Sciences Po Energy Review

Global Energy Transitions: Narratives and Sequencing

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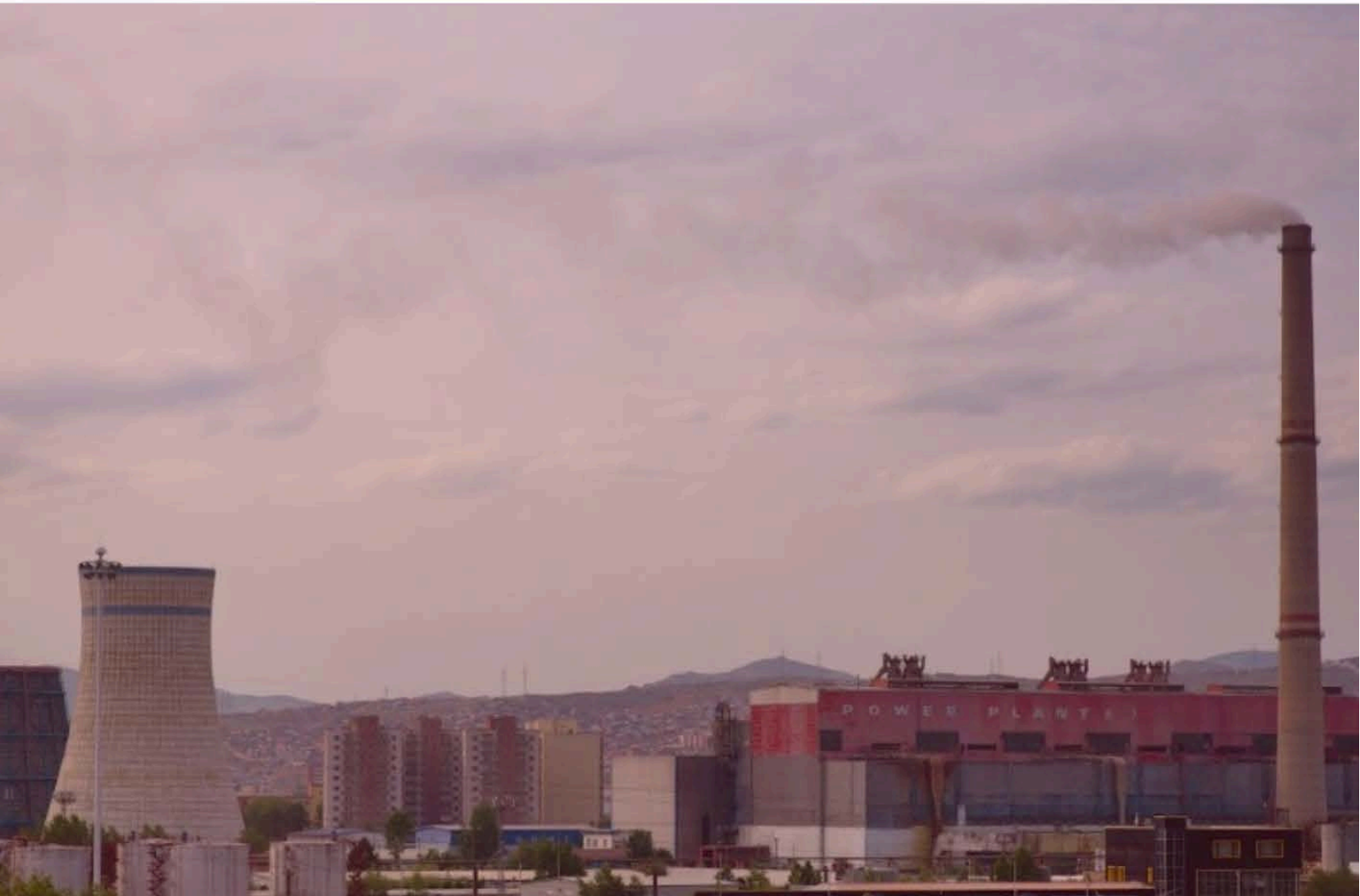
SciencesPo
EUROPEAN CHAIR FOR SUSTAINABLE DEVELOPMENT AND CLIMATE TRANSITION



About the European Chair for Sustainable Development and Climate Transition

The mission of the Chair is to advance education, innovation and public dialogue for the design and practice of policies for sustainable development and climate transition, within and outside of Europe. Challenges of climate change adaptation, decarbonisation, safeguarding planetary boundaries, green financing, biodiversity depletion and geopolitical environmental risks need to be understood and overcome in order to advance ambitions of the European Green Deal.

The Chair's mission is to drive education, innovation, and public discourse in the development of sustainable policies and climate transition, both within Europe and globally. We are dedicated to addressing critical challenges such as decarbonization, climate change adaptation, implementing the energy transition, green finance and minimising environmental risks. Our ultimate goal is to support the European Green Deal's ambitious objectives.

Our work centres on facilitating social and environmental transitions. We focus on analysing the content and governance of policies, partnerships, and actions needed to create transformative pathways for regions and cities. Our aim is to strike a balance between economic growth, social progress, and environmental protection.

We are committed to establishing a broad network of actors who will contribute to research, education, and discussions on important topics such as regional well-being, just transition, climate mitigation and adaptation, energy transition, and climate-resilient infrastructure. Our approach embraces various perspectives, including economic, sociological and technological, overcoming traditional disciplinary boundaries.

Hosted at the Paris School of International Affairs (PSIA) and the School of Public Affairs, the Chair is governed by two committees with the help of a team. The Chair is funded by: Hermès International, HSBC and the European Investment Bank (EIB).

About the Sciences Po Energy Review

The Sciences Po Energy Review is a graduate student-led publication to advance dialogue about energy. Motivated by the pressing global need for energy transitions, the journal primarily employs a social scientific approach without being constrained by any single discipline, featuring graduate student writing and expert analyses.

By placing contributors in conversation with peers and experts, the publication seeks to strengthen existing debates and research about energy at Sciences Po and beyond, and welcomes submissions from all around the world.

The Sciences Po Energy Review is hosted by the European Chair for Sustainable Development and Climate Transition.

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Foreword by Marc Ringel

Dr. Marc Ringel is the Chairholder at the European Chair for Sustainable Development and Climate Transition at Sciences Po, Paris. Dr. Ringel is the director of the Institut franco-allemand (dfi) and full professor at Nuertingen Geislingen University, Stuttgart, Germany. Furthermore, he is a senior associate researcher with the University of Brussels, Belgium (Vrije Universiteit Brussel) and an affiliated lecturer with Université d'Aix en Provence/Marseille, France. He leads multidisciplinary research on green transitions in the energy and climate field, focussing on the role of public governance.

We at the European Chair for Sustainable Development and Climate Transition are proud to host this inaugural edition of the Sciences Po Energy Review. When the editors, all young professionals studying here at Sciences Po, first shared their vision for this initiative, it struck us as ambitious yet perfectly timely. It aims to foster a global debate on the ongoing energy transitions and their far-reaching implications. These transitions are often viewed narrowly as policy programmes, technological applications, or climate policies. However, these aspects are interconnected and require a comprehensive and thorough discussion.

This debate is more urgent than ever. The latest findings from the IPCC underscore the necessity for ambitious climate policies. In many countries, this translates directly into calls for swift and comprehensive energy transitions. Take the European Union as an example: with 75% of its greenhouse gas emissions being energy-related, transforming the European energy systems is not optional but essential.

The European Union has set a brisk pace for this transition through its European Green Deal, aiming for full decarbonisation by 2050, and its associated Fit for 55 legislative package, which updates and increases the ambition of nearly the entire energy acquis. Over the past five years, achievements in this policy field have been remarkable, with more than 50 European regulations promoting renewable energy, increasing energy efficiency, and improving market rules for electricity and gas. The Green Deal blueprint has not only facilitated ambitious climate policies but also enhanced resilience in response to the Russian aggression against Ukraine and the subsequent gas crisis in many European countries.

At the same time, this regulatory ambition has highlighted interactions in many other areas. The current debate on the speed of the transition and the highly ambitious promise of "leaving no one behind" shows that the transition is neither straightforward nor guaranteed. It remains to be seen how the incoming European Commission will position itself regarding the Green Deal and ambitious energy transition policies. It is clear that for the transition to succeed, it must benefit people while also managing structural changes in all our economies. Balancing the empowerment of individuals and supporting them when facing high energy prices or managing structural changes by requalification is crucial for the success of this transition.

These issues are not unique to Europe but are ever more relevant to the numerous transformations occurring globally, particularly in the global south. Here, the challenges of attracting investment, increasing capacity building, and finding suitable governance mechanisms add complexity for local policymakers. However, these challenges also provide opportunities for establishing good practices and mutual learning worldwide. Especially from a global perspective, it is essential to look beyond energy systems and consider the broader supply chain, including resource availability and use. In this context, the trade-offs and limits of the transformation become more apparent and merit further discussion.

Readers will find many of these aspects explored in-depth in this first edition of the Sciences Po Energy Review. The wide range of contributions from students across several PSIA master's programmes and beyond truly honours the comprehensive view of ongoing transitions and the critical analysis needed to develop workable solutions in this field. I commend my colleague Giacomo Luciani for igniting interest in these debates and congratulate the editors and reviewers for their outstanding efforts in producing this impressive first edition.

Let me conclude by saying that every journey begins with a first step, and I am confident that future editions of the Sciences Po Energy Review will continue to provide insightful analyses and discussions. With this, I wish you an informative and inspiring reading.

Foreword by Giacomo Luciani

Giacomo Luciani teaches at the Paris School of International Affairs, Sciences Po (since 2010), and at the University of Geneva in the Master of Commodity Trading (since 2008). From 2008 to 2023 he also taught at the Geneva Graduate Institute of International and Development Studies, and in 2010-13 he was Global Scholar at Princeton University. He has launched a MOOC on Coursera entitled "Politics and Economics of International Energy" that has seen 71 '000 students enrolled as of July 2024. His latest edited publications include the open access "Handbook of International Energy Economics" (2022), co-edited with Manfred Hafner, with 1.4 million downloads.[1]

When the Paris School of International Affairs (PSIA) was launched in 2010, I was asked whether it might be appropriate to offer a Master in International Energy. My answer was cautiously positive, although Sciences Po was not known for energy studies. Oil was central to international relations: oil prices had been on an almost exponential growth path since 2004, only briefly interrupted by the Global Financial Crisis due to the collapse of Lehman Brothers. Meanwhile, the unconventional oil and gas revolution in the United States was only beginning. While the United Nations Framework Convention on Climate Change had entered into force already in 1994, the main concern at the time was still that oil production might soon not be sufficient to meet continuously growing global demand.

Then came COP21 and the Paris Agreement, which established a timed and measurable goal for containing greenhouse gas emissions, and brought the energy transition to the forefront of energy policies in many - but far from all - countries. Close to ten years later, significant progress has been made, yet such progress falls well short of stated ambitions. A lot of the debate has focused on the various technologies that underpin the energy transition, with emphasis laid primarily on the falling cost and increasing uptake of some technological solutions such as wind and solar power generation, or electrification of mobility. However, other technologies have stalled, and the expected exponential growth in the deployment of the more successful ones has lost steam.

It is increasingly evident that existing policies have largely failed to create a strong business case to support the energy transition. Government pledges and various administrative measures have encouraged numerous companies, large and small, to invest in a panoply of energy transition projects. Unfortunately, profitability has disappointed. When capital invested does not generate large rates of return, new investment cannot be financed from accumulated profits, and fresh money is not attracted. The cost of technological solutions has in some cases declined dramatically, but their respective value has also declined, and large solar and wind projects are being abandoned. The boom in EV uptake has stalled, because most final consumers are either unable or unwilling to abandon thermal engines, or simply delay buying new cars. Producers of batteries are in turn scaling down their planned capacity increases.

[1] Hafner, Manfred, and Giacomo Luciani. *The Palgrave handbook of international energy economics*. Springer Nature, 2022. Available at: https://link.springer.com/book/10.1007/978-3-030-86884-0

As we approach the tenth anniversary of the Paris Agreement, its goals increasingly appear out of reach. We still refer to scenarios of net zero emissions by 2050, although the path to implementing them is by now so narrow as to be impassable. But revising this crucial target is fraught with political danger. A backlash against stringent Environmental, Social and Governance (ESG) goals is already evident even in many democratic countries, and admitting to the failure of the Paris goals may worsen the situation.

Evidence of climate change continues to become clearer and clearer. It is frequently repeated that prompt climate mitigation is cheaper than adaptation, but the benefits of mitigation are not instantaneous. We will not be able to stop climate change very soon, hence we will need to invest in adaptation anyhow. Thus, mitigation and adaptation are not alternatives, they must be pursued in parallel. The social and economic burden of doing so will affect governments' fiscal capacity, and mobilising private investment – at the corporate but also household level – is increasingly important.

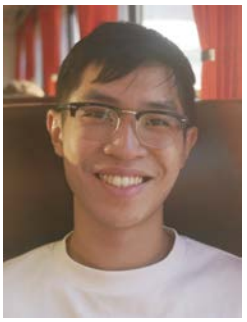
In the face of these multiple challenges, the voice of young professionals must play a decisive role. We need more well-educated and politically aware young energy experts to form public opinion and policies.

I am very happy to see that our young professionals have decided to launch the Sciences Po Energy Review, a totally bottom-up initiative. I am also very happy to see that contributors to this first issue of the journal come from several of PSIA's Master programmes, not just the Master in International Energy Transitions, as well as from other Sciences Po Schools or from outside Sciences Po altogether. My congratulations to the initiators, with the confident expectation that their Energy Review will become a catalyst for wider, well-informed energy debate, and an incubator of policy consensus for energy transitions success.

2. Editorial Introduction

Gabriele Romeo

Founding Editor,
Student in International Energy Transitions



Ernest Lee

Founding Editor,
Student in International Energy Transitions

The imperative for 'decarbonisation' and 'energy transitions' have quickly become terms unrivalled in their urgency and frequency, all seeking to relegate carbon emissions to the past within this century. More than half a year has passed since COP28, where parties reached an agreement to align their shift away from carbon-based energy sources and achieve a transition towards net zero in "a just, orderly and equitable manner".[2] The 'net' of 'net zero' rests on the possibility to continue relying on certain fossil inputs, insofar as their emissions can be captured, sequestered, or offset.

However, when it comes to passing from the concepts of net zero by 2030 or 1.5 to their actual implementation, a Pandora's box of conflicting narratives is unveiled. The UNFCCC foundational principle of Common but Differentiated Responsibilities and Respective Capabilities exemplifies how any truly global transition is heterogeneous in its conception, implementation and consequences. Developments since our call for submissions reveal that the path to achieving the Paris Agreement - keeping a "global temperature increase to well below 2°C above pre-industrial levels" - is increasingly elusive.[3] States with transformative climate and energy agendas are on track to miss many of their targets, complicating a global decoupling from fossil sources. Room for implementing pathways that are socially, economically, and environmentally sustainable continues to shrink.

The divergence of these realities is both exacerbated by and encapsulated in the notion of a 'polycrisis' - as popularised by historian Adam Tooze - whereby various causally entangled shocks prevent clear solutions from emerging.[4] These shocks are historically stratified: current tradeoffs between security, resource management, and decarbonisation in fossil fuels-rich countries add up to decades-old calls from vulnerable states to recognise their

[2] UNFCCC. 'COP28 Agreement Signals "Beginning of the End" of the Fossil Fuel Era', 13 December 2023. https://unfccc.int/news/cop28-agreement-signals-beginning-of-the-end-of-the-fossil-fuel-era.

[3] UNFCCC. 'The Paris Agreement'. COP 21, November 2015. https://unfccc.int/documents/184656.

[4] For an overview, see Lawrence, Michael. 'Polycrisis in the Anthropocene: An Invitation to Contributions and Debates'. *Global Sustainability* 7 (January 2024): e5. https://doi.org/10.1017/sus.2024.2.

condition, reframed as “loss and damage” and addressable through ‘Just Energy Transition Partnerships’ in today’s institutional parlance.

Successful energy transitions demand both scale *and* speed. Energy historian Vaclav Smil has recently contextualised the extent to which this is a tall order, entailing the replacement of over 4 TW of fossil-based electricity production within a single generation, at a juncture before global fossil consumption is likely to peak before falling gradually, and prior to mass electrification and carbon sequestration.[5] The premiere issue of the Sciences Po Energy Review addresses both the scale and speed aspects that shape global developments.

Diagnosing and grappling with the immense nature of energy transitions, or even the narratives and sequences that make them imaginable and practicable, is a Herculean exercise. Amidst the sea of reports from international organisations, think tanks, national bodies, and universities, how can we move beyond conventional forms of thinking and governance about energy? This issue unites graduate student contributions with the perspectives of experts to extend such conversations about energy transitions. Taking as one starting point the diverse narratives surrounding energy transitions, our contributors examine how these transitions are understood and unfold at various levels, sharing the fundamental premise that the energy transition is urgent but not guaranteed to unfold in a just, equitable, welfare-improving, and predictable way.

[5] Smil, Vaclav. ‘Halfway Between Kyoto and 2050: Zero Carbon Is A Highly Unlikely Outcome’. *J.P. Morgan*, 5 March 2024. https://privatebank.jpmorgan.com/content/dam/jpm-wm-aem/global/pb/en/insights/eye-on-the-market/Vaclav.pdf.

Experts interviews

The energy transition is necessarily global and thematically intertwined. As such, this issue benefits from four experts who provide insight into how the transition is unfolding across various regional and thematic lenses:

Miguel Gil Tertre dissects several narratives underpinning the European Union’s energy transition. How does the bloc plan to solve the triple quest for affordable, decarbonised, and secure energy supplies? Amidst the EU structural competitive disadvantages in all traditional and some emerging energy supplies, Gil Tertre exposes several tradeoffs that help inform the energy trilemma discourses: those between domestic cleantech deployment and manufacturing, between subsidies and constrained public budgets, and between prioritising industrial policies and keeping the Global South on board the transition.

Editors’ quote: *“Ultimately, if the transition is going to work, it will have to work in a win-win scenario.”*

How can innovative and contested technologies find new forms of acceptance? Our interview with Dr. Adnan Shibab Eldin discusses the role of Small Modular Reactors (SMR), often heralded as a revolutionary energy technology that simplifies the construction and lowers the costs of nuclear reactors, while preserving the traditional advantages of nuclear power. The interview further sheds light on the potential opportunities of a SMRs’ driven decarbonisation in power and non-power applications such as desalination and heavy industry, elaborating the implications of such transition in Gulf OPEC countries.

Editors’ quote: *“It's better to use nuclear power or renewables and export your oil*

and gas, maybe in the form of decarbonized oil and gas, outside of your country."

Contrasting the EU's fast-speed transition approach with cruder realities of power and prices, Andrei Marcu critically ponders the EU's pioneering climate efforts. The interview traces today's conflicting narratives currently hindering progress towards market-based approaches to climate policy, and how they negatively reverberate on the EU transition pro-activism. If the spread between climate-ambitious and non-ambitious countries keeps growing absent a global carbon price, so will the potential for opportunistic behaviour, resulting in an erosion of prosperity and a vicious loss of geostrategic importance for the EU.

Editors' quote: *"The EU right now is moving at its own speed and it's passing everybody. At some point, there's going to be a policeman somewhere, and the policeman is going to be the economic sustainability of this."*

Dr. Thibaud Voïta discusses the development of both voluntary and compliance carbon markets in Africa, which thus far have occurred under Article 6 of the UNFCCC agreements. Despite the inherently complex architecture and mechanisms of these markets, the capacity of participating countries remains uneven and carbon offset mechanisms remain plagued with biodiversity, implementation and human security issues. Yet, many projects provide opportunities for sustainable development or emissions trading at more local and regional levels and meet the developmental finance gaps discussed in the previous section; carbon markets are not greenwashing or neocolonial schemes, insofar as monitoring, reporting and verification schemes are robust.

Editors' quote: *"There will always be critics and they will always be defenders of carbon markets. Like many actors in the field, I am hopeful that stricter regulations, transparency and better monitoring would allow for better results."*

Debate

The second section proposes a student debate centred on the question "Should we slow down the energy transition to guarantee political and economic affordability?" Although both authors agree on the need to be realistic and pragmatic, Christy Pang defends the proposition in her contribution that market volatility and inflation must be kept in check, while an overly-ambitious pace of transition will face grid limitations, lead to regulatory gaps, and alienate communities. Against this, Pietro Rinaldi argues that the energy transition must remain the main focus, with the window to keep global heating to under 1.5C rapidly shrinking. Moreover, he points out ambiguity over emission responsibility, and that cooperation and burden-shifting must be strengthened. Readers will undoubtedly benefit from the debate's thought-provoking, geographically and thematically broad insights.

Critical Essays

Although COP agreements constitute the closest thing approximating an international regime to attain energy transitions, both their targets and their underlying assumptions are not immune from criticism. In "It's Not Only About Gigawatts: A comment on the COP28 renewable energy target's conceptual issues", Ana Diaz Vidal scrutinises COP28's seminal agreement to triple

renewable energy capacity and double energy efficiency over 6 years. Two main critiques of COP28 emerge: namely that it downplays the enormous role that fuel and heating play, with the marginalisation of these energy carriers, and secondly, that the agreement embodies a quantitative focus on the absolute growth of renewable capacity, overlooking the role of energy demand.

Another neglected dimension within the international political economy of energy transition emerges: geography. Decarbonisation is capital, technology and knowledge-intensive, but Harshad Gaikwad's essay, "Don't Look Up North, Look Down South: Financing the energy transition of the 'Global South' will benefit everyone" reveals how the necessary support needed for the global energy transition remains lacking in the Global South. Echoing the 'great carbon arbitrage' argument introduced by the economists Kleinnijenhuis, Adrian, and Bolton, the essay explores the case for advanced-country financial support for emerging markets and developing economies.[6] Gaikwad thus explores both the extent of finance needed, and the deeper normative responsibilities necessary for equitable forms of transition and global development. Isha Hiremath delves even deeper into one specific energy carrier in her essay "Navigating contested narratives for India's Coal Transition", paying close attention to the necessary sequencing of policies. Introducing a mandate for decommissioning thermal power plants, followed by repurposing them should be conducted under a robust roadmap, whereby other countries can provide both positive examples and warnings.

Nonetheless, the dichotomy of 'Global North' and 'Global South' is not always instructive in understanding the global politics of the energy transition. The rise of 'petrostates' in the later half of the 20th century redrew the geopolitics of fossil fuel resources and economic activity in the "oil revolution", per energy historian Giuliano Garavini.[7] Today, fossil exporters occupy a key role in setting the pace and appetite for transition, exercising influence over international decarbonisation projects' financing. Pietro Gioia's article "From Black Gold to Green: The Role of Petrostates and Oil Money in Driving the Global Energy Transition" examines the role of petrostates and oil producers alike in the energy transition, against critiques of 'greenwashing'. Arguing that producer nations and companies, both established and emerging ones, can marshall much-needed resources for decarbonisation, conditional on the right mix of technology and priorities.

Implementing the energy transition goes beyond the material dimension: skills are needed: the essay "Skills for Global Energy Transitions: Building a Greener Future Together" by Marie Kepler looks at the institutional structures and goes beyond a simple paradigm of 'human capital'. Constructing renewable energy infrastructure, green construction must go hand-in-hand with longstanding commitments in the labour literature, such as closing the gender pay gap. Integrating skills plans into NDCs and reforming technical and vocational education and training systems are crucial for strengthening the social fabric, making it both an active stakeholder and an enabler in the transition.

[6] Adrian, Tobias, Bolton, Patrick, and Kleinnijenhuis, Alissa. 'The great carbon arbitrage'. International Monetary Fund, 2022.

[7] Garavini, Giuliano. *The Rise and Fall of OPEC in the Twentieth Century*. Oxford, New York: Oxford University Press, 2021.

The second thematic section of the issue concerns both the old and new technologies and market mechanisms crucial to the energy transition. Examining these economic, scientific and infrastructural developments reveals many centres of gravity behind processes ranging from clean electrification to carbon markets that commodify 'carbon offsets' in the form of CO2. These processes are subject to various questions of appropriate sequencing - how can they be introduced and sustained over time? - and contested narratives, given the grossly uneven starting positions of countries attempting to decarbonise, electrify and offset emissions.

Despite the real promise of solar and wind, the bulk of today's renewable electricity production lies in hydropower, at 15%.[8] Dams, with their significant capacity for power generation and undeniable impact on local environments, demand specific analyses of their promises to provide large-scale, dispatchable and perils on local environments alike. Linus Chen's essay, "Lao hydropower exports to Singapore: the hidden costs behind ASEAN's "sustainable energy" promise of sustainability and security", unpacks the twin narratives of hydropower being inherently sustainable, while simultaneously guaranteeing stability of supply. The realities of those affected by dam development in Laos have often been overlooked in impact assessments or mitigation measures, while the actual design of hydropower 'exports' reveal themselves to sometimes be an accounting exercise that fails to increase renewable generation capacity.

The implications of interstate hydropower governance, this time from Central Asia, are also discussed by Rebeca Olmos del Canto, whose article "Emotional narratives regarding hydropower plants in Central Asia as obstacles for energy transition: mistrust and ambition in international cooperation over water management" further embed emotions in the study of international relations. Trust and mistrust are key to understanding dynamics around why countries like Kyrgyzstan, Uzbekistan and Kazakhstan have often for self-sufficiency over cooperation; yet, ambition also enables other projects to be intertwined with national identity. Beyond the geographical and topical resonance, both pieces underscore how the decisions behind and the development of hydropower are not always technical, or even economic in nature, but subject to deeply political decisions at the interstate and micro-level.

The energy transition also rests on a material and physical substrate: the components needed to fabricate and produce the mass of infrastructure needed to decarbonise, sequester, or otherwise replace fossil-based activity are process-specific and indispensable. Critical minerals, as expanded in Vadim Kunezov and Lucille Poulard's essays "A Critical Perspective on Critical Minerals: the Limitations of a Just Energy Transition for the Global South" and "Critical Mineral Recycling and Circular Economy: Perspective on a World of Finite Resources" presents another lens to incorporate perspectives and the interests of countries in the Global South. The first essay evaluates the interesting potential for mineral-endowed nations to move up the value chain and reap more benefits beyond raw materials exports. Meanwhile, Poulard's contribution integrates the Global South perspective by qualifying the

[8] IEA. 'World Energy Outlook 2023', 2023, 126. https://www.iea.org/reports/world-energy-outlook-2023.

recent strategic autonomy dynamics and what is portrayed as an overinflated trust in minerals' recycling as a panacea to counter the staggering rising demand.

Hydrogen energy shares several thematic reverberations with critical minerals. Clean hydrogen production allows geographies with abundant solar irradiation and wind to transform these resources, once relegated to electrons production only, into zero-emissions molecules - vital for the deep decarbonisation of shipping, aviation, heavy and chemical industries, and the power sector. Nicolas Moinier's essay "Opportunities for Hydrogen-Based Energies in the Global Energy Transitions" addresses the key question surrounding natural resources-rich countries: to what extent can they promote economic growth, job creation, and skill development? According to the author, the Namibian case demonstrates how hydrogen can drive sustainable development and support a global energy transition, but careful management is needed to avoid new dependencies on fossil fuels and ensure equitable growth.

At a time when the European Union and the US grapple with the strategic risks of overreliance on foreign clean technologies manufacturers, the nuclear energy debate is tiptoeing back into the equation of any country looking for a decarbonised, dispatchable, and safe energy source. However, as critically analysed by Michel Galper and Håkon Syrrist in their essay "Nuclear Energy in Europe: Monumental Mistake or Sustainable Blessing?", dependence on Russian nuclear supplies persists. Efforts must therefore increase to diversify nuclear supply chains, invest in domestic nuclear capacity, and develop SMRs to mitigate the risks deriving from this crucial energy source.

Regional energy transitions succeed and remain socially sustainable when new value chains are built upon existing ones. The North Sea, once central to Europe's oil industry, is now transforming into a hub for wind energy. This transition leverages the engineering expertise of the offshore oil sector, creating natural employment opportunities for those impacted by the shift. In their essay, "TenneT's Target Grid: Takeaways for Planning Next-Generation Offshore Wind and Electricity Transmission", Arina Khotimsy and Clement Violot go beyond wind energy alone. They explore the integration of wind energy development in conjunction with transmission grids in the North Sea, highlighting how the latter is an essential but often overlooked enabler of cost-efficient and resilient electrification.

Conclusion

Across the expert interventions, critical essays, and debates in the premiere issue of the Science Po Energy Review, it is evident that any implementation of an energy transition must be holistic. The transition cannot be conceptualised in terms of sheer numbers: regardless of how factors like capital investment, energy efficiency, and technology diffusion can be quantified, it is crucial for any energy transition to be context-specific and integrate various sectors of society and industry alike. Similarly, technology will play a huge role in the transition, but will not be a panacea. By focusing on sequencing and narratives, this issue highlights how rhetoric must be met by sustainable, equitable means of energy transition: nothing is a foregone conclusion.

The premier issue of the Sciences Po Energy Review was born out of the Master in International Energy Transitions

programme at the Paris School of International Affairs (PSIA). It is all too easy to conflate the 'International' with 'European', or otherwise overemphasise the perspectives of affluent, influential states and actors. By incorporating more diverse voices, this issue strives to offer conversations and policy debates about the energy transition that can truly arrive at the scale of the 'global' - one necessary to confront a crisis that is planetary and all-encompassing.

Many other issues are to be examined down the Review's road. While this premiere publication consciously adopts a horizontal and broad scope of analysis, future outputs will focus on more specific themes. Given the current trend of macro-scale energy additions, it is timely to explore and potentially re-evaluate the role of traditional energy sources in the future - and the consequences this would imply. As large-scale climate finance mobilisation still struggles to emerge, an in-depth look at energy infrastructures' financing in developed and developing economies is also warranted. Resource management and its implication on a just transition represent an additional lens of analysis worth dissecting in subsequent issues.

We extend our deepest gratitude to the inaugural contributors to the Sciences Po Energy Review. The collaboration, knowledge sharing, and curiosity from both experts and graduate students have been invaluable. Hosting contributions from beyond the PSIA premises at this early stage is an additional precious achievement. We are indebted to the Editorial Board members for their invaluable and patient support. We further thank the Scientific Advisors for their positive and proactive belief in this project.

3. Experts interviews

Interview with Miguel Gil Tertre - Competitiveness amidst Decarbonisation

Miguel Gil Tertre is currently Chief Economist in the Directorate-General for Energy at the European Commission, where he is responsible for modelling the impact of energy-related policy proposals and ensuring that they are economically coherent. Mr. Gil Tertre's previous assignments include, among others, negotiating the recovery and resilience plans for various EU Member States and the design and coordination of the Investment Plan for Europe. He was part of the private office of the Director-General for Economic and Financial Affairs from 2011 to 2014.

Interviewed by Gabriele Romeo (GR)

GR: *Industrial competitiveness is essential for fostering a vibrant and sustainable EU economy while preventing carbon leakage. This issue is anticipated to gain prominence in the next EU political cycle. The EU contends with structural competitive disadvantages, including limited fossil resources, high electricity costs, fragmented capital markets, and varying regulatory frameworks that increase bureaucratic expenses. At present, many industrial processes, such as steelmaking and ammonia production, incur significant cost premiums between decarbonized and fossil-based production, even when considering the phase-out of free allowances under the EU ETS.*

What are the key measures needed to boost European competitiveness? Which of them entail a structural rethinking of the current energy-related framework?

Miguel Gil Tertre: The issue of competitiveness is a very broad one and we need to differentiate between those parts of the economy that are very sensitive to energy prices and those parts of the economy that are less dependent on energy. The spread between the EU energy prices and those of the US and China has widened since the 2000s. We have always had more expensive energy costs than the US and China. In the case of the US, this is because they are producers of fossil fuels and we have to import and transform them. In the case of China, it is because they have had a very aggressive policy of increasing supply above domestic demand. Now, this spread in energy prices mainly impacts those energy industries like steel, plastics, glass, ceramics and others, and this is why a specific answer for these industries might be warranted.

The question of competitiveness can also be differentiated in terms of energy prices and the clean tech industries. Sometimes the two discussions get a bit blurred, but it's not the same. In terms of energy prices, as we saw during the shock of the Russian natural gas, a supply shock that leads to a contagion to electricity prices can have a very significant impact on inflation. On the cleantech, it's a different thing. Because the clean tech sector is not that big actually there is a tradeoff between deployment and manufacturing because manufacturing in the EU would be more expensive. This is an area that might be more related to economic

security. The fact is that if supply chains break, what we need is to be able to scale up the production of these technologies even if we cannot get them from other parts of the world. I would say that this is the issue. If we look at the clean tech industry, we need to see those areas where we are still very competitive because there are areas where we are competitive and focus on these ones because again, there is this tradeoff between deployment and manufacturing.

> **GR:** *How can the green premium, in addition to total costs, be reduced? Are the exisiting measures (e.g. EU ETS, Innovation Fund, Horizon Europe) enough?*

Miguel Gil Tertre: In terms of tools, we need to pursue the European Green Deal as soon as we can and try to benefit from PPAs and CfDs for renewables as today we are not benefiting that much. We need to accelerate the permitting, so as to increase installed capacity. We also need to do the investments that are needed to electrify the economy. So enabling investments like grids, which they are not available: 40% of our grids are more than 40 years old. So this is an important element.

Something I would not recommend is to focus very much on subsidies. Subsidies alone risk creating a subsidy race: there will be Member States who can versus some Member States that cannot because we have constrained public budgets and the European budget is going to be constrained as well. So there we need more intelligent policies.

Looking at the demand side, according to our studies, we are talking about 660 billion annually of investment needs. Currently we have 300 billion invested annually. So we have half of the investments which are needed to fill the gap currently. And that's for the net zero economy.

When we are instead talking about the supply side, the clean tech sector becomes pivotal. We did some analysis on the Net Zero Industry Act and what emerges is that we need to make sure that we attract private investments in the EU. We cannot provide subsidies across the board. So this is one important point.

> **GR:** *So the idea would be to try and build a competitive clean tech european sector able to close the spread as opposed investing into making the old energy framework more competitive because there's just no margin for closing the spread there?*

Miguel Gil Tertre: Right, exactly. Because we're locked with imports in that regard. Upstream investments secure cheap and stable access to the commodities needed for the green transition. This is going to be critical.

> **GR:** *A significant development in recent years has been the resurgence of industrial policy, both within and outside the energy sector, and within and outside the EU. Recent initiatives aimed at strengthening domestic strategic value chains seek to rebalance the energy trilemma by placing greater emphasis on security.*
>
> *Do you see a tradeoff emerging between increased security of supply and affordability? Is this dynamic time-wise (short-term vs long term), and geographically sensitive?*

Miguel Gil Tertre: You put it very rightly. I think the tradeoff is in the short term because we want to increase economic security. And again we need to differentiate between energy prices and clean tech manufacturing. I mean, these two things are very different. But clearly

there's a premium if you want to do things in Europe. But in the end, the expectation is that we will have cheaper prices if we can benefit from a higher number of cheaper generation sources like renewables. The problem is that flexibility costs are going to increase massively. We need to adopt a cost efficient approach towards flexibility. So we need a good coordinated approach to make sure that there's a fine tuning between interconnections, batteries and storage, and backup power plants, which are extremely expensive. A coordinated approach will always be more cost efficient than a decentralized approach. That is for the energy side.

Now, in terms of clean tech, compared to China, who benefits from lower labor costs, economies of scale, and vertical integration, it will be complex to compete with them. And this is why we need to be very precise on what we want to support from the point of view of economic security. In case supply chains break, how can we have some manufacturing capacity in the EU that could be also scaled up quickly?

> **GR:** *This is a good argument requiring hedging against risks. In the end, rebuilding a value chain from scratch in case of a systemic shock or the outbreak of geopolitical conflicts could be costlier and longer.*
>
> *Geographically speaking, I think there's also a very interesting reflection to be made because of course there's the European transition, but there's also the Global South transition. How does this economic security game and trilemma play out geographically? How do you think EU industrial policy influences the geographies that are yet to decarbonize?*

Miguel Gil Tertre: Well, I think we need to be a little bit humble and assess which parts of the world are truly decarbonizing and which parts are not. I mean, if one looks at consumption of coal gas in the world, I'm not sure it's going down everywhere. But ultimately, if the transition is going to work, it will have to work in a win-win scenario. So we can find partnerships with countries in Africa, Latin America and others, where we buy some of the commodities in exchange for technology transfers. I think this is what we should be pushing for, so that there is an interest for all the parties involved. The transition cannot work if it's only in our interest.

> **GR:** *Another key issue you have previously discussed is the pace of transition, in particular how shifts in supply and demand induce energy price volatility. In turn, this introduces constraints on the feasibility and range of interventions the EU can make within a green energy transition.*
>
> *In these cases, what kind of structural changes are preferable for the EU to focus on?*
>
> *How can the EU influence international and corporate attitudes that support continued fossil fuel investment and subsidies? One possibility is to redirect capital from subsidies towards decarbonised investment, alongside carbon fuel maintenance for fossil asset owners; how should such spending be sequenced and allocated?*

Miguel Gil Tertre: Standards can play an important role. We also work with multilateral banks, for instance. I think leveraging the private sector is extremely important too. And then, we should remember that the EU is still the biggest donor for development aid globally. So these are the levers I would use myself.

GR: *There is a very interesting analysis by the IMF, which introduces the idea of a 'great carbon arbitrage'. And basically they make the point of positive net gains from investing into developing countries' decarbonisation, as opposed to developed countries, where the marginal returns are way lower. So is there room for more EU proactivity in that regard or is it just too politically unfeasible?*

It does not only depend on us. We can do things, but I mean, ultimately, this is why I think we need to be a bit humble as well, because there is sometimes this feeling that Europe leads and that the rest of the world follows, but in reality, I'm not sure it's the case still.

GR: *Even acting domestically does provoke a 'Brussels effect' all over the world, probably. So the EU can lead by example by acting domestically only.*

Miguel Gil Tertre: Exactly, exactly.

Interview with Adnan Shihab Eldin - A Nuclear Renaissance with Small Modular Reactors?

Adnan Shihab-Eldin is a Senior Visiting Research Fellow at the Oxford Insititute for Energy Studies (OIES), and a member of the Board of Directors of Kearney Energy Transition Institute (Nederland). Dr. Adnan Shihab-Eldin is the former Director General of the Kuwait Foundation for the Advancement of Sciences (2011-2021) and former Acting Secretary General and Director of Research at OPEC. He held earlier senior Director positions at both UNESCO and the International Atomic Energy Agency (IAEA). In Kuwait, he served as Director General of the Kuwait Institute for Scientific Research (KISR) and Vice President, Academic Affairs, and a faculty member at Kuwait University. He is a member of the board of Directors and international Advisory councils, of many academic and research institutions, including Georgetown University in Qatar and American University in Beirut.

Interviewed by Gabriele Romeo (GR) and Ernest Lee (EL)

GR: *Small Modular Reactors (SMRs) are often portrayed as a revolutionary advancement in the realm of energy technologies. Their designs allow for construction in segments, which simplifies building and reduces costs when producing multiple units. SMRs can also utilise alternative fission and cooling materials and are equipped with passive safety features. They also retain the structural advantages of traditional nuclear power, such as dispatchability, round-the-clock baseload electricity production, and life cycle emissions comparable to those of renewable technologies like wind and solar*.

How can SMRs shape the narratives of global energy transitions amidst recent geopolitical tensions, supply chains de-risking, and the need for decarbonised energy systems?

Adnan Shihab Eldin: Nuclear energy is considered a mature, safe, and low-carbon energy source, aligning well with the transition to clean energy. Almost all energy experts recognize the important role nuclear can play. However, there remains a significant perception issue regarding the safety of large nuclear power plants, which many in the public and among decision-makers in the West associate with the disasters at Chernobyl, Fukushima, and even the bombings of Hiroshima and Nagasaki. This perception has led to reluctance or resistance to incorporating nuclear power based on large reactors into the clean energy toolkit, particularly in countries that hold ideological positions on the matter.

With the advent of Small Modular Reactors (SMRs), the narrative has shifted. SMRs address major concerns about safety and economics. Due to their smaller size (around 100 MWe on average), even a catastrophic accident would result in a release that is only 1/10th or 1/15th of that from a large reactor (1000-1500 MWe). This has garnered attention from those seeking clean, safe, and reliable dispatchable power, contributing to a more favourable perception of SMRs and their role in the energy transition. Over more than half a century, there have been significant improvements in the safety of large nuclear reactors, which have

been incorporated into evolutionary SMRs. Revolutionary SMRs, with completely different conceptual designs, offer even greater safety. These designs rely on the laws of physics to shut down the reactor in the event of an accident, without needing human or mechanical intervention.

As a result, nuclear power is increasingly accepted in climate debates. Just a couple of years ago and before, COP final communications did not mention nuclear power. For the first time, COP28 acknowledged nuclear power, mainly because of the potential of SMRs. These reactors are flexible and allow for better quality control, which has helped shape a positive narrative around their use in the energy transition. Nuclear power is also overcoming objections from environmental groups, particularly European green parties. Nuclear energy is now part of most pathways to Net Zero Emissions (NZE), largely due to the promise of SMRs.

Even in terms of financial risk, SMRs offer significant reductions. Building a 1000 MWe plant traditionally required a large light-water reactor, which involved high financial risk due to the substantial upfront capital investment. However, switching to a series of 5 or 10 ready-to-ship SMR modules reduces initial investment risk, as it is spread over multiple units. If only one module is installed at first and something goes wrong, the financial risk is limited to 1/5th or 1/10th of that associated with a large reactor. This modular approach is akin to ordering a car from an assembly line rather than assembling it from parts in your backyard or garage. It is clear why this method makes more sense.

> **GR:** *What is the difference between economies of scale and economies of multiples, a concept which appears in your recent Oxford Energy Forum article contribution?*

Adnan Shihab Eldin: The history of nuclear power points to the benefits of economies of scale. In the early days (50s and 60s) reactors were built with a capacity of the order of 100 MW. If you needed a 300 MW station, instead of building three 100 MW reactors, you would build one 300 MW reactor to benefit from cost reduction of common services. This led gradually to increasing the size of nuclear power reactors to about 1500 MW in current large light water reactors.

But with the advantage of economy of scale, comes bigger financial and safety risks. Switching to SMRs means losing some benefits of scale, but at a certain point, the economy of producing many multiples, like an assembly line in a factory, will likely surpass the economy of scale benefit of a large reactor. This transition is not straightforward; someone has to bear the initial higher unit cost by ordering and paying for one unit first. Initially, this will be more costly per unit of power capacity. But once the assembly lines start producing and shipping multiple units, the cost per power unit will become cheaper, at least as attractive as before.

> **GR:** *What factors do you identify as the main obstacles to an SMR-driven nuclear renaissance? Are these barriers influenced by geographical and socioeconomic peculiarities? How can SMRs succeed where traditional nuclear power has failed?*

Adnan Shihab Eldin: The main obstacle is overcoming the initial higher first-of-a-kind (FOAK) costs. Currently, there are around 80 different designs, with some still only on paper,

two or three built and operational, and several having received licences to construct. Overcoming the FOAK syndrome requires government intervention, in the form of subsidy or by placing orders for the first few units of a particular SMR design, and/or initial funding from other sources. Once several leading designs get past this stage, the next challenge is filtering the different SMR designs to less than 10, likely down to only a handful. The market cannot sustain that many suppliers, but the surviving SMR designs must remain competitive. Several governments are providing strong initial support in terms of policy, orders and funding to position their national SMR vendors favourably. Many private sector investors are also joining forces with governments to support a few FOAK SMR projects in those countries.

Who will win that competition and at what cost? The competition for the best designs and the associated costs will reflect geographical and socioeconomic factors and the policies of different governments. For instance, Germany has decided against developing nuclear power altogether, despite having the capability. In contrast, countries like France, the United Kingdom, Japan, South Korea, Canada, the United States, Argentina, and South Africa all are heavily investing in developing their preferred national SMR designs.

Another challenge is proving that SMRs indeed represent an improvement in safety in the real world. Studies indicate that all the 80+ SMR designs show significant safety improvements, likely reducing the probability of a serious core accident by a factor of 10 or more. Public acceptability remains crucial for the success of any SMR design. Recent years have seen a shift towards greater public acceptance of nuclear power in many Western countries, but more progress is needed. Also, a serious nuclear accident like Fukushima could set back the nuclear industry, whether it involves SMRs or not. However, nuclear power remains one of the safest sources of electricity per kWh generated, even considering past accidents like Fukushima, Three Mile Island, and Chernobyl. Public education is therefore essential to continue this progress.

Balancing the climate change driver and the energy security driver against the efforts needed to address these challenges will determine the future of SMRs. The climate change and energy security drivers are responsible for pushing nuclear power forward.

> **GR:** *The power and industrial sectors in Gulf countries are heavily reliant on fossil fuels. In Qatar, Kuwait, Saudi Arabia, Iraq, Bahrain, and Oman, the share of electricity production from fossil fuels ranges between 90% and 100%. The petrochemical, refining, and heavy industries in these countries also depend heavily on fossil energy for process heat.*
>
> *How can nuclear energy be leveraged in the Gulf region to decarbonise the grid? Given the potential abundance of cheap solar power, what role should nuclear play in the power sector of the Gulf in the coming decades?*

Adnan Shihab Eldin: Many people don't know that there were several attempts to build nuclear power plants in the Gulf dating back to the 1970s. For example, Kuwait issued a tender for a 50-MW reactor in the late 70s and received offers from French, German, American, and Italian companies. I was involved in such efforts in the 70s and again in the 80s and more recently in 2009-2011. But these efforts were halted due to the accidents at the Three Mile Island, Chernobyl, and more recently, Fukushima nuclear plants.

But why did major oil-producing and exporting countries like Kuwait, UAE, and Saudi Arabia think about nuclear power? The answer is simple. These countries considered nuclear power for economic reasons. When oil prices rose, it made sense to free up oil or gas, used for domestic electricity generation, for export, as the oil rents would be higher. Even solar power was explored as an option in the Gulf in the 1970s, for the same economic reasons. For example, Kuwait built, in partnership with Germany, a 1 MW experimental solar plant for research and testing of German CSP technology. So again this had to do with oil prices; as they went up, countries started doing calculations, setting up programs, commissions and organisations, signing contracts with the IAEA and engaging to import nuclear technologies from industrial economies.

The advent of climate change has further changed the picture. It's now also about emissions as well as economics. Countries have committed to the 2015 Paris Climate Agreement, so they need to decarbonize their domestic energy sources. The UAE responded early by preparing in 2007 a carefully crafted comprehensive plan to introduce nuclear energy into their energy mix. The plan was implemented impeccably, with help from South Korea; and today UAE has four large nuclear reactors operating at its Baraka nuclear plant site; UAE is seriously considering a second phase to build more nuclear reactors to decarbonization its grid. There was also a call from Kuwait in 2006 to launch a Gulf-wide regional nuclear program. The call was approved by the GCC summit in December 2006, but it didn't materialize. Similarly, Kuwait launched in 2009 another effort to establish a nuclear power program, but the Fukushima accident ended it.

In the Gulf countries, nuclear power can play a crucial role in decarbonizing domestic energy sources and providing economic incentives. It's better to use nuclear power or renewables and export highly priced oil and gas now and, possibly in the form of decarbonized oil and gas in the future; it is expected that there will continue to be demand for oil and gas for a long time, especially from developing countries.

But how about renewables? Then the question becomes what is the optimal mix between nuclear and renewable in the Gulf countries? One has to remember that in the short term, Renewables will lead because they can be built quickly, mostly solar PV. However, they are intermittent, so a reliable baseload like nuclear is necessary. If it's not oil and gas, it must be nuclear. The alternative could be blue or green hydrogen. In the medium to long term, a mix of renewables supported by nuclear power plants will provide emission-free power generation, even reducing emissions from the transportation sector.

In summary, Middle Eastern countries will rely on renewables in the short term, but as the share of renewables increases, a low-carbon baseload will be needed. Nuclear power, along with renewables, will form the backbone of an emission-free power generation system.

> **GR:** *What are the most promising complementarities in non-power applications and positive spillovers that nuclear can provide in the Gulf context?*

Adnan Shihab Eldin: The obvious answer to that is water desalination. These countries rely heavily on desalination for the provision of fresh water supply for almost all their needs. In Kuwait, for example, 95% of the water consumed is from desalination, and 5% is fossil or underground water. So you can combine nuclear to run desalination plants when the demand

for nuclear power is low because the sun is shining and renewable power is abundant.

You can also have dedicated SMRs for certain applications like hard-to-abate heavy industry. That option was not available before when only large nuclear reactors existed. You could even have 50 MWe or 5 MWe microreactors for special applications. So it opens up. These options were not available before, but now they become available like in refineries and even for upstream decarbonization.

Industrial clusters, whether in the oil sector, or in the power sector, require a constant power supply, which intermittent solar energy cannot provide. Small or microreactors would be ideal for such industrial centres, ensuring a reliable 24/7 power supply.

> **EL:** *Going forward, the energy transition is not simply about finance and policy; it will require technical knowledge and expertise and intergovernmental cooperation.*[9]
>
> *From your perspective as an expert trained in nuclear engineering, are engineers, economists, politicians etc. talking to each other? How equipped are energy governance regimes to deal with the various phases of nuclear energy transition, especially if future phases entail the spread of SMRs?*[10] *Recently, the FT discussed how many nuclear engineers are being asked to come out of retirement as there simply aren't enough engineers to keep up with new projects.*[11]

Adnan Shihab Eldin: That's true, and if this is a problem in industrial countries, it's even more of a problem in other countries. But, let's look at an example where it worked: the United Arab Emirates, now referred to as a gold standard. They went about it when they started their Programme with a steady, holistic approach; in 2007 they only had a single PhD in nuclear engineering, and he is now their ambassador to the IAEA.

The UAE took a holistic approach, investing in all aspects of development. They asked industrial countries, like the US, Korea, and France to work with them on developing their plans. They sent engineers and economists for training abroad and brought back enough knowledge to lead their nuclear program. This commitment requires a long-term vision and commitment for many decades with steady progress. Fukushima did not derail their plans. In contrast, Kuwait had knee-jerk reactions to nuclear accidents, cancelling or freezing their program every time there was a nuclear accident somewhere else. Commitment to nuclear needs to be holistic, long-term, and in partnership with countries that have proven nuclear technology. When engineers and politicians collaborate, successful programs can be established.

The Saudi program is taking even more time due to the complexities of technology transfer and the commitments to the Nuclear Non-Proliferation Treaty (NPT). Technology transfer is not just about signing an agreement to get the technology but also, at the same time, how do you meet the commitment to the NPT? Saudi Arabia wants to retain their right, under NPT, to

[9] E.g. in the same OEF Forum, Tomas Kåberger and Lars J. Nilsson argued in the Feb 24 OEF issue that "[m]any of the SMR concepts are of the kind that were already dismissed by nuclear engineering veteran Hyman Rickover in 1970 as unrealistic 'academic reactors', able to seduce politicians who are unable to understand the complexities of real reactors."

[10] See "WILL SMALL MODULAR REACTORS DRIVE THE ENVISIONED EXPANSION OF NUCLEAR ENERGY WITHIN THE ENERGY TRANSITION?", 27, in OEF Feb 24.

[11] Smyth, Jamie, and Sarah White. 'Nuclear Industry Brings Back "Silver Tsunami" of Retirees'. *Financial Times*, 17 May 2024. https://www.ft.com/content/eb89cbc1-2cc3-48d4-9c8c-e2c10f2b2ce0.

enrich its domestic uranium, while the UAE gave up this right in an agreement with the US. The Saudis want a different agreement, in part, because they have large domestic uranium deposits.

Second is their desire to retain parity with Iran - the Iranians have achieved the capacity to enrich uranium to near weapons grade. The Iranians claim their enrichment program is peaceful but of course, there is always a dual purpose [to uranium enrichment], and the Saudis do not want to give up their right even as they currently have only peaceful intentions. This geopolitical factor must be addressed.

So, if nuclear development is only about technology, then the UAE example exists and it works. Yet, we have a geopolitical factor of how to handle restrictions demanded by nuclear technology transfer countries like the US; there is also the question of availability of nuclear fuel from the international market and how to avoid dependency. Does one become dependent on enriched uranium, or do you prefer to enrich domestically with full compliance with IAEA safeguards? These issues need to be discussed bilaterally, and there needs to be a rethinking of the dual-purpose nuclear technology.

In the case of Egypt, they avoided this issue by working with Russia, which offers to take back spent fuel and save you the problem of nuclear waste. After all, not every country with a plan for a small fleet of nuclear plants can afford to have a nuclear waste repository. Multiple countries in the MENA region will have to establish a consortium for a permanent repository, perhaps in the Gulf or North Africa.

This issue of nuclear cooperation matters therefore on the backend as well; without such clarity, it's hard for countries to implement a nuclear power programme, even one based on SMRs. And this backend aspect, for developing/Gulf countries - requires special agreements. Currently, only Russia provides this service, while the US and Europe need to adjust their national laws, to permit take-back of spent nuclear fuel to support selling their SMRs in developing, especially newcomer, countries.

> **EL:** *Discussions of an "energy transition", especially when framed globally, remain relatively recent; yet, even oil producers today are invested in some form of energy transition. During your tenure as Acting Secretary General and Director of Research at OPEC, how was the mood in the room?*

Adnan Shihab Eldin: There were two views after the 1960s, especially after 1973. This was when nuclear power was expanding in Europe and the US, in response to the energy crisis where oil was no longer used for power generation. Nuclear was not looked at in OPEC favourably, as it was linked to the demise of the role of oil in power generation; during this period, natural gas began to take over, especially since nuclear's expansion slowed following the Three Mile Island accident, and the strengthening of anti-nuclear movements in the West, etc.

The shift away from oil in the power sector became de facto, and gas was brought in to replace not just oil but coal, until natural gas became dominant. Later, the cost of renewables went down - first wind, then solar. So now if you look at the oil-producing countries, whether within OPEC or outside OPEC (and OPEC+), they do not see nuclear as a competition with

oil, which is only used for power generation in very limited cases, like Kuwait and Saudi Arabia.

However, decarbonisation means you can even use clean electricity for the transportation sector. There is some apprehension about too fast of an expansion in the use of nuclear for the purposes of electrifying the transport sector, but so far its impact has been quite small.

The literature of OPEC points out other challenges from the rapid expansion of renewables, such as the risk associated with the limited availability of rare minerals/metals supply. The views of OPEC on nuclear is therefore part of a bigger picture of both the purpose of nuclear and the purpose of renewables. Is it to generate electricity to challenge the oil sector, in terms of demand from the transport sector? That's when they become more apprehensive,

In sum, the situation is much less dramatic now than in the years immediately following the 1973 energy crisis, when the impact was felt quickly in the power generation sector. Now it is not as simple or as easy. It will take a longer time for renewables and nuclear to dramatically reduce the demand for oil in the transportation sector. Personally, I don't believe we will see oil demand moving down to 20% of the current level. This is because there is an opportunity for decarbonisation of hard-to-abate sectors, through the use of blue hydrogen. And that is the view current of OPEC countries and the organisation. That's why in COP28, there were calls for the development and use of decarbonised fossil fuels to be supported alongside expanded deployment of nuclear and renewable energy sources

We are currently seeing heavy investments in carbon capture and storage as well as blue hydrogen coming from both the UAE, and SA. That is a way to maintain the value of the huge resources.

> **EL:** *It's interesting how this plays out from technological and historical perspectives. As you also pointed out earlier, there have been innovation shocks in the oil sector which were driven by exogenous dynamics - 1973, then the shale boom. Perhaps decarbonised technologies can actually trigger decarbonization in the fossil fuel sector.*

Adnan Shihab Eldin: Precisely. We are beginning to see this in investments in new clean energy technologies. In Saudi Arabia and the Emirates, we see heavy investment in carbon capture and storage, whether to use it in the oil sector or to produce blue hydrogen as a way of decarbonizing their oil and gas resources. This will drive innovation in carbon capture technologies and reduce costs, helping maintain the economic value of these countries' resources.

> **EL:** *Thank you very much for the really interesting geographical, sectoral, technical, and even historical oversight of these things. Many researchers don't go into a longer time frame of situating nuclear developments across the past decades. This was clear during the interview: that this is a story that begins decades ago, not just with the 21st century.*

Adnan Shihab Eldin: Thank you. I enjoyed our discussion and it allowed me to reflect on what I know and I hope what I provided will be of value to whoever will read it or listen to it. Thank you very much for the opportunity.

Interview with Andrei Marcu - Challenges in EU Climate Policies

Andrei Marcu is the founder and Executive Director of the European Roundtable on Climate Change and Sustainable Transition (ERCST), a Brussels-based think tank. In different capacities, he has been engaged in multilateral negotiating processes and subsequent implementation action, both at the global and sectorial level. He pioneered cooperation between the UN system and multinational corporations when serving as Manager of Private Sector Cooperation in the United Nations Development Programme. During his career, Mr. Marcu has performed at the highest managerial level, both in business organisations and in non-profit organisations.

Interviewed by Gabriele Romeo (GR)

> **GR:** *Market mechanisms have emerged as pivotal tools in achieving environmental goals. The European Union Emissions Trading System (EU ETS), developed in the late 1990s, was one of the pioneering efforts to incorporate these mechanisms on a large scale. Your work has highlighted how the EU ETS operates in a dynamic environment, influenced by other EU, global, and Member State policies. Although a global carbon price has yet to emerge, the EU actively promotes carbon pricing and its worldwide adoption.*
>
> *How do you assess the development of the European carbon market up to today? What are the main concerns going forward?*

Andrei Marcu: The EU ETS has evolved over a number of years, and its architecture and the premises on which it was built are good. In principle, it sounds like a great story. The fact of the matter is that it has started with a simple concept and it evolved into a complex system, which really detracts from the simplicity that was its main attraction. So, my first reflection would be that it has evolved into something very complex. Second thing is, markets are a tool for price discovery and hedging, but the EU ETS has also become a tool for financing now, which really creates a bit of conflict between its initial and original and stated purpose and what it is.

Also, a number of instruments were introduced that detract from the transparency of the ETS. Over the last few years the cap has changed. Another reality is that it has now become a very complex tool. I think that it is doing price discovery within the limits where it is allowed to do so, because it's quite clear that this is not allowed to function as a free market.

There's a band aid being slapped here and slapped there if it goes too high or too low, too fast, too slow. But the main concern is that there's no realization that this market has another ten years of life in it, after which, mathematically, it will not be able to be. The tool that uses some other approaches is going to need to be used at that time.

> **GR:** *Is there room for the emergence of a global carbon price? What do the negotiations on Article 6 of the Paris Agreement reflect about the international community's attitude towards market-based approaches to climate policy?*

Andrei Marcu: We started with the idea of competitiveness. I'm not sure it was called carbon leakage, but the idea of competitiveness was something that was on people's minds when the ETS was produced and hence reallocation. And we saw that we would solve it by having a global carbon price. I don't think that we thought we had sold this one very well, because it's quite obvious that the global price implies a couple of things.

One of them is the fact that you surrender a good part of your ability to do energy policy, which is not going to be acceptable to major powers, or middle powers, they are not going to accept that. The second thing is the fact that it would imply a price that reflects that diversity of mitigation costs. And that is also not something that people that are doing the ETS are looking for - this is probably one of the few markets where people are looking for a high price as opposed to low price. So I think that because of this, the global carbon price is not going to happen.

Article 6 is going through a lot of pain for a variety of reasons. But the main reason is the lack of demand. If there was demand, there would be a resolution to all the kinds of almost childish problems that they have in Article 6, but that is not the case.

I think most people are probably to some degree not unhappy with the fact that it hasn't been solved because they have no intention of using it. If you let a bunch of people lose to find this agreement, they will find disagreement. And there are differences in philosophy and if they are left unchecked, they will complicate finding agreement.

If there was this enormous demand and desire to use this mechanism, Article 6 would be ironed out. So at this point there's a lack of attention and lack of interest.

> **GR:** *Looking at the next EU political cycle, you have recently called for the EU to redouble its efforts on climate diplomacy and international cooperation, which are necessary conditions for the EU climate policy to be sustainable and for the EU to prosper economically. The EU Carbon Border Adjustment Mechanism (CBAM) can be seen as an indirect climate diplomacy instrument, increasing incentives for decarbonization and the adoption of carbon markets in countries producing carbon-intensive goods.*
>
> *Are the EU's climate ambitions holding the industrial base back? Is the speed of the transition in the EU consistent with the "highway rules" of not being slower than traffic (speed of global partners) and not too fast to imperil its passengers (EU economy)?*

Andrei Marcu: You use the word incentives. What incentives? Incentives imply a carrot, and this is a stick. So either you do that or you pay. So let's get our language straight, is not an incentive. It is a threat that you're going to get some form of punishment and tax if you don't do it as we do now. That's within the right of any country to choose to do that.

I think that the CBAM is the only instrument that people can think of for some kind of adjustment at the border. The fact is that you can make it effective internationally in terms of export. But in the end, the story of it is that the EU right now is moving at its own speed and it's passing everybody. At some point there's going to be a policeman somewhere, and the policeman is going to be the economic sustainability of this.

Either we convince them by carrots or we convince them by sticks. Unless we convince them to do the same thing, Europe is going to find itself alone. The whole Paris Agreement is about betting that we plough ahead and somebody's going to follow behind us. If nobody follows behind us and the rest of the world chooses to do business with itself, we will increasingly become disadvantaged.

The fundamental thing that you need to look at is that the EU share of global GDP went down from 20-21 percent to about 12-13 percent in the last 20 years. I'm sure that an economist could explain that, but it's still a number. The ability of the EU to play a role is based - like in any other great power empire - on having the economic cojones to do this. The Spanish didn't have the economic cojones and their empire collapsed; the Russians, great power, lots of nukes, but they don't have the economic power to do this. You know, the Chinese have the economic power to do this. So unless the EU can maintain its economic power, it will struggle to push the green transition ahead globally.

> **GR:** *Should the EU role be more inward-looking or more proactive? Carrot approaches are expensive most of the time.*

Andrei Marcu: Well, unless you believe in coercion and forcing people to do what you do. Now we are giving money to the Chinese to do emissions trading, which sounds a little bit crazy. So either we spend money or we impose some kind of adjustment. These are instruments that we currently have.

I think that the slow diplomacy of persuading people of the rightness of your cause is certainly something that we should give more attention to going forward. You will persuade people of the righteousness of a cause if you show them that you're right. And the righteousness stands behind the fact that you're doing this environment stuff. But the economic and social consequences of it are positive. And the world is not stupid. I mean, the world is watching. In Brazil, a steel association told us “great that you guys screwed up the steel industry of the EU, because we are having a great time exporting steel now”. So unless we manage to adjust and recalibrate ourselves a little bit to what other people do, if we continue to say “damn the torpedo, full speed ahead”, I think that at some point we're going to find out we're going to find ourselves stranded and it may not be so easy to turn around the ship after that or correct course.

So it's not being negative or not being pessimistic. Let's be realistic and look at what is happening out in the world. Yes, we can tell the world, but the world also needs to be convinced to listen.

> **GR:** *How should the revenues from CBAM be spent? What is the difference, if any, between the use of EU ETS and CBAM revenues?*

Andrei Marcu: We are currently working on this. It’s important to recall that there is no ‘CBAM’. There's a CBAM as a companion to the ETS. If you want to convince people of the righteousness of your cause then in some way you have to treat the ETS and the CBAM the same way. So you impose a cost domestically though the EU ETS and the revenues are recycled domestically. There are many funds and the money is to some degree milked from the ETS.

Now if that is the case, and you start impacting trade flows with a CBAM then I think it follows that some portion of that needs to be returned. The problem is, you know, that if you return some money to Mozambique probably nobody's gonna raise problems. But if you start returning money to US or Chinese companies, people will say “what the hell are you doing?”. This is the political debate but it is always part of the negotiation as the CBAM itself. And the international regime continues to evolve, part of it in the UN negotiation, part of it outside.

Interview with Thibaud Voïta - The promise and perils of African Carbon Markets

Thibaud Voïta is a clean energy and climate policy expert and freelance consultant, working on energy policies and climate change. He has worked for 20 years on energy transitions and climate policies. He has managed partnerships accelerating energy transitions and involving multinational companies in 50 countries, advised African governments on climate policies, and supported Chinese facilities in their energy efficiency efforts. He defended a PhD on China's energy policies in 2011 and has worked with the United Nations, the International Energy Agency, and private companies. He has lived in China (he speaks Mandarin) and in several European countries. He is a research fellow at IFRI, and has published many papers on energy and climate transitions.

Interviewed by Gabriele Romeo (GR) and Ernest Lee (EL)

EL: *Under Article 6 of the Paris Agreement, countries may transfer carbon credits earned from greenhouse gas (GHG) emission reductions to other countries. These are referred to as Internationally Transferred Mitigation Outcomes (ITMOs).*

Given the relative development of voluntary markets compared to compliance markets, our first question is about sequencing and how you assess the priorities behind the development of compliance carbon markets in Africa. Are governments prioritising exporting the reduction of carbon over domestic emissions reductions? How have the latest Article 6 negotiations panned out?

Thibaud Voïta: Firstly, Article 6 negotiations have been going on for a long while now and there are hopes at each COP, every year, that a final agreement would be reached. These hopes were particularly strong during the previous COP in Dubai. And unfortunately, there were some disagreements, mostly about the transparency issues, accounting, and the transition of the clean development mechanisms (CDM) from the Kyoto Protocol into new credits under Article 6.

Yet, overall there is a gap between the different negotiators on how much the market approach should be implemented within these carbon markets. Some actors, like the US, are more focused on market approaches, while some other actors, mostly European ones, prefer regulatory ones. You also have new actors that seem to be trying to push for market-based approaches, like Gulf countries with plans for huge investments and new organisations.

In Bonn these days, the UNFCCC is convening subsidiary body meetings. There aren't any heads of state there and the negotiations tend to focus on more geeky details. This is where supposedly many of the very technical issues are discussed and sometimes sorted out, with the hope that this will pave the way to reach an agreement at COP29.[12]

[12] Interviewee's note: The negotiations in Bonn did not bring any significant outcome, leaving most of the work for COP29 and raising new questions about the possibility of an agreement there

EL: *There isn't always light at the end of the tunnel, especially with compliance markets like you mentioned. Can developing economies with huge carbon sinks experience some form of trade-off between the export of credits and the development of the domestic market? Of course, these two options seek to reduce and abate the same ton of CO2. Do you see some positive spillovers or complementarities to choose one against the other today? Why would a country, say, in the Congo Basin choose a domestic registry over a system like the ETS or a carbon tax?*

Thibaud Voïta: The first and easy answer is that we don't know yet - the only time we will know is after Article 6 mechanisms are implemented and assessable. Nonetheless, negotiations are not over yet. There are many Article 6.2 agreements, namely credit carbon offset exchanges between one country and another that are already happening. Switzerland, Singapore, and other countries are particularly active in signing different agreements with countries like Peru, Senegal, Ghana, and others. In the Congo Basin region, none of these agreements exist right now, although in Rwanda next door they are in place.

Under the design of some of these agreements, which the UNDP (United Nations Development Programme) has played a big role in, the idea is that part of the offset will remain in the country. For projects generating GHG emissions reductions, something like 10% will stay within the country and will be placed under the registry of this country. Then the money generated by the acquisition of the rest of the carbon offsets will be dedicated to the implementation of the nationally determined contribution (NDC) and development plans of the country. These mechanisms should allow the seller to avoid having all of their emissions reductions sold away to other countries.

Yet, a huge challenge for these markets remains the understanding of how all this works. The architecture of these markets is ridiculously complex, and this is I believe a major issue. Also, in all the projects I've been working on, I've never seen an assessment of the potential of these carbon markets, nor an assessment of the challenges for the countries. My impression is that many countries are moving towards such agreements without having all the necessary information to implement them. Hence, there's lots of experimentation, and things seem to be going pretty well in the most advanced projects like Ghana and Senegal in Africa. But how will the rest work? It's a big question.

We should also consider capacity. Again, we are talking about mechanisms that are extremely complex. Now, consider actors like Switzerland's KLiK Foundation, which has many staff, mostly graduates from great universities. They don't have Internet connection issues, and have access to many repositories of knowledge and languages. Conversely, in developing economies, most points of contact are staff working for the ministries of environment, which in general have limited capacities financially, personnel-wise, or even internet connection or English proficiency and document access. There is a real asymmetry in terms of capacities, which makes such agreements very challenging.

EL: *This note of asymmetry is very important : carbon offsets today have ostensibly global coverage, but in reality are implemented in such uneven ways. Let's transition to the second question.*

Carbon markets, both compliance and perhaps voluntary ones, continue to strengthen in Africa. How does this change this narrative of global energy transitions? Do you think there's actually a lot of continuity regarding how Article 6 or even how Article 6.2 has been unfolding thus far? You mentioned it's mostly advanced economies like Switzerland and Singapore are the ones initiating these agreements: is there a lot of potential for change, or one of continuity in how the global energy economy is structured?

Thibaud Voïta: Well, first of all, it's not only about energy, right? For the Congo Basin, forestry is the biggest matter. Energy projects are probably the easiest because most of them are small, such as clean cooking. Is the money that will be generated by these credits really best used for clean cooking, which uses a relatively small amount of money? Governments can use their own budget or other international projects to finance this part of the energy transition, and do not necessarily have an interest in promoting these projects in the carbon market context rather than others.

So that's one point. Then, in terms of narrative. I think it's a make-or-break case and probably that we will remain between continuity and disruption. The documentation and criticism towards carbon markets is very voluminous and it's growing. *The Guardian*, for instance, has recently published an exposé about the scandals surrounding Verra and REDD+ [Reduction Emissions from Deforestation and Forest Degradation] projects which are often extremely problematic.

In Congo and Kenya, various populations have been expelled from their territories, and we see reports about repeated sexual abuse from NGO staff, with questionable emission reductions, among other scandals. It resembles a typical neocolonial situation with Western staff or Western-employed staff coming to exploit natural resources whose benefits will go to foreign companies. A report that was published in 2023 about ACMI, the African Carbon Market Initiative by a group of local and regional NGOs deeming ACME a 'wolf in sheep's clothing'.[13] These projects look great on paper, especially with money flowing to the African countries, but the reality can be very different on-the-ground.

However, we should also bear in mind these funds flowing to African countries are typically left over from international development and international climate money. Such flows generate development-side benefits that are extremely important, and can complement national plans. The development side of these carbon markets are often ignored by Western critics, who only see carbon markets as a greenwashing/neocolonialism mechanism. However, these markets can, or should in theory, also help address the international development finance gap. This is why many developing countries are very attached to these. There's a good example: a waste company growing thanks to a project with the Swiss KLiK foundation, which would really develop waste management systems in the country and potentially in other West African countries because of its expertise that it could export in other regions.

So you have these two narratives facing each other. Which one will be the best one, and which one will succeed? It's impossible to tell for the time being. And I think they are bound

[13] Power Shift Africa. 'The Africa Carbon Markets Initiative: A Wolf in Sheep's Clothing', 2023. https://www.powershiftafrica.org/publications/the-africa-carbon-markets-initiative-a-wolf-in-sheeps-clothing.

to coexist. And there will always be critics and they will always be defenders of carbon markets. Like many actors in the field, I am hopeful that stricter regulations, transparency and better monitoring would allow for better results.

> **GR:** *We have a follow up question on the political buy-in and the acceptability of carbon markets as a climate mitigation measure. In Africa, these are heterogeneous; you've mentioned Ghana and Senegal are ahead, but have you observed whether the revenues from commoditising carbon offers really accrue to the country in an appropriate way so that they reap the benefits of it? Can such agreements play a role in boosting acceptability both from the bottom-up, but also top-down from the politicians?*

Thibaud Voïta: My experience is that most governments are totally buying it. Many officials see this as a huge opportunity for their countries, and I'm tempted to say that maybe they're seeing it as too much of a big opportunity. Perhaps their expectations are too high because they're seeing this as an opportunity to reduce their national GHG emissions, and therefore implement their indices. Sometimes I wonder if they consider how these GHG emissions reduction will go to other countries' registries. Again, we are talking here about a very complex mechanism that we do not necessarily know the outcome of yet.

They also see this as an opportunity, obviously, to gain some money that will allow development projects. Article 6 projects have the key aspect of SDG [Sustainable Development Goals] which go beyond just the climate.

Finally, these officials also see this as an opportunity to raise African profiles. There is the concept of 'carbon nationalism', with the idea that for once, Africa has the opportunity to take full advantage of its resources rather than have these resources exploited. So there are some pushes for the international carbon exchange to be based in Africa, potentially in the MENA region, typically Morocco, if power cuts do not allow Sub-Saharan countries to host it. There are also some very strong pushes for the countries to be selective about their buyers and if possible, to create more exchanges within Africa.

The Democratic Republic of Congo was discussing allocating part of the revenues from the carbon markets to development to Small Island Developing States and countries that are facing severe droughts in Africa. So there's a very strong push for this that's at the government level.

With NGOs, the situation can be different. They look at how projects are actually implemented: going to the forest where the REDD+ projects are. What are the benefits for the local population? Sometimes you have a completely different story. Typically, there are all kinds of problems with tree planting t, in terms of impact on the ecosystem, the soils, and local agriculture. These are issues that are very difficult to predict. The action of planting trees looks nice on paper, but it can actually have bad consequences.

> **EL:** *Monitoring, reporting and verification systems are quite unevenly implemented around the world. How robust are these systems currently in the countries you are familiar with? And is there a differing perception of African-origin carbon credits compared to ones from other parts of the world?*

Thibaud Voïta: I won't talk about Africa as a whole because I don't know the situation in every country. However, looking at the UNFCC's report on DRC's REDD projects, their assessment is that there is room for improvement.[14]

There are lots of issues with the way the data is handled and there are inconsistencies within the report. So there's a lot of progress to be made. This has to go through some very strong institutional reinforcements and capacity building. That's the situation in only the DRC. Generally, there are new technologies that should allow for better data and therefore better practices in terms of MRV to better monitor these projects.

I've never been on the ground to check how these projects are working. I hope that not all the projects are going the wrong way; as mentioned, the Senegal waste management project for the time being, seems to be a successful one. I believe this is one out of many and hopefully there will be more in the future.

In sum, carbon markets are a very complex and constantly evolving topic. I've met some very impressive people in Central and West African governments who have great technical knowledge of all these aspects, a much better understanding than mine and who are pushing hard for great projects leading to greater GHG emission reduction, better forest protection and broader development to happen. This gives me lots of hope. Now, how will this evolve? There's lots of unknowns. One thing that many people are hoping, is that local universities would take over these issues, and be able to develop local capacities, with academics able to understand, evaluate and monitor the projects, and who could support governments, but also local populations. But they would need some support.

Moreover, we haven't talked much about the price of a carbon credit, which obviously needs to be profitable for the countries. Thus, there are lots of discussions between the countries about how to set this. On the other hand, there is the risk that countries would be put in competition between each other by the buyers, by companies and so forth. So that's also a potential issue.

Finally, I should also mention that there are projects of emission trading scheme, regional emission trading scheme, that are emerging. And this could also be an interesting topic to explore, though to my knowledge, we are still at a very early phase.

> **GR:** *Elsewhere, for the energy transition, the huge, well-developed Chinese market has brought down prices for clean technology dramatically. Think about the learning curve of EVs or solar panels and batteries, which have proceeded dramatically. From the perspective of Europe, how can international compliance with subsidies regimes be ensured? Or do Europe's strategic interests stand regardless of the competition problem, and lie with keeping prices for crucial parts like electrolysers low*?

Thibaud Voïta: I understand these two points of view. On one hand, there is a need to reindustrialize and to do in Europe what the US is doing with the Inflation Reduction Act (IRA) and aggressive measures toward Chinese goods. Or on the other hand, there is a narrative that I've seen not so much in France, probably more in northern European countries or in parts of the German government. This narrative is about simply benefiting from low cost

[14] UNFCCC. 'Technical Report on the Technical Analysis of the Technical Annex to the First Biennial Update Report of the Democratic Republic of the Congo Submitted in Accordance with Decision 14/CP.19, Paragraph 7, on 30 December 2022 | UNFCCC'. REDD+ technical analysis technical report (TATR), 29 May 2024. https://unfccc.int/documents/638722.

technologies that are arriving on the European market: “forget about industry and use this as a way to accelerate decarbonization”. My belief is that we can't only rely on foreign technologies like this.

Don't get me wrong, there are benefits. China pushed prices down, enabling an acceleration which was not foreseen in the most optimistic scenario of the penetration of solar panels. That's absolutely amazing and has really boosted the energy transition. On the other hand, we are strongly dependent on Chinese goods. When you look at solar PV panels, China is manufacturing approximately 95% of ingots and wafers. What this concretely means is that if China chooses to close its borders because of a new Covid-type of pandemic or – who knows – a war with Taiwan, our energy transition is simply stuck.

A few things that have shocked me at the European level is that we have here a situation that results from a very clear plan in China. Beijing has always been clear about its ambitions, and the steps it would take to reach them. General information about this was released, and often analysed by Western think tanks and experts. During the catch up and the rise of these industries, nobody reacted in Europe. The European Net Zero Industry Act (NZIA) is a good step in the right direction, but a very tiny step towards what's needed. This was not a reaction towards the flood of Chinese goods, but a reaction to the Inflation Reduction Act in the US… which itself was a reaction towards cheap Chinese imports. Our capacity for reaction in Europe is extremely poor, that is a real pity and it may have cost us our industry.

We are suffering in Europe from a total lack of vision and of preparation for our industrial policies. I've been talking a lot to solar PV industries recently. You have those who used to suffer and who died. A company I spoke to recently, Systovi, went bankrupt a couple of weeks after a conversation I had with their CEO, because they couldn't compete with Chinese goods. For reference, in early 2023, a Chinese solar panel was approximately a third cheaper than its European counterpart. Over the course of the year 2023, the price dropped by a further 40%, which made it absolutely impossible for these companies to survive. This has real impacts for local employment and economies. We're talking about engineers and high qualified jobs most of the time.

On the other hand, you have new companies, and I'm more specifically thinking in France, of two companies, HoloSolis and CARBON, who are developing giga-factories with an integrated value chain for Holosolis at least, and these should be competitive or allow for the gap to be bridged. No matter where you come from, or your political beliefs, no one can disagree about the fact that having one country producing 95% of a good is not a good thing. It's putting us in a very strategically tricky position.

> **GR:** *I agree that the geostrategic aspect of all these clean tech supply chains has been neglected. At least the Net Zero Industry Act, Critical Raw Materials act, are a first step. Of course, not conclusive, but hopefully the next commission will also give a lot of attention to the implementation and the competitiveness aspect of it.*
>
> **EL:** *So maybe we could have a call in one year for an update. Or September. Thank you for your time, this has been an insightful interview.*

4. Debate

Debate question

Should we slow down the energy transition to guarantee political and economic affordability? What responsibilities do countries and communities have for responsibility for climate change?

For: The energy transition *should* be slowed down to guarantee political and economic affordability

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The author is currently a second-year master's student pursuing a degree in International Energy Transitions at Sciences Po, coupled with a double degree in International Political Economy at LSE.

Navigating the energy transition: A pragmatic approach

The appropriate pace of the energy transition, a monumental shift from fossil fuel dependence to renewable energy systems,[15] beckons with its promise of a sustainable future. However, as we venture towards this goal, we must face the implications on our economic stability and political fabric, even if it means slowing the energy transition.

Reducing market fluctuations and inflation before transitioning energy resources is essential.

Firstly, accelerating the energy transition encounters obstacles such as energy price fluctuations and financial constraints. As one example of many, New England experienced significant volatility in natural gas spot prices in 2022, with an average price of $8.880/MMBtu at Algonquin Citygate but a December spike of $34.900/MMBtu.[16] The U.S. relies on natural gas as a bridge fuel in transitioning to renewables due to its lower emissions than coal and oil. However, economically, volatile prices lead to inflation, raising living and business production costs. Politically, this may affect public opinion and major elections, contributing to a change in the ruling party to one less supportive of the energy transition.

In developed economies, inflation and changes in strategic priorities have led to the postponement or cancellation of major renewable projects. Ørsted, the world's leading offshore wind developer, exited a consortium bidding for Norwegian offshore wind projects,

[15] S&P Global, "What is energy transition?," 24 February 2020, https://www.spglobal.com/en/research-insights/articles/what-is-energy-transition.
[16] Natural Gas Intelligence, New England natural gas spot prices: Algonquin Citygate, 2022, https://www.naturalgasintel.com/haynesville-output-to-top-16-bcf-d-as-total-lower-48-production-continues-to-climb/.

prioritising other investments amid rising costs and supply bottlenecks.[17] Ørsted's withdrawal may slow Norway's renewable energy development by deterring potential investors and complicating project planning and funding. In developing economies, energy transition is even more challenging due to the higher capital costs, lack of preexisting technology development, and less experienced labour force. Geopolitical tensions, such as the Russia-Ukraine conflict, exacerbate the financial challenges: Following the conflict's outbreak, developing countries such as Zimbabwe and Argentina experienced extreme interest rates surging 80% and 44.5%, respectively.[18] The escalation of interest rates amplifies financial pressures on developing countries, forcing them to rely on international funding with stringent conditions, undermining local ownership and self-sufficiency in energy sectors. At the same time, continued reliance on fossil fuels exposes their economies to the fluctuations of global oil and gas markets.

Thus, establishing stability is essential for a successful energy transition. Challenges include volatile energy prices, as seen in New England, and financial constraints, such as Ørsted's delays. Geopolitical tensions like the Russia-Ukraine conflict exacerbate these issues by increasing interest rates and straining resources. Quelling inflation and establishing a stable economic environment is crucial for nations to effectively plan, invest in, and implement a sustainable energy transition.

The energy transition faces significant hurdles due to grid integration challenges, inconsistent and inadequate regulatory frameworks, and community backlash.

Secondly, our ambitions for a renewable energy landscape meet with coordination and integration challenges, including gridlock, insufficient regulation frameworks, and community opposition.

The gridlock issue extends beyond physical infrastructure limitations like outdated transmission lines and substations. Instead, it precipitates from the complex tapestry of our grid infrastructure, which is woven with technological mismatches, investment shortages, and infrastructure unsuitable for renewables. Chile, targeting 70% green energy by 2030, struggles with its geographically extensive grid, unable to transport surplus solar energy from the northern regions, where peak production occurs, to the central and southern regions, where demand is highest.[19] The outdated grid was initially designed to support centralised hydroelectric and coal-fired plants in significant consumption areas. As a result, it cannot effectively accommodate new solar installations' decentralised, intermittent output. Oversupply in the northern regions resulted in significant energy losses and continued reliance on fossil fuels in-demand areas.

Moreover, existing regulatory frameworks cannot easily adapt to an accelerating energy transition. EDF, a prominent French renewable energy company, withdrew from a solar plant project in Girardot, Colombia, two years after the project was awarded to it in 2021 due to environmental permitting delays and unfavourable tax reforms.[20] The project, initially planning a 145 megawatt (MW) peak capacity, became infeasible due to these challenges.[21] For future

[17] Kennedy, C., “After U.S. withdrawal, Orsted pulls out of Norway wind bidding,” 2023, *OilPrice.com*.
[18] Neufeld, D., Mapped: Interest Rates by Country in 2022, Markets in a Minute, 21 April 2022, https://advisor.visualcapitalist.com/mapped-interest-rates-by-country-in-2022/
[19] Antonia Laborde, I.F., *Renewable energy boom in Chile takes a toll on electrical grid*, *EL PAÍS English*, 2023.
[20] Reuters, “France’s EDF to withdraw from Solar Project in Colombia,” 2023.
[21] Ibid.

energy transition projects in Colombia and elsewhere, it is vital to advocate for a more gradual approach that ensures adequate and long-term stable regulatory support before projects are enacted.

Most poignantly, communities opposed to new renewable energy development make themselves heard. A study tracking utility-scale wind, solar, and geothermal projects from 2008 to 2021 across 28 U.S. states found that 53 initiatives were delayed or blocked due to local resistance, affecting 37% of the potential generation capacity.[22] One-third of opposition is linked to the rights of Tribes under the Federal Trust Responsibility, which requires additional federal oversight for projects impacting Tribal lands, halting renewable energy development in the U.S.[23]

These examples underscore a disconnect between boardroom strategic plans and the complex realities encountered in infrastructure upgrades, governmental arenas, and local communities. Despite our ambitions for a swift energy transition, careful pacing is essential to manage public sentiment effectively, as negative publicity may hinder the energy transition over the long term.

Widespread energy efficiency improvements in the building sector are financially infeasible for most homeowners, reducing the speed of the energy transition.

Finally, we confront the stark realities of energy transition within the building sector. The sector's unique challenge lies in the longevity of buildings, requiring careful initial design and material choices to ensure energy efficiency over decades. As of 2022, the sector, encompassing residential and non-residential structures, accounts for nearly 30% of global energy consumption and contributes 26% to global energy-related emissions.[24] High emissions are primarily due to energy inefficiency, including outdated building designs, poor insulation, inefficient heating and cooling systems, and reliance on non-renewable energy sources. While direct emissions from building operations decreased by 3 gigatonnes, indirect emissions from electricity and heat used in buildings increased by 6.8 gigatonnes from 2015 to 2021.[25] These facts highlight the need for comprehensive mitigation strategies across the entire building value chain to address both direct and indirect impacts of building energy consumption. If implemented successfully, we could go a long way in reducing emissions with less investment in expensive energy transition technologies.

Yet, the UK's experience illustrates the complexities between energy-efficient building transition and economic and social repercussions. With around 36.5% of housing stock built before 1945, the UK grapples with carbon lock-in, as immediate upgrades of outdated infrastructures pose a significant financial burden for homeowners.[26] The lack of financial incentives for home efficiency improvements exacerbates the challenge of the green building transition. The U.K.'s Boiler Upgrade Scheme, funded only by £450 million (£6.50 per

[22] Susskind, L., et. al., Sources of opposition to renewable energy projects in the United States. *Energy Policy*, *165, (2022)*, 112922. doi:10.1016/j.enpol.2022.112922.
[23] Ibid.
[24] IEA, Buildings - Energy System, 2022, https://www.iea.org/energy-system/buildings.
[25] Ibid.
[26] Seto, K. C. et. al (2016). Carbon lock-in: Types, causes, and policy implications. *Annual Review of Environment and Resources*, *41*(1), 425–452. doi:10.1146/annurev-environ-110615-085934.

capita),[27] falls far short of motivating the widespread adoption of energy-efficient technologies that would allow a building energy transition to occur.

Conclusion

To sum up, we must be realistic about the transition pace, ensuring it is manageable and aligns with long-term sustainability goals. Rather than rapid adoption of renewables, the energy transition requires the pragmatic enhancement of current systems to ensure stable energy supplies and functioning grids, mitigate inflation risks and financial burdens, reduce political and social unrest, and encourage collaboration. Building a future-ready energy system must come in parallel with building a foundation of political trust and shared ambition – even if that means a slower energy transition.

[27] GOV.UK, Boiler Upgrade Scheme (BUS) monthly statistics, March 2023, https://assets.publishing.service.gov.uk/media.

Against: The energy transition should *not* be slowed down to guarantee political and economic affordability

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Coming from Italy, Pietro Rinaldi is currently pursuing a master's degree in International Energy Transition at SciencesPo with a minor in Sustainability. In July 2023, Pietro graduated with distinction (110/100 Cum Laude) in Diplomatic and International Sciences from the University of Bologna, Italy.

We should not slow down the energy transition to guarantee political and economic affordability. It is imperative that the focus remains on the energy transition, and any process that could potentially slow down the phase-out of fossil fuels needs to be thoughtfully considered before being actuated.

In countries that are largely dependent on fossil fuels as producers and as consumers, the argument in favour of energy equity to the detriment of energy sustainability is widespread. It appeals to ideas that generate resilient emotions in the readers: energy independence and security, the fight against energy poverty, and the equal possibility for any country to develop its natural resources. However, it does not consider the time sensitivity in the fight against climate change. Indeed, the IPCC recognises with "*very high confidence*" that the window of opportunity to secure a sustainable future is rapidly closing.[28] This becomes even more critical considering that the goal of not surpassing +1.5°C of global warming is barely feasible anymore.[29] Considering this urgency, it is crucial to prioritise mitigating climate change effects on populations; to slow down the energy transition, a key step in this effort, is impossible to justify.

The issue of political and economic affordability then still stands. To address this debate, it is central to examine an important factor: the responsibility for causing climate change. An analysis of the level of CO2 emitted per country enables an interpretation of this liability. There are many different methods to do so, but the most relevant in this case are cumulative CO2 emissions, annual CO2 emissions, and per capita CO2 emissions.[30]

Each measurement emphasises a specific aspect of emissions. In the first case, cumulative CO2 emissions describe historical data, which are relevant because CO2 remains in the atmosphere for hundreds of years.[31] When using this measurement the top emitters are the US, the EU, and China. At the same time, it would not be fair to consider only historical emitters and not the countries emitting most today. That is why, if we observe more recent annual emissions, there are significant differences. In particular, European countries have

[28] IPCC, "Synthesis Report of the IPCC Sixth Assessment Report (AR6) Summary for Policymakers," IPCC, 2023, https://www.ipcc.ch/report/ar6/syr/downloads/report/IPCC_AR6_SYR_SPM.pdf.
[29] Hansen, J. E. et. al, 2023. "Global Warming in the Pipeline." Oxford Open ClimateChange 3 (1). https://doi.org/10.1093/oxfclm/kgad008.
[30] Ritchie, Hannah, and Max Roser. January 2024. "CO2 Emissions." Our World in Data. .https://ourworldindata.org/co2-emissions.
[31] MIT Climate. 2023. "How Do We Know How Long Carbon Dioxide Remains in the Atmosphere? |MIT Climate Portal." Climate.mit.edu. January 17, 2023. https://climate.mit.edu/ask-mit/how-do-we-know-how-long-carbon-dioxide-remains-atmosphere.

significantly decreased their emissions in past decades, dropping out of the leading positions. Lastly, while it is important to understand every country's net emissions, this data can be weighted to account for the population of each country. Observing CO2 emissions per capita, the results are considerably different: countries that were initially not high emitters in the previous measurements are now at the top of the list, such as Bahrein, the UAE, and Australia. In other words, every metric yields a different result.

Two conclusions can be made from this analysis. First, there is no one piece of evidence for who is most responsible for the majority of the emissions, and thus most responsible for climate change. To understand the full picture, all of the different measures should be considered jointly. Secondly, and perhaps most notably, today's developing countries are ranked at the bottom of all the categories taken into consideration before; they are not significant emitters today and they were not in the past. This brings an important point to the discussion: why should developing countries then bear the costs of the energy transition, when they have not been the main cause of climate change by any measurement, and for whom an energy transition would be most costly? The answer ought to be clear: they should not.

But how is it possible to reduce CO2 emissions and further the energy transition in countries that bear no responsibility, given the urgency of climate change?

The responsibility of leading the energy transition, catalysing the transition from fossil fuels, should be put on the countries that have contributed most to CO2 emissions historically and continue to do so. Fundamentally, both energy equity and the energy transition must be considered as two sides of the same coin. Developing countries that are rich in fossil fuel resources should receive assistance in establishing fossil-free energy systems and economies. With this support, they can develop the knowledge needed to establish their energy transition strategies and develop green energy projects. After all, the potential in many emerging economies for renewable energy is incredibly high: the estimates of generation capacity for the developing country in Africa alone include 10 TW of solar, 350 GW of hydropower, and 110 GW of wind.[32]

Needless to say, the initial capital requirement for such investment will be enormous. But here, past fossil fuel users must intervene. Funds need to be established and concessional loans given, which can be achieved through large financial institutions backing emerging economies in these projects. This would be the perfect opportunity to re-establish the World Bank as the uncontested global leader in the matter.

Finally, to obviate the immediate problems of energy equity and a stable supply of energy, it is unquestionable that some transition fuels, those that reduce but don't fully remove CO2 emissions from the energy sector, will be used.[33] For example, in different African countries, such as Mozambique, that have copious amounts of natural gas reserves, natural gas can be utilised not for export to developed countries, but instead for domestic consumption.[34] This

[32] African Development Bank. 2019. "Why Africa Is the Next Renewables Powerhouse." African Development Bank - Building Today, a Better Africa Tomorrow. January 28, 2019. https://www.afdb.org/en/news-and-events/why-africa-is-the-next-renewables-powerhouse-18822.
[33] Gürsan, C., and V. de Gooyert. 2020. "The Systemic Impact of a Transition Fuel: Does Natural Gas Help or Hinder the Energy Transition?" Renewable and Sustainable Energy Reviews 138 (138): 110552. https://doi.org/10.1016/j.rser.2020.110552.
[34] EIA. March 7, 2022. Natural gas reserves in Africa as of 2021, by main country (in trillion cubic feet) [Graph]. In *Statista*. Retrieved June 16, 2024, from https://www-statista-com.acces-distant.sciencespo.fr/statistics/1197585/natural-gas-reserves-in-africa-by-main-countries/.

would in turn relieve an immediate problem of energy supply and energy price stability, and it would also signal a concrete movement away from more polluting fuels, such as coal or oil.

In conclusion, while the energy transition may cause economic and political challenges, we cannot risk delaying it any longer. This means that even countries for whom the transition is bound to be especially difficult must participate. However, from all the possible perspectives, ethically, morally, and altruistically, the weight that emerging economies will carry to achieve their energy transitions needs to be divided between all the states that are currently exploiting fossil fuels and have in the past. To achieve a positive outcome in the fight against climate change, the dynamic of state cooperation needs to be strengthened and accelerated, not weakened.

5. Critical essays

It's not only about gigawatts: A comment on the COP28 renewable energy target's conceptual issues

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Walking into Dubai Expo City on day one of COP28, many of us were sceptical that a climate conference hosted by a major oil nation would bring about any success. Instead, the energy and climate communities melted together under the scorching sun, and managed to deliver an unprecedented agreement.

For me, coming to work in the energy field with an environmental background, the connection was clear, but for the past few decades, energy and climate discussions have been conducted in parallel, with sustainability and energy experts speaking to separate audiences, failing to blend, like oil and water.

The paradigm of the energy trilemma, whereby sustainability is placed in competition with energy equity and security in a zero-sum game style, has shaped the energy transition debate. However, renewable energy is increasingly visible as a win-win-win solution to the energy trilemma, or perhaps a set of solutions that can adapt to all kinds of scenarios. From increasing energy access through decentralised solar PV, to improving air quality in cities and ensuring a stable and local energy supply in the face of geopolitical tension.

After years of sidelining energy in climate discussions, COP28 was the moment when it became a centrepiece. The Dubai conference started strong, with the EU-led pledge of close to 130 countries to triple renewable energy capacity and double the rate of energy efficiency improvements by 2030 being launched on December 2nd.[35] The discourse of the pledge, backed by civil society, academia, and industry players, was key in shaping the energy sections of the First Global Stocktake released on December 13. Paragraph 28 "*further recognised*" the need for several global efforts, including "*(a) Tripling renewable energy*

[35]COP28, 'COP28: Global Renewables And Energy Efficiency Pledge', 2023, https://www.cop28.com/en/global-renewables-and-energy-efficiency-pledge.

capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030." [36]

The COP28 target has been framed as a great victory for renewable energy,but questions remain about whether it is the best tool to push for a quick, equitable and feasible decarbonisation of our energy system.[37] Before challenging any implementation challenges we may encounter, such as the finance gap, or issues of distributive justice, and other socio-economic and geopolitical considerations, we must look at the conceptualisation of the target itself.

This piece will sketch two key critiques of the COP28 target, and argue that renewable energy capacity increase must go hand in hand with a focus on energy beyond the power sector, energy demand reduction, and reducing fossil fuel dependency.

Renewable fuel and heat: The missing 80%

The COP28 target is focused on increasing electricity or power capacity, a carrier that, as of 2020, only represented 23% of Total Final Energy Consumption (TFEC).[38] While the share of electricity in TFEC is estimated to grow to 28% in IRENA's Planned Energy Scenario (under existing policies) and over 50% by 2050 following IRENA's 1.5 Scenario the reality is that the target is leaving aside nearly 80% of energy consumption today, in the form of heat and fuels, and that these will still represent a significant share of TFEC in all scenarios.[39]

The so-called renewable energy target is reflective of the biases of broader energy discussions, which have led to an uneven development of renewables across the different **energy carriers**.While renewables are providing close to 30% of electricity consumed, they represent only 3.7% of fuels, mainly in the form of biofuels, and 9% of heat, mainly coming from bioenergy, solar thermal, and geothermal.[40]

Efforts in shifting to renewable heat and fuels, concentrated, in some cases, in specific **regions**, are not being recognised in the COP28 target. China represented 73% of solar water heating, and only four countries: China, Türkiye, Iceland and Japan, accounted for 90% of direct geothermal use in 2022. In the case of renewable fuels, North America and Latin America held a combined 69% of supply in 2020.[41] These efforts must also be encouraged and recognised in international forums.

Additionally, the target is biassing efforts towards the most dominant power generation **technologies**. Solar PV and wind energy are often portrayed as the heroes of the energy transition, and it is true that they represented 73 and 24% of power capacity additions in 2023 respectively.[42] However, we often forget that modern bioenergy is the most used

[36]UNFCCC, 'Outcome of the First Global Stocktake. Draft Decision -/CMA.5. Proposal by the President | UNFCCC', 2023, https://unfccc.int/documents/636608.
[37] GRA, 'COP28 Pledge on Tripling Renewables Kicks off Massive Scale up of Renewable Energy - but Action and Accountability Must Now Match This Ambition - Global Renewables Alliance', 2023, https://globalrenewablesalliance.org/cop28-pledge-on-tripling-renewables-kicks-off-massive-scale-up-of-renewable-energy-but-action-and-accountability-must-now-match-this-ambition/.
[38] REN21, 'GSR 2023: Renewables in Energy Supply', 2023, https://www.ren21.net/gsr-2023/.
[39]IRENA, 'World Energy Transitions Outlook 2023: 1.5°C Pathway', 22 June 2023, https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023.
[40]REN21, 'GSR 2023: Renewables in Energy Supply'.
[41] *Ibid.*
[42]IRENA, 'Record Growth in Renewables, but Progress Needs to Be Equitable', 27 March 2024, https://www.irena.org/News/pressreleases/2024/Mar/Record-Growth-in-Renewables-but-Progress-Needs-to-be-Equitable.

renewable energy source and accounts for 55% of renewable energy supply globally.[43] While it is important to highlight that bioenergy must be linked to stringent sustainability standards, tacking impacts on biodiversity, food availability or human livelihoods,[44] it is equally important that, once those are fulfilled, it is valued as a flexible and accessible renewable energy source.

Even if electrification is a priority and renewable power technology deployment is accelerating at an unprecedented rate, the reality is that renewable fuels and heat are, and will be necessary for the energy transition. Energy use for transport applications will still require the direct use of fuels, despite the rise of hydrogen and e-mobility. Moreover, key industrial processes such as cement and steel production require temperatures above 1,000°C, which are hard to reach via electrification.[45] Here, direct renewable heat can play a key role in decarbonisation.

From accelerating to re-thinking

The other weak point of the target, conceptually, is the use of an absolute growth goal. Tripling renewable energy would mean moving from the 2,282 GW of installed capacity in 2022 to over 11,000 GW in 2030.[46] However, capacity additions must be read in the broader energy consumption context. Over the last few years, growth in renewable energy use has not displaced fossil fuel use. Despite consumption of renewable energy growing by 58% between 2012 and 2022, the share of renewables in final energy consumption only increased from 9.5 to 13%, and consumption of fossil fuel is at a record high, still representing 79% of final energy consumption.[47]

We can triple renewable energy capacity, but this will mean nothing if we also triple our fossil fuel consumption to meet the ever-rising energy demand. Increasing renewable energy capacity without replacing fossil fuels will not be enough to keep the Paris Agreement alive.[48]

Adding the energy efficiency target to the renewable capacity one could be a way to incorporate some of the concerns over the rising energy demand - since higher efficiency would mean lower energy demand for the same output. Here, we run the risk of entering the Jevons' paradox: an increase in energy efficiency leads to higher energy consumption through reducing energy use costs. Thus, change must be more fundamental than efficiency improvements.

While the debate between shares or absolute growth may seem like a technical one situated far from the realities of everyday people, it is a decision that is shaping the societal and economic pathway our energy transition is to follow. And it is clear that, despite increased ambitions, we are far from meeting the capacity needed to stay below 1.5. While in 2023 we

[43]'Bioenergy', IEA, accessed 7 April 2024, https://www.iea.org/energy-system/renewables/bioenergy.
[44] Ibid.
[45] REN21, 'GSR2023: Energy Demand', 2023, https://www.ren21.net/gsr-2023/modules/energy_demand/.
[46]IRENA, 'Tripling Renewable Power and Doubling Energy Efficiency by 2030: Crucial Steps towards 1.5°C', 30 October 2023, https://www.irena.org/Publications/2023/Oct/Tripling-renewable-power-and-doubling-energy-efficiency-by-2030.
[47]REN21, 'GSR2024: Global Overview', 2024, https://www.ren21.net/gsr-2024/.
[48]IPCC, 'Summary for Policymakers: *Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*' (Geneva, Switzerland: World Meteorological Organization, 2018).

installed 473 GW of new renewable energy capacity, the tripling target would entail having installed over 1000 GW, and the same from 2024 to 2030.[49]

This is where using renewable energy shares as a Key Performance Indicator (KPI) broadens our toolset. While adding renewable capacity is a way of producing green energy, if fossil fuel consumption equally increases, the share would show no progress. Here, we **move from the prevailing accelerationist paradigm to one of re-thinking our economic and societal models**, emphasising a qualitative shift.

Before assessing how politics would have to work in the paradigm of high renewable energy shares, a quick note on economic and technical feasibility is due: Despite concerns about balancing a grid with high shares of variable renewables, more and more players are seriously exploring 100% renewable energy systems.[50] And the economic case for high shares in electricity generation is strong: in the United States, for instance, it is estimated that reaching up to 90% of renewables in the electricity mix would cost just as much as the current system[51] - and that is considering the decreasing benefits of higher shares of wind and solar PV in the energy mix.

Let us return back to the *how* of this share-based target. Increasing renewable energy shares is achievable through two main mechanisms:

First, **removing incentives to fossil fuel production and consumption** to reduce their share in the energy mix. On the demand side, we need an orderly and well-planned removal of direct and indirect fossil fuel subsidies which, as of 2022, accounted for over USD 7 trillion worldwide.[52] We also need to start unpacking what climate leadership means. Countries cannot be considered climate leaders when oil and gas exports are at the backbones of their economies. The case of Norway comes to mind here: while 61.3% of energy consumption in 2020 came from modern renewables, oil and gas still represented 93% of domestic energy production, mainly for exports, while oil revenues constituted 4.3% of GDP (compared to 0.2% on average in OECD countries.[53]

The second key leaver to increase renewable energy shares is looking beyond energy generation, to the energy demand side. The **lower demand** is, the easier it is to cover it, and to do so with renewables.[54] Here is where proposals coming from the degrowth literature can prove invaluable. The main tenet of degrowth is to deconstruct the need for constant and global economic growth as a driver of prosperity, replacing it with other human and social progress indicators. Degrowth thus challenges the need for increasing resource use, mainly in high-income economies, and instead calls for a planned downsizing of economic activity, together with a widespread and fair redistribution of resources.[55] While discussing the merits

[49] IRENA, 'Record Growth in Renewables, but Progress Needs to Be Equitable'.
[50] One Earth, 'Updated One Earth Climate Model (OECM): Decarbonizing All Sectors of the Economy to Limit Global Temperature Rise to 1.5°C', One Earth, accessed 27 April 2024, https://www.oneearth.org/updated-one-earth-climate-model/.
[51] Amol Phadke et al., 'The 2035 Report: Plummeting Solar, Wind, and Battery Costs Can Accelerate Our Clean Electricity Future', *White Paper. Goldman School of Public Policy*, 2020.
[52] REN21, 'GSR2024: Global Overview'.
[53] IMF, 'Putting Oil Profits to Global Benefit', IMF, accessed 28 April 2024, https://www.imf.org/en/Publications/fandd/issues/2022/12/POV-putting-oil-profits-to-global-benefit-isachsen-gylfason. IEA, 'Norway - Countries & Regions', IEA, accessed 28 April 2024, https://www.iea.org/countries/norway.
[54] Joshua Floyd et al., 'Energy Descent as a Post-Carbon Transition Scenario: How "Knowledge Humility" Reshapes Energy Futures for Post-Normal Times', *Futures* 122 (1 September 2020): 102565, https://doi.org/10.1016/j.futures.2020.102565.
[55] Tim Jackson, *Prosperity without Growth Foundations for the Economy of Tomorrow*, 2nd ed.. (London: Routledge, Taylor & Francis Group, 2017).

and challenges of degrowth is outside the scope of this piece, it is clear that the degrowth literature highlights an alternative path to that of scaling up our economic and energy systems.

Energy and climate models that include degrowth principles are increasingly being developed: One of these is the Degrowth Path without overshoot scenario by Keyßer and Lenzen[56], that aims for Net Zero by 2050 without surpassing 1.5 degree warming and focuses on energy demand reduction. Here, renewable energy primary energy demand would only need to increase 1.4 times (or 41%), while fossil fuels consumption would decrease by 31% from 2023 to 2030. This is far lower than the current tripling objective and is enabled by a more systemic approach to the energy and economic system. In an application of degrowth scenarios to the national level, in Australia, Kikstra et al. find that given a reduction in energy demand and economic growth (with it going from 3%/year to −5%/year), the need to upscale wind and solar energy is 40% lower than in the IPCC SSP2 baseline scenario which makes it a more achievable feat.[57]

A shift from an energy planning that promotes acceleration and growth to one that looks at broader social and economic prosperity indicators would also accentuate the advantage of renewable energy as compared to fossil fuel. When we change what we value as a society, our indicators of success, we can also shift incentive structures, and priorities, in this case from profits to prosperity. And one can imagine that the possibilities that renewables offer - as always, if well managed - of energy decentralisation, citizen ownership, and generally the democratisation of the energy system would fit right in with a focus on using less, in a more meaningful way.

Conclusion

It is clear that COP28 set the stage for collaboration, and put energy at the centre, but we may be barking up the wrong tree: the COP28 target encourages growth in renewable power capacity only. A renewable energy target, covering power, heat, and fuel, and focusing on increasing renewable energy shares would force decision-makers to look at the energy system in a more holistic manner. To reach our climate targets while ensuring prosperity, we need to look beyond an increase in renewable energy capacity, rather focusing on reducing energy demand, shifting consumption patterns (mainly in high-income economies) and addressing our dependence on fossil fuels.

[56]Lorenz T. Keyßer and Manfred Lenzen, '1.5 °C Degrowth Scenarios Suggest the Need for New Mitigation Pathways', *Nature Communications* 12, no. 1 (11 May 2021): 2676, https://doi.org/10.1038/s41467-021-22884-9.
[57]Jarmo S. Kikstra et al., 'Downscaling down under: Towards Degrowth in Integrated Assessment Models', *Economic Systems Research* 0, no. 0 (2024): 1–31, https://doi.org/10.1080/09535314.2023.2301443.

Don’t look up north, look down south: Financing the energy transition of the Global South will benefit everyone

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The 2021 apocalyptic satirical comedy movie ‘Don’t Look Up’ presents a scenario where a doctoral candidate in astronomy discovers a giant comet which is expected to collide with planet Earth in six months. After confirming their calculations, the doctoral candidate and her professor inform political decision-makers about the imminent danger, expecting them to mobilise resources and implement actions to avert this disaster. Their expectations are not met. Instead, a series of events take place where political and industry actors incorrectly estimate the danger the planet is facing, prioritise their own short-term political and financial gains, and do not do enough to avert disaster. Eventually, the comet strikes Earth, presumably destroying life on the planet as we know it. While using the comet strike as an allegory of the ongoing climate crisis, the director Adam McKay borrows the name for his movie from a slogan one of his characters uses to divert their audience’s attention from an existential risk. This essay is my way of telling you that acknowledging one of our biggest existential climate risks might turn out to be one of our greatest opportunities.

It was around the time of the ‘Industrial Revolution’ that cheap coal started displacing expensive renewable energy sources like wood, water, and wind which were widely used back then.[58] Today’s modern society can be traced back to this period where fossil fuels powered growth that helped communities escape the Malthusian Trap, and set the Global North on a path towards prosperity.[59,60] Over time fossil fuels helped improve human lives to such an extent that we have never before lived better and longer lives in all of history. However, around half a century ago, we realised that along with the improvement of living conditions, fossil fuels were also largely responsible for climate change.

[58] Robert C. Allen, ‘1 Then and Now’, in *The Industrial Revolution: A Very Short Introduction*, ed. Robert C. Allen (Oxford University Press, 2017), 0, https://doi.org/10.1093/actrade/9780198706786.003.0001.
[59] John Komlos, “The Industrial Revolution as the Escape from the Malthusian Trap,” 2003, https://doi.org/10.5282/UBM/EPUB.57.
[60] The terms ‘Global North’ and ‘Global South’ do not refer to geographic regions, but to the geopolitical power and economic wealth of countries and regions. The ‘Global North’ generally includes the United States of America, Canada, England, members of the European Union, Singapore, Japan, South Korea, and some countries in the southern hemisphere like Australia, and New Zealand. The Global South generally includes countries in Africa, South and Central America, the Middle East, India, and large parts of Asia.

According to the Intergovernmental Panel on Climate Change (IPCC), since systematic scientific assessments began in the 1970s, the influence of human activities on the warming of the climate system has evolved from theory to an established fact.[61] A large number of these human activities involved burning fossil fuels and thereby releasing greenhouse gases like carbon dioxide into the atmosphere. Research on these issues predates the 1970s and 1980s, but it was around this time that the dire consequences associated with unabated carbon emissions entered public discourse.[62] If these emissions were allowed to continue, they could potentially disrupt life and civilisation as we know it. Alternatively, less polluting fuel sources were seen as necessary to ensure the safety and health of future generations.

Existing multilateral organisations mustered as much political will as they could to enable this. New organisations like the United Nations Framework Convention on Climate Change (UNFCCC) and the IPCC were set up to help diminish impact of human actions on the climate system collaboratively, and inform political decisions on the matter. Over the years, as investments and deployment of low-carbon energy sources accelerated, they became increasingly cost-efficient and competitive.[63] This naturally led to increased interest in these technologies, and since 2019 investments in clean energy have outpaced those in fossil fuels.[64]

Along with the investments, the share of clean energy in the global energy mix has also gradually increased. But it still pales in comparison to the share of fossil fuels in most countries. As of 2022, approximately 80% of global primary energy consumed came from fossil fuels like coal, oil, and gas.[65,66] Unsurprisingly, this is the case even in Global North countries like the United States of America (USA) where renewable energy represented only around 13% of the total primary energy consumption in 2022.[67] The European Union (EU), one of the flagbearers of the global fight against climate change, got approximately 70% of its total energy supply from fossil fuels.[68] Similarly, in China, the highest energy consuming country in the world, 90% of the energy consumed was generated from fossil fuels.[69] These numbers should not be surprising as these countries (or region in case of the EU) have followed a model of development where fossil fuels were their principal energy source for more than two centuries. The transition to alternative, less polluting fuels should not be expected to take place overnight.

Yet, this need not be the case when it comes to the part of the world that is only now setting up its energy infrastructure. Certain parts of Africa, Asia and Latin America could benefit from

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[61] Intergovernmental Panel On Climate Change (Ipcc), *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1st ed. (Cambridge University Press, 2023), https://doi.org/10.1017/9781009157896.
[62] NASA, "Evidence - NASA Science," accessed May 6, 2024, https://science.nasa.gov/climate-change/evidence/.
[63] IRENA, "Renewable Power Generation Costs in 2022" (Abu Dhabi: International Renewable Energy Agency, 2023), https://www.irena.org/Publications/2023/Aug/Renewable-Power-Generation-Costs-in-2022.
[64] IEA, "World Energy Investment 2023" (Paris: International Energy Agency, 2023), https://www.iea.org/reports/world-energy-investment-2023.
[65] According to INSEE, Primary energy includes all energy products not transformed, directly exploited or imported. It mainly includes crude oil, oil shale, natural gas, solid mineral fuels, biomass, solar radiation, hydraulic energy, wind energy, geothermic energy and the energy taken from uranium fission/ https://www.insee.fr/en/metadonnees/definition/c1189
[66] Hannah Ritchie, Pablo Rosado, and Max Roser, "Fossil Fuels," *Our World in Data*, January 5, 2024, https://ourworldindata.org/fossil-fuels.
[67] US Energy Information Administration, "U.S. Energy Facts Explained - Consumption and Production - U.S. Energy Information Administration (EIA)," 2023, https://www.eia.gov/energyexplained/us-energy-facts/.
[68] "Europe – Countries & Regions," IEA, accessed May 6, 2024, https://www.iea.org/regions/europe/energy-mix.
[69] "China - Countries & Regions," IEA, accessed May 6, 2024, https://www.iea.org/countries/china/energy-mix.

all the information that is available today, on the lessons learnt from using fossil fuels. Thanks to the enormous amounts of resources invested in research and development, the harmful effects of fossil fuels, as well as the benefits associated with cleaner alternatives are both well known. Clean and renewable energy technologies have progressively been deployed over the last two decades all over the world. These technologies and the associated knowhow should be transferred to the Global South, especially to the parts that are on the verge of deciding whether to go down the fossil fuels path, or instead choose cleaner alternatives right from the beginning, and restrict dependence on fossil fuels to the bare minimum.

To do so, the clean energy technology transfer should be accompanied by corresponding financial resources. The countries that stand to gain from such technological and financial support usually have priorities like providing socio-economic development and well-being to their citizens. The sooner these measures are delivered, the better it is for everyone. Financial resources and access to energy go a long way in expediting this process. Absent the financial support, it is very likely that such countries would choose to invest in fossil fuels like gas or coal to construct their energy infrastructure as they are more familiar with these technologies, and the raw materials are generally more readily available to them. If this is allowed to happen, it might negate a lot of the progress that the Global North is making through its carbon emissions reduction actions.

The EU has decided to mobilise at least €1 trillion in sustainable investments over the next decade as part of its Green Deal Investment Plan.[70] Through a combination of existing and new EU programs, the Green Deal aims to help create a climate-neutral green economy by 2050. Similarly, the USA has also recently come up with the Inflation Reduction Act (IRA) which is projected to have a fiscal cost of approximately $1 trillion from 2022 to 2032.[71] This initiative represents the USA's most significant investment in combating climate change to date.[72] It is clear that an impressive amount of financial resources are being dedicated by both these actors to enable progress towards their climate goals. However, on taking a closer look, it appears that these are probably not the smartest climate investments that could be made.

For instance, let us consider the EU's ambition to be climate-neutral by 2050.[73] In 2019, the EU was responsible for only 9% of the global carbon emissions.[74] In other words, approximately one out of 10 carbon dioxide molecules emitted on the planet that year, was emitted in the EU. This begs the question of whether the amount of investment that is being directed towards eliminating approximately 10% of global carbon emissions by 2050 is justified. It is likely that the rest of the countries emitting the 90%, might not be able to

[70] European Commission, "The European Green Deal Investment Plan and JTM Explained," Text, European Commission - European Commission, January 14, 2020, https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_24.
[71] Arik Levinson et al., "The Inflation Reduction Act's Benefits and Costs," U.S. Department of the Treasury, March 1, 2024, https://home.treasury.gov/news/featured-stories/the-inflation-reduction-acts-benefits-and-costs.
[72] Eric Van Nostrand and Arik Levinson, 'The Inflation Reduction Act: Pro-Growth Climate Policy', U.S. Department of the Treasury, 13 November 2023, https://home.treasury.gov/news/featured-stories/the-inflation-reduction-act-pro-growth-climate-policy.
[73] European Commission and Directorate-General for Climate Action, *Going Climate-Neutral by 2050 – A Strategic Long-Term Vision for a Prosperous, Modern, Competitive and Climate-Neutral EU Economy* (Publications Office, 2019), https://doi.org/10.2834/02074.
[74] European Commission, "EU's CO2 Footprint Continues to Decrease," May 24, 2022, https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20220524-1.

decrease their emissions significantly by 2050, or might even increase them, leading to suboptimal results overall. There is certainly an argument to be made for large investments in the USA, which is the second largest carbon emitting country in the world, and has among the highest per capita emissions.[75] But even the USA, like the EU and most of the Global North, has already reached peak carbon emissions. In fact, carbon emissions in most of the Global North are currently on a downward trend, having successfully decoupled its GDP growth from carbon emissions.[76]

This is undoubtedly positive, but the bigger picture should not be out of sight. The target is to restrict the rise in average global temperatures to 1.5°C compared to the pre-industrial era by the end of the 21st century by cutting global carbon emissions. If Europe unilaterally directs all its resources towards achieving climate neutrality by 2050, it might reach there first, but will probably not have much to celebrate about. The other countries, especially from the Global South that will not have been able to keep up due to lack of financial resources, will probably have been responsible for emitting far more emissions than those cut by the EU. This is why it is important to finance the Energy Transition in the Global South.

Today, more than half of global carbon emissions originate in the Global South.[77] India and China alone account for some 60% of these emissions, the top 10 countries account for some 78%, while some 120 countries account for the remaining 22%.[78] Among these countries China is expected to hit peak emissions before the end of this decade.[79] According to certain estimates, it already has.[80] This is far from the truth for most of the other countries in the group. India, the second largest carbon emitter in the Global South, is expected to reach peak emissions between 2040 and 2045.[81] The emissions in other parts of the Global South are also likely to increase for another decade, if not more, before they hit a peak and start reducing. If these countries are to hit peak emissions sooner, their energy transition needs to accelerate. And if this energy transition is to be accelerated, adequate financial resources will need to be provided.

At the 15th edition of the Conference of Parties in Copenhagen, Denmark in 2009, the developed countries agreed that they would mobilise $100bn/year for developing nations as climate finance by 2020.[82] According to OECD estimates, the finance mobilised under this accord has over time increased to approximately $90bn in 2021.[83] The threshold of $100bn in financing is supposed to have been crossed in 2023 for the first time (This has not yet been

[75] Hannah Ritchie and Max Roser, 'CO_2 Emissions', *Our World in Data*, CO_2 emissions, 24 May 2022, https://ourworldindata.org/co2-emissions.
[76] Homi Kharas, Wolfgang Fengler, and Lukas Vashold, "Have We Reached Peak Greenhouse Gas Emissions?," Brookings, November 30, 2023, https://www.brookings.edu/articles/have-we-reached-peak-greenhouse-gas-emissions/.
[77] Center For Global Development, "Developing Countries Are Responsible for 63 Percent of Current Carbon Emissions," Center For Global Development, accessed April 8, 2024, https://www.cgdev.org/media/developing-countries-are-responsible-63-percent-current-carbon-emissions.
[78] Harald Fuhr, "The Rise of the Global South and the Rise in Carbon Emissions," *Third World Quarterly* 42, no. 11 (November 2, 2021): 2724–46, https://doi.org/10.1080/01436597.2021.1954901.
[79] Christian Shepherd, "China Is Close to Peak Emissions, but It Doesn't Want to Talk about It," *Washington Post*, December 12, 2023, https://www.washingtonpost.com/world/2023/12/11/china-climate-emissions-peak-cop28/.
[80] Kharas, Fengler, and Vashold, "COMMENTARY Have We Reached Peak Greenhouse Gas Emissions?"
[81] "Climate Change: What Emission Cuts Has India Promised?," October 27, 2021, https://www.bbc.com/news/world-asia-india-58922398.
[82] UNFCCC, "Copenhagen Accord," 2009, https://unfccc.int/resource/docs/2009/cop15/eng/l07.pdf.
[83] OECD, *Climate Finance Provided and Mobilised by Developed Countries in 2013-2021: Aggregate Trends and Opportunities for Scaling Up Adaptation and Mobilised Private Finance*, Climate Finance and the USD 100 Billion Goal (OECD, 2023), https://doi.org/10.1787/e20d2bc7-en.

confirmed at the time of writing this essay). . If this investment continues for another decade, it would amount to a $1trillion which is comparable to the investments in the EU's Green Deal and the USA's IRA. However, this amount is to be used to implement climate actions over a much larger geographical area and is meant to impact a much bigger population.

The mobilisation of finances is essential for the Global South to be able to implement its climate actions. In fact, the OECD estimates that these countries need roughly USD 2.4 trillion each year between 2026 and 2030 for this purpose.[84] This figure clearly dwarfs the $100 bn/year that is promised by the developed countries under the Copenhagen Accord. Furthermore, 91 countries representing 51% of the global population expressed their climate finance needs to the tune of $4.5 trillion total, of which $2.9 trillion would be needed to achieve unconditional National Determined Contribution (NDC) pledges under the Paris Agreement, and the remaining $1.6 trillion to achieve conditional NDC pledges[85, 86]. The amount that is currently being invested by the Global North, is nowhere close to these requirements. This lack of funds might lead such countries to reduce their commitment to achieving their NDCs.

Many of these countries find themselves in an unenviable position where they have contributed very little to the global climate crisis historically, but happen to be the most vulnerable to climate change today. The Loss and Damage Fund set up at the Conference of Parties in Dubai (COP28) recently, will go a long way in helping such vulnerable communities recover ex-post from adverse effects of climate change, however the ex-ante needs, in terms of mitigation and adaptation, remain.[87] Thus, they have an interest in getting themselves into climate change mitigation and adaptation funding programs. Unfortunately, as we have seen previously, these funds are not always enough, and more needs to be done.

The Global North has taken a head start on its journey towards net-zero and climate neutrality objectives. The Global South is also moving towards the same destination, albeit it is likely to reach there later. In some ways, the situation is like the Prisoner's Dilemma, a game theory thought experiment where cooperation between two parties leads to a relatively favourable outcome compared to both of them acting alone.[88] By acting alone on climate change, the Global North might successfully cut its carbon emissions. Unfortunately, these emission cuts are likely to be compensated by the increased emissions in the Global South, which in turn will be acting alone to provide development to its people, most probably using fossil fuels. In such a situation, both parties will be mutually worse off due to stable, or even increased carbon emissions in the atmosphere. Instead, a wise distribution of financial resources, by performing cost-benefit analyses on each cent invested, and allocating it to where it will do the greatest good would lead to a much more favourable outcome for everyone involved.

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[84] Ibid.
[85] Conditional NDC pledges are additional pledges made by many Global South countries. The fulfilling of these pledges is subject to availability of adequate international financing, technical support, capacity building etc.
[86] Taryn Fransen et al., "9 Things to Know About National Climate Plans (NDCs)," *World Resources Institute*, December 7, 2023, https://www.wri.org/insights/assessing-progress-ndcs.
[87] "Fund for Responding to Loss and Damage | UNFCCC," accessed May 7, 2024, https://unfccc.int/loss-and-damage-fund-joint-interim-secretariat?gad_source=1&gclid=EAIaIQobChMIoJabo4X6hQMV8kZBAh1KbwvgEAAYASAAEgIjnfD_BwE.
[88] 'Prisoner's Dilemma - an Overview | ScienceDirect Topics', accessed 7 May 2024, https://www.sciencedirect.com/topics/social-sciences/prisoners-dilemma.

Purely fossil fuels-based development in the Global South, without involving cleaner alternatives, is one of our biggest collective existential climate risks. Acknowledging this fact, and acting on it could prove to be the biggest opportunity to avert a climate disaster. The Global North followed the fossil fuels-based model of development for more than two centuries, and for the majority of the time, it was not aware of the negative consequences of their emissions. It could be considered to be an innocent mistake attributable to ignorance. However, the mistakes regarding climate finance being made today, are far from being innocent. The longer it takes for them to be corrected, the more convinced I get that they never will be.

Navigating contested narratives for India's coal transition

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How Sequencing of Policies could accelerate India's transition away from coal

The toning down of COP 26 summary statement from '*phase out*' to '*phase down*' of coal is symptomatic of India's predicament in its transition to net zero. As a means to an end, policies seek to transform societies. The larger the transformation it intends to catalyse, the larger the resistance towards this change. Achieving critical policy objectives, such as Net Zero, require carefully calibrated policies that inspire support among all constituencies to achieve its aim. Herein lies the art of sequencing of policies, where the singular target is attained through multiple incremental policies, with each successive policy having a higher target than its predecessor.[89]

Achieving net zero, is again a means to an end – to keep global temperature changes within 1.5°C. Deliberate sequencing of policies generates self-reinforcing feedback in the form of supporting lobbies, improved perceptions, etc. which in turn sets the stage for stricter green policies, leading to decarbonisation of the economy.[90]

With India's share in global primary energy demand projected to approach 10% by 2050, the pace of India's energy transition will determine the pace of the global transition. Addressing the power sector, which is responsible for 40% of India's overall greenhouse gas emissions, is a prerequisite to achieve net zero.[91,92] Coal presently powers 75% of India's electricity.[93] Although India is projected to reduce this share to 54% by 2030, its demand for coal will increase by 178 MT in absolute numbers by 2030.[94]

Facing an energy trilemma – pursuing energy security, development, and energy transition – India is abound with multiple contesting narratives on energy policy. The prominent policy narratives revolve around energy access, and energy as an instrument for development.[95]

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[89] Montfort, Simon, Lukas Fesenfeld, Isabelle Stadelmann-Steffen, and Karin Ingold. 'Policy Sequencing Can Increase Public Support for Ambitious Climate Policy'. *Policy and Society* 42, no. 4 (1 December 2023): 454–77. https://doi.org/10.1093/polsoc/puad030.
[90] Meckling, Jonas, Nina Kelsey, Eric Biber, and John Zysman. 'Winning Coalitions for Climate Policy'. *Science* 349, no. 6253 (11 September 2015): 1170–71. https://doi.org/10.1126/science.aab1336.
[91] *Press India Bureau*. 'India Has Been Ranked Third Largest Primary Energy Consumer in the World'. 24 March 2022. https://pib.gov.in/PressReleasePage.aspx?PRID=1809204.
[92] India, Ministry of Environment, Forests & Climate Change, *India's 3rd Biennial Update Report*, (2021)
[93] India, Ministry of Coal, *Generation of Thermal Power from Raw Coal*. https://www.coal.nic.in/en/major-statistics/generation-of-thermal-power-from-raw-coal.
[94] Sanjay Mitra and Rohit Chandra, Working Paper, *Deep De-Carbonization And Regional Equity* (NIPFP, 2023).
[95] Mohan, Aniruddh, and Kilian Topp. 'India's Energy Future: Contested Narratives of Change'. *Energy Research & Social Science* 44 (October 2018): 75–82. https://doi.org/10.1016/j.erss.2018.04.040.

These come at the cost of coal transition. Sequencing of policies can help navigate these contesting narratives.

The traditional theory of sequencing of policies suggests creating new constituencies through subsidies, such as the renewable industries which would create strong counter-lobbies against the traditional polluting industries. Overtime, stringent policies targeting these polluting industries could be introduced without facing much opposition. In India, despite the massive increase in installation of renewables from 75.52 GW in 2014 to 143.64 GW by end of financial year 2023-24, coal production continues to rise. Therefore, this article suggests creating *prior policy induced benefits perception* among stakeholders, as suggested by Montfort et al (2023), for its transition.[96]

Sequencing in Power Transition

The transition away from coal in some regions of Europe and the US at the turn of the 21st century was largely driven by market forces, later accelerated by targeted policies.[97] In the European Union (EU), the Renewable Energy Directives (RED) generated feedback and strong constituencies that supported subsequent iterations of the RED.[98] The original RED adopted in 2009, set a national renewable energy consumption target of 20% by 2020. The revised RED in 2018 ratcheted up this target to increase renewable energy consumption to 32% by 2030. The RED III, revised in 2021, and later in 2023 increased the target to 45% by 2030. In this period, the share of coal declined in the EU from 25% in 2009 to 12% in 2023.[99] By generating positive policy feedback, RED-I helped create strong renewable industry lobbies which created a network of coalitions across Europe that influenced subsequent targets.[100]

Furthermore, transitions from coal in Europe, the US, and Australia have involved a "*bridge fuel*" on the path to renewable energy, where coal was substituted for natural gas instead of moving directly toward renewables integration into the grid. [101]

Missing Bridge

The transition from coal in India is being undertaken in completely different circumstances. Infrastructure issues and cost considerations do not favour natural gas as a bridge fuel.[102] Despite the official endorsement of natural gas, its adoption in India has been rather underwhelming. The Hydrocarbon Vision 2025 of 1999 projected the share of natural gas in

[96] Montfort, Simon, Lukas Fesenfeld, Isabelle Stadelmann-Steffen, and Karin Ingold. 'Policy Sequencing Can Increase Public Support for Ambitious Climate Policy'. *Policy and Society* 42, no. 4 (1 December 2023): 454–77. https://doi.org/10.1093/polsoc/puad030.
[97] Jamie Wong et al., "Coal Phase-out and Just Transitions," ed. Takeshi Kuramochi et al. (NewClimate Institute, 2022), https://newclimate.org/sites/default/files/2022-11/coal_phase_out_paper_nov_2022.pdf.
[98] Anna Leipprand, Christian Flachsland, and Michael Pahle, "Starting Low, Reaching High? Sequencing in EU Climate and Energy Policies," Environmental Innovation and Societal Transitions 37 (December 1, 2020): 140–55, https://doi.org/10.1016/j.eist.2020.08.006.
[99] Brown, Sarah, and Dave Jones. 'European Electricity Review 2024'. Ember Climate, 7 February 2024. https://ember-climate.org/insights/research/european-electricity-review-2024/.
[100] Anna Leipprand, Christian Flachsland, and Michael Pahle, "Starting Low, Reaching High? Sequencing in EU Climate and Energy Policies," Environmental Innovation and Societal Transitions 37 (December 1, 2020): 140–55, https://doi.org/10.1016/j.eist.2020.08.006.
[101] Mariangela Guidolin and Tansu Alpcan, "Transition to Sustainable Energy Generation in Australia: Interplay Between Coal, Gas and Renewables," Renewable Energy 139 (August 1, 2019): 359–67, https://doi.org/10.1016/j.renene.2019.02.045.
[102] Tongia, Rahul. 'Challenges for Natural Gas to Become India's Bridge Fuel: Economics, Availability, and Alternatives'. Working Paper. New Delhi: Centre for Social and Economic Progress, April 2021. https://csep.org/working-paper/difficulties-of-natural-gas-being-indias-transition-bridge-fuel-economics-availability-and-alternatives

India's primary energy consumption to reach 25% by 2025. The current Vision 2030 for natural gas has lowered this target to 15% by 2030.[103]

As of 2024, natural gas contributes 6.7% to India's primary energy consumption basket.[104] Within power, the installed capacity of gas power plants is lower, at 5.7%.[105] However, when it comes to actual power generation from gas-based power plants, its share was just 1% in 2022-23.[106] The plant load factor for gas-based power plants for the same year was 10.98%.[107]

The primary reason for lack of utilisation of existing gas-based power infrastructure is its cost of generation. Domestic production of natural gas did not live up to expectations and has decreased since 2011.[108] Therefore, the country relies on imports of natural gas. Political instability in neighbouring countries of Myanmar, and Afghanistan, geopolitical tensions with Pakistan, and American sanctions on Iran have indefinitely delayed the construction of planned trans-country pipelines.[109] This leaves import of natural gas through LNG as the only option. Yet, electricity produced from imported LNG is expensive compared to alternatives.

In 2018, the price for power from imported LNG came to INR (Rs.) 8 per kWh, compared to Rs. 1.97 – 5.73 per kWh for coal-based power, and Rs. 2.44 – 3.34 per kWh for solar electricity.[110] Moreover, battery storage is expected to make renewable power more attractive. In 2023, the cost for battery storage was discovered at Rs. 10.18 per kWh, and is expected to only decline in the coming years.[111]

The continued relevance of gas-based power plants lies in its ability to meet peak summer electricity demand due its quick ramp up rates. Recently, the Ministry of Power directed gas-based power plants to ensure supply of electricity for the summer season, till the end of June 2024. [112]

These circumstances strengthen narratives that stress upon the importance of coal – the only energy resource that the country is well-endowed with – as an imperative for energy security and development even while transitioning to cleaner energy sources.

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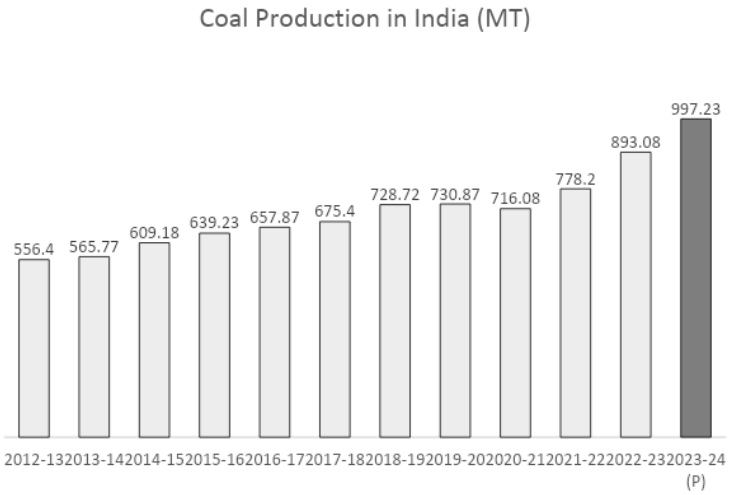
[103] Corbeau, Anne-Sophie, Shahid Hasan, and Swati Dsouza. 'The Challenges Facing India on Its Road to a Gas-Based Economy'. King Abdullah Petroleum Studies and Research Center, October 2018. https://doi.org/10.30573/KS--2018-DP41.
[104] *Press India Bureau*. 'SHARE OF NATURAL GAS IN TOTAL ENERGY MIX'. 18 December 2018. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1987803.
[105] India, Central Electricity Authority, *Dashboard*, https://cea.nic.in/dashboard/?lang=en
[106] Author's calculations from CEA reports. Power from gas-based power plants for FY 2022-23 was 23,885.04 MU, and overall power generated in India was 1624.47 BU.
[107] India, Central Electricity Authority, *Energy Generation, Programme, and Plant Load Factor for Gas / Liquid Based Stations,* (2023), https://npp.gov.in/public-reports/cea/monthly/generation/18%20col%20act/2023/MAR/18%20col%20act-17_2023-MAR.pdf
[108] Corbeau, Anne-Sophie, Shahid Hasan, and Swati Dsouza. 'The Challenges Facing India on Its Road to a Gas-Based Economy'. King Abdullah Petroleum Studies and Research Center, October 2018. https://doi.org/10.30573/KS--2018-DP41.
[109] Pimpalkhare, Ameya. 'India's Import Diversification Strategy for Natural Gas: An Analysis of Geopolitical Implications'. Issue Brief. New Delhi: ORF, 11 September 2023. https://www.orfonline.org/research/india-s-import-diversification-strategy-for-natural-gas-an-analysis-of-geopolitical-implications.
[110] Jain, Purva. 'Flexible Generation: A Role for India's Stressed and Stranded Gas-Based Power Plants?' Institute for Energy Economics and Financial Analysis, October 2022. https://ieefa.org/sites/default/files/2022-10/Flexible%20Generation-a%20role%20for%20India%27s%20stressed%20and%20stranded%20gas-based%20power%20plants_Oct2022.pdf.
[111] *Press India Bureau*. 'Cost of Energy Storage Discovered in Bid Is 10.18 Rupees per Kilowatt Hour; VGF and PLI for Battery Energy Storage Expected to Bring down Cost of Storage: Union Power and New & Renewable Energy Minister'. 12 December 2023. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1985538.
[112] *Press India Bureau*. 'Government Takes Measures to Operationalize Gas-Based Power Plants to Help Meet Summer Electricity Demand'. 13 April 2024. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2017826.

Persistence of coal

India reported its highest coal production in the financial year 2023-24, an increase of 11.6% compared to the previous financial year.[113] In terms of the scale of transition, national circumstances, and policy objectives, China is the only country whose transition can be compared with India. Coal is regarded as a '*ballast-stone*' and '*backbone*' for energy security in China and India respectively, as their policies steer towards using coal to stabilise their grids while renewables are integrated.[114]



Source: Coal Ministry

Coal Production is expected to increase in the coming years, even as India's share of coal-fired thermal power plants (TPP) in overall power generation declines. Steering its role towards grid stability, the Central Electricity Authority (CEA) has published guidelines for flexibilisation of TPPs to be able to reduce their load factor to 40% by 2030.

The omnipresence of coal in India is expected to make the transition away from this fossil fuel a long-drawn process. States within India that are richly endowed with coal are also the states that have lower endowment of renewable energy resources. The states of Jharkhand, Odisha, and Chhattisgarh could lose up to 23%, 15%, and 24% of their non-tax revenue, through coal royalties, respectively.[115] Coal has created monolithic coal-centred communities, with close to four million people dependent on the coal industry in the country.[116] Furthermore, an additional 45 million people are expected to enter the workforce from six coal rich states by 2030.[117]

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[113] Baruah, Rituraj. 'India's Record Coal Output Tad Shy of 1 Billion Tonne Target'. Mint, 1 April 2024. https://www.livemint.com/companies/news/at-997-4-million-tonnes-india-fy24-coal-output-at-record-but-tad-shy-of-1-billion-tonne-target-11711976302203.html.

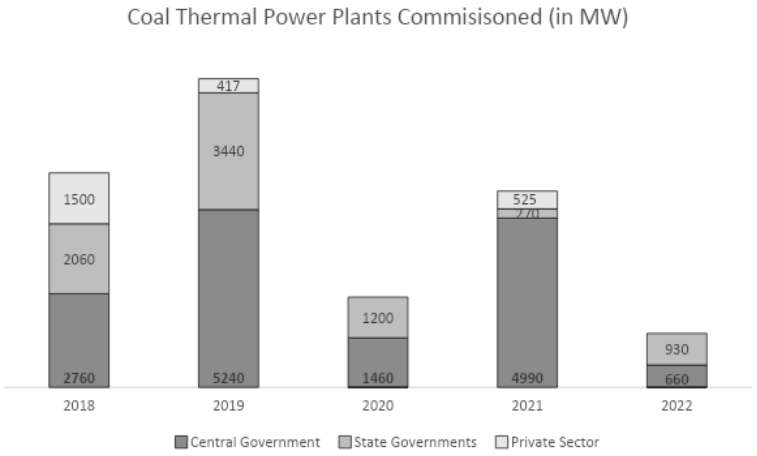
[114] China, National Energy Administration, *Summary of Reply to Proposal No. 0481 (Economic Development Category No. 049) of the Fourth Session of the 13th CPPCC National Committee*, (2021) http://zfxxgk.nea.gov.cn/2021-08/27/c_1310486070.htm; Tiwari, Vinod Kumar. 'Recommendations of Post Budget Webinar - "Session on Coal Gasification"'. New Delhi, 4 March 2022. https://coal.gov.in/sites/default/files/ncgm/ppt-recommendation-t.pdf.

[115] Bhattacharjya, Souvik, Ruchi Gupta, G. Mini, Saswata Chaudhury, Mani Juneja, and Kartikey Sharma. 'Assessing Vulnerability from Coal Dependence and Need for a Just Transition'. New Delhi: The Energy and Resources Institute, 2021. https://www.teriin.org/sites/default/files/2021-06/Coal-Dependence-Need-Just-Transition_WP1.pdf.

[116] Swarnakar, Pradip, Mudit Kumar Singh, and Riti Chatterjee. 'What Is Just Transition? Perception of Grassroots Stakeholders.' Kanpur, Uttar Pradesh: Just Transition Research Centre, Indian Institute of Technology Kanpur, 2022. https://www.iitk.ac.in/JTRC/file/What%20is%20Just%20Transition_JTRC_IIT%20Kanpur_1st%20December%202022.pdf.

[117] The states are – Andhra Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, and Odisha. Spencer, Thomas, Raghav Pachouri, G Renjith, and Sachi Vohra. 'Coal Transition in India'. Discussion Paper. New Delhi: The Energy and Resources Institute, November 2018. https://www.teriin.org/sites/default/files/2018-12/Coal-Transition-in-India.pdf.

However, economic forces reign. Out of the 87 coal mines auctioned by the Coal Ministry between 2021 and 2023, only four have received financial backing to begin operations.[118] TPPs face an increasing risk of becoming stranded assets. The recent lack of private participation in commissioning new TPPs can be attributed to this. Although at present, 34% of coal fired thermal power plant capacity is owned by the private sector, the last five years (2018-2023) has seen a tepid response from this sector in commissioning new TPPs. During this period, government owned companies have commissioned over 90% of new capacity, with the private sector at just 9%.



Source: Central Electricity Authority

In 2021, the average age of India's TPPs was 13 years, and if the Ministry of Power's recommendation to retire plants at 25 years is followed through, large-scale retirement of plants will occur over the next decade. [119] However, to avoid an energy shortage, the CEA has recently advised against any TPP closures in the current decade, slowing down this transition.[120] This makes it clear that only a careful sequencing of policies will allow the Indian government to proactively enable retirement of plants for a timely transition. Developed countries, on the other hand, can compensate for earlier than scheduled closure of TPPs through grants, possibly through a mechanism like the Just Energy Transition Partnership (JETP).

Framework for coal transition

India first needs to develop a statutory framework for decommissioning TPPs and a Roadmap for repurposing the plants. The Statutory framework should cover social, technical, and environmental safeguards. At present, there is no mandate for decommissioning TPPs, which can be created by expanding the scope of present laws.[121]

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[118] Sharma, Roli. "India's Coal Mining Bet Stumbles as Wary Banks Weigh Rising Risks." *Reuters*, July 20, 2023. https://www.reuters.com/world/india/indias-coal-mining-bet-stumbles-wary-banks-weigh-rising-risks-2023-07-20/.
[119] IEA, Average age of existing coal power plants in selected regions in 2020, IEA, Paris https://www.iea.org/data-and-statistics/charts/average-age-of-existing-coal-power-plants-in-selected-regions-in-2020,
[120] Varadhan, Sudarshan. 'India Asks Utilities to Not Retire Coal-Fired Power Plants till 2030 - Notice'. *Reuters*, 30 January 2023. https://www.reuters.com/business/energy/india-asks-utilities-not-retire-coal-fired-power-plants-till-2030-notice-2023-01-30/.
[121] Bhushan, Chandra, Mandvi Singh, and Yukti Chaudhary. 'Just Transition of Coal-Based Power Plants in India: A Policy and Regulatory Review'. New Delhi, November 2022. https://iforest.global/wp-content/uploads/2022/11/Just-Transition-of-coal-based-power-plants-in-India_.pdf

An attempt was made in 2021, when the Central Pollution Control Board (CPCB) published the draft Environmental Guidelines for decommissioning TPPs, in compliance with a court order, but there is no progress since.[122] The draft guidelines only list the provisions of multiple other statutory rules that would be relevant in decommissioning these plants, such as the Hazardous Waste Management Rules of 2016, and Water (Prevention and Control of Pollution) Act of 1974. They also provide additional measures for closing ash ponds and handling asbestos. Rather than guidelines, the government must introduce statutory rules under the Environment Protection Act (1984) that streamline the obligations of owners of TPPs.

For social aspects covering labour issues, the coal dependent states can look to replicate the success of the 'Colorado Just Transition from a Coal-Based Electrical Energy Economy' law, enacted in 2019.[123] The law focuses on the lives of workers and communities impacted by the coal transition. It established the Just Transition committee tasked with drafting a just transition plan that includes financial sources to fund the transition. It also constituted the Just Transition Office to overlook the implementation of the plan. The plan recommended individual worker transition plans, training workers, investment in community infrastructure and creation of investment funds to reduce investment risks for the private sector.

Five years since its enactment, Indian states can learn from its implementation, by constituting representative transition committees. Research shows that although communities in the vicinity of TPPs suffer from adverse impacts of the plants, they are reluctant to voice their difficulties due to fears of shutting them down. Moreover, the inability to work with advanced technology in TPPs have already rendered unskilled workers unemployed.[124] These concerns can be allayed only by securing their representation in these committees. They can also learn from the challenges associated with implementing the Just Transition Law in Colorado. These were related to sourcing funds and creating jobs that match former wage levels.[125] One of the learnings reported by the Just Transition Office is to focus on the household level to plan the transition, and to assist families, rather than just the impacted worker.[126]

Repurposing of TPPs

After TPPs are decommissioned, it needs to be repurposed to productive uses. TPPs constructed on diverted forest land should be regenerated. For such cases, Lusatia's transition in Germany offers an interesting example where transition was centred around environmental restoration of the sites.[127]

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[122] Original Application No.30 of 2021 (SZ) (National Green Tribunal, Southern Zone 30 September 2021).
[123] JUST TRANSITION FROM A COAL-BASED ELECTRICAL ENERGY ECONOMY, AND, IN CONNECTION THEREWITH, MAKING AN APPROPRIATION., HOUSE BILL 19-1314 § (2019). https://leg.colorado.gov/sites/default/files/2019a_1314_signed.pdf.
[124] Swarnakar, Pradip, Mudit Kumar Singh, and Riti Chatterjee. 'What Is Just Transition? Perception of Grassroots Stakeholders.' Kanpur, Uttar Pradesh: Just Transition Research Centre, Indian Institute of Technology Kanpur, 2022. https://www.iitk.ac.in/JTRC/file/What%20is%20Just%20Transition_JTRC_IIT%20Kanpur_1st%20December%202022.pdf.
[125] De Filippis, Gianna. 'Lessons Learned from the Colorado Office of Just Transition'. BlueGreen Alliance, 9 November 2023. https://www.bluegreenalliance.org/resources/fact-sheet-lessons-learned-from-the-colorado-office-of-just-transition/.
[126] Buchanan, Wade. 'Early Lessons from Colorado's Coal Transition'. University of New Mexico, 11 April 2024. https://grandchallenges.unm.edu/teams/2023/buchanan-co-just-transition-slides-4_11_24.pdf.
[127] Mitra, Jayanta, Apoorva Singh, and Arpita Victor. 'Just Transition Framework for a Sustainable Future in India's Coal Mining Regions'. New Delhi: The Energy and Resources Institute, 2023. https://www.teriin.org/policy-brief/just-transition-framework-sustainable-future-indias-coal-mining-regions.

The theory of sequencing suggests that before introducing statutory mandates, schemes incentivising repurposing can be implemented, to create *prior policy induced benefits perceptions.* Therefore, transition can be sequenced through three phases – pilot phase; policy phase; and the final statutory mandate phase.

TPPs across the world have been converted to biomass plants, solar plants, battery storage, etc.[128] This requires positive attitudes towards repurposing of coal TPPs. Successful pilots of repurposing will create positive feedback that will generate prior policy-induced benefit perception among other TPP owners, and reluctant governments, lowering the initial perception barrier against the high costs of retirement.

Due to unique circumstances of each TPP, repurposing will be case specific. To create indigenous success stories of repurposing coal plants, the Central Government can introduce a competition-based method to choose the initial batch of coal TPPs whose transition would be financed through international grants. The competition-based method was utilised for the Smart Cities Mission in 2015 by the Central Government, where cities across India competed against each other to access funds to transform their infrastructure.

With over 27 GW of TPPs aged over 30 years, originally scheduled to retire in the current decade, the first phase could be put to test immediately.[129] Based on these successful cases, a nationwide uniform policy (second phase) can be implemented. Eventually, a mandate can be introduced for repurposing TPPs aged above a threshold. In this process, perception barriers are lowered with time, making way for stricter laws for thermal power plants which would not be met with opposition.

At present, pollution-control rules for TPPs are regularly relaxed.[130] The 2015 SO_2 emission norms notified by the Ministry of Environment, Forests & Climate Change (MoEF&CC) offer an illustrative example. TPPs were originally scheduled to comply with the norms by 2017. In 2017, the deadline was extended to 2022, with plants located near National Capital Region (NCR) Delhi (Category A plants) being given time till 2019 to adhere to the norms. However, in 2022, these deadlines were relaxed again. TPPs now have time till 2026 to comply, while Category A plants have time till December 2024 to comply with the norms.[131]

For Repurposing, a roadmap summarising the sequence of the phases of policies should be created. This roadmap should contain the methodology of selecting the first batch of coal TPPs (for pilot phase), potential timeline for implementing this phase and timelines for implementing subsequent phases. The parameters for choosing these potential TPPs could be related to technology, age, or even their tendency to aggravate air quality in their regional airshed. At present, the cost of decommissioning an Indian TPP has been estimated at US$

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[128] 'Coal Plant Repurposing for Ageing Coal Fleets in Developing Countries. ESMAP'. Technical Report. Energy Sector Management Assistance Program. Washington DC: World Bank, 2021. https://documents1.worldbank.org/curated/en/144181629878602689/pdf/Coal-Plant-Repurposing-for-Ageing-Coal-Fleets-in-Developing-Countries-Technical-Report.pdf.

[129] Bhushan, Chandra, Mandvi Singh, and Yukti Chaudhary. 'Just Transition of Coal-Based Power Plants in India: A Policy and Regulatory Review'. New Delhi, November 2022. https://iforest.global/wp-content/uploads/2022/11/Just-Transition-of-coal-based-power-plants-in-India_.pdf.

[130] Aggarwal, : Anubha. 'Environmental Status of Coal-Based Thermal Power Plants in the National Capital Region'. New Delhi: Centre for Science and Environment, November 2023. https://www.cseindia.org/environmental-status-of-coal-based-thermal-power-plants-in-the-national-captial-region-11966.

[131] Yadav, Nivit Kumar. 'Environment Takes Back Seat: MoEFCC Extends SOx Compliance Deadline Again'. *Down to Earth*, 6 September 2022. https://www.downtoearth.org.in/news/pollution/environment-takes-back-seat-moefcc-extends-sox-compliance-deadline-again-84754.

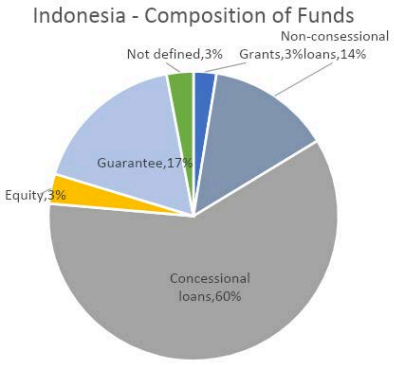
58 million.[132] The realisation of the first phase could be made conditional on receipt of funds from initiatives that focus on just transition, specifically, the Just Energy Transition Partnership (JETP).

Just Energy Transition Partnership

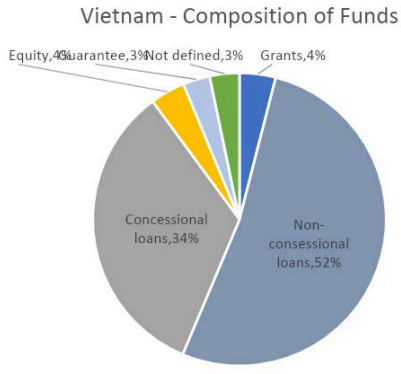
Launched in 2022, the Just Energy Transition Partnership (JETP) is an initiative of more advanced economies such as the EU, US, Canada, etc. to finance coal transition in developing countries such as Indonesia, South Africa, Vietnam, and Senegal, that are heavily dependent on it. International Development Banks have also promised funds for this initiative. The JETP would finance projects related to renewable energy, modernising electricity grids, and skill development for just transition.

The JETP has been met with cynicism among India's policy makers and civil society. Successful implementation of JETP in present partner countries could prompt a change of heart in Indian policy-makers by creating prior policy induced benefits perception, a playbook of the sequencing theory.

However, the ongoing JETP negotiations, and promises prove the cynics right in India. The funds guaranteed to Indonesia and Vietnam are only 22% and 11% of their requirements respectively. For the Indonesian partnership, the fund packages are of various sizes, ranging from US$ 700,000 to US$ 1.7 billion. Further, up to US$ 2 billion funded by the US and the UK are through the World Bank that can be accessed only after the country reaches its Single Borrower Limit (SBL).[133] For Vietnam, non-concessional loans form most of the funding, at 52%.[134]



Source: Indonesia CIPP



Source: Vietnam RMP

[132] Jindal, Abhinav, and Gireesh Shrimali. 'Cost–Benefit Analysis of Coal Plant Repurposing in Developing Countries: A Case Study of India'. *Energy Policy* 164 (May 2022): 112911. https://doi.org/10.1016/j.enpol.2022.112911.
[133] Indonesia, Just Energy Transition Partnership Secretariat, *Comprehensive Investment and Policy Plan*, (2023), https://jetp-id.org/storage/official-jetp-cipp-2023-vshare_f_en-1700532655.pdf
[134] Vietnam, *Recourse Mobilisation Plan*, (2023), https://climate.ec.europa.eu/system/files/2023-12/RMP_Viet%20Nam_Eng_%28Final%20to%20publication%29.pdf

Finding the middle ground

For India to participate in this partnership, the western countries are seeking a timeline for phase-out of coal, an unviable proposition for India. The dominant energy policy narratives in the country focus on the importance of coal for India's development and energy security. This narrative blames the western 'carbon imperialism' as undercutting India's development agenda.[135] The government's perspective is perhaps best reflected in an interview by the former Power Minister where he pointed out the hypocrisy of India having to bear the burden of lifting 30% of its population out of poverty while paying the price of the carbon spewed by the 200-year British coal power industry.[136] These views are largely reflected within the Indian civil society. India would participate in the JETP only if it is financed through grants, to develop renewables, without shutting its coal plants.[137]

However, this narrative is multilayered. The dominant narrative of western hypocrisy is juxtaposed with pragmatic understanding of the necessity to transition with the constraints of charting a unique path of low carbon development. The government promotes coal while simultaneously releasing guidelines for flexibilization of TPPs, signalling future reduction of demand for coal. Moreover, some Indian states have announced to not establish any new TPPs.[138] Therefore, these contradictions are bound to exist.

Coal is expected to play a stabilising role for India's grid, to tackle the challenges that come with variability of renewables. This was seen in the EU in 2022, when usage of coal rose due to drastic reduction in hydropower and nuclear power.[139] Notwithstanding the constraints that India currently faces, 27 GW coal TPP capacity is expected to be retired in the next decade.[140] An early action plan in the form of a roadmap for decommissioning and repurposing will not come in the way of India's development or security interests, and will only help in arriving at a middle point, where proponents of JETP can be asked to meet.

[135] Mohan, Aniruddh, and Kilian Topp. 'India's Energy Future: Contested Narratives of Change'. *Energy Research & Social Science* 44 (October 2018): 75–82. https://doi.org/10.1016/j.erss.2018.04.040.
[136] ibid.
[137] Shrivastava, Roli. 'CORRECTED-ANALYSIS-India Wants a Clean Energy Transition Deal - and Its Coal Too'. *Reuters*, 24 February 2023. https://www.reuters.com/article/idUSL8N34P0HT/.
[138] Raj, Brij, and Amit Kumar. 'Transitioning India's Power Sector: Repurposing of Coal Fired Power Plants'. Reserve Bank of India, November 2023.
[139] Jones, Dave, Sarah Brown, and Dr Paweł Czyżak. 'European Electricity Review 2023'. Ember Climate, 31 January 2023. https://ember-climate.org/insights/research/european-electricity-review-2023/.
[140] Bhushan, Chandra, Mandvi Singh, and Yukti Chaudhary. 'Just Transition of Coal-Based Power Plants in India: A Policy and Regulatory Review'. New Delhi, November 2022. https://iforest.global/wp-content/uploads/2022/11/Just-Transition-of-coal-based-power-plants-in-India_.pdf.

From black gold to green: The role of petrostates and oil money in driving the global energy transition

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Contextualization

The decision to host COP28 in the United Arab Emirates (UAE) has cast a spotlight on a crucial and contentious issue at the intersection of climate policy and economic reality: the role of oil money in financing the energy transition. This choice has amplified a global debate about the legitimacy of petroleum-rich nations as well as oil companies in leading climate conversations and, by extension, the morality of utilising hydrocarbon-generated wealth – referred to as 'oil-money' – to support the green transition worldwide.[141] Over the past decade, sustainability has emerged as a critical topic throughout the Gulf region, with petrostate governments allocating substantial funds to various impressive environmental initiatives, including events such as the World Future Energy Summit or COP and large domestic and overseas investments.[142] The same trend can be observed in international oil companies (IOCs) where billions of dollars are increasingly being invested into low-carbon energy technologies.[143]

This notion of oil money funding the transition has drawn scepticism and allegations of greenwashing. Critics argue that this approach may simply be a sophisticated effort to maintain the status quo under a façade of progress and that the primary objective of these activities is green credentials through overblown media coverage.[144] While it is acknowledged that greening initiatives are often strategically and tactically deployed by oil companies, who are conscious of the paradoxical nature of their position, this essay argues that these efforts are not only beneficial but essential in advancing the energy transition. Revenues from wealthy oil-producing nations, emerging oil producers and IOCs have the potential to facilitate the energy transition in different ways. Direct investments in renewable energy projects and infrastructure, alongside the creation of favourable investment conditions, present significant opportunities for advancing the energy transition. Additionally, leveraging

[141] Mooney, A., Williams, A. 2023. "The cheque book COP: UAE's $200bn bid for climate influence." Financial Times.
[142] Koch, N. 2023. "Sustainability Spectacle and 'Post-Oil' Greening Initiatives." Environmental Politics 32, no. 4: 708-731. DOI: 10.1080/09644016.2022.2127481.
[143] Van Benthem, A. 2023. "Why Oil Companies Support Renewable Energy." Kleinman Center for Energy Policy. https://kleinmanenergy.upenn.edu/podcast/why-oil-companies-support-renewable-energy/.
[144] Koch, Natalie. 2022. "Greening Oil Money: The Geopolitics of Energy Finance Going Green." Energy Research & Social Science 93: 102833. DOI: 10.1016/j.erss.2022.102833.

the expertise, strategic positioning, and commitment to economic diversification of IOCs further enhances these opportunities, driving forward the global shift towards sustainable energy. These avenues will be explored in detail throughout this essay.

Wealthy Oil Producing Nations

UN-commissioned research from 2021 indicates that over $125 trillion in climate investments are needed by 2050 for targets set by the Paris Agreement to be reached.[145] Unfortunately, the world is not investing at the scale nor the pace necessary to meet our goals. Even though the generation costs of traditional renewable energy sources have significantly decreased during the past few years, the issue of financing continues to be one of the greatest challenges of the transition.[146] The high upfront capital costs and various risks – including technological uncertainties, market and financial fluctuations, regulatory and policy changes, environmental and social challenges, geopolitical instability, operational issues, and legal and compliance hurdles - associated with renewable energy projects make it difficult for private capital to invest in them.

Wealthy petrostates such as the UAE, Saudi Arabia, Qatar, and Norway, have the capability not only to allocate direct resources to renewable energy projects but also to create the economic conditions necessary for mobilising private capital. Simultaneously, they can benefit from attractive business opportunities, the diversification of their economic activities, and sustain their global status as leaders in the energy sector. Sovereign wealth funds (SWF) from oil-producing countries such as those from the United Arab Emirates, Saudi Arabia and Norway possess substantial amounts of wealth, controlling nearly $8 trillion in assets.[147] In 2023, around $9.3 billion were involved in low-carbon initiatives.[148] This number, though increasing compared with previous years, still represents a small share of the available funds.

By channelling a portion of fossil fuel revenues directly into investments for renewable electricity projects internationally governments have a straightforward path to fund the energy transition. Should there be a need to increase funds, wealthy petrostates have the advantage of debt access at comparatively low interest rates. This financial leverage could significantly increase investment in the clean energy sector, provided there is sufficient political determination to do so. Norway provides a notable case in point. The Norges Bank Investment Management, Norway's SWF, has played an essential role in the nation's sustainability successes, notably in electric vehicle (EV) adoption. Despite Norway's challenging weather conditions, which are not ideal for EV operations, an impressive 82% of new vehicles sold in 2023 were EVs.[149] This achievement underscores how vast resources, combined with political will, can turn ambitious environmental goals into reality.

While the public sector can directly fund renewable energy projects through different mechanisms, it has been historically hesitant to do so, and public funds shouldn't be

[145] Libby, G., Al Sayegh, H. 2023. "Sovereign Wealth Funds Struggle to Turn Their Trillions to Climate Finance." Reuters. https://www.reuters.com/sustainability/sustainable-finance-reporting/sovereign-wealth-funds-struggle-turn-their-trillions-climate-finance-2023-12-06/.
[146] International Renewable Energy Agency (IRENA). 2017. "Renewable Power: Sharply Falling Generation Costs."
[147] Libby, G., Al Sayegh, H. 2023. "Sovereign Wealth Funds Struggle to Turn Their Trillions to Climate Finance." Reuters. https://www.reuters.com/sustainability/sustainable-finance-reporting/sovereign-wealth-funds-struggle-turn-their-trillions-climate-finance-2023-12-06/.
[148] IE University. 2023. "Sovereign Wealth Funds Report.". https://static.ie.edu/CGC/2023_Sovereign_Wealth_Funds_Report.pdf
[149] Visit Norway. 2024. "Norway – the EV capital of the world.". https://www.visitnorway.com/plan-your-trip/getting-around/by-car/electric-cars/.

exclusively relied upon to drive the transition.[150] A different approach that the public sector of wealthy oil nations can take is to create the necessary economic conditions to 'crowd in' private sector finance. Apart from CAPEX costs, other barriers for private capital are its cost (interest rate), risks associated with counterparty risk, liquidity, and other uncertainties. Governments can utilise their resources to provide favourable interest rates and access to capital, through mechanisms such as green bonds or subsidised loans. The proposed bond support fund is a financial mechanism where governments use a portion of their fossil fuel revenues to provide debt guarantees for bonds issued by private or public sector entities. These bonds are specifically aimed at funding decarbonization and just transition projects, such as renewable energy development and job creation in sustainable industries. By offering these guarantees, the mechanism significantly lowers the investment risk for private investors, making it more attractive to fund green and sustainable projects. This approach not only directs funds towards essential sustainable projects but also stimulates economic growth by making these investments safer and more lucrative. As these projects contribute to the economy, they are expected to boost government revenues, creating a positive feedback loop that supports further investment in sustainability. Additionally, the existence of a creditworthy issuer of debt guarantees such as bonds or Power Purchase Agreements (PPAs) can significantly increase private investments.[151]

The reasons for using such mechanisms extend far beyond mere altruism. By rebranding themselves as pioneers of a 'post-oil' future, fossil fuel-dependent countries aim to mitigate anticipated losses in fiscal revenue by future-proofing their economies. Furthermore, this repositioning enables them not only to preserve their international status as energy leaders but also to legitimise their authority domestically, particularly pertinent for countries in the Gulf region.[152] While efforts to green oil money might have economic and geopolitical objectives over climate, Government assistance can significantly accelerate the energy transition by directly allocating resources, improving investor confidence or by generating favourable investment conditions through different financial mechanisms.

Developing Oil-Producing Nations

The transition narrative shifts as we turn to developing oil-producing countries where the economic stakes are even higher. Developing oil-producing countries represent a significant part of both the world's population and carbon emissions. For instance, Brazil, Russia, India, Indonesia, China, and South Africa (BRIICS) constitute both 45% of global emissions and population, 25% of the world's GDP and a large portion of the world's most vulnerable population.[153] Additionally, they are particularly threatened by the energy transition, given the high share these revenues represent of their total government revenues (8.4% of total government revenue for Brazil, 18% for India, 15.7% for Indonesia, 33.7% for Russia).[154] In addition to these revenues already being highly volatile, technological (efficiency) innovations in oil extraction and the phasing out of fossil fuels in alignment with Net Zero goals will likely

[150] Krupa, J., Rahmatallah, P., L.D. Danny, H. 2019. "Renewable Electricity Finance in the Resource-Rich Countries of the Middle East and North Africa: A Case Study on the Gulf Cooperation Council." Energy 166: 1047-1062.
[151] Laan, T., Maino, A.G. 2022. "Boom and Bust: The Fiscal Implications of Fossil Fuel Phase-Out in Six Large Emerging Economies." GSI Report. International Institute for Sustainable Development.
[152] Koch, N. 2023. "Sustainability Spectacle and 'Post-Oil' Greening Initiatives." Environmental Politics 32, no. 4: 708-731. doi: 10.1080/09644016.2022.2127481.
[153] Laan, T., Maino, A.G. 2022. "Boom and Bust: The Fiscal Implications of Fossil Fuel Phase-Out in Six Large Emerging Economies." GSI Report. International Institute for Sustainable Development.
[154] Ibid.

create downward pressure on oil demand and prices, driving down their fiscal revenues. Oil price volatility tends to be more detrimental for developing oil-exporting countries compared to wealthier producers given their relatively limited diversification, lack of financial buffers and weaker institutional capacity.[155] Given that various energy forecasts project peak oil prices within the next decade, developing oil countries must be strategic in how they utilise their oil revenues in the short and long term to meet environmental goals while at the same time safeguarding their own financial well-being.[156,157]

Under the IEA's Sustainable Development Scenario (SDS) – 2°C global warming by 2100 against the pre-industrial levels – BRIICS countries' fiscal revenues could decrease between 35% and 65% of 2019 levels by 2050.[158] This scenario of 2°C warming is not enough to mitigate the risks associated with climate change and relies heavily on unproven CO2 capture technologies. Under the IEA's Net Zero Emissions (NZE) scenario, it is estimated that these revenues will drop to around 10% of 2019 levels by 2050.[159] At the same time, these scenarios project a boost in fossil fuel revenues well into the 2030s, when peak oil demand is expected to happen. Consequently, these augmented oil revenues must be utilised strategically through fiscal transition planning to simultaneously prevent severe shortfalls in fiscal revenues, foster the energy transition and mitigate poverty and inequality.

Among the various strategies that could be employed, a green, social, and sustainability (GSS) bond support fund stands out as particularly beneficial and well-suited for emerging markets.[160] This mechanism involves governments allocating a portion of their fossil fuel income to back debt for bond issues. These bonds can be issued by either private or public entities engaged in suitable green projects. Green bonds are attractive because they can draw in a wider base of investors and offer the chance to access capital at lower costs and more favourable borrowing terms.

This financial instrument is poised to boost the construction of productive capacity in low-emission, non-resource sectors, which is ideal for diversification due to their low exposure to commodity price volatility and carbon prices. The fund generates its assets from cash flows derived from fossil fuel revenues. On the liabilities side, it acts as an insurance to eligible bond issuers, which can include both private companies and public sector entities like utilities or state-owned energy firms. By covering potential initial losses up to a predetermined percentage of the total bond issuance — for example, 5% — the fund significantly increases the bonds' appeal to investors. This first-loss buffer provides a credit enhancement, meaning that investors only face losses after the initial 5% has been absorbed by the fund.

The 'greenium' – the difference in interest rate between a green and a regular bond – has been increasing in recent years, signifying a lower cost of capital for issuers. Specifically, in emerging markets the greenium widened from 4.2 basis points in 2021 to 7.2 basis points by

[155] Mabro, R. 2001. "Does Oil Price Volatility Matter?". The Oxford Institute for Energy Studies. https://www.oxfordenergy.org/publications/does-oil-price-volatility-matter/
[156] Institute for Energy Research. 2023. "IEA Forecasts Global Oil Demand Peaking by 2028." https://www.instituteforenergyresearch.org/international-issues/iea-forecasts-global-oil-demand-peaking-by-2028/
[157] Barcelo, Y. 2024. "When Will Oil Demand Peak? And Does it Matter?". Morningstar. https://www.morningstar.co.uk/uk/news/244443/when-will-oil-demand-peak-and-does-it-matter.aspx
[158] Laan, T., Maino, A.G. 2022. "Boom and Bust: The Fiscal Implications of Fossil Fuel Phase-Out in Six Large Emerging Economies." GSI Report. International Institute for Sustainable Development.
[159] Ibid.
[160] International Finance Corporation. 2023. "IFC-Amundi Emerging Market Green Bonds." July 2023. https://www.ifc.org/content/dam/ifc/doc/2023/ifc-amundi-emerging-market-green-bonds-july2023.pdf.

the end of 2022. This greenium increase translates to lower cost of capital for issuers.[161] It is projected that an investment of USD 10 billion in a GSS bond support fund could catalyse up to USD 400 billion in further investments.[162] However, it is crucial to recognize that this instrument is not without its flaws and is susceptible to greenwashing. To address this, regulators must clearly define the roles of market participants, scrutinise sustainability-related claims, tackle misleading information like selective disclosure, and develop standardised global definitions and methods.

International Oil Companies

The narrative pivots once again when considering the role of International Oil Companies (IOCs) in the energy transition. IOCs are uniquely positioned with extensive operational experience, capital, and global influence to play pivotal roles in the shift towards low-carbon energy. They possess the necessary tools to engage with decarbonization efforts, not just as passive participants, but as active facilitators of low-carbon energy deployment. Having their core business model threatened by global decarbonization efforts, IOCs should leverage their competitive advantages to capture massive business opportunities and position themselves as global, clean, energy companies. The shift from hydrocarbons to clean technologies has already started to be observed especially in European oil companies. IOCs such as BP, Shell and Equinor, while with widely different decarbonization strategies, have already started investing significant money beyond fossil fuels into solar PV farms, wind farms, and EV infrastructure, sectors with high opportunities for growth.[163] Other key decarbonization tools which could greatly benefit from leveraging IOCs competitive advantages are electrification, bio and synthetic fuels, carbon capture and storage (CCS) and hydrogen. Although many of the aforementioned IOCs have begun to invest in these ventures, these investments still represent a small portion of their available funds. It is a positive beginning, but there is significant progress yet to be made.

Electricity is projected to become the world's prominent energy carrier. As mentioned above, some IOCs are already entering the industry with the ambition of playing an increasing role in the production and transmission/distribution of renewable energy (RE). While venturing into the electricity sector presents attractive opportunities for IOCs, it comes with its complexities, particularly as we achieve higher RE penetration rates. In regard to alternative fuels, IOCs have been investing in the sector for decades already, manifesting their bet on the continuity of combustible fuels as the energy source for hard-to-electrify transport.[164] As governments set plans to retire internal combustion engine (ICE) vehicles, investing in alternative fuels becomes a strategic move. CCS is a technology in which most IOCs are already invested in since it could potentially allow them to prolong the lifetime of their hydrocarbon extraction activities well beyond 2050. While not necessarily a negative force to the transition, the potential effect of CCS in further locking in the fossil fuel economy must be considered. For hydrogen developments, the high investment required for infrastructure, as well as for the large-scale production, storage, and transport, positions IOCs in a favourable way. Their

[161] Ibid.
[162] Laan, T., Maino, A.G. 2022. "Boom and Bust: The Fiscal Implications of Fossil Fuel Phase-Out in Six Large Emerging Economies." GSI Report. International Institute for Sustainable Development.
[163] NPR. 2021. "When Oil Companies Say They're Going Green, Should We Believe Them?" NPR, July 7, 2021. https://www.npr.org/2021/07/07/1013645625/when-oil-companies-say-theyre-going-green-should-we-believe-them.
[164] Asmelash, E., Gorini, R. 2021. "International Oil Companies and the Energy Transition." Technical Paper 1/2021. International Renewable Energy Agency (IRENA).

existing experience in transporting and marketing gas, coupled with their substantial resources, gives them a solid foundation to establish themselves in the hydrogen sector.

Critics contend that oil and gas companies' investments in green energy are strategic manoeuvres aimed at preserving their dominance in the energy sector and slowing the transition to a low-carbon economy. These firms remain committed to extracting and selling fossil fuels, their primary source of profit. They may also use their green investments to greenwash their image and divert attention from their main operations. Additionally, these companies might leverage their financial and political clout to influence policies and regulations in favour of their interests during the transition to a low-carbon economy.

To tackle this evident conflict of interest, companies must be transparent and accountable in their green energy investments, including mandatory disclosures of their renewable energy investments and the impact on their overall emissions. This transparency will enable investors and stakeholders to assess the genuineness of companies' efforts to reduce their carbon footprint.[165] Moreover, policymakers need to resist the influence of oil and gas companies and prioritise society's long-term interests, ensuring that the transition to a low-carbon economy is both fair and effective.

IOCs can and should deploy their expertise in offshore projects, supply chains and market development to support the energy transition, utilising renewables and new technologies to decarbonize their production and capitalise on emerging energy sectors. Investments outside traditional oil and gas present new avenues for diversification and innovation if they’re disclosed and reported properly.

Conclusion

The hosting of COP28 in the UAE underscores a complex and multifaceted scenario where the intersection of climate goals and economic realities demands a nuanced understanding. While the utilisation of 'oil money' into sustainable initiatives is often met with scepticism and accusations of greenwashing, such financial contributions are indispensable for advancing the global energy transition. The capacity of petrostates and international oil companies to fund and foster renewable energy ventures is undeniable. They possess the financial clout and the strategic positioning necessary to catalyse significant changes within the energy sector.

At the same time, the utilisation of oil revenues to promote green projects certainly does not merely serve an altruistic purpose but strategically positions these entities for a sustainable future in a post-oil world. As these investments increase, the role of stringent regulations and transparent reporting becomes paramount to prevent actual greenwashing and ensure genuine progress towards global climate goals. This dual approach not only secures environmental targets but also stabilises the economic and political standing of oil-rich nations and IOCs in the evolving global energy landscape.

Ultimately, while the road is not without its challenges and ethical dilemmas, the involvement of oil-producing nations and corporations in the energy transition presents a critical opportunity. If leveraged correctly, with oversight and genuine commitment to sustainability,

[165] Raden, N. 2023. “Big oil in VC funding of GreenTech – positive sign or cynical greenwashing?”. https://nraden.medium.com/big-oil-in-vc-funding-of-greentech-positive-sign-or-cynical-greenwashing-a72eb5df4ed5.

these entities can transform their legacies from fossil-fuel dependency to champions of a greener future, making substantial contributions to the global fight against climate change.

Skills for global energy transitions: Building a greener future together

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In 2015, 194 countries signed the Paris Agreement to limit global warming to 1.5 degrees, aligning with the Sustainable Development Goals for a climate-neutral and equitable global society. As the negative effects of climate change worsen annually, the timeframe for taking action diminishes quickly.[166] The upcoming 2025 deadline of submitting updated National Determined Contributions (NDCs) as required in the Paris Agreement will therefore be an important moment to assess where the global community stands in slowing down the climate crisis. NDCs define targets to mitigate greenhouse gas emissions, the measures to adapt to climate change, and the strategies on how to reach as well as monitor the targets.[167] Moreover, they provide potential points for international cooperation and for leveraging multilateral partnerships. While the roadmaps of reaching net zero or 1.5 can look differently in terms of sequencing or methods, one prerequisite for all their achievement cannot be denied: the need for skilled workers. From renewable energy to energy-efficient infrastructure, sectors such as solar power installation, wind turbine maintenance or energy auditing are just a few examples that demand skilled professionals to drive the energy transition forward. With the upcoming deadline of submitting updated NDCs, including concrete initiatives on skills and technical and vocational education and training (TVET) systems is crucial to move towards net-zero targets.

Currently, decarbonisation plans and NDCs often overlook the crucial aspect of skill development. While these strategies focus extensively on emission reduction targets and renewable energy adoption, they frequently neglect equipping the workforce with necessary skills for green industries.[168] For instance, countries may pledge to increase the share of renewable energy in their energy mix without providing outlines on how workers will be trained in solar panel installation, wind turbine maintenance, or waste management. Similarly, initiatives to decarbonise fossil fuel-dependent industries may lack concrete steps for reskilling workers for employment in growing sectors such as renewable energy, energy efficiency or renovation. Just as initiatives to decarbonise fossil fuel-dependent industries may overlook concrete steps for reskilling workers, it's vital to acknowledge the already existing and transferable expertise within these sectors. For instance, individuals working in

[166] United Nations, "All about the NDCs," *United Nations Climate Action*, Accessed at https://www.un.org/en/climatechange/all-about-ndcs.
[167] Ibid.
[168] International Labour Organisation and Organisation for Economic Cooperation and Development, "Skills for Decarbonisation, Paper prepared for the Labour and Employment Ministry Meeting under the German G7 Presidency," *ILO & OECD*, May 2022.

projects related to oil, gas or chemicals possess valuable skills that can be transitioned into emerging sectors such as hydrogen.

Skill shortages due to demographic changes and high retiring rates are already hampering the achievements of climate targets, especially in high-income countries.[169] Core sectors for the green transition such as construction, IT, or renewable energies are particularly affected by this. According to a 2021 study, Germany will require 767,200 additional workers in 2035, of which 58% are skilled workers, to reach its goals towards climate neutrality.[170] While in some sectors, automation can alleviate skill shortages, the emergence of new technology is useless without an adequate number of skilled workers to utilise and deliver these technologies to benefit the green transition.[171] For instance, a recent survey conducted on behalf of the EU Commission revealed that the insufficient availability of technicians is a major obstacle to the widespread adoption of heat pumps, with a significant 68% deficit in skilled or certified installers, thus posing a significant obstacle to the green transition.[172]

Moreover, the need to fill the skill gap for decarbonisation is especially challenging for low-income countries. Here, the skill gap often revolves around basic technical competencies and access to education and jobs, especially for young people. Many individuals lack foundational skills in mathematics, science, and technology necessary for green jobs. UNESCO estimated in 2020 that 773 million adults worldwide lacked basic literacy skills, with a significant portion being women residing in low-income countries.[173] More than 20 percent of youth in low and middle income countries are not in education, employment, or training. This rate rises to almost 40% among young women.[174] Literacy serves as the foundation upon which individuals can comprehend and apply technical knowledge, understand safety protocols, and effectively communicate within a professional environment. Without proficient literacy skills, accessing and succeeding in TVET programmes becomes more difficult, limiting the availability of qualified workers with green skills and for green jobs. Thus, investing in education accessibility is crucial to bridge this gap and facilitate a smoother transition to a green economy. Additionally, tailored skill development programmes are needed to address specific needs and create pathways for educationally marginalised groups to access green job opportunities.

Furthermore, green jobs and decent work in the sectors relevant for the necessary transitions will not occur automatically; instead, they require planning, commitment, cooperation, and regular monitoring from governments, educational institutions, and the private sector.[175] Unlike traditional sectors where skills may be more standardised and readily available, the renewable energy transition demands a diverse range and ongoing refinement as the rapid evolution of renewable technologies necessitates continuous learning and adaptation.

[169] Marta Pacheco, “Talent deficit undermining green building renovation, say officials,” Euronews.green, 2024, Accessed at https://www.euronews.com/green/2024/01/16/talent-deficit-undermining-green-building-renovation-say-officials.
[170] Prof. Dr. Jürgen Blazejczak and Dr. Dietmar Edler, “Arbeitskräftebedarf nach Sektoren, Qualifikationen und Berufen zur Umsetzung der Investitionen für ein klimaneutrales Deutschland,” *Kurzstudie im Auftrag der Bundestagsfraktion Bündnis 90/Die Grünen*, May 2021.
[171] Intereg Europe, “Skills for the Energy Transition, A policy brief from the policy learning platform on low carbon economy,” *Intereg Europe*, February 2021.
[172]Marta Pacheco, “Talent deficit undermining green building renovation, say officials,” Euronews.green, 2024, Accessed at https://www.euronews.com/green/2024/01/16/talent-deficit-undermining-green-building-renovation-say-officials.
[173] UNESCO Institute for Statistics, “Literacy,” *UNESCO*, 2020, Accessed at https://uis.unesco.org/en/topic/literacy.
[174] World Bank, ILO and UNESCO, “Building Better Formal TVET Systems Principles and Practice in low and middle-Income Countries,” *World Bank, ILO and UNESCO*, 2023.
[175] Amit Kumar, “How skilling initiatives can be aligned with just transition goals in the energy sector,” *Economic Times*, 28 August 2023.

Moreover, the investment into human capital is also a long-term commitment and requires time. Unlike financial capital, which is often readily available, forming human capital is a process that takes time. Apprenticeships, for example, typically span two or more years.[176] Thus, the inclusion of comprehensive skills development in decarbonisation strategies and the alignment of initiatives with climate targets cannot wait any longer. The following text will outline some of the most urgent measures to include skill initiatives into NDCs and to upgrade TVET systems globally in order to serve the green transition.

Key Strategies for Integrating TVET into NDCs and Enhancing Vocational Training Quality

Firstly, concrete skills development plans need to be included in NDCs and align with national and international commitments. This requires a systematic orientation of the education and TVET systems towards sustainability and climate targets. Hence, in conjunction with the mention of climate goals and strategies, these need to include considerations on needed skills and ways of satisfying the needs. This must also occur vice-versa. The education sector and TVET need to integrate sustainability policies.[177] For example, in the context of concrete skills development plans, a country might outline specific training programmes for renewable energy technicians or hydrogen infrastructure engineers. These plans could involve collaboration between educational institutions, government bodies, and industry stakeholders to ensure that the skills being taught are directly relevant to the demands of a changing climate and a transitioning economy.

A positive example in this case is Germany, once home to a major coal industry which accelerated its structural change through targeted reskilling programmes and investments into green industries in regions that were previously dominated by coal.[178] In the Lausitz region, a specialised qualification network facilitates collaborations among businesses, civil society, and local technical educational institutions. Its aim is to equip workers transitioning from traditional fossil fuel industries with the necessary skills for emerging jobs in renewable energies, like hydrogen or battery production.[179]

Secondly, countries need to reform their education and TVET systems holistically. As the transition to sustainable practices proceeds and more public and private investments are injected into mitigation and adaptation efforts, the demand for skilled workers will increase, which could lead to higher wages. However, for this to occur, governments, the private sector and educational institutions need to work together to change the image from participating in TVET as a second-rated education option to a viable, interesting and respected career path. Examples for this include the provision of sufficient social protection of workers, offering financial incentives and rewards for participation and ensuring that TVET qualifications are recognised and valued by employers across industries and countries and society as a whole.[180] Especially in countries with advanced TVET systems such as the ones in the European Union, these could become hubs for innovation and interdisciplinary learning to

[176] Delphine Strauss, “Green skills shortage threatens Europe’s climate ambitions,” *Financial Times,* 2023.
[177] Kirsten Freimann and Gerda Magnus, “Skills for a Just Transition to a Green Future: Measuring the South African TVET System and providing input to support its development,” *Gesellschaft für Internationale Zusammenarbeit* (GIZ), May 2023.
[178] Land Brandenburg, Strukturstärkung und Erneuerbare Energien: Lausitz bleibt Energieregion,” Land Brandenburg, 2023. Accessed at https://brandenburg.de/cms/detail.php/bb1.c.760653.de.
[179] See for instance Qlee Verbund. Accessible at https://verbund.qlee.eu/p/home.
[180] Kirsten Freimann and Gerda Magnus, “Skills for a Just Transition to a Green Future: Measuring the South African TVET System and providing input to support its development,” *Gesellschaft für Internationale Zusammenarbeit* (GIZ), May 2023.

advance energy transitions, for instance by establishing Centres for Excellence or cooperating with universities and leading enterprises in the renewable energy sector.

Thirdly, to provide a high quality TVET system that drives the energy transition, collaboration between the public and private sector is key and ranges from financing to curriculum development, implementation of in-company training, examination, and certification of acquired competencies. In-company training and workplace learning facilitates vocational competence through hands-on experience in real work situations alongside academic learning.[181] Moreover, standardisation and social acceptance of qualifications need to be ensured through inter-company training and uniform examination standards, which needs to address the emerging demands of the renewable energy sector and thus requires constant updating to reflect the developments of the sector. This guarantees consistently high-quality qualifications that hold value both in supporting the greening of the economy and acceptance of this transition within society.[182]

Moreover, transferable skills especially in digitalization and environment are key to ensure labour mobility and potential upskilling in the future. For example, individuals trained in digital skills can easily transition between different industries as the technology to accelerate the energy transition continues to evolve. Similarly, workers with strong environmental literacy and expertise in areas such as resource management and energy efficiency can contribute to sustainability efforts across a wide range of sectors.

Challenging Gender Stereotypes

A further blindspot of NDCs is gender equality. A recent study of 120 NDCs found that only 27% highlighted the importance of women's participation in climate change decision making and only 24% identified national gender equality institutions as part of climate change governance.[183] To tackle gender inequality in TVET for the green transition, a multifaceted approach is essential. In general, girls and women still suffer from unequal access to education and training, especially to fields that can be seen as the pipeline for entry into the sectors related to the energy transition. This is due to the notion of sciences, technology, engineering and mathematics (STEM) as male dominated fields. Down the line this prejudice results in less women taking on decision making roles in the sector, as for instance seen in a UNESCO study finding that women only account 30% of those employed in scientific research and development worldwide.[184] Less women in STEM fields also means that females are less likely to be part of designing technologies and decision making, ultimately excluding a significant proportion of end users in expressing their views and making decisions impacting effective dissemination, uptake and use of renewable energies and related products. In January 2023, a UN Women study of 190 countries showed that women held only 11 % of ministerial positions for energy, natural resources, fuels and mining.[185] Thus, increasing the share of girls and women in STEM education and TVET is vital. To do so, breaking stereotypes and promoting inclusivity should be prioritised through targeted outreach efforts by TVET institutions and private enterprises. Collaborating with schools to

[181] Ibid.
[182] Bundesinstitut für Berufsbildung, "10 Jahre Qualitätsmerkmale im Praxistest Deutsche Berufsbildungszusammenarbeit aus einer Hand," *Bundesinstitut für Berufsbildung*, 2017.
[183] Carla Kraft, Seemin Qayum, Katharina Pröstler and Carmen Schuber, "Gender Equality and the Sustainable Energy Transition," UN Women and UNIDO, 2023.
[184] Ibid.
[185] Ibid.

invite girls to test and build their skills in jobs related to the energy transition could be part of such efforts. Others could involve showcasing diverse role models and creating supportive networks for women interested or already working in green jobs.[186]

In sectors related to the energy transition, challenging gender stereotypes and enabling flexible working conditions is crucial.[187] Offering flexible hours and parental leave can further foster inclusivity and allow all people to balance their care-taking responsibilities with their career.[188] This is particularly important in traditionally male dominated sectors such as fossil fuels or extractions in which workers should transition into greener jobs. In fact, entrenched socio-cultural norms defining masculinity as tough and stoic can undermine safety and efficiency as the pressure for men to assert their masculinity may lead to a reluctance to admit mistakes and disregard precautionary measures.[189]

Thus, for a transition from brown to green jobs that is accompanied by higher security, efficiency and also satisfaction and productivity of workers, employers need to support the creation of inclusive working environments, for which flexible working conditions that allows for equal parental leave and that breaks stereotypes is vital.[190] Another step that could reach trainees and encourage a bottom up change would be to implement anti-discrimination modules to foster a culture of equality, eliminating instances of discrimination and gender-based violence within the TVET or other educational environments.

Unlocking Potential: The Crucial Role of the Informal Sector in Low-Income Countries

Low-income countries face particular challenges to align their TVET systems with climate goals. 61% of the worldwide population is active in the informal sector, 68% in Asia and the Pacific and in the Arab States, and up to 86% in sub-Saharan Africa.[191] The informal sector encompasses diverse industries and activities and understanding its nuances is crucial, as it often operates beyond formal regulations, taxation structures, and legal frameworks. While the sector is certainly a major contributor to emissions, informal labourers often carry out some of the most harmful activities such as mining critical minerals for the energy transition or engaging in waste management.

Thus, offering educational programmes for informal economy workers to engage in the green transition is essential. Firstly, such efforts help curtail environmentally harmful practices by providing education and training tailored to sustainable practices. Secondly, it upholds the principle of Leaving No One Behind, ensuring that all segments of society have access to opportunities for healthier and greener economic advancement. However, addressing the challenges posed by the informal sector requires a multifaceted approach that acknowledges broader socio-political dynamics.[192] The prevalence of informal employment often reflects underlying issues such as low state capacity for taxation and regulation, fragmented firm

[186] TVET Programme, “Programme Reform of Technical & Vocational Education & Training (TVET) in Viet Nam (2020-2024),” *Gesellschaft für Internationale Zusammenarbeit,* 2020.
[187] IRENA, “Renewable Energy: A Gender Perspective,” *IRENA*, 2019; IRENA and ILO, “Renewable Energy and Jobs – Annual Review 2021,” *International Renewable Energy Agency, International Labour Organization*, 2021.
[188]International Labour Organisation, Gender Equality and Inclusion for a Just Transition in Climate Action A Practical Guide,” International Labour Organisation, 2023.
[189] Sarah Jane Gilbert, “Manly Men, Oil Platforms, and Breaking Stereotypes,” *Harvard Business School,* 2006.
[190] Ibid.
[191] UNESCO, “Transforming technical and vocational education and training for successful and just transitions: UNESCO strategy 2022-2029,” UNESCO, 2022.
[192] Ibid.

structures, and inadequate legal frameworks and even human rights abuses.[193] Therefore, effective policies must not only aim to integrate informal workers into formal training programs but could start by offering non-attached training for greening the informal sector.[194] Examples include small and locally based training for waste management to avoid the burning of trash and toxic waste or offering small self-sufficient energy production courses and equipment.

Fostering International Collaboration: Advancing TVET to Address Global Skill Shortages

The international community must prioritise TVET programmes in both development and climate cooperation efforts due to their high economic and environmental returns and opportunities to empower people to create lasting change. While currently the bulk of the largest capital is concentrated in financial cooperation, the building of human capital needs to play a bigger role. In fact, TVET initiatives offer practical skills that drive long-term economic growth and resilience to climate change. Moreover, integrating TVET into development and climate agendas creates synergies, as skilled individuals contribute to both economic progress and environmental sustainability. This approach aligns with the principle of Leaving No One Behind, fostering inclusive growth and mitigating inequality. For this, the private sector's financial support for the education sector which could be facilitated by the public sector is of utmost importance.

Engaging in development cooperation can also help alleviate skill shortages in the private sector of high-income countries without leading to brain drain in their partner countries. One example of such cooperation is the PAM project facilitated by the German Corporation for International Cooperation (GIZ), which partners with the governments of Ecuador, Jordan, Nigeria, and Vietnam. By taking a holistic approach of providing technical assistance to partner countries to improve their TVET systems while enabling regulated migration to high-income countries, skill shortages are alleviated in both regions.[195] More concretely, the project \ established a class in Vietnam where all pupils engage in training which certification is recognised in Germany while also learning German. Recruiters from Germany can reach out to them through the programme and offer them to continue their apprenticeship in their enterprise after which they can either return to Vietnam or remain in Germany.[196]

As the 2025 deadline for updating NDCs approaches, it is clear that integrating Technical and Vocational Education and Training into climate strategies is essential to move the global energy transition forward. Concrete actions are needed, including integrating skills plans into NDCs, reforming TVET systems, and fostering public-private collaboration. The breaking of stereotypes and creating inclusive working environments that can integrate a more diverse workforce is also a main task for a more just green transition. International cooperation, exemplified by initiatives like the PAM project, offers opportunities to address skill gaps globally while advancing sustainable development. By prioritising TVET within climate and development agendas, we can build a skilled workforce capable of driving the green transition as well as economic growth and fostering inclusive societies, aligning with the Paris Agreement and Sustainable Development Goals.

[193] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), “Toolkit and Learning in the Informal Sector,” GIZ, 2019.
[194] Ibid.
[195] Gesellschaft für Internationale Zusammenarbeit (GIZ), “Partnerschaftliche Ansätze für entwicklungsorientierte Ausbildungs- und Arbeitsmigration (PAM),” Accessed at https://pam-partnerships.org/.
[196] Ibid.

Lao hydropower exports to Singapore: The hidden costs behind ASEAN's "sustainable energy" promise

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In June 2022, Singapore announced plans to import hydropower from Laos' state-owned electricity provider Électricité du Laos (EdL) through transmission cables in Thailand and Malaysia, as part of supply diversification efforts to decarbonise Singapore's energy grid and reinforce energy security.[197] **In this paper, I argue that Singaporean state-led narratives that valorise Lao hydropower as enhancing 'sustainability' and promoting 'regional energy cooperation' obscure the significant harm dams can bring to ecosystems and livelihoods along the Mekong River**.[198] I thus caution against conflating renewable energy with sustainable energy. Sustainable energy demands not only reducing carbon emissions but also minimising environmental damage and socio-economic losses suffered by vulnerable populations.[199] I also highlight the risk of multilateral conflict inherent in damming transboundary rivers, undermining the boosterism central to wider Association of Southeast Asian Nations (ASEAN) narratives on energy diplomacy.[200] In regional energy boosterism, narratives of sustainability and cooperation that transcend the national scale are essential for political actors seeking to enhance their legitimacy (both domestically and internationally) through positioning themselves as enablers of 'green growth', fulfilling objectives of environmental responsibility and economic productivity simultaneously.[201]

[197] Tan, A. (2022). Singapore begins importing renewable energy from Laos via Thailand, Malaysia. *The Straits Times*.
[198] Energy Market Authority. (2022). Singapore commences first renewable energy electricity import via regional multilateral power trade.
[199] Moran, E. F., Lopez, M. C., Moore, N., Müller, N., & Hyndman, D. W. (2018). Sustainable hydropower in the 21st century. *Proceedings of the National Academy of Sciences of the United States of America*.
[200] Kresnawan, M. R., & Wijaya, T. N. (2021). Energy Diplomacy: A Vital Piece to Boost Renewable Energy Investment. *ASEAN Centre for Energy*.
[201] Albrecht, M., Kortelainen, J., Sawatzky, M., Lukkarinen, J., & Rytteri, T. (2017). Translating bioenergy policy in Europe: Mutation, aims and boosterism in EU energy governance. *Geoforum*.

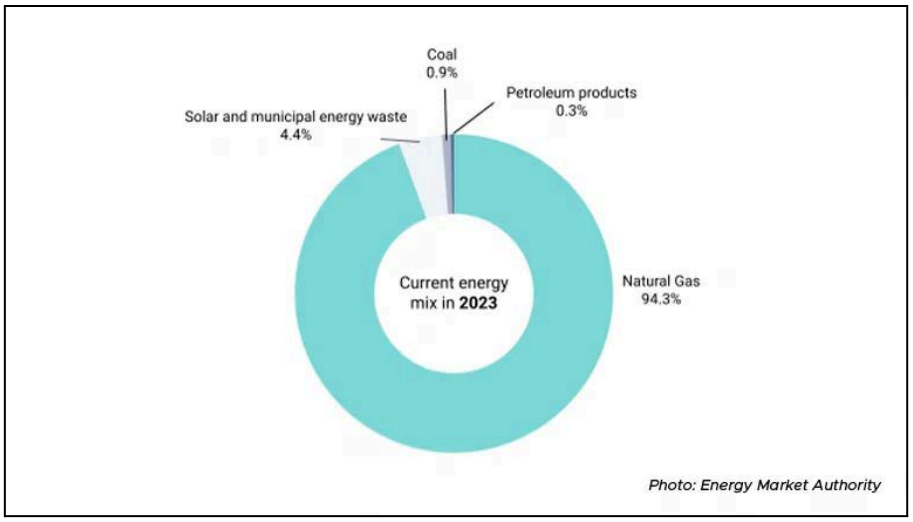

Figure 1: Singapore's energy mix as of June 2023.[202]

Currently, Singapore's electricity demand is overwhelmingly fulfilled by natural gas (Figure 1). Under the Singapore Green Plan 2030, Singapore aims to increase solar deployment to a capacity of 2 gigawatts by 2030, with the aid of energy storage systems to address the intermittency of solar power generation, which is otherwise highly dependent on prevailing weather conditions. Moreover, Singapore aims to import up to 4 gigawatts of 'low-carbon electricity' from regional power grids by 2035, which is projected to fulfil 30% of Singapore's electricity needs.[203] The reliance on regional imports to fulfil low-carbon electricity ambitions can be explained by Singapore's lack of access to hydroelectric, geothermal, wind, and tidal resources.[204] Even harnessing solar potential is challenging, as Singapore's dense urban morphology makes it difficult to maximise sunlight exposure for photovoltaic panels mounted within the city.[205]

As for energy security, Singapore remains concerned that its overreliance on natural gas imports leaves it vulnerable to significant price volatility stemming from global demand fluctuations and supply shocks.[206] The government's official position is that "energy security need not be incompatible with Singapore's climate goals." Intense investment in liquified natural gas (LNG) technology and infrastructure includes measures aimed at reducing the environmental impact of gas burning, such as carbon capture, utilisation and storage (CCUS) solutions.[207] But by introducing an alternative to natural gas, regional energy imports are intended to diversify sources of energy, create back-up options, and enhance energy security'.[208]

[202] Economic Development Board. (2024). What could Singapore's energy mix look like in 2035?
[203] Singapore Green Plan 2030. (2024). Energy Reset.
[204] Quek, A., Ee, A., Ng, A., & Wah, T. Y. (2018). Challenges in environmental sustainability of renewable energy options in Singapore. *Energy Policy*.
[205] Poon, K. H., Kämpf, J. H., Tay, S. E. R., Wong, S. H., & Reindl, T. G. Parametric study of URBAN morphology on building solar energy potential in Singapore context. *Urban Climate*.
[206] EMA. (2021). Pre-emptive measures to enhance Singapore's energy security and resilience.
[207] Subhani, O. (2023). LNG ensures energy security as S'pore works on decarbonisation goals: Tan See Leng. *The Straits Times*.
[208] EMA. (2023). Why does Singapore need to import electricity?

Figure 2: Visualisation of the current and future installations within the ASEAN Power Grid. The solid red lines and dotted blue lines show existing and future transmission cables for cross-border energy exchange.[209]

According to Singapore's Energy Market Authority (EMA), the interconnected ASEAN Power Grid (Figure 2) "contributes towards economic development" of partner countries.[210] However, the contributions of private capital (including investors from China and Thailand) to Lao hydropower projects has led to increased focus on profit at the expense of environmental conservation and the rights of affected villagers.[211] 'Selling electricity' to Singapore generates profit for the Lao state and private investors, but at the cost of local livelihoods. Downstream fisheries have been drained as a result of upstream dam construction, depriving fishing communities of income.[212] Redistribution of funds from the state-level to the local-level is likely to be insufficient to maintain local livelihoods, with displaced villagers complaining of inadequate financial and land compensation from the government.[213]

Villagers' complaints about inadequate compensation should be taken seriously, rather than simply as a negotiation tactic for better compensation. A standardised Cumulative Impact Assessment (CIA) Framework, developed by Laos' Ministry of Natural Resources and Environment (MONRE) in collaboration with the International Finance Corporation (IFC) has been made available, but damaging projects continue to be greenlighted without robust mitigation plans. CIAs are intended to assist stakeholders in identifying the "potential incremental (environmental and social) impacts resulting from proposed and/or anticipated future developments," which "would not be expected in the case of a stand-alone development."[214] Political ecologists have drawn attention to the need to consider the cumulative impacts of successive hydropower developments as well as other industrial

[209] Tenaga Nasional Berhad. (2023). Analyst briefing 2QFY23.
[210] EMA, 'Singapore commences energy import'.
[211] Chattranond, O. (2018). Battery of Asia? The rise of regulatory regionalism and transboundary hydropower development in Laos. [Doctoral thesis, Erasmus University Rotterdam].
[212] Gerin, R. (2022a). Worries in Laos and Thailand as upstream dams drain Mekong River. *Radio Free Asia*
[213] Gerin, R. (2022b). Lao villagers to be displaced by dam want more money for their trouble. *Radio Free Asia.*
[214] International Finance Corporation. (2013). Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, 19.

developments like tree plantations, as "cascading environmental transformations can also undermine developers' attempts at mitigation and livelihood compensation."[215] According to the MONRE-IFC CIA Framework, mitigation plans "should have *specific and detailed* descriptions of proposed measures."[216]

An Environmental Impact Assessment (EIA)[217] prepared by the Thai branch of engineering consultancy Pöyry for the Luang Prabang Hydropower Project noted that the "Livelihood Restoration Program will have to include supply or provision of suitable agricultural area and/or alternative means for implementing income restoration."[218] In practice, however, mitigation procedures remain haphazard. Construction of the Luang Prabang dam was planned to commence in 2020. Yet, in 2022, Luang Prabang district's Natural Resources and Environment Department established resettlement villages without checking if sufficient agricultural land was available at the designated locations.[219] Only after selecting the relocation sites did officials from the province's Natural Resources and Environment Department conduct detailed land surveys. They soon found that only 0.7 hectares of farmland could be provided to families displaced by dam construction, rather than 1.0 hectare as initially projected.[220] This example highlights how hydropower developers in Laos approach impact mitigation in hydropower projects as an afterthought rather than a core planning focus, contravening not only villagers' expectations but Laos' own established guidelines. Paying attention to issues of scale thus reveals the hidden costs. Singapore's attempts to portray itself as a benefactor towards the economic development of Laos overlook how Singapore is complicit in the dispossession and displacement of local villagers.

The EMA's claims about promoting regional energy cooperation are similarly overstated. Taking the rhetoric about "strong support and close collaboration" at face value, one might imagine a frictionless multilateral negotiation process in which equal partners work towards shared goals.[221] The EMA's collaboration-focused narrative feeds into wider ASEAN narratives about "Enhancing Energy Connectivity and Market Integration in ASEAN to Achieve Energy Security, Accessibility, Affordability and Sustainability *for All*."[222] While the first ASEAN Economic Ministers on Energy Cooperation (AEMEC) meeting was convened in 1980, focusing on regional energy security,[223] the ASEAN Plan of Action for Energy Cooperation 2016 - 2025 was the first to introduce the theme of sustainability as a key concern for energy cooperation.[224] This professed focus on 'sustainability' followed the United Nations' declaration of the Sustainable Development Goals (SDGs) in 2015, in particular SDG: Affordable and clean energy.[225] In such formulations, energy diplomacy leverages

[215] Baird, I. G., & Barney, K. (2017). The political ecology of cross-sectoral cumulative impacts: modern landscapes, large hydropower dams and industrial tree plantations in Laos and Cambodia. *The Journal of Peasant Studies.*
[216] IFC. (2016). Cumulative Impact Assessment Guidelines for Hydropower Projects in the Lao People's Democratic Republic.
[217] For further information on the development of EIAs as a policy instrument around the world, see Morgan, R. K. (2012). Environmental impact assessment: the state of the art. *Impact Assessment and Project Appraisal*.
[218] Pöyry. (2019). Luang Prabang HPP Environmental Impact Assessment.
[219] Gerin, 'Lao villagers to be displaced'.
[220] Ibid.
[221] EMA, 'Singapore commences energy import'.
[222] Ienanto, G., Richard., and Yurnaidi, Z. (2021). Highlighting the Four Pillars of ASEAN Energy Cooperation in Achieving Sustainable Development. *ASEAN Climate Change and Energy Project.*
[223] ASEAN. (2024). ASEAN Energy Cooperation.
[224] ASEAN Centre for Energy. (2023). ASEAN Plan of Action for Energy Cooperation (APAEC) 2016 - 2025 Phase II: 2021 - 2025.
[225] Pranandi, A. D., Suryadi, B., & Yosiyana, B. (2018). 'Status on Renewable Energy Policy and Development in ASEAN.'

synergies between ASEAN Member States in order to "ensure the country's energy security while also promoting business opportunities related to the energy sector."[226]

In reality, hydropower exemplifies "the political economy of resource allocation that always benefits some and harms others."[227] The theme of lacklustre impact assessment and mitigation frameworks returns here. Cambodia, Thailand and Vietnam voiced their displeasure at the inadequacy of Laos' transboundary impact assessment for the Luang Prabang dams, in particular the lack of proper mitigation plans for issues such as river sedimentation.[228] The EMA's vision of the ASEAN Power Grid as enhancing multilateral ties in the region may thus be utopianistic. Rather, as more dams are constructed and the impacts on regional river regimes become increasingly unpredictable, conflict between affected nations is likely to intensify.

The spectre of China looms large over the Mekong. China's economic and military might far outweighs downstream riparian nations of the river. China's refusal to participate in the Mekong River Commission (MRC), the multilateral consensus-based governance body, thus presents diplomatic challenges when MRC members disagree on how to respond to China's insistence on damming the upstream Mekong without the consent of downstream nations.[229] The MRC was founded in 1995, but functions mainly as a data management and sharing organisation rather than a regulatory body, with member countries required to undergo a Prior Consultation process before initiating any large-scale infrastructure projects but lacking the power to veto other members' plans.[230] Defence analyst Derek Grossman has highlighted how Cambodia and Laos have developed closer ties with China, refusing to support Vietnam's position on the ASEAN Code of Conduct in territorial disputes with China over the South China Sea.[231] Chinese capital has flowed into Lao hydropower projects, while water shortages worsen in Vietnam's rice-cultivating Mekong Delta region.[232] Should ties continue to sour, the MRC's lack of legally-binding authority may hinder it from any effective multilateral action against a China-backed Laos' continued dam development at Vietnam's expense.[233]

[226]Kresnawan & Wijaya, 'Energy Diplomacy'.
[227]Chattranond, 'Battery of Asia?', 163.
[228]Mekong River Commission. (2020). Statement on the Prior Consultation Process for the Luang Prabang Hydropower Project in Lao PDR.
[229] Thailand, Cambodia, Laos and Vietnam are full members of the MRC, while China and Myanmar are 'dialogue partners'.
[230] Kittikhoun, A., & Staubli, D. M. (2020). 'The Mekong River Commission as a water diplomat'; Pham, T. P. (n.d.). The Mekong River Commission is striking a balance between development and protection of the Mekong river.
[231] Grossman, D. (2020). Vietnam Is Losing Its Best Friends to China. *The Diplomat*.
[232] Grossman, 'Vietnam Losing Best Friends'.
[233] Neusner, G. (2016). Why the Mekong River Commission Matters. *The Diplomat.*

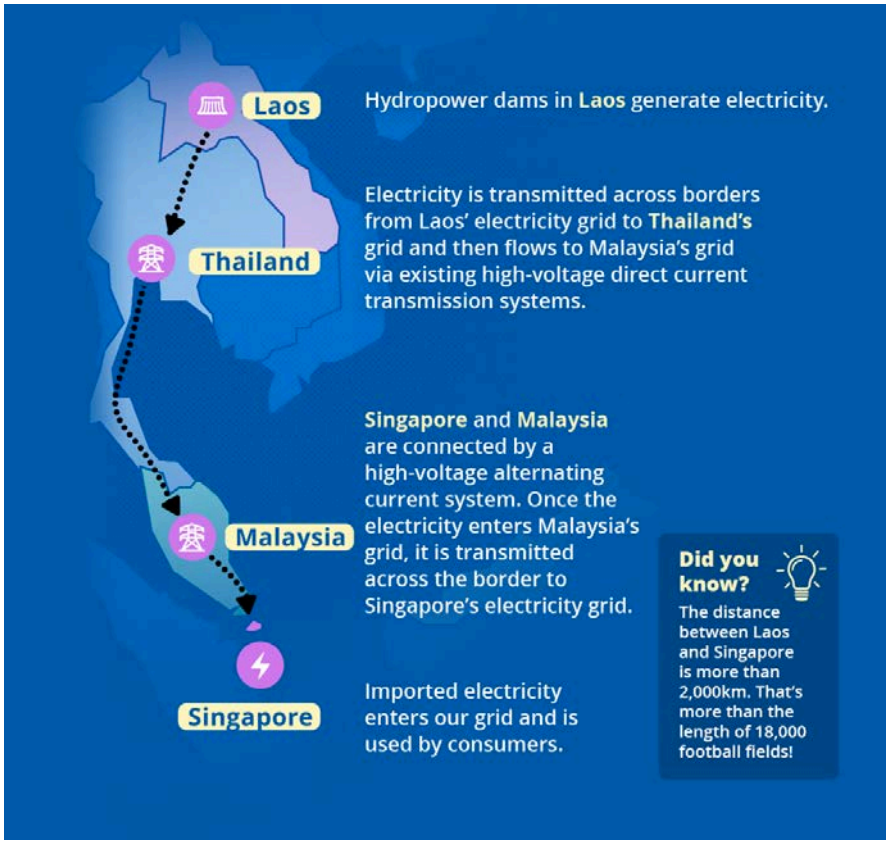

Figure 3: How electricity is imported from Lao PDR to Singapore.[234]

Singapore's state-linked Keppel Electric is working with EdL to produce Renewable Energy Certificates (RECs), purchasable certificates that allow companies to claim emissions reductions, "in support for the Singapore Green Plan 2030 as well as to meet the growing demand for renewable energy and energy transition for the ASEAN region."[235] The additionality provided by RECs has been called into question, meaning that purchasing RECs may not lead to an increase in renewable energy production and concurrent decrease in energy production from fossil fuels.[236] Of course, electricity is not physically travelling from Luang Prabang to Singapore. Electricity transfer between national grids occurs only at the borders: Laos-Thailand, Thailand-Malaysia, Malaysia-Singapore (Figure 3). What Singapore is purchasing from Laos is in fact an accounting trick: the right to declare a portion of its electricity generation as renewable energy, without necessarily having contributed to any real increase in renewable energy generation. The discourse of ASEAN energy cooperation is thus based upon fictitious mobility, a fiction with very real consequences on the lives and livelihoods of displaced villagers in Laos and Vietnam.

Should companies in Singapore and beyond purchase RECs that link them to the systematic destruction of livelihoods in Laos and Vietnam? Can Singapore's people trust the promises of energy security based around a river threatened by conflict and uncertainty? The ASEAN Power Grid's decarbonisation ambitions are laudable, but ASEAN Member States must

[234] EMA. (n.d.). Regional Power Grids.
[235] Bjørn, A., Lloyd, S. M, Brander, M., & Matthews, H. D. (2022). Renewable energy certificates threaten the integrity of corporate science-based targets. *Nature Climate Change*; Keppel Corporation. (2022). Singapore makes first renewable energy import.
[236] Bjørn *et al*, 'Renewable energy certificates'.

demand much more robust mitigation procedures within local ecosystems and across national boundaries before the ASEAN Power Grid can properly be labelled sustainable.

Moreover, I find it disturbing that the Singaporean state is using 'renewable' energy imports to brand itself as a sustainable global city under the Green Plan 2030, knowing that the costs forced onto local communities by large infrastructural projects like dams are mostly invisible to the public eye. When foreign capital colludes with local elites to produce megaprojects like dams, not to meet the energy needs of local communities but to accumulate wealth through energy exports, it is always local communities that lose out. The 'energy security' of importing countries like Singapore thus comes at the expense of the tremendous insecurity of local people threatened with eviction and ruined livelihoods. This is the very opposite of what narratives of 'sustainability' and 'security' are supposed to accomplish when they are translated to projects on the ground. The latest discourses on 'energy cooperation' are part of this upsetting, damaging trend, and should be opposed.

What, then, should be the way forward? From the outset, energy governance in ASEAN has been "mostly characterised by a 'top-down' elite-driven" approach rather than "'bottom-up' local initiatives" which involve the participation of civil society.[237] How could things be done differently if, for instance, project developers in ASEAN were mandated to respect the free, prior and informed consent (FPIC) of local communities, to allow for community-controlled impact assessments (CCIAs) with legally-binding impact-benefit agreements (IBAs)?[238] It is hard to imagine governments in ASEAN having the political will to impose such restrictions on themselves, or for energy importers to place such demands on the countries they source from.

Yet, a sliver of hope may come from challenging the bad geography that allows governments to characterise large-scale hydropower developments as 'sustainable energy'. If Singaporeans were to understand the hidden costs behind the energy security they supposedly enjoy, perhaps they can begin to develop an ethic of care towards the people on the losing end of such developments. From there, we can envision a new form of energy cooperation, where what constitutes a 'win-win relationship' is not profits for capitalist elites in both exporting and importing countries, but forms of development that meet the needs of people on the ground, and safeguard the natural environments their lives and livelihoods depend upon.[239]

[237] Winanti, P. S., & Hanif, H. (2018). 'Understanding ASEAN Energy Governance: Opportunities and Challenges', 176.
[238] Rodhouse, T., & Vanclay, F. (2016). Is free, prior and informed consent a form of corporate social responsibility? *Journal of Cleaner Production;* O'Faircheallaigh, C. (2017). Shaping projects, shaping impacts: community-controlled impact assessments and negotiated agreements. *Third World Quarterly.*
[239] EMA, 'Why does Singapore need to import electricity?'

Emotional narratives regarding hydropower plants in Central Asia as obstacles for energy transition

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Introduction[240]

As we approach the symbolic year of 2030, a European Commission and global deadline for decarbonisation targets, energy transition research still exhibits disparities in the geographical areas it examines. Less developed countries are often ignored, even though they are "more vulnerable to the adverse effects of climate change, show rapid growth in domestic energy demand, and are rich in natural resources critical for energy transition."[241] The study of emotions within the discipline of International Relations (IR) also suffers from this geographical bias. As such, studying non-Western cases can be a way of distancing oneself from how Western perspectives of the state "have intensively conditioned the study of emotions and passions in world politics."[242] It is this *decolonisation of the international,* understood here as an effort to geographically expand dominant imaginaries of what constitutes the international, that this article applies at its limited scale, that of hydropower plants with dams in Central Asia.[243]

Talking about hydropower is especially relevant in the context of Western-biassed attention to climate change. First, hydropower is a form of renewable energy that is more likely to be present in less developed countries than solar or wind energy. Secondly, there is a mutually influencing relationship between climate change and hydropower, in which hydropower appears as a promise of renewable energy to limit climate degradation, yet is itself constrained by climate change-induced droughts. Climate change is likely to be decisive in the future of Central Asia, an agricultural-dependent region with "inefficient water resource management at the national level and sluggish regional collaboration in the management of

[240] This work is largely based on a class essay done by the author for a course at St Andrews University.
[241] Burulcha Sulaimanova, Indra Overland, Rahat Sabyrbekov, and Roman Vakulchuk. "Energy Transition in Central Asia: A Systematic Literature Review," in *Climate Change in Central Asia: Decarbonization, Energy Transition and Climate Policy*, eds. Rahat Sabyrbekov, Indra Overland and Roman Vakulchuk (Cham: Springer, 2023), 70.
[242] Yasmine Zarhloule, "Theorising Emotions in IR: A Maghrebi Perspective on the Concept of Rivalry," in *Non-Western Global Theories of International Relations*, ed. by Samantha Cooke (Cham: Palgrave Macmillan, 2022), 215.
[243] L. H. M. Ling, "Decolonizing the international: towards multiple emotional worlds," *International Theory* 6, no.3 (October 2014).

the limited water resources."[244] Yet, hydropower appears as the region's best shot towards a successful energy transition.

Furthermore, addressing hydropower from an 'emotional' perspective, meaning an IR analysis on emotions implicit or explicitly present in interstate relations, forces historical and social considerations into debates regarding the energy transition. This brings much-needed clarity to the understanding of current narratives of modernisation and energy autarky. Looking at emotions – in the case of this analysis, those latent in official speeches and actions – is a means of asking what influences political decision-making in contexts of recently-created national identities, poverty among their populations, and authoritarianism. Taking as example two feelings, mistrust and ambition, this article will focus on how the first acts as an impediment for international cooperation and how the latter consolidates positions.

Overview of existing literature

Literature on Central Asia's water management mostly revolves around water scarcity and agriculture, a key issue in the region. Hydropower, although discussed, takes a secondary position, despite dams being a major interdisciplinary field of study. The same goes for literature on Central Asia's energy transition(s): it is by no coincidence that a systematic literature review on the subject barely mentions hydropower relative to other topics.[245]

In opposition to the relative scarcity of sources on the topic of hydropower in Central Asia, the literature on emotions in IR is ever growing since the early 2000s. Among others, Neta C. Crawford played an eye-opening role, arguing that the presence of emotions in IR literature was "unproblematized" and "taken-for-granted."[246] IR literature has studied emotions by "Theorising the state as an emotional actor," which may result in limitations.[247] Keeping such limitations in mind, this article follows Sasley's categorization of the positions regarding states' emotions, dividing them into: 1) states as single entities, 2) individual leaders, and 3) states as a group of people. Sasley, in this context, understands the state under the third category.[248] In turn, inspired by Antonio Damasio,[249] this analysis considers emotions as conscious reactions to exogenous stimuli, highlighting their relational dimension: in that sense, a state's emotions in regard to hydropower are not understood as a persuasive monologue but as a fully-fledged component of their interaction with populations and other states.

1. Mistrust and international cooperation

Trust has often been identified as a pre-existing condition for international cooperation. Within academic literature, "scholars agree that *trust* refers to an attitude involving a

[244] Rahat Sabyrbekov, Indra Overland, and Roman Vakulchuk. "Introduction to Climate Change in Central Asia," in *Climate Changa in Central Asia: Decarbonization, Energy Transition and Climate Policy*, eds. Rahat Sabyrbekov, Indra Overland and Roman Vakulchuk, (Cham: Springer, 2023), 2.
[245] Sulaimanova, Overland, Sabyrbekov, and Vakulchuk, "Energy Transition in Central Asia: A Systematic Literature Review," 72-73.
[246] Neta C. Crawford, "The Passion of World Politics: Propositions on Emotion and Emotional Relationships," *International Security* 24, no.4 (Spring 2000): 118.
[247] Emma Hutchison, and Roland Bleiker, "Theorizing emotions in world politics," *International Theory* 6, no.3 (November 2014): 500.
[248] Brent E. Sasley, "Theorizing States' Emotions," *International Studies Review* 13, no.3 (September 2011): 453-454.
[249] Antonio Damasio, *The Feeling of What Happens. Body and Emotion in the Making of Consciousness* (London: Vintage, 2000).

willingness to place the fate of one's interests under the control of others" (emphasis in original) driven by the belief that others will choose not to harm one's interests.[250] Similarly, "scholars understand distrust to be the expectation that others will not act in one's best interests," as opposed to trust.[251] Distrust is usually considered a more 'rooted' emotion; in the case of states, distrust by decision-makers could even be crystallised through policies, while mistrust can co-exist with trust.[252]

Mistrust, and to some extent distrust, plays a role in Central Asia's gestion of hydropower. Hydropower is linked to water management – defined by Soviet agreements and, among others, the 1992 Almaty Agreement which institutionalised cooperation between the newly independent countries – and hence to agriculture, making the poorly (inter)nationally managed water essential. The change from a centralised USSR decision-making process to an interstate one has made international cooperation indispensable. The *Toktogul* dam in Kyrgyzstan offers a key example of opposed interests. Located in the country where the Naryn river originates, it is the largest reservoir under control of Kyrgyzstan, though downstream, it irrigates Tajikistan, Uzbekistan and Kazakhstan by contributing to the Syr Darya river. Simply put, Kyrgyzstan wants to store water in summer to open the reservoir in winter for electricity, while downstream Uzbekistan and Kazakhstan want it open in the summer to irrigate cotton fields. The agreements obliging Kyrgyzstan to abandon its hydropower goals and to use coal and gas during the summer were broken by all three countries: "A fundamental lack of trust has been central to the failure of interstate agreements" and pushed states towards self-sufficiency policies.[253]

Water is perceived by states as a source of power, and its lack of control is therefore associated with injustice and humiliation. The dynamics of water can lead to an emotive attitude towards the state perceived to be in control, conveyed by the terms of "hydro-hegemony" or "hydro-egoism," the latter being particularly emotionally connotative.[254] Uzbekistan opposes upstream Kyrgyzstan's *Kambarata-I* dam and Tajikistan's *Rogun* dam because "it trusts neither Kyrgyzstan nor Tajikistan to release the water when it is needed for irrigation, and it resents and fears the opportunity the dams would enable both to withhold water for political and economic coercion."[255] This position is highly emotionally charged, for the stakes are high: failure to release water could lead to desertification, accelerating the deterioration of land fertility that already affects much of Central Asia. Making an enemy could transform mistrust into distrust, rendering international cooperation difficult in a moment when, due to climate change, it is increasingly needed. Of course, mistrust could encourage forms of cooperation among downstream countries – sharing the common goal of pressuring the upstream country, as with the *Toktogul* dam. However, this impact can be expected to be flawed, as it does not include all the actors.

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[250] Aaron M Hoffman., "A Conceptualization of Trust in International Relations," *European Journal of International Relations* 8, no.3 (September 2002): 376-377.
[251] Roy J. Lewicki, Daniel J. McAllister, and Robert J. Bies, "Trust and Distrust: New Relationships and Realities," *The Academy of Management Review* 23, no.3 (July 1998): 439.
[252] Ling-Ye She, "Trust, Mistrust and Distrust in Alliancing," in *Procs 29th Annual ARCOM Conference*, eds. S. D. Smith and D. D. Ahiaga-Dagbui, (Reading: Association of Researchers in Construction Management, 2013), 1003.
[253] Klaus Abbink, Sarah O'Hara, and Lars Christian Moller, "Sources of Mistrust: An Experimental Case Study of a Central Asian Water Conflict," *Environmental and Resource Economics* 45 (February 2010): 284.
[254] Sharmila L. Murthy, and Fatima Mendikulova, "Water, Conflict, and Cooperation in Central Asia: The Role of International Law and Diplomacy," *Vermont Journal of Environmental Law* 18, no.18-21 (Spring 2017): 431.
[255] International Crisis Group, *Water Pressures in Central Asia.* Europe and Central Asia Report N°233 (Brussels: International Crisis Group, September 2014), 7.

2. Ambition and the consolidation of identities

Unlike mistrust, which appears incompatible with international cooperation, ambition entertains a more nuanced relationship with it: cooperation is, for some countries, a means or a goal of their ambition. Yet, for others, fulfilling their ambition entails a deterioration of their relations with other states. This is particularly true regarding the fulfilment of water control ambitions by upstream countries. Furthermore, hydropower entails a particular relation with the territory, that of governing a natural resource around which forms of life articulate themselves, modifying the landscape while promising modernisation. In cases like Ethiopia's *Renaissance* dam, ambition and existing commitment turn hydropower policies into a component of national identity. And how could a state renounce a part of its identity?

An example of this link between identity and ambition can be found in Tajikistan's dam building in the Vakhsh river. The Vakhsh originates in Kyrgyzstan and crosses Tajikistan before joining the Amu Darya river in Afghanistan. Tajikistan's *Nurek* and *Rogun* dams, located on the Vakhsh river, were started during the USSR. They constitute an inheritance whose completion and maintenance has been reframed by the state as a national project on which the Tajik pride depends, linked with water and electricity needs. This nationalistic repurposing sometimes treats dams as a tabula rasa, as seen in the case of the *Nurek* dam, for much of its initial goal is debated and seems to be unknown.[256] Emotions associated with the project are accentuated by a context of climate change, as demonstrated by the Tajikistan and Kyrgyzstan energy crisis during two unusually cold winters between 2007 and 2009.[257] In this context of energy scarcity, poor water management, and recently created states, some governmental policies turn towards hydropower as the magic answer to their economic and legitimacy problems. Following the vision that "Water would transform the country into a 'progressive' nation,"[258] Emomali Rahmon associated the completion of the *Rogun* dam with national prosperity.[259] It came to be presented as a need instead of an ambition, justifying the economic effort and the forced resettlements in front of domestic and foreign public opinion.[260] This framing as a need by the state identified energetic dependence as a vulnerability exploitable by adjacent countries, linking the ambition of self-sufficiency with mistrust.[261] It could even be said that the dam has become "the centrepiece of an ideological production propagated by the government to legitimise itself, gain consensus and assert its regional power."[262] Tajikistan's government presents hydropower facilities as a "source of pride and well-being" domestically and internationally.[263]

This goes to show the role of ambition in decision-making, by which political projects become associated with identity. It then becomes difficult for states to accept compromises, for the

[256] Kai Wegerich, Oliver Olsson, and Jochen Froebrich. "Reliving the past in a changed environment: Hydropower ambitions, opportunities and constraints in Tajikistan," *Energy Policy* 35, no.7 (2007): 3816.
[257] Filippo Menga, "Building a nation through a dam: the case of Rogun in Tajikistan," *Nationalities Papers* 43, no.3 (2015): 483.
[258] Diana Ibañez-Tirado, "Everyday disasters, stagnation and the normalcy of non-development: Roghun Dam, a flood, and campaigns of forced taxation in southern Tajikistan," *Central Asian Survey* 34, no.4 (November 2015): 553.
[259] Idem, 554.
[260] Alexander Sodiqov, "Resettlement for the Rogun Dam Reservoir Begins in Tajikistan," Field Reports, The Central Asia-Caucasus Analyst (6 March 2009).
[261] Ibañez-Tirado, "Everyday disasters, stagnation and the normalcy of non-development: Roghun Dam, a flood, and campaigns of forced taxation in southern Tajikistan," 556.
[262] Menga, "Building a nation through a dam: the case of Rogun in Tajikistan," 484.
[263] Idem, 485.

total success of the project has been associated with their national pride. Compromises can lead to a loss of face, which in turn creates new emotions, directed towards other states, such as humiliation, fear, or hate. The interlinking of project and identity is translated into political and economic investments. Investments may lead to an "escalation of commitment" or *sunk-costs* bias: once an actor has greatly invested, politically and financially, in a project, backing down would be a recognition of the project and investment being a mistake.[264] As such, actors may persevere, despite the most 'rational' choice being the project's abandonment. In the case of Tajikistan, the aspiration to build the tallest dam of the world – *Rogun* dam – could simultaneously be understood as a symptom and an origin of this fear of losing face, illustrating the extent to which ambition, pride and other emotions, constitute part of an identity. They play a major role in political and financial narratives regarding energy transitions, for it is not only current national identities that are at stake, but also future ones. Fear, largely shaped by mistrust, and ambition both allow future identities to define current ones.

Conclusion

Taking into consideration the emotions behind key elements of energy transitions, such as hydropower plants, is essential to understanding the dynamics of political cooperation. Such dynamics can be the presence or absence of legally binding agreements, and, in the first case, the (dis)respect of their norms. In Central Asia, emotions can help identify social, historical and political elements that shape international cooperation. To make this point, this article has looked at emotions around hydropower, particularly the role of mistrust and ambition. The former plays an individualising role, dissuading from risk-taking and eventually leading to isolationism and autarkic policies, which may endanger energy transition as well as international cooperation in the event of a climatic crisis. The latter goes to show the links between emotions and identity. As projects become increasingly emotionally charged, they come to define the state's national identity, making international cooperation or concessions over energy management, which risk the project's success, unlikely. The study of emotions' influence on current environmental issues, such as energy transitions and agreement on the management of renewable energy sources, can inform much about states' positions in future environmental crises, which is particularly relevant in Central Asia, a region especially vulnerable to climate change.

[264] Jonathan Renshon, "Losing Face and Sinking Costs: Experimental Evidence on the Judgment of Political and Military Leaders," *International Organization* 69, no.3 (Summer 2015): 660.

A critical perspective on critical minerals: The limitations of a just energy transition for the Global South

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The missing part

The narrative of ensuring a just energy transition which leaves no one behind is now a constant in multilateral diplomacy. At United Nations Framework Convention on Climate Change (UNFCCC) Conferences of the Parties, G20 summits, and International Energy Agency (IEA) meetings, this concept has become uncontested, and country negotiators usually endorse it by default. Nevertheless, the notion of a just transition is far from being clearly conceptualised, let alone legally agreed on. In the just energy transition equation, the "energy" part is undoubtedly the one that provides a sense of direction because the COP28 formula of "transitioning away from fossil fuels", adopted by all UNFCCC Parties in December 2023 in Dubai, indicates the way the world has agreed to go.[265] Yet, even this seemingly groundbreaking decision leaves room for interpretation as, given the principle of Common but Differentiated Responsibilities and Respective Capabilities, nations are free to choose their own strategy and means of decarbonization, which leads to what many now identify in plural as energy transitions.[266] Against this backdrop, there is still no single definition for a just energy transition at a time when the Global South is questioning its role in the clean economy of the future.

The scope of criticality

While the energy sector remains the largest emitter globally, it is decarbonizing at a rapid pace. According to the IEA, since 2019, the massive deployment of solar PV and wind in electricity systems worldwide has helped to avoid an amount of annual coal consumption equivalent to that of Indonesia and India's electricity generation combined.[267] Overall, global renewable energy capacity in 2023 reached 4,000 GW, rising by around 500 GW from the previous year, while the commitment to triple renewable energy capacity by 2030 was a highlight of the COP28 Global Stocktake.[268,269] All of these measures, summed up with

[265] UNFCCC, *First Global Stocktake*, (UNFCCC, Dubai: December 2023), https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf (accessed: March 29, 2024).
[266] Mar Rubio Varas, *Energy Transition(s)*, (Elgar Encyclopedia of Ecological Economics: September 2023), 181-187.
[267] IEA, *Energy Technology Perspectives 2023*, (IEA, Paris: 2023).
[268] UNFCCC, *First Global Stocktake*, (UNFCCC, Dubai: December 2023), https://unfccc.int/sites/default/files/resource/cma2023_L17_adv.pdf (accessed: March 29, 2024).
[269] IEA, *Renewable Energy Market Update*, (IEA, Paris: June 2023).

extensive policy support packages for clean energy in key emissions-intensive economies like the European Union and the United States, are boosting the uptake of net-zero technologies in the short- and medium-term.[270] By 2030, it is expected that the global market for key clean energy technologies will be worth around USD 650 billion a year.[271]

There is a wide array of factors underpinning this transition, ranging from investment and carbon pricing to electricity grid expansion and innovation. While these drivers usually take centre stage in high-level policy discussions, the availability of critical raw materials is often overlooked. Although renewable energy technologies produce no emissions when in operation, they are still more material-intensive than their fossil fuel-based power plant counterparts.[272] Battery energy storage systems and electric vehicles, integral parts of the energy transition toolkit, showcase elevated mineral intensities too. Thus, the raw materials needed for clean energy technologies production represent strategic value for countries where net-zero development is an absolute priority and a key driver for maintaining economic growth.

There are generally two essential criteria defining the criticality of a raw material: supply risk and economic importance. If the risk associated with supply disruptions and potential economic damage is elevated while substitutes are scarce or inexistent, such minerals are considered critical. This notion reflects a purely consumer-centric paradigm of resource management. It is worth noting that there is no common list of critical minerals internationally, and yet some national classifications significantly converge, e.g. the 2023 EU Critical Raw Materials List and the 2023 U.S. Department of Energy Critical Materials List.[273]

Critical concentration

In a context of rising geopolitical rivalry and mounting export restrictions in producing countries, access to critical energy transition minerals has become a major source of concern for industrialised nations. Guided by the net-zero target imperative and the speed required to deliver on the climate ambition, they are responding with robust policy packages aimed at reducing supply dependencies to avoid disruption and mitigate economic risks. At the core of this policy lies the strategy of keeping the mineral production base domestically to reap economic benefits of the net-zero transition, either through reshoring industrial capacities from afar or developing them from scratch. Yet, as achieving full self-sufficiency in critical raw materials remains out of reach, a key question is who may still act as suppliers.

The recent shift towards ensuring the security of supply therefore requires imports diversification through various trade and investment arrangements, most of which fall under the notion of friend-shoring which the World Economic Forum defines as “a growing trade

[270] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, *A Green Deal Industrial Plan for the Net-Zero Age,* (Brussels: 1.02.2023).
[271] Department of Energy, *Inflation Reduction Act of 2022*, (Washington D.C.: 2022), https://www.energy.gov/lpo/inflation-reduction-act-2022 (accessed: March 29, 2024); IEA, *Energy Technology Perspectives 2023*, (IEA, Paris: 2023).
[272] Gerald Kalt, Philipp Thunshirn, Fridolin Krausmann and Helmut Haberl, *Material requirements of global electricity sector pathways to 2050 and associated greenhouse gas emissions*, (Journal of Cleaner Production: 2022).
[273] Milan Grohol and Constanze Veeh, *Study on the critical raw materials for the EU 2023 : final report*, (Publications Office of the European Union: 2023); Notice of Final Determination on 2023 DOE Critical Materials List. *Federal Register*, 28 July 2023, www.federalregister.gov/documents/2023/08/04/2023-16611/notice-of-final-determination-on-2023-doe-critical-materials-list (accessed: April 1, 2024).

practice where supply chain networks are focused on countries regarded as political and economic allies."[274] This is indeed a tempting alternative to trading with a partner who does not necessarily share your values or approaches. However, it also poses a legitimate question of whether the fundamental value of free and regulated trade, which has helped many emerging economies lift billions of people out of poverty, still has its place in a world where values are upheld within the limits of one's friend zone. Is this a clear sign of economic deglobalization that, in this case, is paradoxically spurred by a net-zero transition which was once perceived as an opportunity to overcome disputes, so typical of the fossil-fuel economy?

Regardless of the political ambition to re- or friend-shore, finding substitutes to fulfil one's energy transition needs is not a quick nor sometimes geologically viable process. On average, critical mineral resources are highly concentrated in just a few geographies, many of which are countries in the Global South: the Democratic Republic of the Congo accounts for over 70% of global cobalt production, the People's Republic of China produces nearly 60% of all rare earth elements, and the Republic of Indonesia is responsible for nearly half of the world's nickel production.[275] Once a resource curse, the mineral-driven development model today makes the Global South uniquely positioned to reap the benefits of the rising critical raw materials demand. Obviously, this is not guaranteed. To get there, a structural change, e.g. enhanced investor rights protection, and a paradigm shift, from perceiving oneself as a mere raw material provider to an added value creator, are needed so that the main component - domestic value addition becomes the driving force of mineral-rich countries' inclusive economic growth.

Ambitions and limitations

Indeed, from Latin America to Africa to Asia and the Pacific, mineral-rich economies are embracing the energy transition as a game-changer. Most importantly, they aspire to move away from extractivism and move up the global value chain of clean energy technologies. For instance, countries want to export lithium-ion batteries, not simply lithium ore; as Guillaume Pitron, a French author, rightly opined, "the French do not sell grapes but wine."[276] As if they had read the line, in 2020, Indonesia fully banned nickel ore exports in a bid to increase domestic added value and attract foreign investors, especially producers of batteries in which this metal is a key component.[277] In 2022, Zimbabwe imposed a ban on the export of unprocessed lithium.[278] In 2023, Namibia imposed a ban on unprocessed minerals export, including lithium ore, cobalt, graphite, manganese, and rare earth minerals.[279]

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[274] Stefan Ellerbeck, "What's the Difference between 'Friendshoring' and Other Global Trade Buzzwords?" *World Economic Forum*, 17 Feb. 2023, www.weforum.org/agenda/2023/02/friendshoring-global-trade-buzzwords/ (accessed: April 1, 2024).
[275] IEA, *The Role of Critical Minerals in Clean Energy Transitions*, (IEA, Paris: 2021); Michele E. McRae, *Mineral Commodity Summaries*, (U.S. Geological Survey: January 2023), https://pubs.usgs.gov/periodicals/mcs2023/mcs2023-nickel.pdf (accessed: 2 April, 2024).
[276] Guillaume Pitron, *La guerre des métaux rares. La face cachée de la transition énergétique et numérique*, (Les Liens qui Libèrent: 2018), 155.
[277]"Indonesia embraces resource nationalism", The Economist, 26 Jan. 2023, https://www.economist.com/asia/2023/01/26/indonesia-embraces-resource-nationalism (accessed: April 4, 2024).
[278] Nelson Banya, "Zimbabwe bans raw lithium exports to curb artisanal mining." Reuters, 21 Dec. 2022, https://www.reuters.com/world/africa/zimbabwe-bans-raw-lithium-exports-curb-artisanal-mining-2022-12-21/ (accessed: April 4, 2024).
[279] Nyasha Nyaungwa, "Namibia bans export of unprocessed critical minerals." Reuters, 8 June 2023, https://www.reuters.com/markets/commodities/namibia-bans-export-unprocessed-critical-minerals-2023-06-08/ (accessed: April 4, 2024).

Although little time has passed since those decisions took shape, the case of Indonesia suggests some preliminary outcomes. The country has managed to attract foreign direct investment (FDI) to support the development of its nascent electric battery value chain, with most of Indonesia's USD 47 billion FDI in 2023 coming to the metals industry from Asian investors, such as Hyundai Motor and Tsingshan.[280] The move has also allowed the country to maintain a considerable trade surplus over the last three years, keeping its currency stable and generating jobs domestically. However, progress has been relatively limited due to, inter alia, slowing growth in the global electric-vehicle market and moderate local refining infrastructure. In addition, the export ban was challenged by the European Union at the World Trade Organization (see dispute settlement DS592: Indonesia — Measures Relating to Raw Materials), whose ruling said that Indonesia's export restrictions were not in conformity with its WTO obligations.[281] Nevertheless, the country did not lift the ban as it insists on the priority of domestic value addition as a prerequisite for becoming an industrialised nation.[282]

This example summarises quite well the potential gains and implications of moving up the value chain. While the gains speak for themselves - more investment, increase in exports, and job creation, the implications are hard to calculate as they always lie at the intersection of one's rightful aspirations and WTO obligations. The process of moving up the value chain might be constrained by both domestic impediments, such as insufficient industrial infrastructure, and exogenous factors, including unfavourable global market dynamics and trade frictions. Moreover, another point of concern is the diversification of FDI giving access to the critical minerals sector. The benefits of having foreign investors build up new domestic refining capacities are indeed uncontested but it is legitimate to question (and regulate) the extent to which they control the industry. In this regard, if a just energy transition is expected to shift the status of mineral-rich economies of the Global South as equal players in mid- and downstream segments, it is still unclear whether and how fast they will get integrated into higher levels of the global clean technology value chain.

In addition, the potential gains are unlikely to benefit all producing Global South countries in an equal manner. Those more poised to move up the value chain are the ones that have already reached a significant share of the global market within their specific export niche. In this regard, Chile is a good example. The country has a developed mining and refining infrastructure and accounts for 27% of the world's copper and over 25% of the world's lithium exports, which gives it a competitive advantage and opens up better economic prospects in comparison to the copper-producing Democratic Republic of the Congo or lithium-producing Zimbabwe.[283]

Furthermore, a modernised trade policy aimed at increasing access to the markets of industrialised economies is going to be a key tool not only for boosting critical minerals

[280] Anshuman Daga, "Indonesia's nickel policy looks fragile." Reuters, 26 Jan. 2024, https://www.reuters.com/breakingviews/indonesias-nickel-policy-looks-fragile-2024-01-26/ (accessed: 21 May 2024).
[281] DS592: Indonesia — Measures Relating to Raw Materials, WTO Dispute Settlement, 2022, https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds592_e.htm (accessed: 21 May 2024).
[282] "WTO backs EU in nickel dispute, Indonesia plans appeal", Reuters, 30 Nov. 2022, https://www.reuters.com/markets/commodities/indonesia-plans-appeal-after-losing-wto-nickel-dispute-with-eu-2022-11-30/ (accessed: 21 May 2024).
[283] U.S. Geological Survey, *Mineral Commodity Summaries*, January 2024, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-lithium.pdf (accessed: 20 May 2024); U.S. Geological Survey, *Mineral Commodity Summaries*, January 2024, https://pubs.usgs.gov/periodicals/mcs2024/mcs2024-copper.pdf (accessed: 20 May 2024).

exports but also ensuring measures to create domestic industrial capacities in the upper segments of the value chain. For example, this is the case of the modernised EU-Chile Association Agreement, where Chile improves the conditions of access to the EU market and secures the right to introduce and maintain measures to promote value addition by supplying raw materials to domestic companies at preferential prices so that new industrial sectors could be developed in the country.[284] However, this should not be considered a universal recipe for the Global South as the negotiation process is neither fast nor easy. After all, the bureaucratic lengthiness of any trade deal talk and the primary interest of consuming countries surrounds securing the resilient supply of raw materials, not end products.

Notwithstanding potential economic gains, the limitations of the critical minerals-based transition for the Global South are numerous. Ideally, a just energy transition would reverse the decade-long issue of delocalization of pollution towards the Global South given that, for too long, the least environmentally friendly upstream production has been outsourced to the developing world, while the end product - technologies deemed "clean" - would be assembled mostly in industrialised economies. Yet, growing mineral demand, coupled with the friend-shoring policy, will simply reshuffle the current production landscape towards those Global South countries which are considered reliable suppliers. This, in turn, will add pressure on existing mines as there is a clear need of filling up the supply gap after cutting imports from key producers who are not on the "friend list". Moreover, attempts to launch exploitation of mineral resources in international waters without any multilateral deep-sea exploitation rulebook in place creates uncertainty regarding preservation of the marine environment.[285]

If a just energy transition is meant to change the approach towards measuring how clean an energy technology really is, the industry remains largely focused on end user's climate commitments rather than on sustainability compliance along the whole value chain. Finally, if a just energy transition is thought to mitigate tensions over energy resources, it is now only exacerbating them as clean energy is still a matter of geopolitics, just like fossil fuels are, and critical minerals are a politically securitized subject. When the geographic concentration of mineral resources is already high and the number of eligible suppliers is already limited, the competition for supply is set to increase sharply and might become a new source of tension, disproportionately hitting Global South countries whose commodity exports are volatile.

Too critical to be just

There is no doubt the ongoing energy transition will change the world economic order. It is also evident that this transition is highly material-intensive and is powered by millions of tonnes of mineral resources which require exploration, mining, and processing before being used in manufacturing and, at the end of lifecycle, retrieved for recycling or disposed of. What remains unclear, though, is how Global South countries will handle this immense opportunity and whether they will participate in the energy transition as mere raw material suppliers.

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[284] *Interim Agreement on Trade between the European Union and the Republic of Chile*, Brussels, 17 November 2023, https://circabc.europa.eu/ui/group/09242a36-a438-40fd-a7affe32e36cbd0e/ library/7668ad45-b14f-4ef6-823d-8899fbac72d2/details?download=true (accessed: 21 May 2024).
[285] Travis Washburn, Phillip Turner, Jennifer Durden, Daniel Jones, Philip Weaver, and Cindy Dover, *Ecological risk assessment for deep-sea mining*, (Ocean & Coastal Management: 2019), 24-39.

Although the major trend is clear - more domestic value addition and less raw materials exports, the hurdles are many in the Global South's way. It should also be recognized that both challenges and prospects are not homogeneous as the Global South itself is not a monolithic entity. While some countries seem to be already moving up the global clean technology value chain, especially in Latin America and Asia, others, mostly in Africa, struggle to find their way out of the extractivist trap. In this context, the effects of friend-shoring look ambiguous as, on the one hand, this may indeed open up new export opportunities for the countries regarded as reliable trading partners but, on the other hand, the very meaning of shifting raw materials production from one jurisdiction to another does not imply shifting the downstream activities too. If so, the importance of equally involving Global South countries in the global energy transition might be outshined by the consumer's priority to source more and cheaper.

Critical mineral recycling and the circular economy

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The energy transition entails a profound transformation of our energy system, which still relies heavily on fossil fuels, accounting for 80% of our energy mix today.[286] While the deployment of variable renewable energies in electricity grids and the replacement of conventional vehicle fleets with electric vehicles receive significant media attention, the entirety of these major transformations harbours a hidden aspect that struggles to be brought to light. Indeed, all efforts towards energy transition cannot be realised without critical minerals, aptly nicknamed the "vitamins of the modern era."[287]

Critical minerals, also referred to as strategic minerals, designate a raw material which "is used in numerous industrial sectors; is difficult to substitute in the short term; is required for numerous industrial applications; and whose reserves and production are geographically concentrated."[288] Although critical minerals have long been a staple in various industrial processes, the paradigm of an energy system powered by low-carbon energy sources has considerably exacerbated the importance of these materials. As underscored by the International Energy Agency (IEA), "energy policies in place or announced suggests that the world is currently on track for a doubling of overall mineral requirements for clean energy technologies by 2040 [in the Stated Policies Scenario, STEPS]" while "a concerted effort to reach the goals of the Paris Agreement would mean a quadrupling of mineral requirements for clean energy technologies by 2040."[289]

If the gradual electrification of the energy mix necessarily requires rethinking electrical grids and electricity markets, and involves massive investments in both non-dispatchable renewable energies and the electrical transmission and distribution network, it is essential to consider the increasing demand for strategic minerals inherent in the energy transition. Indeed, at both macro and micro levels, their growing use is evident. The production of an EV requires six times more critical minerals than an internal combustion vehicle, and an onshore wind plant requires nine times more mineral resources than a gas-fired plant.[290] In light of this stark observation, a complex trade-off emerges between the rate at which the energy transition can be implemented and the sustainability of finite mineral resource stock

[286] *Planète Énergies. "Le mix énergétique mondiale 2022-2050." January 2024.*
[287] *Hache, Emmanuel ; Barnet, Charlène ; Seck, Gondia-Sokhna « Les terres rares dans la transition énergétique : quelles menaces sur les « vitamines de l'ère moderne » ? », Les métaux dans la transition énergétique, n° 3, IFPEN, Janvier 2021*
[288] *Graedel, T., and Philip Nuss. 2014. "Employing Considerations of Criticality in Product Design." JOM: the Journal of the Minerals, Metals & Materials 66 (November).*
[289] *IEA, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions, 2021 Licence: CC BY 4.0*
[290] *ibid.* 282

management.

In response to this emerging challenge, states have adopted various responses through the development of comprehensive national strategies, opting for a targeted approach. This may involve efforts towards diversification of supply chains, incentivizing domestic production, fostering, and supporting research and development through new programs, or introducing circular economy principles into the value chain of critical minerals, notably through the lens of recycling. UK's Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech), launched in 2020 with funding from the UK Research and Innovation's National Interdisciplinary Circular Economy Research (NICER) Programme, epitomises a willingness to foster collaboration between academia and industry and thus to design and include recycling technologies along the critical minerals' value chain.[291] Following the example of the UK, Italy has also placed a strong emphasis on recycling by introducing in 2017 legal and fiscal instruments aimed at improving the traceability of materials and strengthening the recycled raw materials market by institutionalising a tax incentive system to render the latter competitive.[292] Among the numerous measures implemented by the United States, which notably focus on economic protectionism of domestic critical minerals production. In this vein, the US Department of Energy announced in 2019 a 192-million-dollar dual-purpose fund to support the administration's goal to have EVs make up half of all vehicle sales in America by 2030.[293] While the *Consumer Electronics Battery Recycling, Reprocessing, and Battery Collection FOA* aims to promote the purchase of EVs among consumers and help states, local governments and retailers to collect batteries, the *Advanced Battery R&D Consortium FOA* will provide fundings to universities, National Laboratory partners and EVs manufacturers to address critical battery needs.[294] At the supranational level, the European Union through the Critical Raw Minerals Act (CRMA) has stated diverse objectives. They encompass diversifying EU's import of critical raw minerals (CRMs), strengthening the different stages of the European CRM value chain and facilitating circularity and sustainability in CRM markets, notably with the establishment of "a minimum recycled rare earth content threshold and the implementation of ESG standards and systematic verification of the environmental footprint of CRM."[295]

If the public sector seeks to address the issue of critical minerals through the lens of a narrative advocating a return to strong industrial policy, ensuring national strategic autonomy, the private sector also appears to be engaging with this issue by implementing circular economy measures. Undoubtedly aligning with this trend, NorthVolt emerges as a pioneer in this regard, thanks to a recycling plant project, under a joint venture named Hydro Volt. This first-of-its-kind recycling facility was established in Norway. Strategically positioned due to the country's advanced electric vehicle market, it aims to process over 8000 tonnes of batteries (roughly the equivalent of 23 000 mid-sized batteries) annually and targets for 50% recycled material to be used in new cells by 2030.[296] Even more recently, Northvolt has opened the Revolt Ett recycling site, with an annual capacity of 125 kt, thus making it Europe's largest

[291] *IEA, "Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech)." Interdisciplinary Circular Economy Centre for Technology Metals (Met4Tech) – Policies,* 2023
[292] IEA,"N*ational Strategy for the Circular Economy" – Policies, 2023*
[293] IEA, "*DOE Funding Opportunity to Advance Battery Recycling Technology" – Policies, 2023*
[294] *IEA, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris*
[295] *European Commission, "European Critical Raw Materials Act." 2023.https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1661.*
[296] *IEA, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris*

battery recycling plant.[297] Nonetheless, recycling is not solely the prerogative of battery cell producers but also of mining companies. Boliden AB, one of the world's leading producers of responsibly sourced minerals, also exemplifies the efforts of European companies to incorporate circular economy issues into their production. Thus, in addition to its extraction and processing activities, this Swedish company owns five recycling facilities for zinc, copper, nickel, and lead.[298] The Rönnskär site particularly illustrates their approach, where nearly 200,000 tonnes of copper, 400 tonnes of silver, and 13 tonnes of gold are produced each year by recycling metals from electronics.[299]

Despite the recognition of this crucial issue, as evidenced by national policies concerning the management of stocks and the supply of critical minerals, and industrial efforts on the side of private companies, it is imperative to contextualise their effectiveness, drawing upon a 2010 article by Grosse and Mainguy.[300] This article qualifies the hope placed on the recycling of raw materials by highlighting the strong positive link between economic growth and the use of raw materials. They notably suggest that the Jevons' paradox plays a significant role in the implementation of recycling. Indeed, if the price of recycled materials is reduced, this will lead to an increase in overall production and, in fact, a faster depletion of materials.

Nearly 15 years after the publication of this article, it is interesting and rich to analyse to what extent current academic literature allows us to complexify the picture painted by Grosse and Mainguy. We can also delve more deeply into the potential of the circular economy in light of new records in terms of EV sales, as affirmed by the IEA: "electric car sales keep rising and could reach around 17 million in 2024, accounting for more than one in five cars sold worldwide".[301] While the current economic and geopolitical landscape is vastly different from a decade ago, it seems nonetheless that on a purely theoretical level, the conclusions drawn by the two authors in 2010 still resonate with the findings of current academic literature.

While recycling is not inherently a panacea for critical minerals concerns, it will nevertheless play a major role in the future, as demand for critical minerals follows a constant upward trajectory. Enhanced recycling rates in the future can serve as a significant mechanism mitigating the escalating demand for primary minerals, as can the reutilization of components in energy storage technologies. Consequently, incentivizing of recycling, reuse, and refurbishment emerges as a key component of the transition to a low-carbon economy[302]. Yet, it is crucial to qualify this promising projection, notably because "there will not be enough secondary feedstock to meet a significant share or material demand".[303] What is more, as highlighted by the World Bank, if there was to be 100% end-of-life recycling by 2050, aluminium, copper and nickel would see secondary suppliers meet around 60% of demand".[304]

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[297] *Northvolt, "Recycling", https://northvolt.com/recycling/*
[298] *New Boliden, "Global Assets and Sustainability"*
[299] IEA,"N*ational Strategy for the Circular Economy" – Policies, 2023*
[300] *Grosse, François. "Is recycling "part of the solution"? The role of recycling in an expanding society and a world of finite resources." SAPI EN. S. Surveys and Perspectives Integrating Environment and Society 3.1 (2010).*
[301] *IEA, "The World's Electric Car Fleet Continues to Grow Strongly, with 2024 Sales Set to Reach 17 Million.", 2024*
[302] *World Bank, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition", 2020*
[303] *Nick Ferris, "Why Recycling Is No Golden Ticket to Endless Critical Minerals." Energy Monitor, March 2024*
[304] *IEA, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris*

Recent studies highlight the shortcomings of the circular economy in meeting global demand and also add the technological dimension, which poses a serious hurdle to boosting the recycling rates of certain metals.

It is particularly relevant to examine the case of rare earths in order to better understand the technical challenges making the recycling of these elements a particularly daunting task. “Vitamins of the modern era”[305], they are nevertheless today very little recycled from end-of-life consumer products or industrial waste, largely due to inefficient (or nonexistent) collection, the high cost of dismantlement to retrieve the components containing the targeted elements, and the lack of cost-effective methods for recovery from recycling feedstocks.[306] Other significant impediments are that many potential feedstocks have very low REE content, and available quantities of the feedstocks are not sufficient to warrant investment in recycling facilities[307]. Lithium constitutes another blatant example as extracting and repurposing this element from Lithium-Ion batteries is also extremely labour-intensive and expensive.[308]

David Livingstone, associate fellow at Chatham House specialising in critical minerals, further deepens this reflection by adding an additional dimension: “the expense of this process means that huge range battery formats that typically happen in places where human capital is cheap, which raises other concerns around ESG”.[309] Recycling is not exempt from the market dynamics observed in the critical minerals market. Therefore, given that price is the primary driver, the development of recycling infrastructure in countries with weaker regulatory frameworks necessitates careful consideration of the extent to which it is possible to avoid the current pitfalls of the mining industry.

The example of nickel production in Indonesia provides relevant insight into understanding ESG (environmental, social, and governance) issues. The nickel production landscape was significantly disrupted by the commercialization of the High-Pressure Acid-Leaching (HPAL) process for processing nickel in laterite ores at highly competitive prices. Indonesia quickly emerged as the new leader in Class 1 nickel production due to its low prices, but at the expense of sustainability criteria. The mining industry in Indonesian islands, particularly in Sulawesi, has led to both public health issues due to freshwater pollution and ecosystem destruction. The management of nickel mines in Indonesia thus highlights the dangers of developing a critical minerals recycling industry in countries where ESG criteria are often compromised, harming workers, local communities, and the environment. It is therefore essential to establish strict regulatory frameworks to prevent the violation of ESG criteria in the emerging market of mineral materials recycling.

Despite the undeniable hopes that recycling and the implementation of a circular economy for the production sector of critical minerals bring, it is now clearer than ever that recycling is no golden ticket to endless critical minerals.[310] Bearing in mind that a raw material which continues to be consumed at a rate significantly above 1% per annum cannot “be subjected to any successful measure to slow down the depletion of the resource”, a dilemma clearly

[305] *IEA, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris*
[306] *Fujita, Y., McCall, S.K. & Ginosar, D. Recycling rare earths: Perspectives and recent advances. MRS Bulletin 47, 288 (2022).*
[307] *Grosse, François. "Is recycling “part of the solution”?*
[308] *Northvolt, “Recycling”, https://northvolt.com/recycling/*
[309] *David Livingstone, "Chinese Supply Chains Could Tip the Balance in Ukraine." Chatham House, March 2023*
[310] *Northvolt, “Recycling”, https://northvolt.com/recycling/*

emerges as the IEA highlights in its 2023 report entitled *The Role of Critical Minerals in Clean Energy Transitions* the unprecedented surge in demand for critical minerals, in the context of the acceleration of the energy transition.

Nevertheless, the fundamental issue of critical minerals cannot be reduced to the equilibrium between supply and demand and is ultimately underpinned by two distinct aspects with concomitant dynamics: the environmental dimension and the geostrategic dimension. While China's hegemony over the entire critical minerals supply chain is deeply entrenched, the geopolitical crises tearing the world apart today have led to a notable shift towards a narrative of strategic autonomy and supply sovereignty. This new political direction in terms of critical minerals echoes notably the outbreak of war in Ukraine, which acted as a wake-up call for European governments, extremely dependent on Russian gas. If the dynamic of strategic autonomy takes the form of a security of supply policy at the level of the European Union, notably through a "renaissance" of major industrial sectors, the United States has chosen a narrative based on the need to boost the domestic economy and face the severe competition imposed by the chain with measures incentivizing the relocation of the entire supply chain to American territory. China, on the other hand, although a confirmed leader in critical minerals, must contend with oversupply and maintain its hegemony, which not only gives it unmatched competitiveness in the market but also and above all, allows it to retain a central geostrategic leverage instrument for its foreign policy.

The implementation of a solid critical minerals recycling industry is, therefore, only a partial solution to mitigate the dependence of major regional blocs on China, which was responsible in 2019 for 80% of total global chemical production of battery-grade raw materials.[311] Furthermore, recycling could also help reduce dependence on critical minerals derived from production that flouts ESG criteria or at least applies very lax standards in this regard. While recycling offers a promising perspective to address the challenges of increasing demand for critical minerals, this solution appears to be limited and must be combined with a policy of diversifying exploitation sites, particularly by promoting exploration efforts. At the scale of the European Union, for example, the opening of new mines could strengthen the security of supply and boost domestic industry while also providing greater transparency and traceability of final products, thus ensuring more sustainable and low-carbon production. While these new mining projects appear as genuine opportunities, they nonetheless encounter numerous resistances, as evidenced by the lithium mine project in Echassières[312], France. This shows that the “not-in-my-backyard” dynamic is a major obstacle to the relocation of mining and processing activities. The phenomenon, prevalent in Europe, underscores the intricate challenges and trade-offs associated with transitioning to more sustainable resource management practices while ensuring supply security amidst a significant increase in demand.

Considering these developments, it is pertinent to recall a few statistics that shed light on the magnitude of the challenge at hand. Presently, only 18 metals have recycling rates exceeding 50%, with a mere 1% of rare earth elements being recycled[313] while 70 to 100% of

[311] *Simon Moores, "Chart: China's Grip on Battery Metals Supply Chain.", Mining.com, May 2020*
[312] *Bastien Bonnefous,"Dans l'Allier, la future mine de lithium enflamme le débat.", Le Monde, March 2024*
[313] *ADEME, “Les métaux: des ressources qui pourraient manquer?”, 2021*

metals consumed in Europe are imported[314]. The energy transition, and the demand for critical minerals it entails, thus pose a challenge that is both technical, economic, and also involves public acceptability, which is urgent to meet the burgeoning demand for critical minerals.

[314] *Bureau de Recherches Géologiques et Minières (BRGM), "Métaux critiques : chiffres clés 2022." , June 2022*

Opportunities for hydrogen-based energies in the global energy transitions

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Introduction

"Accelerating zero- and low-emission technologies, including, inter alia, renewables, nuclear, abatement and removal technologies such as carbon capture utilisation and storage [CCUS], particularly in hard-to-abate sectors, and low-carbon hydrogen production." These words entered in the final draft of the COP28.[315] Agreeing that low-carbon hydrogen production is an essential step towards achieving the Paris Agreement marks a historical breakthrough for this energy source and carrier. This acknowledgement was encouraged by countries seeking cost-effective decarbonisation while still partially relying on fossil fuels. This essay seeks to address two questions: What obstacles could impede the transition of hard-to-electrify sectors to low-carbon hydrogen-based energies? Additionally, can low-carbon hydrogen provide a viable opportunity for countries facing challenges in launching a new capital-intensive sector?

Hydrogen Trade Transportation Perspectives & Challenges

The debate on a possible global hydrogen market has identified several new end uses potentially increasing hydrogen demand. Global players are already considering hydrogen as a fuel for transportation, as a fuel for industries requiring medium- or high-grade heat, as a feedstock for industrial and chemical processes (i.e. green ammonia, e-fuels, renewable fuels of non-biological origin - RFNBOs), and as seasonal energy storage. This diverse demand has permitted potential hydrogen suppliers to begin planning a ramp-up of low-carbon hydrogen production in the near future, which is characterised by a carbon content below 3.38 kgCO2e/kgH2 under EU taxonomy.[316] Indeed, in the 2023 Net Zero Emissions Scenario of the International Energy Agency, hydrogen demand passes from 95Mt in 2022 to 430Mt in 2050.[317] The implementation of low-carbon hydrogen is characterised by different economic metrics (i.e. levelized cost of hydrogen - LCOH, cost of capital, capital expenditure) and engineering solutions (i.e. diverse production, storage, and transportation technologies) drivers.

[315] UNFCC (2023), *Outcome of the First Global Stocktake: Draft Decision.*
[316] SFEN (2023), *Towards a First Recognition of the Role of Nuclear Power for Hydrogen Production in Europe.*
[317] IEA (2023), *Net Zero Roadmap: A Global Pathway to Keep the 1.5°C Goal in Reach.*

In Europe, regulatory and market interest in low-carbon hydrogen soared following the 2022 Russian invasion of Ukraine. The EU was forced to not only reshape the global natural gas trade routes to secure LNG tankers at the expense of markets with a lower willingness to pay (i.e. Bangladesh, Pakistan), but also to plan on accelerating its transition away from fossil fuels for the long term. This resulted in the REPowerEU plan, targeting an import of 10 million tonnes of hydrogen by 2030 and 10 million tonnes produced domestically[318]. This plan underscores a general trend among advanced economies towards relying on low-carbon hydrogen imports from countries such as Morocco, Chile, Saudi Arabia, or Namibia.

However, this strategy may be hampered by a challenging aspect in the hydrogen value chain: the transportation of the hydrogen molecules. Currently, all hydrogen transport options – liquid hydrogen, liquid organic hydrogen carriers (LOHCs), ammonia, e-methanol – present multiple weaknesses. Hydrogen liquefaction requires a temperature of -253°C, decreasing overall energy efficiency by a third. In other words, the more molecules are further transformed in state, the more the overall energy efficiency is decreased because of the large electricity consumption required at each step of the associated value chain.This can still be considered as an opportunity for territories with overpotential of renewables, as the concept of energy efficiency is historically linked to oil and gas industry with finite resources and reservoirs, which differ from renewable sources-based energies located in areas where renewables with long-term feed are in excess compared to local demand. LOHCs are still in the development phase, making them hard to consider as a certain solution in the medium term. Ammonia is a promising alternative with a proven transport track record, but, like e-methanol, it reduces energy efficiency due to extra transformation steps required, which may limit their use for specific industries (i.e. chemicals, fertiliser, shipping). E-methane could be transported in the form of liquefied natural gas using available techniques, but it is substantially more expensive than fossil methane due to the CCUS cost, making it unrealistic to consider in the short term, in addition to important methane leakages.

Finally, hydrogen has considerable potential as a raw material for producing low-carbon fuels, but transportation presents substantial problems that affect efficiency and cost. It hints that hydrogen may only be the Trojan Horse for hydrogen-based electro-fuels due to the current logistics bottlenecks. Current means of transporting low-carbon hydrogen, such as turning it into ammonia, e-methanol, e-kerosene require energy-intensive procedures that lower overall energy efficiency. On the one hand, these fuels are becoming the best compromise between accelerated decarbonisation and already existing demand. On the other hand, converting hydrogen into these energy carriers requires additional electricity to crack and reform molecules, and to capture, store and use biogenic carbon for carbonaceous e-fuels and RFNBOs. These limits indicate that, while hydrogen might be used efficiently as a chemical feedstock in business such as shipping, aviation, and some industries; direct hydrogen use may be efficient in areas such as long-haul transportation, power, and refining industrial processes. Therefore, under current techno-economic conditions, territories with the largest potential for diversified renewable sources, and cheap electricity prices can be expected to drive down the LCOH and associated e-fuels. These countries stand out as the most promising candidates for new synergistic energy value chains.

[318] A. Sullivan (2022), *Europe's Liquefied Natural gas Demand Surges Hits Asia*, DW.

Case Study: The Republic of Namibia

The Republic of Namibia exemplifies a country that aims to fully participate in global decarbonisation through its confidence in low-carbon hydrogen. It seeks to establish win-win partnerships to maximise its renewable energy potential. The announcement of the REPowerEU plan acted as a catalyst for spurring hydrogen projects' development in Namibia, in addition to the signing of several Memorandum of Understanding (with Germany, Netherlands, Belgium, EIB, Japan). Notably, Namibia granted Hyphen Hydrogen Energy (HHE), a German consortium, the right to develop and operate a hydrogen project in Namibia over a period of 40 years, starting in 2026. HHE expects to produce over 300,000 tonnes of hydrogen and 1,000,000 tonnes of ammonia annually thanks to the abundant solar and wind resources in Namibia's Tsau Khaeb National Park, one of the world's cheapest sites for producing electricity.[319,320] The question arising from this initiative is whether Namibia's reliance on an external stakeholder risks developing into an unequal trade relationship. It is a legitimate ethical debate considering that Namibia has formerly been colonised by Germany, which hampered the local development.[321] Therefore, strong partnership and confidence need to be built to overcome historical recognised damages and ensure a sustainable development for Namibia in the long-term.

Local Development

According to the HHE-Namibia agreement, the consortium parties are cooperating technically, operationally, and financially, in alignment with the 17th United Nations SDGs, to "strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development."[322] The project aims to employ 90% Namibian personnel, both for the five-year development phase (est. 15,000 personnel) and the operational phase (est. 3,000 personnel).[323] In addition, German operators will have to train a local Namibian workforce, therefore creating new educational and professional prospects. After 40 years, if no other foreign firms are picked to oversee operations, Namibia will ultimately have access to infrastructure invested in by others, yet built by their own citizens. Furthermore, it should be noted that such a project is not subject to resource depletion after four decades, as it is the case for fossil fuels-related projects. The natural feed of wind and solar power means that the project may continue to produce hydrogen and ammonia as long as the infrastructure is maintained. This long-term potential will sustain an entirely new value chain in the Namibian economy, leading to an equitable hydrogen industry.

Financial and Economic Perspectives

HHE's project will contribute to the growth of Namibia's economy through the development of renewable energy production, hydrogen and ammonia manufacturing facilities, water desalination plants, and large-scale electricity transmission and gas pipeline infrastructure at an expected total capital expenditure of $9.4 billion if developed at full capacity. Namibia has a high weighted average cost of capital (WACC), which restricts its capacity to independently finance the infrastructure required for an integrated green hydrogen project. International collaboration, such as through the HHE project, can reduce projects' WACC and enhance the

[319] 0.748 tons of captured nitrogen and 0.161 tons of produced hydrogen generate 1 ton of ammonia.
[320] Namibia Green Hydrogen Council (2022), *Namibia Eyes Green Hydrogen Future.*
[321] D. Brown, *Why Namibia Invoked a Century-Old German Genocide in International Court*, The Washington Post
[322] United Nations (2015), *General Assembly: Resolution adopted by the General Assembly on 25 September 2015.*
[323] Hyphen Hydrogen Energy (2024), Southern Corridor Development Initiative (SCDI), Namibian Green Hydrogen Project.

LCOH – in our case by around 17%.[324] This improvement in project economics allows the feasibility of projects and can foster additional hydrogen-related industrial initiatives in Namibia.

Furthermore, the Namibian government, through the Welwitschia Fund, is acquiring a 24% equity stake in HHE's project. This contract includes annual lease payments of $27.7 million during the operational phase increasing by 2% each year, along with Namibian royalties and taxes set at more than 5% of total profits.[325] A successful project implementation can greatly contribute to readjusting the national trade balance (thanks to equity) and will permit the national government to benefit from a project worth nearly as much as the country's 2022 GDP of $12.91 billion.[326] Building off of the HHE project, Namibia plans to leverage the lease and royalty revenues to fund further projects, in addition to welcoming additional foreign investments necessary for building the infrastructure that Namibia needs to maximise its ambition in the green energy economy and to become a low-carbon energy net exporter.

Global Trade Routes Reshape

With coastline's wind capacity factors reaching 57% (higher than the 40% average in Australia, Republic of Ireland, and South Africa) and a coastline solar capacity factor of 34%, a project like the Welwitschia Fund-HHE partnership's seeks to maximise the potential for Namibia to emerge as a major global hydrogen producer and to diversify other aspects of its trade, with large volumes of green hydrogen is a key driver to attract new heavy industries to a region. Indeed, given the above-mentioned challenges of transporting hydrogen, EU President Ursula von der Leyen has announced that nations like Mauritania should consider manufacturing steel and iron and selling them to the EU.[327] Another potential de-industrialisation, at the expense of social and economic conditions of EU residents, but to the advantage of developing nations, is again on the table. Given the significant reduction in overall energy efficiency of recombining and re-cracking steps on the hydrogen value chain, the primary question is whether it makes sense for importing markets to purchase low-carbon hydrogen derivatives from strongly export-oriented ones to decarbonise energy-intensive industries and overcome the technical challenges associated with transporting hydrogen. On the one hand, this question will need to be studied on a case-by-case basis for derivatives uses. On the other hand, it can become a multi-industrial opportunity for countries with a high renewable energy potential.

As a result, a large amount of heavy and energy-intensive industries will shift to countries like Namibia, Morocco, and Mauritania. These countries will be able to improve their trade balance by exporting not just hydrogen and its derivatives but also commodities and materials (i.e. steel, chemicals). These new enterprises, if holistically managed, will generate revenues and employment, improving local socioeconomic circumstances and reshaping global trade. Furthermore, the coupling of industries from renewable energy to hydrogen derivatives, commodities, and RFNBOs, will allow renewable energy-rich countries to diversify their source of revenues, avoiding the 'resource curse'. Indeed, one unique element here is that green hydrogen is just a byproduct of endless sunshine and wind, as opposed to

[324] Ministry of Mines and Energy (2022), *Namibia: Green Hydrogen and Derivatives Strategy*, Republic of Namibia : Government of Namibia.
[325] New Climate Institute (2023), *The Landscape of Green Hydrogen in Namibia.*
[326] World Bank (2024), *GDP (current US$) - Namibia.*
[327] L. Collins (2024), *'Make Green Iron and Steel from Hydrogen and Export them to Europe', EU President tells Mauritania*, Hydrogen Insight.

coal or lithium, which will be depleted eventually. Green hydrogen generation is sustainable, and is seen as a viable alternative fuel for hard-to-electrify sectors in this century. There will be no curse if the Namibian government can begin creating its hydrogen infrastructure now and, meanwhile, invest in fields relevant to hydrogen application while maintaining an international trade-oriented policy, when the clean resource supply is in excess to local demand.

Conclusion

Hydrogen energy, as seen through the prism of global cost-effective energy transitions, has both enormous promise and difficulties as it comes into practice. To overcome obstacles, take advantage of technical advancements, and guarantee that hydrogen will be a catalyst for sustainable growth worldwide, certain changes are needed to build towards win-win partnerships requiring international collaboration, from lowering the energy projects' WACC to sharing technical knowledge. Namibia serves as an example of how hydrogen may fundamentally promote economic growth while keeping fairness and sustainability in mind, along with hydrogen's role in enabling a worldwide energy transition avoiding the resource curse. Hence, its success as a cornerstone for the energy transition will depend on international collaboration, innovation, and a dedication to sustainability as nations negotiate the difficulties of transportation logistics, technical scalability, and economic feasibility. Lastly, to scale up the low-carbon hydrogen supply, some countries are considering the production of hydrogen from fossil fuels (mainly methane and coal) coupled with CCUS. On the one hand, this solution makes low-carbon hydrogen objectives, that renewables-based hydrogen struggles to reach independently, reachable and cost-effective. On the other hand, it keeps the industry heavily reliant on fossil fuels which currently experience important supply chain's scope 1 and 2 methane leakages, responsible for around 30% of the rise in global temperatures since the Industrial Revolution.[328]

[328] IEA (2024), *Methane Abatement.*

Nuclear energy in Europe: Monumental mistake or sustainable blessing?

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A 'historic monumental mistake' is how Fatih Birol, Executive Director of the International Energy Agency, characterised Europe's decision to turn away from nuclear energy.[329] Following years of negative media coverage, propaganda in pop culture, and ultimately the decision following the Fukushima tsunami disaster in 2011, nuclear has been largely sidelined in European energy policies. Despite no injuries or deaths related to radiation contamination in Fukushima,[330] several countries decided to decommission their nuclear power plants.[331] Similar irrationality followed the Three Mile Island and Chernobyl accidents in the 70s and 80s, contributing to the negative perception of this critical energy source, polarising the debate.

Positive movements are made, epitomised by the COP28 in December 2023 where 22 nations pledged to triple nuclear power by 2050.[332] Twelve of the signatory countries are European, as well as Ukraine. Positive signs are also seen within the EU, as Ursula von der Leyen emphasised the need for nuclear energy in a balanced energy portfolio at the Nuclear Energy Summit 2024. The positive outlook of nuclear energy in Europe was further seen by the "nuclear alliance" in Europe signing a joint declaration to develop 150 GW of installed nuclear capacity in the EU by 2050.[333] These are important steps in recognizing nuclear energy, but real investments are needed to back up these ambitious pledges and improve Europeans' view of this largely misjudged and misunderstood technology. A look at Finland might be worthwhile, implementing their Mankala model. It is a form of cooperative corporate

[329] Alice Hancock, Europe trails China and US after 'monumental' energy mistakes (Financial Times, 2024).
[330] WHO, Radiation: Health consequences of the Fukushima nuclear accident (World Health Organization, 2016).
[331] Federal Office for the Safety of Nuclear Waste Management, The nuclear Phase-Out in Germany (Federal Office for the Safety of Nuclear Waste Management, 2024).
[332] IAEA, Nuclear Energy Makes History as Final COP28 Agreement Calls for Faster Deployment (International Atomic Energy Agency, 2024).
[333] Paul Messad, Nuclear alliance aims for 150 GW of nuclear capacity in EU by 2050 (Euractiv, 2024).

finance, where the risk of large investments is shared among several private energy companies, successfully giving Finland a competitive price on two-thirds of their energy. [334]

The EU has made decarbonizing their energy mix and moving away from fossil fuels a top priority. With the increased penetration of variable renewables, there is a need for a dispatchable source of energy to underpin solar and winds' inconsistent power generation.[335] To fulfil this ambition, it is imperative to recognize the pivotal role nuclear energy has played, and must continue to play, in Europe's energy strategy if they are serious about the climate goals, requiring a doubling from 413 GW capacity in 2022 to 812 GW by 2050. [336]

Just like any other energy source, nuclear power has its risks. However, in lieu of the mainstream discussions that surround it, namely potential disasters, proliferation of nuclear arms, exaggerated dangers of radioactive waste, and high upfront investments, this work discusses the geopolitical nuances of nuclear energy technologies and supply chains.[337,338] As such, this essay wishes to outline the reasons that back nuclear development in Europe while addressing some of the potential criticisms.

Why is Nuclear's role so important?

Nuclear reactors can operate essentially nonstop all year long, offering cheap electricity per MW generated and electricity with incredibly low carbon intensity. It meets all aspects of the so-called "energy trilemma", offering the benefits of security, affordability, and low greenhouse gas emissions, in comparison to other energy sources, fossil and non-fossil. Reliability is another peculiar feature of nuclear energy that cannot be overlooked.

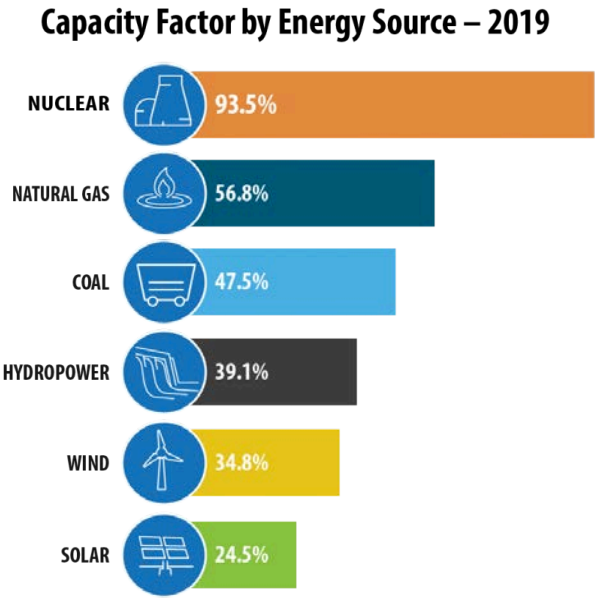

Figure 1[339]

Affordability

To have a just transition, it is important to provide access to equitable and affordable energy. An often-cited critique of nuclear power is its prohibitively high costs and precisely its low affordability.[340] Indeed, compared to conventional power generation sources such as coal and natural gas, nuclear power is more costly on a cost-per-MWh basis, even when controlled for carbon prices of $30/tonne.[341] However, it proves more

[334] World Nuclear Association, Financing nuclear energy (World Nuclear Association, 2024).
[335] IEA, Managing Seasonal and Interannual Variability of Renewables (Paris, IEA, 2023).
[336] IEA, Nuclear Power and Secure Energy Transitions (International Energy Agency, 2022).
[337] Pete Roche et. al, The global Crisis of Nuclear Waste (France: Greenpeace France, 2018).
[338] Mark Z Jacobson, The 7 reasons why nuclear energy is not the answer to solve climate change (Brussels: Heinrich Böll Stiftung, 2021).
[340] Claudia Kemfert et al, Nuclear Power Unnecessary for Climate Protection—There Are More Cost-Efficient Alternatives (Berlin: German Institute for Economic Research, 2017).
[341] WNA, Economics of Nuclear Power. (World Nuclear Association, 2023).

economical than renewable alternatives like wind and solar once network integration, material efficiency, and lifetime considerations are factored in (cost per MWh produced). [342, 343]

Sustainability

The second part of the energy trilemma addresses the need for sustainable energy. Not only is nuclear energy the safest energy source by deaths per megawatt-hour generated, it also boasts minimal environmental impact.[344] A common fear is the toxic waste associated with nuclear power.[345] This fear has little basis in reality, as the amounts are low and 95 % of nuclear waste is either very low level or low level of radioactivity.[346] If we were to pile up all the spent nuclear fuel from 1954 to 2016 onto a football field, it would cover the first 3 metres![347] We must start viewing nuclear waste as a safe byproduct of an almost carbon-free power source, and not as something from a “Simpsons episode”.[348] Neither does nuclear require severe intervention in nature to build reservoirs, as hydropower requires.

Reliability

While solar and wind power are undeniably crucial and have grown immensely in recent years, the variability of these sources underscores the need for reliable baseload electricity and power.[349] Due to their dependency on weather conditions, they are unable to provide stable and reliable power round the clock, and are thus insufficient to constantly fulfil energy security of sufficient generation at all times. As solar and wind penetration increases in the power mix, their limitations of cannibalization, and storage needs become more evident, something that is largely avoided through nuclear.

The "cannibalization effect," where wholesale electricity prices plummet during periods of strong renewable energy production, reduces the economic viability of renewables.[350] Additionally, integrating more renewables leads to increased price volatility, curtailment, and the need for significant investment in transmission infrastructure. For instance, Bloomberg revealed earlier this year that in the UK, apart from the curtailment costs - a consequence of electricity oversupply, when the grid operator (TSO) pays firms NOT to produce - consumers have been facing higher electricity costs because companies are overpredicting generation, leading to higher compensations for avoiding grid input.[351]

The variable nature of renewables requires backup capacity to ensure grid stability. Without the option of quickly-available fossil sources, we need storage. A promising solution to this is

[339] US Department of Energy, Office of Nuclear Energy.
[342] Lars Schernikau, The Role of Nuclear in the Global World of Energy (Oxford Institute for Energy Studies, Issue 139, 2024).
[343] Holger Rogner et. al., Will small modular reactors drive the envisioned expansion of nuclear energy within the energy transition? (The Oxford institute for Energy studies, Forum: nuclear energy in the global energy landscape, Issue 139, 2024).
[344] Bassam Fattouh, Sara Vakhshouri, and Jim Henderson, Introduction (The Oxford institute for Energy studies, Forum: nuclear energy in the global energy landscape, Issue 139, 2024).
[345] Pete Roche (n 6).
[346] IAEA, Status and Trends in Spent Fuel and Radioactive Waste Management (Vienna: IAEA Nuclear Energy Series No. NW-T-1.14 (Rev. 1), 2022).
[347] IAEA (n 17).
[348] Mathew L. Wald, The boring truth about Nuclear Waste (The Breakthrough Institute, 2022).
[349] IEA, World Energy Outlook 2023. (International Energy Agency, 2023).
[350] Lion Hirth, The market value of variable renewables: the effect of solar wind power variability on their relative price (Berlin: Elsevier Energy Economics, 2013).
[351] Gavin Finch, Wind Farms Are Overstating Their Output — And Consumers Are Paying For It (Bloomberg, 2024).

large-scale batteries, but they remain in the infant stage. For reference, the US with its relatively developed battery storage had 11 GW of capacity deployed in the grid.[352] To fully decarbonize, they need 6 Twh. Put more bluntly: 87 times more! Nuclear power thus emerges as a compelling complementary in the global quest for a net-zero energy future, as batteries fail to solve the variability issue by acting as a supply buffer for off hours.

Security

While hydroelectric power represents a potential alternative to nuclear energy due to its dispatchable nature, offering the capability to serve as a base load energy supply, its capacity factor is less than half that of nuclear power (Figure 1) - likely not sufficient to cover the loss of power from switching away from fossil sources. Neither is hydro available everywhere, as it is constrained by natural environments. In a hypothetical situation where Europe fully develops hydro's potential, it can only add 73GW.[353] Hydropower is needed for the transition, but to make it truly happen, it needs nuclear as a complimentary. This is further stressed by a UN study on hydropower concluding that 16% of the worldwide capacity of hydropower plants is already lost due to climate change, significantly hampering its ability to work alone.[354]

The imperative for a reliable and decarbonized base-load fuel becomes evident as we strive to maintain an uninterrupted power supply during our transition to cleaner energy sources. Thus, embracing nuclear power is not just pragmatic but essential for securing a sustainable energy future. However, one pertinent issue that deserves intense debate is the issue of dependency in Europe. Are we exchanging one Russian dependency for another - gas to nuclear - ?

Are we paving the way for another REPowerEU?

Russian-led Rosatom dominates the nuclear supply chain and has done so for a long time. They hold 35% of the global market share of enriched Uranium, and within the EU they are the sole supplier for 4 member states (Bulgaria, Czechia, Hungary, and Slovakia).[355,356] As nuclear energy delivers a significant share of electricity output for some of these countries, it makes them particularly vulnerable. Russia holds significant ownership of nuclear activities with supply agreements, partnerships, and uranium services, and offers a 'full package' approach. It provides its clients with a "vertically integrated" business framework.[357] This includes best-in-class know-how, comprehensive supply structures, waste handling, and nuclear technologies for plant functioning, all coupled with very appealing financing options. This comprehensive package is difficult to financially and technically compete with and is what puts Rosatom atop of nuclear activities deals.[358] Having just witnessed the weaponization of energy by Russia before and during the invasion of Ukraine, the burden of

[352] Alsym Energy, How much energy storage do we need for a completely clean U.S. electric grid? (Alsym Energy, 2023).
[353] IHA, Hydropower 2050: Identifying the next 850GW towards Net Zero (International Hydropower Association, 2021).
[354] UNU, Trapped Sediment Robbing World's Large Dams of Vital Water Storage Capacity, United Nations University, 2023).
[355] Rosatom, Key operating results of state atomic energy corporation rosatom 2022 (Rosatom, 2023).
[356] Vasco Guedes Ferreira, Strategic autonomy and the future of nuclear energy in the EU (European Parliamentary Research Service, 2024).
[357] Lars Schernikau. Ibid.
[358] Lars Schernikau. Ibid.

being overly reliant on Russia for energy again seems less appealing. After all, what would deter them from repeating it?

To properly evaluate the risks of said action, we must look into the market dynamics of nuclear and its fuel: uranium. First, the threats related to pipeline gas cuts are very divergent from halting uranium deliveries. Pipeline gas could be cut immediately, with no available means to quickly cover the supply. Conversely, the uranium market is more slow-paced, and the fuel needs to be filled infrequently due to higher energy content, material efficiency, and storability. In fact, reactors are only refuelled once every 1.5 or 2 years.[359] Additionally, all of the uranium produced and consumed in the U.S., for example, could fit in a football field at a depth of fewer than 10 metres. How? 1 uranium pellet has the same energy content as 1 ton of coal, 120 gallons of oil, or about 500 cubic metres of natural gas.[360] All of these factors help to visualise how reduced the exposure to short-term disruptions in nuclear supply chains is. (IEA, Nuclear Power, and Secure Energy Transitions Report, 2022).[361] Once the reactors are built, the risk is significantly diminished compared to the risk of gas, seen before the full-scale invasion of Ukraine.

To further appease the supply obstacles, the EU has been developing strategies with the European Atomic Energy Community through the Euratom Supply Agency (ESA). ESA was established to ensure a consistent supply of nuclear materials and fuels to all users within the Union and mitigate the risks of dependency on Russian nuclear supplies and services.[362] Currently, 62% of the enriched uranium used in EU nuclear power plants comes from local production, 30% is purchased from Russia, and the remaining 8% is imported from other nations.[363]

For the countries that are solely reliant on Russia, there are also initiatives to diversify. One notable initiative involves a collaboration between Orano and Urenco, two private companies based in Europe dedicated to cultivating expertise and stockpiling high-assay low-enriched uranium (HALEU). HALEU is a specialised fuel crucial for advanced power reactors, including two-thirds of Small Modular Reactors (SMRs) currently in development, of which Russia currently holds 100% of the stock.

In September 2023, Urenco and Orano inked a significant deal aimed at reducing reliance on Russian nuclear dependency by jointly developing a compatible transportation cylinder for HALEU logistics.[364] Additionally, Orano, a major player in the nuclear industry, plans to enhance the enrichment of this fuel. Their target is to supply enrichment levels of up to 6% by 2025 and exceed 6% by 2030, fully aligning with the commissioning of new nuclear reactors worldwide.[365] This demonstrates a proactive response from nuclear stakeholders, driven by market forces and governmental pressures, to establish a secure supply chain with dependable partners in the evolving energy landscape.

An intriguing development in this regard is Small Modular Reactors (SMRs), where the distance to Russian dominance is arguably less than in conventional reactors. The recently

[359] US Department of Energy, The Ultimate Fast Facts Guide to Nuclear Energy (Office of Nuclear Energy, 2018).
[360] US Department of Energy. Ibid.
[361] IEA, Nuclear Power and Secure Energy Transitions Report, 2022.
[362] Vasco Guedes Ferreira. Ibid.
[363] Vasco Guedes Ferreira. Ibid.
[364] Orano, Urenco and Orano sign consortium agreement to develop 30B-X cylinder for LEU+ - HALEU fuel transport (2023).
[365] Orano, HALEU (n.a.).

launched EU SMR Alliance to streamline the collaboration on SMRs may be read as a signal of a positive approach to SMRs. [366] The central role SMRs had in the '24 IAEA & Government of Belgium meeting on nuclear energy in Brussels, indicates an increased political marketability for atoms and SMRs. The enormous differences in cost structure (CAPEX vs OPEX) between SMRs and conventional nuclear, even if the operating costs should be higher for the former, a lower initial cost is considerably easier to pitch politically. From a strategic policy perspective, SMRs may be instrumental to the EU, since they can be played as the "new-tech card". By focusing on this novel technology and decoupling it from its politicised cousin, a top-down approach could work well.

Another way to avoid the risk of dependency is to proactively invest in and rebuild the European supply chain. Looking back, Russia has not always dominated these supply chains. Russia's current dominance in the market stems from its substantial investments and the relative absence of the West. Only through strategic investments in nuclear expertise, technology, and resources can Europe attempt to narrow this gap.[367] Presently, significant delays in buildout are causing significant economic costs, and the inactivity in the sector has given Europe years of loss in critical competencies and supply chain capabilities in comparison to Russia.[368] Developing domestic nuclear sourcing is imperative to address this dependency, and also to improve the confidence in the energy source. With time, as we enhance our technology and reduce reliance on Russian supplies, we can compensate for lost ground.

Conclusion

The European power mix strategy should evolve aligned with the acknowledgement of the benefits of nuclear, not by neglecting it. As mentioned, some relevant political developments were achieved during the last COP, and the EU is actively pursuing the diversification of supply chains and embracing SMRs. Positively, 13 of the 20 signatories to the COP28 nuclear pledge were European countries - which signals the popularisation of benefits associated with nuclear power. Much can be done in terms of acquiring/deepening knowledge, technological development, sourcing our raw materials from others, and associating a positive image with nuclear activities. There must be a top-down investment commitment by the EU body, and a commitment to keep interest rates down. The technical complexity of nuclear power requires political stability and low costs of capital, as it is a key component of overall costs.[369] This could lead to a halt in bad political associating if they show results, but is not enough. People must also be made more aware of the intermittency and security of supply risks for variable renewable sources, and understand the need for nuclear. A comprehensive change in the school curriculum could be a potential driver to educate new generations on this largely misunderstood technology.

If not made clear already, the geopolitical risk is exaggerated. We must not let fear and the fog of war in Ukraine distract us from developing and embracing nuclear energy. The crucial role it can play in contributing to the energy mix in a net-zero future outshines the risks.

[366] European Commission, European Industrial Alliance on SMRs (European Commission, 2024).
[367] Giacomo Luciani, Nuclear Energy in Europe: It's Time to Consider Outcomes (The Oxford institute for Energy studies, Forum: nuclear energy in the global energy landscape, Issue 139, 2024).
[368] Oksana Matselyukh, Retaining critical competences in nuclear energy sector:national initiatives and best practices, instruments and tools (European Commission JRC Science and Policy Report; 2015).
[369] World Nuclear Association. Ibid.

There is no free lunch, but we have our climate goals and climate change is happening at an alarming pace. Vladimir Smakhtin, director of the UN University's Institute for Water, Environment and Health said in an interview with Reuters: “I would argue that the question we should now be asking is what are the alternatives to dams".[370] Our answer is clear: Nu-clear.

[370] Reuters, “World’s dams to lose a quarter of storage capacity by 2050 - UN research,” Reuters, 2023, https://www.reuters.com/business/environment/worlds-dams-lose-quarter-storage-capacity-by-2050-un-research-2023-01-11/

TenneT's Target Grid: Takeaways for planning next-generation offshore wind and electricity transmission

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Arina Khotimsky is a second-year master's student at Sciences Po in International Energy Transitions. Prior to this, she completed her bachelor's degree at the Massachusetts Institute of Technology in Materials Science and Engineering with a minor in Energy Studies. Arina is currently interning at the Energy Transition Institute at Kearney in Paris. Previously, Arina co-led the MIT Energy and Climate Club (2022-2023).

Offshore wind power generation has become a key part of the European Green Deal objective of reaching net zero by 2050.[371] Indeed, nine European countries–Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway and the UK–pledged in the 2023 Ostend Declaration to jointly develop North Sea offshore wind capacity. Building on the Esbjerg Declaration from a year earlier, they committed to 120 GW of capacity by 2030 and 300 GW by 2050.[372,373,374] For comparison, as of 2023, the EU only had 19 GW of offshore wind installed–roughly one-fifteenth of the updated target.[375] The North Sea is thus expected to become one of the most important generators of renewable electricity for the northwest European region.

In this context, TenneT, the Dutch transmission system operator (TSO), which also operates a part of the German transmission grid, announced in April 2023 the launch of Target Grid: an ambitious renewable energy-ready electric grid extending into the North Sea.[376] Through developing standardised offshore electricity infrastructure, high-voltage direct current (HVDC) transmission, and by improving alternating current (AC) transmission on land, the Target Grid will connect North Sea offshore wind hubs to areas of electricity demand, starting with the

[371] European Commission. (n.d.). "The European Green New Deal." European Commission. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[372] Government of the Netherlands. 24 April 2023. "Ostend Declaration on the North Seas as Europes Green Power Plant."

[373] De Croo, Alexander and Mark Rutte, Xavier Bettel, Emmanuel Macron, Olaf Scholz, Leo Varadkar, Jonas Gahr Støre, Rishi Sunak, and Mette Frederiksen. 23 April 2023. "The North Seas can be the world's biggest power plant." Politico. https://www.politico.eu/article/north-sea-global-power-plant-clean-energy-renewable-green-deal-climate-crisis/

[374] ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E.

[375] Costanzo, Giuseppe and Guy Brindley. February 2024.*Wind Energy in Europe: 2023 statistics and the outlook for 2024-2030.* WindEurope. https://windeurope.org/intelligence-platform/product/wind-energy-in-europe-2023-statistics-and-the-outlook-for-2024-2030/

[376] A TSO is an entity that provides transmission of electric power via a high-voltage electricity grid from sources of electricity generation to regional electricity distribution. TSOs are highly regulated because they typically operate as regional monopolies. (Renewables Grid Initiative. December 2015. "Factsheet Transmission System Operators." Renewables Grid Initiative.

Netherlands and Germany, and eventually expanding to neighbouring countries like Belgium, the United Kingdom, and France.[377,378]

The challenge of this project is hard to describe. Imagine a 5,000 piece puzzle that needs to come together, from market regulation, to environmental permitting, technological innovation, financing strategies, international agreements, and business plans for wind farms. The individual pieces themselves are still being moulded, since such a large, interconnected offshore project has never been made before. To make it harder, you can't start in isolation in one corner of the puzzle and slowly work your way out. All of the pieces must be laid out simultaneously, or risk not fitting together later. This is what it will take to build an interconnected North Sea Grid.

Such ambition sets an example but also raises a number of questions and challenges for TenneT and other European TSOs. TenneT's detailed public plans for the Target Grid and its offshore bidding zone blueprint are key pieces of the puzzle if Europe is to put together an interconnected North Sea grid. The November 2023 European Commission Communication "Grids–the Missing Link," also known as the Grid Action Plan (GAP), likewise addresses the numerous challenges associated with this project, projecting a net requirement of 584B€ for grid expansion by 2030 in the European Union.[379]

In this essay, starting from the Target Grid project, and then expanding to the broader European landscape, we discuss the challenges of planning offshore electricity transmission grid investment, focusing on the need for HVDC transmission, environmental and supply chain challenges, financing frameworks for transmission investments, and electricity market regulatory changes.

Target Grid's infrastructure modularity and backcasting approach set the project up for success.

One of the components of TenneT's Target Grid is the connection between offshore wind farms (OWF) and the onshore electricity grid. These connections will be built through TenneT's 2GW Program (referring to the 2 GW capacity of each connection), utilising a standardised design (Figure 1).[380] The connection begins with an offshore converter station. Each station receives AC electricity from nearby wind turbines (a maximum of 2 GW) and converts it to Direct Current (DC) electricity, suitable for transport to land. From the station, HVDC cables carry electricity to shore. There, an onshore DC-to-AC converter station converts the electricity back to AC, suitable for distribution through typical transmission networks. By 2031, TenneT aims to build at least 14 such connections to Germany and the Netherlands, creating a 28 GW capacity for new offshore wind (roughly a quarter of the Ostend Declaration's 2030 goal).[8]

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[377] AC transmission refers to electricity that, while transmitted to end consumers, changes direction at a set frequency. DC refers to electricity that doesn't switch direction; while its infrastructure is more expensive than AC, it is more efficient when being transported over a long distance. HVDC refers to DC electricity whose voltage is increased before being transmitted long distance; this increase in voltage makes the transmission even more efficient. AC/DC is an Australian rock band.

[378] TenneT. 13 April 2023. "TenneT presents Target Grid, its vision for the electricity grid of 2045." TenneT. https://www.tennet.eu/news/tennet-presents-target-grid-its-vision-electricity-grid-2045.

[379] European Commission. 28 November 2023. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Grids, the missing link - An EU Action Plan for Grids. COM(2023) 757 final. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A757%3AFIN.

[380] Tennet. (n.d.). "The 2GW Program." TenneT. https://www.tennet.eu/about-tennet/innovations/2gw-program

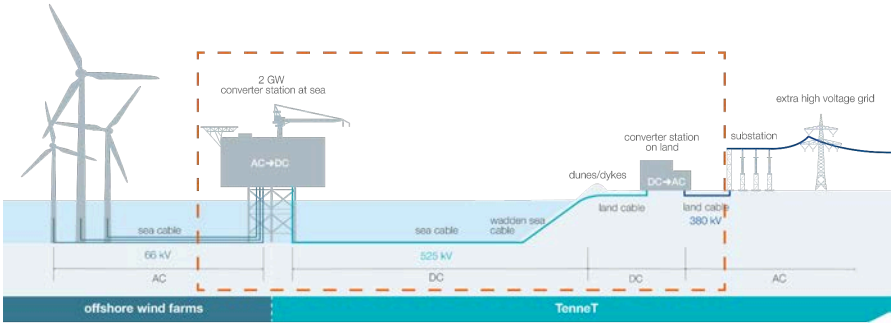

Figure 1: TenneT's 2GW Project, with the standardised components boxed in red. Source: TenneT | The 2GW Program

The Target Grid project comes amid other offshore electricity transmission projects in the EU, such as Princess Elisabeth Island in Belgium (North Sea) and Bornholm Energy Island in Denmark (Baltic Sea), both eventually intended to be connected to multiple countries.[381,382] However, while these projects focus primarily on constructing energy islands, TenneT's modular approach with its 2 GW design renders it more versatile, allowing cost savings at the scale of the Target Grid from various future projects.

TenneT's Target Grid is also characterised by its use of backcasting. Backcasting is a planning approach which first defines a desired outcome, and then works backwards to determine what steps are necessary to get there. The Target Grid's backcasting uses Germany's and the Netherlands' most ambitious electrification scenarios as its end goal: Under these scenarios, they *each* install 70 GW of offshore wind in the North Sea–the highest national targets among Ostend Declaration signatories, coming from starting points of 7.1 GW and 5.6 GW, respectively.[383,384] The achievement of these goals is not guaranteed. Without hydrogen demand materialising for example (what part of this 70 GW capacity is intended for), TenneT would have to revise its plan. However, TenneT's defence in switching to a backcasting strategy, away from its previous plans which only look ten years ahead, is that the plans can always be scaled down and adapted. What is key is creating a plan that can be compatible with EU decarbonisation goals and which can be compatible with greater electrification needs in the future.[385]

Backcasting can lead to other benefits, such as allowing utilities to obtain necessary permits for projects earlier, reducing the chance of delays once construction begins. Balthasar Klimbie, a member of TenneT's Energy System Planning (ESP) unit, stresses the merits of the backcasting approach for this reason: "We can prepare [projects] in advance. Discussing routes, buying land, initiating permits. With that preliminary work, projects go much faster in the future."[386] Thus, backcasting can ensure that a complicated, multi-stage investment project is set up for success. With this strategy, as well as its 2GW project, TenneT

[381] Elia Group. (n.d.). "Princess Elisabeth Island." Elia. https://www.elia.be/en/infrastructure-and-projects/infrastructure-projects/princess-elisabeth-island
[382] Energinet. (n.d.). "Energy Islands in Denmark." Energinet. https://en.energinet.dk/infrastructure-projects/energy-islands/
[383] TenneT. (n.d.). "Target Grid: Approach." TenneT. https://www.tennet.eu/target-grid#approach
[384] TenneT. 29 January 2024. "'Wind yield' in the Dutch and German North Sea generates more than 30 terawatt hours." TenneT. R https://www.tennet.eu/news/wind-yield-dutch-and-german-north-sea-generates-more-30-terawatt-hours
[385] TenneT. (n.d.). "Balthasar Klimbie." TenneT. https://www.tennet.eu/target-grid-brings-electricity-grid-2045-focus-balthasar-klimbie
[386] https://www.tennet.eu/target-grid-brings-electricity-grid-2045-focus-balthasar-klimbie

addresses two of the key challenges facing large electricity infrastructure projects: costs and permitting.

More DC transmission – finally!

The HVDC cables that TenneT has planned will not only connect offshore stations to onshore stations, but they will also extend over the continent, providing additional electricity transmission throughout Europe. This infrastructure investment will be expensive. ENTSO-E, the European Network of Transmission System Operators, estimates that nearly €260 billion will be needed through 2050 to fully develop offshore wind in the North Sea Region (the issue of financing is explored later in this article).[387] But if the Ostend Declaration's goals are to be met, this grid investment is needed.

The choice to develop HVDC transmission in spite of its cost is due to the need to operate in a marine environment far from shore. Most OWF in the North Sea will be more than 50 km away from the coast.[388] The future Norwegian Sørlige Nordsjø II/Sørvest F wind farm will be located around 250 km away from the Norwegian coast.[389]

While DC transmission is more efficient than AC, involving less power losses,[390] AC is a cheaper option to deliver power over short distances. However, as shown in the graph below (Figure 2), this only applies until a break-even distance. Then, DC becomes more cost efficient. This break-even distance is approximately 800 km for overhead transmission lines and only 50 km for underwater transmission lines. With most North Sea wind farms being more than 50 km away from the coastline, DC technology is the most cost-viable option to connect offshore wind power.

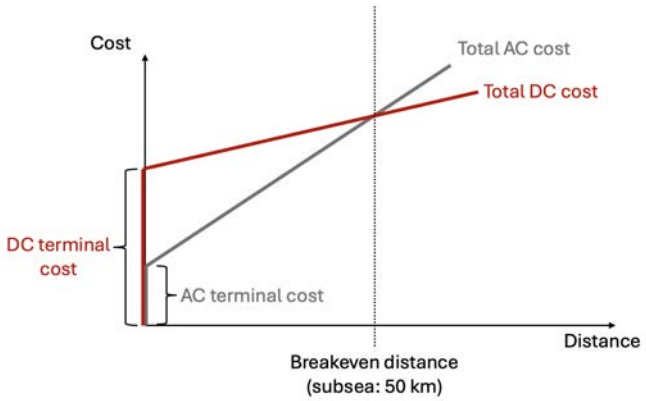

Figure 2: Comparison of cost of AC and DC cables depending on transmission distance. While for overhead cables the breakeven distance is 800 km, for subsea cables, as required

[387] "In total, the cost of the interconnected offshore infrastructure for the Northern Seas is about 260 bn€ (some of which relates to GB+NO)" ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E. p. 9.
[388] From authors' own analysis using announced project locations and point-to-point distances on Google Maps.
[389] ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E. p. 56.
[390] Transmitting power naturally involves power losses through the form of heat: this phenomenon is known as the Joule's effect. Depending on the type of current, power losses differ significantly. High Voltage Alternating Current (HVAC) transmission results in 5 to 10% power losses compared with 2-3% with High Voltage Direct Current (HVDC) transmission. (The Benefits of High-Voltage Direct Current (HVDC) Power, October 19, 2020, Andreas Berthou: https://eepower.com/technical-articles/the-difference-that-dc-makes/#).

for Target Grid, the breakeven distance is 50 km. Modified from Figure 2.1 "Comparaison entre HVAC et HVDC."[391]

Moreover, new HVDC transmission infrastructure, extending onshore, is also expected to prevent overloading existing onshore AC infrastructure, which may otherwise face congestion issues from the influx of new offshore electricity. The new HVDC grid therefore has a double objective: transmitting power from distant OWF on the one hand, and decongesting the onshore grid through new transmission paths on the other. ENTSO-E summarises the improvements that an interconnected offshore grid will bring to Europe: it will facilitate transport of electricity to demand centres; create multiple paths for electricity to get between locations, improving energy security; increase the sharing of electricity and flexibility between countries; and by connecting regions with different wind patterns, the net electricity production can become more consistent.[392] For all of these reasons, a next-generation transmission grid is a much-needed investment to meet Europe's decarbonisation goals. The ENTSO-E report, led by TenneT but representing the views of all EU TSOs, provides encouragement that the need for HVDC infrastructure is widely acknowledged; TenneT's Target Grid concretely addresses this.

Not enough discussion of wildlife protection yet.

The footprint of offshore wind installations in the North Sea will inevitably impact the local ecosystems. ENTSO-E's January 2024 report highlights risks such as impacting animal migration, stratification of water columns, and damage to the seafloor and breeding sites. Many of the risks are not fully understood, and more research is needed.[393] Though TenneT has not yet published detailed plans regarding safeguarding the North Sea ecosystem, other North Sea projects are taking positive steps, such as Belgium's Princess Elisabeth Island.[394] A proactive approach like this is key – if a thorough action plan is completed in initial planning phases, it will allow for more nuanced conversations with environmental stakeholders, providing robust support to final investment decisions and preventing delays. It is important to remember that the extraction of fossil fuels, CO2 emissions, and climate change have caused a dual climate and biodiversity crisis; a responsible energy transition should do its best to solve both.

Supply chain risks will be inevitable as European TSOs race to decarbonise.

As Europe grows its offshore wind ambitions, supply chains for key construction materials and infrastructure–cables, converter stations, installation vessels, ports, etc.–will come under stress.[395] To be ready to start building the Target Grid with its modular 2GW approach by 2025, TenneT recognizes that it must collaborate with contractors and suppliers.[396]

In time, European TSOs may be forced into competition with one another for contracts.[397] For example, France is expecting immense grid investment according to its TSO RTE's 2024

[391] Sakraoui, Mohamed Amine. 2016. *Gestion du Réseau Électrique : HVDC et Services Auxiliaires*. Thesis from École Polytechnique de Louvain.
[392] ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E. p. 8.
[393] ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E. p. 18.
[394] Elia Group. 13 November, 2023. "Elia takes seven tangible measures to enhance biodiversity around the Princess Elisabeth Island." Elia.
[395] ENTSO-E. January 2024. *TEN-E Offshore Priority Corridor: Northern Seas Offshore Grids*. ENTSO-E.
[396] TenneT. 2024. *Target Grid.* https://open.overheid.nl/documenten/ronl-f6e9941e17913396a826a6ff87338aebb1abedbb/pdf
[397] Costanzo, Giuseppe and Guy Brindley. February 2024. *Wind Energy in Europe: 2023 statistics and the outlook for 2024-2030.* WindEurope.

previsions. In its recent "Schéma Décennal de Développement du Réseau,"[398] RTE expects a total grid infrastructure investment of €100B by 2040. Simultaneously, TenneT expects a total €160B investment in its most recent ten-year plan for the period 2024-2033.[399] Furthermore, this competition for resources is happening in the face of European offshore wind manufacturers facing recent financial challenges, inflated costs, and competition from China.[400]

Europe-wide coordination and planning could reduce risks, ensuring countries cooperate, not compete, to achieve their respective decarbonisation goals. The GAP Action 13, targeting supply chain security, addresses this, even noting TenneT's 2 GW program as an example of creating standardised specifications that "would lower costs, accelerate project delivery, increase the amount of output with the already existing manufacturing facilities."[401] As offshore grid planning proceeds, TSOs and project developers must continue keeping standardisation and cooperative contracts with suppliers in mind.

New national financing frameworks will be required for offshore transmission.

Financing the required infrastructure for Target Grid and the rest of the new North Sea transmission will be a massive challenge. Traditionally, grid transmission capital expenditure (CAPEX) and operating expenditure (OPEX) is paid for by electricity tariffs set by TSOs in cooperation with their national regulator. For new offshore grid development, tariffs will inevitably have to increase to cover the anticipated growth in CAPEX and OPEX. Yet, industries and consumers will not accept limitless soaring electricity prices (for example, when consumer electricity prices increased across the EU by over 20% on average from 2021-2022, a range of government intervention ensued, from tax waivers to price caps and other support mechanisms).[402] Tariffs may increase, but only to a certain point of socio-economic acceptance.

Next-generation grid infrastructure will require new financing strategies. To attract more investment capacity, TSOs may have to consider extending the share of equity financing, which can be difficult in light of government regulation and some TSO's semi-public status. This will require cooperative work with national regulators to update regulatory frameworks, for instance considering increasing the palatability of private sector investments through higher incentives. Per the GAP Actions 8 and 9, ACER and the European Commission will provide guidance for identifying tariff and financing strategies, respectively.[403]

A successful example of modifying financing strategies for offshore projects is Belgium, which updated its regulatory framework to incentivise investment in offshore grid infrastructure and to cover the higher risks of the offshore environment. For the 2024-2027 tariff period, the Belgium regulator, Commission de Régulation de l'Electricité et du Gaz, confirms a clear separation between the classic Regulated Asset Base (RAB) and the

[398] RTE. March 2024. *Schéma décennal de développement du réseau 2024, document B.* p. 4. https://assets.rte-france.com/prod/public/2024-03/SDDR2024-volet-etudes-technico-%C3%A9onomiques-doc-B.pdf
[399] TenneT. 11 March 2024. "TenneT delivers 2023 results with a record high of EUR 7.7 billion in grid investments coping with grid congestion and bottlenecks." TenneT.
[400] Janipour, Zahra. 13 March 2023. "The Bottlenecks Challenging Growth in the EU Offshore Wind Supply Chain." Rabobank.
[401] European Commission. 28 November 2023. COM(2023) 757 - Grids, the missing link - An EU Action Plan for Grids. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A757%3AFIN&qid=1701167355682
[402] Eurostat. 26 April 2023. "Electricity and gas hit record prices in 2022." Eurostat.
[403] European Commission. 28 November 2023. Ibid.

offshore RAB. Investing in a classic project will be remunerated over time with a particular interest rate (a set risk-free rate of 3.5% + a 1.68% risk premium), while investing in an offshore grid project, which is riskier and more costly, will receive an additional risk premium of 1.4%.[404] Belgium uses this strategy to finance its "Modular Offshore Grid" (I and II) projects, which will transmit the power generated by OWF to the Belgian onshore grid. A similar strategy could help other North Sea countries incentivise investment in offshore projects.

Thorough regulatory changes spanning the EU will accompany the North Sea grid.

Many regulatory changes will be necessary for a hybrid North Sea grid. For one, cost-sharing strategies between countries must be defined. Some countries already have such frameworks; for instance, Denmark and Germany signed an agreement for sharing the costs of Bornholm Energy Island in the Baltic Sea. This pioneering agreement between the countries' TSOs (Germany's 50Hertz and Denmark's Energinet) stipulates that each will assume half of the infrastructure cost and clarifies how they will share revenues.[405] However, future strategies will need to go beyond bilateral agreements if the grid is to become truly interconnected between many countries. Action 5 of the GAP, which announced the future publication by the Commission in June 2024 of a "guidance on cross-border cost sharing for offshore projects," will hopefully address these concerns in detail.[406]

A second regulatory challenge is defining a framework for anticipated investment capacity for future, but still uncertain, projects like the adaptable Target Grid. The GAP's Action 4 focuses on "identifying conditions under which anticipatory investments in grid projects should be granted."[407] TenneT especially stands to benefit from such a framework given its backcasting-defined sequential investments. The Commission is expected to release guidance on approving anticipatory investments by early 2025.[408]

Third, the offshore grid will require a market redesign to create offshore bidding zones (OBZs), intended to optimally integrate offshore generation and reduce congestion in an interconnected grid. In April 2024, TenneT released a blueprint for such a proposal, summarising the challenges and possible mitigations for offshore electricity bidding zones.[409] The report builds on current discussions among European TSOs regarding alternative bidding zone configurations (so-called Bidding Zone Review).[410] While there is already precedent in the form of Denmark's recently approved offshore bidding zone for Bornholm

[404] Commission de Régulation de l'Électricité et du Gaz (CREG). 30 June 2022. *Arrêté fixant la méthodologie tarifaire pour le réseau de transport d'électricité et pour les réseaux d'électricité ayant une fonction de transport pour la période régulatoire 2024-2027*. CREG. p 49.
[405] Buljan, Adrijana. 2 June 2023. "Denmark and Germany Sign Bornholm Energy Island Agreement, First Legally Binding Cooperation on Joint Offshore Renewable Energy Project in EU." offshorewind.biz.
[406] European Commission. 28 November 2023. Ibid.
[407] Ibid.
[408] Ibid.
[409] TenneT. 24 April 2024. *The offshore bidding zone - a blueprint by TenneT*. https://www.tennet.eu/news/offshore-bidding-zones-key-efficient-market-integration
[410] Ibid.

Energy Island, dialogue must continue in coming years to ensure optimal market functioning and fair electricity prices.[411]

Taking a step back, any uncertainty in the progress of offshore grid development increases risks for OWF project developers. OWFs profit by selling their electricity; without functioning transmission to export their electricity, they cannot make money. Uncertainty in transmission may thus delay project investment. To encourage the buildout of projects, existing project finance risk-hedging strategies, like power purchase agreements (PPAs) and contracts for difference (CfDs), will have to be redesigned. New strategies, like transmission access guarantees (TAGs), which compensate projects when transmission is not available (e.g. during delays in the transmission development or during maintenance periods after operation has begun), will have to be developed.[412]

There has not yet been collective agreement over which risk-hedging strategies will be optimal. While the European Commission concluded in a 2022 report that TAGs are preferred, a March 2023 ENTSO-E report criticised the initially-proposed TAG mechanism for being non-transparent and discriminatory in its financing strategy, and for using uncertain congestion incomes as a source of funding.[413,414] TenneT's 2024 offshore bidding zone blueprint similarly states that TAGs are not sufficient.[415] Intense dialogue will be necessary between the government regulators, TSOs, and project developers to define sufficient measures for projects to be successfully built.

The EU's recently approved Electricity Market Design reform represents the first step to create an optimised grid expansion framework which addresses offshore project needs.[416] The reform will develop PPAs and CfDs to incentivize investments in renewable energy as well as protect consumers from price variations. Rapidly developing these policies and putting them into action will facilitate projects like the North Sea grid, fulfilling the Ostend Declaration, increasing energy security, and accelerating the energy transition.

Conclusion

As demonstrated by the plans for TenneT's Target Grid, the future of offshore wind in Europe comes with complex challenges. Utilising modularity and backcasting will be key to keeping project development efficient and within budget. A new HVDC grid will be necessary to create the capacity to transport electricity generation through the North Sea via a hybrid grid structure, but building this HVDC infrastructure will stress supply chains and require unprecedented investments. Countries must work together to develop cost-sharing strategies

[411] Danish Energy Agency. 18 December 2023. "Denmark is establishing a new bidding zone at the Bornholm Energy Island." The Danish Ministry for Climate, Energy, and Utilities. https://ens.dk/en/press/denmark-establishing-new-bidding-zone-bornholm-energy-island#:~:text=In%20connection%20with%20the%20establishment,zone%20DK3%20at%20Energi%C3%B8%20Bornholm.
[412] TenneT. 24 April 2024. *The offshore bidding zone - a blueprint by TenneT*. Page. 59.
[413] Laur, A. et. al. August 2022. Support on the use of congestion revenues for Offshore Renewable Energy Projects connected to more than one market. European Commission. https://energy.ec.europa.eu/system/files/2022-09/Congestion%20offshore%20BZ.ENGIE%20Impact.FinalReport_topublish.pdf
[414] ENTSO-E. 31 March 2023. *Electricity Market Design Reform - ENTSO-E Position on the EC proposals on Market Design.* ENTSO-E. Page 2, 8. https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Publications/Position%20papers%20and%20reports/2023/entso-e_EMDR_One-pagers_230331.pdf.
[415] Ibid. Page 55-57.
[416] Council of the European Union. 7 May 2024. Regulation of the European Parliament and of the Council amending Regulations (EU) 2019/942 and (EU) 2019/943 as regards improving the Union's electricity market design. https://data.consilium.europa.eu/doc/document/PE-1-2024-INIT/en/pdf .

for such hybrid grids and plan for anticipated future investments in grid upgrades. Regulatory changes will be necessary to define a North Sea bidding zone and create investment certainty for project developers. Negotiation and collaboration will be critical; all five of the key challenges that TenneT identifies concern proactive outreach and planning.[417]

TenneT's Target grid finds itself in the larger scheme of the European Union's wind power development. Since October 2023, when the European Commission released its European Wind Power Action Plan, the European Investment Bank (EIB) has pledged €5 billion to assist the financing of wind projects by providing counter-guarantees, and 26 Member States have signed the Wind Energy Charter, aligning their support for the Wind Power Action Plan, along with 300 industry companies.[418,419,420] The Grid Action Plan confirms the EU's urgency to address these issues at the European level and promote grid development. It's encouraging that many of the key challenges that TenneT identifies share ground with the European Wind Power Action Plan; stakeholders are in agreement on where changes must be made to unlock the offshore wind market and reach decarbonisation goals.

Europe's wind energy ecosystem will continue to evolve, and the Target Grid is still in its early stages. Its successes and struggles will be important to watch and learn from. All things considered, it is somewhat misleading to call Target Grid simply a project. It is an idea that embodies hope for a renewables-rich North Sea and a decarbonised European Union.

[417] 1) Developing a 2050 North Sea Strategy with partner countries, 2) Determining hotspots of electricity demand, 3) Permitting, 4) Electricity market regulation, 5) Supply chain security via a unified European strategy. TenneT. 2023. Target *Grid*. https://open.overheid.nl/documenten/ronl-f6e9941e17913396a826a6ff87338aebb1abedbb/pdf

[418] European Commission. 24 October 2023. "Commission sets out immediate actions to support the European wind power industry." European Commission. from https://ec.europa.eu/commission/presscorner/detail/en/ip_23_5185

[419] WindEurope. 14 December 2023. "EIB delivers its bit of the Wind Power Package with counter-guarantees for wind energy manufacturing." WindEurope. https://windeurope.org/newsroom/press-releases/eib-delivers-its-bit-of-the-wind-power-package-with-counter-guarantees-for-wind-energy-manufacturing/

[420] Directorate-General for Energy. 19 December 2023. "New Wind Charter and national wind pledges underline ambition for wind power in Europe." European Commission. https://energy.ec.europa.eu/news/new-wind-charter-and-national-wind-pledges-underline-ambition-wind-power-europe-2023-12-19_en

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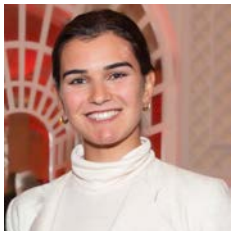

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