NEWS FEATURE:

Coming clean

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Often viewed as the fossil-fuel industry's spotless neighbour, renewable energy's association with a 'dirty' activity is intensifying. Renewable energy companies need to disclose more about their heavy reliance on mining.

Ambitions for renewable energy are high. Countries in the developing world have cottoned on to building renewable micropower plants to cut costly fossil-fuel imports and increase rural electricity access. Industrialized countries hope to slash emissions. Prices of solar photovoltaic cells are falling, inspiring great optimism. Out of the world's 193 countries, 144 had set targets for renewable energy deployment by early 2014, up from 138 the previous year[1]. They range from the tiny Caribbean island of Grenada targeting 20% renewable energy by 2020, to Germany's aim for 60% by 2050.

But this promise ignores a flip side. Mineral requirements for new renewables are likely to contribute to fresh environmental damage, while mining constraints could obstruct planned emissions cuts. That dilemma emerged in 2009 when China suddenly shut down its exports of rare earth metals, which are used in wind turbines. Substitutes were found, so the scare has passed but geologists at CNRS, France's science research centre, have drawn attention to an inconvenient problem relating to a whole range of metals.

"A shift to renewable energy will replace one non-renewable resource (fossil-fuels) with another (metals and minerals)," claims Olivier Vidal, an Earth scientist at the CNRS, in a recent paper[2]. Vidal notes the massive increase in metals and minerals needed for the world to fulfil aspirations to cut greenhouse-gas emissions. He estimates that 3,200 million tonnes of steel, 310 million tonnes of aluminium and 40 million tonnes of copper would be needed to build the latest generations of wind and solar facilities. Based on a 2050 100% renewables scenario by NGO WWF[3], these projections exclude metals demand from electric vehicles and other transport. The steel requirements compare with 1,649 million tonnes of crude steel produced in 2013[4]. Vidal's investigation indicates that the metals required correspond to a 5–18% annual increase in global production for the next 40 years.

The European Union 2050 energy roadmap[5] notes that an EU 80–95% greenhouse-gas emissions cut by 2050 means sourcing two thirds of energy from renewables, altering the above estimates. To this rise in production would be added the accelerating global demand for ferrous, base and minor metals from developing and developed countries.

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"The increase in aluminium, copper and iron production needed for the construction of solar and wind facilities to 2050 will be similar to that driven by all industrial sectors between 1970 and 2000," says Vidal. One of the problems is a metals lock-in lasting 20–30 years as new wind farms and solar plants now being built cannot be quickly recycled. For instance, just 1% of all photovoltaic modules have reached the end of their 30-year lifetime. Yet the coming period coincides with a major leap in renewable energy construction, much of which will depend on virgin materials.

Given these startling numbers, it is easier to visualize renewables' demand for less common metals. Solar photovoltaic cells, which use silver for a conductive paste, will consume 109 million ounces of the precious metal in 2018[6] in a market predicted to grow by 27% by then. This is 16% of total industrial demand for silver, forecast at 680 million ounces in 2018, the largest for any individual industrial sector. Industrial demand constitutes about half of the silver market. Solar photovoltaic cells compete for silver with the automotive and battery sectors, among others. Meanwhile, about 60% of copper available is used to conduct energy through any type of energy system, because it is the best metal conductor for electricity and heat.

Making sense of this, of course, demands knowledge of supply sources and volumes. Only the crisis in availability of rare earth metals shocked manufacturers into realizing their level of dependency on monopolized metal sources. For instance, China is the world's largest source of rare earths (97%) alongside 83% of gallium and 58% of silicon — all used in renewable energy. Chile is responsible for 44% of lithium, used in batteries, and 31% of copper production[7].

Greater awareness of these limiting factors explains doubts about producer ability to fulfil targets by sourcing raw materials when they need them. Copper is an especially critical case, and considered relatively scarce with only 60 years of availability remaining at current production levels[8]. Copper in existing installations may take decades to be recycled and is likely to use increasingly intense amounts of energy.

Mathijs Harmsen, formerly of Utrecht University's Copernicus Institute of Sustainable Development, foresees greater resource pressures on the metal in future: "the gross energy requirement of copper in a 2050 100% renewable energy system will be a factor 2–7 times larger than it is today…Because of an increasing in-use stock of copper, recycling will play a relatively small role even when the recycling rate is high," he states.

Recycling will be limited for many of the major materials. According to Olivier Vidal, the cumulative amount of concrete, steel, aluminium, copper and glass sequestered in wind and solar facilities in 2050 will be two to eight times 2010 world production. Cable infrastructure is a particular concern, as he explains: "copper is needed for high voltage cabling on the sea floor, and there is no

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Chilean copper mine.

technology for recovering that yet. Even if the technology did develop, it can be too expensive to recycle. It's a very tricky issue," he says. Estimates indicate that at least 40,000 kilometres of new high-voltage lines are required offshore in Northern Europe by 2030[9].

Of course, any industrial company can manage resource limits, if it has enough control over the market. Energy and metals expert Chris Berry, of consultancy House Mountain Partners, draws attention to the potentially weak position of renewable energy companies today. "It's not that we'll run out of copper but that we'll run out of cheap copper," he says. In a competing situation with prices rising, the players with the most muscle are bound to capture the market, yet many renewable energy companies are still quite small and technology-driven.

"How resource scarcity is played out is regardless of whether you are dealing with renewable energy, the big guys that have scale and deep pockets can weather the volatility and higher prices. They have the negotiating power," says Berry. The constriction in the supply of rare earth metals illustrates the point, as smaller companies went bankrupt. Reasonable predictions for some metals are possible using futures market indicators. But public prices are not available for some substances, such as rare earth metals, graphite and lithium.

In unstable circumstances, renewable energy companies need to consolidate with big industrials to stand a chance against ICT and other global manufacturing and technology brands. Alstom, GE, Siemens and others have also joined the renewables sector. They could use their influence to both disclose more and demand more data about mineral supply.

Greater transparency would allow companies and policymakers to plan more easily and assess new supply. But mining, like oil and gas, is an obscure industry plagued with data uncertainties. Undiscovered resources can, of course, only be guessed at, while competitive secrecy creates procurement headaches. Companies on stock exchanges are obliged to list their reserves according to a hierarchy of certainty.

"The more drilling a company does, the more certain you can be about the claims they are making about the size, grade, and overall composition. It's never a sure thing, but the more you drill, the more you know," says Berry. But Vidal is more sceptical. More data could be provided by the industry, he suggests they sometimes publish unreliable or less than comprehensive information, or nothing at all." Meanwhile, national geological survey data are incomplete, and leading scientists calling for improved metals inventories.

At the same time, buyers and planners all over the world face a big hole in international data. "One of the things that make data difficult to rely on is China. I'm fairly confident of the data apart from China. People don't know what's in there, and no-one can be sure of the state of reserves; it's difficult to know what they are doing. Why would they let the world know they are running out of ore?", asks Berry. Other intelligence holes are the 'unknown unknowns' — the mineral resources hidden in the most remote locations, such as under the planet's oceans.

Among the most worrying unknowns is the future environmental impact of renewable energy. Mining waste and land grab are the most obvious problems it may contribute to. Undersea mining could be the most disturbing. According to Vidal, existing mines are likely to be put under greater pressure. "The discovery of new mineral resources is not increasing with time, so mines are lowering the ore grades they extract to increase their reserves. If you decrease the ore grade to increase your reserves, you can access more but this has a negative environmental impact," he says. Copper is especially affected by this problem. To assess environmental impacts, mining companies need to reveal more about their operations. "We need data on the ability of the mining industry to increase production while keeping [the number of] mines constant," he observes.

Innovation will reduce some of these impacts, or at least alter the criticality of particular metals. Copper, for instance, could replace silver: "it is a cheaper substitute to silver. I can foresee the renewable energy industry using a lot more copper than almost any other metal," suggests Berry.

New devices would alter the demand for minerals per watt of power produced. One example is the development of floating wind turbines, which use less material. Another is the possible substitution of lithium batteries with newer generations using different metals. A third innovation is in production technology, as when fracking was introduced for gas extraction.

Not surprisingly, the carbon footprint of renewable energy is good, and lifecycle analyses consistently rate it less polluting than competitors. "The renewable energy produced from a wind turbine can offset the emissions discharged for the construction of that turbine within six months," points out Oliver Joy, spokesman for the European Wind Energy Association. "The 1.4 million tonnes of steel used by the wind industry in 2011 accounted for just 0.8% of European steel consumption that year and the demand for resources pales in comparison to the raw materials needed in other sectors such as the automotive industry," he adds.

A 2014 study[10] on overall green impacts is also positive: "material requirements per unit generation for low-carbon technologies can be higher than for conventional fossil-fuel power generation: 11–40 times more copper for photovoltaic systems and 6–14 times more iron for wind power plants. However, only two years of current global copper and one year of iron production will suffice to build a low-carbon energy system capable of supplying the world's electricity needs in 2050," says Edgar Hertwich of the Norwegian University of Science and Technology.

The scarcity of these types of investigations is surprising, though. Studies on mining and renewable energy are few. The Hertwich research is the first holistic global analysis of the environmental impacts of renewable energy. The EU first began to examine metals and minerals availability in 2010 in its Critical Raw Materials Review[11] aimed at the whole of industry.

At the same time, upstream material impacts are absent from many major EU policy plans like the Energy Roadmap 2050, as well as from low-carbon industry annual reports. Instead, their sustainability discussions focus on the consequences of wind farms and solar plants on land selected for the facility. Alternatively, they describe industrial injuries, health or safety.

Chief executives all over the world have trouble understanding their supply chains. Renewable energy companies growing into industrial giants could also lose touch with theirs. Like the rest of industry, the sector does not report on upstream impacts, nor are environmental externalities or costs included in payback calculations, profit/loss or balance sheet figures. Innovation that the renewables sector benefits from does not always integrate ecological criteria.

Unlike the rest of industry, the existence of the renewable energy sector is founded on green values. Since their mining dependency is only going to increase, renewable energy businesses need to open up and take the lead on metals disclosure. ❒

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