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ANAYAKOHA CHUKWUNONYE N.

NEW ENERGY GEOPOLITICS

GLOBAL TRADE AND MARKET TRANSFORMATIONS

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PREFACE

The chapters ahead examine the shifting landscape of global energy and trade, focusing on how these transformations are reshaping geopolitical dynamics and market structures. The first chapter explores the global energy transition, highlighting its profound impact on power relations, resource control, and strategic alliances in the emerging energy order.

The subsequent chapters turn to the evolving global trade system, analyzing its influence on energy markets from multiple angles. Repeated for emphasis and depth, these chapters unpack the interplay between trade liberalization, supply chain disruptions, and energy pricing, offering a layered understanding of how trade reforms and tensions reverberate across energy sectors.

Together, these chapters provide a timely and critical perspective on the interconnectedness of energy and trade in a rapidly changing world, equipping readers with insights into the forces driving future policy and market developments.

Editorial Team
November 12, 2025
Türkiye

CHAPTER 1
GLOBAL ENERGY TRANSFORMATION AND ITS EFFECTS ON NEW ENERGY GEOPOLITICS

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INTRODUCTION

For a century, international energy relations have been dominated by fossil fuels, whilst energy geopolitics has had a great deal of influence over how we frame these relations. More recently, however, a global energy system transformation (GEST) has commenced, which forces us to reckon with what is too often downplayed: the contingent, conflictual, socially produced character of the global energy system.

It is precisely because of this that so much is at stake. On the one hand, greenhouse gas (GHG) emissions reductions are a key characteristic of the GEST: countries responsible for over 88% of global emissions have committed to net zero GHG emissions (Zero Tracker Citation2024), and renewable energy has started to scale at pace, with some now projecting a peak in oil demand by 2030. On the other hand, the world still derives over 80% of its energy from fossil fuels, and the threat of catastrophically over-shooting the Paris Agreement is palpable. Visions of the transition reflect this discrepancy, offering different accounts of the pace, scope, technologies, and socio-political forms of change (Bazilian et al. Citation2019; BP Citation2022; IEA Citation2021; Newell Citation2019; Shell Citation2021; Sovacool Citation2016). The GEST opens out into many, competing futures.

Attempts to reduce global emissions are now taking place in an era of multiple crises, amidst frequently competing priorities of energy security, affordability, and economic development, and as the physical effects of climate change continue to bite. The 2022 energy crises, resulting largely from Russia's war on Ukraine, highlight these tensions within the GEST. European governments have responded with a mix of newly-ambitious renewable targets and an expansion of fossil fuel exploration and import infrastructure, as they have negotiated between the short-term exigencies of energy security and the long-term imperative of decarbonisation. In Asia difficulties in accessing Liquid Natural Gas (LNG), in part due to the EU's scramble for gas to replace Russian imports, have caused energy affordability crises and a switch back to coal for electricity generation (Kuzemko et al. 2022). The current energy crisis highlights how geopolitics can create pressures to both decelerate and accelerate the transition (Blondeel *et al.*, 2024). In this paper we stage a thematic and theoretical re-orientation of energy geopolitics.

We rethink each of the constituent elements of ‘energy geo-politics’, energy, geography, and politics, to make sense of the reality of the *transformation* of the global energy system – its drivers, contradictions, and contingencies. This necessitates breaking from purely ‘realist’ and ‘geotechnic’ understandings of energy geopolitics, and offering a constructivist alternative capable of understanding the active and changing social production of energy materialities, geographies and political economies over time.

This also allows us to better encompass the complexity and interconnections between these three areas. Our aim is to reorient the direction of the field of energy geopolitics towards, rather than offer a final account of, the GEST. The provisional framework we offer here is conceived in this spirit; it is intended to be suggestive, not exhaustive, and to spur a wide process of rethinking.

The paper proceeds as follows. In section two we set out the starting coordinates of this re-orientation by articulating a critique of existing approaches to energy geopolitics. In section three we draw from disparate literatures, ranging from energy geography, to socio-technical transitions, to international political economy (IPE), to rethink each element of ‘energy geo-politics’.

In section four we work through all three dimensions of this approach in relation to two case studies, the role of fossil gas as a ‘bridge’ fuel, and electrochemical energy storage – both focal points of the GEST. In the conclusion we briefly explore some of the conceptual, empirical and policy implications of our attempt to reorientate energy geopolitics.

1. A CRITICAL REVIEW OF ENERGY GEOPOLITICS

Is energy geopolitics equal to the challenge of understanding this tension-riddled global transformation? Despite the field’s multifarious insights, we think not. In order to see why, it is necessary to say something about the field of ‘geopolitics’ as such, and the emergence of both ‘neo-classical’ approaches to energy geopolitics, and the fledgling field of renewable geopolitics. We use this brief history and critique as a foil for our own approach.

The original, or ‘classic’, tradition of geopolitics stretches from the fin de siècle to the end of the Second World War.

Proponents held in common the modernist goal of creating a scientific macro-mapping of the world to guide their nations in an era of inter-imperial conflict, as well as certain ideas: like social Darwinism, geographical determinism, and moral relativism (Criekemans 2022; Kearns 2009). But the perceived association of geopolitics with Nazism tainted the enterprise, at least outside of South America. This was largely on account of the Bavarian geopolitical thinker Karl Haushofer's relationship to the Nazi party, influence on the writing of *Mein Kampf*, and apologia for German revanchism, which met with sensational and exaggerated coverage in America's wartime press (Specter 2022, 50-67, 118-119; Barnes and Abrahamsson, 2015).

What followed? On the one hand, there is the afterglow of classical geopolitics. It was one of the cocktail of ingredients blended into the more palatable theory of 'realism', which came to dominate the post-war study of international relations in the United States (Specter 2022, 132–135, 203–205). The term 'geopolitics' was slowly re-popularised from the 1970s, most notably by Henry Kissinger, largely as shorthand for a realist-inspired vision of global power politics (Hepple 1986).

This loosely-defined body of thought is sometimes called 'neo-classical geopolitics' (Mamadouh Citation1998), a convention we follow. On the other hand, a constructivist school of 'critical geopolitics' emerged in the academy in the 1990s, investigating and problematising all spatialised representations of international politics, across theories, statecraft and popular media (Ashley 1987; Tuathail 1996; Tuathail and Agnew 1992).

Born of the 1973–74 OPEC oil crisis, energy geopolitics first emerged as a genre of neo-classical geopolitics (Bradshaw Citation2009; Conant and Gold Citation1978; Mitchell, Beck, and Grubb Citation1996; Odell Citation1974; Schlesinger Citation1979; Yergin Citation2012). Neo-classical authors tend to view the energy system from the vantage point of net energy importing Western states, and their interest in securing cross-border oil and gas supplies. While this focus on the fragility of internationally-traded oil and gas does have the salutary effect of emphasising the role of energy as the 'lifeblood' of modern economies, sustaining daily life and socio-economic development, it also occludes a great deal.

Among other things, we hear little about the downstream energy services and domestic policy driving demand, about land use change, society and environment, or about other sources of energy. Its politics fixate on the significance that asymmetries of fossil fuel trade and dependency have for interstate rivalry.

Its geographical vision foregrounds uneven resource endowments, critical waterways and transit routes. Often these geographical factors are taken as given, creating one-way causality where a reified geography conditions international politics, but not the other way round (a point emphasised by Blondeel et al. Citation2024). A focus on cross-border fossil fuel flows, a reified geography unilaterally conditioning international politics, and a fixation on state power politics: these are the limits of neo-classical energy geopolitics.

More recently, a literature on renewable energy geopolitics has emerged (IRENA Citation2019; O'Sullivan, Overland, and Sandalow Citation2017; Scholten Citation2018; Scholten et al. Citation2020; Vakulchuk, Overland, and Scholten Citation2020). Much of this work follows a common pattern.Footnote[3] It starts with the geotechnical features of a world powered by renewables, from which it then deduces constraints and opportunities binding on the future of international politics.

By juxtaposing this picture with a fossil-powered world, it is able to bring into relief the nature and scale of these predicted changes, as well as its beneficiaries and losers. We can, for example, deduce from the global dispersion and abundance of renewable resources that it will give rise to a less oligopolistic global energy trade. Or, from the techno-economics consequent to the efficiency losses per distance travelled of high-voltage electricity cables, that the benefits of interconnection will find an upper-limit at the level of regions, leading to bounded 'grid communities. Rich with insight, a major lesson to come out of this literature is that a fully renewable global energy system will likely be a less tension-ridden one.

But there are limits to renewable energy geopolitics, too. It, like neo-classical variants, tends to represent politics as a response to, or as an *outcome* of, fixed energy geographies and materialities, rather than as a *key social input* into how energy systems and geographies change.

Its synchronic analysis of a fully renewable system, held in static juxtaposition to a fossil-powered world, elides the global energy system *transformation* – a diachronic, unfolding process. It can only proffer predictions as to a renewable world in the distant future by focusing on those *necessary* features of it that can be deduced from the fixed geotechnical characteristics of renewables. Taken together, this means it systematically downplays the role of contingency, uncertainty and politics, and the dynamic process of social change that will lead to some *specific* renewable future. More prosaically, over the coming decades, it is the global energy system transformation, and not a fully renewable-powered world, that we will have navigate. The latter depends on the former's success.

Our aim in this paper is to re-orientate energy geopolitics to the challenge of transformation, by offering a provisional framework for understanding the GEST as a socially produced, conflictual and diachronic process. This requires, first, starting from the reality of the unfolding transformation, where low-carbon and high-carbon sub-systems intersect and compete, and where neither can therefore be understood independent of the other.

We need a 'whole systems' geopolitics reaching *across* high- and low-carbon subsystems, and *up and down* their entire supply chains. But, more substantively, it means taking seriously the *socially produced* character of the GEST. In saying this, we are not suggesting a voluntarism where human agency supersedes social structure, or an ontological idealism in which the physical world does not figure.

The point is a constructivist or historicist one. The global energy system does not have a determinate structure, it is not reducible to pre-given characteristics of geography, power politics, or techno-economics. Rather, it is contingent and open-ended because it is mediated by the contested social practices of specific historical contexts.

While we can speak of a certain distribution of fossil or renewable resources as conditioning geopolitics, for example, how these conditions emerge from and impact society, how actors understand and respond to them, and what their secondary effects are, reflect socio-political processes. The geopolitical economy of the energy system is not self-instantiating.

2. RE-ORIENTING ENERGY GEOPOLITICS

In this section, we build on the principal critiques of each aspect of energy geopolitics, outlined in “a critical review of energy geopolitics”, to rethink ‘energy’ and ‘geo-politics’. In doing so, we delineate a provisional geopolitical economy framework for approaching energy system transformation. We take a constructivist, inter-disciplinary approach that integrates insights from energy geography, socio-technical transitions, and international political economy. This process of re-orienting energy geopolitics necessarily involves big picture thinking within each of these three elements. This leaves abundant room for future scholarship to add to and complicate our account, including by attending to the meso- and micro-levels.

2.1 Foregrounding the Materialities of Energy

Neo-classical and renewable energy geopolitics both focus our attention on the importance of natural resources, where they are found and produced and how they are transported, to energy systems and politics, but leave other material and technological aspects of energy underdefined. Neo-classical energy geopolitics has tended to define the material aspects of energy in relation to fossil fuels, sometimes just oil, and their associated conversion and transport infrastructures (Jones Citation2016). Unsurprisingly, given that the emphasis has been on understanding existing production and consumption patterns and cross-border flows of energy resources, both energy and geography in neo-classical energy geopolitics are treated as ‘givens’ – the former is reduced to oil and gas, and the latter to a ‘static mosaic of inherited difference’ (Bridge et al. 2013).

Renewable energy geopolitics scholarship has typically focused on static comparisons of fossil-based and renewable-based systems, rather than attempting to get to grips with their simultaneous, interacting and dynamic roles in the GEST. But it is, nonetheless, rich with insight. It explicitly extends the definition of energy to include renewables, draws attention to the increasing importance of critical materials within renewable energy systems and highlights the growth of demand-side technologies and infrastructures such as storage (Criekemans Citation2018; Scholten Citation2018; Vakulchuk, Overland, and Scholten 2020).

Our conceptualisation of GEST continues this direction of travel by defining energy materialities to include a wider range of resources, technologies, and global production networks and supply chains to reflect better how energy systems are changing.

Further, although forms of energy, infrastructures, and technologies are deeply embedded within society today, making them seem fixed, we explicitly see energy materialities as constructed and maintained to meet socio-economic demands, and therefore open to active recreation (Geels Citation2005; Shove and Walker Citation2010; Stripple and Bulkeley Citation2019). For one, energy systems are changing because the extensive role of fossil fuels in (re)producing (the materiality) of lives, and generating rents and profits, is no longer socially tenable.

2.2 Complexity and Diversity in the Material Attributes of Energy

Centring the material attributes of energy systems, and emphasising their interdependencies and tensions, is a primary step towards revealing growing energy diversity and complexity. we see the global energy system as comprised of a wide-ranging array of interconnected, material attributes that together deliver energy services to society. This includes: primary and secondary energy resources; non-fuel material inputs; systems of energy conversion, including prime movers; transport infrastructures; household, commercial and industrial users; technologies for storing and harnessing energy; and GHG emissions. By including GHG emissions, non-fuel material inputs, and technologies for storage, we seek to emphasise just how important these attributes of energy systems have become.

This capacious understanding of the material basis of the energy system allows us to recognise the full gamut of its transformation as the world decarbonises. For example, not only are primary sources becoming increasingly diverse, now including oil, gas, coal, biomass, geothermal, wind, solar, hydro, and wave, but differences in their GHG emission attributes increasingly matter to their (continued) role in energy systems. The growing role of hydrogen as a secondary source is also significant, not least as it creates increasing complexities in the conversion of primary to secondary energy.

Non-fuel inputs, including manufacturing processes and material resources, are also diversifying, and becoming an increasingly significant aspect of energy systems.

Foregrounding the material attributes of energy helps us to see how primary resources do not equate to globally accessible energy services without the, now increasingly complex, material systems that sustain energy extraction, harnessing, processing, conversion, transport, and trade (Balmaceda et al. Citation2019; Scholten and Bosman Citation2016).

In short, the material qualities of energy systems matter and not only because of their high- or low-emissions potential: changes in one set of material attributes – such as substitution among primary resources – implies shifts in many other attributes of the energy system, including its sources, infrastructures, key sites, and spatial connectivity. Attention to the material qualities of energy systems, then, is a first step to examining the implications of energy system transformation for geographies and political economies.

One illustrative and important example is the ongoing shift from fuels as primary resources, defined by energy content, released by combustion, and consumed by use, to materials that harness ambient energy sources. This is important, in political economy terms, as these mineral-based materials are not valued by decision-makers in R&D, industry and policy for their energy content but for their technological capacities, and because they are not consumed by use, they can potentially be recovered, recycled, and reused.

During the global renewable electricity build-out phase there will be significant demand for minerals and metals, including many classifieds by governments as 'critical' given their importance in national economies and degree of import dependency. However, the life cycle and temporal profile of these materials are different to those of fossil fuels (and the fuel rods in nuclear energy) in important ways: minerals and metals can, if well designed, be reused multiple times so that they remain in circulation, as opposed to oil, coal and gas whose function as fuels is destroyed through use.

One implication of this is the emergence of a whole new political economy of materials associated with low-emissions systems which is not present in high-emissions, fossil-fuel heavy systems (Bridge and Faigen Citation2022).

This includes an emerging ‘circular economy’ of materials reuse and recycling and associated geopolitical efforts to capture and ‘territorialise’ these circular flows, for example the EU’s Circular Economy initiatives. These imply new international relations because of the fundamentally different character of e-tech materials versus fossil fuels and nuclear energy.

2.3 High- and Low-Emissions Energy

An equally important step towards centring the material complexity of energy is to see the global energy system as being made up of two distinct, connected and transitioning sub-systems, which we refer to simply as *high-* and *low-emissions*. Each of these sub-systems, in turn, can be further disaggregated into more sub-systems – such as gas, electricity, or electro-chemical storage.

This is a significant departure from neo-classical and renewable energy geopolitics as it means we are no longer analysing just one global energy system, i.e., an incumbent fossil fuel OR renewables-based system, but two major sub-systems competing and intersecting with one another.

There are important temporalities at work here, beyond questions of whether energy emissions can be reduced in time to meet global targets. The low-emissions energy system needs to be sufficiently developed, providing resilient, accessible, and affordable services, in time to replace high-emissions energy.

At the same time, material changes in the energy system have, thus far, been heavily concentrated in adding low-emissions technologies, but far less in decommissioning and disassembling the high-emissions system (Blondeel et al. Citation2021; Bridge Citation2018). As such, when considering the material attributes of energy, we see the high- and low-emissions systems co-existing for many decades to come – see Figure 1. Ultimately, given global GHG emissions reduction targets, the end point should be a low-emissions energy system.

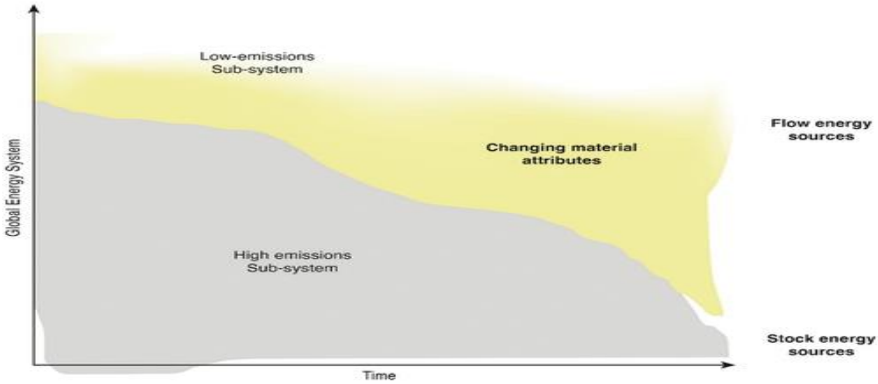

Figure 1. Changing material attributes of the global energy system.

2.4 Geography, Space & Scale

There are useful notions of space embedded within energy geopolitics, such as the strategic importance of location, geographical differences between fossil fuels and renewables, and the influence of physical geography on transportation routes (Scholten et al. Citation2020). For example, renewable energy geopolitics argues that the relative geographical ubiquity of renewable versus fossil fuel primary resources alters the basis for international energy relations (Overland Citation2019).

The range of renewable resources, combined with their wide distribution, means that most countries in the world will be able to produce some form or another (Criekemans Citation2018, 54–56). Geographical constraints still apply to renewables – certain locations, of course, have a relatively greater abundance of solar, wind, land (for biomass) or wave energy. Renewable energy geopolitics, then, begins to acknowledge the consequent spatial changes of renewables.

Thus far, however, the geography of energy geopolitics is understood rather narrowly – still emphasising resources, territory, states and borders. Research in the field of energy geographies has, however, begun to think more systematically about the re-working of space consequent to energy system transformation and provides a useful vantage point for rethinking geography in relation to energy and politics. Energy geography largely adopts a socio-technical, constructed view of energy system transformation.

To enrich the spatial repertoire of GEST further, we draw on this literature to outline four additional ideas – production of space, uneven development, scale/scaling, and power density. These help to reveal further geographical aspects of energy systems as they undergo transformation.

Neo-classical energy geopolitics acknowledges that energy geographies have implications for politics but offers few insights on how transformations in the way energy is captured, transformed, and consumed can also have far reaching geographical consequences. The emergence of new landscapes of, and possibilities for, energy generation associated with renewables vividly illustrates how energy transformation can re-work both place and space (Kuzemko Citation2019).

The closure and abandonment of facilities associated with fossil fuel production, transport and consumption, and parallel calls for 'just transitions', highlight the other pole of this creative-destructive process, and its capacity to marginalise places and communities within regional and national economies (Bridge and Gailing Citation2020; Bridge et al. Citation2013; Calvert Citation2016; Castán Broto and Baker Citation2018; Jiusto Citation2009; Nadai and van der Horst Citation2010).

2.4.1 Production of Space

Production of space, a first-order concept for much of human geography, expresses an important idea for understanding the geopolitical economy of the GEST. To describe space as 'produced' is to understand geography as a social product, an outworking of political-economic relations and, therefore, historically malleable and open-ended rather than fixed.

This contrasts with neoclassical energy geopolitics' understanding of space, which regards geography as a set of fixed dimensions and attributes, primarily those of physical geography, in which space is akin to a stage or container upon/within which energy systems unfold. The production of space is a valuable conceptual tool, given our task in this paper, because it centres very directly on how energy system transformation is a 'space making process' (Bridge and Gailing Citation2020, 2; see also Newell Citation2019).

The production of space offers a ‘post-Cartesian’ perspective, directing attention away from mapping ‘geographical consequences’ of energy (Bridge, Özkaynak, and Turhan Citation2018, 13).

This production of space is consistent with energy geography’s focus on understanding energy not only ‘as an economic asset or ecological phenomenon … (but) as a social relation’ (Calvert Citation2016, 110). Highlighting the produced character of space draws attention to the new geographies emerging from the GEST, such as the way low-emissions energy systems introduce new economic, cultural and political attachments to places that can radically transform their meaning and wider role. For example, the scaling up of battery electric vehicle production has substantially revised the meanings and global role of the Salar de Atacama (Chile) and Salar de Uyuni (Bolivia).

It has produced the space of the ‘Lithium Triangle’, as a target of largely foreign investment in extraction and processing, and as an object of state strategy in both countries (Forget and Bos Citation2022). Such places have consequently become sites of existential struggle for traditional land users (often not recognised as landowners) who value them for subsistence farming and their ecology, biodiversity and water rather than their lithium (Bustos-Gallardo, Bridge, and Prieto Citation2021). Here new productions of space intersect directly with new social and political contestations of low-emissions energy.

2.4.2 Uneven Development

The ‘uneven’ character of development builds on the production of space and alludes to the spatially variegated character of energy systems. This stubborn fact of geographical difference is characteristic of the ‘messy’ and contingent nature of the GEST. Rather than attribute this variegation to fixed or innate qualities, however, it focuses on how difference emerges and is reproduced over time. Work on uneven development thus highlights the tension and interplay between processes that tend to equalise conditions across space (such as the diffusion of technology or norms of consumption like thermal comfort), and those that actively differentiate it, including national territories differentiated by institutions, policies and norms (cf. Smith Citation2008).

Energy system transformation, then, may be a space-making process, but it is one also shaped by spatial and historical context (Bridge and Gailing Citation2020, 2). This is an important insight for GEST as it draws attention to how processes of transformation produce new regional winners and losers because of the way 'remnants of previous eras … are carried over and come into conflict with [the] new' (Brophy Citation2018), sometimes recreating existing power relations. In sum, the concept of uneven development allows us to see how geographic variation is inherent to the GEST and, moreover, how it arises through novel re-combinations of old and new shaped by geographical and historical context. The broader insight here is to move beyond accounts of emergent geographies of energy system transformation that stop at describing their spatial form and pattern, to explore how these new geographies reproduce or challenge existing distributions of political and economic power (Bridge and Gailing Citation2020).

2.4.3 Scale

Scale describes the material size and areal extent of phenomena and focuses our attention on hierarchies of *potential* organisational forms that characterise the material attributes, and politics, of energy systems (Bridge et al. Citation2013; Goldthau Citation2014; Kuzemko Citation2019). Scale, therefore, is a very useful concept for examining the claims and objectives of a socially produced energy system transformation, which is frequently characterised by normative claims about the technical, organisational, and geographical forms through which both supply and demand should be managed.

Such questions are particularly significant for renewable energy technologies as they can be deployed across a very wide range of material sizes. This is what Walker and Cass (Citation2007) termed the 'hypersizeability' of renewable energy hardware, as exemplified by the enormous variation in the diameter of wind turbine blades, from 1 metre to over 150 metres. Scale, then, is important for an analysis of GEST as it highlights political questions such as who is affected, who has a capacity for action, and where boundaries of responsibility may lie.

This question of scale features in several dominant narratives of energy system transformation, such as the need to ‘scale-up’ critical technologies (be it CCS or battery storage) or the potential for re-scaling traditionally large installations (such as small modular reactors for nuclear power generation). Scale here references both the installed capacity of such technologies and geographical reach of their deployment.

Energy geography and IPE scholars have drawn out the analytical value of spatial scale by exploring links between hierarchies of technical and geographical scales and the administrative scales at which these technical and geographical elements are governed. Work has shown, for example, how decentralised parts of the energy system – distributed supply, end use technology, and determinants of demand – can be marginalised in settings (like the UK) where energy policy makers operate predominantly at the national scale (Kuzemko et al. Citation2016; Newell and Johnstone Citation2018).

A tendency to treat decentralised actors as remote and unpredictable leads to a preference for ‘reliable’, centralised, supply side solutions, while ‘the centralisation of policy arguably … results in ineffective policy when the object of “delivery” is widely distributed’ (Bridge et al. Citation2013, 338; Eyre et al. Citation2010). Other scholarship has explored how small and medium scale renewable energy generation affects the geographies of energy systems (e.g., Scholl and Westphal Citation2017), a decentralisation that compresses the distances between primary energy sources, such as wind, conversion, electricity generation, and prime movers. This also affects the range of actors involved in sustainable energy to the extent that distributed renewables broadens out who can generate and who, for example, can become involved in active local trade and demand responses (Kuzemko Citation2019).

2.4.4 Power Density

Finally, the geographical concept of surface power density can help us to reflect on where some of the political tensions and points of control arise in the shift away from fossil fuels. Surface power density can tell us, for each primary energy source, the horizontal surface area needed to produce the same quantity of exploitable energy (Nøland et al. Citation2022; Smil Citation2015).

Renewable energy landscapes, as currently conceptualised, have power densities that are several orders of magnitude lower than resource landscapes associated with fossil fuel extraction and thermal power generation. This is because the latter rely on 'vertical', subterranean energy regimes that are, effectively, dense concentrations of solar energy accumulated over time and space (Huber and McCarthy Citation2017; Sieferle 2001).

As work in renewable energy geopolitics has begun to recognise, the logistics of energy capture and distribution for renewables are different to those of fossil fuel extraction and thermal power generation. Fossil fuel generation is based on: the control of highly concentrated energy forms, the transformation of energy into usable forms at very high-power densities and in a relatively small number of locations, and the centralised distribution of energy from those large facilities.

By contrast, energy strategies that target flow resources, like wind or solar, for electricity production require the co-ordination of multiple dispersed locations to manage their relatively low power densities and intermittency. This implies a growth in the number of energy resource landscapes, their potential overlay upon other land (or marine) uses, and the development of extended and new networked energy resource landscapes in which non-contiguous elements are nonetheless managed.

To the extent that renewables and electricity make up a greater share of energy, then, the GEST will involve a sharp uptick in the energy system's land requirements (Nøland et al. Citation2022). A low-emissions sub-system implies a '(re)turn to the surface' and, with it, potential for the intensification of the political economy of land ownership and control (Huber and McCarthy Citation2017).

This will involve fraught, conflict-ridden trade-offs between energy conversion, and a range of competing demands on land, including biodiversity and forestation, meat agriculture, crop agriculture, local populations, and urbanisation. It will also heighten the visual impact of power production, bringing all the familiar political dynamics of contested infrastructural development, including location choice, planning permissions, and environmental concerns.

At the same time, however, the lower power densities of renewables make it harder to replicate the level of control and excludability associated with concentrated fossil sources, potentially, increasing security of supply (Huber and McCarthy Citation2017).

Of course, not all renewable installations require land given that solar and wind can be placed on existing surfaces, such as rooftops, as part of infrastructural installations. Decisions to increase offshore wind replicate old energy norms of 'out of sight, out of mind' – but open up other environmental and spatial planning issues along with a need for extensive new transmission networks.

2.5 Politics as Political Economy

Both neo-classical and renewable energy geopolitics underplay the role of politics, and policy, in the social (re-)construction of energy system materialities and geographies.

Neo-classical energy geopolitics focuses on assessing the implications of energy geographies *for* international relations and/or state-level energy security (Bradshaw Citation2009; Hogselius Citation2019), whilst renewable energy geopolitics explores potential outcomes of renewables-based energy *for* patterns of cooperation and conflict between countries (Criekemans Citation2018; Overland Citation2019; Scholten Citation2018; Smith Stegen Citation2018; Vakulchuk, Overland, and Scholten Citation2020). We argue that politics, and policies, actively drive, constrain, and shape energy materialities and geographies.

We turn here to Paterson's (Citation2021) tri-fold conceptualisation of politics, as power relations, as arena for decision-making, and as inherently conflictual (Paterson Citation2021, 19–22), as a helpful framing device through which we can start to rethink the political aspect of the GEST.

This framing acknowledges the traditional interest within energy geopolitics in conflict and power relations between states – but places relatively greater emphasis both on the agency of policy, in particular climate change mitigation, and on economic interests and actors in shaping the nature of the GEST.

We adapt Paterson's conceptualisation, originally conceived to understand climate politics, to energy by incorporating insights from the political economy of sustainable energy transitions, particularly critical and constructivist perspectives (Kuzemko et al. Citation2016; Newell Citation2021; Roberts et al. Citation2018).

2.5.1 Politics as Power Relations

Power relations shape the overall direction of the GEST and how the benefits and costs of change are distributed (Paterson Citation2021, 20–21). In part, the GEST reflects struggles between coalitions of actors pursuing strategies *for* and *against* GHG emissions reduction (see Burke and Stephens Citation2018; Kuzemko et al. Citation2016). Those actively resisting tend to be those that need to change their practices, and therefore both stand to lose the most and can leverage their power as incumbents to resist and shape change.

Incumbent national (NOCs) and international oil and gas corporations (IOCs) continue to shape debates about, and delay, emissions reductions (Franta Citation2021; Newell Citation2021). The value and uneven distribution of fossil fuels means corporate and national fossil fuel actors have considerable capacities to influence energy and climate policy, bending markets, politics and geography to their interests (Colgan Citation2014; Mamadouh Citation1998; Vakulchuk, Overland, and Scholten Citation2020).

We deepen these explanations of power relations and incumbency by applying insights from research that places (fossil) energy systems at the heart of capitalism (Di Muzio Citation2015; Malm Citation2016; Mitchell Citation2011). IPE also emphasises the continued dominance of a broad range of elite factions of capital within global (energy) politics. This, like human geography's concept of uneven development, takes the politics of the GEST beyond matters of high versus low-emissions energy, to questions of *economic* incumbency and related questions of energy equity and justice (Bridge, Özkaynak, and Turhan Citation2018; Newell Citation2021). Recognising inter-dependencies between fossil fuels, finance, transport, and economic development extends the range of powerful actors with vested high-emissions interests.

Banks, investors, global transport incumbents, political groups funded by high-emissions interests, and others that enjoy, profit and/or generate a wage from high-emissions energy all potentially stand to lose out financially and/or socially from the GEST. Powerful financial actors continue to invest in high-emissions businesses and to shape who has access to finance for low-emission alternatives, with many developing countries facing prohibitive costs of capital (Newell Citation2021). This expands our understanding of actors involved in the GEST to incorporate the breadth and depth of high-emissions incumbency.

Too much emphasis here can, however, obscure significant changes within energy power dynamics, including recent growth in the political influence and economic power of coalitions seeking to reduce emissions. Climate change mitigation is a fast-growing policy arena, reflecting in part ever-more perilous warning signs of climate breakdown. Today 133 countries and 1,064 companies have adopted net zero emissions targets (Zero Tracker Citation2024).

Related shifts in energy power relations can be seen in: the emergence of a global clean-tech 'race' (Lachapelle, MacNeil, and Paterson Citation2017); the growth in influence of low emissions transnational networks, such as IRENA; the rise of sustainable finance and fossil fuel divestment campaigns (Blondeel Citation2019); and the diffusion of distributed energy resources (DER) that enable new forms of decentralised ownership (Brisbois Citation2020; Burke and Stephens Citation2018; Johnstone et al. Citation2021; Kuzemko Citation2019).

Indeed, the International Energy Agency (IEA) has become a leading global voice for low-emissions energy. The GEST is fashioned, then, by the overall direction of travel within struggles between elite factions fighting for against climate mitigation from diverse sectional interests.

This is not simply a matter of whether actors position themselves as pro or contra climate mitigation. What also matters is its sociological and organisational form, i.e., *how* emissions reduction happens. For example, in terms of struggles to shape low-emissions energy systems, some incumbent high-emissions actors have recently shifted from strategies based on resistance, towards efforts to actively shape and participate in emerging low-carbon energy systems by.

For example, championing 'technofixes' and calling for an 'orderly and secure' transition (Buller Citation2022, 73–85; Newell Citation2021; Stokes Citation2020). The ability of incumbents to shape the GEST in their interests has significant implications for the speed and scale of transitions, and for who benefits and who bears its costs.

2.5.2 Politics as Arena

Paterson conceptualises the arena of politics as formal and informal sites of collective and authoritative decision-making (Paterson Citation2021, 19). Energy policy decisions, designed to deliver an increasingly complex range of policy goals (Bridge, Özkaynak, and Turhan Citation2018), play a fundamental role in driving and conditioning the GEST.

Policies and rules shape markets, (re-)construct energy materialities, spatialities, and geographies, (re-)distribute authority and resources, and arbitrate between competing interests (Paterson Citation2021, 20). T

Increasingly, energy politics, directly or indirectly, is influenced by the norms agreed at UNFCCC conferences of the parties (COPs). Hard-won global climate mitigation norms, in turn, reflect difficult compromises made to facilitate consensus and political agreement. One such compromise was the accommodation of developing economies through the principle of 'Common but Differentiated Responsibilities'.

This recognises that states have different levels of responsibility for historic emissions and varying capacities to mitigate their emissions. It allows some high emitting countries like China, India and Indonesia to reach net zero later than advanced economies. This multi-speed timetable is an expression of uneven development in the arena of climate policy, and has been a long-standing axis of diplomatic wrangling.

Although built through successive compromises, global climate agreements have encouraged a series of energy emissions reduction policies at the national level (Death and Tobin Citation2017). In the other direction, domestic policies have international implications.

National solar PV support policies in a range of countries, particularly China and Germany, have contributed towards the widespread diffusion of solar PV, associated demand for panel manufacturing, and rapidly lowered the economic costs of PV uptake for other political actors (IEA Citation2016, Citation2022). This points towards a multi-level, multi-directional political economy of energy transformation.

Importantly, however, climate mitigation policies have impacts well beyond emissions reduction, which are important to consider given the extended timespan of the GEST and difficulties experienced in many parts of the world in keeping climate mitigation on energy agendas. Here we turn to the notion of 'policy feedback' effects, which emphasises the often broad and long-lasting socio-economic political effects of policy decisions (Béland and Schlager Citation2019; Lockwood Citation2016; Pierson Citation1993). Energy decarbonisation policies can have non-emissions effects that are *positive* for other public policy goals, in which case they create socio-economic co-benefits. For example, energy efficiency policies are not just good for climate mitigation, but for reducing fuel poverty, driving job creation, and strengthening energy security. Positive feedback effects can help legitimise climate mitigation and build supportive social constituencies, and embed low-emissions technologies and business models in the economy and help build pro-climate corporate interests (Jordon and Matt 2014; Lockwood 2013, 2016).

It is important, however, that the benefits of the GEST have so far been unevenly distributed, both between and within countries. Lachapelle, MacNeil, and Paterson (Citation2017) show that only a limited number of, mainly industrialised, countries have benefitted from the clean-tech race – influenced by access to patents and low-cost capital. Countries and companies with access to critical mineral reserves have the opportunity to benefit from rapid increases in global demand, but only if they can access the capital and expertise to develop these deposits. At the same time, the US Inflation Reduction Act and the EU's RePowerEU plan include policies to onshore aspects of low-emissions energy systems to reduce their global supply chain dependencies. It is not yet clear, then, what new power relations will emerge over access to unevenly distributed fixed resource inputs into low-emissions energy (Di Odoardo et al. 2022).

2.5.3 Politics as Conflictual

Energy geopolitics scholarship has long emphasised inter-state conflict over resources. Here, following Paterson (Citation2021, 20), conflict is taken as endemic to the GEST, but for an extended range of reasons. This is partly, building on the previous section, because climate mitigation has a wide range of socio-economic consequences, whose costs and benefits are unevenly distributed. Politics as an arena can sublimate and compromise between these differences, and how it does so is key to the politics of the GEST.

These are iterative processes, once decisions have been made and policies implemented, new conflicts arise. We highlight the dynamic and ongoing nature of GEST conflict through the notion of *negative* policy feed-back effects. Examples abound – from new land struggles as demand for non-fuel material inputs intensifies, to financial losses from stranded assets, to the potentially negative socio-economic implications of fossil fuel phase out. Many, amongst them the IPCC and IEA, argue that significant percentages of fossil fuel reserves must be kept in the ground to limit warming to 1.5°C – according to Welsby et al. (Citation2021), 65% of all oil and gas reserves. This could lead to an existential loss of economic and political advantage for some fossil fuel incumbents. The capacity of different actors to adapt and diversify ranges widely (Ivleva and Tänzler 2019).

Negative and uneven socio-economic outcomes emphasise arguments about the need for the GEST to become more equitable in the eyes of those countries, companies, workers, and shareholders who stand to lose out from emissions reduction (Heffron and McCauley Citation2018; Le Billon and Kristoffersen Citation2020; Newell and Mulvaney Citation2013). There has, as a result, been an increased tendency to craft policies, at domestic and regional levels, that address negative feedback effects – examples being the EU's 'Just Transitions' and 'Social Climate' funds. Political approaches taken to coal mine closures in Spain, and to coal-fired power generation phase-outs in Germany, demonstrate that objections from corporations and citizens experiencing negative effects of phase-out policies can be assuaged by political action (Healy and Barry Citation2017; Sanz-Hernández et al. Citation2020). This supports the notion of policy shaping the politics of the GEST over time, and specifically its ability to *pre-empt* and reduce potential conflict.

Fossil fuel phase-out lies at the heart of attempts to ensure that emissions reduction remains a core characteristic of the GEST. Yet there is no firm global agreement on oil and gas phase-out, and no mechanism to decide which reserves should stay in the ground (Le Billon and Kristoffersen Citation2020; Pye et al. Citation2020), notwithstanding the expansion of movements like Beyond Oil and Gas Alliance, and the emergence of the Fossil Fuel Non-Proliferation Treaty.

Meanwhile, some fossil fuel corporations have created scenarios that envisage 1.5°C compliant energy systems with significant levels of fossil fuels, especially gas, made possible through extensive use of unproven technologies (Blondeel et al. Citation2024). High gas scenarios have the potential to stoke conflict over the attenuation of low-emissions alternatives (Carton et al. Citation2023). Scenarios, technologies and policies that enable continued fossil fuel production can also perpetuate the geopolitical pathologies associated with the high-emissions energy system.

3. TWO ILLUSTRATIVE CASE STUDIES

In this section we use two case studies to elucidate the reoriented perspective on energy geopolitics that we have tried to develop in this paper thus far. We bring together the three areas we have explored, and show how their criss-crossing influence helps to make sense of concrete sub-sectors of the GEST as socially produced, diachronic, contingent, and contested.

It bears emphasising that we are not offering an explanatory theory, a set of nomothetic tendencies or propositional ‘if-then’ statements, which would be an exuberantly immodest task.

Indeed, to do so would threaten a return to the modernist confabulations of early twentieth century classical geopolitics. We are attempting to re-orient the thematic and theoretical outlook of energy geopolitics by rethinking its constituent elements in answer to the reality of the GEST, and against the foil of neo-classical and renewable energy geopolitics. In part by inserting constructivism into the heart of energy geopolitics. It is a framework for making sense of the GEST *as* a process of social transformation (see Figure 2).

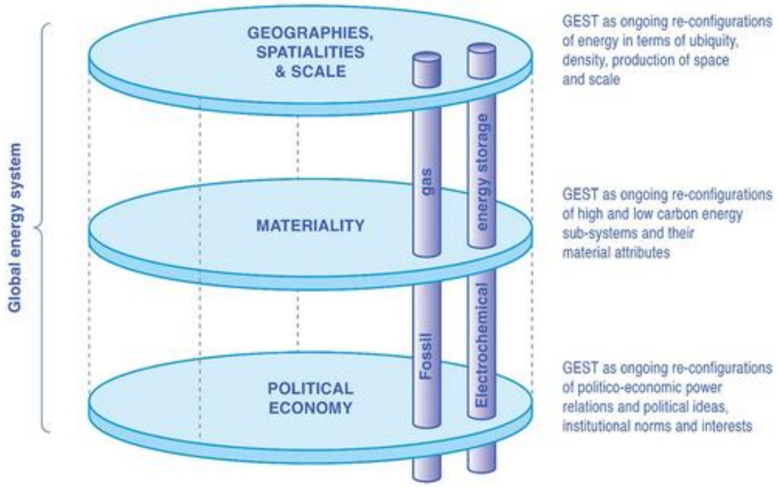

Figure 2. A geopolitical economy of global energy system transformation.

3.1 Fossil Gas

In this case study we look at the contested and uncertain role of fossil gas as a 'bridge fuel'. It has long been spoken of as a playing a 'bridging' role in the transition on the basis of claims that it has a lower carbon-intensity than coal (though upstream methane emissions complicate this), and can provide energy system functions to support renewables as they are progressively built-out (McGlade et al. Citation2018; Szabo Citation2022).

Gas-fired power plants can provide ballast to intermittent renewable electricity systems as a source of flexible generation, while residual fossil gas infrastructure can serve as a backstop of redundant import capacity. Hydrogen is also often assigned a large role in future low-carbon systems, as a form of long-duration storage, and as a source of high specific heat, crucial to the decarbonisation of 'hard-to-abate' sectors like shipping, heavy-goods vehicles and industrial heat processes (e.g., CCC Citation2023). Blue hydrogen, created with fossil gas using steam methane reformation and CCS to capture most of its emissions at the point of combustion, could represent a large share of hydrogen production during the transition when renewable output is too constrained to produce low-cost green hydrogen at scale. Yet CCS remains entirely unproven, and is shrouded in questions about its opportunity costs and social legitimacy (Storrs, Lyhne, and Drustrup Citation2023).

Blue hydrogen would leave upstream emissions intact and CCS has a mean capture rate of roughly 80% (Rosenow and Lowes Citation2021). It would also expose many countries to continuing gas supply risks. The fear, across these possible use cases, is that the fossil gas industry is lobbying to push the fuel from a temporary bridge across the transition, justified from exigency, to a permanent and desirable part of its end-state (Szabo Citation2022).

The global fossil gas system is therefore undergoing an open-ended process of transformation around synergies between the low- and high-carbon transition, where the scale and forms of its future role are mediated by socio-politics. Its makes for an exemplary case study for our approach, then. We look at how the uncertain role of fossil gas as a ‘bridge fuel’ is being shaped by two developments: the coming of age of the global LNG market, and the nascent hydrogen industry.

LNG involves supercooling natural gas to −163°C to increase its volumetric energy density six-hundred-fold, overcoming the diseconomies of space that prohibits the commercial transport of fossil gas by freight (Bradshaw and Boersma Citation2020; Bridge and Bradshaw Citation2017). This necessitates new capital-intensive coastal infrastructures for liquefication, shipping and regasification and storage.

By opening up seaborne trade, it unchains gas supplies from fixed pipeline routes, increases the scope of inter-regional arbitrage, and diversifies potential fossil gas suppliers. It rescales the fossil gas market from the regional to the global according to the uneven development of economic infrastructures and relations. The LNG trade has existed for almost 50 years, but over the past 15 years or so, the growth in LNG trade, in terms of geographic reach, volume and value, has been quite remarkable.

In the period 2005–2021, total trade in LNG grew by 264% (BP Citation2022), and by 2021 LNG accounted for 50.5% of all gas traded. While LNG trade has traditionally been conducted via long-term purchase agreements indexed against the price of oil, creating fixed point-to-point shipping, the scale of growth in global capacity and the emergence of less vertically integrated commercial arrangements, has facilitated the emergence of a short-term and spot trade. In 2023, 28% of all trade LNG volumes were on a spot basis, and 35% on a spot or short-term basis (GIIGNL Citation2023, 9).

LNG's reworking of spatial and organisational forms can helpfully be understood as a production network, a platform 'through which actors in different regional and national economies compete and cooperate for a greater share of value creation, transformation, and capture through geographically dispersed economic activity' (Coe and Yeung Citation2015, 30).

The development of an increasingly global seaborne trade in fossil gas, including a growing flexible market, has unsettled energy markets and tied importers and exporters into volatile market relations. Take the recent role of LNG in European energy geopolitics. In 2015 the Nord Stream 2 was announced, a subsea pipeline intended to connect Russia directly to Germany via the Baltic Sea. In 2016, the first LNG cargo left port in the US, the start of a rapid ramp-up in American export capacity. These two events set the coordinates for a triangular conflict over the terms of European gas imports. Declining European gas production, Germany's attempt to simultaneously phase out coal and nuclear power and its long-standing policy of *Ostpolitik*, and the technical and geopolitical risks of Ukraine as a transit route for Russian gas, initially motivated Nord Stream 2 (EPRS Citation2021; Jong Citation2023). Western European energy companies Engie, Shell, OMV, Wintershell and Uniper helped to finance the project, and together with Germany, Austria, Belgium, and the Netherlands, lobbied for its completion.

Yet the European Commission repeatedly tried to halt construction on legal grounds and publicly favoured LNG as a more secure alternative (EC Citation2016), while Eastern European member states – Czechia, Estonia, Hungary, Latvia, Poland, Slovakia, Romania, Lithuania – concerned about Russian influence and lost transit revenues objected to the project's 'destabilising geopolitical consequences' (Sytas Citation2016). When Poland received its first shipment of US LNG in 2017, Prime Minister Beata Szydlo declared it a historic occasion, and that Poland could finally say that it was 'a safe and sovereign country' (Scislowska Citation2017). In 2019 the US Congress passed 'Protecting Europe's Energy Security Act', introducing sanctions against companies involved in the construction of Nord Stream 2, later expanded in 2021, at the same time as the Trump administration promoted US LNG exports to Europe as 'freedom gas' (Jong Citation2023).

This was a consequential and multi-level conflict, involving infrastructure and energy companies, dissensus within the institutions and between the member states of the EU, and pitting the US and Russia into direct competition, developing around the new geographies of trade made possible by the materialities of LNG.

Russia's invasion of Ukraine, and the subsequent sabotage of the pipeline by unknown actors, terminated Nord Stream 2. Soon after Russia's invasion, the EU launched the REPowerEU plan, aiming to cut Russian gas imports by two-thirds by the end of 2022, and to phase them out completely by 2030 (EC Citation2022). The EU's diverging range of policy responses reflect the tensions and contingencies of the transition. REPowerEU turned to renewables as a redoubt against soaring gas prices, setting newly ambitious targets. But in the short-term US LNG filled the supply gap, with Germany and other member states constructing LNG import capacity, and signing long-term LNG supply contracts, endangering EU climate goals (GEM Citation2022). European demand for LNG saw the rechannelling of supplies away from emerging Asian economies dependent on spot LNG as a bridge away from coal, most notably Pakistan, Bangladesh and Vietnam, driving inequalities of crisis (Kuzemko et al. Citation2022).

What about hydrogen? Hydrogen is already produced and consumed at scale, with 95 MT combusted in 2022, almost all of it produced from gas ('grey hydrogen') or coal ('black hydrogen') (IEA Citation2023b, 20). But the viability of hydrogen as a technology of decarbonisation depends on the success of two principal alternatives, at a far greater scale. The renewable-powered electrolytic separation of hydrogen from water ('green hydrogen'), or the production of hydrogen with gas via steam methane reformation, using CCS to capture the majority of the emissions released ('blue hydrogen'). Yet, as of 2023, electrolytic hydrogen accounts for just 0.1% of global hydrogen production (IEA Citation2023b, 68), while there are just 47 operational CCS projects worldwide (IEA Citation2023a).

One of the defining features of the geopolitics of hydrogen, therefore, is uncertainty. Blue hydrogen's prospects are entwined with the economic, security and environmental credibility of fossil gas, and the viability of CCS with efficient capture rates (Rosenow and Lowes Citation2021).

Green hydrogen on whether renewable deployment can ramp-up quickly enough in the medium-term to power electrolysis at scale given competing demands on electricity grids, and the scale of future international hydrogen trade (CCC Citation2023). It also depends on electrolyser manufacturing capacity, and one of its two dominant technologies – proton exchange membrane electrolysers – require platinum and iridium, 'critical' minerals with tight and securitised supplies over the transition (Clapp, Zalitis, and Ryan Citation2023; Rasmussen et al. Citation2019). Hydrogen's future role in industry, space heating, energy storage, road transport, aviation, and shipping are subject to wind-ranging forecasts (Quarton et al. Citation2020).

The supply, technological and demand uncertainty afflicting hydrogen means its expansion depends on the ability of the state to superintend the sector and facilitate investment, development and security. What we see, therefore, are wide differences of approach mediated by politics. The UK has adopted a 'technology neutral' approach that ultimately subjects the future balance of green and blue hydrogen deployment to price competition (DESNZ Citation2023), for example, while the EU has set a decisive target to produce 10 mt/y of green hydrogen in the EU, and to import a further 10 mt/y from abroad (EC Citation2022).

In the US debate about tax subsidies for clean hydrogen under the Inflation Reduction Impact revolve around how to establish that the power used in the production of electrolytic hydrogen is attributable to renewable generation that is 'additional' to the existing grid (Hedreen Citation2024). In the EU it has centred on if and how to include nuclear-powered electrolytic hydrogen under renewable targets (EU Citation2023a), pitting a pro-nuclear France against an anti-nuclear Germany. Unlike Western states, South Korea has de-emphasised battery electric vehicles, and pursued a multi-decade industrial strategy to develop a world-leading hydrogen fuel cell vehicle industry (Yoo and Park Citation2023).

Hydrogen also risks augmenting existing fossil gas geographies. Hydrogen is similar enough to fossil gas that it could utilise existing or retrofitted gas infrastructure, although its lower volumetric density, and its embrittling, dissipative and explosive properties, mean this is still subject to trialling.

Given this potential interoperability, it is often argued that fossil gas or blue hydrogen infrastructure can be built as a stopgap in the transition and later converted to green hydrogen (CCC Citation2023). Thus, the German government has justified its build-out of LNG import capacity since the Russian invasion of Ukraine as a far-sighted strategy to support green hydrogen (Reed and Schuetze Citation2022). In the EU, a coalition of national gas network operators – 'EntsoG' – has been tightly linked to the development of the EU list of 'projects of common interest' entitled to financial assistance from the bloc, and under which dozens of hydrogen infrastructure proposals have found support (Maggiore Citation2020).

Similarly, transmission network operators in Europe have tried to piggyback on the European Hydrogen Backbone, even though 90% of all newly proposed pipelines are expected to, at least initially, transit gas or a blend of gas and hydrogen (GEM Citation2023, 15). This process of co-optation by the gas industry works to preserve otherwise defunct assets, repurposing old energy geographies for the transition, and leveraging the path-dependent hold of 'locked-in' infrastructures, regulations and markets (Unruh Citation2000).

3.2 Electrochemical Energy Storage: Lithium-Ion Batteries

The second illustrative case is that of lithium-ion batteries, which are an important energy storage solution in the context of expanding the role of (intermittent) renewables in electricity generation and decarbonising transportation. There are extensive renewable energy and electric vehicle (EV) support policies in place in many parts of the world – the EU's REPowerEU, for example, includes a raft of new policies to accelerate their deployment. These, and other emissions reduction policies aimed at the transportation sector, will result in significant demand destruction for oil.

At the same time, intermittent renewables and EVs depend on the availability of electrical energy storage. The rapid uptake of lithium-ion batteries in the context of commitments to emission reductions (primarily in the power generation and transportation sectors) highlights three significant aspects of GEST, each demonstrating the interaction of the material, geographic, and political-economic dimensions.

First, we highlight one material aspect of the shift away from fossil fuels towards renewably generated electricity and electrical energy storage that, while acknowledged in some critical scholarship (e.g. Huber and McCarthy Citation2017; Malm Citation2016), is currently under-emphasised in energy geopolitics.

Fossil 'fuels' are stock energy sources, that is, materials defined by their potential energy *content*, whilst renewables are flow sources that *harness ambient sources*, like sun, water, and wind (Blondeel et al. Citation2021).

Footnote[7] The intermittent nature of flow sources requires adapting energy systems, and electrochemical energy storage can help offset the intermittency of ambient flows (at grid scale) while also (at household scale) adjusting the rhythms of electricity demand. Rechargeable lithium-ion batteries exemplify the evolution of the electricity system towards renewable assets that 'harness, convert, store and use' energy from flow sources, rather than the linear 'extract, refine, store and consume' sequence associated with stock sources – see Figure 3 below.

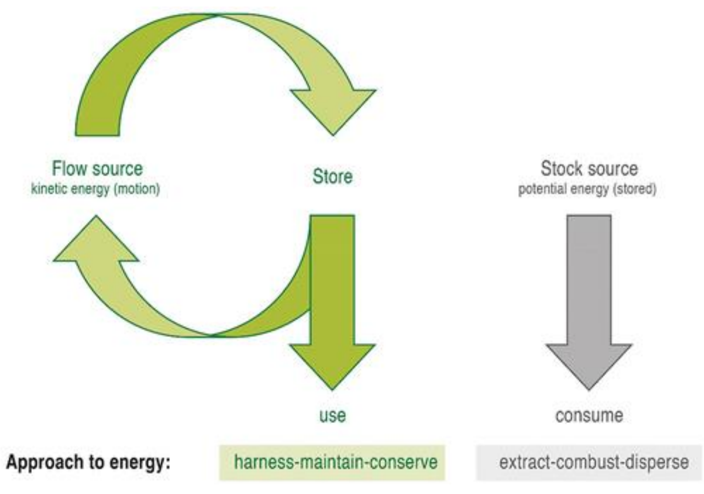

Figure 3. Flow & stock sources of energy.

What is more, the rapid uptake of lithium-ion batteries illustrates how the GEST is characterised by new products, business models and value chains that simultaneously disrupt markets while also reproducing existing relations of economic and political power.

The automotive sector illustrates this very well: lithium-ion battery production is currently tied closely to the performance needs of incumbent producers. As such, the geopolitical economy of energy storage is profoundly shaped by the geo-economic strategies of global automotive firms, states, and regions with significant automotive manufacturing capacity (Bridge and Faigen Citation2022).

The role of IOCs in rolling out EV charging is another example of these complex interconnections between high- and low-emissions systems, characteristic of the 'messy' process of energy system transformation. Shell, for example, has a significant role in direct current (DC) high performance charging across South-east Asia. This exemplifies the ability of large, incumbent corporations, and their interests, to shape the GEST through their involvement in clean energy technology roll out, thereby maintaining positions of political and economic power. These insights into the emergence of lithium-ion batteries as an increasingly important part of the energy system show how material changes within sub-systems can have competing tendencies: in this case, towards greater decentralisation, to the extent that batteries support the creation of micro-grids; and, simultaneously, the replication of large-scale oil, gas, and automotive incumbents.

The case of batteries illustrates the value of understanding the GEST as a messy process of transformation in which political decisions shape the nature of change, with significant material and geographic outcomes remaining unsettled. It also highlights each dimension of the geopolitical economy of energy and their convergence: the different material attributes of low-emissions energy technologies add a new significance to minerals, manufacturing and trade, drive novel energy geographies, while also reproducing some existing political-economic dependencies.

CONCLUSION

Our aim has been to re-orientate the study of energy geopolitics towards the global energy system transformation now taking place by rethinking each of its three constituent elements – energy, geography, and politics – along constructivist lines to capture the diachronic, conflictual and open-ended character of this process.

That means, substantively, engaging with the whole energy system comprising interacting material attributes across high- and low-carbon sub-systems, with the uneven social production of energy spaces across scales and densities, and with conflict-ridden struggle pitting contending power structures against one another and playing out across decision-making fora. We have tried to illustrate where this re-orientation might lead in two case studies, showing that the role of two core sectors of the GEST – fossil gas and lithium-ion batteries – are far more messy, complex and contingent that existing approaches to energy geopolitics allow for. This is what 'transformation' looks like, and it overflows the conceptual structure of cross-border fossil fuel competition among great powers, or geo-technical necessity.

At the start of this paper, we suggested that a defining characteristic of the GEST is decarbonisation. But we have given emphasis throughout to the fact that complex materialities, social relations of geography, and political economies of power and conflict, will shape how, where and at what pace emissions will be reduced. Which fossil fuels will be kept in the ground, how fast their low-carbon substitutes will be built and deployed, who will benefit and who will lose: these basic questions remain open, and it is essential for any geopolitical economy of energy today to recognise the indeterminacy of the present conjuncture brought about by the GEST. Yet, recognising and foregrounding this contingency also has a salutary effect. It presents us with a view of geopolitical energy relations as having the potential to drive more sustainable, and more just change, rather than as a constraint, or as something unfolding along pre-given tracks set by fixed attributes of geography, politics or the energy system.

We end by re-emphasising that we intend this paper to be a first step towards a geopolitical economy of GEST. Certainly, we make no claim to completeness or finality. We hope others bring their own perspectives, imagination and specialisms to this task of rethinking energy geopolitics. In this spirit, we want to highlight two important limitations to this paper. First, although we have disaggregated the GEST into two systems and recognised that beneath these there are many more sub-systems (like fossil gas and energy storage), each sub-system has discrete, changing materialities that we have not had the space to elaborate on here.

Secondly, we have taken the constituent elements of 'energy geo-politics' as our starting point, and have anchored our rethinking in this tradition. But the GEST strains against these conceptual limits. Other dimensions deserve attention, too, not least the role of nature and the environment – in particular land, water, and ecosystems. Our approach has skirted some of these questions, like the relationship between new inputs into energy systems, the reproduction of uneven geographies, and land use change. But there is much more to be done.

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CHAPTER 2
TRANSFORMATION OF THE GLOBAL TRADE SYSTEM AND ITS IMPACT ON ENERGY MARKETS

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INTRODUCTION

The global trade system is undergoing a fundamental transformation, marked by significant shifts in geopolitical alliances, climate policy commitments, technological innovation, and economic resilience strategies. These changes are not occurring in isolation but are deeply interconnected with the global energy landscape. As countries reassess their trade relationships and economic priorities in response to growing environmental concerns and geopolitical uncertainties, the ripple effects are being strongly felt in the energy sector. The once-stable patterns of global energy trade—dominated by fossil fuel exports from resource-rich nations to industrialized consumers—are now giving way to more diversified, regional, and sustainable energy exchanges.

One of the most critical drivers of this transformation is the global commitment to decarbonization and the urgent need to address climate change. International agreements like the Paris Accord and the rise of climate-conscious trade mechanisms such as Carbon Border Adjustment Mechanisms (CBAMs) are compelling countries to integrate environmental criteria into their trade and energy policies. As a result, countries that have traditionally relied on fossil fuel exports are facing declining demand, while those investing in renewable energy and clean technology are gaining a competitive advantage in the emerging green economy. Trade is no longer just about economic efficiency; it is also about environmental sustainability and strategic autonomy.

Geopolitical tensions, such as those between major powers or arising from resource-rich regions, further complicate the energy-trade nexus. The COVID-19 pandemic and the Russia–Ukraine conflict, for instance, exposed the vulnerabilities of over-globalized and centralized energy supply chains. These crises have accelerated the trend toward regionalization of trade and localization of energy production. Countries are increasingly investing in domestic renewable energy infrastructure—such as solar, wind, and hydrogen—to enhance their energy security and reduce exposure to global supply disruptions.

Technological innovation is another powerful force reshaping the global trade and energy interface. Digital technologies like blockchain, artificial intelligence, and smart grids are enabling real-time energy trading, greater supply chain transparency, and more efficient demand-response systems.

These advancements not only support the transition to clean energy but also redefine the rules of global commerce by enabling smaller and decentralized energy producers to participate in global markets.

Moreover, energy-intensive industries are under pressure to adapt. With trade regulations now factoring in carbon intensity, manufacturers in sectors such as steel, aluminum, cement, and chemicals must either innovate to reduce emissions or face trade barriers. The geographic location of industries is also shifting, often to regions with access to abundant clean energy sources or favorable regulatory frameworks, further altering traditional trade flows.

In this context, the transformation of the global trade system and its impact on energy markets is a dynamic and multifaceted process. It underscores the growing interdependence between trade policies, energy strategies, and climate objectives. Understanding this transformation is essential for policymakers, businesses, and international institutions seeking to navigate a future where energy resilience, sustainability, and economic competitiveness are inextricably linked. This paper explores how the evolving trade system is reshaping energy markets and what this means for the global transition toward a more sustainable and secure energy future.

1. GEOPOLITICAL REALIGNMENT AND ENERGY DEPENDENCIES

The ongoing geopolitical realignment across the globe is significantly reshaping traditional energy dependencies and redefining the contours of the global energy trade. As nations recalibrate their foreign policy and economic strategies in response to rising multipolar tensions, conflicts such as the Russia–Ukraine war and increasing U.S.–China competition have exposed the fragility of global energy supply chains. Energy-importing countries, particularly in Europe and Asia, have been compelled to diversify their sources of oil and gas, while simultaneously accelerating investments in renewable energy to reduce reliance on geopolitically sensitive regions. The strategic imperative for energy security is now driving nations to reassess long-standing partnerships and explore alliances based on resource access, political stability, and shared climate goals.

For instance, Europe's shift away from Russian gas has led to an increased focus on LNG imports from the U.S., Qatar, and African nations, while simultaneously boosting solar and wind capacity within its borders. Similarly, China's Belt and Road Initiative is increasingly emphasizing energy infrastructure development in regions like Central Asia, Africa, and Latin America to secure critical supplies and strategic influence. These shifts underscore the growing entanglement between energy policies and national security agendas, where energy is both a tool and a target of geopolitical leverage.

Moreover, countries rich in critical minerals required for clean energy technologies—such as lithium, cobalt, and rare earth elements—are emerging as new nodes of strategic interest, sparking a new form of resource diplomacy. The reconfiguration of energy dependencies also presents risks, as efforts to localize energy supplies and control key technologies may lead to trade fragmentation and increased competition for resources. In this context, geopolitical realignment is no longer just a matter of military or diplomatic strategy—it is central to shaping the global energy architecture. Nations are now navigating a complex landscape where the pursuit of energy autonomy, strategic resilience, and climate ambition must be balanced with the realities of interdependence and geopolitical volatility.

The 21st-century geopolitical landscape is undergoing a significant transformation, with direct and far-reaching implications for global energy dependencies. Traditional energy relationships—once characterized by stable, long-term oil and gas trade agreements between producing and consuming countries—are being challenged by evolving alliances, regional conflicts, and national security concerns. Events such as the Russia–Ukraine war, escalating U.S.–China tensions, and instability in the Middle East have exposed the vulnerability of over-centralized energy supply chains. In response, countries are rethinking their energy sourcing strategies, aiming to reduce reliance on a few dominant exporters and instead diversify both suppliers and energy types. For instance, Europe's efforts to wean itself off Russian gas have led to a surge in Liquefied Natural Gas (LNG) imports from the United States, Qatar, and African nations, alongside accelerated investments in renewable infrastructure such as offshore wind and solar.

Similarly, Asian economies are seeking to strengthen ties with energy-rich regions like the Middle East and Africa, while also boosting domestic clean energy capabilities. These shifts reflect a broader trend toward energy security and resilience, where geopolitical considerations are influencing not just the source, but also the nature, of energy traded.

Geopolitical realignment is also being shaped by the strategic importance of critical minerals used in clean energy technologies. Countries rich in lithium, cobalt, nickel, and rare earth elements—like Chile, the Democratic Republic of Congo, and Australia—are becoming central to the new energy geopolitics. Nations are entering into long-term trade agreements, launching strategic investments, and even forming alliances to secure access to these resources, which are essential for batteries, wind turbines, and solar panels. Meanwhile, emerging powers are using energy as a geopolitical tool—investing in infrastructure through initiatives like China's Belt and Road, or leveraging oil and gas supplies for political influence.

As a result, the global energy map is becoming more fragmented, with new alliances forming around shared strategic interests and climate goals. However, this diversification also brings challenges, including competition over resources, risks of new dependencies, and the potential for trade protectionism. In this evolving context, energy is no longer just an economic commodity—it is a geopolitical asset. Navigating this complex environment requires integrated strategies that account for security, sustainability, and diplomacy. The intersection of geopolitics and energy is now a defining force in global trade, influencing national policies, international relations, and the transition toward a more resilient and low-carbon energy future.

2. CLIMATE POLICIES AND CARBON BORDER MECHANISMS

Climate policies are increasingly shaping the global trade landscape, with profound implications for energy markets. As countries commit to ambitious climate goals under international frameworks such as the Paris Agreement, they are implementing stringent domestic regulations to reduce greenhouse gas emissions. These include carbon pricing, emissions trading systems, subsidies for clean energy, and mandates for energy efficiency.

However, when only some countries adopt such measures, it creates an uneven playing field, potentially disadvantaging industries in countries with strict climate policies. To address this imbalance and prevent "carbon leakage"—where businesses relocate to nations with laxer environmental rules—countries are introducing Carbon Border Adjustment Mechanisms (CBAMs). CBAMs are trade tools that impose carbon-related tariffs or levies on imported goods based on their carbon footprint. The European Union's CBAM, for example, targets emissions-intensive imports such as steel, aluminum, cement, fertilizers, and electricity, requiring importers to pay for the carbon embedded in these products if they originate from countries without equivalent climate policies. This incentivizes foreign producers to adopt cleaner technologies and align with global decarbonization efforts, while also protecting domestic industries from unfair competition.

These mechanisms are likely to expand globally, as other major economies explore similar tools. While CBAMs promote climate accountability, they also pose challenges—especially for developing countries that rely on carbon-intensive exports and may lack the resources to decarbonize quickly. This dynamic may lead to trade tensions, making international cooperation and support for low-carbon transitions essential.

In energy markets, CBAMs are accelerating the shift toward low-carbon sources, influencing investment decisions, production practices, and trade flows. Energy-intensive industries are under pressure to reduce emissions or face financial penalties at the border. As climate policies become more integrated with trade regulations, the alignment of global economic and environmental strategies is becoming a key driver of sustainable development and competitive advantage.

3. REGIONALISATION AND LOCAL ENERGY SECURITY STRATEGIES

The evolving global trade landscape is marked by a clear trend toward regionalisation, driven by geopolitical uncertainties, supply chain disruptions, and the urgent need for energy security.

In contrast to the previous era of globalization, where energy resources were traded globally through long and complex supply routes, countries are now focusing on strengthening local and regional energy systems to reduce vulnerability to external shocks. This shift has been particularly evident in the aftermath of the COVID-19 pandemic and the Russia–Ukraine war, which highlighted the risks of overdependence on imported fossil fuels and centralized supply chains. Regionalisation enables countries to leverage nearby energy resources, foster local innovation, and build resilient infrastructure that aligns with their specific climate, economic, and social contexts. For instance, the European Union is promoting cross-border energy cooperation through interconnected electricity grids and regional hydrogen corridors, while countries in Asia are developing regional LNG networks and solar alliances. Similarly, African nations are exploring regional power pools and shared renewable energy projects to enhance access and reliability. At the national level, local energy security strategies are gaining momentum. Governments are investing in renewable energy, such as solar, wind, hydro, and bioenergy, not only to meet climate targets but also to ensure long-term, stable energy supplies. Decentralized energy systems, such as microgrids and community-based power generation, further enhance resilience by reducing reliance on large-scale, centralized infrastructure. Additionally, policies supporting energy storage, grid modernization, and local manufacturing of clean energy technologies are being prioritized to bolster domestic capacities. These efforts reflect a strategic shift: energy is no longer just a tradable commodity but a critical asset for national stability and sovereignty. Together, Regionalisation and local energy strategies represent a foundational transformation toward self-reliant, climate-resilient energy systems that are better equipped to navigate future uncertainties.

4. RENEWABLE ENERGY AND GREEN TRADE GROWTH

The global shift toward renewable energy is emerging as a powerful driver of green trade growth, fundamentally altering traditional trade patterns and reshaping energy markets. As countries accelerate their transition to low-carbon economies, the demand for clean energy technologies—such as solar panels, wind turbines, green hydrogen, and energy storage systems—is surging.

This has given rise to a rapidly expanding international market for renewable energy components and services, creating new trade opportunities and fostering technological innovation across borders.

Green trade is not limited to the exchange of clean energy technologies. It also includes trade in environmentally sustainable goods and services, such as electric vehicles, energy-efficient appliances, and eco-friendly construction materials. Nations that are early adopters and producers of renewable technologies are positioning themselves as global leaders in green exports. For example, China dominates the global solar photovoltaic market, while European countries are leading in wind energy and hydrogen innovation. Meanwhile, developing countries with abundant renewable resources, such as sunlight, wind, and geothermal potential, are exploring green energy exports, especially in the form of green hydrogen and ammonia.

At the policy level, many governments are integrating climate goals into their trade strategies by offering incentives for clean energy exports and introducing green procurement standards. Trade agreements are increasingly including environmental clauses that promote renewable energy cooperation, technology transfer, and sustainability practices.

This green trade growth also enhances energy security, economic resilience, and job creation, especially in sectors aligned with sustainable development. However, the rapid rise of green trade poses challenges, including the need for fair access to clean technologies, harmonized standards, and the resolution of emerging trade disputes related to environmental regulations. Ultimately, renewable energy and green trade are becoming central pillars of the global economic transformation toward a climate-resilient, inclusive, and sustainable future.

5. TECHNOLOGY-DRIVEN STAGE IN ENERGY TRADE

The energy trade sector is entering a transformative, technology-driven stage, where digital innovations are enhancing efficiency, transparency, and sustainability in global energy markets. From production and distribution to trading and consumption, advanced technologies such as blockchain, artificial intelligence (AI), the Internet of Things (IoT), and smart grids are revolutionizing how energy is managed and traded across borders.

One of the most significant changes is the digitalization of energy trading platforms, allowing for real-time price discovery, automated transactions, and data-driven decision-making. Blockchain technology, for instance, enables secure, transparent, and tamper-proof energy trading by recording transactions on decentralized ledgers. This is particularly beneficial in decentralized renewable energy markets, where smaller producers—such as households or communities with solar panels—can sell excess electricity directly to consumers or the grid through peer-to-peer (P2P) energy trading systems.

AI and predictive analytics are also being used to forecast energy demand, optimize grid operations, and improve supply chain management. These technologies enhance the responsiveness of energy systems, reduce losses, and ensure reliability in both traditional and renewable energy sectors. Smart meters and IoT devices further enable real-time monitoring of energy use, helping consumers and producers make informed decisions and allowing utilities to balance supply and demand more efficiently.

Moreover, digital twin technology is being adopted to simulate and manage energy infrastructure, improving planning and maintenance while minimizing disruptions. In logistics, digital tools help optimize the transportation of energy commodities, reducing costs and emissions.

These innovations are not only increasing the speed and accuracy of energy trade but also supporting the integration of variable renewable energy sources into the grid. As technology continues to evolve, the energy trade is becoming more decentralized, democratized, and sustainable, paving the way for a smart, resilient, and low-carbon global energy ecosystem.

6. INDUSTRIAL ADAPTATION AND LOW-CARBON MANUFACTURING

The global push toward decarbonization and sustainable development is compelling industries to undergo significant adaptation, with a sharp focus on low-carbon manufacturing. Traditionally, sectors such as steel, cement, aluminum, chemicals, and heavy manufacturing have been among the largest emitters of greenhouse gases due to their energy-intensive processes and reliance on fossil fuels.

As international climate commitments tighten and trade policies begin incorporating carbon accountability—such as Carbon Border Adjustment Mechanisms (CBAMs)—industries are under increasing pressure to transform their production methods to reduce carbon footprints and maintain global competitiveness.

One of the key drivers of industrial adaptation is the integration of renewable energy into manufacturing operations. Industries are investing in solar, wind, biomass, and green hydrogen as cleaner alternatives to fossil fuels for powering plants and processes. For example, green hydrogen is gaining attention as a viable solution for decarbonizing high-temperature industrial processes in steelmaking and chemical production, which are difficult to electrify using conventional renewables. At the same time, electrification of equipment and machinery, powered by renewable sources, is being adopted to lower operational emissions.

Energy efficiency is another crucial area of focus. Companies are optimizing manufacturing processes through the use of advanced technologies such as automation, artificial intelligence (AI), and the Internet of Things (IoT) to monitor and control energy usage in real-time. Smart sensors and analytics help identify inefficiencies, reduce energy waste, and improve overall productivity. Additionally, circular economy practices, such as recycling materials, reusing industrial by-products, and designing for longevity, are being embedded into production cycles to minimize resource use and emissions.

Governments and international organizations are playing a critical role by offering incentives, regulatory frameworks, and technical support for industrial decarbonization. Carbon pricing, green public procurement, and low-carbon product labeling are helping create market demand for cleaner industrial goods. In parallel, environmental, social, and governance (ESG) standards are increasingly influencing investment decisions, encouraging firms to align with sustainability goals.

Supply chains are also undergoing transformation. Companies are working with suppliers to implement low-carbon sourcing, trace emissions across production cycles, and report sustainability metrics transparently.

This is particularly important in global trade, where environmental standards are becoming a condition for market access. Firms that fail to adapt risk losing access to key export markets and facing reputational damage.

Despite these advances, challenges remain. The high cost of clean technologies, lack of infrastructure for green energy, and uneven regulatory support across countries can slow the pace of industrial adaptation. Moreover, small and medium enterprises (SMEs) often lack the resources and expertise to transition to low-carbon models without targeted assistance.

In conclusion, industrial adaptation and the shift to low-carbon manufacturing are not just environmental imperatives—they are becoming essential for economic survival and global trade participation. As industries embrace cleaner technologies, energy efficiency, and circular practices, they contribute to a more sustainable industrial future that aligns with both climate goals and the evolving demands of green global markets.

7. SUPPLY CHAIN DIVERSIFICATION AND CRITICAL RESOURCES

In the context of energy transition and evolving global trade dynamics, supply chain diversification and secure access to critical resources have become strategic priorities for nations and industries alike. The shift toward renewable energy and low-carbon technologies has dramatically increased demand for certain raw materials—such as lithium, cobalt, nickel, graphite, and rare earth elements—which are essential for manufacturing batteries, solar panels, wind turbines, and electric vehicles. However, the supply of these critical resources is geographically concentrated, with a few countries controlling the majority of extraction and processing capabilities. This concentration poses significant risks, including geopolitical dependencies, export restrictions, market volatility, and potential supply disruptions due to political instability or trade disputes.

To mitigate these risks, governments and companies are adopting strategies to diversify supply chains, both geographically and technologically. This involves securing alternative sources through new mining projects in underexplored regions, establishing long-term trade partnerships, and investing in domestic capabilities for resource extraction, processing, and recycling.

For example, countries like Australia, Canada, and several African nations are becoming focal points for new critical mineral investments. At the same time, initiatives in Europe, the United States, and Japan aim to rebuild local supply chains for key materials and reduce reliance on dominant players like China.

Technological innovation also plays a key role in diversification. The development of substitute materials, improved resource efficiency, and advanced recycling technologies helps reduce pressure on primary resource extraction. Urban mining and circular economy models are increasingly being promoted to recover valuable materials from end-of-life products such as smartphones, EV batteries, and solar modules.

Moreover, supply chain transparency and traceability are being enhanced using blockchain and digital tracking systems, ensuring ethical sourcing and compliance with environmental and labor standards. This is particularly relevant in global energy markets, where the social and environmental footprint of raw material extraction can influence trade relationships and investor confidence.

In summary, supply chain diversification and critical resource security are foundational to a resilient, sustainable, and geopolitically stable energy future. Ensuring diversified, ethical, and reliable access to these inputs is not only a technical challenge but also a matter of national security, economic sovereignty, and climate ambition in the emerging green economy.

8. GLOBAL GOVERNANCE AND TRADE-ENERGY COORDINATION

The interdependence of global trade and energy systems necessitates robust international governance mechanisms to ensure coordinated, equitable, and sustainable development. As the world transitions to a low-carbon economy, aligning trade policies with energy goals has become a critical challenge—and opportunity—for global governance institutions. The complex nature of energy markets, influenced by geopolitics, environmental imperatives, and economic interests, requires cooperation across multiple levels of governance, including international organizations, regional bodies, and multilateral trade agreements.

Global institutions such as the World Trade Organization (WTO), International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and United Nations Framework Convention on Climate Change (UNFCCC) play vital roles in shaping policy coherence. The WTO, for instance, is increasingly called upon to address disputes related to carbon tariffs, clean energy subsidies, and environmental standards, all of which influence trade flows in the energy sector. Meanwhile, IRENA and IEA provide technical support, policy frameworks, and data to facilitate energy transition and cross-border cooperation.

One of the most pressing areas for governance is the coordination of carbon pricing mechanisms and the integration of Carbon Border Adjustment Mechanisms (CBAMs) into trade rules. Without harmonization, these measures risk becoming sources of conflict or protectionism, especially between developed and developing countries. Transparent, fair, and inclusive governance is essential to ensure that climate-related trade tools do not disadvantage poorer nations or restrict their access to clean technologies.

Global governance also plays a crucial role in promoting technology transfer, capacity building, and financial support to ensure that all countries, particularly those in the Global South, can participate in and benefit from the green economy. Multilateral development banks and climate funds are instrumental in bridging investment gaps and facilitating low-carbon infrastructure projects.

Furthermore, regional energy agreements—such as the European Energy Union, ASEAN Power Grid, and African Continental Free Trade Area—highlight the importance of sub-global cooperation in coordinating trade and energy development, especially in aligning infrastructure, regulations, and market standards.

In conclusion, effective global governance and trade-energy coordination are essential to managing the complexities of the energy transition. By fostering cooperation, reducing policy fragmentation, and ensuring fairness, global governance can guide the world toward a more secure, inclusive, and sustainable energy future.

CONCLUSION

The transformation of the global trade system is intricately linked to the evolving dynamics of the energy sector. As nations transition toward a more sustainable and low-carbon future, trade policies, energy strategies, and geopolitical alignments are being reshaped to reflect new economic and environmental realities. The shift is not merely about replacing fossil fuels with renewables—it involves a deep restructuring of supply chains, industrial processes, market regulations, and international cooperation frameworks.

A key feature of this transformation is the growing emphasis on energy security, regional resilience, and diversified supply chains, especially for critical minerals essential for renewable energy technologies. Countries are no longer viewing energy merely as a commodity but as a strategic asset that influences national stability, competitiveness, and sovereignty. The reconfiguration of energy flows—from centralized fossil fuel dependencies to decentralized, clean energy networks—is enhancing both environmental sustainability and economic adaptability.

At the same time, trade policies are becoming climate-sensitive. Mechanisms such as carbon border adjustments, green product standards, and environmental clauses in trade agreements are integrating climate accountability into global commerce. These measures are vital to leveling the playing field, reducing carbon leakage, and encouraging widespread adoption of low-carbon technologies. However, they also bring challenges of equity and fairness, particularly for developing countries that need financial and technological support to meet climate and trade demands.

Technological innovation is acting as a catalyst in this global shift—facilitating smarter, more efficient, and transparent energy trade through digital platforms, AI, blockchain, and smart grids. The future of energy trade will likely be more localized, automated, and digitally coordinated, with real-time monitoring and decentralized energy exchanges becoming commonplace.

In this context, global governance plays a vital role in ensuring that the transition is inclusive, coordinated, and aligned with shared climate goals. International institutions must support equitable access to clean energy, facilitate knowledge exchange, and mediate emerging trade frictions linked to environmental policies.

Ultimately, the transformation of the global trade system, driven by the imperatives of the energy transition, offers a unique opportunity to build a more resilient, inclusive, and climate-compatible global economy. Success will depend on the collective ability to harmonize trade, technology, and climate action in a balanced and forward-looking manner.

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CHAPTER 3
TRANSFORMATION OF THE GLOBAL TRADE SYSTEM AND ITS IMPACT ON ENERGY MARKETS

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INTRODUCTION

Trade is seen as the buying and selling of goods and services in a market. Trade can be done locally or internationally. Trade among nations has been growing rapidly, and most developing countries are actively trying to expand their trade. Global trade has more than doubled in the last three decades, with trade in developing countries tripling. Developing countries import many more goods and services than they once did in the early centuries, ranging from appliances to sophisticated machinery, they also export agricultural products, automobiles parts, clothing, computers, oil, minerals and other raw materials. Global trade has traditionally been a driver of economic growth, with energy playing a central role in powering industrial production, transportation, and services. However, the 21st century has witnessed pivotal changes in trade patterns driven by shifts in geopolitical power, technological innovation, environmental regulations, and disruptions such as the COVID-19 pandemic and the Russia-Ukraine conflict. These shifts have restructured supply chains and altered the dynamics of energy production and consumption.

Global trade serves as a cornerstone of economic growth and international cooperation. However, the structures, institutions, and dynamics that define global trade are not static. The evolution of the trade system reflects changes in political ideologies, technological capabilities, and socio-economic priorities. In recent years, new developments such as digital globalization, climate policies, and rising protectionism, have led to a significant transformation of the global trade landscape.

1. EVOLUTION OF THE GLOBAL TRADE SYSTEM

The global trade system has evolved significantly from ancient exchanges to the modern era of globalization, shaped by technological advancements, political shifts, and institutional developments. Key milestones include the rise of mercantilism during exploration, the post-World War II pushed for free trade, and the more recent digital age characterized by e-commerce and increased trade integration. Mercantilism, a dominant economic theory in 16th- 18th century Europe, emphasized national wealth and power through maximizing exports and minimizing imports, aiming for a favourable balance of trade.

This system encouraged the accumulation of precious metals like gold and silver, and the establishment of colonies to secure raw materials and markets.

Mercantilism was based on the principle that the world's wealth was static, and consequently, governments had to regulate trade to build their wealth and national power. Many European nations attempted to accumulate the largest possible share of that wealth by maximizing their exports and limiting their imports via tariffs.

1.1 Mercantilist Is Characterized by The Following

- **National Wealth as Power.** Mercantilists believed that a nation's wealth, measured by its holdings of precious metals, directly translated to its power and influence.
- **Favorable Balance of Trade:** The core principle was to export more goods than import, creating a trade surplus and bringing in gold and silver.
- **Government Intervention:** Mercantilist policies involved extensive government regulation of the economy, including tariffs, subsidies, and control over trade routes.
- **Colonialism:** Colonies were seen as essential for providing raw materials (like timber, cotton, and minerals) and serving as captive markets for the mother countries manufactured goods.
- **Protectionism:** Mercantilist nations often implemented protectionist measures, such as tariffs and import quotas, to shield domestic industries from foreign competition.

1.2 Liberalization and Globalization (1980s–2008)

The period from the 1980s to 2008, often referred to as the era of liberalization and globalization, witnessed significant shifts in global economic policy and integration. This period was characterized by the gradual removal of trade barriers, increased cross-border capital flows, and the rise of international economic cooperation. While proponents argued for increased growth and development, critics pointed to potential instability and inequality.

Trade liberalization, in the context of a transforming global trade system, can significantly impact energy markets by influencing energy prices, trade flows, and the adoption of renewable energy technologies. Increased trade can lead to greater energy efficiency, especially in regions with pilot free trade zones, and can also spur innovation and productivity in emerging economies. However, it can also present challenges for developing countries with weak industrial bases. Trade liberalization, under the World Trade Organization (WTO), refers to the process of reducing or removing barriers to international trade, aiming to foster free and fair trade among nations. This involves decreasing tariffs, quotas, and other restrictions that hinder the flow of goods and services across borders. The WTO, as the primary international body governing global trade, plays a crucial role in facilitating this process and promoting a rules-based trading system. During this period, trade liberalization under the WTO and regional agreements facilitated unprecedented global trade growth. Fossil fuels were the backbone of industrial economies, with major exporters like OPEC countries dominating energy supply chains.

Trade liberalization has the potential to reshape energy markets by influencing prices, trade flows, and the adoption of renewable energy. However, it is crucial to carefully consider the potential challenges and ensure that supportive policies are in place to maximize the benefits and minimize the negative consequences.

1.3 Impact of Trade Liberalization on Energy Markets

- **Reduced Barriers:** Trade liberalization, through the reduction of tariffs and other trade barriers, can lower the cost of energy imports, making them more competitive with domestic energy sources
- **Increased Competition:** Lower trade barriers can lead to increased competition in energy markets, potentially driving down prices for consumers and businesses.
- **Shifting Trade Patterns:** Trade liberalization can alter the flow of energy resources, with some countries becoming more reliant on imports while others may see increased exports of specific energy sources.

1.4 Disruptions in Trade System and Energy Markets in The Covid-19 Pandemic Era.

The COVID-19 pandemic triggered a series of profound shocks to both the global trade system and energy markets. Below are some of the key disruptions.

Severe Shipping and Logistics Bottlenecks

- **Port congestion & container shortages**: Localized outbreaks and uneven reopenings led to sudden surges in goods shipments, overwhelming major ports in Asia, North America and Europe. Containers piled up at docks or were mis-routed, creating multi-month delays.
- **Skyrocketing freight costs**: With vessel space at a premium, spot rates for e.g. sending a 40-ft container from Shanghai to Los Angeles rose by over 400% between late 2020 and mid-2021.
- **Labour shortages**: Illnesses, quarantines and social-distancing rules thinned the ranks of port workers, truck drivers and warehouse staff—further slowing cargo throughput.

Collapse and Rebound in Energy Demand

- **Oil demand shock & price crash**: Global lockdowns drove oil consumption down by roughly 30 million barrels per day in April 2020—leading Brent prices to fall nearly 70% and even briefly trade below zero on limited storage capacity.
- **Natural gas volatility**: In many markets, demand dipped as industrial and commercial activity stalled—contributing to lower spot-market prices, supply-side cutbacks, and even supplier insolvencies in Europe in 2021.
- **Renewables' relative resilience**: While overall power-sector demand fell, wind and solar generation proved relatively robust, briefly increasing their share of the energy mix as fossil-fuel plants were ramped down.

Policy and Production Adjustments

- **OPEC + production cuts & swings**: To balance an unprecedented demand collapse, OPEC + members agreed to historic output cuts (1.5 million bpd in March 2020), but quickly had to renegotiate as markets rebounded unevenly.
- **Strategic stock releases**: Some governments tapped their strategic reserves (e.g. U.S. SPR) to stabilize markets, while others-imposed export curbs on key commodities—adding new layers of uncertainty to trade flows.

2. DISRUPTIONS IN TRADE AND ENERGY AS A RESULT OF RUSSIA/UKRAINE WAR

The Russia–Ukraine war, which began in February 2022, caused major disruptions in both the global trade system and energy markets**,** with wide-ranging geopolitical and economic consequences. Below are key areas of disruptions:

Disruptions in the Energy System

- **In the Oil and Gas Supply Shocks:** Russia supplied over 40% of Europe's natural gas before the war. The war led to sharp reductions in Russian exports, especially via Nord Stream pipelines, forcing Europe to seek alternatives. Also, gas and oil prices surged globally in 2022. European gas prices reached more than 10 times the average 2020 level, while Brent crude exceeded $120 per barrel mid-2022. Europe therefore, made efforts in diversification rapidly by shifted to LNG imports from the United States, Qatar, and others, investing in new terminals and infrastructure.
- **Energy Security Concerns**: In this area, countries prioritized energy independence and strategic reserves**,** rethinking reliance on single sources (especially Russian energy). There was also the resurgence of coal where some countries restarted coal-fired plants to bridge the energy gap, impacting climate goals.

- **Disruption in Nuclear and Electricity Supply**: Ukraine's nuclear power stations (e.g., Zaporizhzhia) were caught in conflict zones, raising global safety concerns and potential supply risks.

Disruption of Global Trade System

- **Commodity and Grain Trade Blockages**: Ukraine and Russia as global breadbaskets reduced in the exportation of global wheat and significant shares of maize, barley, and sunflower oil. Ukrainian Black Sea ports like Odesa were blockaded or mined, halting exports for months. There was global food crisis in countries like Africa and the Middle East which were heavily reliant on these imports, faced food insecurity and inflation.
- **Supply Chain Disruptions:** Russia and Belarus are key fertilizer exporters. Sanctions and war disrupted global supply, raising prices and threatening agricultural productivity worldwide. Also, Ukraine and Russia export critical metals like nickel, palladium, and titanium for important automotive, aerospace, and electronics were affected.

Trade System and Impact on Energy Markets

- **Shift from Globalization to Regionalization:** The rise of regional trade agreements (e.g., USMCA, RCEP, AfCFTA) reduces dependence on distant energy suppliers, promoting regional energy integration (e.g., EU energy market). For instance, Europe's effort to diversify away from Russian gas post-Ukraine war has accelerated regional LNG imports and renewable energy cooperation. The transformation of global trade is reshaping the landscape of energy production, distribution, and consumption. Energy is not only a traded commodity but also a key input into global manufacturing and logistics. As global trade becomes more fragmented, localized, and digitally driven, the energy sector must adapt to shifting trade routes, new policy environments, and changing technological standards.
- **Rise of Protectionism and Energy Nationalism:** Protectionist trade policies disrupt global energy supply chains, especially in oil, gas, and clean energy components (e.g., solar panels, batteries).

Example is United States tariffs on Chinese solar panels and India's push for domestic solar manufacturing reflect growing energy nationalism**.**

- **Technological Change and Digital Trade:** Technologies like block chain, AI, and IoT enhance transparency and efficiency in energy trading, grid management, and carbon tracking. Example**:** Energy trading platforms now leverage real-time data analytics and smart contracts for faster and more secure transactions.
- **Energy Security and Strategic Stockpiling:** Countries increasingly stockpile energy reserves and invest in local capacity to reduce reliance on volatile global markets. Example is China and India have expanded their strategic petroleum reserves to buffer against global supply shocks.
- **Green Trade and Decarbonization:** Environmental clauses in trade deals (e.g., EU CBAM – Carbon Border Adjustment Mechanism) affect fossil fuel exporters and boost renewable energy investments. Example**s** Oil-dependent economies face long-term risk as importers impose carbon tariffs or shift to clean energy sources.

Benefits of Global Trade in Energy Resources and Technology

Some of the major advantages of Global trade in energy resources and technology **on** economic, environmental, and strategic benefits to nations and industries are as follows:

- **Accelerated Technology Transfer and Innovation:** Trade enables the global distribution of advanced energy technologies like solar panels, wind turbines. As energy technologies are adopted, local industries gain expertise and develop capacity.
- **Economic Growth and Job Creation:** Resource-rich countries (e.g., Saudi Arabia, Norway and Nigeria) benefit economically from exporting oil, gas, or renewable electricity. Countries leading in energy innovation (e.g., Germany in solar, the U.S. in LNG, China in wind/solar tech) boost their economies through global sales. Energy trade supports millions of jobs in exploration, extraction, refining, transport, manufacturing, and installation.
- **Reduction of Regional Energy Imbalances:** Countries with surplus energy (e.g., Qatar in LNG, Canada in hydropower) can help meet the

needs of energy-deficit regions (e.g., Sub-Saharan Africa, parts of Europe), thereby balancing global supply and demand, it also Energy trade contributes to global market stability, helping to smooth out price volatility and improve resilience

- **Acceleration of the Energy Transition:** Developing countries can access clean energy systems via trade, accelerating decarbonization even in regions without domestic technical development capacity. Trade enables economies of scale, reducing costs of clean energy systems (e.g., solar panels became cheaper partly due to mass production in China and global distribution).

Digitalization and Technological Disruption

Digitalization and technological disruption are central forces reshaping the global trade system in the 21st century. As traditional models of international trade give way to digitized, data-driven ecosystems, technologies such as artificial intelligence (AI), block chain, cloud computing, and the Internet of Things (IoT) are transforming the way goods, services, and capital flow across borders. This shift has not only enhanced efficiency and connectivity but also introduced new challenges around regulation, cyber security, and digital inequality.

Technological advances, including block chain, AI, and IoT, have revolutionized trade logistics, increasing transparency and efficiency. In the energy sector, digital technologies optimize energy grids, forecast demand, and facilitate smart contracts in energy trading.

3. ENERGY MARKET DYNAMICS IN A CHANGING TRADE LANDSCAPE

- **Shift from Fossil Fuels to Renewables:** Global decarbonization efforts, driven by the Paris Agreement and national policies, are reducing reliance on oil and coal, affecting exporters like Nigeria, Venezuela, and Russia. Countries are investing in renewables to mitigate trade and energy insecurities.
- **Supply Chain Resilience and Energy Security:** Disruptions in global trade (e.g., Suez Canal blockage, Russia-Ukraine war) highlighted the

need for resilient supply chains. Many nations now prioritize local or regional energy sources, impacting global energy trade routes and pricing.

- **Regionalization of Energy Trade:** There is growing trade in electricity and hydrogen within regional blocs (e.g., EU, ASEAN), reducing the dominance of traditional fossil-fuel-exporting regions.

Implications For Global Decarbonization Shift in Energy Markets

The global shift toward decarbonization (reducing greenhouse gas emissions to combat climate change) has profound implications for energy markets. This transition affects supply chains, investment flows, national policies, trade dynamics, and energy prices, thereby creating both opportunities and challenges. Below are the implications:

- **Short-term Instability:** As energy systems shift, transitional imbalances in supply and demand (e.g., underinvestment in oil before full renewable capacity is ready) can lead to price spikes and volatility.
- **Climate and Environmental Benefits:** Significant reduction in air pollution and GHG emissions improves public health and environmental sustainability. Enhanced energy efficiency and technological innovation support more sustainable consumption patterns.
- **Decline in Fossil Fuel Demand:** Global policies and climate agreements (e.g., the Paris Agreement) are pushing for reduced oil, coal, and natural gas consumption. Long-term demand for coal is expected to drop sharply, followed by oil and eventually gas.
- **Decline in Petrostates' Influence:** Countries heavily reliant on oil and gas exports (e.g., Russia, Nigeria, Saudi Arabia) face revenue losses and must diversify their economies or shift toward low-carbon exports.

4. THE NEXUS BETWEEN TRADE AND ENERGY

Understanding the nexus between trade and energy is vital in a globalized and energy-constrained world. As energy systems undergo transitions toward sustainability and resilience, trade will remain a crucial facilitator of access, innovation, and strategic alignment. Therefore, the intersection of trade and energy plays a critical role in the global economy. International trade facilitates the flow of energy resources—such as oil, gas, coal, and increasingly, renewables—across borders, enabling countries to meet their energy needs, support industrial production, and fuel economic growth. Conversely, energy is essential for powering trade-related infrastructure and activities, including manufacturing, transportation, and digital networks.

- **Trade as a Channel for Energy Distribution:** Energy commodities, particularly fossil fuels, have historically dominated global trade flows. The ability to import and export energy allows countries to diversify their energy mix, enhance security, and leverage comparative advantages. For example, oil exports from the Middle East power manufacturing economies in Asia, while natural gas exports from the United States and Russia shape regional geopolitics (IEA, 2023). LNG (liquefied natural gas) trade has expanded global energy interdependence by making it easier to ship natural gas over long distances (BP Energy Outlook, 2023).
- **Energy as a Driver of Trade Competitiveness:** Energy access and costs are central to a country's trade competitiveness. Low-cost and reliable energy supplies boost productivity and lower the cost of exports. Countries with abundant and cheap energy (e.g., Qatar, Norway) often enjoy trade surpluses due to energy exports. Also, high energy prices can increase the cost of production and shipping, reducing export competitiveness (World Bank, 2020).
- **Decarbonization and the Green Trade Transition:** The shift toward renewable energy and low-carbon technologies is transforming the nature of global trade. Countries are increasingly trading clean energy technologies such as solar panels, wind turbines, and electric vehicles (UNCTAD, 2022). Trade policies are evolving to include carbon border taxes and green supply chain standards (OECD, 2022).

- **Geopolitics and Energy Trade Dependencies:** Energy trade dependencies can influence international relations and trigger conflicts or alliances. The Russia–Ukraine war highlighted Europe's reliance on Russian gas and its consequences for energy security and trade shifts (IEA, 2022). Energy-exporting nations often wield strategic influence in trade negotiations and diplomacy (Ghosh, 2021).

CONCLUSION

The transformation of the global trade system is linked to the evolution of global energy markets. As nations balance economic growth, energy security, and environmental sustainability, the structure and flow of energy trade will continue to evolve. A proactive policy approach that integrates trade, energy, and climate strategies is essential for managing the complex interdependencies of the modern global economy. The Russia–Ukraine war fundamentally disrupted global energy and trade flows. Although, it exposed the vulnerabilities of interconnected systems and accelerated efforts to diversify supply chains, increase resilience, and transition to renewable energy sources. However, it also intensified geopolitical divides and economic uncertainty across the globe.

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CHAPTER 4
TRANSFORMATION OF THE GLOBAL TRADE SYSTEM AND ITS IMPACT ON ENERGY MARKETS

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INTRODUCTION

Energy markets have been significantly impacted by the way the global trade system has changed in recent decades, changing the political, economic, and environmental landscapes worldwide. Globalisation, technological advancement, regional integration, and changing geopolitical alliances have all contributed to the evolution of the global trade framework from a largely Western-centric model to one that is more multipolar and includes emerging economies, especially those in Asia, Latin America, and Africa. In addition to redefining investment and trade patterns, this shift has created intricate interdependencies and vulnerabilities within the global energy system.

The volume and speed of trade transactions have increased due to trade liberalisation, the growth of digital platforms, and the proliferation of bilateral and multilateral trade agreements. Concurrently, the Belt and Road Initiative and China's ascent to prominence in global manufacturing have fundamentally changed the conventional East-West trade axis, creating new infrastructure corridors and energy demand centres. Global energy pricing and supply chains are now more volatile and uncertain as a result of trade disputes, sanctions, and tariff wars, particularly those involving significant energy producers and consumers.

Countries are being prompted to reevaluate their reliance on fossil fuels and invest in renewable alternatives as a result of these changes, which also coincide with a rising global consensus on climate change and a drive towards sustainable energy practices. Thus, traditional demand-driven growth and sustainability-driven disruption are interacting in a dynamic way in the energy markets.

Countries are rearranging their import-export balances, investing in energy-efficient technology, and diversifying their energy sources in an effort to lower geopolitical risks as energy security becomes a more strategic concern. Furthermore, a significant regulatory factor affecting the competitiveness of energy-intensive exports is the decarbonisation of trade, which is exemplified by carbon border fees, green certification programs, and tariffs related to climate change. As a result, many emerging countries are having to balance meeting their internal growth and energy needs with adjusting to more stringent trade regulations.

The necessity of increased resilience, regional self-reliance, and sustainable energy transitions has been brought to light by these crises. Furthermore, energy commodity trading is becoming more transparent and efficient due to the digitalisation of trade—through blockchain, artificial intelligence, and smart contracts—which is improving risk management, demand forecasting, and pricing. But, especially in developing and transitioning economies, these technological changes also call for significant investment, regulatory harmonisation, and cybersecurity frameworks.

In order to harmonise trade and energy policies and to facilitate collaborative strategies to address global energy challenges, organisations like the World Trade Organisation (WTO), International Energy Agency (IEA), and regional trade blocs like the European Union (EU) and ASEAN are playing an increasingly significant role. Energy considerations must now be incorporated into trade strategies and vice versa in this changing environment.

To be relevant in a world that is decarbonising, energy-exporting countries must diversify their trading partners and invest in renewable energy infrastructure. Securing sustainable, reliable, and long-term energy sources is also essential for economic resilience in nations that import energy. Global trade's relationship to the energy sector will continue to be a crucial topic for investigation and policy intervention as it develops in the face of technical, political, and environmental developments. Formulating strategic responses that guarantee energy security, economic competitiveness, and environmental sustainability in the twenty-first century requires an understanding of this shift.

Table 1. Transformation of Global Trade and Energy Markets

Aspect	Previous Trends	Current/Transformed Trends	Impact on Energy Markets
Trade Geography	West-centric (U.S., EU dominated trade flows)	Eastward shift (Asia-Pacific as trade and demand center)	Increased energy exports to Asia; reorientation of supply chains toward China, India, ASEAN
Economic Power Centers	G7 nations driving global trade	Rise of China, India, and emerging economies in global trade	Changing demand patterns; increased bilateral energy agreements with Asia

Energy Demand	Concentrated in developed nations	Rapid growth in developing Asia	Surge in energy imports by Asia; diversification of suppliers
Energy Sources Traded	Oil and coal dominated	LNG and renewables expanding	Greater environmental compliance; more flexible supply chains
Technological Integration	Limited digital facilitation	Automation, AI, blockchain-enabled trade	Enhanced transparency, tracking, and efficiency in energy trading
Geopolitical Alliances	Stable Western alliances (NATO, EU)	Shifting alliances (BRICS, China-Russia, Indo-Pacific pacts)	Emergence of new energy corridors and security arrangements
Trade Policies	Push for liberalization and globalization	Mix of liberalization and new protectionism	Impact on energy tariffs, investment flows, and strategic reserves
Energy Transport Infrastructure	Pipeline and oil tanker-based	LNG terminals, undersea cables, and electricity grids expanding	Increase in cross-border electricity trade, LNG mobility, and resilience to disruptions
Renewable Energy Trade	Minimal cross-border trade	Growing trade in solar panels, batteries, critical minerals	Creation of green technology trade routes; new dependencies on raw materials
Climate & Sustainability Goals	Secondary to economic growth	Central to trade and investment decisions	Shift toward low-carbon energy sources; climate-aligned energy deals
Hydrocarbon Trade Flows	Middle East to West (U.S., EU)	Middle East, Russia, Africa to Asia	Energy diplomacy pivoting toward Asia-Pacific
LNG Trade	Limited to few countries	Widespread with flexible contracts	Growth in spot markets, price competitiveness, and supplier diversification

Global Supply Chain Strategy	Just-in-time, cost-driven	Resilience-focused, regionally diversified	Energy storage capacity rising; investment in domestic backup infrastructure
Energy Security Concerns	Reliance on OPEC and long-term oil contracts	Diversification, strategic reserves, green self-sufficiency	New policies for energy independence and transition to renewable security models
Key Players (New)	U.S., EU oil majors	China, India, ASEAN, Qatar, Australia (LNG), renewable tech exporters	New geopolitical dynamics in energy pricing, OPEC influence shifting

1. EVOLUTION OF THE GLOBAL TRADE SYSTEM

A complicated story spanning century, the development of the global trading system is characterised by turning points, changes in the balance of power, technical advancements, and an increase in the interdependence of states. In the past, trade started out as a small-scale interchange of products and services before growing into regional networks like the Indian Ocean trade routes and the Silk Road.

Geographical closeness, cross-cultural exchanges, and imperial aspirations all influenced these early commerce networks. However, the Age of Exploration in the 15th and 16th centuries, when European powers like Spain, Portugal, and later Britain, France, and the Netherlands established colonial trade networks that connected continents, marked the beginning of the modern global trade system. By moving goods like textiles, gold, spices, and later slaves, these early systems—which were highly extractive and frequently exploitative—established the groundwork for international trade.

A major turning point was the Industrial Revolution of the 18th and 19th centuries, which made mass production possible and necessitated access to new markets and raw materials. This resulted in a boom in international trade and the formalisation of global trade norms. Early trade agreements and the creation of international standards were prompted by the growing demand for free and open trade as economies industrialised.

As a result, organisations like the General Agreement on Tariffs and Trade (GATT), which aimed to lower trade barriers and advance multilateralism, were established in 1947. In 1995, GATT changed its name to the World Trade Organisation (WTO), a historic step that established international trade regulations, dispute settlement procedures, and a framework for talks. In keeping with a tendency towards both global and regional integration, regional economic blocs like the European Economic Community (now the European Union), the North American Free Trade Agreement (now the USMCA), and ASEAN also emerged in the post-World War II era.

Belief in the economic advantages of globalization—lower prices, wider markets, technology transfers, and access to a variety of resources—fueled these advancements. Thanks to developments in information technology, telecommunications, and transportation, globalisation reached previously unheard-of heights in the late 20th and early 21st centuries. Global value chains (GVCs), in which production was dispersed across several nations, emerged as a result of the removal of tariffs, the expansion of neoliberal economic policies, and the growth of multinational firms.

Businesses were able to access worldwide talent and resources, cut expenses, and increase efficiency as a result. A pivotal point in the history of trade was marked by China's 2001 WTO entrance, as the nation quickly transformed into the "world's factory," bringing billions of people into the global capitalist system and altering trading patterns. Similar to this, India became a significant player in the global services sector, particularly in IT and business process outsourcing, because to its liberalisation in the 1990s and quick technological advancement.

As a result of these changes, the global economic balance has changed, and emerging markets are now more powerful in trade talks and supply chain management. But the quick growth of international trade also brought disparities and weaknesses to light. Unfair benefit distribution, environmental damage, labour exploitation, and the decline of homegrown industries in industrialised nations became issues. The global financial crisis of 2008 served as a warning, exposing the vulnerability of excessively interwoven trade and financial networks.

The post-crisis era saw a change in feeling as populism, protectionism, and economic nationalism gained ground globally, even as trade rebounded. A major change towards inward-looking policies and a rebalancing of global trade tactics was signalled by the emergence of trade conflicts, including the U.S.–China trade war, Brexit, and a reexamination of multilateral trade accords. Innovation in technology has continued to influence the evolution of trade in novel ways.

The trade of products and services is changing as a result of the digital economy, which is defined by e-commerce, fintech, artificial intelligence, and blockchain. Even small businesses may now access international markets thanks to the expansion of digital trade, but it also brings with it new difficulties in the areas of taxation, cybersecurity, and data protection. Climate change and sustainability have emerged as major issues at the same time, sparking discussions about how trade policies may support environmental objectives.

A step towards incorporating environmental responsibility into international trade is indicated by initiatives like the European Union's Carbon Border Adjustment Mechanism and calls for climate-conscious trade agreements. The diversification of supply chains in reaction to external shocks is another significant trend. The COVID-19 pandemic revealed serious flaws in just-in-time production techniques, which led to significant disruptions in the energy, food, electronics, and pharmaceutical industries. This has prompted many nations and businesses to reevaluate their excessive reliance on particular areas, particularly for essential items.

Building robust, localised, or regionalised supply chains—also known as "friend-shoring" or "near-shoring"—is therefore receiving more attention in an effort to lower risks and improve economic stability. The conflict between Russia and Ukraine further demonstrated how geopolitical tensions have the power to disrupt energy commerce, cause price shocks, and hasten the shift to more stable trading relationships and alternate energy sources. The international trading system is become more multipolar as it develops. A more equitable distribution of economic power is progressively replacing the dominance of Western economies, with nations like China, India, Brazil, and Indonesia taking up a larger role in trade governance and rule-making.

This diversification and the creation of new trade corridors are reflected in initiatives such as the African Continental Free Trade Area (AfCFTA), the Regional Comprehensive Economic Partnership (RCEP), and China's Belt and Road Initiative. Global trade governance must be rethought in light of these developments in order to promote sustainable development, guarantee inclusion, and take into account a range of interests. In summary, innovation, institutional growth, economic integration, and altering political ideologies have all contributed to the dynamic change that has characterised the evolution of the global trading system.

It has revolutionised international relations, the production and exchange of products and services, and the allocation of economic power. But it also raises important issues of resilience, sustainability, and equity. The future of international trade will rely on cooperative strategies that strike a balance between growth and responsibility, competitiveness and cooperation, and openness and strategic autonomy as the globe confronts new problems including climate change, technological disruption, and geopolitical tensions. Navigating the complexity of the modern, interconnected world and making sure that commerce remains a force for equitable and sustainable development require an understanding of this transformation.

2. FORCES TRANSFORMING GLOBAL TRADE

A confluence of potent forces, including globalisation and digitisation, rapid technological advancements like automation, artificial intelligence (AI), and blockchain, geopolitical realignments, and shifting trade policies marked by waves of liberalisation and protectionism, is driving a transformative shift in the global trade system in the twenty-first century. These factors are changing the character, framework, and administration of global trade, impacting the cross-border movement of capital, data, goods, and services. These factors provide enormous potential for economic expansion and integration, but they also pose serious difficulties, especially when it comes to striking a balance between innovation and regulation, efficiency and equality, and openness and national security. Policymakers, corporations, and international organisations must comprehend how these forces interact in order to manage international trade in the future.

Expanding trade networks have long been facilitated by globalisation, which also makes economic integration possible through international cooperation, liberalised markets, and the spread of ideas, goods, and services. But in recent years, digitisation has accelerated this process, creating new avenues for economic interchange and connectivity. Small and medium-sized firms (SMEs), who previously lacked the capacity to participate in international trade, now have easier access to global markets thanks to the growth of digital platforms like Amazon, Alibaba, and Shopify.

While digital services like cloud computing, online education, and finance have changed what trade means in the digital age, e-commerce has emerged as a significant force in cross-border retail. Shipping tangible items is no longer the only aspect of globalisation; data, software, and services are now being moved more and more, frequently instantly and affordably. To manage cross-border data flows, safeguard consumer rights, and maintain fair competition, this change calls for a reevaluation of taxation laws, trade rules, and data governance frameworks.

2.1 Technological Advancements: Automation, AI, and Blockchain

Technology is still transforming the trade system in all its facets. Global supply chains are changing as a result of automation and artificial intelligence (AI), which are also improving inventory management, streamlining shipping, and accurately forecasting consumer demand. Manufacturers can now create high-quality products more quickly and affordably thanks to smart factories and Industry 4.0 techniques. Meanwhile, the service sector is being redefined by AI-powered technologies in financial modelling, customer service, and product customisation. Additionally, automation affects labour markets by causing a transition from traditional manufacturing occupations to tech-driven positions, which has consequences for employment laws and workforce training. Another layer of change is brought about by blockchain technology, especially in the areas of efficiency, security, and transparency in business dealings. Blockchain improves trust in global supply chains and streamlines certification, payment verification, and customs clearance by generating decentralised, impenetrable ledgers.

In emerging nations where trust and documents can be trade barriers, this technology has the potential to decrease bureaucratic delays, fraud, and corruption. Blockchain-powered smart contracts minimise transaction costs and disputes by automatically executing terms if predetermined conditions are satisfied. Together, these developments are changing the nature of trade and necessitating the development of new governing frameworks, infrastructure, and skill sets.

2.2 Geopolitical Shifts and Realignment of Alliances

Global trade dynamics are increasingly being impacted by geopolitical changes in addition to technological and economic factors. A multipolar reality is replacing the post-Cold War unipolar international order, which was controlled by Western liberal democracies and institutions led by the United States.

In this new reality, regional blocs like the African Union and ASEAN, as well as developing powers like China, India, and Russia, are gaining more clout. International trade ties are now more cooperative and more tense as a result of these changes. For instance, China's Belt and Road Initiative (BRI) has created alternative trade corridors and energy supply chains by establishing new infrastructure investments and trade routes in more than 60 countries, raising geopolitical worries among Western nations.

Tariffs, sanctions, export limitations, and technology decoupling are the results of tensions between major economic powers, most notably the trade dispute between the United States and China. Trade is increasingly seen as a vehicle of geopolitical influence rather than just an economic one.

Energy resources, rare earth metals, and semiconductors, for example, have evolved into tools of geopolitical influence. The crisis in Ukraine has further highlighted how geopolitical strife may speed up changes in trade alliances and disrupt global supply networks, particularly for energy and agricultural commodities. The comeback of industrial policy in trade strategy, "friend-shoring," and trade partner diversity are the results of countries placing a higher priority on supply chain resilience and strategic autonomy than on pure market efficiency.

2.3 Trade Liberalization and Protectionism

With the help of organisations like the World Trade Organisation (WTO), regional trade agreements (RTAs), and free trade agreements, trade liberalization—the lowering or elimination of tariffs, quotas, and other restrictions—has long been a fundamental aspect of globalisation. Consumer choice, poverty alleviation, and global GDP development have all benefited greatly from liberalisation.

Global value chains (GVCs), in which production is dispersed across nations to take advantage of cost advantages and specialisation, have also grown as a result of it. Liberalisation has, however, often resulted in unhappiness, particularly in developed nations where workers and sectors that have been displaced by cheaper imports have not always had the backing of sufficient transition strategies. Over the past few years, a surge of protectionist legislation has surfaced in response to these inequalities.

This trend was accelerated by the COVID-19 pandemic, when countries fought for access to essential commodities like food, vaccines, and medical equipment. The implementation of trade restrictions to protect national security and public health has sparked debate over how to strike a balance between openness and sovereignty. Furthermore, as nations implement carbon border fees and environmental regulations to combat climate change, new types of "green protectionism" are appearing.

Despite their environmental motivations, these policies may also shield home sectors from competition by making imports from nations with less stringent environmental laws more expensive. Cooperation and conflict coexist in the fragmented and frequently unexpected trade landscape created by this dual tendency of protectionism and liberalisation. The contemporary global trade environment is defined by the dynamic interaction between nationalist resistance and globalising forces, technical advancements and regulatory gaps, competitive rivalries and cooperative frameworks. In addition to pushing the boundaries of commerce and making it more accessible and inclusive, globalisation and digitisation are also upending established institutional and legal standards. Automation, artificial intelligence, and blockchain are examples of technological advancements that are transforming efficiency and transparency, but they are also uprooting labour and introducing new risks.

A formerly stable system is becoming unclear as a result of geopolitical changes that are redefining strategic goals and trade partnerships. Growth is still fuelled by trade liberalisation, but growing protectionism highlights the need to combat inequality, maintain justice, and safeguard vital industries. The global trading system's evolution necessitates sophisticated and flexible tactics. In order to empower workers by upskilling them, policymakers must invest in digital and physical infrastructure, promote international collaboration, and create trade regulations that take into account the reality of the economy in the twenty-first century. In addition to managing geopolitical threats and adhering to environmental regulations, businesses must constantly innovate. Additionally, in order for trade to continue being a driver of shared prosperity in a world that is becoming more linked and complex, international institutions must change in order to be relevant.

2.4 Changing Energy Trade Patterns: The Shift in Global Dynamics

A major eastward shift in energy demand, the growing power of emerging Asian economies, and the growing popularity of cleaner and more adaptable energy sources like renewables and liquefied natural gas (LNG) are all signs of a profound shift in the global energy landscape. Traditional commerce routes, geopolitical alliances, and the shift to more sustainable and varied energy sources are all being accelerated by these changes. Under the main thematic areas, these changing patterns are examined in the sections that follow.

3. CHANGING ENERGY TRADE PATTERNS: THE SHIFT IN GLOBAL DYNAMICS

3.1 Shift from West-to-East Energy Demand

Western countries, especially those in North America and Europe, accounted for a large portion of the world's energy consumption during the 20th century due to the enormous demand for fossil fuels brought on by urbanisation and industrialisation. Over the past 20 years, this pattern has reversed, with Asia emerging as the new centre of energy consumption.

Rapid economic growth, urbanisation, the expansion of the middle class, and industrial development in nations like China, India, and Southeast Asia are the main drivers of this change. The International Energy Agency (IEA) reports that more than 60% of the increase in the world's energy demand is currently coming from Asia.

The global energy trade map has changed as a result of this eastward migration. In order to meet the region's expanding energy needs, new supply chains and strategic alliances have developed, and traditional producers in the Middle East, Russia, and Africa have shifted their exports more and more towards Asian markets.

This has led to the diversification and expansion of maritime routes, including increased flows through the Strait of Malacca, the South China Sea, and the Indian Ocean. In order to guarantee long-term energy supplies, this transformation also highlights the necessity of improved regional energy infrastructure, port facility investments, and heightened cooperation among Asian countries.

3.2 Role of China, India, and Southeast Asia

China has become the world's biggest importer and consumer of energy, significantly impacting global energy patterns. It has established itself as a vital trading partner for significant energy exporters due to its enormous demand for coal, natural gas, oil, and increasingly electricity. Specifically, China is now the world's biggest importer of LNG and crude oil.

The nation has made significant investments to extend its LNG import terminals, create pipeline connectivity with Russia and Central Asia, and construct local refining capacity. The Belt and Road Initiative (BRI), which directs investments into foreign energy infrastructure throughout Asia, Africa, and the Middle East—securing access while projecting geopolitical influence—is another example of China's energy diplomacy. The third-largest energy consumer in the world, India, is on a similar path. Demand for a variety of energy sources is being driven by its expanding economy, population, and energy-intensive sectors. India is a key market for Middle Eastern and North American exports since it imports over 85% of its crude oil and 50% of its natural gas needs.

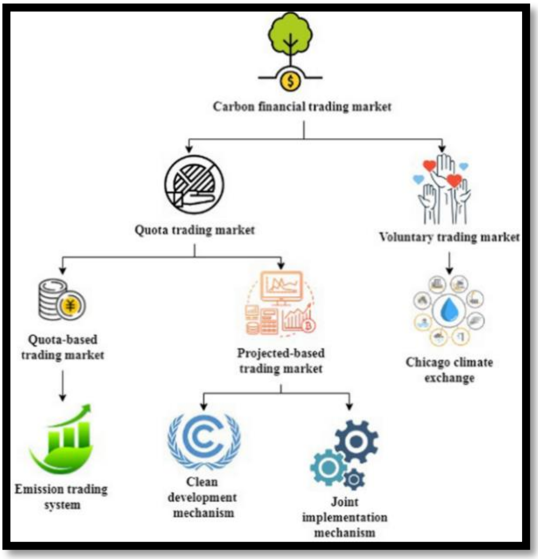

Figure 1. Energy Trade in Asia

India has implemented a multifaceted approach to enhance its energy security, which includes boosting domestic production, developing strategic petroleum reserves, growing its infrastructure for LNG and refining, and investing in foreign energy assets. India's twin emphasis on energy availability and sustainability is also reflected in its leadership in global climate diplomacy, especially through the International Solar Alliance. Southeast Asia, which includes nations like the Philippines, Malaysia, Vietnam, Indonesia, and Thailand, is developing into a more vibrant and varied energy sector.

While some countries, like Vietnam and the Philippines, are becoming major energy users, others, like Indonesia and Malaysia, are both producers and exporters of gas and oil. By 2040, it is anticipated that the region's energy consumption would have increased by more than 60% due to economic expansion, urbanisation, and population growth. This need is driving cross-border infrastructure initiatives like the ASEAN Power Grid and changing the regional power trade. Southeast Asia is also making investments in LNG imports and renewable energy to better sustainably and cleanly meet the region's growing electrical demands.

3.3 Expansion of LNG and Renewables in Global Energy Trade

With liquefied natural gas (LNG) serving as a key transitional component, the global energy trade is undergoing a dramatic shift away from conventional fossil fuels and towards more adaptable and sustainable alternatives. LNG allows natural gas to be transported across continents, which makes supply networks more secure and varied than pipeline-bound gas. Improved liquefaction and regasification technology, floating storage facilities, and a competitive spot market have all contributed to the recent exponential growth in the LNG trade.

To keep up with the growing demand from Asia, major exporters including the United States, Australia, and Qatar are increasing their output. In order to improve energy flexibility, lessen reliance on coal, and meet peak power demand, importers—in particular, China, Japan, South Korea, and India—are increasing the capacity of LNG terminals. As evidenced by the COVID-19 outbreak and the Russia-Ukraine conflict, nations are increasingly seeing LNG as a strategic asset to secure energy security in the face of global disruptions, in addition to being a source of energy.

Given the growth of LNG hubs and futures markets in Asia, it is likely that the area will have a significant influence on future supply agreements, investment, and pricing in the LNG industry. Simultaneously, the global energy economy is being redefined beyond fossil fuels by the renewable energy revolution. Even though the majority of electricity generated by solar, wind, and hydropower is produced and used locally, the technology, parts, and essential raw materials required for the development of renewable energy are becoming more and more in demand worldwide. Solar panels, wind turbines, and battery storage devices are mostly exported from China.

The worldwide supply chain for sustainable energy currently depends on these components, making their commerce geopolitically sensitive. Furthermore, the concept of transnational green electricity trading via underwater cables or long-distance transmission lines is gaining popularity. This tendency is demonstrated by projects such as India's transnational solar endeavours and the projected Sun Cable, which would connect Australia and Singapore.

Green hydrogen is also on the verge of becoming a worldwide energy commodity since it is created with renewable energy and exported as ammonia or other carriers. To position themselves in this developing market, nations including Saudi Arabia, Germany, Japan, and the United Arab Emirates are investing in hydrogen alliances, pilot projects, and trade frameworks.

3.4 Toward a New Energy Trade Order

A wider realignment of economic power, environmental priorities, and technological capabilities is reflected in the shift in global energy trading patterns. Trade maps and exporting countries' energy plans have been redirected towards Asia due to the eastward shift in demand. In addition to influencing global energy flows, China, India, and Southeast Asia are also propelling investments in sustainability, diversification, and infrastructure.

Climate goals are becoming ingrained in business strategy and trade portfolios are becoming more diversified due to the growth of LNG and renewable energy components and services. Future regulations must take into account supply chain resilience, energy security, fair access, and environmental sustainability as the energy trade grows more intricate and dynamic. Managing these shifts will require inclusive governance frameworks, trade logistics innovation, and regional cooperation. A more multipolar, diversified, and low-carbon energy trade system is replacing the conventional, fossil fuel-dominated, West-centric one. This system reflects the shifting needs and obligations of a quickly changing global economy.

4. CHANGING ENERGY TRADE PATTERNS: A GLOBAL REALIGNMENT

Significant changes in demand centres, supply source diversity, the introduction of new technologies, and the growing push for decarbonisation are all contributing to the historic upheaval of the global energy trade. A significant geographic and structural realignment of energy trade patterns is at the core of this shift, as evidenced by the move in demand from the West to the East, the importance of China, India, and Southeast Asia in the world's energy markets, and the rapid growth of renewable energy and liquefied natural gas (LNG) in international trade flows.

The conventional energy map is being redrawn by these changes, which also offer governments, corporations, and international organisations new opportunities, difficulties, and approaches. The industrialised Western economies of North America and Europe, whose high energy intensity facilitated rapid economic growth, infrastructural development, and high living standards, were the main drivers of energy consumption in the 20th century. The 21st century has seen a dramatic change, nevertheless, as Asia's energy needs continue to grow. The fast industrialisation and urbanisation of emerging nations, especially in the Asia-Pacific region, which currently contributes the majority of the rise in global energy consumption, has fuelled this shift. Due to growing middle classes, population growth, and increased energy demands for manufacturing, transportation, and services, China, India, and other rapidly emerging Southeast Asian countries are spearheading this movement. India's energy consumption is expected to increase at one of the quickest rates in the world, while China alone currently consumes more energy than the US and the EU combined. Global supply chains have undergone a parallel rearrangement as a result of this eastward trend. New shipping routes and port infrastructure are emerging, especially in the Indian Ocean, South China Sea, and Western Pacific, as major energy exporters like the Middle East, Russia, Africa, and North America reorient their trade flows to meet Asia's booming energy markets.

4.1 Role of China, India, and Southeast Asia

China is the world's biggest importer of natural gas and crude oil, therefore its energy policy choices affect the entire world. Its long-term plans centre on the transition to sustainable energy, supply chain security, and source diversification. China imports energy from many different places, such as Africa, Latin America, Russia, and the Middle East. Its aim to improve energy resilience is demonstrated by the building of major LNG terminals along its coast and the construction of vital pipelines like the China–Central Asia Gas Pipeline and the Power of Siberia from Russia. With the highest installed capacities of solar and wind power, as well as the most advanced manufacturing capabilities for solar panels and batteries, China is a global leader in renewable energy at the same time.

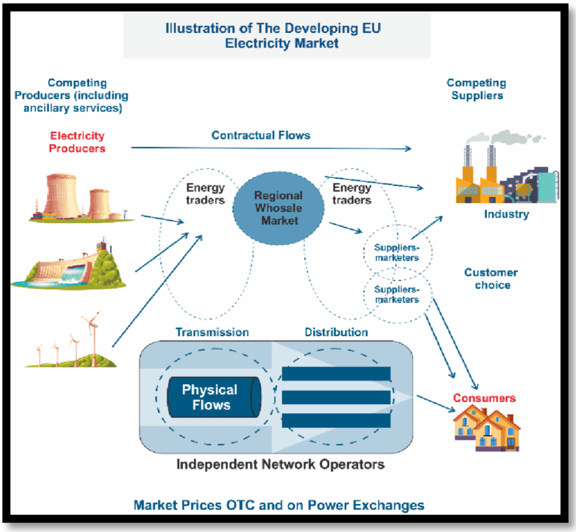

Figure 1. Developing EU Electricity Market

Another important pillar in the world's energy exchange is India. With one of the largest populations in the world and a rapidly expanding economy, India has an increasing demand for energy, particularly coal, oil, natural gas, and electricity. India imports more than 80% of its oil to fulfil this growing demand, and it has quickly expanded its LNG imports to suit urban and industrial demand.

The Indian government is making significant investments in the development of LNG terminals, refining capacity, and renewable energy. Reducing import vulnerability and ensuring a variety of supply sources are the goals of strategic energy relationships with the United States, Russia, the United Arab Emirates, and Central Asia. India's international efforts, including the International Solar Alliance, demonstrate its dedication to sustainable development and energy access.

With its distinct producer-consumer dynamics, Southeast Asia—which includes countries like Indonesia, Malaysia, Vietnam, Thailand, and the Philippines—represents a fast-growing energy demand centre. Although Malaysia and Indonesia have historically exported fossil fuels, the region's rapid industrialisation and urbanisation are making many other countries more and more dependent on imports.

Intraregional energy commerce is changing as a result of ASEAN nations' investments in renewable energy, regional power grids, and LNG infrastructure. By integrating electrical infrastructure across borders, the ASEAN Power Grid initiative seeks to save costs and improve dependability. The area is a vital centre for the global transportation of energy due to its advantageous location close to important sea lanes.

4.2 Expansion of LNG and Renewables in Global Energy Trade

Coal, crude oil, and pipeline gas are no longer the only factors that define the structure of the energy trade. LNG and renewable energy sources have gained popularity recently as safer, more flexible, and cleaner alternatives from a geopolitical standpoint. The worldwide gas market is being revolutionised, especially by LNG. LNG can be transported across vast distances, giving energy importers more options and flexibility than pipeline gas. Improvements in liquefaction technology, floating storage and regasification units (FSRUs), and a more active spot market have all contributed to the expansion of the LNG market.

While major Asian users, including China, Japan, South Korea, and India, are building import terminals and negotiating long-term contracts, key LNG suppliers, like Qatar, Australia, and the United States, are rushing to increase capacity. With the help of international financial and technical assistance, LNG provides a possibility for developing nations in Southeast Asia and some areas of Africa to switch from coal to cleaner-burning natural gas. Furthermore, LNG is a major facilitator of the clean energy transition due to its compatibility with renewable energy systems (by acting as a backup during sporadic solar and wind generation).

However, the commerce in renewable energy is developing in distinctive and intricate ways. International trade in renewable technology and components is expanding, despite the fact that electricity produced by solar, wind, and hydropower is mostly consumed domestically due to transmission limitations. China is the world's top exporter of wind turbines, solar panels, and battery storage systems, giving nations going through energy transitions vital inputs.

Similar to this, a new type of energy-related trade is being driven by the need for vital minerals like lithium, cobalt, and rare earth elements—all of which are necessary for the production of clean technology. Through regional interconnectors and high-voltage transmission lines, cross-border electricity commerce is likewise becoming more popular. Long-distance exporting of renewable energy is feasible, as shown by projects like the India-Bhutan-Bangladesh power corridors and the Sun Cable between Australia and Singapore.

Green hydrogen, which is generated from renewable electricity, is also becoming a commodity of the future on a worldwide scale. In an effort to create a worldwide hydrogen economy, nations including Saudi Arabia, Germany, Japan, and Australia are making significant investments in green hydrogen production and transportation technology. A world in transition—a change in both geography and energy philosophy—is reflected in the shifting trends in global energy trade. The increasing significance of Asia as a global centre for energy consumption has caused producers and investors to reevaluate their strategic ambitions.

These days, China, India, and Southeast Asia actively influence demand, pricing, infrastructure, and innovation rather than being passive consumers of energy from across the world. In the meantime, the growth of LNG and the quickening worldwide shift to renewable energy mark the start of an energy system that is more adaptable, diverse, and climate-conscious.

Important questions are also raised by these phenomena for international organisations and governments. In a world that is decarbonising, how can energy security be preserved? What kinds of governance are required for an equitable and effective energy transition? How can industrialised and poor countries fairly share the advantages of new energy trade flows? Building a robust, inclusive, and sustainable energy future will require answering these issues. The global energy economy is at a turning point, a time of tremendous challenge and unheard-of opportunity, as the conventional fossil fuel-based energy order gives way to a more dynamic and multi-vector trade system.

CONCLUSION

Energy markets are undergoing a fundamental revolution at all levels—geopolitical, technological, environmental, and economic—as a result of the global trade system's transition, which is no longer a theoretical process on the fringes of economic theory. The expansion of emerging economies, particularly China, India, and the larger Asia-Pacific area, has changed the gravitational centre of global demand, which is at the heart of this change. The world's trade flows, which were formerly dominated by the West, are now shifting eastward, rerouting energy resources, reorganising alliances, and questioning long-standing market paradigms.

This change involves a qualitative change in the how, where, and why of energy production, consumption, and transportation rather than just a numerical adjustment to trade balances. Energy markets have changed from a system based on oil tankers and inflexible pipeline networks to a more flexible, dynamic, and multipolar structure propelled by liquefied natural gas (LNG), renewable energy sources, and digital transactions as trade has become even more globalised. The energy mix is changing quickly, and both market competition and environmental concerns are calling into question the place of conventional fossil fuels.

The need for clean technologies, carbon border adjustments, and green finance is rising as a result of governments and businesses increasingly coordinating their energy and trade policies with climate goals. As trade strategy and energy security become inextricably linked, the growing significance of regional cooperation and interdependence is at the centre of this transition. Examples of how energy is evolving into a shared infrastructure beyond national borders include the creation of interconnected power networks throughout South Asia, cross-border renewable electricity commerce in Africa, and hydrogen corridors in Europe. Energy has become a crucial element in international diplomacy, as evidenced by the growing inclusion of terms on sustainable energy, technological transfer, and critical resource access in trade agreements. The worldwide drive towards digitisation, which makes it possible for real-time tracking, carbon footprint auditing, and effective energy distribution through technologies like blockchain, artificial intelligence, and smart grids, has further expedited this.

Energy is becoming more democratised and driven by the market thanks to the emergence of platforms that link buyers and sellers in decentralised markets, dismantling long-standing monopolies. The result is a more flexible energy market with speedier transactions, more flexible contracts, and a decision-making process that heavily relies on data. These technology developments are promoting a more inclusive ecosystem by levelling the playing field and enabling smaller countries and businesses to engage in the global energy trade.

This change is not without its challenges, though. A conflicting environment for energy flows has been produced by the simultaneous presence of protectionism and liberalisation in international commerce. In order to safeguard their home markets, some nations have turned back to energy nationalism and implemented export restrictions, tariffs, and state-controlled pricing schemes, while others have welcomed globalisation and green trade. This contradiction poses a problem for policymakers because, while international cooperation is necessary to address transnational problems like climate change, domestic political constraints frequently give short-term energy independence precedence over long-term sustainability.

The vulnerability of interdependent supply chains and the significance of resilience in energy infrastructure have been further highlighted by the COVID-19 epidemic and the geopolitical upheavals that followed, such as the conflict between Russia and Ukraine. Localised production, strategic reserves, and investments in renewable energy sources that provide protection against geopolitical shocks are therefore being incorporated into updated energy security plans.

In order to future-proof their income, countries that export fossil fuels are also being forced to reconsider their economic models and diversify into renewable energy and services as a result of the continuing energy shift. In order to stay competitive in a post-oil world order, nations like Saudi Arabia and the United Arab Emirates are making significant investments in green hydrogen, solar energy, and carbon-neutral technologies. Financially speaking, a substantial reallocation of money within the energy markets has been sparked by the restructuring of global trade.

Trillions of dollars have been steered into low-carbon innovation, energy efficiency, and sustainable infrastructure through the use of green bonds, climate funds, and environmental, social, and governance (ESG) investing. Private equity is pouring into renewable energy firms at a never-before-seen pace, and multilateral development banks and institutional investors are now giving priority to projects that fit with net-zero ambitions. With technologies like offshore wind, solar PV, battery storage, and electric vehicles not only transforming domestic energy systems but also becoming into important export commodities in and of themselves, this has opened up new trade frontiers.

Global trade flows have taken on a new dimension as a result of the globalisation of clean energy supply chains, which has been fuelled by countries such as China (batteries, solar panels), Australia (critical minerals), and Germany (green hydrogen). This has increased both opportunities and vulnerabilities concerning trade competition, intellectual property, and reliance on raw materials.

The transition is also heavily influenced by environmental factors. International action has been sparked by climate agreements like the Paris Accord, which have made emissions reductions a requirement for trade cooperation and international legitimacy. By tying environmental responsibility to commercial transactions, the EU's Carbon Border Adjustment Mechanisms (CBAM) and comparable ideas in other areas are reshaping global supply chains. While encouraging investments in low-emission alternatives like LNG, renewables, and hydrogen, these measures will have a significant impact on carbon-intensive energy exports like coal and oil.

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