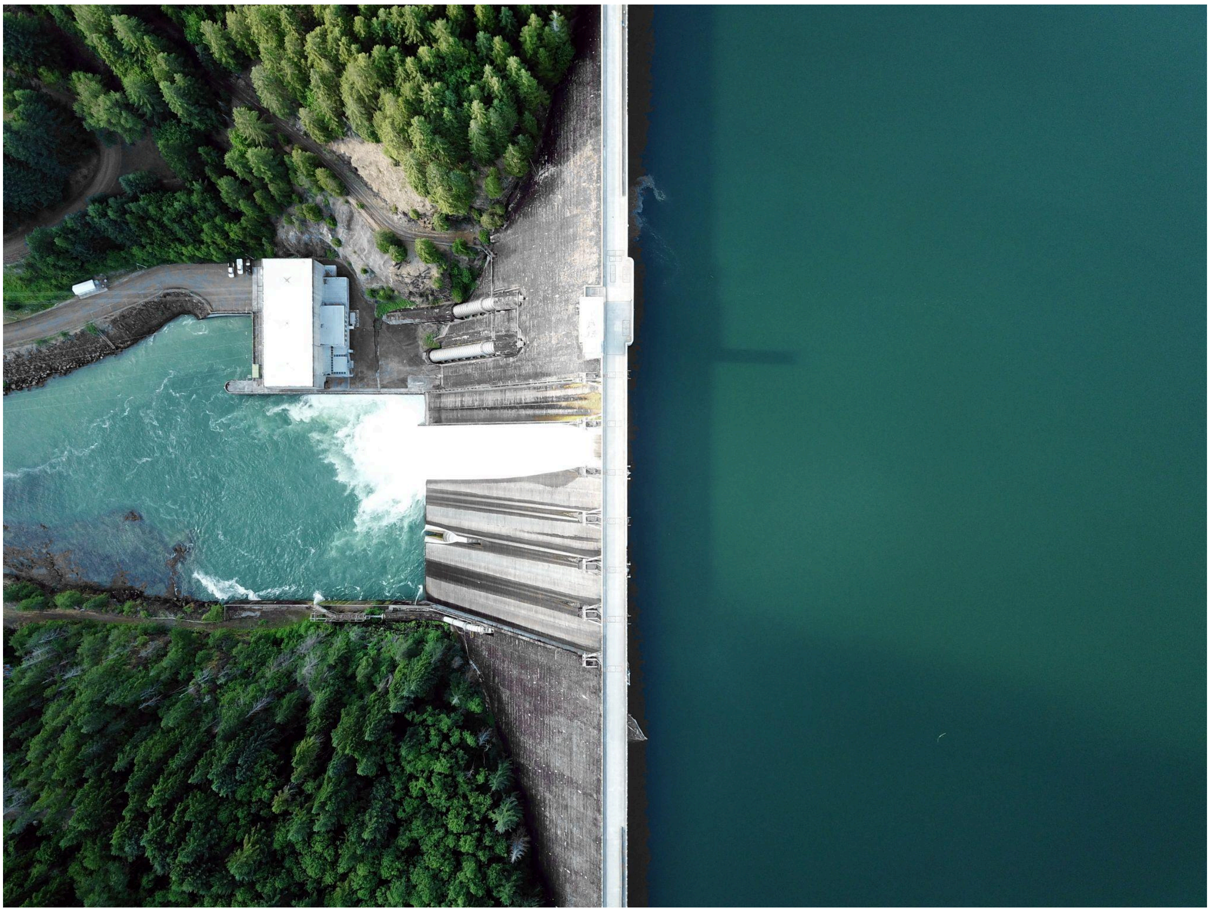
October, 2023

Green Growth versus degrowth

The case of green hydrogen



Sofie van Knippenberg
Rethinking Economics for the Real World

WAGENINGEN
UNIVERSITY & RESEARCH

Introduction

July 2023 was the hottest month on earth ever recorded (WMO, 2023). Antarctica is likely warming at nearly twice the rate of the rest of the world, having lost around 40% of its ice shelves since 1997 (The Guardian, 2023). By 2050, over 200 million people are projected to be displaced due to climate change (World Bank, 2022). Yet even if climate targets set to date are fully achieved, the world will still fall short of bringing global energy-related carbon emissions to net zero by 2050 (IEA, 2023). Considering the urgency of the climate crisis, policy makers world-wide are focussing on the development of renewable energy sources to reduce the economy's dependence on fossil fuels. For the European Union, strategies for decarbonising the energy supply are laid out in the European Green Deal. Within these strategies, hydrogen is key in reducing fossil fuel dependency in sectors such as heavy industry and transportation. When produced sustainably, hydrogen has an edge over other renewable energy sources to decarbonize hard-to-electrify industries. Meeting the EU target of net-zero emissions by 2050 therefore depends heavily on the successful integration of hydrogen into the energy supply. This makes hydrogen a prominent technology to achieve a green growth future, whereby economic growth is decoupled from environmental impacts.

Degrowth challenges the possibility of green growth.[1] In a nutshell, degrowth scholars argue that economic growth cannot be decoupled from material use, and they highlight the link between ecological impacts of material extraction and social inequality. Instead of promoting green growth ideas, degrowth policies aim for a deliberate reduction of consumption through the downscaling of certain sectors in the Global North, which will likely lead to a decrease in economic growth. Degrowth is therefore not about reducing GDP, but rather about reducing material and energy throughput (Hickel, 2020). Current degrowth research on green hydrogen is limited, but considering that the EU's ambition to reach net-zero by 2050 stands or falls with hydrogen, a deeper inquiry is necessary. This paper will therefore analyse the role of hydrogen in the European Green Deal and the degrowth critique against this strategy.

[1] The academic discourse knows many misconceptions about degrowth. For this paper, I follow Hickel (2020) in this definition where degrowth is "a planned reduction of energy and resource throughput designed to bring the economy back into balance with the living world in a way that reduces inequality and improves human well-being."

Hydrogen as an alternative to fossil fuels

In 2022, more than 80 percent of global primary energy came from fossil fuels. Despite the share of renewables increasing over time, as energy demand keeps rising, this increase in renewables has not substituted for the use of fossil fuels but rather added onto the energy supply. As *Figure 1* highlights, the increase in consumption of solar and wind energy was not paired with a reduction in consumption of fossil fuels. On a global scale, the absolute consumption of coal, oil, and natural gas still shows an increasing trend. Some therefore say we are not seeing an energy transition, but an *energy addition* (Rammelt, 2023).

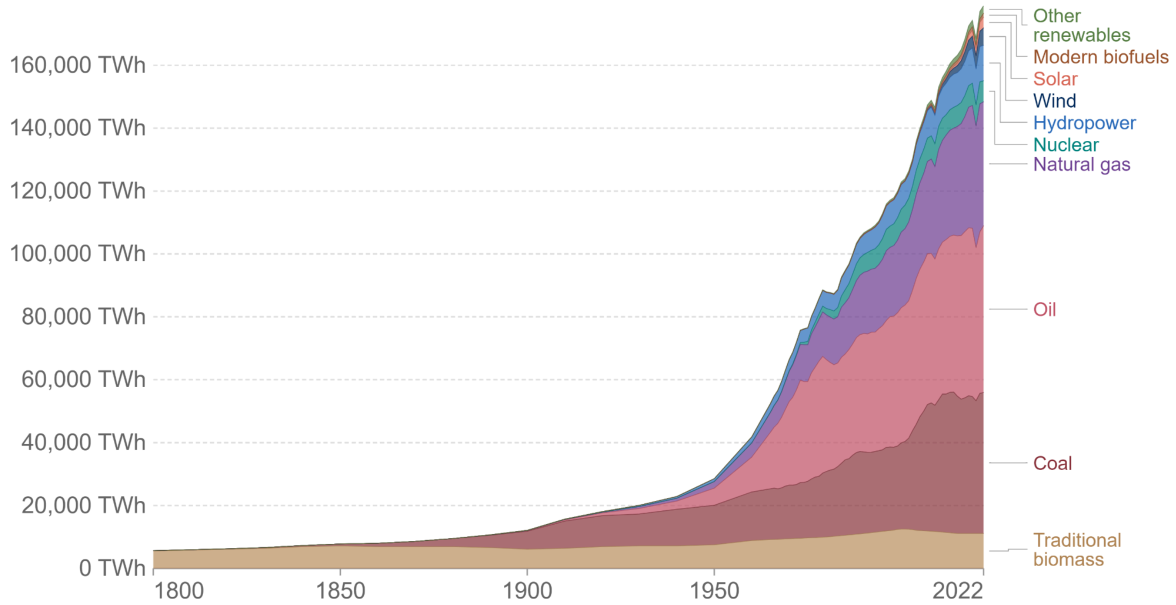


Figure 1 - Global primary energy consumption. Source: Our World In Data.

There are different theories on why fossil fuels are still so dominant, relating to path dependencies, technological lock-ins, and the institutional inertia protecting the status quo (Blondeel et al., 2021). For the comparison with hydrogen however, two characteristics are key, namely the logistic and economic advantages. Basically, fossil fuels are relatively cheap to produce and easy to transport. This gives them an edge compared to current low-carbon and renewable energy sources. To effectively replace fossil fuels, alternatives should not only be cost-competitive, but also possess logistic capabilities to transport and store energy. These characteristics are especially important in sectors that are difficult to electrify, such as heavy industry and transportation. This is where hydrogen has an edge over other renewable energy sources, since it does not require batteries for energy storage (Squadrito et al., 2023). Once produced, hydrogen could be transported in similar ways to natural gas, through pipelines, or stored and transported in liquid form, similar to LNG in tanks. In this way, hydrogen could be stored to compensate for the fluctuations in the RES supply (Noussan et al., 2021).

There are different colour classifications for hydrogen depending on how sustainably it is produced. The three most common types are grey, blue, and green. Currently over 95 percent of all hydrogen supplied is considered to be grey hydrogen, meaning that the energy used in the production process is sourced from fossil fuels (IRENA, 2022). This results in a substantial CO_2 footprint that is not compatible with net-zero targets. Blue hydrogen is produced in a similar way to green hydrogen, but paired with carbon capture and storage technologies to compensate for the emissions (Noussan et al., 2021). The sustainability of this process therefore depends heavily on technologies that are not yet possible at the large scale that is required. Due to the requirement of fossil fuels in the production process, there is debate on whether blue hydrogen can be classified as sustainable, or low-carbon. In the production of green hydrogen, renewable energy sources provide energy for water electrolysis necessary to obtain hydrogen. It is considered sustainable because unlike the other production processes, it does not create any greenhouse gas emissions as a byproduct (Squadrito et al., 2023). Considering the sustainability benefits of green hydrogen, it is often considered a promising alternative to replace fossil fuels, especially in sectors of the economy that are difficult to electrify such as heavy industry and transportation. The importance of green hydrogen is also evident in the EU Green Deal.

Green hydrogen and the EU Green Deal

Hydrogen has a prominent role in the EU ambition to become net-zero by 2050. To achieve this, the EU Green Deal was created, presenting different strategies aimed at reducing Europe's dependency on fossil fuels. But where many parts of the economy can be decarbonized through electrification, two large polluting sectors, heavy industry and transportation, are considered difficult to electrify. Currently, transportation is responsible for around a quarter of EU emissions, and the combined heavy industries of metals, minerals and chemicals contribute to around 20 percent of EU-wide emissions (ICCT, 2021; EEA, 2022). In the policy document "A New Industrial Strategy for Europe", the focus lies not on reducing the size of these industries, but rather becoming a market leader in clean technologies and to ensure industry as a global frontrunner. Emission reductions for these industries are based on an "efficiency first" principle (European Commission, 2020c). It is in these sectors that hydrogen seems to be the most promising alternatives to fossil fuels. As part of the Green Deal, several strategies highlight the importance of green hydrogen. The REPowerEU strategy states that "Renewable hydrogen will be key to replace natural gas, coal and oil in hard-to-decarbonise industries" (European Commission, 2022a). Furthermore, the Net Zero Industries Act consists of policy packages that aim of scaling up the manufacturing of key technologies, such as electrolysers. Lastly, the EU Hydrogen Strategy specifies targets and pathways for the development of green hydrogen. This pathway is split up into three phases.

In the current first phase, from 2020 to 2024, the aim is to install 6 GW of green hydrogen electrolysers in the EU and the production of up to 1 million tonnes of green hydrogen. As of March 2023, only 160 MW capacity had been installed, producing less than 0.3 tonnes. In the second phase, from 2025 to 2030, the objective is to install at least 40 GW of green hydrogen, producing 10 million tonnes. The strategy specifically states that in this phase, hydrogen needs to become an intrinsic part of an integrated energy system. In the third and final phase, green hydrogen technologies should reach maturity and be deployed at a large scale in hard-to-decarbonize industries. With green hydrogen replacing fossil fuels in large emitting industries, this will effectively decarbonize those industries, allowing them to decouple their production processes from emissions. The strategy mentions that this phase will require a massive increase in renewable electricity production, as the projection is that around a quarter of renewable electricity might be used for the production of renewable hydrogen by 2050 (European Commission, 2020b). This reliance on renewable energy capacity is one of the key critiques against green hydrogen from a degrowth perspective.

Green growth versus degrowth

To understand the critique against the reliance on green hydrogen in EU policy from a degrowth perspective, it is necessary to briefly highlight the green growth versus degrowth debate. Central in this debate is whether economic growth can effectively be decoupled from environmental impacts (Hickel, 2019). Green growth strategies, such as those promoted by the EU Green Deal, assume that the economy can continue to grow while reducing ecological impacts (European Commission, 2020a). Key in this idea is the assumption that increasing efficiency and circularity can reduce the material and carbon intensity of an economy. Indeed, some countries show promising signs of decoupling economic growth from CO_2 emissions. Degrowth scholars nevertheless challenge these assumptions. Instead, they argue that economic growth cannot be decoupled from material extraction at a global level, and that this material extraction leads to irreversible ecological impacts and exacerbates global inequalities (Hickel & Slameršak, 2022). Degrowth does thus not only focus on material aspects, but also on social outcomes. The critiques of degrowth against growth in general, and green growth in particular, can extend to the role of green hydrogen.

First, degrowth scholars challenge the assumptions underlying green growth by highlighting the limitations to efficiency increases. This idea comes from early ecological economists who challenge the possibility of limitless growth by referring to the laws of thermodynamics. These laws state that all transfers or conversions of energy are irreversible and will lead to a decrease in quality due to increasing entropy (Georgescu-Roegen, 1986). In short, this means that in the long term, there can be no absolute decoupling of consumption growth (GDP) and raw material use. This is highly applicable to the case of green hydrogen. The production of hydrogen comes with significant energy losses at each stage of the value chain. Electrolysis specifically has a low conversion efficiency[2] of around 60 percent (Squadrito et al., 2023). Policies enabling innovation may lead to some improvements in efficiency, but research finds that even if electrolysis capacity grows at a rate equal to that of wind and solar power, the green hydrogen supply will remain scarce in the short-term, and uncertain in the long-term (Odenweller et al., 2022). A large part of this uncertainty stems from the problem that many required technologies, specifically those necessary to decarbonize heavy industry and maritime transport, are not yet developed or are not yet possible at scale (IRENA, 2022).

Second, the production of green hydrogen requires large inputs of critical metals and minerals, both directly and indirectly. Directly for the production of hydrogen technologies such as electrolysers and fuel cells. Europe is fully dependent on the foreign supply of 19 of 29 raw materials relevant to fuel cells and electrolyser technologies (European Commission, 2020b). Indirectly because to meet net-zero targets, the production of green hydrogen depends on large amounts of renewable energy far beyond current capacities. To illustrate the scale of this problem at a global level, IRENA finds that by 2050, the consumption of electrolysers is expected to be around 2100 TWh - nearly equal to all electricity globally produced today (IRENA, 2021). They state specifically that “a lack of sufficient renewable electricity may become a bottleneck for green hydrogen.” Other research finds that the expected demand for rare earth minerals needed for one generation of renewable energy to

[2] Conversion efficiency is defined as the ratio of hydrogen energy content and electrolysis power consumption.

replace the current consumption of fossil fuels is around 944 Mt. Current known reserves are at 22 Mt - only 2.33 percent of the projected demand (Michaux, 2022). The supply of key minerals for green hydrogen production such as copper, zirconium, and platinum-group metals will therefore come under increasing pressures (IRENA, 2021). For instance, some projections estimate that meeting EU hydrogen demand in 2050 requires 110 percent of global iridium supply, more than 30 percent of global tantalum supply, and 25 percent of global platinum supply (TNO, 2021).

Third, from a degrowth perspective, material extraction cannot be decoupled from social impacts. Already today, the mining of rare earth minerals and metals is associated with increased social and material inequality through land grabbing (Dunlap, 2019), human rights violations (Idemudia et al., 2022), and the ecologically unequal exchange of resources through international trade (Dorninger et al., 2021). With the increasing demand for metals and minerals necessary for hydrogen production, these consequences are only expected to worsen. As hydrogen will play a more prominent role, a group of importers and exporters could emerge which will likely alter the geopolitical playing field (Noussan et al., 2021; IRENA, 2022).

The role of hydrogen in a degrowth future

Considering the urgency of the climate crisis, and green hydrogen being a low-carbon alternative despite questions on its long-term sustainability, what is the place of green hydrogen in a degrowth future? The way I see this is twofold.

On the one hand, there will always be a societal need to produce and consume certain goods and services that require raw material inputs. Think of the construction of houses, the maintenance and expansion of railways, and the visiting of overseas relatives. In these industries that are difficult to electrify, there will be a need for green hydrogen as an alternative to fossil fuels. On the other hand, there is an urgent need for policy aimed at reducing energy use in the Global North in the short term (Hickel & Slamersak, 2022). From a degrowth perspective, the main critique at the reliance on green hydrogen in EU strategies is that it is not paired with policies aimed at absolute reductions in energy demand. For instance, the mid- to long-term strategy in the EU Energy Savings policy focuses solely on energy efficiency improvements (European Commission, 2022b).[3] Related to hydrogen specifically, these improvements depend on future technological developments characterized by high uncertainty (Odenweller et al., 2022). In other words, current net-zero policies depend on the adoption of hydrogen based energy for hard-to-decarbonise industries, yet there is little evidence that green hydrogen technologies or capacity will develop quick enough to meet future demands. From this perspective, focusing on green hydrogen alone lacks the urgency and feasibility necessary to meet climate targets**.** Although degrowth is sometimes characterized as utopian, degrowth policies do not depend on future technological innovations and could be implemented to start reducing energy requirements urgently. Some of these proposals include declining caps on resource use, taxing industrial energy consumption, and investing in community owned and operated renewable energy systems (Fitzpatrick et al., 2022; Kunze & Becker, 2015). These could be implemented to reduce the fossil-fuel intensity of certain sectors in the short-term.

In sum, the degrowth argument against green hydrogen is that it cannot be decoupled from material use. Hydrogen being the only viable alternative to fossil fuels in hard-to-decarbonize industries, this means that the extraction of massive amounts of materials linked to hydrogen production will continue to increase for as long as these sectors keep growing. Taking into account the laws of thermodynamics, and the life-cycles of RES and electrolysers, even efficiency increases are not expected to lower absolute material requirements in the long-term. Policy packages as part of the EU Green Deal nevertheless depend on green hydrogen to reach net-zero by 2050, specifically because hydrogen is considered the sole option to decarbonize large emitting sectors. Yet focusing on green hydrogen alone comes with many uncertainties, and risks overlooking the root causes of ecological problems related to material extraction. Although there are brief statements on reducing absolute energy consumption, EU policies fail to look beyond efficiency increases. From a degrowth perspective it remains necessary to ask how the economy can reduce its material intensity, and betting on green hydrogen alone is not the answer. Without downscaling certain sectors, without deliberately degrowing material use in the Global North, material extraction will ultimately continue to grow, with all the environmental and social impacts as a consequence.

[3] The EU Save Energy communication does offer a short-term strategy for reducing energy demand (created as a response to increasing gas prices after Russia's invasion of Ukraine) but focuses only on individual consumers, listing voluntary actions such as turning down the heating and taking the train instead of the car.

Bibliography

Badshah, N. (2023). Antarctica has lost 7.5tn tonnes of ice since 1997. *The Guardian*. https://www.theguardian.com/world/2023/oct/12/antarctica-has-lost-7-5tn-tonnes-of-ice-since-1997-scientists-find

Blondeel, M., Bradshaw, M. J., Bridge, G., & Kuzemko, C. (2021). The geopolitics of energy system transformation: A review. *Geography Compass*, *15*(7). https://doi.org/10.1111/gec3.12580

Dorninger, C., Hornborg, A., Abson, D. J., Von Wehrden, H., Schaffartzik, A., Giljum, S., Engler, J., Feller, R. L., Hubacek, K., & Wieland, H. (2021). Global patterns of ecologically unequal exchange: Implications for sustainability in the 21st century. *Ecological Economics*, *179*, 106824. https://doi.org/10.1016/j.ecolecon.2020.106824

Dunlap, A. (2019). Wind, coal, and copper: the politics of land grabbing, counterinsurgency, and the social engineering of extraction. *Globalizations*, *17*(4), 661–682. https://doi.org/10.1080/14747731.2019.1682789

European Commission, Directorate-General for Environment (2020a). *Investing in the circular economy: a blueprint for a green recovery*, Publications Office. https://data.europa.eu/doi/10.2779/48431

European Commission. (2020b). *A hydrogen strategy for a climate-neutral Europe* (COM/2020/301). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0301

European Commission (2020c). *A New Industrial Strategy for Europe* (COM/2020/103). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0102

European Commission. (2022a). *REPowerEU Plan* (COM/2022/230). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0230

European Commission. (2022b). *EU 'Save Energy'* (COM/2022/240). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52022DC0240

Fitzpatrick, N. P., Parrique, T., & Cosme, I. (2022). Exploring degrowth policy proposals: A systematic mapping with thematic synthesis. *Journal of Cleaner Production*, *365*, 132764. https://doi.org/10.1016/j.jclepro.2022.132764

Georgescu-Roegen, N. (1986). The entropy Law and the economic process in retrospect. *Eastern Economic Journal*, *12*(1), 3–25. https://www.jstor.org/stable/40357380?typeAccessWorkflow=login

Hickel, J. (2020). What does degrowth mean? A few points of clarification. *Globalizations*, *18*(7), 1105–1111. https://doi.org/10.1080/14747731.2020.1812222

Hickel, J., & Kallis, G. (2019). Is green growth possible? *New Political Economy*, *25*(4), 469–486. https://doi.org/10.1080/13563467.2019.1598964

Hickel, J., & Slameršak, A. (2022). Existing climate mitigation scenarios perpetuate colonial inequalities. *The Lancet Planetary Health*, *6*(7), e628–e631. https://doi.org/10.1016/s2542-5196(22)00092-4

IRENA (2022). *Geopolitics of the Energy Transformation: The Hydrogen Factor.* International Renewable Energy Agency, Abu Dhabi. ISBN: 978-92-9260-370-0. www.irena.org/publications

Kallis, G., Kostakis, V., Lange, S., Muraca, B., Paulson, S., & Schmelzer, M. (2018). Research On Degrowth. *Annual Review of Environment and Resources*, *43*(1), 291–316. https://doi.org/10.1146/annurev-environ-102017-025941

Kunze, C., & Becker, S. (2015). Collective ownership in renewable energy and opportunities for sustainable degrowth. *Sustainability Science*, *10*(3), 425–437. https://doi.org/10.1007/s11625-015-0301-0

Michaux, S. (2022) The quantity of metals required to manufacture just one generation of renewable technology to phase out fossil fuels. *JKMRC Friday Seminars 2022*. https://smi.uq.edu.au/event/session/11743

Noussan, M., Raimondi, P. P., Scita, R., & Hafner, M. (2020). The role of Green and Blue Hydrogen in the Energy Transition—A Technological and Geopolitical Perspective. *Sustainability*, *13*(1), 298. https://doi.org/10.3390/su13010298

Odenweller, A., Ueckerdt, F., Nemet, G. F., Jensterle, M., & Luderer, G. (2022). Probabilistic feasibility space of scaling up green hydrogen supply. *Nature Energy*, *7*(9), 854–865. https://doi.org/10.1038/s41560-022-01097-4

Rammelt, C. (2023). *Demystifying degrowth 1: Introducing degrowth*. Studium Generale, Wageningen University & Research.

Sadik-Zada, E. R. (2021). Political Economy of green hydrogen rollout: A Global perspective. *Sustainability*, *13*(23), 13464. https://doi.org/10.3390/su132313464

Squadrito, G., Maggio, G., & Nicita, A. (2023). The green hydrogen revolution. *Renewable Energy*, *216*, 119041. https://doi.org/10.1016/j.renene.2023.119041

TNO (2021). Towards A Green Future Part 1: How raw material scarcity can hinder our ambitions for green hydrogen and the energy transition as a whole. http://resolver.tudelft.nl/uuid:8f47a97e-8577-4998-a151-47527a87100c

World Bank (2023) *Climat Change Overview.* https://www.worldbank.org/en/topic/climatechange/

World Meteorological Organization (2023). *July 2023 is set to be the hottest month on record*. https://public.wmo.int/en/media/press-release/july-2023-set-be-hottest-month-record#