Research Paper

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Left Stranded?

Extractives-Led Growth in a Carbon-Constrained World

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Summary

- Throughout the commodities boom of the last decade, multilateral banks, donor agencies and investors joined hands in promoting or supporting 'extractives-led growth'. Their approach assumes that low-income countries with fossil fuel, mineral or metal reserves will be able to deploy them for economic development. The resulting assistance and policy advice has generally had little or no connection to parties' broader commitment to low-carbon development.
- Two global factors now seriously challenge the extractives-led growth model. The first is the recent fall in oil prices and the longer-running downward trend in mined commodities prices. With most exporters now facing a period of rising deficits and debt, newer producers such as Ghana and Mozambique must revise their expectations for growth. The second is climate change and the longer-term risks to export markets from action to reduce greenhouse gas emissions.
- The concept of fossil fuels as 'unburnable carbon' or 'stranded assets' has little traction in low- to middle-income countries, especially when set against urgent poverty alleviation and infrastructure needs. Yet emissions regulation, fuel subsidy reforms and new technologies, particularly across Western and Asian markets, will affect the prospects for new and prospective exporters.
- Most countries banking on extractives-led growth have also committed to national visions for green growth and sustainable development. Their 2015 'intended nationally determined contributions' (INDCs) demonstrate ambition to create a range of social goods through climate resilience and emissions management measures. Without careful handling, the political and investment emphasis on extractive-sector development could derail implementation.
- In contrast to prevailing pressures to develop reserves quickly, donors and advisers should help put back on the table the full range of options available to a country. This includes choices to pace development, in tandem with boosting local capacity to benefit from investments, business and job opportunities; to integrate extractives development into sustainable economic diversification plans from the outset; and the choice not to extract or expand the sector.
- To make responsible policy choices, new and prospective producers need better information. This applies not only to their own resources and the full costs of producing them (including social and environmental impacts), but also to deciding whether and how to use resources at home, and to understanding the future risks to export markets for their products given evolving energy and carbon policies globally.
- Practical conversations regarding low-carbon development aims for extractives-rich low-income countries might best be framed in terms of national goals for sustainable economic diversification. They should place strong emphasis on energy policy and pricing, industrial planning, investment in efficient, resilient infrastructure and the development of skills such as the management of carbon within national oil companies.

1. Introduction

Throughout the commodities boom of the past decade, the prospects for the hydrocarbons and minerals sectors looked rosy. This raised expectations internationally about the potential for 'extractives-led growth' to boost economic development and alleviate poverty. Through these years, GDP in several countries with emerging extractives sectors – such as Uganda, Ghana, Zambia, Mongolia and Mozambique – grew at over 7 per cent a year (World Bank, 2016a). Many established producer countries used revenues from hydrocarbons and mining to deliver social dividends, reinforcing ambitions among lower-income societies with less developed extractive resources.

As the consensus flourished among multilateral financiers and donor countries in support of extractives-led growth, a very different argument was gaining traction among climate scientists, researchers, insurers and large investors: that the majority of proven fossil fuel reserves will ultimately become 'stranded assets', because they cannot be burned without unmanageable effects on the Earth's climate. Both of these discourses claim deep cross-cutting political and market implications, but to date they have taken place with little or no reference to one another.

A similar disconnect exists between climate change negotiations and policy debates over extractive-sector prospects and governance in low- to middle-income countries. Multilateral banks and donors deploy specialist teams to advise countries on extractive-sector development, often emphasizing its potential to reduce poverty and enable countries to graduate from foreign aid. Climate change rarely features in these conversations.[1] Yet these same institutions are also promoting green growth, albeit through different sets of experts, speaking with different government departments in the countries concerned.

With good reason, governance of the extractive sector and its revenues has often been a top priority of donors. The underlying assumption underpinning the extractives-led growth paradigm has been that demand for hydrocarbons and minerals on global markets would remain generally high, albeit with some volatility in price levels. After all, fossil fuels remain the largest source of energy worldwide. Their use doubled in volume between 1973 and 2013, and a growing middle class across Asia and Africa that uses more home appliances and expects greater mobility is set to further increase energy demand.

Yet this view of the long-term prospects for extractives is far from assured. In June 2015, the G7 leaders stated that, in line with scientific findings, 'deep cuts in global greenhouse gas emissions are required with a decarbonisation of the global economy over the course of this century' (Clark and Wagstyl, 2015). In December, the Paris climate change conference brought agreement among 195 countries to reduce greenhouse gas emissions, which will have profound implications for energy systems.[2] The policies and finance that countries and international investors commit to in implementing the Paris Agreement over the next few years will define the commodities markets of the 2030s and beyond.

[1] Efforts to reduce gas flaring are perhaps the exception. See, for example, World Bank, 2016b.
[2] Under the Paris Agreement on Climate Change, 195 nations agreed a framework for keeping the global average temperature increase to 'well below' 2°C above pre-industrial levels – aiming to limit it to 1.5°C above pre-industrial levels in order to reduce the risks and impacts of climate change. See United Nations Framework Convention on Climate Change (UNFCCC), 2015a.

Given that hydrocarbon projects may take 10 or 20 years to reach full production, a key question for producers is whether thermal power generation and oil-fuelled transport will continue to dominate the global energy system. Meanwhile, a growing number of poorer countries have ambitious plans for sustainable development, as they seek to avoid the damage that carbon-intensive industrialization has caused elsewhere and reap the benefits of clean-energy technologies. Changes in technology and legislation related to carbon emissions mitigation will also affect demand for minerals and metals.

Now is the time to explore the longer-term risks of a carbon-constrained world and what the related considerations should be when choosing or planning for extractive-sector expansion. The fall in oil prices since mid-2014 and the longer downward trend in prices of mined commodities are causing new or prospective producer countries to review and revise their expectations. Whether or not these price trends prove to be a cyclical phenomenon, they have again laid bare the economic vulnerabilities of dependence on volatile export commodities.

Governments and societies currently relying on their extractive resources to drive long-term national development will need to understand and manage evolving risks and opportunities. This paper sets out the parameters of the emerging debate, with specific emphasis on fossil fuels. It addresses a number of questions for new and prospective extractives producers, and the donors, researchers and private-sector stakeholders who work with them – in particular:

- If development of the extractives sector represents a 'once in a lifetime' opportunity, to what extent is that opportunity changing in a carbon-constrained world?
- What risks does extractive-sector dependence pose for other emerging sectors of the economy, which stand to benefit from the global shift to lower-carbon growth?
- Can donor support for extractives-led growth and for low-carbon, green development be reconciled?

2. Evolving Risks and Uncertainties

Extractives-led growth is variously considered a route out of aid dependency and an opportunity to achieve broad socio-economic development. As a paradigm it has gained numerous high-level advocates,[3] and versions of it have become the accepted narrative for most multilateral organizations, donors and consultancies working with hydrocarbons and minerals over the past decade.[4] The World Bank, for example, has characterized its support for extractives-led growth as 'driven by a mixture of optimism and hope about the potential of the extractive industries for positive, sustainable development, particularly in the world's poorer countries and in post-conflict societies' (EI Sourcebook, 2016).

The assumption underpinning extractives-led growth strategies is that high-value extractive resources will be developed. The narrative focuses on 'governance' – at the host government, investor and wider societal levels – as the way to ensure broad-based and inclusive benefits from below-ground resources. In its most fervent form, it suggests that even the least developed country can and should use its below-ground resources as the basis for economic growth, provided that it signs up to and follows all the international initiatives on good governance. These prescriptions generally involve a combination of revenue transparency, institution-building, fiscal measures such as the use of sovereign wealth funds and stabilization funds, and local capacity-building to increase 'forward' and 'backward' linkages from the sector.[5] While some governance frameworks may focus on environmental regulation and minimizing negative environmental and social impacts, consideration of global carbon constraints and the concept of low-carbon transition is generally absent.

The climate-related risks associated with investing in fossil fuels have become increasingly well known among political and financial analysts. Carbon Tracker Initiative (CTI) first raised the prospect of a 'carbon bubble' in global financial markets in 2011 (CTI, 2011). Further analysis led researchers to argue that 60 to 80 per cent of the coal, oil and gas reserves held by publicly listed companies cannot be burned under a climate change scenario of 2°C, and that these reserves therefore present a serious risk of leaving investors with stranded assets (CTI and Grantham Research Institute LSE, 2013). In its discussion of 'the CO_2 energy budget' required to stay within the 2°C limit, the Sciences Po/United Nations-backed Deep Decarbonization Pathways Project questions the logic of the energy sector investing 'hundreds of billions of dollars each year to discover and develop new resources and reserves' when existing proven reserves are already many times what can be safely used (IDDRI and SDSN, 2014:11).

Norms in multilateral finance have begun to shift away from the dirtiest fossil fuels and towards clean energy. Since 2013 the World Bank has decided not to finance new coal projects 'except in rare circumstances' (World Bank, 2013a; Plumer, 2013).[6] More recently, it has committed to spend over

[3] These include former UK prime minister Tony Blair and former UN secretary-general Kofi Annan. For example, Annan's foreword to the 2013 Africa Progress Panel report stated that there is 'good reason to be optimistic … economic governance continues to improve, providing protection against the boom-bust cycle fuelled by earlier commodity booms … Defying the predictions of those who believe that Africa is gripped by a "resource curse", many resource-rich countries have sustained high growth'. See Africa Progress Panel, 2013.

[4] 'Extractives-led growth' has been broadly promoted by international financial institutions such as the World Bank, the Asian Development Bank and the African Development Bank; by many donors, including Norway's Oil for Development Programme and the UK Department for International Development (DFID); and by civil society organizations and major extractives companies.

[5] 'Forward linkages' typically refer to outputs from the extractive sector that contribute to the wider economy (e.g. supplying oil and gas for domestic consumption). 'Backward linkages' generally refer to inputs to the extractive sector (e.g. local content and employment), in addition to foreign direct investment. See Stevens, Lahn and Kooroshy, 2015.

[6] Since then, other institutions including the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD) have followed suit, committing to finance coal only in 'exceptional circumstances'.

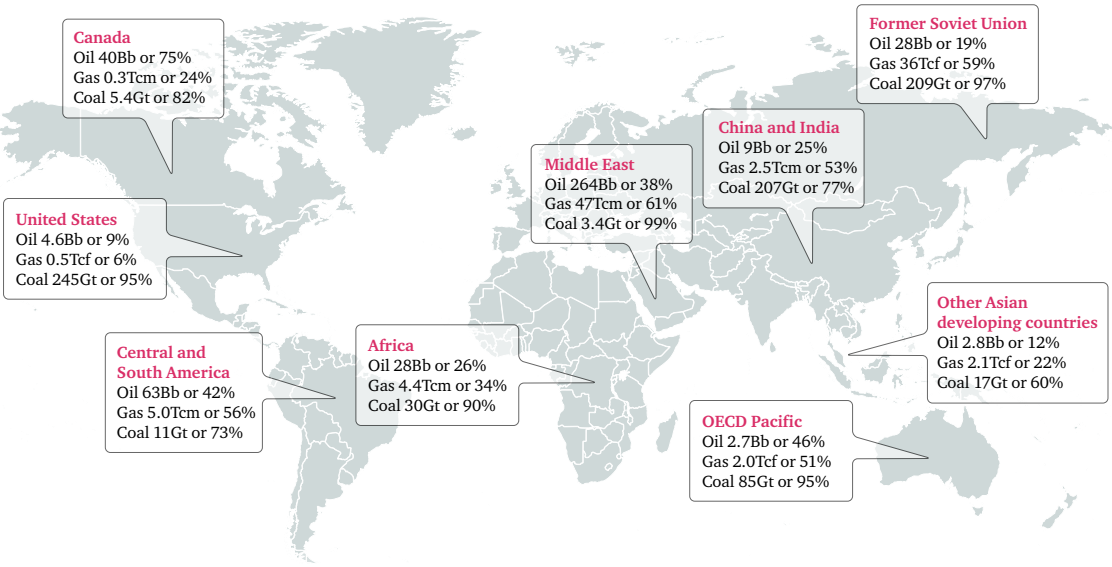
one-quarter of its investments on climate change projects, and to account for climate change in all future investment (Harvey, 2016).

Meanwhile the risk of stranded assets has helped trigger the emergence of the fossil fuel divestment movement. More than 500 institutions (many of them institutional investors under pressure from stakeholders), with combined assets of around $3.4 trillion, have now divested all or part of their holdings in higher-carbon commodities such as coal and oil sands (Fossil Free, 2016). Yet the divestment movement has so far had limited impact on the investment decisions of major companies, which remain far more affected by price changes and technology. Where oil and gas companies' operations are affected by climate and environmental risks, this is chiefly through national policies or legal cases in response to popular opposition, which compound concerns regarding the commercial viability of investments – moratoriums on shale gas drilling in parts of Europe and withdrawals from exploration in the Alaskan Arctic are examples (Conley et al., 2013; Lahn, 2013).

Rising climate ambition is expected to create winners and losers among fossil fuel-producing countries. A University College London (UCL) study concludes that 'globally, a third of oil reserves, half of gas reserves and over 80 per cent of current coal reserves should remain unused from 2010 to 2050 in order to meet the target of 2°C' (McGlade and Ekins, 2015). The authors estimate the geographical distribution of unburnable fossil fuel deposits based largely on carbon intensities in production and combustion. Under this scenario, emerging gas producers such as those in East Africa would appear to be the relative 'winners', while those with coal and higher-carbon liquid fuel reserves, such as Canada and the OCED Pacific countries (most notably, Australia), would be among the 'losers' (see Figure 1). While this assessment does not take into account any political basis for equity in distribution of unburnable carbon, it does raise questions for governments that consider their fossil fuel reserves as assets with durable value.

Figure 1: The geographical distribution of unburnable carbon resources

	Oil		Gas		Coal	
Global (with CSS)	431Bb	33%	95Tcm	49%	819Gt	82%
Global (without CCS)	449Bb	35%	100Tcm	52%	887Gt	88%



Note: Regional values are for volume and share of proven reserves which cannot be burned before 2050 under a 2°C scenario, without application of carbon capture and storage (CCS).
Source: Based on McGlade and Ekins, 2015.

These issues are not generally factored into discussions about governance and long-term strategy among hydrocarbon and mining ministries and state extractives companies, least of all in poorer countries.[7] Simply put, the concepts of climate change mitigation and stranded assets have little traction when set against urgent debt- and poverty-alleviation imperatives. However, the vision of decarbonizing energy systems in order to maintain climate stability and reduce local environmental pressures is already ingrained in the energy policies of the world's largest fossil fuel-consuming economies. This should be of interest to countries expecting to develop their fossil fuel reserves over the next two decades, as it implies risk to the markets for their products.

Risks to global export markets

Greater policy constraints on carbon are increasing market risks for fossil fuels, which currently account for over 85 per cent of global energy consumption.[8] Burning them is thought to cause 65 per cent of man-made greenhouse gas emissions, although the real figure is likely to be higher when escaped methane and nitrous oxide, among other factors, are taken into account (IPCC, 2014).[9] Under most scenarios, fossil fuels will continue to meet the majority of global energy needs until at least 2050 (see Box 1).

Box 1: What do scenarios say about fossil fuel use in the energy mix?

The general outlook portrayed by international fossil fuel companies and the media has been of a world of growing fossil fuel use for at least the next 25 years, with the implication that hydrocarbons will continue to dominate the energy mix for most of the century thereafter. BP's 'base case' scenario sees fossil fuels accounting for 80 per cent of total energy supply in 2035, with oil, coal and gas demand all growing between 2014 and 2035, but gas growing fastest.[a] ExxonMobil's projection to 2040 is similar, but sees slightly slower growth in demand for oil and gas, while coal demand declines by 0.2 per cent a year over the same period (ExxonMobil, 2016).The head of the World Coal Association disagrees with these scenarios, and expects coal demand in 2040 to be 33 per cent higher than in 2015 (Hagemann, 2015).

The mainstream New Policies Scenario (NPS) of the International Energy Agency (IEA) is based on policies and plans that countries have already announced (though not necessarily implemented). It sees growth in coal demand of 11 per cent by 2040 (or 0.4 per cent a year), a similar pattern for oil, and higher growth of 1.7 per cent a year for gas (IEA, 2015a). This is similar to the BP and ExxonMobil projections.

This and the current oil company projections remain way off the course needed to give the world a 50 per cent chance of avoiding dangerous climate change, in line with Intergovernmental Panel on Climate Change (IPCC) assessments. The IEA has developed a '2°C scenario' (2DS) to project what is needed. In this, the volume of fossil fuel use declines by one-third between 2012 and 2050, accounting for around 50 per cent of the global energy mix by that time (IEA, 2015b).

[a] Between 2014 and 2035, BP sees coal demand growing by 0.5 per cent a year, oil demand by 0.9 per cent a year and gas demand by 1.8 per cent a year. See BP, 2016.

[7] Observation based on the authors' experience in many discussions on good governance in the extractives sectors over the past decade. Glada Lahn was on the organizing committee of the Good Governance of the National Petroleum Sector project from 2005 to 2008, and both she and Siân Bradley are involved in the New Petroleum Producers Discussion Group run by Chatham House.
[8] Chatham House analysis of *BP Statistical Review of World Energy June 2015*, https://www.bp.com/content/dam/bp/pdf/energy-economics/statistical-review-2015/bp-statistical-review-of-world-energy-2015-full-report.pdf.
[9] Based on 2010 data.

Governments and economic planners should look critically at these scenarios and forecasts and understand the assumptions behind them. For instance, the New Policies Scenario (NPS) of the International Energy Agency (IEA) is frequently interpreted as a projection, when in fact it represents an illustration of an unsustainable trend, while the emissions trajectory that would be associated with the IEA's 2°C scenario (2DS) falls far short of the growing consensus that the world should aim for 'net zero carbon emissions' by 2050. At the same time, the IEA has repeatedly underestimated growth in the share of renewables in the energy mix in recent years (EWG, 2015; CTI, 2015).

Crucially, models may not be taking into account step-changes in infrastructure design, urban planning and the penetration of disruptive technologies such as storage or electric vehicles. Models may also ignore the speed with which new technologies can move down the cost curve (as proven with solar and shale technologies in the past decade), and the role of government policy through standards and regulation (such as through carbon pricing and taxation). These factors all suggest the need to consider downside as well as upside forecasts for fossil fuel demand.

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Shocks to the global energy market may also result from resource stress and weather patterns produced by climate change itself. These forces would effectively push up fuel prices in certain markets in the short term, but create potential demand destruction in the long term, as consumers and governments responded to tight markets with greater investment in decentralized and resilient renewable energy systems.

Changing patterns of use in one fossil fuel may also have cross-cutting implications for others. Table 1 outlines how greater carbon constraints might affect demand for different fossil fuels. Rapidly limiting the use of coal, the most carbon-intensive fossil fuel, for example, could lead to greater use of gas, its primary competitor in power generation. Equally, it may reduce demand for diesel, which is frequently used in the transportation of coal.

There is also significant variation within fossil fuel types.[10] Recent research by the Carnegie Endowment for International Peace has illustrated the variation in life-cycle greenhouse gas emissions between different oils: up to 50 per cent between light oils from Nigeria and the Caspian region, and heavy oils from Canada and Venezuela (Carnegie Endowment for International Peace, 2015). A study published in 2015 highlighted the variation in emissions factors for coal, finding that those for Chinese coal were generally 40 per cent lower than the global average provided by the Intergovernmental Panel on Climate Change (IPCC) (Liu et al., 2015).[11] The increasing availability of life-cycle emissions data may facilitate more targeted demand reduction policies, and put more pressure on producer countries and companies to employ climate-smart production processes such as eliminating flaring and increasing the use of renewables.

While the focus of this paper is on fossil fuels, it should be noted that the fuel intensity of metals and minerals extraction and production also remains a major consideration in a carbon-constrained world. With up to 60 per cent of the world's projected urban areas in 2030 still to be constructed

[10] For a snapshot, see table 'Pounds of CO2 emitted per million British thermal units (Btu) of energy for various hydrocarbon fuels', at US EIA, 2015.
[11] It should be noted that any downward revision in emission factors is more than offset by an upwards revision of China's estimated coal consumption since 2004. See Buckley, 2015.

(UN-Habitat and UNEP, undated), it is likely that demand for non-fossil fuel commodities will continue to rise over the next two decades. There is likely to be particularly pronounced growth in demand for copper, precious metals and certain rare earths, owing to the expansion of electricity networks and information and communications technology applications. In the long term, the main threat to demand for these commodities will come from the expansion of capacity for recycling and reuse in major consumption centres. Innovation in business models, such as the 'circular economy',[12] could also undermine primary demand while favouring integrated industries.

Table 1: Prospects for various fossil fuels under stricter global carbon constraints

Gas	Oil	Coal
Some see gas as a 'transition' fuel. Demand for gas will almost certainly rise in the near to medium term. Gas has the potential to act as a 'bridging fuel' from coal and oil to renewable forms of energy. In many markets, gas will displace coal in electricity generation and potentially oil in other sectors such as transport, reducing national emissions. **The question is, for how long?** Some models 'back-casting' for a 2°C world see a limited shelf life for gas.[a] McGlade and Ekins conclude that almost half of proven reserves would need to be left in the ground, even with the full application of carbon capture and storage (CCS). In the IEA's 2DS, global natural gas use begins to decline slowly in the 2020s. **Burning gas still emits CO_2.** Its role in a low-carbon economy will depend on regulations and development in ultra-efficient turbines and on the application of CCS. Methane emissions from gas extraction are also a concern, and may restrict or add costs to certain forms of production. **There is the potential for major regional markets for gas to emerge.** The development of markets between Russia and China, as well as the Middle East, East Africa and India, will be driven partly by the need to reduce coal's share of the energy mix. In East and Southern Africa, a regional gas market could help increase energy access and displace biomass (Demierre et al., 2014). However, in all cases the current supply glut, the costs of long-distance transport, the politics around pipelines, infrastructure finance and pricing remain obstacles to efficient markets.	**Oil is only marginally cleaner than coal, but is far less easily substituted.** In carbon terms, there is little between the two. However, in transport – the main consumer application of oil – few alternatives are available within the timeframe or at the scale necessary today. **Oil demand has levelled off or is falling in most developed countries, but high growth is evident in emerging economies.** Vehicle efficiency gains will be offset by growing populations, increased vehicle ownership and expanding road and trade routes. However, in the IEA's 2DS, the volume of global oil use in 2030 is 17 per cent less than in 2012, and in 2050 it is 37 per cent less than in 2012. **Regulation and disruptive technology will displace oil demand in the long term.** The prospect of a higher carbon price, carbon tax, increasing city-level taxes and fuel restrictions, along with the expansion of mass transit systems, suggests that a mix of electricity, hydrogen and biofuels could become the dominant energy sources in transport over the longer term. Advances in car battery technology and government investment in charging infrastructure would encourage the switch to electric vehicles. **In the meantime, efficiency gains are likely to have the greatest impact on demand.** More probable in the medium term is that the introduction of more efficient internal combustion engines in markets currently dominated by older and less efficient vehicles will reduce demand for liquid fuel in the transport sector.	**Without accounting for social and environmental externalities, coal is the cheapest fossil fuel.** However, it is also the most exposed to a high carbon price. Even increased generation efficiency will not overcome the additional operating costs of CCS, which is likely to undermine its competitive price advantage in power provision. **Despite growing demand, the price of coal has halved since 2011.** Increased gas use may result in greater volumes of coal becoming available on international markets (as happened when shale gas displaced a significant share of coal in the United States' domestic power generation). This would reduce coal prices, buoying demand in poorer countries. **Efficiency measures may force prices even lower.** China's energy intensity targets and efforts to reduce coal's share in the energy mix are likely to push down regional and even international prices. There are signs that Chinese coal consumption may have peaked (Green and Stern, 2015), although India and other countries may help to prop up the coal market in the coming years. **Coal investment is under increasing pressure.** Institutional investors and NGOs are driving a growing divestment movement, and increasing public opposition – as well as environmental policies – may affect investment in coal-fired power plants and thus future coal markets (Caldecott, Tilbury and Ma, 2013).[b] In the IEA's 2DS, global coal use declines in the 2020s, sinking to less than half its 2012 level by 2050.

[a] See, for example, 'The Global Calculator', developed under the oversight of the UK Department of Energy & Climate Change (DECC), available at http://www.globalcalculator.org/.
[b] The argument is made that sub-critical coal-fired power plants present a significant risk of stranded assets, given their far higher levels of pollution and water intensity compared with best available ('ultracritical') technology.

[12] In a circular economy, industrial processes are rewired along ecological lines so that waste from one process becomes input for others. See, for example, Preston, 2012.

The policies of consumer countries will be major factors driving the growth or decline of markets for extractive commodities. Looking at fossil fuel investment through the lens of shifting oil prices, the changing financial environment and increasing climate change regulation, Mitchell et al. argue that in the long term demand will be dampened by climate regulation and the increasing 'wedge' that this will drive between the cost of production and the cost of consumption (Mitchell, Marcel and Mitchell, 2015). The following factors are contributors to this wedge and are already influencing domestic policy-making:

Climate change mitigation commitments

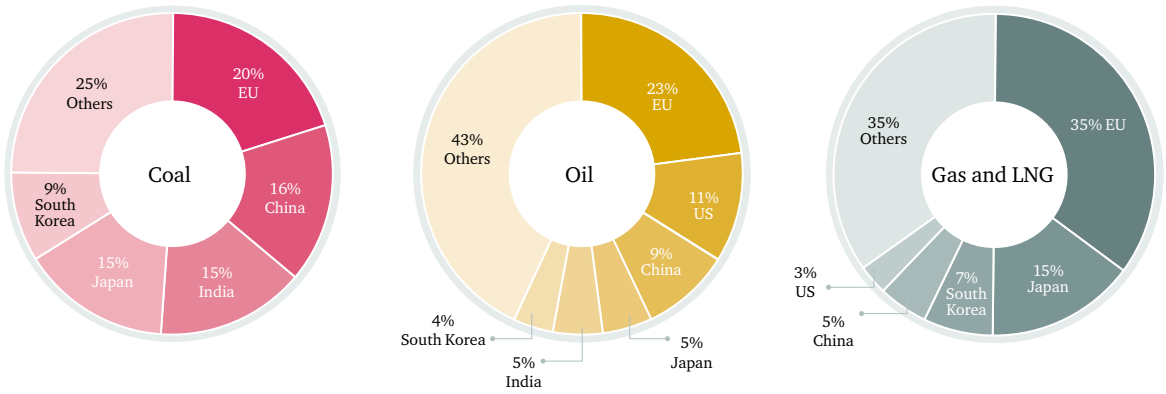
As part of the Paris Agreement in December 2015, many countries have agreed to reduce greenhouse gas emissions and increase forest cover in order reach global carbon neutrality by 2050, while recognizing that emissions will take longer to peak in developing countries (UNFCCC, 2015b). Parties have submitted 'intended nationally determined contributions' (INDCs) under the Paris Agreement, setting out how they plan to contribute to this goal.[13]

While exact estimates vary, the INDCs are expected to prompt a significant slowdown in fossil fuel demand. The IEA modelled future emissions and energy trajectories on the basis of unconditional commitments contained within the INDCs and the latest available global energy data. It found that, if the commitments were implemented, fossil fuel demand growth would slow to a 'relative crawl' of just 0.5 per cent a year by 2030, with natural gas increasing its share in the energy mix as the proportions for coal and oil declined. According to the IEA: 'Countries accounting for more than half of global economic activity are projected to either see their energy-related GHG emissions plateau or be in decline by 2030, including the likes of the European Union, the United States, China, Japan, Korea and South Africa' (IEA, 2015c).[14] This scenario does not meet the emissions reductions needed to achieve the Paris Agreement's goal of limiting the rise in global temperature to 'well below' 2°C. The facilitative dialogue that begins in 2018 (ahead of the Paris Agreement itself coming into force in 2020) and the review of INDCs every five years thereafter are designed to support a progressive increase in aggregate ambition.

For exporters, the demand growth expectations in markets they can economically serve will be an important indicator of future investment prospects, and of the staying power of prospective investors. Figure 2 and Table 2 outline the current energy imports and stated climate change commitments of the largest energy importers and growth markets for fossil fuels. The European Union, United States, China, Japan and India collectively account for around two-thirds of global fossil fuel imports.[15] China and India are currently the two major growth markets for oil. Under the IEA's New Policies Scenario, India's oil consumption is expected to grow by 6 per cent between 2014 and 2040, and on current trends the country is expected to overtake the EU, China and Japan to become the largest importer of coal by 2020 (IEA, 2015d). Other growth markets for fossil fuel consumption – some large producers in their own right – will also influence global demand. These include Thailand, Brazil, Malaysia and Indonesia, which together account for around 6 per cent of global fossil fuel imports.[16] Their INDCs indicate their direction of travel on carbon emissions reduction, although much will depend on the success of fossil fuel subsidy reform plans.

[13] It should be noted that the INDCs vary considerably by country in terms of the level of detail they provide on the institutional capacities, policy frameworks and investments required for their effective implementation.
[14] The IEA based its study on INDC pledges covering over 150 countries submitted by October 2015. Note that some countries' INDCs set out a conditional pledge (on climate finance, for example) and an unconditional pledge – the IEA analysis considers only the latter.
[15] Import data (2014) from Chatham House Resource Trade Database, UN COMTRADE, 2016. For further information, see https://www.chathamhouse.org/about/structure/eer-department/resource-trade-database-project.
[16] Import data (2014) from Chatham House Resource Trade Database, UN COMTRADE, 2016, as above.

Figure 2: Percentage of global imports, by value, 2014



Source: Chatham House Resource Trade Database, UN COMTRADE, 2016.

Table 2: Emissions reduction targets with implications for fuel imports, as outlined in INDCs

Importer	Target
EU	Reduce GHG emissions to 40% below 1990 levels by 2030. Reduce GHG emissions to 80–93% below 1990 levels by 2050.
US	Reduce GHG emissions to 26–28% below 2005 levels by 2025.
China	Reduce carbon intensity by 60–65% from 2005 levels by 2030. Increase share of non-fossil primary energy to 20% of energy mix. Peak emissions by 2030 or earlier.
Japan	Reduce GHG emissions by 26% by fiscal year (FY) 2030 from FY 2013 levels (maintaining consistency in the energy mix).
India	Reduce carbon intensity by 33–35% from 2005 levels by 2030. Increase share of non-fossil fuel-based power generation capacity to 40% of installed electric power capacity by 2030.
Korea	Reduce GHG emissions by 37% from the BAU level by 2030.

Note: GHG = greenhouse gas. BAU = business as usual.
Source: UNFCCC, 2015c.

Taxation and regulation to incorporate social damages

The International Monetary Fund (IMF) estimates that global 'post-tax' fossil fuel subsidies were in the region of $5.3 trillion (equivalent to 6.5 per cent of global GDP) in 2015, after accounting for 'externalities' and the social cost of carbon (Coady et al., 2015).[17] There is also a growing trend towards taxation policies that aim to incorporate these factors, first and foremost to protect public benefits in terms of clean air, health and traffic control. IMF economists estimated that in many countries a 'corrective tax' on air pollution caused by coal-fired power plants would be higher than that for carbon, depending on public exposure to emissions, values for mortality risk and the pollution intensity of different coal types (Parry et al., 2014:70).

[17] This sum includes an estimate for 'carbon costs', for example the discounted cost of future damage from climate change; and 'non-carbon externalities', which include health impacts and deaths from air pollution, congestion, accidents and road damage.

Environmental policies, including regulation and taxation, are already having an impact on demand, particularly in countries that do not subsidize fuel sales prices (mainly OECD countries, but also China and India, for the main transportation fuels). Moreover, many countries and cities are planning greater restrictions on fuel types or measures to enforce environmental performance (for example, restrictions on high-sulphur fuel, or carbon content goals). These will affect the cost of fossil fuel power generation and oil-fuelled car use. Some 'green' taxes may also generate revenue for governments to spend on improving the long-term efficiency of infrastructure.

Moves to mitigate local pollution are likely to affect global demand for coal more than the existing climate change commitments indicate. The dominance of coal in China's energy mix, for instance, has had huge human and economic impacts. Fossil fuel combustion and certain industrial processes are known to increase fine particulate matter, known as $PM_{2.5}$, which was linked to 1.23 million premature deaths in China in 2010 (median estimate) and damages worth between 9.7 per cent and 13.2 per cent of China's GDP (NCE, 2014). Now, $PM_{2.5}$ levels in Delhi are almost twice those in Beijing, and India has the world's highest death rate from respiratory illnesses; the government is proposing new rules to reduce nitrates, sulphates and other emissions by 80 per cent over the next three years (Jai Krishna, 2015). These trends are also evident in high-income countries – in the United States the Environmental Protection Agency (EPA)'s Clean Power Plan, which aims to cut power-sector carbon emissions by 32 per cent by 2030, is framed around safeguarding public health (US EPA, 2014).[18]

Reform of fuel price policies

Of all the above factors, it may be that fuel price reforms play the biggest role in dampening demand growth over the next decade. The decline in global oil prices since mid-2014 has given several countries – including large producers and consumers of fossil fuels, such as Indonesia, India, China, Egypt, Malaysia, Mexico, Saudi Arabia and the United Arab Emirates (UAE) – the political space to introduce transport fuel price reform. For importers, lower import prices can facilitate subsidy reduction by offsetting the immediate price impact on consumers; while for producers, falling oil revenues increase budgetary pressure and can help justify tighter national expenditure, particularly where subsidies are concerned. Emerging economies are increasingly interested in adding duties and taxes on fuel, which can increase government revenues (China and India have both raised taxes and duties on transport fuel since late 2014). As noted above, this effectively drives a wedge between the cost of production and the cost of consumption, so that lower international market prices are less likely to stimulate demand (Mitchell, Marcel and Mitchell, 2012). This lack of consumer response has already been noted across OECD countries during the 2014–15 fall in oil prices. In the long term, one possible outcome is that market reforms, coupled with the spread of electric vehicles and cheaper public transport options, will permanently undermine demand for fossil fuels.

Risks and opportunities for domestic sustainable development goals

Low-capacity new producers are not under direct political pressure to constrain their emissions, but a range of other factors warrant the consideration of low-carbon strategies.

First, so-called 'resource curse' impacts are back on the agenda and represent a serious threat to the economies of early-stage producers. Good governance initiatives in transparency and the establishment

[18] The US EPA's Clean Power Plan is intended to prevent 150,000 asthma attacks and up to 6,600 premature deaths per year.

of a sovereign wealth fund, for example, are rarely sufficient to counter the overwhelming impact of extractives-sector growth – or even the expectations of it (Stevens, Lahn and Kooroshy, 2015). Overspending, debt, inflation, declining agricultural competitiveness and vulnerability to commodity market volatility are all common symptoms of an extractives-led development pathway, and may outweigh the benefits of such a pathway for the country as a whole.

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Second, extractives-led development models risk locking countries into carbon- and pollution-intensive trajectories. Green growth and reducing carbon intensity have become increasingly accepted concepts for extractive producers in the developing world. For example, Vietnam adopted a comprehensive national green growth strategy in 2014, and green growth is one of the six strategies integrated into Malaysia's plan for 2016 to 2020. The Africa Progress Panel's 2015 report, *Power People Planet: Seizing Africa's Energy and Climate Opportunities*, made rethinking the relationship between energy and development its primary focus. In his foreword to the report, Kofi Annan noted the strong progress that many countries with extractive resources, such as Ethiopia, Ghana, Kenya, Nigeria and South Africa, have made towards climate-resilient, low-carbon development (Africa Progress Panel, 2015:12). A number of common factors, explored below, are driving these shifts in domestic ambition.

Improving public health

As the discussion above sets out, carbon-intensive development models have repeatedly been linked to negative public health and environmental impacts. Countries further along the development path have urged others not to replicate their experience. Gao Xiqing, when president of the China Investment Forum, warned: 'Do not necessarily do what we did … We now suffer pollution and an unequal distribution of wealth and opportunities.'[19] Putting in place strong environmental regulations and progressive standards on issues such as air quality will pay off over time in terms not only of health, but also in terms of economic growth and political stability, since environmental breaches are often sources of social unrest.

Choices made regarding development and use of a country's resource base and associated revenues will have long-term implications for the industrial processes, energy infrastructure and transport systems that are developed. In South Africa – a country that produces coal and relies on coal-fired power – state utility Eskom was granted postponement of the need to ensure that its coal-fired power plants comply with new air quality legislation.[20] Some of these plants have been the subject of a civil society campaign, alleging that ambient air pollution is resulting in chronic local health impacts.[21] For oil producers that have based their growth on cheap domestic fuel inputs, such as Venuzuela, Iran and Qatar, the impact of vehicle emissions and industrial processes on urban air quality is now a major concern.

[19] Gao Xiqing, chairman and president of the China Investment Forum, speaking to African leaders at the World Economic Forum 2012, cited in Mulugetta, 2015.
[20] Eskom applied for the postponement of the compliance time frames for Minimum Emission Standards. See Republic of South Africa/ Department of Environmental Affairs, 2014. These were granted, conditional on execution of an emissions reduction programme and air quality offsets. See page 71 of Eskom, 2015.
[21] See, for example, Myllyvirta, 2014. Eskom strongly denies all such allegations; see Eskom, undated.

Adapting to climate change

Adaptation and resilience are priorities for low-income countries, which are among the most exposed to climate risk. The INDCs of some emerging extractives producers, such as Mozambique, focus largely on these issues, particularly on the resilience of critical energy infrastructures. Others such as Nigeria and Kenya have included resilience of the extractive sector as part of their adaptation strategy.

The drivers for climate-smart and resilient development are broad, and include the ambition to gain early advantage in new green sectors, protect climate-sensitive national assets, access climate finance and avoid dependence on imports. As Tanzania's former president, Jakaya Kikwete, put it: 'If Africa focuses on smart choices, it can win investments in the next few decades in climate resilient and low emission development pathways' (Africa Progress Panel, 2015).

There are valid questions over how far the extractives sector can support these goals, either through resource revenues or co-benefits such as technology and training. Extractives may enable faster urbanization and infrastructure delivery, but ensuring that such development proceeds in a climate-resilient and resource- and emissions-efficient manner is a major challenge.

How the pursuit of extractives-led growth contributes to political advantage and positioning for climate finance should also be explored. Many developing countries are looking to 'leapfrog' industrialized countries by adopting low-carbon technologies, such as solar power and high-efficiency cooling. But while the costs of such technologies are falling, access to appropriate finance remains a challenge.[22] Opportunities to capitalize on international funds for renewable energy and efficiency interventions may be either helped or hindered by the extractives industry, depending on local circumstances and development strategies.

More generally, resolving the question of whether extractives projects are in countries' best interests in terms of climate resilience will remain challenging. It is impossible to weigh public costs and benefits against commercial project appraisals, for example, if the operator is not accounting for externalities such as pollution, depletion of non-renewable water resources, and greenhouse gas emissions. Opportunities should be considered in light of the water and energy intensity of extractives production, and their impact on local vulnerability to climate change.[23]

Increasing access to energy

Increasing access to energy is a core aim of both sustainable development and poverty reduction. The Sustainable Energy for All (SE4All) agenda on meeting global energy access goals – to which all major donors and multilateral agencies have signed up – emphasizes the role of technology and innovation in supporting access to energy, energy efficiency and increased uptake of renewables (SE4All, 2012). These objectives are also incorporated in the intergovernmental Sustainable Development Goals (SDGs), agreed in 2015, which provide a partial blueprint for national development plans to 2030.[24]

Table 3 shows current levels of access to energy among selected African countries with extractive resources and the twin objectives of improving access to energy and shifting the energy mix towards greener, cleaner sources.

[22] Climate finance and technology transfer are perhaps the most critical issues in development and climate debates. See, for example, Goldemberg, 1998.
[23] See, for example, Chapter 4 of UN Economic Commission for Africa (UNECA), 2016a.
[24] Goals 7 ('Ensure access to affordable, reliable, sustainable and modern energy for all'), 12 ('Ensure sustainable consumption and production patterns') and 3 ('Ensure healthy lives and promote well-being for all at all ages') are particularly relevant in this context. See United Nations, 2015.

Table 3: Energy statistics and targets in selected emerging hydrocarbon producers in Africa

		Ethiopia	Ghana	Kenya	Mozambique	Tanzania	Uganda
Electricity access	Latest	54% (2014/15)	66% (2010)	32% (2014)	25% (2014)	36% (2014)	14% (2015)
	Target	90% (2019/20)	100% (2020)	100% (2020)	50% (2023)	75% (2035)	30% (2020) 80% (2040)
Installed generating capacity	Latest	2,267 MW (2014/15)	2,000 MW (2010)	2,173 MW (2015)	2,300 MW (2015)	1,564 MW (2014)	850 MW (2013)
	Target	17,346 MW (2019/20)	5,000 MW (2016)	6,600 MW (2017) 24,000 MW (2030)	~10,000 MW (2018) (7,410 MW planned)	2,780 MW (2015) 10,798 MW (2025)	2,500 MW (2020) 41,738 MW (2040)
Energy mix	Primary energy balance	92% biomass 7% oil products and waste 1% electricity <1% coal	53% oil products 35% biomass 12% electricity	74% biomass 20% oil products 4% electricity 2% coal	80% biomass 10% electricity 9% oil products 1% natural gas	86% biomass 11% oil products 2% electricity 1% natural gas <1% coal	92% biomass 7% fossil fuels 1% electricity
	Sources of electricity	96% hydro 4% wind	64% hydro 26% oil 10% natural gas	44% hydro 31% oil 23% geothermal <1% wind <1% solar PV	98% hydro 2% natural gas	47% natural gas 31% hydro 22% oil <1% solar PV <1% biofuels	78% hydro 15% thermal 7% co-generation
Renewable energy targets	Various measures	Additional 25 GW by 2030 (22,000 MW hydro, 1,000 MW geothermal, 2,000 MW wind)	10% of installed capacity and 30% of rural electrification by 2020	Additional 9.3 GW by 2031	Additional 100 MW wind, 125 MW small hydro, and establish local PV supply chains by 2025	40% of total installed capacity by 2035	61% of gross final energy consumption by 2017
Tree cover loss	Total tree cover (% of total land mass)	12 million ha (11%)	7 million ha (30%)	3 million ha (6%)	29 million ha (37%)	26 million ha (30%)	8 million ha (38%)
	Tree cover loss, 2001–14	295,611 ha	616,484 ha	250,306 ha	2,048,678 ha	1,699,305 ha	439,968 ha

Sources: *Energy mix* – IEA (2016) 2013 data and Uganda Electricity Regulatory Authority (2016) 2014 data; *tree cover loss* – Hansen/UMD/Google/USGS/NASA (2016); *all other national data and targets* – Federal Democratic Republic of Ethiopia (2015), Republic of Ghana (2010), Ghana Energy Commission (2006), Republic of Kenya (2015), IBRD/World Bank (2015), República de Moçambique (2011), EDM (undated), African Development Bank (2015a), United Republic of Tanzania (2014), United Republic of Tanzania (2013), World Bank (2016c), Republic of Uganda (2015), Republic of Uganda (2007) and African Development Bank (2015b).

In contrast to many more established producers, some early-stage producer countries have plans for integrated energy policies that support broader national development or poverty reduction strategies, or certain sectors – for example, Mozambique's natural gas master plan and Tanzania's power system master plan (IEA, 2014:73). There is considerable scope for discussion around the costs, implementation and enforcement of these plans over time, and how these might intersect with low-carbon development opportunities.

Efficiency and renewable energy-related applications are central to this discussion, especially in rural areas, as they may lessen fossil fuel demand in future. For many rural populations, off-grid or mini-grid solutions are already generally cheaper and more competitive than coal-fired power (ETA and CTI, 2014).[25] In parts of Nigeria, widespread reliance on kerosene or diesel generators makes renewables cost-competitive, at as little as half the price of those fuels.[26] Increasing urbanization and the expansion of centralized power generation mean that renewables are not a 'silver bullet' yet. They are, however, playing an increasingly prominent role in plugging gaps where existing capacity is unable to meet demand. However, under certain circumstances, renewables are competing with grid electricity, for example in South Africa where delays and cost overruns on the construction of two new coal-fired power plants have left the estimated cost of grid electricity higher than that of wind.[27]

> It is impossible to weigh public costs and benefits against commercial project appraisals if the operator is not accounting for externalities such as pollution, depletion of non-renewable water resources, and greenhouse gas emissions.

None the less, there remain high societal expectations of the potential benefits of hydrocarbons development in terms of access to energy, security of supply and cost. Much will depend on the nature of the resource base, and its implications for prices and infrastructure. For example, where gas is a by-product of a reserve consisting predominantly of oil, and where the quantities are inadequate to support the development of expensive gas export infrastructure, domestic use may appear more logical. A government will then need to overcome a range of practical challenges, as the example of bringing associated gas to the domestic market in Ghana illustrates (World Bank, 2013b).[28]

Promoting the sustainable use of forests

Most sub-Saharan African countries and many countries in East Asia and South Asia suffer dangerous levels of deforestation. As Table 3 shows, many new and prospective extractives producers have seen decreasing levels of forest cover since 2001; this trend is often linked to energy access as wood and charcoal are staple cooking fuels. Burning firewood for cooking is about twice as carbon-intensive as using liquefied petroleum gas (LPG), and generates less than half as much useful energy.[29] In addition to its inefficiency, the use of firewood has substantial negative health impacts, such as high mortality rates linked to indoor pollution.[30]

[25] Modelled using IEA data.
[26] Electricity from kerosene or diesel generators is estimated by Chris Newsom of the Stakeholder Democracy Network to cost >$0.50/kWh, compared with renewables at $0.24–0.50/kWh. For context, grid electricity costs $0.10–0.15/kWh. See Newsom, 2013.
[27] Electricity generated from the Medupi power plant is now expected to cost SA97c/kWh (levellized cost) compared with SA89c/kWh for wind. See Donnelly, 2012.
[28] Many reports refer to avoidable failures in coordination and finance.
[29] Chatham House Model created for the Moving Energy Initiative – details available in Lahn and Grafham, 2015.
[30] For a useful account of health impacts of biomass and coal use for cooking and the potential co-benefits for climate and green economy, see WHO, 2011.

Using natural gas instead of wood and charcoal in cooking applications has the potential to make a significant contribution to SDG15, which is concerned with the sustainable management of forests and combating desertification, as well as with public health. The role of natural gas in reducing deforestation will be of real relevance for some early-stage producers, and for holders of gas reserves in particular. Whether it is practical to use gas to help reduce deforestation rates, given the costs of establishing supply chains and transportation routes and the uncertain potential for markets in poor rural and peri-urban areas, is a question of great interest to new producers.[31]

Harnessing new technologies

Another pull factor for low-carbon pathways in developing countries is the desire to take advantage of new technologies. Just as mobile phone technology bypassed traditional banking infrastructure in parts of Africa and enabled banking and money transfer services for poor agricultural workers, mobile phone companies are now pioneering finance models based on phone contracts, thereby allowing customers to lease or incrementally purchase home solar systems (Davies, 2015). The growth of an extractives sector can stifle entrepreneurship by crowding out other private-sector activity. Where industry crowds around the perceived competitive advantage offered by hydrocarbons and minerals, it may jeopardize opportunities to capitalize on emerging technologies and business models around renewable energy. Opportunities in agriculture, tourism, sustainable buildings and other sectors may also be constrained. This compounds the challenges that low-income countries already face in creating competitive industries.

[31] This draws on conversations with early or prospective producers of oil and gas from around the world at the New Petroleum Producers Discussion Group workshop and training sessions held in 2015 in Dar es Salaam, Tanzania. See Chatham House, 2015.

3. The Logic for Low-Carbon Growth in Extractives-Rich, Low-Income Countries

Many low-carbon development measures align directly with the national interests of extractives producers (particularly hydrocarbons producers). Energy efficiency measures and the use of renewables, for instance, help to protect export revenues by reducing the amounts of fossil fuel needed for domestic applications. Finding ways to factor environmental and social costs into regulation and pricing can help to incentivize productivity and higher industry standards at an early stage. But while the fossil fuel-intensive industrialization pathway of emerging economies and of established oil, gas and coal producers has significant drawbacks, there are no 'off the shelf' alternative models for emerging new producers. Aligning incentives, regulatory frameworks and industrial development plans in order to promote low-carbon growth will be challenging. Context-specific solutions will be needed, yet important lessons can be drawn from past experience in other countries.

Rethinking diversification: lessons from established exporting countries

Developing a diversified economy is the best way to mitigate the economic vulnerabilities of dependence on a single product with a volatile export market. For countries dependent on extractives revenues, this means both fostering growth across a variety of other sectors and ensuring that those sectors do not simply grow up dependent on extractives inputs (for fuel and feedstock). This requires significant political will and government capacity; even high-capacity states such as Norway have struggled with this challenge. Malaysia, Indonesia and Mexico offer perhaps the best examples of diversification among extractives-producing developing countries. However, in each instance, diversification only gained pace after resource revenues began to decline, and only with extensive incentives for high-productivity industrial activity, technological transfer and skills development (Callen et al., 2014).

Generally, major political and economic challenges are evident when diversification relies on a sector that receives government protection. Experience suggests that diversification is not sustainable unless infant industries are weaned off government protection in the form of low-cost energy and resource inputs or subsidies.

Diversification strategies also need to be reassessed in the light of market developments and opportunities over time. As a model of inclusive consultation and coherent policy, Trinidad and Tobago's story is a compelling one (see Box 2). However, the decisions taken and development pathway followed in that country reflect the economic and technological opportunities of the time. Developing the gas value chain to enable exports of steel and petrochemicals made sense in the 1970s and 1980s. It is questionable whether a similar approach would make sense today for gas reserve holders in East Africa, for example, given market trends, local sustainable development goals and the potential for alternative pathways.

Box 2: Trinidad and Tobago's experience of extractives-led development

Trinidad and Tobago (T&T) is an established oil producer, with over a century of production behind it and a total reserve base (calculated since the start of production) of around 3 billion barrels of oil and a roughly equivalent quantity of gas. The country shifted its focus from oil to gas production in the 1990s, becoming the world's sixth-largest liquefied natural gas (LNG) exporter. Today, natural gas output is around eight times that of oil. Of this gas, 60 per cent is exported as LNG and 40 per cent utilized in domestic petrochemical industries and power generation (IMF, 2012). T&T has around 728 million barrels of proven crude oil reserves and 13.1 trillion cubic feet of proven natural gas reserves left (US EIA, 2016).

T&T's development of its oil and gas sector is notable for the national vision it fostered, and for the clear policy framework guiding development of the natural gas value chain. The government set up a Commission of Enquiry into the Oil Industry of Trinidad and Tobago in 1963 and a national consultation on the future of the oil and gas industry in the late 1960s. It established a National Gas Vision in 1976, well ahead of the major gas discoveries of the 1990s, which transformed T&T's resource base and export profile.

Crucially, the Gas Vision recognized the limited life of extractives, so instead of relying on export revenues, which in the long term would have been 'tantamount to putting the nation on the dole', the government took the more challenging route of developing domestic steel and petrochemicals industries. Expanding local capacity and creating linkages with the rest of the economy were prioritized. This included using gas for domestic power and constructing massive power infrastructure to support industrial corridors, as well as efforts to generate wider economic activity around the latter. The rapid expansion of electricity generation ensured high levels of redundancy in the power sector, which translated into reliable access to energy for both industry and the wider population.

Yet the drawbacks of this model of economic development are increasingly clear. T&T has high GDP per capita and low levels of inequality, but also the second-highest emissions per capita in the world after fellow LNG producer Qatar (World Bank, 2016d), reflecting the unsustainable and resource-intensive nature of its economic diversification. Oil production is in decline, having fallen from 179,000 barrels/day in 2006 to 114,000 barrels/day in 2014 (US EIA, 2016). Gas reserves are also a concern: T&T's reserve-to-production (R/P) ratio is just 8.2 years, by far the lowest known ratio among the world's top 10 LNG exporters.[a] It is now working against the clock to transform its engine of growth from this hydrocarbons-driven industrial base towards a knowledge economy.

[a] The R/P ratios of the top 10 LNG exporters are as follows: Qatar (not reported), Malaysia (16.2), Australia (67.6), Indonesia (39.2), Nigeria (not reported), Trinidad and Tobago (8.2), Algeria (54.1), Russia (56.4), Oman (24.3) and Yemen (28.0). Data from BP, 2016.

Source: This box is based on a presentation by Anthony E. Paul at the New Petroleum Producers Discussion Group meeting in Dar es Salaam on 30 June 2015. See Chatham House, 2015.

Notably, countries that achieved relative success in diversification, including Malaysia, Indonesia and Mexico, adopted comprehensive energy policies to help guide fossil fuel use in their economies over time. Many oil- and gas-exporting countries, including Venezuela, Saudi Arabia, Iran, Nigeria, the UAE and Kuwait, have lacked such policies, although most are now developing them. When a significant hydrocarbons discovery is made, there is enormous political pressure on government to reduce poverty and distribute wealth by setting low domestic energy prices. Energy efficiency has seldom been a consideration in the large-scale urban planning, building and transportation networks that follow such discoveries.

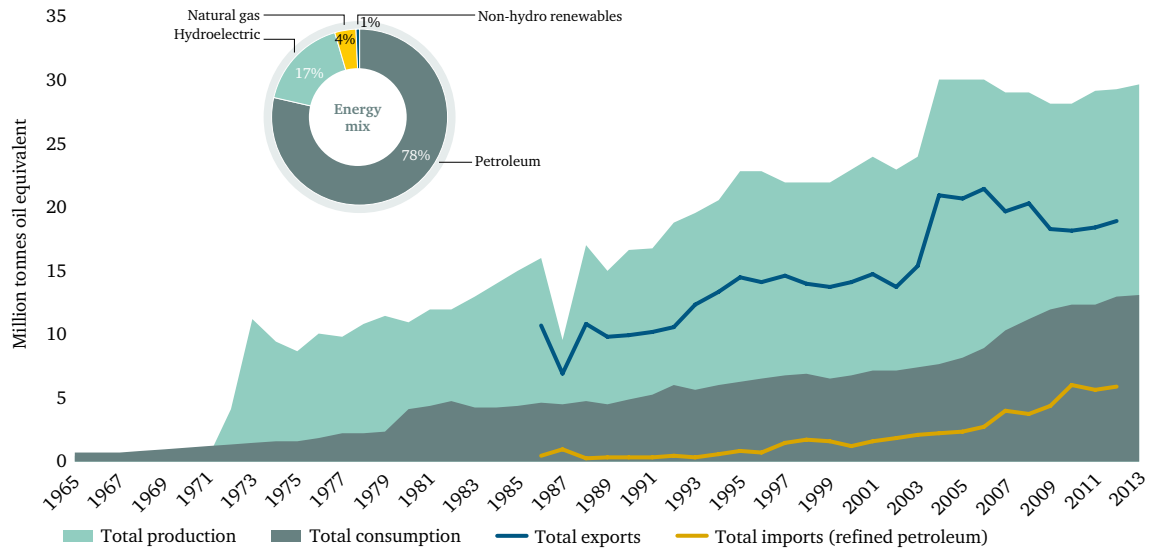
Avoiding locking in wasteful consumption

Energy policies have a major impact on economic productivity and energy demand over time. Mining and metals-processing – for example, the smelting of iron to make steel – are naturally energy-intensive, and these industries tend to support rising industrial demand for fossil fuels. In the Gulf

Cooperation Council (GCC) countries, oil and gas act as economic drivers not only in terms of generating financial revenues but also by providing cheap physical inputs for industry, construction, agriculture, and consumer goods and services. But reliance on energy-intensive industries such as petrochemicals, fertilizers, aluminium and cement to promote economic diversification (owing to the competitive advantage that oil and gas inputs provide) tends to lock in ever-rising demand for fossil fuels while encouraging inefficiency (Lahn, Stevens and Preston, 2013). In Kuwait, Saudi Arabia and the UAE, CO_2 emissions intensity (for each unit of GDP) has increased, even during a period of phenomenally high oil prices, bucking the global trend towards a gradual decoupling of emissions from economic productivity.[32] Ultimately, growth in inefficient demand resulting from low feedstock prices and other forms of protection can reduce a country's capacity to export hydrocarbons.

These are not just challenges for major fossil fuel exporters with sizeable industrial bases. The same unsustainable patterns are evident in countries with much smaller resource bases and relatively lower levels of development. Figure 3 shows the pattern of hydrocarbons production and domestic consumption over time in Ecuador as an example. Returns from oil and gas exports clearly decline as domestic demand continues to rise. With fossil fuel subsidies, rising domestic demand for fuel coupled with lower prices for oil exports creates a clear squeeze on the government's revenues.

Figure 3: Depletion-led development: Ecuador's hydrocarbon balance and energy mix



Sources: Chatham House analysis of US EIA, 2016; BP, 2015.

Laying the political foundations for sustainable, equitable development

The influx and growth of (generally centralized) extractives revenues will influence the power dynamics in any country. Countries with low pre-existing institutional capacity are particularly vulnerable to power imbalances as ministries and companies in the high-value extractives sector

[32] US EIA figures for 2007–11. Energy intensities also indicate CO_2 emissions intensity as oil and gas make up the entire energy mix, as shown in Figures 5 and 6 in Lahn and Preston, 2013. The latter also discusses the problems with using energy intensity trends as a performance gauge for fossil fuel-exporting countries.

acquire greater influence. The strength of the sector presents challenges for the design and implementation of low-carbon growth strategies, given conflicts of interest and a general lack of political alignment with agencies leading low-carbon strategies. Innovation in the energy system also represents interference with the status quo; as a fossil fuel-based energy system develops, vested interests are likely to become stronger (Bailey and Preston, 2014).

This combination of practices, infrastructure, established industrial base and vested interests makes the transition to clean energy and greater efficiency difficult and expensive to implement. At least one recent paper has talked of a 'carbon curse', referring to the carbon-intensive industrial base, entrenched fossil fuel subsidies and political dynamics of many fossil fuel-exporting countries which inhibit the shift to less polluting and more efficient systems (Friedrichs and Inderwildi, 2013).

One interesting area of consideration in relation to the development of a national oil company and/or extractives-sector regulator is how expertise is focused and spread, and whether that ultimately enables or restricts diversification into other industries. International oil companies are facing serious constraints on their business models as energy becomes less about 'owning geologies' and 'managing fuel', and more about 'owning technologies' and 'managing carbon'. This shift is forcing such companies to look for ways to reorient their investment strategies (Mitchell, Marcel and Mitchell, 2015). The same is true for large, successful national oil companies (NOCs) such as Petronas (Malaysia) and Saudi Aramco (Saudi Arabia), which are trying to diversify into renewable energies, efficiency services and carbon sequestration and use. The UAE government, for example, emphasizes several aspects of carbon management as part of its green growth agenda (UAE MoE, 2016; UAE MoEW, 2015).

> New NOCs may benefit from developing expertise in carbon management and a more balanced portfolio of energy interests from the outset, in order to reduce risk in the transition away from hydrocarbons.

New NOCs may benefit from developing expertise in carbon management and a more balanced portfolio of energy interests from the outset, in order to reduce risk in the transition away from hydrocarbons. In terms of financial, technical and human capacity, a key question is how NOCs in their early stages of development can set in place structures and incentives to drive their focus towards such issues. If a country chooses to have an NOC, and reserves are sufficiently large to warrant a long-term strategy, it is important to consider how this agenda can be incorporated into its core mission and managers' performance incentives.

Understanding how resources and/or export revenues will enter the economy, at what price, and how they will affect politics and entrenched interests, is crucial to formulating policies in support of sustainable development objectives. Several established oil and gas exporters are now pursuing dual strategies, both investing in extending the life of their reserves and seeking to increase the amount of renewables in their energy mix. Mexico, for example, is introducing reforms to allow increased investment in oil and gas, while also aiming for a switch in the power sector to cleaner gas and renewable energy (Hering, 2015). In the past five years, plans for fuel conservation and substitution have been ramped up in the Gulf states, where governments are seeking to meet rising domestic demand for subsidized energy through alternative means, in order to reserve more oil for export. All face major problems in implementing this shift because of the price environment and the political economy that has grown up around the fossil fuel industry. Incumbent actors and institutions may lobby against environmental regulations and rises in tariffs and fuel prices.

Table 4: INDC pledges of selected established and emerging producers

	Country	Top-line commitment (% change in GHG emissions)	Key sectors	Lead ministry/agency
Established and reforming producers	Norway	40% reduction from 1990 levels	• **Energy** (CCS, renewable energy) • **Industry** (low-emissions technology) • **Transport** (reduced emissions, environmentally friendly shipping)	Ministry of Climate and Environment
	Angola	Unconditional 35% reduction from BAU (up to 50% conditional)	• **Energy** (power generation from renewables – hydro, solar, wind, biomass/biofuels) • **Forests** (large-scale afforestation/reforestation, 'forest carbon' options)	Ministry of Environment
	Mexico	Unconditional 25% from BAU (up to 40% conditional)	• **Energy** (fuel combustion and fugitive emissions) • **Industry** (industrial processes and product use) • **Agriculture** (management of production, soil and the burning of residues) • **Waste** (solid waste and wastewater) • **Land and forests** (afforestation, reforestation, land-use management)	Secretariat of Environment and Natural Resources
	Nigeria	Unconditional 20% reduction from BAU, conditional 45%	• **Energy** (renewables [esp. decentralized], multi-cycle power stations, scalable 20–50 MW power stations, energy efficiency, switching from liquid fuels to natural gas) • **Oil and gas** (enforce gas flaring restrictions, gas-to-power plants at flare sites (micro grid), blending transportation fuels) • **Agriculture and land use** (Climate Smart Agriculture, elimination of charcoal use) • **Industry** (benchmarking against international best practice re. energy usage, adoption of green tech) • **Transport** (shift to rail, upgrade of roads/road pricing, urban transit systems, increasing use of compressed natural gas (CNG), reform of petrol/diesel subsidies)	Department of Climate Change
New and prospective producers	Ethiopia	64% reduction from BAU; aim for carbon neutrality	• **Agriculture** (improved crop and livestock production practices) • **Forestry** (protection/re-establishment of forests) • **Energy** (expansion of power generated from renewables) • **Technology** (more efficient technology in transport, industry, buildings)	Ministry of Environment & Forest
	Kenya	30% reduction from BAU	• **Energy** (increased use of renewables, especially geothermal, solar, wind; promotion of energy and resource efficiency) • **Forests** (increase in tree cover of over 10%; use of clean-energy technology to reduce reliance on wood fuels) • **Transport** (low-carbon and efficient transportation systems) • **Agriculture** (Climate Smart Agriculture) • **Waste** (sustainable waste management systems)	Ministry of Environment & Natural Resources

	Country	Top-line commitment (% change in GHG emissions)	Key sectors	Lead ministry/agency
New and prospective producers	Ghana	Unconditional 15% from BAU (up to 45% conditional)	• **Energy** (scale up renewables to 10%; clean rural household lighting; market-based cleaner cooking solutions; double energy-efficiency improvements in power plants) • **Transport** (scale up sustainable mass transportation) • **Forests** (sustainable use of forest resources through REDD+) • **Waste** (alternative solid waste management) • **Industry** (double energy-efficiency improvements in industrial facilities, energy-efficient refrigeration and air conditioning – 'Green Cooling Africa Initiative')	Ministry of Environment, Science, Technology and Innovation
	Uganda	Estimated and unconditional 22% reduction from BAU	• **Energy** (enabling infrastructure for electricity-sector development [offsetting wood and charcoal burning], increase renewables to 3,200 MW) • **Forestry** (reverse deforestation and increase forest cover from 14% to 21% through forest protection, afforestation, sustainable biomass production measures) • **Wetland** (increase wetland coverage from ~10.9% to 12% through demarcation, gazetting and restoration of degraded wetlands) • *Additional measures contingent on finance, technology and capacity-building include:* ***Energy*** *(sustainable energy solutions in public buildings, promotion/uptake of efficient cookstoves, solar energy systems, energy-efficient building codes);* **Transport** *(long-term transport policy, cleaner fuels, fuel-efficient vehicle technology); and* **Agriculture** *(Climate Smart Agriculture, livestock, manure)*	Ministry of Water and Environment
	Tanzania	10–20% from BAU (level of ambition = level of support)	• **Energy** (energy diversification, clean technology for power generation and diversification of renewable energy, enhanced use of natural gas, promotion of energy-efficient technologies and behaviour, rural electrification) • **Transport** ('Mass Rapid Transport Systems', investment in air, rail, marine and road infrastructures) • **Waste** (waste to energy programmes, co-generation) • **Forests** (scaling up participatory forest management, afforestation, reforestation, enhancement and conservation of forest carbon stocks)	Cross ministerial – National Climate Change Steering Committee (NCCSC)
	Mozambique	Total reduction of approx. 76.5 $MtCO_2$ equivalent during 2020–30, baseline not specified	• **Energy** (electricity production, transport and other – residential, commercial and institutional) • **Land and forests** (land use, land-use change, forestry REDD+) • **Waste** (solid waste disposal and treatment)	Ministry for the Coordination of Environmental Affairs

Note: BAU = business as usual; REDD+ = Reducing Emissions from Deforestation and Forest Degradation. All commitments to 2030.
Sources: INDCs of selected established and emerging oil and gas producers, available at UNFCCC, 2015c.

The role of energy and industrial policy in achieving national development goals

This section has illustrated the critical role of energy and industrial policy as a bridge between extractive-sector planning and equitable, sustainable development ambitions. Two reports released by the United Nations Economic Commission for Africa in spring 2016 reinforce the case for industrial policy – rather than a simple acceptance of 'free market' policy orthodoxy – to guide 'structural transformation' in Africa's economies (UNECA 2016a). Many African nations aspire to transcend structures 'largely based on raw material extraction, with very little value addition and limited employment generation' and are also suffering the heavy environmental costs of extractives-led growth (UNECA, 2016b:xxi). 'Greening' the process is therefore both a necessity and an opportunity, especially in the context of the Paris Agreement and the SDGs. UNECA notes the centrality of infrastructure investment in this: 'Decisions today will have long-lasting impacts on patterns of growth and consumption. So getting it right first time is vital to avoid retro-fits, which are always more expensive' (UNECA, 2016b:xxiv).

Energy systems will be a key part of this potentially transformative infrastructure. Many established and emerging oil and gas producers have outlined reforms to the energy sector as a central component of their INDCs. Table 4 gives a selection of cases. These reforms include shifting the energy mix towards cleaner fuels, and increasing the rate of renewable energy generation and domestic gas utilization. Yet the expertise involved in INDC plans is usually housed within ministries of environment, energy and/or forests and agriculture, rather than in ministries of planning or industry where key decisions over future development affecting INDC goals will be taken.

4. New Considerations for Prospective and Emerging Producers and Their Advisers

Prospective and early producers need information about their resources, available technology, costs, and near- and long-term market outlooks and risks in order to make choices about the role that extractive-sector development should or should not play in their economies. Yet major information gaps and knowledge deficits among decision-makers still exist.

Information gaps lead not only to poor policy choices, but also to poor public information strategies. The latter can foster unrealistic popular expectations regarding access to energy and job creation, in turn creating societal pressures that further impair decision-making. In view of this, donors should consider providing relevant information in an impartial way that helps countries at each stage of the decision-making process. It is important to put back on the table the full range of options available to a country when a resource discovery is made. Advisers should be realistic about the difficult choices and trade-offs that each option entails, and their input should take into account all the factors potentially influencing long-term sustainable national development.

Table 5 presents a simple list of resource development options for a new or prospective fossil fuel producer, and their challenges and implications in the context of a potentially carbon-constrained world. It should be acknowledged that all four options require significant (albeit varying) levels of domestic institutional and financial capacity.

Global market risks for fossil fuels may create something of a 'green paradox', as producers rush to get resources out of the ground before they become 'stranded'. The 'paced development' pathway may increase the risk of stranding – particularly for higher-carbon resources. In each case, the trade-offs will vary depending on the long-term market prospects for the resource in question, its size,

Table 5: Potential development pathways for new and prospective producers

Scenario	Policy	Challenges/implications
'Rush to market'	Expand resource production quickly (go for fast depletion). Channel initial investment and revenues into activities around the oil sector and infrastructure to bridge the growth gap.	Difficulty of resisting immediate pressures for wealth distribution and managing wider high expectations. Inadequate capacity to manage and utilize revenues effectively. Risk of high dependence on volatile markets and 'resource curse' effects.
'Development on parallel tracks'	Export fossil fuels while taking action on low-carbon development at home.	Requires political resolve and financial assistance, especially in meeting domestic energy access and security goals. Risks high dependence on volatile markets and 'resource curse' effects.
'Paced development'	Deliberately slow resource development (i.e. the Norwegian model) and speed up economic diversification in sustainable ways.	Requires political resolve and ability to resist investor pressure. Risk of political contest from parties promiswsing faster extraction (and more rapid short-term wealth distribution).
'Focus on non-extractives sectors'	Choose not to develop extractives in the light of market risks and potential damage to the economy, and focus instead on current and potential future sustainable growth areas.	Difficulty of resisting pressure from investors and other interest groups, possibly including donors. Risk of political contest from parties promising extraction. Pressure to show equal benefits to society from non-extraction path.

the costs of extraction, and the host country's other economic potential. These are just some context-specific factors that require much greater consideration when assessing the options for exploitation of hydrocarbons and minerals.

In view of this, there are opportunities for useful conversations, peer-to-peer learning and advice at two stages: before and after the extraction decision.

The decision to extract

The decision to extract is a sovereign one and will be grounded in national discussions, but a number of other actors will influence the decision itself and the ultimate direction of exploration and development. They include government agencies, civil society, international investors, donors and financiers. Asymmetric knowledge is a complicating factor here. Given the access to government and influence that extractives companies frequently enjoy, choices may be skewed by those who have a commercial interest in the 'rush to market' scenario. Helping governments understand the full range of risks and opportunities – given each country's specific resource base and political economy – and make transparent comparisons of costs and benefits would help address asymmetries of knowledge and the differing agendas of the many stakeholders in resource development.

Key questions include the following:

- What are the full costs and impact of extraction? Developing understanding of the costs of production in conversations with fossil fuel producers is critical. So, too, is looking outside the sector to consider fishing or farming losses, water requirements and impacts on air and soil quality.
- What are the opportunities for domestic sustainable development and diversification? Might aspects of an extractives-led growth path jeopardize these?
- What do the country's sustainable development aims and national vision look like, and how would extractives-sector development affect them?

Where extractives development is linked to national development goals, discussions and capacity-building should not just involve the oil and gas or mining ministries and state-owned companies. They should also include other government departments, including those with a stake in national planning and broader economic development, as well as commercial actors such as infrastructure and utilities companies. In this context, donors may be able to foster better horizontal linkages and information-sharing.

Post-extraction decisions

Once the decision to extract has been made, several further questions need to be examined:

- What should be the balance between exports and domestic use of resources? Should production be channelled first towards domestic consumption and building national industrial value chains, or should it be used for export? This decision requires considerable understanding of the resource base, the economics of production, market dynamics and infrastructure requirements. It is likely that development of domestic gas infrastructure and industry will require the expertise of foreign companies; what form of remuneration will they receive, and will that be attractive enough to sustain their engagement?

- In terms of institutions and regulations, where are the checks and balances to ensure that the ends, rather than the means, of national development are the focus of policy?
- How can development of resources be best planned as a transitional industry, taking account of the reserve base? What targets, legislation and assessments can help keep the transition to a lower-carbon economy on track?
- What role might the extractives and energy industries play in new producer countries' sustainable energy and energy access goals?
- In terms of infrastructure, what makes sense given current and realistic future needs? How can flexibility to adapt and resilience to environmental change be built in at the tendering stage?
- Where skills and employment are concerned, can experience and service industry capacity in one energy sector (e.g. coal, oil, gas) be transferred into other engineering and high-tech sectors?
- Can the development of the energy sector offer co-benefits between hydrocarbons and renewables? And how can co-objectives – such as access to energy, positive public health outcomes, emissions targets and job creation – be better incorporated into energy decision-making?

5. Conclusion

This paper challenges the assumption that extractives will be the primary driver of economic development in extractives-rich low-income countries. In a carbon-constrained world, there is incoherence in donor support for extractives-led growth and low-carbon, green development. It may be that this can be addressed through better internal coordination of objectives, priorities and information within agencies. This paper has set out the key considerations and questions for re-evaluating the focus of aid and donor advice, with the aim of avoiding the promotion of potentially contradictory development models.

'Low-carbon' is a contentious term in many poor and hydrocarbons-producing countries, because of a suspicion of the motives of rich countries telling poor ones not to follow their own previous industrialization pathways. The implication that carbon fuels are 'bad' is hard to accept when they are considered a major natural asset in countries with few other opportunities for fast growth.

At present, the strongest imperatives for reconsidering extractives-led growth come from the fall in the prices of oil and other commodities. The necessary period of adjustment of expectations in new or prospective producer countries offers an opportunity to discuss short- and long-term market scenarios (including carbon constraints), and what this will mean for the extractives sector. In most extractives-led economies, the price boom and decline have brought 'resource curse' effects into sharp relief, supporting the common agreement that the best way to reduce such effects over time is to diversify into other sectors of the economy.

> To offer low-income countries with extractives reserves a better basis for decision-making, advice from donors, multilateral financial institutions and the private sector on extractives governance and low-carbon development must be more coordinated and coherent. There is no 'one size fits all' approach.

A practical conversation regarding low-carbon development aims might be most usefully framed in terms of national goals for sustainable economic diversification. The topline questions for early-stage and emerging producers would be: How can realistic scenarios for production and marketing of extractive products inform national development strategies? Are wider strategies for economic growth robust in the light of export market risks? What trade-offs are involved in choosing a slower pace of extractives development and focusing on other sectors for growth?

Once countries have decided to pursue extraction, governance discussions should give as much weight to domestic energy policy and industrial policy as to extractives-sector investment frameworks and revenue governance. Further key questions arise here. How should domestically mined commodities be valued, and how should the costs and impacts of their production and use be assessed? To what extent can resources help improve energy access and stem deforestation by replacing reliance on traditional biomass with cleaner cooking fuel such as LPG and electricity? Are such investments sufficiently attractive for sustained foreign investment? To what extent can linkages between the extractives sector and the rest of an economy be built to foster longer-term capacities that can be applied in sectors with the greatest potential for climate-sensitive transition?

Resolving each of these questions will require comprehensive understanding of the stakeholders, institutions and underlying political economy involved. To offer low-income countries with extractives reserves a better basis for decision-making, advice from donors, multilateral financial institutions and the private sector on extractives governance and low-carbon development must be more coordinated and coherent. From an adviser's perspective, there is no 'one size fits all' approach. How global developments around climate regulation and investor risk affect the prospects for future wealth creation from fossil fuel resources for individual producers will depend upon a host of factors, not least the type of commodity, the stage of development and the scale of the resource base. Both the timescale from discovery to production and emerging norms around investment suggest that countries with larger reserves, higher-cost production or higher-carbon commodities will face the greatest uncertainty. Production scenarios should be carefully mapped alongside market risks and local impacts, costs and environmental trade-offs, in order to assist in early decision-making about governance and development priorities.

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Cover image: A fisherman pulls a canoe as he walks by the Marshall Islands-flagged tanker *Miracle* after it ran aground at the mouth of Dar es Salaam's harbour on 13 February 2016.

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