Don't look 'down'! Is NZ costing the earth?

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Hundreds of new mines will have to be opened up if we are to meet current plans for Net Zero (NZ). The world, in slowly moving from fossil fuel dependency to 'green' electricity as the dominant energy vector, is absorbing a high price for this 'clean' energy impacting the environment, biodiversity, local populations and resulting in the exploitation and dispersal of local communities.

The IEA makes clear that solar and wind farms, EVs, batteries, all require more minerals to build than their fossil fuel-based counterparts. An electric car needs six times the minerals of a conventional car. Onshore wind needs nine times more mineral resources than a gas-fired plant. Since 2010 the average minerals needed for a new unit of power generation capacity has increased by 50% as renewable energy use has risen.

Total mineral demand from new EV sales by scenario, 2020-2040

Chart 1; Source: Mineral requirements for clean energy transitions – The Role of Critical Minerals in Clean Energy Transitions – Analysis – IEA

To save the planet the current NZ plans effectively mandate opening almost 400 new mines with recycling only reducing the need for new mines by around 20%.

So whilst we drive around in our ever heavier EVs, we are in fact continuing to deplete vital resources and along with it the planet's biodiversity. And whilst the Department for Transport focusses on 'zero tailpipe emissions' in the UK, this simply allows for vast offshoring of emissions, and the spawning of a newly coined term, 'Climate Imperialism'.

By contrast, hydropower and bioenergy have low mineral intensities accounting for only about 2% each of the total demand for copper from low-carbon power additions in 2040 with this article considers bioenergy in further detail.

Biomethane, with a volumetric energy density 4.7 times greater than hydrogen, has been effectively dismissed by the Climate Change Committee in the UK in its Technical note of 2016 stating, *'biomethane could be used to displace some … natural gas to offer … significant savings, but **in the long term supply will be limited** and there will be competition from other sectors.'*

And the CCC certainly dismissed the potential for biomethane use as a means of reducing carbon dioxide emissions in transport stating:

'…our assessment suggests that the total biomethane resource is likely to remain significantly lower than total natural gas demand, such that any increase in demand for gas from HGVs would be met by fossil natural gas at the margin.'

Whilst low-emission hydrogen is a rare gas, according to the IEA, amounting to less than 1 Mt in 2021, practically all of it coming from plants using fossil fuels with carbon capture, utilisation and storage (CCUS), this does not prevent hydrogen being targeted for substantial growth. This, even though green hydrogen is currently hugely expensive in monetary and energy terms, estimated at

Euro 500 per MWh to produce in comparison with biomethane, estimated at between 65-100 Euros per MWh, according to the Financial Times (Lex, 13th February 2023).

The Swedish, in comparison, have recognized that biomethane represents one of the lowest greenhouse gas intensive pathways when the whole emissions lifecycle is measured. They have outlined their concerns that, '*when nations implement bans on internal combustion engines to cut the use of fossil fuels, they are also blocking the way for biomethane in transport. Instead, legislation should stimulate the deployment and availability of renewable fuels….And CO2 emission performance standards should consider the whole lifecycle, not just what comes out of the vehicle's tailpipe."*

By blocking sales of combustion engines from 2030, costs will escalate as supply chains are reinvented, along with maintenance and servicing skills, with many jobs lost in what is hardly likely to be a 'just transition': 500k supply chain jobs are forecast to be lost in automotive alone. Not only is the green hydrogen used in running a fuel cell expensive, but an 80-100kw fuel cell costs around $60,000 compared to perhaps $1,500 for a similar sized combustion engine run on petrol or even on biomethane.

New Scientist analysed the UK's Carbon Budget Delivery Plan outlining five 'big bets' being made by the UK government if we are to reach NZ by 2050. The five bets account for 40% of emissions cuts if delivered. All involve heavy dependency on electricity in powering up the economy. They include:

- Decarbonising power by 2035; at present renewables generate over 40% electricity, targeted capture over 100MtCO2e between 2023 – 2037
- Creating a market for 'greenhouse gas removals' including CCUS, due to capture 117MtCO2e between 2033-37, currently amounts to 0.54MtCO2e, with some experts calling these predictions 'speculative'
- Decarbonising steel production by 2037 – although no 'green' steelmaking has been trialled at scale to-date
- Mass deployment of heat pumps to eliminate 14% emissions from heating UK homes (this requires a jump from 55,000 heat pump installations in 2021 to 1.9m in 2035)
- Electric car use with an impending ban on sale of new petrol and diesel cars from 2030. 265,000 EV sales were registered in 2022 and there are now over 735,000 battery-electric cars on UK roads, plus a further 480,000 plug-in hybrids. LGA anticipates the number of EVs and hybrids could reach 25.5 million by 2040. National Grid is looking at the challenges of keeping 36 million electric vehicles on the move by that date.

All these targets and predictions require vastly increased dependency on electricity. Even in steel making it is anticipated that emissions will be cut through electrifying this process as well as introducing some hydrogen-powered iron-making.

WMCA has previously estimated that if every car in the region converted to electric power it would take three times the existing power used in the region just to power these vehicles.

Government is projecting a 50% increase in electricity demand by 2035, with the targets for low-carbon power generation having been increased in the Energy Security Strategy launched in May 2022, aimed at reducing dependency on Russian oil and gas, in contrast to previous targets in the Energy White Paper.

Chart 2; Source: Where will Britain's future energy supply come from? (parliament.uk)
Previous policy target capacities: Energy White Paper. CCC target capacity: CCC (PDF) for solar and wind, CCC (PDF) for nuclear. Current capacity: ONS (for wind and solar), ONS (for hydrogen and nuclear). Capacity in gigawatts (GW).

As can be seen, the government have increased offshore wind energy targets almost fivefold by 2030. No further role is anticipated for onshore wind, solar PV electricity production will increase five times by 2035. Hydrogen output will increase from zero to 10GW by 2035 and nucler will increase over three times in the period to 2050.

Off shore wind generated around 45% of electricity over the past year, solar around 4%. Whilst these technologies are working well, in part thanks to Britain's position in the north-east Atlantic where we host some of the world's largest offshore wind farms, these on-off technologies do still require some balancing and energy storage will certainly be needed. This is where biomethane can usefully add to the mix, and at affordable prices. However, to do this, the UK will need policies that incentivise investment in biomethane production, ones which also recognise that emissions are whole-life matters, not simply at point of use. Doing this would facilitate keeping the gas grid open to homes, providing another cost-effective home heating option, especially given current costs for installing heat pumps.

The IEA reports contain details assessments of the mineral requirements of green energy options. Wind turbines typically contain around 8,000 parts requiring: concrete, steel, iron, fibreglass, polymers, aluminium, copper, zinc and Rare Earth Elements (REE).

The mineral intensity of each depends on the size of the turbine. Around 85% of the turbine can be recycled but the blade is a challenge with the mixed nature of the materials used making it very difficult to separate the plastics from the fibre glass for recycling and with the strength of the blades making them physically challenging to break apart. This means they are mostly currently disposed of at landfill sites.

Copper demand is projected to grow from 217 kt in 2020 to 600 kt per year by 2040 in line with sustainable development goals. Offshore wind requires greater cabling and accounts for almost 40% of copper demand from wind.

The expansion of solar power increases demand for chromium, copper, manganese and nickel by eye-watering amounts according to the International Energy Agency, (IEA),. Between 2020 and 2040 chromium demand grows by 75 times (to 91 kt), copper by 68 times (to 42 kt), manganese by 92-fold (to 105 kt), and nickel 89-fold (to 35 kt).

The IEA projects potential world shortages of lithium and cobalt as early as 2025 unless sufficient investments are made to expand production. Lithium use is set to increase at least 40 times by 2040 to support battery production. With anything between 400,000 -2m gallons of water required for each tonne of lithium produced, these mines are already impacting severely on local environments, biodiversity, displacing indigenous peoples, with the IEA projecting at least 300 new mines will be required during this period.

China (PRC) is the leading player at all stages of rare-earth production, holding over a third of the world's largest rare-earth reserves and has even greater dominance downstream in rare-earth

minerals processing, controlling over 85% of rare earth processing supply chains. PRC provides nearly 98% of the EU's supply of rare earths. They control more than 80% of all manufacturing critical to the production of solar panels, and could produce more than 95% of the world's polysilicon and wafers in the near future, according to an IEAreport. With the largest polysilicon makers based in China's Xinjian Uyghur Autonomous Region participating in a forced labour program operated by Chinese government, the U.S. Customs and Border Protection has banned imports of silica-based products made by Hoshine Silicon Industry Company, as well as goods made using those products.

Annual mineral demand from renewable technologies by scenario, 2020-2040

Chart 3; Source: Mineral requirements for clean energy transitions – The Role of Critical Minerals in Clean Energy Transitions – Analysis – IEA

The EU, in switching out its dependency on Russian fossil fuels is increasingly looking to rely on minerals from China. There's been a steep rise in Chinese solar panel exports to Europe rising in value from January to August from $7.2bn to $16bn.

Chart 4; Source: EU reduces Russia energy dependence, adds China solar reliance (qz.com)

The EU's Critical Raw Materials regulation, introduced earlier this year, aims to reduce the block's dependency on imported materials from, 'quasi monopolistic third country suppliers', setting voluntary targets for one-tenth of Strategic Raw Materials (SRMs) to be extracted within the EU, compared to around 3% at present. The Commission estimates up to €20 billion is needed to support the raw materials sector's growth. They also introduce the idea of a 'CRM Club', "bringing together consuming countries and resource-rich countries to foster sustainable investment in producing countries and allowing them to move up the value chain".

The Europeans have also set the goal of increasing biogas output by fivefold to 2030 increasing output to 35bcm along with providing incentives for upgrading biogas production to biomethane. A Biomethane Industrial Partnership has been established as biomethane is recognised as the cheapest and most rapidly scalable renewable gas available today.

With biomethane produced from organic wastes – plants, including seaweeds, human and animal manures and food wastes, there is a real opportunity to harness this as the only circular economy naturally occurring energy source. During 2016-2019 the EU-27 and UK generated over 1.4 billion tonnes of manure from animal farming with over 90% of this directly re-applied to soils as a fertiliser leading to methane emissions. However, analysis of the biogas potential for manure by Scarlat et al., (Renewable and Sustainable Energy Reviews. 2018), estimated this to be 26 billion cubic metres, or nearly three quarters of the current EU's biogas target of 35bcm to 2030, all from just one readily available organic waste material source.

It is sobering to consider that over 40% of developing country's greenhouse gas emissions are due to export production for developed countries, according to the "Summary for Policymakers" of Working Group III on *Mitigation* in the IPCC's Sixth Annual Assessment, details of which were (conveniently) removed from the final report. In addition, IMF research indicates that through both explicit subsidies, (undercharging for supply costs) and *implicit* subsidies, (undercharging for environmental costs and foregone consumption taxes), global fossil fuel subsidies totalled $5.9 trillion in 2020 alone and are expected to increase to 7.4 percent of GDP in 2025.

Size of Fossil Fuel Subsidies US$ Billions
Chart 5; Source: Fossil Fuel Subsidies (imf.org)

With current estimates suggesting the UK government's policies would only cut UK methane output by about 14%, by 2030 compared with 2020 levels, falling well short of projected 30% methane emissions cuts pledged as part of the Methane Pledge signed by 150 countries, it is time to look again at how we can act now and act effectively.

We can save the planet, there is finance available and we have the technologies. We need to divert them to the least invasive energy vectors – of which biomethane is clearly one. We need to move funding into scaling up production of this renewable green gas, as the EU envisages, and we need to do this at once if we are to save the planet from the next big threat – the rollout of vast quantities of mineral mines.

References:

Lex, Financial Times, 13th February 2023

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