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Climate change, fossil fuels, and the energy transition in the Global South

Governance pathways to leave fossil fuels underground

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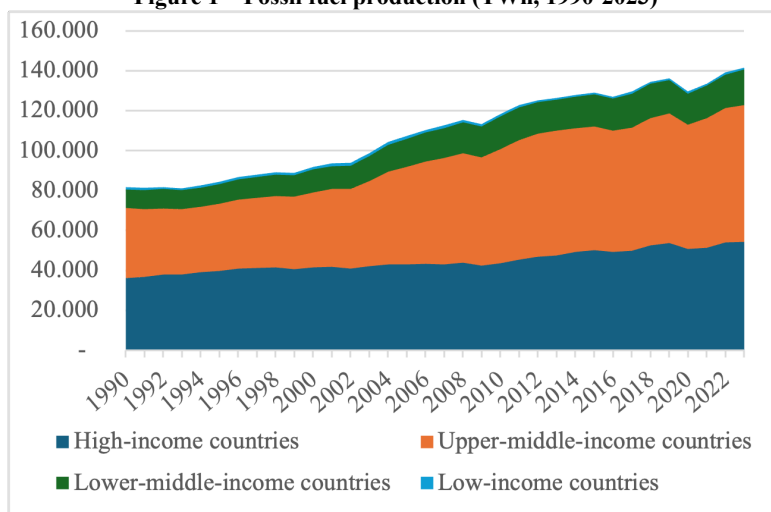
1 Introduction: the climate-energy challenge facing the Global South

The crisis consists precisely in the fact that the old is dying and the new cannot be born; in this interregnum a great variety of morbid symptoms appear.
Antonio Gramsci (1971, p. 276)

1.1 The context: the mid-transition's interregnum

In 1992, when the United Nations Framework Convention on Climate Change (UNFCCC, 1992) was adopted, global average temperature increase was 0.49°C above pre-industrial levels. The adoption of the Paris Agreement, which codified the temperature rise objective of 2°C with an effort to reduce to as low as 1.5°C (Art. 2a; UNFCCC, 2015), witnessed a temperature increase of 1.19°C. In 2024, global average temperatures crossed the 1.5°C threshold for one year, while a definitive breach is expected by 2030 (Copernicus, 2024). Projections based on extrapolating current mitigation efforts estimated a 2.8°C increase by 2100 (UNEP, 2025). In July 2025, the International Court of Justice (ICJ) issued a landmark Advisory Opinion on the Obligations of States in respect of Climate Change (ICJ, 2025), according to which, building on decisions of the Conference of the Parties (COPs), the 1.5°C target is legally binding and failure to take appropriate action to protect the climate system, including through fossil fuel production, exploration licenses or subsidies, may constitute a wrongful act under international law. Nonetheless, the direct cause of global climate change and greenhouse gas (GHG) emissions, the burning of fossil fuels, keeps growing (Figure 1). The current UN Secretary General's repeated calls to end our fossil fuel addiction do not appear to be taking hold, against short-term pressures and hunger for energy (UN News, 2022). A significant drop in fossil fuel production, and therefore in associated GHG emissions, happened only in two major global events, the 2008 financial crisis and the COVID-19 pandemic. As soon as the global economy came back on track, production resumed.

Figure 1 – Fossil fuel production (TWh, 1990-2023)



Source: Author. Data from Energy Institute (2024), with processing by Our World in Data.

Indeed, access to energy sources relies on a complex system of global markets, extensive cross-border infrastructure networks, a limited group of primary energy suppliers, and interdependencies with financial markets and technology (Chester, 2010). In this complex system, external factors, including major geopolitical events, macroeconomic shocks, and short-term fiscal pressures, profoundly reshape public policy priorities. These factors lead to a focus on energy security and macroeconomic stability, resulting in a dilution of long-term decarbonisation targets and a deferral of strategic resilience investments. A vivid example is the energy crisis triggered by the post-pandemic recovery and the Russian invasion of Ukraine, which further aggravated the existing relationship between climate change and energy investment decisions, in Europe and in the Global South.⁹ While the EU hurried to substitute for Russian gas and Germany returned to mine coal, the Global South found new fossil fuel export opportunities to Europe, postponing phasing out.

The governance architecture born to address the socioeconomic and climate implications of the climate change-energy nexus is built on three cornerstones: emissions, decarbonisation and electrification. The international community, particularly high-income countries, gave the task to achieve this goal to the private sector, resulting in a market-steered global energy transition, particularly in those geographies, i.e., the Global South, which are expected to experience the greatest surges in energy and electricity demand. In a context marked by unbundling of the earlier vertically integrated system (generation-transmission-distribution), privatisation and marketisation of the electricity sector (Christophers, 2024), instruments such as blended finance and derisking are the carrots that States currently have to lure investors and make RES-projects bankable (Christophers, 2024; Gabor, 2021).

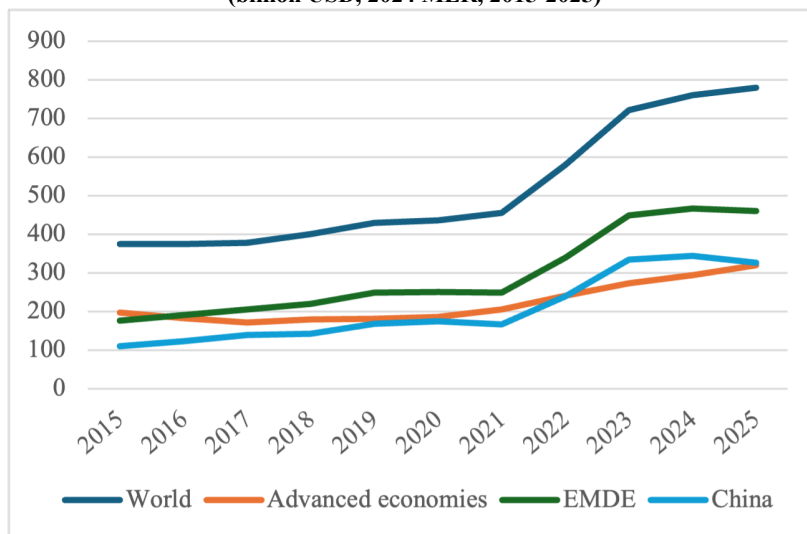
Nevertheless, the Low- and Middle-Income Countries (LMICs),¹⁰ whose fossil fuel share in the 1990s was 53.7%, have so far increased production (61.56% share in 2023; Figure 1), with differences across geographies, socio-economic contexts, climate and environmental impacts, and development aspirations. Indeed, the fossil fuel demand trajectory in the next decades worldwide will depend on factors such as the rapidity of new technologies deployment for the energy transition, political will to substitute fossil fuels, economic fundamentals, geopolitics and cultural attitudes and values towards energy consumption (IEA, 2021c, 2024c). It seems paradoxical that at the same time, due to declining costs, renewable energy sources (RES) have been exponentially growing, with China alone accounting for 60% of all renewable capacity installed worldwide between 2024-2030 (IEA, 2024d). Investments in renewable power generation have almost doubled since 2015, reaching almost 800 billion USD in 2025 (IEA, 2025c), with “Emerging Markets and Developing Economies (EMDE)” investing 460 billion USD,

⁹ In this thesis I define Global South as being a LMIC and a non-Annex I party to the UNFCCC (see 1.3.2).

¹⁰ Economies where 2021 income per capita (current USD) was less than USD 13.205 (World Bank, 2022a).

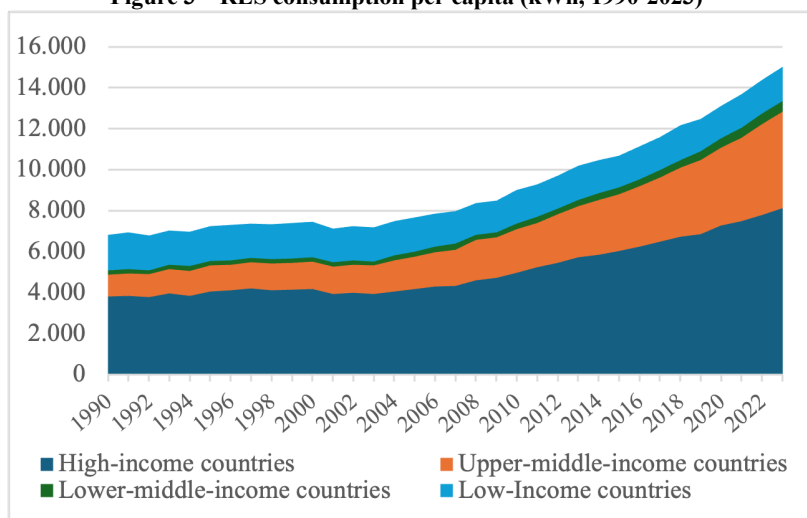
more than the “Advanced Economies” and China (Figure 2).¹¹ Furthermore, looking at RES consumption per capita, consumption in LMICs is growing faster than in high-income countries (Figure 3).

Figure 2 – Investment in renewable power generation (billion USD, 2024 MER, 2015-2025)



Source: Author. Data from IEA (2025c).

Figure 3 – RES consumption per capita (kWh, 1990-2023)¹²



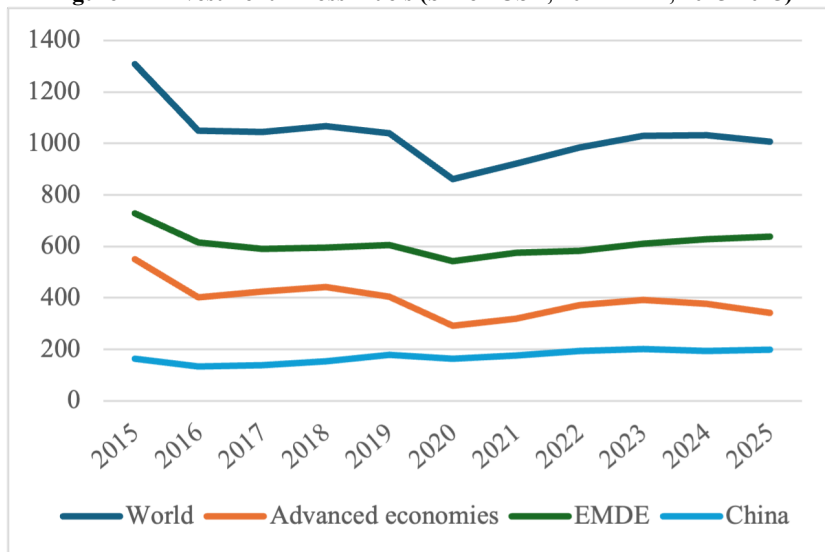
Source: Author. Data from Energy Institute (2024), with processing by Our World in Data.

¹¹ “Advanced economies” are OECD countries plus Bulgaria, Croatia, Cyprus, Malta and Romania; “EMDE” are all other countries not included in “Advanced Economies”; China is treated separately. World total is adjusted to remove overlapping investment lines (IEA, 2025c).

¹² Renewables include hydropower, wind, solar, geothermal, wave and tidal, and bioenergy, but not biofuels.

Despite all this progress, the pace of investment in RES is still not enough, and to have any reasonable prospect of achieving 1.5°C, no new fossil investments, including in fossil gas,¹³ should happen (IEA, 2021c), though existing projects may continue operating, which some may argue as unjust. Nevertheless, investments in fossil fuels, despite experiencing a declining phase between 2015 and 2020, are still higher than investment in RES power generation (see Figure 2 and Figure 4). This dynamic is worrisome, for two mirrored reasons. First, emissions are cumulative, and underinvestment in RES today therefore increases the mitigation burden in later years (Christophers, 2024); second, and for the same reasons, ongoing investment in fossil fuels today exacerbates the costs of mitigating tomorrow.

Figure 4 – Investment in fossil fuels (billion USD, 2024 MER, 2015-2025)



Source: Author. Data from IEA (2025c).

Looking at this pattern, we could argue that the global energy landscape, and prominently in the Global South, is caught in a mid-transition (Grubert & Hastings-Simon, 2022): in the foreseeable future, the conventional fossil-based energy system will coexist with the new, RES-based energy system, imposing on each other some operational constraints, with the latter developing and nesting within the fossil fuel-based energy system's structures. Against this deeply uncertain backdrop, between fossil fuels and RES, Antonio Gramsci's words, in this chapter's opening quote, powerfully resonate. This thesis fits precisely into an *interregnum* between the old and the new, in a critical decade for transitioning away from fossil fuels in energy systems (UNFCCC, 2023), but marked, hopefully short-term, by *morbid symptoms*: the erosion of international cooperation, the

¹³ I chose to abandon the adjective 'natural' for gas, preferring the term 'fossil' (Lacroix et al., 2021), changing it *ex-post* in already published articles (Chapter 4). I thank an anonymous reviewer of Chapter 5 for the suggestion.

rise of reactionary politics and disinformation, and a deepening attack on multilateralism, from trade to war, from climate change to genocide.¹⁴

This research, which falls under international development studies, energy transition, social science and climate change, is part of the European Research Council Advanced Grant to Principal Investigator Joyeeta Gupta for Climate Change and Fossil Fuels (CLIFF), which investigates the role of large institutional investors in leaving fossil fuels underground (LFFU), examining the North-South implications of this transition and exploring how to allocate shareholder and stakeholder responsibilities in an equitable energy transformation for inclusive development. Within CLIFF's integrated theoretical and methodological framework (see Chapter 2), this thesis based on publications analyses the energy transition in the Global South, focusing on fossil fuel phase-out and its economic and climate impacts, as well as how these are distributed, adopting a critical international political economy (IPE) perspective.¹⁵

This thesis aims to analyse the barriers to an inclusive energy transition, amidst North-South and South-South power dynamics, fossil fuel incumbents' vested interests, and energy pathways beyond fossil fuels. In what follows, Section 1.2 defines the problem and the related gaps in knowledge. Section 1.3 explains the overarching question, sub-questions, and the focus and limits of this research. Section 1.4 outlines the policy and scientific relevance of the study. Lastly, Section 1.5 outlines the thesis structure.

1.2 Problem definition

1.2.1 Societal problem: the double-edged sword

1.2.1.1 Climate change and cumulative injustices

Anthropogenic GHG emissions and human-induced climate change (e.g., increasing extreme weather events), have caused widespread and increasingly irreversible, negative consequences including losses and damages to the environment and people: for instance, 1990-2020 saw 420 million hectares of forest loss; warming is altering biome distributions; 50% of global population experiences at least one month of water scarcity each year; while since 2008 floods and storms have displaced more than 20 million people annually (IPCC, 2022b). Climate-related risks to livelihoods, biodiversity, water supply, food security, human health, and economic growth, already high at 1°C, are predicted to increase with 1.5°C global warming and significantly more with 2°C and beyond: at 1.5°C, more than 200 million people may face unprecedented temperatures, and more than 500 long-term sea level rise, while in scenarios 1.5-2°C, between 0.95-1.15 billion people are exposed to water stress, heat stress and desertification, and 14-18% of land

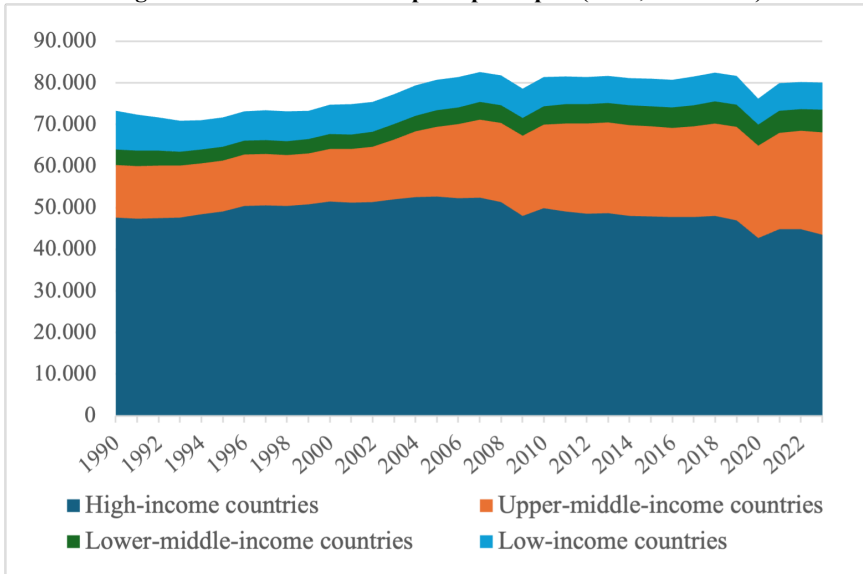
¹⁴ Since 2022, major global events have put multilateralism under extreme strain: the Russian invasion of Ukraine, the tariff trade war triggered by President Trump's administration, the second withdrawal of the US from the Paris Agreement, and Israel's genocide against Palestinians (Amnesty International, 2024; Bartov, 2025).

¹⁵ The other actors analysed by CLIFF are FF companies (Herzog-Hawelka & Gupta, 2023), pension funds (McDonnell & Gupta, 2023), philanthropic foundations and multilateral development banks.

species are at high risk of extinction (IPCC, 2018, 2022b; Rockström et al., 2023). Beyond 1-1.5°C warming, the likelihood of triggering climate tipping points increases, while these risks are getting more intricate and impossible to manage as they become unpredictable: many climate hazards, as well as multiple climatic and non-climatic threats, will occur at the same time, resulting in a compounded total risk and risks cascading across sectors and geographies (IPCC, 2022b).

Climate change vulnerability varies greatly between and within countries, with the Global South being disproportionately affected and vulnerable to impacts such as reduced crop yields, higher floods and droughts, climate-related migration, and poverty (Hallegatte et al., 2016; IPCC, 2022b). This disparity is primarily driven by socioeconomic development patterns, unsustainable ocean and land use, historical and current inequality, marginalisation, and governance, while current unsustainable development increases people's exposure to climate hazards (IPCC, 2022b). About 3.3 billion people are living in highly vulnerable countries and, within the Global South, hotspots of high human vulnerability include West-, Central- and East Africa, South Asia, Central and South America, and Small Island Developing States (IPCC, 2022b).

In this sense, North-South relations in climate governance (see Chapter 3) is a history of cumulative injustices (see 3.4.1; Gupta, Chen, McDonnell, et al., 2025). Starting from historical emissions, despite awareness of climate change, rich countries' delay and weakening of the temperature objective until 2015 allowed them to continue exploiting fossil fuels and emitting, resulting in a limited carbon budget space to maintain temperatures rise at 1.5°C and preventing an equitable distribution of the budget considering the principle of common but differentiated responsibilities and respective capabilities (CBDRRC), adopted in the UNFCCC (1992). Indeed, in terms of fossil fuel consumption per capita (rather than overall, as in Figure 1), high-income countries continue to consume substantially more fossil-based energy and emit than the rest of the world (Figure 5).

Figure 5 – Fossil fuel consumption per capita (kWh, 1990-2023)

Source: Author. Data from Energy Institute (2024), with processing by Our World in Data.

1.2.1.2 LFFU and the cost of inaction for the Global South

From above, we can conclude that near-term measures that limit global warming to 1.5°C are necessary to reduce (but not totally eliminate) predicted losses and impacts from climate change in human systems and ecosystems (e.g., at 1.5°C, 350 million *more* people would experience water scarcity by 2030, while 70-90% of coral reefs could be lost; IPCC, 2018, 2022b). As fossil fuel combustion account for 64% of annual anthropogenic GHG emissions (IPCC, 2022a), this requires a rapid phase-down and phase-out of fossil fuel investment, production and consumption. Governments worldwide, however, plan to produce more than double the amount of fossil fuels consistent with limiting warming to 1.5°C by 2030, regardless of their commitments under the Paris Agreement (2015) and projections on global demand for fossil fuels (SEI et al., 2021, 2023, 2025), the so-called ‘production gap’ (see 4.4.1.2 and 6.1).

Past and current energy investments have resulted in technological, institutional, and behavioural path dependencies related to fossil fuels (i.e., carbon lock-in; Seto et al., 2016; Unruh, 2000). If fossil-fuel decommissioning does not happen and fossil-fuel infrastructure expansion continues, energy systems will be locked into higher emissions, making it increasingly difficult to keep global warming at the safe level of 1.5°C (IPCC, 2022a). Cost escalation, lock-in in carbon-emitting infrastructure, and less flexibility in medium to long-term response choices are all risks of delayed action to reduce GHG emissions, as delayed action strengthens the magnitude of action required at a later point in time, exacerbating development challenges (see 1.1). These factors may accentuate inequalities in distributional impacts between nations at different stages of development (IPCC, 2018), leaving the burden of stranded assets to the Global South.

1.2.1.3 LFFU and the cost of action for the Global South

The global fossil fuel system has an estimated asset value of USD 25 trillion and, from 2015 until 2025, has added one trillion dollars of assets each year (Figure 4; Global Commission on the Geopolitics of Energy Transformation & IRENA, 2019, p. 64). Therefore, limiting warming to 1.5°C will result in stranding fossil-related assets, such as fossil infrastructure, stranded labour and unburned reserves, with the economic consequences of stranding worth trillions of dollars (IPCC, 2022a).

Stranded assets are assets that unexpectedly or prematurely become written off, undergo downward revaluations, cease generating economic returns, or are converted to liabilities due to the low-carbon transition (Bond et al., 2020; IPCC, 2022a; SEI et al., 2021). Hence, stranding can be regulatory, economic or physical (Blondeel, 2019). They can be physical (infrastructure, equipment, or technology), financial (shares, bonds and loans), human (know-how, jobs in the fossil fuel sector) or indirect (such as vehicles, creating cascading stranding in many sectors; Caldecott, 2018). Stranded resources are broadly defined as “resources which are considered uneconomic or cannot be developed or extracted as a result of technological, spatial, regulatory, political or market limitations, or changes in social and environmental norms” (Bos & Gupta, 2019, p. 3).

Hence, stranding is extremely expensive. From 2015 to 2050, the total global discounted value of unburned fossil fuel and stranded infrastructure will be in the range of USD 1-4 trillion if global warming is restricted to 2°C, and it will be higher if global warming is limited to 1.5°C (IPCC, 2022a, p. 37). However, this cost of action (LFFU) is lower with better near-term mitigation strategies than the cost of inaction or delayed action (IRENA, 2019): faster mitigation will restrict new projects (with an expected lifespan of 35-75 years) and phase out existing infrastructure in rich countries as well as the building of infrastructure that may later be stranded, preventing the early retirement of FF infrastructure. However, if governments continue to invest in and expand fossil fuels, mitigation will have to be expedited, leading to more stranded assets and increased costs (IPCC, 2022a; IRENA, 2019). Stranded assets may threaten financial markets and macroeconomic stability, resulting in huge losses for private investors in developed countries that are extensively exposed through financial markets and pension funds (Mercure et al., 2018; Semieniuk et al., 2022). If assets become stranded, stakeholders and investors face a number of risks, including political, economic, and legal hazards, as well as ecological and social challenges such as health risks and a lack of access to affordable energy (Bos & Gupta, 2018, 2019; Curtin et al., 2019). A cognate problem is labour (see 2.4.1.3): the International Labour Organisation’s (ILO) Just Transition Guidelines and subsequent reports set out safeguards for fossil-fuel sector employees (e.g., social dialogue, retraining, income protection, and place-based diversification; ILO, 2015, 2024; IRENA, 2023). However, closing these jobs down remains politically very challenging across Global North and South countries (J. V. Araújo et al., 2025; Hids, 2022; Kalt, 2021). Empirically, rapid phase-out pathways entail sectoral employment

shifts (8 million fossil jobs less under a well-below 2°C scenario; Pai et al., 2021) that will need to be managed with just transition plans, especially in coal regions (ILO, 2018).

The issue of asset stranding reveals a third cumulative injustice across North and South (Gupta, Chen, McDonnell, et al., 2025), which is intimately related to the role of LMICs in the energy transition, the focus of this study (see Chapter 3). Indeed, the delay in addressing fossil fuels in climate governance allowed rich countries to deplete the carbon budget, disregarding the geographical distribution of remaining fossil fuels. Since most reserves (78%, 88% for coal) are physically located in the Global South, with 45.8% in non-OPEC Global South (Y. Chen & Gupta, 2024; Gupta, Chen, & Rammelt, 2024),¹⁶ this strategic delay shifted the burden onto Global South countries, which would exacerbate the climate problem if they used their ‘fair share’ (Rajamani et al., 2021).

In addition, non-OECD governments ultimately bear the potential losses resulting from stranded assets, and the associated development implications and dilemmas of stranding have been overlooked and unresolved (Foster et al., 2024; Hoffart & Holz, 2024; Semieniuk et al., 2022). Countries in Latin America and the Middle East with large oil, gas, and coal deposits are vulnerable to stranding (Ansari & Holz, 2020; Binsted et al., 2020; Van de Graaf, 2018), but among prospective fossil fuel producers, the risks of stranded assets may be greater since the infrastructure is newer (Bos & Gupta, 2018; IPCC, 2022a). In light of their Right to Development (see 1.2.1.4 and 6.1), due to the risks and impacts of stranded assets on low-carbon development trajectories, climate objectives are important for investment decisions even in countries with historically low GHG emissions, like the Global South (Binsted et al., 2020; Foster et al., 2024).

Because financial flows often originate in the Global North and fossil resources are concentrated in the Global South, the costs of LFFU are unevenly distributed. Economic growth, energy security, and poverty reduction may all suffer as a result of LFFU (Bos & Gupta, 2016; Gupta & Chu, 2018; see Chapter 4). More generally, asset stranding poses a different and more fundamental risk to producing Southern countries than the Global North (Foster et al., 2024; Hoffart & Holz, 2024). Indeed, many Global South producing countries are structurally dependent on fossil fuels, on three main dimensions which *de facto* restrict economic development through external flows: productive dependency, fiscal dependency, and balance of payments constraints. The interaction of these factors results in phenomena greatly analysed by the literature, such as enclave economy, deindustrialisation, and the Dutch disease (Cardoso & Faletto, 1979; Corden & Neary, 1982).

Indeed, a prominent feature of many Global South countries’ development trajectory, rooted in colonialism and imperialism (see Chapter 3), is extractivism, understood as an

¹⁶ A key limitation of this estimate is the lack of reserve data for most US onshore hydrocarbon sites (personal communication with Dr. Yang Chen concerning the Global Energy Monitor data quality check).

economic development model and policy based on the extraction and exports of resources, supplying the Global North, with social, cultural, environmental and economic consequences (Gudynas, 2019; Pellegrini, 2018; Riofrancos, 2020; Svampa, 2012; Veltmeyer, 2022). Extractivism and its effects of dependency on resource extraction, in the context of climate change and fossil fuels, is taking a “broadened, deepened and self-sustained form [...] as the extractive imperative” (Arsel et al., 2016b, p. 881), which redefines policy priorities while reinforcing the framing of extraction as a legitimate pathway to development, thereby shaping both policy frameworks and societal expectations (see Chapters 5, 6, and 7; Arsel et al., 2016b; Gupta, Hogenboom, Rempel, et al., 2024).

1.2.1.4 The Right to Development and the Right (and Duty) to Sustainable Development

The Right to Development (RtD) (UNGA, 1986) is a human right; there is some controversy about whether it is a right of individuals or countries. Parallel to the developments within this Right to Development regime, the Climate Convention codified that: “The Parties have a right to, and should, promote sustainable development”; the latter differs in that it refers to countries and, through the strategic use of a comma during the negotiations (Biniiaz, 2016), discusses a right to promote sustainable development (RtSD) which is not really a right (see Chapters 3, 4 and 6; Gupta & Arts, 2018; UNFCCC, 1992).

In the context of climate change, the Global South focuses on the original RtD narrative and link it with claims of environmental and climate justice for the redistribution of ecological space between North and South. However, the RtD is often interpreted in relation to increasing GDP growth by Global South countries, because some consider it a prerequisite for social development and inclusiveness (Gupta & Pouw, 2017), and it translates into ‘development first’ claims, allowing for pollution and FF exploitation for redistribution under the guise of inclusive growth (Bos & Gupta, 2016, 2018; Gupta & Pouw, 2017; Rauniyar & Kanbur, 2010). This perspective is mostly based on a linear conception of development, in which Global South nations would follow the Global North’s footsteps (Arsel et al., 2016b; Gupta & Chu, 2018).

Given the hazards of climate change impacts, pollution, and asset stranding, arguing for a pure RtD with legitimacy in the context of climate change and the Paris Agreement remains questionable (Gupta & Chu, 2018). Although the RtD and the RtSD are distinct, they complement each other, calling for a comprehensive redefinition of development (Gupta & Arts, 2018). The Global South should learn from the Global North’s failures and claim their RtSD, building their own alternative and context-specific development trajectory (Gupta & Arts, 2018; Gupta & Pouw, 2017).

The above problems clarify why focusing on LMICs’ energy transition and LFFU is important (see 4.1). Since most fossil fuels reserves are physically located in the Global

South, it is likely that these countries will use their resources to foster economic growth, industrialisation, and address development challenges such as energy access, poverty and inequality, fulfilling their RtD. On the other hand, fossil fuel-based development is a double-edged sword: it exacerbates climate change impacts, which already disproportionately affect the Global South (IPCC, 2022b), and these countries risk ending up with carbon lock-in, stranded assets, and increased debt. Distrust in climate negotiations towards the Global North (see Chapter 3) and the current global political economy are pushing the Global South towards short-term priorities that further lock them into fossil-based trajectories, fuelling the cumulative injustices of climate change (Foster et al., 2024; Gupta, Chen, McDonnell, et al., 2025).

These issues are increasingly socially relevant because addressing climate change now requires urgency and justice, as the window for LFFU and reaching 1.5°C is already shrinking. Anthropogenic CO₂ emissions must be cut by 45% from 2010 levels by 2030, and net zero emissions must be achieved by 2050 (IPCC, 2018). Promoting the exploitation of fossil fuels to foster development will conflict with climate mitigation, making even more urgent to address the challenge of balancing the development needs of the Global South with fossil fuel exploitation and climate action (Caney, 2016).

1.2.2 Academic problem and relevance: scholarly knowledge gaps

The research addresses a global issue that has received little attention. Global South's abundant fossil fuel reserves are exploited to meet growing energy demand and rapid economic growth through exports and revenues, but potential losses from fossil fuel phase-out and stranding can be enormous and transferred to these countries (see 1.2.1; Bond et al., 2020; Malek et al., 2022; Semieniuk et al., 2022). The short-term goals of Northern financial actors align with those of Global South investors and governments. This study explores the complex causes, institutional incentives, and narratives that hinder global efforts to meet the 1.5°C target and related financial and policy commitments for tackling climate change (UNFCCC, 2015). The CLIFF project identified a broader gap in knowledge regarding the global politics of stranded resources and assets in the context of the Global South (especially LMICs). Within this gap, three more specific knowledge gaps in the existing literature are worth investigating (see Chapters 3 and 4): (1) the links between the energy transition and stranded assets in LMICs; (2) the underlying power dynamics embedded in the energy transition; and (3) the feasibility of leapfrogging and energy transformation in the Global South.¹⁷

First, the energy transition and stranded assets in LMICs (KGI). There has been little investigation into the relationship between the energy transition centred on fossil fuel phase-out, the risks of stranded assets and resources, and their implications for the Global

¹⁷ In this thesis I employ a qualitative spectrum-like distinction between *transition* (as incremental policy and market adjustments) and *transformation* (as deeper systemic change) (Newell, 2019). The knowledge gaps follow this spectrum.

South in terms of equity, development, and climate change impacts. Regarding stranded assets, the scholarship primarily targets institutional investors, with very few exceptions focused on emerging countries with newly found fossil resources. Research on the role of Global South governments in (dis)incentivising new investments in fossil fuel resources and assets is also limited, as is research on why fossil fuel investments are preferred over riskier renewables, and how (if at all) governments in the Global South are properly accounting for the risk of future stranded assets and resources in their energy transition.

Second, the power dynamics and agents of change (KG2). There is a paucity of investigation of the underlying power dynamics, both within and between nations, that are embedded in the process of entrenchment, carbon lock-in, and energy transition. The current fossil fuel-based energy system and incumbent actors, who own and control most energy resources, obstruct a fair energy transition, and use their power to maintain the status quo, whereas prospective change agents in the Global South may form coalitions powerful enough to alter power relations. Analysing these interactions requires a political economy perspective, which may help in the inclusive governance of stranded assets while fostering inclusive development (Gupta & Chu, 2018).

Lastly, the feasibility of leapfrogging and energy transformation (KG3). Instead of rapidly eliminating fossil fuels, energy transitions in many Global South countries appear to prioritise incorporating renewables to the energy mix, while fossil fuel production continues to grow. Despite the challenges posed by climate change, these countries often replicate fossil fuel-intensive development strategies similar to those of the Global North, reinforced through subsidies and other incentives. The role of renewables as an addition rather than a substitute for fossil fuels, along with the framing of fossil gas as a ‘transition fuel’, should be critically assessed. Consequently, research on the viability and appeal of energy leapfrogging, as an old (WMO et al., 1990) but vastly underemphasised development paradigm in the Global South, remains limited, despite its potential to prevent new stranded assets and achieve a transition away from fossil fuels.

Focusing on how an energy system is financed reveals power dynamics in energy governance and development amid climate change. Thus, researchers should analyse energy systems more holistically, to ensure inclusive transitions (Cholibois, 2020). By assessing power dynamics embedded in LFFU, the study contributes in two aspects: (a) it addresses a research gap by targeting LMICs that have discovered fossil fuels and have strong interests in fossil-based development; (b) it advances an innovative theoretical framework integrating institutional analysis with critical IPE, focusing on potential agents of change for energy transformation (see 2.4). In terms of scientific significance this thesis employs a multi- and interdisciplinary mixed-method approach (see 2.6) particularly strong in energy transition studies (Sovacool et al., 2018). It combines energy transition studies with international development literature on climate change and fossil

fuels, integrating quantitative approaches to elucidate the political economy of energy transitions.

1.3 Research questions, focus and limitations

1.3.1 Overarching question and sub-questions

To address the abovementioned knowledge gaps on the energy transition in the Global South, this thesis studies the role of LMICs in LFFU, as reflected in the overarching question of the thesis:

What dilemmas do low- and middle-income countries (LMICs) face in LFFU and promoting renewable energies, how have these dilemmas evolved over time, and how can alternative narratives and agents of change be mobilised to promote inclusive development agendas?

Following institutional analysis (Young, 1989, 2002) (see 2.4.1) the overarching question is unpacked into sub-questions on causation, performance and design, which in turn structure the chapter-specific research questions (Table 1).

Table 1 – Research questions

Overarching question	
<i>What dilemmas do low- and middle-income countries (LMICs) face in LFFU and promoting renewable energies, how have these dilemmas evolved over time, and how can alternative narratives and agents of change be mobilised to promote inclusive development agendas?</i>	
Sub-questions	Explanation
<i>a. Which types of institutional settings, relationships, incentives, and narratives shape LMICs governments' responses to the dilemmas in the energy transition? How have these changed over time?</i>	Institutional analysis assesses how poor multi-level institutional and policy mechanisms contribute to a given problem (causation).
<i>b. How have LMIC governments' policies addressed the energy transition's dilemmas over time, and which actions have been successful, and which have not? Why?</i>	Institutional analysis assesses how incentives function or fail in a specific policy setting (performance).
<i>c. Which actors, powers, and narratives can be mobilised to redesign the policies and incentives to LFFU, address the dilemmas, and promote inclusive development?</i>	Institutional analysis explores how to re-design instruments based on the performance of institutional incentives in a specific context (design).
Chapters sub-questions (CSQs)	Chapters
<i>CSQ1: How can energy transitions in the Global South be theorised and examined methodologically, and what are the implications for this thesis?</i>	2 and 5 (published)
<i>CSQ2: What is the Global South in global climate/energy governance? How has the North-South Divide evolved over time?</i>	3 (published)
<i>CSQ3: What is the continuing relevance of the North-South narrative in Earth System Governance, and how do evolving North-South dynamics shape it?</i>	
<i>CSQ4: What can be learnt from reviewing the scholarship on the Global South's energy transition, focusing on LFFU and the issue of stranded resources and assets?</i>	4 (published)
<i>CSQ5: How do LMICs frame their energy transition, and which narratives do they mobilise?</i>	5 (published)
<i>CSQ6: What rationales, based on fossil fuel data and the RtD/RtSD, could underpin Global South countries' engagement in or withdrawal from fossil fuel supply?</i>	6 (published)
<i>CSQ6.1: How do LMIC governments balance LFFU and their RtD? What role does the Right to Sustainable Development (RtSD) play?</i>	
<i>CSQ6.2: Which Global South countries warrant greater attention in supply-side climate action, considering their RtD and justice considerations?</i>	
<i>CSQ7: What are the dynamics of energy politics in fossil fuel supply in the Global South, and which actor coalitions can shape policy pathways for phasing out fossil fuels nationally and internationally?</i>	7 (submitted)
<i>CSQ7.1: How is the policy framework for energy and power generation structured in the focus countries?</i>	
<i>CSQ7.2: How do coalitions mobilise institutional, discursive, and material power to sustain or challenge fossil fuel expansion?</i>	
<i>CSQ7.3: What are the potential sites for countervailing powers to act at different governance levels?</i>	

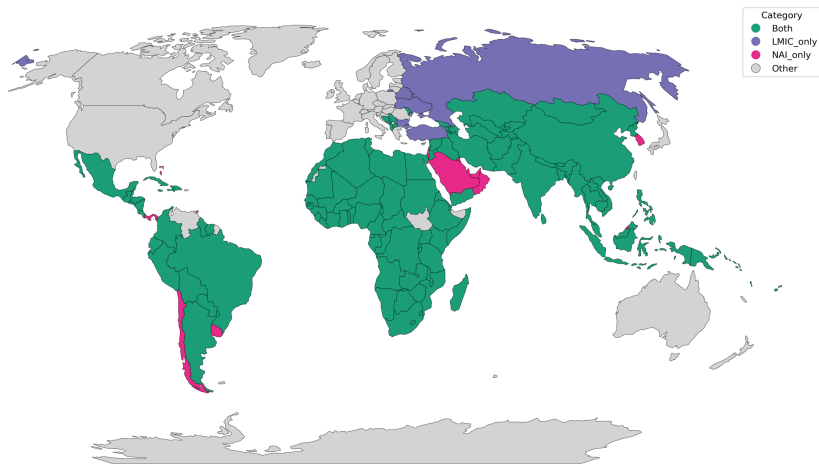
Source: Author.

1.3.2 Scope and limitations

1.3.2.1 Geographical, temporal, and actor focus

Following CLIFF’s proposal, I chose to geographically focus on Global South countries, specifically LMICs which are established or prospective fossil fuel producers, for two reasons. First, the Global South is presently and will continue to be pivotal in addressing climate change, as it is projected to contribute to the majority of GHG emissions, global energy demand, and future investments in clean energy up to the year 2050 (IEA, 2021d; IPCC, 2022a) and most of existing fossil fuel reserves are located in the Global South (Gupta, Chen, & Rammelt, 2024). Second, LMICs, especially countries that recently discovered new FF, are the best material representation of the challenges, dilemmas and opportunities present at the crossroads between climate change, energy, and development. To identify a set of relevant LMICs and then select my case studies, I adopted a double-ended funnel approach (see 2.6.1 and Chapter 6). I operationalise ‘Global South’ by overlapping the categories LMICs and non-Annex I to the UNFCCC (Figure 6).¹⁸

Figure 6 – LMICs, non-Annex I countries, and countries pertaining to both groups



Source: Author, data from World Bank (2022a). Map developed by Dr. Yang Chen.

As the map shows, the groups overlap but are not congruent: non-Annex I includes high-income countries (e.g., Chile, Saudi Arabia, Uruguay), while some LMICs are not non-Annex I (e.g., Russia, Turkey, Ukraine; see also 6.2.5). Using 2021 data is appropriate for contemporary analysis (1.1), but I acknowledge that LMIC classifications (which are debatable *per se*) have shifted and thus diverge from the 1990 LMIC group at the outset of climate negotiations. However, the shifts are limited: since 1990 only 34 countries, mostly European, have “graduated” to high income (World Bank, 2024c). While the

¹⁸ Chapter 4, which is the first publication, operationalises Global South as being non-Annex I only, therefore it features countries later not considered (Figure 12).

mismatch is real (but minimal) and some countries remain excluded, this operationalisation remains a practical approach for capturing established and prospective fossil fuel producers (see 1.3.2).

Given the climate-energy challenge (see 1.1-1.2), the role of LMICs in LFFU, and the implications of fossil fuels for development, the focus of the analysis is global and national throughout the chapters. Despite its relevance, particularly regarding “sacrifice zones” (i.e., communities and territories directly affected by fossil fuel activities) in the global energy transition (Donaghy et al., 2023; Finkeldey, 2022), the local perspective of frontline conflicts at the extractive frontier is out of purview of this thesis. Table 2 shows the spatial coverage for each empirical chapter.

Table 2 – Spatial scope of the different chapters

Chapter	Spatial scope
3	Global South (geographical-geo-economic South, South within the North, South within the South)
4	Global South (non-Annex I)
5	Global South (LMICs and non-Annex I, focus on 14 countries)
6	Global South (LMICs and non-Annex I)
7	Case studies (MICs: Argentina, Brazil and Colombia)
8	Global South (geographical-geo-economic North-South, North-South within the North, and North-South within the South)

Source: Author.

For justice and effectiveness reasons, the temporal scope of this research spans from 1990 to 2050, from the beginning of climate negotiations that led to the UNFCCC in 1992, until the year by when most governments, both from Global North and South, have pledged to reach net-zero emissions (UNEP, 2024). Within this timeframe, I consider a more specific scope, from 2015 to 2030, focusing on the span between the Paris Agreement and the end of “this critical decade” for accelerating action in transitioning away from fossil fuels in energy systems, as decided in the outcome of the first global stocktake (GST) at COP28 (UNFCCC, 2023).

For what concerns the specific actors at the centre of this analysis, this thesis investigates the role of LMICs in the energy transition in the context of climate change, mapping potentially relevant actors, in particular governments and potential agents of change, in order to analyse the vested interests in fossil fuels exploitation and the potential for LFFU (see 2.4).

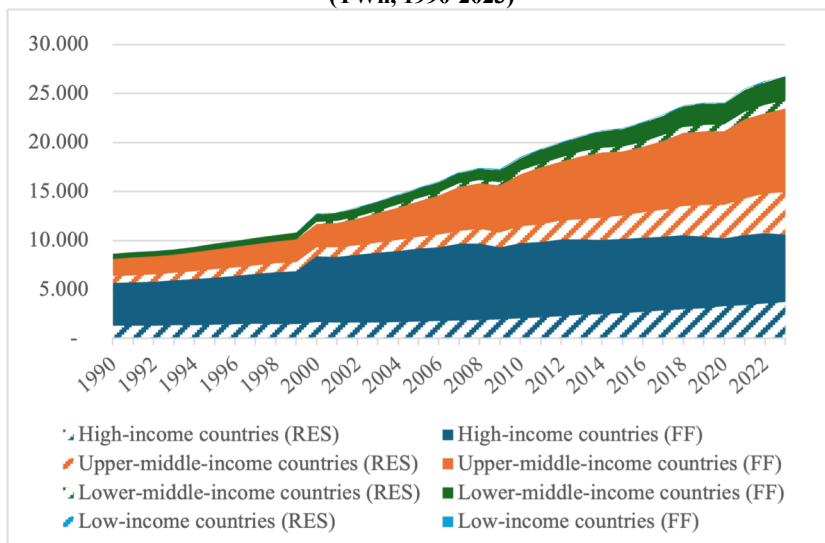
1.3.2.2 Thematic focus: transitioning away from fossil fuels in energy systems

Regarding the substantive thematic scope, I focus on fossil fuel supply (operating/decommissioning and new), national energy systems and transitions, and climate change mitigation. This also implies an implicit focus on reducing the rate of

growth of energy demand in the Global South. Particularly, the purview is on fossil fuel carbon entanglement (Gurría, 2013), fossil fuel extractivism and their implications for climate change and development (see 1.2.1). Although RES are addressed at various points throughout the manuscript, always situating them in relation to fossil fuel supply and LFFU, it is beyond the scope of this thesis to analyse and discuss the specific challenges and opportunities of the so-called *green* transitions, i.e., discuss the environmental impacts and the socio-ecological conflicts implicated in transition minerals extraction, new extractive frontiers and RES deployment (e.g., green extractivism; Riofrancos, 2019, 2020). RES deployment is discussed in relation to costs and profitability of investments in energy systems, therefore in close connection with supply-side climate policy, addressing the dilemmas in phasing *out* fossil fuels.

Indeed, the problem with emissions reduction can be described as a Venn diagram: CO₂ emissions represent 75% of total GHG emissions; the burning of fossil fuels makes 75% of those CO₂ emissions, and the largest single activity involved in fossil fuel combustion is electricity generation (37.5%), which is the core of the climate problem (Christophers, 2024). As discussed above, in the last 30 years, mitigation efforts have focused on decarbonisation through electrification. As such, power generation is relevant since it is an additional enabler for further decarbonisation of other uses (IPCC, 2022a). In this regard, growing electrification in other end-use sectors, such as transportation, industrial processes and households, if not decarbonised, will ultimately increase emissions (IEA, 2024b). Therefore, I primarily set the analysis on power generation and the role of fossil fuels in LMICs' energy systems. Looking at electricity generation from RES and FF by income group between 1990 and 2023 (Figure 7) despite RES increasing share, energy systems in all countries, but particularly in LMICs, is still predominantly based on fossil fuels, notably coal and gas used in thermal power plants.

Figure 7 – Electricity generation from renewables and fossil fuels (TWh, 1990-2023)



Source: Author. Data from Ember, (2025), Energy Institute (2024), with processing by Our World in Data.

Certainly, these general trends overlook the fact that in some LMICs, electricity generation is generally renewable because hydropower or other baseload RES are highly present in the mix (IEA, 2025a). Although the emission and fossil intensity of electricity systems in LMICs is less pronounced than, for instance, in the transport sector, attention to the fossil fuel sector and power generation remains pertinent for three reasons. First, climate change-induced impacts such as droughts and changes in rainfall patterns (IPCC, 2022b) directly affect water supply, exacerbating security in energy systems with high shares of hydropower (Liu et al., 2023).¹⁹ Thus, the greater the impacts, the greater risks for electricity generation and supply from RES, which can lead to increase reliance on FF, raising associated emissions and operational costs (Qiu et al., 2023). Second, in LMICs the transport sector is a major issue for mitigation policies, since oil consumption is widespread and import dependent (Gupta, Chen, & Rammelt, 2024; World Bank, 2024b). This analysis occasionally addresses the potential for coupled-decarbonisation of the two sectors (Ramsebner et al., 2021; Siregar & Möller, 2023), because transport is a crucial policy entry point for energy system decarbonisation, and the pace of fleet electrification will determine future oil demand and associated stranding risks (Bond et al., 2023). Lastly and consequently, the energy sector plays a dual role that is fundamental when discussing LMICs' challenges and opportunities in their energy transitions: it is a cornerstone in achieving national mitigation targets, but above all in preparing economies and societies for the impacts of decarbonisation of *other* countries (see Chapter 4).

¹⁹ This vulnerability is regionally exacerbated by phenomena such as El Niño (IEA, 2021a) and by the deployment of new hydropower capacity primarily through run-of-river systems, whose performance depends on water flow variability.

1.3.2.3 Research limitations

The study has limitations in the spatial and substantive coverage (1.3.2.1). For the spatial scope, the analysis does not provide a dedicated treatment of negotiating coalitions or intergovernmental organisations such as the Alliance of Small Island States (AOSIS) and OPEC. Therefore, it does not extend indistinctly to all Global South countries (however defined). These two groups embody Global South's internal heterogeneity in interests and climate vulnerabilities (see Chapter 3). AOSIS (39 countries) is a key player in climate policy and has mobilised cohesively to secure important outcomes in negotiations (e.g., the Paris Agreement, 1.5°C, loss and damage), including on fossil fuel (Betzold, 2010; Betzold et al., 2012; de Águeda Corneloup & Mol, 2014; Klöck et al., 2024; Ourbak & Magnan, 2018). OPEC (12 members) conversely has historically acted to defend its economic interests in fossil fuels, obstructing and delaying climate negotiations together with Northern countries (see Chapter 3; Dessai, 2004), while its role in a carbon-constrained world remains debated (Gault & Ait-Laoussine, 2020; Muttitt, 2020; Van de Graaf & Verbruggen, 2015). Without downplaying their importance, I address these two coalitions only indirectly by focusing on individual member countries consistent with the thesis' focus and the adopted operationalisation of Global South. These countries feature in Chapters 4, 5 and particularly 6. Finally, fieldwork was possible only in middle-income countries (see 2.6.1), therefore generalising the experience of these three countries to the entire Global South warrants additional caution.

Regarding the thematic scope, following the ERC Advanced Grant proposal, the analysis focuses on mitigation policies in energy and fossil fuel supply. With limited research time and capacity, I do not analyse the role of LMICs governments in other climate change-related issues. It is beyond the scope of this manuscript other areas such as agriculture, forestry and other land use; energy consumption (industrial processes, buildings and households, the military sector or AI); climate adaptation; loss and damage; or assessing the impacts and implications of consumption-based emissions (Davis & Caldeira, 2010; Hickel, O'Neill, et al., 2022). Also, without downplaying the multi-level crises resulting from asset stranding (Hoffart & Holz, 2024), this work does not address migration in relation to climate change and sustainable development (Nijenhuis & Leung, 2017). I define the "cost of inaction" narrowly as increased stranded-asset exposure and its fiscal, employment, and debt risks for the Global South. It is therefore partial, underestimated, and not comprehensive (cf. Narayan & Kuhl, 2025).

The climate change problem is unquestionably a matter of Global North responsibilities and cumulative injustices inflicted to the Global South, in which colonialism is more than a metaphor (see 1.1-1.2; Bhambra & Newell, 2023; Gupta, Chen, McDonnell, et al., 2025). The behaviour of rich countries, companies and people throughout the study is discussed in relation to North-South dynamics in climate governance (Chapter 3), specifically pivoting on the CBDRRRC principle, leadership and finance. Undoubtedly, Global North countries should take the lead in LFFU and be aware of the implications of

their own climate policies for LMICs (Eicke et al., 2021; Erdogdu, 2025; Hoffart & Holz, 2024); however, arguments for LFFU cannot overlook Global South's concerns in LFFU while the Global North does not restrict fossil fuel supply (van Vliet et al., 2025). Therefore, Global North's (dis)engagement in climate action is indirectly addressed in this analysis, explored through the prism of Global South countries' dilemmas in the global political economy. Without absolving rich countries, this analysis re-centres the Global South, with its colonial histories, contexts of subordination, needs and agency.

1.4 Policy relevance

This thesis can contribute to negotiations under the Paris Agreement (2015) regarding the implementation of supply-side policies and a managed phase-out (Muttitt & Kartha, 2020; Pellegrini et al., 2021; Pye et al., 2020; Slothuus, 2025). Specifically, it informs discussions under Art. 2.1(c) (finance flows consistent with low-emission and climate-resilient development) and Art. 4 on National Determined Contributions (NDCs) reporting process (Chapter 5). Additionally, through the analysis of the institutional and political economy constraints that shape LMICs' strategies and showcasing instruments redesign that could strengthen domestic legitimacy and roll-out of LFFU policies (Chapter 7), the findings can support the implementation of COP28 decisions on transitioning away from fossil fuels and tripling renewables, and future decisions on the matter (UNFCCC, 2023).

1.5 Thesis outline

Following this introduction, Chapter 2 provides the theoretical and methodological foundation of this research. Chapter 3 discusses the historical development of the North-South narrative in climate governance. Chapter 4 systematically reviews the academic state-of-the-art on the energy transition in the Global South. Chapter 5 analyse how LMICs governments engage in the energy transition, outlining the narratives through a neo-Gramscian-informed content analysis of UNFCCC submissions. Chapter 6 advances an inventory exercise based on fossil fuel data to identify Global South countries' interest in fossil fuels. Chapter 7, based on a policy analysis and interviews, analyse the policy environment around energy, climate and development policy environment in the case study, focusing on the coalitions in the political economy of fossil fuels. Finally, Chapter 8 integrates the findings from Chapters 3-7, answers the overarching question (see 1.3.1), speculatively develops four scenarios, and outlines a set of conditions for equitably LFFU in the Global South.