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An Unsettled "Stranded Asset Debt"? Proposing a Supply-Side Counterpart to the "Climate Debt" in a Bid to Guide a Just Transition from Fossil Fuels in South Africa and Beyond

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Abstract: The reign of the fossil fuel empire must come to an end if the average global temperature rise is to be meaningfully capped. Accordingly, a myriad of financial and non-financial stranded assets will be generated in the process. Ample research has explored the implications for a South African fossil transition from a domestic perspective, but a lacuna persists in linking South Africa's fossil regime to broader international finance flows, and particularly the role that actors from the "global North" should play in phasing out South African fossil fuels. This research finds that such institutions have exacerbated South Africa's prospective stranded asset exposure, and by doing so, have accrued a Stranded Asset Debt (SAD)—as a supply-side counterpart to the demand-side climate debt, which they have also accumulated—perhaps to the tune of at least several dozens of billions of dollars. Although the Paris Agreement is flawed, it embodies language that can be leveraged to settle the SAD "bill".

Keywords: *stranded asset, climate debt, ecological debt, South Africa, fossil fuels, Paris Agreement*

Introduction

The Climate Change Regime and Climate Debt

A recent study estimates that 60% of proven oil and gas reserves and as much as 90% of proven coal reserves globally must remain underground in order to comply with a 1.5°C temperature rise (Welsby et al. 2021), updating previous estimates indicating that a looser fossil fuel "budget" was aligned with a 2°C rise (McGlade and Ekins 2015). Both studies are rife with issues[1] as they are negligent of climate *justice* considerations (see e.g. Gardiner 2011), but they do make one thing clear: global fossil fuel production must decline—urgently and substantially—in order to minimise the cataclysmic impacts of the mutating climate.

Phasing out fossil production to the extent necessary will not only require substantial capital injections for decommissioning operational fossil-intensive infrastructure, but will also generate a slew of *multidimensional stranded fossil fuel assets* (e.g. Bos and Gupta 2018; Caldecott et al. 2013; Rempel and Gupta 2021), including, inter alia, the physical assets themselves, devalued financial assets (in the form of debt, equity)—potentially to the tune of hundreds of trillions of dollars (Linquiti and Cogswell 2016)—and "stranded labour" in the form of unemployment as e.g. coal miners are left without work (see subsection "Stranded Fossil Fuel Assets" below). These assets not only pose mammoth financial risks to global finance institutions (e.g. Gunningham 2020; Mercure et al. 2018)—with a recent study estimating that stranded upstream oil and gas profits may surpass $1 trillion (Semieniuk and Holden 2022)—but simultaneously existentially threaten the livelihoods of millions of fossil-dependent communities that are already more susceptible to adverse climate impacts (IPCC 2019, 2021—see the next subsection).

The only existing multilateral framework that (implicitly) attempts to coordinate a global fossil fuel phaseout is the Paris Agreement on Climate Change (UNFCCC 2015), which saw ratifying nations in 2015 pledge to curb their national greenhouse gas emissions in order to limit average global warming to 1.5–2°C (Article 2.1a) through Nationally Determined Contributions (NDCs). The Paris Agreement is plagued with inadequacies, prompting renowned climate scientist James Hansen (2015:2) to label some of its components as "pure bullshit". Patrick Bond (2021) has recently written a more expansive critique; here, I only focus on a few key points. The agreement itself does not make a single reference to "fossil fuels", "coal", "oil", "gas", etc., and therefore is a "demand-side" treaty as it targets emissions—rather than fossil fuel supply—governance (Asheim et al. 2019). This is problematic on a number of levels, not least because it enables a reliance on technofixes, like Bioenergy with Carbon Capture and Storage (BECCS), despite numerous studies debunking BECCS for being "fraught with huge uncertainty, technically, economically and politically" (van de Graaf and Verbruggen 2015:458).

This emissions orientation prompted many national governments to embrace the "net-zero emissions" gambit (e.g. the US [DoE 2021]; China [Hu 2021]), through which a reliance on BECCS and carbon offsetting indicates a reluctance by governments and financial institutions to abandon the lucrative fossil fuel industry. Even major fossil fuel Exploration and Production firms (E&Ps) have made similar pledges (e.g. Shell 2021). Leading climate scientists argue that:

> net zero has licensed a recklessly cavalier "burn now, pay later" approach ... perpetuat[ing] a belief in technological salvation and diminish[ing] the sense of urgency surrounding the need to curb emissions now ... [it] effectively serves as a blank cheque for the continued burning of fossil fuels. (Dyke et al. 2021)

Another issue with the Paris Agreement's NDCs and the "net-zero" approach is that it suggests that the contributions by any given nation are bound domestically. For instance, the US "net-zero" plan involves allocating $2 trillion for generating "millions of jobs and modern, resilient infrastructure" (DOE 2021), which neglects the US influence on global fossil fuel production, predominantly evident through homegrown multinationals like ExxonMobil and Chevron (and their respective investors and financiers). This presents a point of departure for this study.

The Paris Agreement does, however, embody language that could be leveraged for mobilising international funds to drive a "Just Transition" away from fossil fuels (see e.g. Newell and Mulvaney 2013). The Paris Agreement explicitly mandates "making finance flows consistent with a pathway towards low greenhouse gas emissions" (Article 2.1c), and although it does not specify any intricacies, it subsequently pledges that "[s]upport shall be provided to developing country Parties ... allow[ing] for higher ambitions in their actions" (Article 4.5), specifying that "[d]eveloped country Parties shall provide financial resources to assist developing country Parties with respect to ... mitigation" (Article 9.1), and will "enhance the capacity and ability of developing country Parties ... to take effective climate action" (Article 11.1).

This altogether indicates that financial institutions from the "global North" could (or *should*) play a role in allocating resources to phase out fossil fuels and govern stranded assets both in the "global South" and beyond. Climate justice scholars and activists have historically argued that this role could entail settling the "climate debt" owed by the North to the South (Bond 2010; Martínez-Alier 2002a, 2002b—see subsection "A Demand-Oriented Climate Debt" below). The climate debt debate is demand-oriented in that it is limited to assigning responsibility for historic fossil fuel *consumption*, and does not grapple with its supply-side counterpart, namely fossil fuel *production*. Fossil fuel supply-side studies are gaining momentum (e.g. Gaulin and Le Billon 2020; Lazarus and van Asselt 2018; Le Billon and Kristoffersen 2019), including in the international policy space with calls for a "Fossil Fuel Non-Proliferation Treaty" to complement the Paris Agreement (Newell and Simms 2020). Altogether, the several aforementioned Paris Agreement Articles, juxtaposed with this scholarly drive for supply-side climate policy studies, suggests that the "climate debt" is missing a supply-side counterpart.

Scope: South Africa's International Fossil Fuel Finance Flows

South Africa presents a particularly influential geographical case to explore the international nature of fossil fuel finance flows. Its economy has developed an inextricable dependence on coal as both a cheap fuel and revenue source (e.g. Baker 2015a, 2015b; Baker et al. 2014). Coal is used to generate roughly 90% of energy (Cock 2019; Spencer et al. 2018) and 25% of national *liquid* fuel (Spencer et al. 2018) after undergoing the toxic, World War II-era coal-to-liquid (CTL) process ("Fischer-Tropsch") (Winkler and Marquand 2009). This fossil-interdependence is best defined as the *Mineral-Energy Complex* (MEC; coined by Fine and Rustomjee [2018]), which describes "a regime of accumulation based on low-cost state-owned electricity production ... and cheap labour ... tightly bound to energy and mining capital" (Baker et al. 2014:797). Eskom, the state-owned power utility, generates roughly 95% of South Africa's electricity (mostly from coal), transmits 90% and distributes 60% (Baker 2015a), and is *responsible for over 45% of South African greenhouse gas emissions* (Walwyn 2020), making it the "the continent's largest" polluter (Baker et al. 2014:792). Eskom single-handedly accounts for 70% of domestic coal *consumption*, with Sasol representing an additional 20% through the aforementioned CTL technique.

Many studies have taken commendable strides to unpack the MEC and the challenges that accompany a South African transition away from fossil fuels (e.g. Baker 2015a, 2015b; Bond 2018; Swilling et al. 2016) but, other than through passive allusions, none (to my knowledge) have unpacked the MEC within the context of a broader international fossil fuel finance and climate policy landscape. Hence, this paper poses the question: *To what extent is the South African fossil fuel industry driven by the international fossil fuel finance landscape, and what role could (or should) international financial, economic and political institutions play in phasing out fossil fuels in South Africa?*

This question and focus are not to suggest that domestic actors—particularly the South African state and national banks—do not play a role in a prospective South African fossil fuel phaseout; to the contrary, South Africa's recent history of state capture—exemplified through former president Zuma's close and corrupt ties to the Gupta family (Martin and Solomon 2016)—paired with the current Ramaphosa administration's policies hoisting the parastatal and fossil-intensive MEC—evident through, for instance, the Integrated Resource Plan (IRP), which forecasts that South Africa's installed coal power capacity will exceed 33 GW by 2030 and account for over at least 50% of total installed capacity (DMRE 2019)—clearly underscore how influential domestic players are in managing (or resisting) South Africa's fossil transition. Moreover, ample green finance has arguably prompted a reconfiguration of the MEC, primarily through the Renewable Energy Independent Power Producer Procurement Programme (REI4P), established in 2011 in an attempt to procure 17 GW of renewable power for South Africa's national grid (Müller and Claar 2021); in the REI4P's first three bidding windows, almost 4 GW of renewable power had been procured across 60 unique projects (Baker 2015a), and by the end of the third round, "the weighted cost of energy has reached a 23% discount to the cost of new coal-based generation" and "falling costs of power from wind and solar" have made South African renewable energy tariffs some 80% cheaper than those from Eskom's largest coal-fired power stations (Walwyn and Brent 2015:391). The MEC is immensely complex, and it would be remiss to frame it as one monolithic fossil bloc entirely at the mercy of international climate policy. Bearing in mind these intricacies, this research explores the extent to which the overlooked international fossil fuel finance flows add a new layer of complexity to South Africa's fossil transition.

This paper first discusses the key analytical concepts utilised and then elaborates on the methodology. The following sections present (1) a meta-level analysis of the international finance flows hoisting South Africa's fossil regime, and (2) a more detailed analysis of key South African fossil fuel projects in relation to said finance flows. The final section concludes by discussing the key findings through the climate debt and stranded asset analytical lens.

Key Concepts
A Demand-Oriented Climate Debt

Climate debt is a subset of ecological debt (Pickering and Barry 2012; Warlenius 2018) and can be deconstructed into two components: an *emissions debt*, embodying a recognition of the "disproportionate contribution to the causes of climate change" by "developed countries ... denying developing countries their fair share of atmospheric space" (Bond 2010:17) through their unabated fossil fuel consumption over the last centuries, and are now "indebted" (Mathews 2016); and an *adaptation debt*, accounting for the "disproportionate contributions to the effects of climate change" resulting in amplified adaptation costs mainly borne by the "global South" (Bond 2010:17). And by evading proactive climate action (Martínez-Allier 2002a), "the global North ... are digging themselves further into climate debt" (Bond 2018:53).

Although "it is important to quantify the [climate] debt in monetary terms" (Mayer and Hass 2016:353), it "must never be reduced to demands for monetary compensation alone" (Mayer and Hass 2016:353) though it may be paid through a combination of "restoration or compensation" (Warlenius 2018:140). Here, "restoration" indicates the "obligation of the creditor to cut current emissions to below its per capita share of sustainable emissions to free up space for debtor emissions", while "compensation" denotes the "transfer finance or technology that enables the same degree of 'development' that the restorative debt repayment would amount to, but without the emissions normally attached to it ('leap frog development' in UNFCCC lingo)" (Warlenius 2018:143).

Although the UNFCCC is "full of language of justice" (Gardiner 2011:310) and (indirectly) endorses climate debt by acknowledging that "Loss and Damage require recognition and calculation" (Bond 2018:53; García-Portela 2020), climate negotiators have met calls for repayments or reparations with friction (Pickering and Barry 2012). Moreover, even if negotiators and policymakers were unanimously to agree that a climate debt had truly been accrued and needed "paying", it is still unclear and contested who should pay this debt, to whom, how much, and how. The most common proposal follows the Polluters (or Emitters) Pay Principle (PPP) (Baer 2012:64; Bond 2010, 2018; García-Portela 2020; Heede 2014; Meyer and Roser 2010), which proposes holding historical GHG emitters (usually geobodies; Warlenius 2018) to account based on the proportion of atmospheric GHGs that they were responsible for emitting, though this has been met with *contractual* and *intergenerational* objections (Meyer and Roser 2010; Pickering and Barry 2012). Alternatively, the PPP could be expanded to account for a "combination of responsibility (contribution to the problem) and capacity (ability to pay)" (Baer 2012:61), or more formally, under the UNFCCC, the "common but differentiated responsibilities and respective capabilities" (CBDR-RC; UN 1992); under this framework, "those who pollute more should pay more, those who are wealthier should pay more, and those with the greatest need should be exempted or even compensated" (Baer 2012:62).

To explore how this climate debt debate could be expanded to encompass a supply-side dimension, I first unpack the second key concept in this study: stranded fossil fuel assets.

Stranded Fossil Fuel Assets

Phasing out fossil fuels will inevitably generate *stranded assets*, or "assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities" (Caldecott et al. 2013:7). This definition is technical, though, and at face value suggests that these "assets" are predominantly monetary, financial or economic; this is not the case, as they can take on various forms. In the context of a fossil transition, these span five dimensions and can include: physical (e.g. coal-fired power stations); natural (e.g. fossil resources themselves); human (e.g. coal mining jobs, fossil-based energy); financial (e.g. fossil debt, equity); and social assets (e.g. networks and communities built around fossil production) (ibid.; Rempel and Gupta 2021). For example, South Africa's 90,000 direct coal mining jobs and additional 180,000 indirect coal mining jobs (SAWEA 2018) run the risk of becoming "stranded" if abrupt and substantial efforts are made to leave South Africa's "coal in the hole", which would simultaneously strand coal-dependent families and communities, and threaten the livelihoods of hundreds of thousands of people. To avoid the objectification of people, I will refer to "stranded labour" and "stranded energy" as separate entities of this typology from here on out.

Moreover, the risks borne by companies, states, financiers and investors due to the prospective stranded fossil fuel assets that they manage may burgeon vested interests that can deter a fossil fuel phaseout. For instance, South Africa's National Development Plan explicitly "aims to eliminate poverty and reduce inequality by 2030" (NPC 2013:14); the aforementioned stranded labour resulting from a national coal phaseout, or the stranded revenue streams from forgoing commercialisation of fossil fuels resources, could be used as justification by the state to delay (or reject altogether) a South African fossil fuel transition. Indeed, financially speaking these prospective stranded assets could destabilise or paralyse nations from phasing out fossil production. For instance, former Ecuadorian president Rafael Correa recognised the several billions of dollars in forgone revenue streams that would result from failing to commercialise a national petroleum reserve, so sought to mobilise $3.6 billion from the international community as compensation for "stranding" these natural assets in 2007—known as the Yasuni-ITT initiative (see e.g. Larrea and Warnars 2009; Vallejo et al. 2015). After failing to mobilise sufficient funds in the following years, Correa pursued his "backup plan, a Plan B—to drill for oil" (Martin and Scholz 2014).

Similarly, institutional shareholders managing hundreds of billions in liquid financial assets (e.g. common shares) pertaining to major fossil fuel exploration and production firms may see it in their best interest to resist a global fossil transition, as that would de facto allocate the accompanying stranded fossil fuel assets onto their own balance sheets (Semieniuk and Holden 2022), violating their fiduciary duty (Rempel and Gupta 2020).

Thus far, studies on stranded assets have focused on, inter alia, *optimising investment portfolios* (e.g. Monasterolo and de Angelis 2020), *optimising carbon prices* (e.g. Kalkhul et al. 2020; Rozenberg et al. 2020; van der Ploeg and Rezai 2020), and *optimising the time to cease fossil fuel investments* (e.g. Baldwin et al. 2020; van der Ploeg and Rezai 2018). Although there is a growing and prominent scholarly body deploying justice-based research vis-à-vis fossil fuel phaseouts (e.g. Abraham 2017; Healy and Barry 2017; Kashwan 2021; McCauley and Heffron 2018), comparatively limited scholarship has explored the socioecological implications of multidimensional stranded assets, particularly in the "global South" (and even more so in the African fossil fuel context).

A Supply-Oriented "Stranded Asset Debt"?

The stranded asset framework presents a useful tool to merge with the "climate debt" in a bid to introduce a supply-side dimension to the latter. I propose conceptualising this with a new concept: the Stranded Asset Debt (SAD).

As a first pass, the SAD could be defined as *the debt owed by financial, economic and political institutions from the "global North" to the citizens of the "global South" arising from investments in coal, oil and gas projects and infrastructure by the "North" in the "South", thereby having generated and exacerbated the "South's" exposure to multidimensional stranded assets and their accompanying socioecological and existential risks.*

The SAD can be conceptualised both as the monetary and non-monetary costs and resources required to strand existing fossil fuel assets in order to adequately curb the average global temperature rise and combat the emergency; non-monetary costs can include, among others, the retraining and relocation that mining communities will have to undergo, while the monetary component includes, inter alia, the costs associated with decommissioning coal-fired power fleets, or providing a universal basic income (UBI) to stranded coal miners as new jobs (in potentially new sectors) are phased in (Bond 2018). Generally, the monetary component of the SAD (SAD_M) is composed of the costs of governing the various stranded dimensions, namely, physical (P), labour (L), energy (E), natural (N), financial (F) and social (S):

$$\mathrm{SAD_M} = P + L + E + N + F + S$$

This dual monetary/non-monetary conceptualisation is aligned with the notion that ecological and climate debts ought not be reduced to purely monetary terms, but should be quantified and "paid" by compensatory means (Mayer and Hass 2016). That is, "footing the stranded asset debt bill" is not to be reduced to writing a cheque; it envisions a power rebalancing to hold economic, financial and political institutions accountable for adequately and equitably evolving the global economy into a low-carbon form. As such, SAD should be seen *complementarily* to the climate debt (see Figure 1), though unlike the climate debt, which typically abides by the PPP (see subsection "A Demand-Oriented Climate Debt" above), the SAD makes use of the "extractors pay" and "capacity principles" (Kartha et al. 2018).

Moreover, the proposed SAD is within the Paris Agreement's bounds, as the SAD is explicitly *not* concerned with reparations for *past consumption*, but rather *present and future production*. The Paris Agreement incorporates language that implicitly mandates the acknowledgement and adequate governance of the SAD; Article 2.1(c), for instance (see subsection "The Climate Change

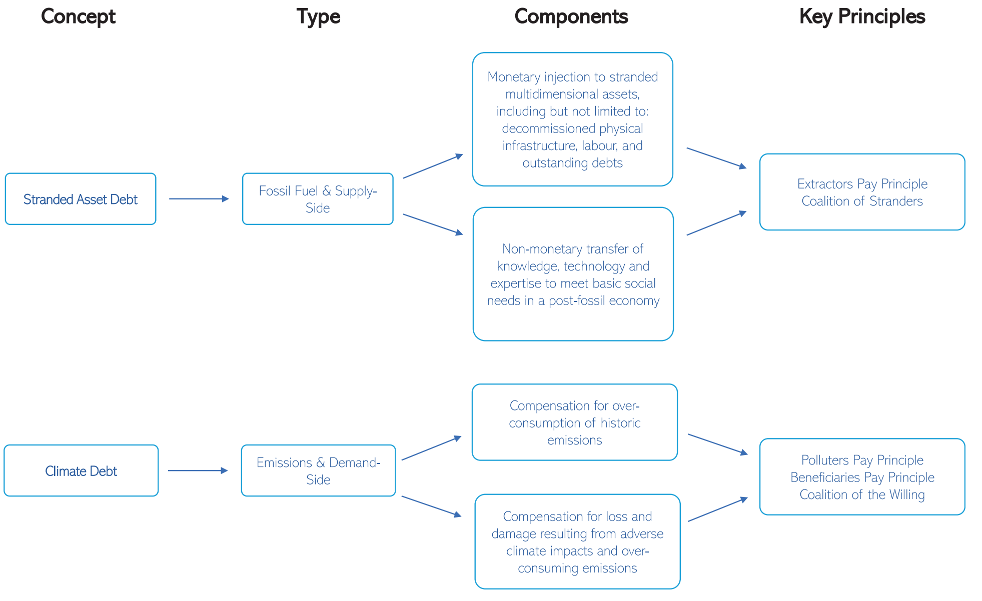

Figure 1: Visualising the complementarity of the Stranded Asset Debt and Climate Debt concepts (source: author) [Color figure can be viewed at wileyonlinelibrary.com]

Regime and Climate Debt" above), is virtually impossible without first establishing an upper-limit on global aggregate fossil fuel production (a "fossil fuel budget"), then *allocating financial resources* to e.g. decommission existing coal facilities, oil and gas refineries and exploration sites that are incompatible with this budget—that is, direct finance flows to strand existing and forthcoming fossil assets.

Methods: Following the Fossil Money

This research employs a "follow the fossil money" approach to explore the extent to which finance institutions from the "North" have de facto accumulated a SAD with respect to South African fossil fuel production. First, the 20 largest coal and 20 largest oil and gas E&Ps (by reserve size) were identified using the Fossil Free Funds (2020) list. Evidence of linkages to South African projects and/or operations was searched for, first on the websites of each company and then in the E&Ps' 2020 annual reports—the latter via a machine key word search using the following terms: "South Africa", "Africa", "Mpumalanga", "Limpopo", "Eskom", "Johannesburg", "Durban", and "Cape Town" (inspired by the ad hoc literature in subsection "Scope: South Africa's International Fossil Fuel Finance Flows" above). Of the 40 E&Ps, 22 were found to have a linkage to South Africa's fossil regime. Furthermore, the reports denoted partnerships with seven other key producers, which were included to the analysis, yielding a complete sample of 29 E&Ps (see Appendix A for the complete sample list).[2] Note that mutlinational E&Ps often disclose details regarding their global operations in their annual reporting to communicate with their shareholders, but depending on the stock exchange in which they are listed, they may not be legally mandated to do so, and as such, it is possible the reports on which this analysis was based may be incomplete.

Financial data was then collected in two ways. First, Yahoo! Finance was used to take an inventory of the major shareholders and the respective value of the equity that they managed in each sampled E&P (as of 30 July 2020, and 1 July 2021).[3] All currencies were converted to US dollars using exchange rates from the same day. Uncovering the major shareholders of these multinational E&Ps is important, for they are responsible for jointly making key decisions to dictate the future of the companies by voting at shareholder meetings. Although it is true that a substantial fraction of shareholders invest and participate passively rather than actively (see Christophers 2019), it is nevertheless an *active decision* to invest passively; it is therefore important to map where the *potential* shareholder influence over E&Ps resides, bearing in mind that in practice this influence may not be realised due to the nature of the institutional investor. Finally, a Python script was developed using the GeoPandas package to map the geospatial distribution of these finance flows.[4] Note that institutional shareholders may themselves be owned and governed by international investors, making it difficult to ascertain the true geospatial distribution of fossil assets and the power that accompanies them, suggesting that future research is merited to unpack these finance flows further down the value chain.

Second, I used Oil Change International's (OCI 2020) *Shifting the Subsidies* database to explore the extent to which Public Finance Institutions (PFIs) had supported the South African coal, oil and gas industry. PFIs, including Multilateral and Bilateral Development Banks (MDBs and BDBs) and Export Credit Agencies (ECAs) play imperative roles in de-risking fossil fuel projects and subsequently attracting external (private) capital that may have otherwise not been allocated for a particular fossil fuel project (Gupta et al. 2020; OCI 2020). It has two key limitations, though, communicated directly by OCI: first, datapoints before 2012 and after 2019 are not entirely comprehensive; second, some PFIs are particularly secretive about their energy-related spending (particularly from countries like South Africa), which suggests that the dataset may speak to the lower limit of PFI financing for South African fossil fuels.

Linking South Africa's fossil projects to multinational E&Ps and their financiers (and subsequently their countries of incorporation) bears major political-economic significance; most obviously, it visualises the global spread of the vested interests in the continued growth of South Africa's fossil fuel industry, and accordingly, and spatial distribution of the accompanying SAD implicit in a fossil phaseout (see subsection "Stranded Fossil Fuel Assets" above).

I then identified four key South African fossil fuel projects ("mini-case studies") to more intricately unpack using the SAD framework: the Medupi coal-fired power station (see subsection below); the Wolvekrans Middelburg Complex (WMC) (see subsection below) and Goedegevonden coal mines (see Appendix C);[5] and the SAPREF (Shell and BP South Africa Petroleum Refinery Company) crude oil refinery (see subsection below). These four mini-case studies were selected on the basis of being some of the most influential projects within their respective domains: Medupi is not only tied for being South Africa's largest coal plant (4.8 GW installed capacity, tied with Kusile), but was also the project that received the most PFI-borne financing according to the OCI dataset; the Goedgevonden and WMC mines are South Africa's two largest mines (by annual capacity); and SAPREF is South Africa's crude oil refinery with the greatest annual production.[6]

These case studies were unpacked using the Banktrack database[7] in addition to Global Energy Monitor's coal plant tracker (GEM 2020a), coal mine tracker (GEM 2020b), and fossil infrastructure tracker (GEM 2020c) datasets, in addition to the annual reports of the key financial and economic actors pertaining to each project, and a news item search, the latter conducted through a Google search (using various permutations of each project name as the search command), which was replicated on the *Daily Maverick*, a South African newspaper with a dedicated climate section called "Our Burning Planet" (see Appendix B).[8]

Once the national overview and project-level profiles were completed, the SAD framework (see subsection "A Supply-Oriented 'Stranded Asset Debt'?" above) was deployed to roughly estimate the extent of the SAD owed by finance institutes from the "North" to South Africans and beyond, culminating in the discussion in this paper's conclusion.

Overview: South Africa's MEC and International Finance Flows

E&Ps and Their Major Shareholders

Despite Eskom and Sasol dominating domestic fossil fuel *consumption* (see subsection "Scope: South Africa's International Fossil Fuel Finance Flows" above), South Africa's fossil fuel *production* is substantially dependent on at least 29 non-South African multinational and publicly-listed fossil fuel E&Ps, which are predominantly European (11), North American (6) and Australian (6). *These E&Ps accounted for almost 75% of South Africa's 2019 coal production (roughly 185 Mt)*, and are expanding these operations: South32 disclosed a $42 million CapEx in 2020; Terracom purchased four assets from Universal Coal in June 2020, all situated in Limpopo and Mpumalanga; and MC Mining has four thermal and metallurgical coal operations currently in the planning stage or under construction. The oil and gas story is more nascent, though a similar E&P dominance tale is told. Only 9/27 offshore oil and gas blocks and fields are under sole operation by South African petroleum firms (mainly by the state-owned petroleum company, PetroSA), *whereas 17 unique blocks are under sole ownership of and operation by non-South African firms*, and one additional block (263ER) is operated by Sasol (South African, 60%) though Eni (Italian) has 40% interest. Furthermore, four (all) of South Africa's crude oil refineries are operated by European and North American multinationals.

Figure 2 maps the major shareholders of the E&Ps, taken both in June 2020 (top) and July 2021 (bottom). A total of $285 billion in shares was tracked for 2020 (equivalent to 29% of the total 2020 market cap), of which 43% ($121 billion) was managed by shareholders from the US and an additional 22% ($63

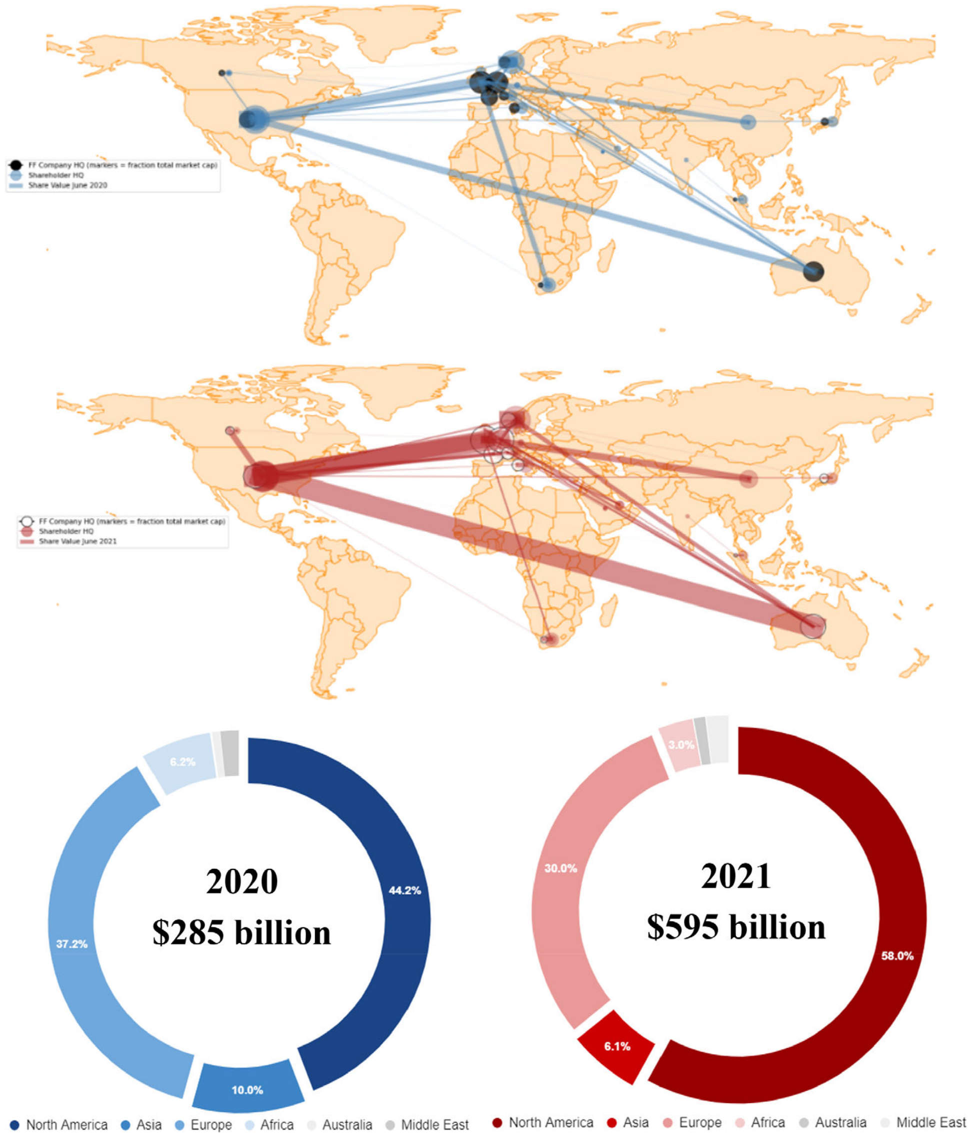

Figure 2: Map depicting the major shareholders of the publicly-listed fossil fuel E&Ps in June 2020 (top map, blue) and July 2021 (bottom map, red). The two donut charts in the bottom complement the maps by breaking down the fraction of the total (source: author) [Color figure can be viewed at wileyonlinelibrary.com]

billion) by the Norwegian Government Pension Fund alone. Overall, European (37%), North American (44%) and Asian (10%) shareholders dominated, jointly managing 91% of the total shares, *whereas African shareholders only managed 6%*. Meanwhile, 45% of the total market capitalisation in 2021 (or $595 billion) was tracked. The concentration of liquid assets outside of African balance sheets intensified, with shareholders from North America ($344 billion, 58%), Europe ($178 billion, 30%) and Asia ($36 billion, 6%) jointly managing 94% of the total shares accounted for. African shareholders still managed roughly $17 billion, but in 2021 account for less than 3%.

This altogether yields two implications: first, that the prospective stranded financial assets—in this case in the form of potentially devalued liquid equity and forgone dividend streams—and their accompanying risks are largely borne by a subset of key, gargantuan and non-South African actors; and second, the power of leveraging the respective E&Ps—and accordingly, the responsibility in failing to do so and exacerbating the climate emergency—lays on the balance sheets of the same subset of actors, mostly from the US and Europe.

Public Finance

At least $16 billion has been allocated by European, North American and Asian PFIs (ECAs, MDBs and BDBs) to finance South African fossil fuel projects in the last 15 years (see Table 1), mostly in the form of loans ($14.8 billion) but partially also in guarantees ($1.1 billion), 98% of which was to develop South Africa's coal sector, while a much more humble $300 million (2%) was funnelled to the oil and gas industry. The nature of this PFI-based fossil finance has been both temporally and geographically variable, although annual lending has remained somewhat consistent before the Paris Agreement ($1.3 billion per year) compared to after ($1.1 billion) (see Figure 3). The bulk of the pre-Paris Agreement (2006–2015) finance was allocated by the World Bank ($3 billion), the African Development Bank ($2.7 billion) and a series of ECAs, the latter mainly French ($2.3 billion), German ($1.5 billion), US ($820 million) and Japanese ($500 million). The vast majority (roughly $11 billion) of this financing was used to finance the controversial Medupi and Kusile 4,800 MW coal-fired power stations. The Chinese Development Bank also allocated $4.3 billion to finance Medupi and Kusile, though much later in 2017. Although these finance flows should be seen as underestimates, one thing is clear: European, Asian and North American BDBs and ECAs—along with MDBs like the World Bank—have played significant roles in sculpting South Africa's fossil fuel (mainly coal) sector, and in doing so have de facto accumulated a SAD owed to South African citizens (unpacked in the discussion).

Table 1: Summary of PFI financing for South African fossil fuel projects in three time periods: before the Paris Agreement was ratified (2006–2015, second column), after it was ratified (2016–2019, third column) and overall (2006–2019, rightmost column) (source: author, using data from OCI [2020] and inspired by Rempel and Gupta [in review])

	Fossil Fuel Financing (Million US$, nominal)		
	2006–2015	2016–2019	Overall
Bilateral	$627.78	$4,403.33	$5,031.12
Multilateral	$5,689.89	$0.00	$5,689.89
Export Credit	$5,163.48	$78.49	$5,241.97
Total	**$11,481.16**	**$4,481.82**	**$15,962.98**

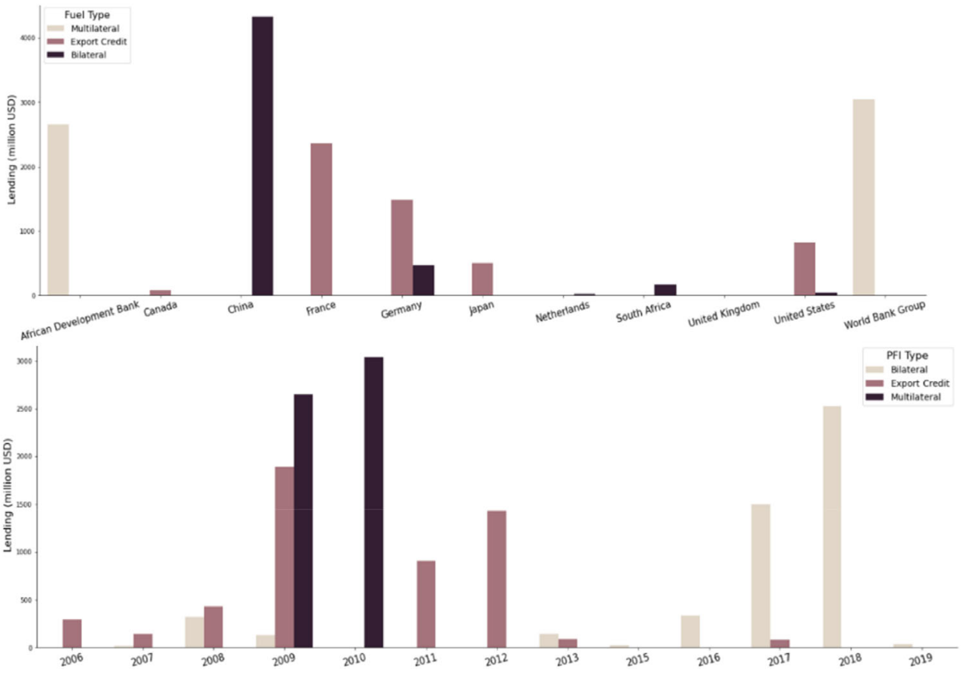

Figure 3: Breakdown of PFI lending to South African fossil fuel projects by institution (top chart) and by year (bottom chart) (source: author, using data from OCI [2020] and inspired by Rempel and Gupta [in review]) [Color figure can be viewed at wileyonlinelibrary.com]

Mini Case Studies: Prospective South African Stranded Assets

Medupi: Prospective Stranded Coal-fired Power Station

Medupi is one of Eskom’s largest coal-fired power stations. It is located in Lephalale, Limpopo province and is composed of 6 × 800 MW units, accounting for 14% of South Africa’s projected 2030 installed coal capacity (DMRE 2019). Eskom secured funding for Medupi in 2008/9, though by 2022 it is yet fully functional, with units 5 and 6 expected to come online by late 2022. Medupi has an expected lifetime of 50 years, and its annual emissions of 32 Mt CO_2e accounts for roughly 8% of South Africa’s proposed 2030 NDC emissions target (DFFE 2021). Exxaro Resources, the South African coal producing multinational, is the sole supplier of coal to Medupi from the Grootgeluk mine; Grootgeluk is expected to increase coal production from 30 Mtpa to 46 Mtpa to accommodate Medupi’s 4,800 MW capacity.

To say that Medupi was an “internationally-influenced” project would be an understatement (see Figure 4). The two leading firms contracted to engineer and develop Medupi were Hitachi Power Europe (HPE), the German-based subsidiary of the Japanese multinational conglomerate, who was contracted (for R20 billion [or $1.5 billion] in 2008) to produce the boiling units for both Medupi and Kusile (Medupi’s sister plant in Mpumalanga), and Alstom, the French-based manufacturer contracted (for R13.6 billion [or roughly $1 billion] in 2008) to engineer

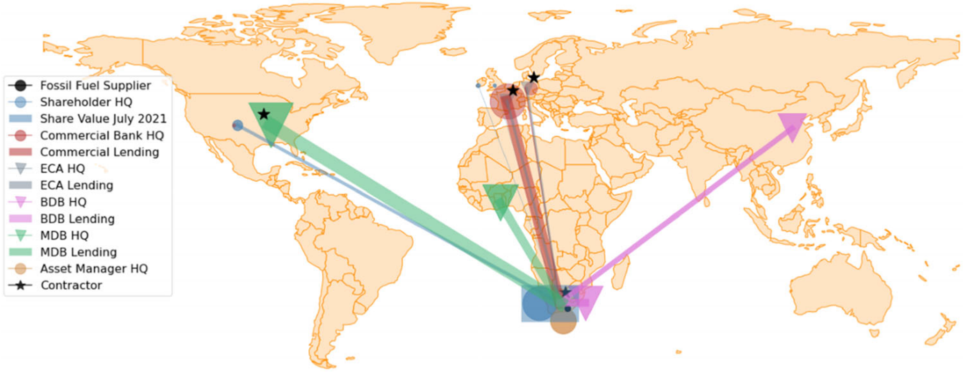

Figure 4: Map depicting the financiers and firms that drove Medupi's development (ECA: Export Credit Agency; BDB: Bilateral Development Bank; MDB: Multilateral Development Bank; HQ: Headquarters) (source: author) [Color figure can be viewed at wileyonlinelibrary.com]

Medupi and Kusile's steam turbines. In 2014, Eskom terminated its contract with Alstom, at which point Siemens (the German multinational) was contracted.

By 2013, Medupi's total project costs were estimated at R150 billion, the bulk of which have been financed by European, North American and Asian financiers (summarised in Figure 5). The World Bank (through the IBRD) and African Development Bank (AfDB) committed $3.75 billion and $1.86 billion, respectively (the former to be repaid in 28.5 years with a seven year grace period, the latter in 20 years with a five year grace period). Furthermore, with German ECA Euler Hermes and French ECA COFACE backing the project, nine French and three German commercial banks issued syndicated loans worth $2.45 billion and $740 million, respectively.

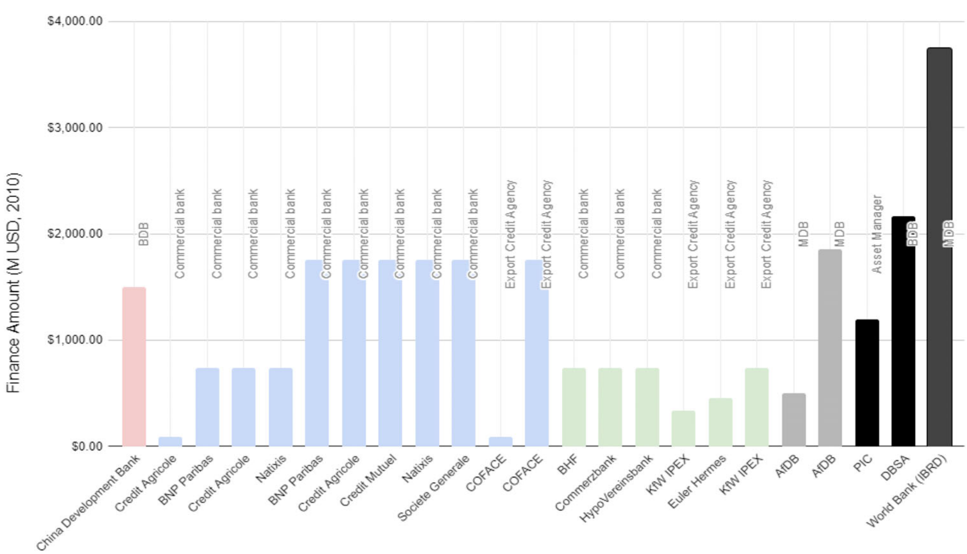

Figure 5: Depiction of Medupi's financiers by type, country and committed project finance (source: author) [Color figure can be viewed at wileyonlinelibrary.com]

Moreover, JP Morgan Chase did not itself finance the project but did play a consultancy role to Eskom. Bilateral development finance was also substantial, mainly from South Africa's own BDB—the Development Bank of Southern Africa (DBSA)—who issued a $2.17 billion corporate loan in 2010. Furthermore, the Chinese Development Bank (CDB) issued a $4.3 billion corporate loan in 2017.

The World Bank loan included a floating interest rate based on the London Inter-Bank Offered Rate (LIBOR). From 2017 to 2020, Eskom made interest payments to the IBRD at an average effective interest rate of roughly 11% (accounting for Rand's deflation from 2010-2020—see Appendix D for details).[9] If this rate persists, Eskom will have paid the World Bank R53.7 billion in interest over the 28.5 year payment period, compared to the principal loan value of R33.7 billion. That is, from 2017 through 2046, *Eskom will have paid almost R87 billion to the World Bank, of which some 62% may be in the form of interest.*

WMC: Prospective Stranded Coal Mine

WMC is a coal mining complex in Mpumalanga, near Middleburg; it has 383 Mt of recoverable coal reserves and produces roughly 14 Mtpa, though its listed peak production capacity is 26 Mtpa. Of the 14 Mt, 8.5 Mt of coal is supplied to Eskom's neighbouring Duvha power station, and the remaining 5.5 Mt is either sold to other Eskom facilities or is transported by rail to Richard's Bay Coal Terminal for exporting. Commissioned in 1982, WMC has 23 years of expected life remaining.

WMC was originally owned and operated by BHP Billiton, but its operating rights were sold to South Africa Energy Coal, a joint venture between South32 (with 92% operating interest) and a smaller, majority black ownership shareholder (Phembani Group, 8% interest). However, in August 2019, *South32 initiated the process to divest its operating interest in the WMC to Seriti Resources* (a major domestic producer), which was officialised in July 2021, granting Seriti Resources full operating rights.

South32's major shareholders (who enabled the divestment decision) were entirely non-African. In July 2021, South32's major shareholders almost exclusively resided in the US—including, inter alia, Vanguard ($563 million) and Blackrock ($425 million)—and in England—e.g. Schroder Investments ($789 million). Norway's Government Pension Fund also held $198 million.

SAPREF: Prospective Stranded Crude Oil Refinery

SAPREF is South Africa's largest and oldest crude oil refinery; it is situated in Durban and is owned by a 50/50 joint venture between Shell and BP. Commissioned in 1963, SAPREF's production capacity is 180,000 bbl/d (equivalent to 35% of South Africa's total refining capacity); however, Shell and BP have recently issued a tender to US firm KBR to upgrade the refinery's fluid catalytic cracker in a bid to expand the refinery's capacity. SAPREF employs 580 full time staff and 600 temporary contractors. Crude oil is imported from Saudi Arabia (38%), Nigeria (29%), Angola (16%), Iran (7%) and UAE (4%), among others, by tanker ships and is offloaded at SAPREF's "single-buoy mooring" (SBM); this SBM is responsible for importing 80–85% of South Africa's imported crude oil, *implying that Shell and BP single-handedly control as much as 85% of South African oil imports*.

US-based shareholders dominate as Shell's and BP's major shareholders as of July 2021, with the likes of Blackrock ($22 billion in Shell, $2.7 billion in BP), Vanguard ($12 billion in Shell, $2.8 billion in BP), Capital Research Management ($11 billion in Shell) and State Street ($2.8 billion in Shell, $885 million in BP) jointly managing $54 billion (22% of the combined market caps). Notably, not a single African financier is a major shareholder in either of these firms.

Discussion

A "Stranded Asset Debt" Owed to South African Citizens

It is evident that South Africa's fossil fuel regime has, to a substantial extent, been sculpted by European, North American and Asian financial and economic institutions. And in doing so, multinational E&Ps and their major shareholders and financiers from the "global North" have generated a slew of prospective multidimensional stranded fossil fuel assets—including, inter alia, the infrastructure itself (physical assets), the labour that drives production, the several billions of dollars in debt owed to multinational PFIs (financial assets), and the communities built around (particularly) mining in Mpumalanga and Limpopo (social assets).

Some simple computations reinforce the assumption that the bulk of these assets are likely to be prematurely decommissioned (i.e. stranded). For instance, annual scope 1 emissions from Medupi and Kusile (Medupi's sister plant, also receiving ample international PFI finance) *alone* sum to 78 $MtCO_2e$, or roughly 19% of South Africa's pledged 2030 reduced emissions (DFFE 2021) and *20–41% of the estimated emissions necessary for South Africa to be 1.5°C compatible* (Climate Action Tracker 2021). This neglects emissions not only from dozens of other fossil-intensive facilities, but also from other sectors—like transport and agriculture—which are historically also significant, altogether implying that in order for South Africa's fossil regime to align with Paris Agreement Article 2.1a, the majority of its existing fossil-intensive facilities (i.e. physical assets) may be decommissioned and therefore stranded.

As a result, the financial and economic actors have de facto accumulated a Stranded Asset Debt (SAD)—a debt that should be settled to prompt a just transition from fossil fuels in South Africa (see subsection "A Supply-Oriented 'Stranded Asset Debt'?" above). Although computing the monetary component of this SAD is well beyond the scope of this paper, it is nonetheless possible to take a first pass at estimating the rough order of magnitude of some of its components (see equation above—$SAD_M = P + L + E + N + F + S$) through simple calculations. For instance, the costs pertaining to the "human" dimension are again decomposed into two components, namely strand labour (L) and stranded energy (E):

$$H = L + E$$

South Africa's fossil regime contains some 270,000 direct and indirect jobs within the coal sector and likely several thousand in oil and gas sector vis-à-vis oil refining (SAWEA 2018), many of which reside in facilities operated by non-South

African E&Ps. We can estimate the costs of a UBI needed to support these fossil-dependents, assuming a liveable wage of ZAR7,000–10,000 for a standard family (WageIndicator 2019):

$$L = wage \times dependents = \frac{ZAR[7000, 10000]}{month \bullet person} \times 300,000$$

$$people = \frac{ZAR2-3B}{month} = \frac{\$147-210M}{month}$$

At an exchange rate of US$1/ZAR14.3 (September 2021), this equates to *an estimated monthly cost of $147 – 210 million per month, or roughly $2.2 billion annually*. This may appear significant before realising that the gross revenue *generated in 2020 alone* by three mining conglomerates: AngloAmerican ($32 billion), Glencore ($142 billion) and BHP ($43 billion) *could finance this UBI for over 85 years*. Note that this does not include the logistical and administrative costs to coordinate and implement the UBI system, which could be costly.

Moreover, South Africa's current grid has some 37 GW of installed coal capacity and an additional 3.8 GW of gas and diesel, yielding a total of roughly 41 GW of installed fossil-based power capacity. Meanwhile, the most recent bidding window (no. 4) of the REI4P procured solar PV and wind power projects with average total costs of roughly ZAR21 million per MW (including construction costs, working capital, development costs, fees, etc.) (Eberhard and Naude 2017). Using this as a baseline, the costs for replacing South Africa's 41 GW of fossil-based energy can be sketched:

$$E = \frac{ZAR21M}{MW_R} \times 41GW_R = ZAR861B = \$60B$$

Adding 41 GW of solar PV and wind installed capacity to the grid could cost an estimated ZAR861 billion, or $60 billion assuming the same exchange rate of US $1/ZAR14.3 (September 2021). Hence, the stranded labour and energy debt amounts to roughly:

$$H = L + E = \frac{\$2.2billion}{year} + \$60billion$$

Other substantial costs pertinent to the SAD include those associated with decommissioning and repurposing existing fossil-intensive facilities (*P*). This includes, among others, costs to decommission existing coal-fired power stations (C_P) and mines (C_M):[10]

$$P = C_P + C_M$$

A study (Raimi 2017) estimated the average costs of decommissioning and dismantling coal-fired power stations at $117,000 per MW capacity (in the US), with a range of $21,000–466,000 (in 2016 US$). Assuming that these costs apply to South Africa's coal regime, this would imply an estimated (average) decommissioning cost of $4.5 billion, with lower and upper estimates of $800 million and $18 billion, respectively:

$$C_{P,min} = \frac{\$21000}{MW} \times 38GW \cong \$800 million \quad C_{P,avg} = \frac{\$117000}{MW} \times 38GW \cong \$4.5 billion$$

$$C_{P,max} = \frac{\$466000}{MW} \times 38GW \cong \$18 billion$$

This is in the same order of magnitude as the estimated UBI costs; note that *this upper limit could be financed solely by the gross revenue that Glencore generated in 2020 ($142 billion) roughly eight times over*. Moreover, estimates suggest that it will cost $7.5–9.8 billion to decommission the coal mines in the US Appalachian region (Savage 2021), equating to $103–135 million per Gt of coal (EIA 2021). For South Africa's 10Gt proven coal reserves, this could imply decommissioning costs of $1–1.4 billion for closing the nation's coal mines:

$$C_{M,max} = \frac{\$135 million}{coal} \times 10 > \cong \$1.4 billion$$

$$C_{M,min} = \frac{\$103 million}{coal} \times 10 > \cong \$1.0 billion$$

Hence, the estimated costs for stranded South Africa's physical assets stand between roughly $2 billion and $19 billion:

$$P_{min} = C_P + C_M = \$800 million + \$1 billion = \$1.8 billion$$

$$P_{max} = C_P + C_M = \$18 billion + \$1.4 billion = \$19.4 billion$$

Altogether, these first pass and rudimentary estimates suggest that the SAD owed by the financial actors from the "global North" to South African citizens comes to at least several dozens of billion dollars, and this does not yet account for the stranded natural, financial or social fossil fuel assets that South Africa's regime is prone to absorbing, or other physical assets and labour, like oil and gas infrastructure and indirect and induced fossil employment, respectively.

This SAD discussion should be contextualised with the outcomes of COP26 most relevant to South Africa, namely the formation of the Just Energy Transition Partnership, through which the governments of France, Germany, UK, US, and EU have pledged to allocate "$8.5 billion for the first phase of financing, through various mechanisms including grants, concessional loans and investments and risk sharing instruments, including to mobilise the private sector" (EC 2021) to decarbonise South Africa's grid. Although this seems relatively promising, not only is this initial pledged $8.5 billion at least one order of magnitude lower than the surface level SAD estimates denoted above, but depending on how it is allocated, it may yield new or exacerbated financial dependencies—perhaps similar to those evidenced through the World Bank's mammoth loan for developing Medupi—particularly if concessional loans or even commercial loans are favoured over grants. Moreover, it is unclear whether these funds will be used explicitly to decommission existing fossil infrastructure, or rather to commission "green" alternatives, given that the central pledge of the Partnership is to "identify financing options for innovative technical developments and investments … to help the creation of quality, green jobs" (EC 2021). The latter would predominantly account for the *stranded labour* and *energy* dimension of the SAD (though evidently falling short), and would likely neglect several of the SAD's remaining dimensions, primarily fossil-intensive physical asset decommissioning. If not carefully monitored, the Partnership may not only create new financial dependencies for South Africa, but may also do little to adequately govern the already existing prospective stranded fossil fuel assets in its economy, despite potentially safeguarding against the creation of new ones by disincentivising investments in *new coal* infrastructure.

Limits and Future Research

Future research should consider conducting a more detailed and expansive estimation of all elements of the SAD to better discern the SAD owed by the "North" to not only South Africa, but the "South" more broadly. Further research is also needed to discern the intricacies of this SAD; namely, how will the costs be distributed among debtors? How much SAD have these (and other) institutions accrued beyond South Africa? Who are the creditors, and how should they be repaid, financially or otherwise? How much SAD have financial, political and economic institutions from the "*global South*" accrued? Finally, what are the financial and legal challenges in addressing SADs?

Although this research focuses on South Africa's fossil economy, it is likely that the SAD argumentation is extrapolatable to other contexts in the "global South". Multinational E&Ps very likely have played an influential role in the generation of prospective stranded fossil fuel assets elsewhere in the African continent; this is particularly true in the cases of Nigeria, Angola, Egypt, Algeria and Libya—nations with well-established oil and gas production sectors and documented linkages to E&Ps and finance institutions from the "North" (e.g. Idemudia 2009). Note, however, that these cases may differ from that of South Africa, not least due to their prominent oil and gas sectors and a virtually non-existent coal and mining sector, which may bear implications for the intricacies pertaining to a prospective SAD.

It should be noted that institutions from the "global South" (or South Africa in this case) should not be absolved from responsibility—they may also have enabled the accumulation of a SAD. For instance, Chinese PFIs were responsible for a substantial fraction of the PFI financing for South African fossil projects (see subsection "Public Finance" above), yet China is not classified as an Annex B nation under the UNFCCC and is therefore technically within the "global South". Since the focus of this research is limited to those from the "global North" (see Appendix A),[11] future research should explicitly unpack the role that institutions from the "global South" played in accumulating a SAD of their own, not only within their own domains, but internationally.

Although "divestment" has been praised and deployed by activist groups for quite successfully stigmatising the fossil industry over the last decade (see e.g. Schneider 2015), by divesting its *physical* assets, South32 (and BHP Billiton) has effectively absolved themselves from responsibility and accountability for years of coal production in Mpumalanga, and has de facto transferred their SAD onto Seriti Resource's balance sheet. Furthermore, in February 2022, Shell and BP announced that they are considering divesting their stakes in the SAPREF refinery to the South African government (Reed 2022), subsequently "dumping" the SAD burden onto another balance sheet. This concern also applies to divestment from liquid, financial assets (i.e. common shares) (Gupta et al. 2020), though fewer instances of major divestments are evident. For instance, Blackrock announced that that they would divest from their thermal coal assets in 2020 (Partridge 2020), but Blackrock's equity investments in major coal multinationals increased between 2020 and 2021—including in AngloAmerican ($2 billion vs. $2.5 billion), BHP ($6.5 billion vs. $19.8 billion), Glencore ($420 million vs. $2 billion), and Rio Tinto ($11 billion vs. $18 billion). That said, following the discussions at COP26 (Roach 2021), institutional investors like Blackrock may be more open or prone to rapid divestment in a bid to "clean and green" their portfolios, despite a consensus denoting divestment's climate ineffectiveness (Rempel and Gupta 2022). At a deeper level, divestment may encompass a critical element of climate *injustice* given its implications for de facto reallocating stranded assets (and thus SAD) across investors and financiers, a point that also merits further research.

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Endnotes

[1] For a comprehensive critique of the latter, see Kartha et al. (2018).
[2] Available at https://antipodeonline.org/wp-content/uploads/2022/06/Rempel-appendices.pdf (last accessed 30 June 2022).
[3] Data collection initially began in July 2020, and was subsequently repeated one year later to explore the extent to which the 2020 equity values remained consistent, particularly during the COVID-19 pandemic.
[4] Available in the GitHub repository: https://github.com/12314196/South-Africa-Fossil-Fuel-Flows.git (last accessed 22 June 2022).
[5] Available at https://antipodeonline.org/wp-content/uploads/2022/06/Rempel-appendices.pdf (last accessed 30 June 2022).
[6] Note that the Medupi mini-case study is substantially lengthier than the others because it was developed some 30-50 years after the others, and therefore more elaborate data was available.
[7] Available at https://www.banktrack.org/ (last accessed 22 October 2021).
[8] Available at https://antipodeonline.org/wp-content/uploads/2022/06/Rempel-appendices.pdf (last accessed 30 June 2022).
[9] Available at https://antipodeonline.org/wp-content/uploads/2022/06/Rempel-appendices.pdf (last accessed 30 June 2022).
[10] Decommissioning costs for crude oil refineries are excluded from this analysis due to a lack of reliable estimates to extrapolate from.
[11] Available at https://antipodeonline.org/wp-content/uploads/2022/06/Rempel-appendices.pdf (last accessed 30 June 2022).

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