 , when Germany was first subsidising solar PV installations on roofs of homes and businesses , it paid a feed-in- tariff of 40 $cents per kwh : earlier this year in Saudi Arabia, a solar PV project won a power auction at 1 cent per kwh

At the ETC we now believe that in most countries, the cheapest way to produce electricity will be wind or solar, and that it will be possible to build electricity systems which draw as much as 75 to 90% of their power from renewable sources, with total system costs no higher than today's fossil fuel systems.

Of course the challenge in renewable electricity systems is not just how to produce electricity, but what to do when the sun doesn't shine or the wind doesn't blow – but here too technological change and dramatic cost reduction is transforming the optimal solution

- with batteries becoming cheap enough to provide an economic mechanism for balancing supply and demand over short periods, for instance day to night
- and green hydrogen made via electrolysis when electricity is in surplus supply, and burnt in gas turbines when renewable supply is insufficient, increasingly emerging as a vital and cost-effective technology

In most countries across the world, the good news is therefore that we now know how to decarbonise our electricity systems, and the costs are far lower than we dared hope 10 years ago.

We should therefore electrify as much of the economy as possible. But there are some sectors where electrification is impossible or likely to be prohibitively expensive.

You cannot electrify the chemical process of turning calcium carbonate into cement : and batteries would have to pack 6 to 8 times more energy per kg before we could imagine battery electric intercontinental flight, or battery-powered intercontinental shipping.

But even in these supposedly hard to abate sectors – in steel, cement and chemicals, shipping and aviation, it is now clear that there are technologically and economically feasible routes to achieve net zero emissions by 2050.

These are routes which the ETC described in our Mission Possible report in autumn 2018. And in many of these sectors green hydrogen will play a central role.

In the global shipping industry, there is now almost universal commitment to reach net zero emissions by 2050, and it is clear that ammonia made from green hydrogen will become an important shipping fuel.

And in the steel sector, hydrogen direct reduction has gone in only three years from being seen as a possible technology for the 2030s and 2040s to being a front runner for application in this decade.

- Arcelor Mittal, the world's biggest steel company outside China, is now committed to produce steel via hydrogen direct reduction in Spain in 2024,
- and in Sweden there is an entirely new steel company, backed by private equity and the capital markets – H2 Green Steel – which aims to challenge the traditional steel industry in the same way that Tesla has challenged slow-moving traditional car manufacturers.

At the Energy Transitions Commission, we can see a world in which total hydrogen production could grow from today's 100 million tonnes to over 700 million tonnes by 2050, and we believe that the vast majority of this hydrogen will be produced in the green fashion, because the cost of green hydrogen production is about to collapse.

The cost of electrolysers is being driven down by the same massive economy of scale effects which previously reduced solar PV panel costs, and by the end of this decade electrolyser costs will likely be 80% below today's typical levels , as low as $200 per Kilowatt of capacity , versus around $100) per Kilowatt until recently.

And across the world – in Australia, in Europe, in North Africa, the Middle East and in India, there are hugely well capitalised companies and projects committed to driving the cost of green hydrogen down from today's $5 per kilogram to below $2 per kilogram by 2025, and below $1.50 a kilogram by

2030. Indeed in India, the industrialist Mukesh Ambani is targeting $1 per kg by 2030, and the US Department of Energy has set the same objective.

So across the world what we now face is a technological revolution

A revolution in renewable power, in batteries, in green hydrogen production, and in many industrial sectors , far more rapid than any of us envisaged 10 years ago

A revolution which makes it now possible to meet those targets of net zero by 2050 at far lower costs than we then feared

But a revolution which also means that companies and countries must change to flourish competitively in a changed world, avoiding the risk that they get stuck in traditional energy technologies which are becoming uncompetitive.

That then is the global pattern ; what about Japan?

Well Japan is different. But of course all countries are different in some ways and we must always tailor specific approaches to specific national circumstances.

So the vital challenge for Japan as for other countries is to work out where there are really unique features and where perhaps there are past assumptions which must now be challenged in the face of global technological and cost trends.

In some ways Japan's differences will make decarbonisation easier than in other countries. Japan is almost certain to face a significant population decline – perhaps as much as 16% by 2050 on United Nation estimates – while the U.K.'s population will probably grow around 9%.

As a result while the UK will need to more than double electricity generation to support the electrification of the economy, Japan's electricity use might grow only 60%, from around 920 Twh today to around 1450TWH by 2050 – even if it electrifies as many sectors as does the UK.

This will reduce the scale of the challenge involved in building a new zero carbon power system.

But conversely Japan's high population density and its geography and climate, make it a relatively expensive location to produce renewable electricity whether solar or wind.

That certainly has been our assumption in ETC analysis.

- In the most favorable locations for renewables across the world – such as the Middle East or Chile – we see total future system costs for a renewable dominated power system at around $30 per mwh (3cents per kwh) , including all the costs of storage, back up and flexibility .
- In north west Europe the cost might be $60 per mwh
- But for Japan , and other space constrained countries, our initial estimate was around $80 per mwh .

And that may mean that the optimal power mix for Japan entails somewhat less renewables, and somewhat more nuclear, or fossil fuel plus CCS than we on average across the world. It may also mean that specific technologies – such as ammonia cofiring in coal-fired power systems -may have a role in Japan while being marginal elsewhere.

And if Japan's renewables always remain much more expensive than in other countries, that could mean that Japan will be a relatively expensive place to produce green hydrogen, and tip the balance of economics towards importing green hydrogen – from low-cost locations such as Australia – rather than producing it at home.

But while that may well be the case, it's not absolutely certain.

Because renewable cost may fall so much that even in relatively high cost Japan, they may become clearly economically advantaged.

There are credible forecasters who believe that by 2050 solar PV costs could be as low as 0.5 cents per kwh ($5 per mwh) in the most favorable locations , and as low as 1.5 cents per kwh ($15per mwh) in the least favorable

And while Japan is certainly constrained in its potential onshore wind and solar resource, it has an enormous potential offshore wind resource. The the IEA estimates that Japan's offshore wind resource at 5600 twh , which is almost 4 times the greatly increased amount of electricity which Japan will likely use in 2050.

And while offshore wind production costs are higher than onshore, particularly in deep seas such as those off much of Japan's coast, the technology of offshore wind production – including floating offshore wind – is progressing rapidly, with huge cost reductions possible.

The challenge for Japan, as it designs its own path to net zero by 2050 is therefore to keep drawing insights from the dramatic global trends in key technologies and costs, and to work out what implications they have for Japan's specific optimal path to net zero – a path which will undoubtedly have many factors unique to Japan but also many which will be common with other countries across the world.