“and they were talking about decarbonisation - what's your take on it like is it feasible or is it super expensive?”

For [redacted]

Why this is a nuanced question

There are three main (generic) variables related to the cost and feasibility in any future pathway or scenario for decarbonisation

- Technical & data limitations
- Ignorance of leadership
- Societal expectations/ Willingness to change

I want to preface this answer by highlighting one of the assessments of my degree involved writing a decarbonisation report for a country (Oman in my case). The module and that specific exercise is largely what my views are based on.

Decarbonisation of a country is a comprehensive exercise. In countries where heating is required, gas boilers are often a flashpoint in discussions. In countries where cooling is needed, that’s already electric so happy days just decarbonise the electricity supply right? What about emissions from the production of cement for that construction boom driving the economy? Let’s not forget international aviation and shipping is largely ignored by every country in national statistics.

Technical and data limitations

To fix a problem, you need to know what you are dealing with. Given the number of sources of anthropogenic carbon emissions in a country, it is an intensive data collection and statistical exercise to estimate the current state of affairs. What ends up happening is both gross under and over estimates of reality. Error bars are so large that frequently, aims can be “achieved” just through statistical manipulation. The IPCC takes a 6-7 years between releasing reports because of the insane amount of work hundreds of leading scientists have to do to make sense of noisy, incomplete, and overwhelming volumes of data. Many national governments and private sector companies do not have the expertise or money to be diligent.

Let’s look at the flip side, taking carbon credits as an example. Carbon trading has exploded in popularity in the last decade. It is a system whereby polluting companies and organizations can pay to preserve a patch of forest, or pay to replace wood-fired cookstoves with electric cooking ranges, and claim the future reduction in emissions from these activities against their own historic or future emissions. The problem with this is similar: in the interest of raising capital for projects, and in the interest of greenwashing, recipients and donors respectively have no interest in ensuring the long-term outcome of the activity is to indeed reduce emissions.

The case of forest conservation is plagued with multiple cases of land already under government protection from deforestation, but with base deforestation rates for calculation high, leading to non-existent credits being sold. Similarly, credits are sometimes sold but forests succumb

to natural or anthropogenic decay anyway. What then? Will accountants go back, write off the payment, and increase reported emissions? They aren't yet.

The case of replacing wood-fired open-range cooking was a project in India, where households were provided with a basic clay kiln like stove that still used wood, but improved efficiency by a factor of 3. It appeared to be a great success on paper, but a year long study on select households showed that recipients often just used this new stove alongside another wooden fire- thereby *increasing* total emissions. This was driven by a combination of a desire to cook faster (in parallel), and to fulfil repressed demand (as there was "leftover" wood to cook more food in parallel with old stoves due to a higher efficiency of the new stove). The recipients still benefit from eating better, or having more free time for leisure or education, but the aim of reducing emissions was not fulfilled and *this was only realised because someone invested time and money over a year to investigate.*

Finally, there are some problems where there are genuinely limited solutions currently. Aviation is a good example. Advances in biofuels and engine efficiencies and aircraft load factors have continually marginally reduced emissions per passenger-kilometre, but there is little we can do "tomorrow" even if we had unlimited funds to decarbonise the majority of the sector. There are ideas in place- I am a strong believer that hydrogen will be the future of clean fuels for aviation- but they are not technologically mature yet.

Ignorance of Leadership

In addition to the greenwashing mindset of many governments and private organizations, where little effort is made to actually optimise a solution, we seem to be picking the safe option every time – perhaps because that is where funding is available.

Take solar power as an example. I would bet £5 you thought of photovoltaics. PV makes up the majority of the solar energy market by a huge margin, and it is stunning how quickly prices have fallen and efficiencies improved. But what about concentrated solar power (CSP)? CSP is where there's a massive array of mirrors focussing sunlight onto a central tower, where a fluid is heated up and that then drives a steam turbine. They're obviously only worthwhile on a large scale, but on a large scale efficiencies can rival or exceed PV. Rooftops can continue to be dominated by PV panels, but why is it just Morocco and to a smaller extent the US that's invested in this for grid-scale projects? It's worth highlighting PV panels are very difficult to recycle, and many versions have multiple heavy metals including lead and cadmium. There is a significant environmental cost in addition to any emissions from the energy for manufacturing a panel. CSP uses mirrors and salt.

Societal Expectations/Willingness to change

I am currently working on a project looking at the impact on the electrical grid if UK heating was based on electricity rather than gas. I suggested we ignore anything beyond 3 sigma – the 0.1% coldest days in the last decade. My supervisor isn't yet convinced because he can't seem to accept the idea of energy austerity. Why do the lights always have to be on? Is watching the TV alongside staying warm really that important 0.1% of the decade when it's a challenge to cater to? And why the hell are we heating up rooms rather than people? To think how much energy could be saved if we all used actively warming sweaters and socks rather than trying to warm up 100m^2 around us.

Society has lived in a period of relative bliss since the 50s, once oil supply chain stabilised. The current cost of living crisis has had the co-benefit of reducing food waste as household attempt to extract more value from grocery shopping. That's wonderful in the context of reducing emissions.

When I worked on the report decarbonising Oman, I acknowledged that one of the biggest challenges in the (wealthy parts of the) middle east was to get people to ditch cars even if efficient public transport existed. To be fair, there are some technical challenges of maintaining comfort in the last mile in the intense summer weather – but even in winter, cycling and walking remains scant as favoured means of transport for short trips despite growing dedicated infrastructure for it in Dubai and Abu Dhabi. This has finally begun to change slightly with the cost of petrol doubling compared to the norm.

Is it feasible and economic to decarbonise?

Despite the cynical tone as I highlighted issues, there definitely is scope to decarbonise most of the world. It is in everyone's interest to do so because future costs to adapt will exceed current costs to mitigate, let alone the ethical impetus to do so to preserve current biodiversity. A strong step to raise capital for change and reduce emissions would be to put a global price on GHG emissions.

Technical limitations are overcome everyday through the contribution of every PhD and every private R&D laboratory. Increasing funding to relevant streams of research in the short term may offer a good way to accelerate the collection of detailed analyses, such as the one on stoves in India for carbon credits, that we need to make better decisions. Data limitations are similar whereby replacing assumptions with well-collected base line data is not impossible, just arduous and expensive. Like any task, with division of labour, this is achievable. Who better to estimate the emissions from aluminium milling than a factory with decades of operational expertise, with funding for monitoring and reporting through tax rebates? Up to a point, global collaboration will allow better estimates as a first step: if a factory in China conducts a life cycle analysis of aluminium tray, perhaps a factory in Finland can just adapt the analysis at a fraction of the cost for a reasonable estimate.

Ignorance of leadership is frustrating for anyone with a deeper understanding of the state of affairs. The "simple" solution is for those with savoir-faire (looking at the REaCT coursemates, for example) to force our way through to positions of control such that [redacted] can't become sustainability advisors in a company instead of more qualified personnel. If I had a way, I'd explain the benefits of CSP to the UAE power authority for free.

Societal expectations often change most quickly with economic forcing. Whether planned (through taxation) or unplanned (through rampant inflation), alternatives magically appear when business as usual becomes too expensive to maintain. The only issue remains wider-pictures and lifecycle impacts. A consumer today may be more inclined to buying an electric car looking at fuel prices. This will help with decarbonisation as the electric grid becomes cleaner, but what about the impact and leeching caused by mining lithium and cobalt for the batteries? We don't want to create another problem as we try and fix the GHG one.

Countries allocate entire single digit percentages of GDP towards military might. The military will not be able to defend anyone against climate change and sea level rise. The other thing to keep in mind is that we humans are still as selfish as ever. Society suddenly waking up to climate change and attempting to stop it is not (generally) driven by a sudden desire to ensure the welfare of the planet and biodiversity, but to maintain our own way of life. The planet and lifeforms will find a way, as always.

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