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Governance of Africa's Resources Programme

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Fossil Fuels are Dead, Long Live Fossil Fuels

Botswana's options for economic diversification

Ross Harvey

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CONTENTS

ABOUT THE AUTHOR

Ross Harvey is a senior researcher with the Governance of Africa's Resources Programme at the South African Institute of International Affairs. His research covers mining and development across the African continent. He has an MPhil in Public Policy from the University of Cape Town (UCT), and is pursuing his PhD in Economics at UCT on the subject of oil-for-infrastructure deals in Nigeria and Angola.

ABBREVIATIONS AND ACRONYMS

BP	British Petroleum
BCL	Bamangwato Concessions Limited
BCM	Botswana Chamber of Mines
BDP	Botswana Democratic Party
BIDPA	Botswana Institute for Development and Policy Analysis
EIA	environmental impact assessment
FDI	foreign direct investment
FQM	First Quantum Minerals
GDP	gross domestic product
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
MCM	Morupule Coal Mine
MEP	Mmamabula Energy Project
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
PPP	public–private partnership
R/P	reserve to production
SNA	system of national accounts
SOE	state-owned entity
TKR	Trans-Kalahari Railway
TSX	Toronto Securities Exchange
UNESCO	UN Educational Scientific Cultural Organisation

EXECUTIVE SUMMARY

Botswana is at a critical historical juncture. It has enjoyed a stable democracy since 1965 and strong, quality economic growth for the last few decades. However, the diamond revenues on which the country depends are likely to decline in the near future. Economic diversification is therefore a pressing policy concern. This report considers Botswana's options in this respect. It frames these options in terms of ecological economics, the fundamental premise being that natural capital should not be treated as a free good to be consumed. The extraction of minerals entails negative externalities that often undermine alternative sources of revenue generation. Botswana should seek to avoid these negative trade-offs insofar as possible, especially in the light of its abundant pristine wilderness areas. Coal and iron ore should be viewed as intermediate sources of revenue, preferably harnessed for domestic beneficiation rather than exported in raw form by rail. At the same time, such downstream beneficiation should not be viewed as a panacea for Botswana's development. Existing diamond rents should be widely invested in human and physical capital. Tourism should be viewed as the country's primary source of future revenue generation, given that its sustainability depends on environmental preservation. A more broadly available supply of human and physical capital would likely support a much larger tourism industry. It may also open up economic opportunities in fields such as renewable energy. In the long run, it would be more efficient for Botswana to be a world leader in the generation of solar power, for instance, than to be an exporter of raw coal. This report explores Botswana's options and concludes by offering relevant policy suggestions.

CHAPTER 1

INTRODUCTION

This report begins by tracing the debates that have characterised 'ecological economics' since the 1970s. Within this contextual framework, it examines how best to harness Botswana's ample fossil fuel supply – particularly coal – for regional energy security at the least possible cost to the environment. It may be tempting to argue that coal should be left in the ground for the sake of mitigating global warming, especially given the rapidly declining costs of renewable energy.[1] However, new technologies are available for cleaner fossil fuel extraction and conversion to energy.[2] If these are correctly employed in Botswana, and other regional sources of fossil fuels (such as natural gas from Mozambique) are optimally integrated, Southern Africa could become a developing-world model for transitioning to low-carbon growth. In the short run, this would carry the benefit of creating employment and alleviating poverty[3] in what remains one of the world's poorest regions.[4] In the long run, it would create the wealth necessary for transitioning to a zero-carbon growth trajectory.[5]

Moreover, Botswana requires a strategy for economic diversification away from dependence on diamond revenues, which are likely to decline rapidly in the near future. While fossil fuels do not provide a sufficient channel through which to diversify, Botswana is also endowed with extensive iron ore and copper deposits. Iron ore is yet to be mined, but sampling inference indicates economic viability. It is the primary contention of this research report that Botswana should integrate the complementary features of each of its mineral deposits to build both a regional energy hub and a steel industry. This must be done in a manner that does not compromise the ecological integrity of the country's great tourist attractions and its increasingly valuable wilderness spaces.

The report follows a simple outline. Chapter two provides a survey of the relevant literature on ecological economics that frames the sections that follow. Chapter three examines the hidden costs of coal on human and environmental wellbeing. Why apparently sensible economic decisions are often hindered by political calculations is discussed in chapter four. Botswana's political institutions are globally recognised as functional, and chapter five provides a historical overview as to why this might be the case. Despite its past economic and political successes, the country appears headed for a critical juncture. Chapter six contends that it remains economically unbalanced, and political stability should no longer be taken for granted. Tourism is an important future driver of economic growth, but its success depends on preserving the environment. Coal extraction and transportation pose a potential threat to the latter but also offer avenues for diversification. Chapter seven therefore examines external and internal economic considerations regarding the viability of Botswana's coal industry. Similar constraints inform questions over the country's potential to develop an iron ore industry, which is still very much at exploration stage. This is the focus of chapter eight. Chapter nine explores how iron ore and other base metals, in combination with coal, might contribute to local

beneficiation that benefits the region. Chapter ten concludes with recommendations on how Botswana might proceed in light of the evidence and the unknowns.

These recommendations aim to provide policymakers, especially within SADC, with a politically and economically feasible plan to harness Botswana's coal and iron ore for sustainable, regionally beneficial growth that does not compromise other economic assets such as tourism.

CHAPTER 2

ECOLOGICAL ECONOMICS

Concerns that environmental degradation poses a limit to future economic growth are not new. As far back as 1972, political economist Anthony Downs argued that public alarm over the declining state of the global environment would fail to translate into meaningful policy action unless the immediacy and scale of the problem was widely accepted. He observed that the status quo would likely persist unless individuals were willing to count the personal cost of behaviour change. It was a typical collective action problem – individuals were unlikely to alter their patterns of consumption for the sake of achieving a collective (and partially intangible) public good.[6] Forty-two years later, 'the immensity of the social and financial costs of cleaning up our air and water and of preserving and restoring open spaces'[7] has only grown. These costs must, however, be incurred if the next generation is to inherit a liveable planet.

Downs himself believed that harmful pollution could be 'reduced through technological change ... The traumatic difficulties of achieving major institutional change could thus be escaped through the "magic" of purely technical improvements in automobile engines, water purification devices, fuel composition, and sewage treatment facilities.'[8] He thought the optimal means through which to attenuate pollution was through the market, favouring higher product prices so as to avoid taxation:[9]

> It is just that those who use any given product should pay the full cost of making it – including the cost of avoiding excessive pollution in its production ... In my opinion, it would be unwise in most cases to try to pay these costs by means of government subsidies in order to avoid shifting the load onto consumers.

However, companies are unlikely to internalise the full costs of negative externalities,[10] especially where these costs are easily hidden or difficult to measure and identify. Policymakers should therefore regard with caution any claims that new technologies can fully solve intractable environmental problems. Even the production of solar and wind power carries hidden costs.[11]

Until there is universal agreement over the identification and measurement of externalities, the global system of national accounts (SNA) is unlikely to change. Changing the SNA would be the ultimate tool for reducing externalities, as it would place an economic value on natural capital instead of treating it as a free good, as is currently the case. What appears profitable at first may therefore be deemed unviable if scarce environmental goods were more accurately valued.

At present, if one company were to internalise polluting costs and pass them on to the consumer through higher product prices, it would risk pricing itself out of the market. If there is no foreseeable advantage to being the first mover, companies are disincentivised to take the risk. There is, however, a caveat. Efforts to mitigate and adapt to climate change create opportunities for price discrimination and 'green products', which wealthier

consumers are able and willing to buy. By and large, however, developing countries do not possess the levels of per capita wealth necessary to spend scarce disposable income on these products. Moreover, fossil fuel extraction and electricity generation, as damaging as they are to the global commons, may provide the means for reducing indoor air pollution and generating capital for investment in new industries.

Economist Robert Solow shares Downs' faith in market-driven solutions. In a 1974 lecture he stated that, 'if it is easy to substitute other factors for natural resources, then there is in principle no "problem"'.[12] The deductive logic stands, but it is practically useless. Assessing Solow's position on the importance of the environment, Herman Daly noted that Solow employed an assumption of a world in which natural resources and capital[13] are substitutes. In other words, economic production could occur without resources: 'We might say that Solow's recipe calls for making a cake with only the cook and his kitchen [and without flour and eggs].'[14] The late Nicholas Georgescu-Roegen challenged the modified version of Solow's growth model – which suddenly included resources in the production function – in 1979. He essentially argued that the fundamental growth models that inform economic policymaking deny the laws of thermodynamics:[15]

> Solow and Stiglitz could not have come out with their conjuring trick had they borne in mind, first, that any material process consists in the transformation of some materials into others (the flow elements) by some agents (the fund elements), and second, that natural resources are the very sap of the economic process. They are not just like any other production factor. A change in capital or labour can only diminish the amount of waste in the production of a commodity: no agent can create the material on which it works. Nor can capital create the stuff out of which it is made. In some cases it may also be that the same service can be provided by a design that requires less matter or energy. But even in this direction there exists a limit, unless we believe that the ultimate fate of the economic process is an earthly Garden of Eden. *The question that confronts us today is whether we are going to discover new sources of energy that can be safely used.* No elasticities of some Cobb-Douglas function can help us to answer it. [emphasis added]

In reflecting on this contribution in 1997, Daly argued that no economist had successfully responded to the challenge, let alone Stiglitz and Solow. The neoclassical production still fails to reflect reality and thus leads to policy options that ignore real constraints to growth. Daly called for an understanding that improvements in technology could not replace natural resources:[16]

> We can often substitute one efficient cause for another, or one material cause for another, but the relation between efficient and material cause is fundamentally one of complementarity, not substitutability ... Accuracy of analytical representation of reality must replace mathematical tractability as the main criterion of a good model. Once we recognise the reality of inputs from nature then we must inquire about their scarcity and about the ecological processes that regenerate them. *Once we recognise the necessity of returning waste outputs to nature then we must inquire about the capacities of ecosystems to absorb those wastes*. We will no longer be able to avoid the ecological economist's vision of the economy as an open subsystem of a complex ecosystem that is finite, nongrowing, and materially closed. [emphasis added]

Solar and wind power technologies are superior to fossil fuels in terms of the 'waste outputs to nature' ratio. Yet the fact that we can substitute the former for the latter does not make the latter a strict substitute for natural capital. Solar panels and wind turbines, for instance, require extensive natural resource inputs for their production. The benefit to the global ecosystem is that once they are generating power they do not emit harmful greenhouse gases (GHGs), ultimately enhancing the system's ability to absorb waste from other productive processes. However, solar and wind power remain financially expensive. They also face continued energy storage challenges despite rapid improvements in battery technology.

A 2013 book by historian Paul Sabin reflects on the clash between biologist Paul Ehrlich and economist Julian Simon, and how the debates have unfolded since his birth in 1970. 'How would a "green economy" actually work? How should we manage trade-offs among economic growth, environmental protection, and social equity?'[17] In attempting to understand current disagreement over how to respond to climate change, Sabin argued that 'resistance to environmental legislation represented more than simply political and economic interest. Extreme claims by environmentalists ... helped spark the backlash against the environmental movement in the United States and helped generate support for equally extreme positions taken by conservative opponents.'[18]

In respect of the latter, the Intergovernmental Panel on Climate Change (IPCC), the voice of the scientific community to policymakers, has to guard its credibility with more diligence if it is to avoid this backlash gaining momentum. According to economist Richard Tol, the IPCC is effectively a natural monopoly and therefore requires regulation: 'Quality standards have slipped. Errors in the Fourth Assessment Report made headlines across the world ... The IPCC ignored its own rules ... [it] glossed over mistakes it made in the relative importance of greenhouse gases and in scenario development. Such behaviour is typical of a monopolist who need not care about the client.'[19]

Simon challenged the view that the planet is necessarily headed for environmental catastrophe. Ehrlich challenged the view that free markets and technological innovation can prevent catastrophe and yield future prosperity. In 1980, after a decade of fuelling alarm over inevitable conflict as a result of scarce resources, Ehrlich bet Simon $5,000 that the cost of chromium, copper, nickel, tin and tungsten would increase over the following decade. In similar vein to Solow, Simon refuted the notion that scarcity posed a limit to growth. He argued that scarcity would, in fact, drive technological innovation, which would allow humanity to escape the dire predictions associated with population growth. Economist Sir John Hicks captured this view by arguing that 'a change in the relative prices of the factors of production is itself a spur to invention, and to invention of a particular kind – directed to economising the use of a factor which has become relatively expensive'.[20]

Ehrlich argued that the limits to growth were fixed and could not be altered; a Malthusian approach. These arguments manifested in the presidential campaign that year between Jim Carter and Ronald Reagan. Reagan's victory signified the end of Richard Nixon's 'environmental decade'. Today, the debate is still predominantly political, although the scientific community is in agreement that climate change is happening, that it is unequivocally a result of man-made global warming, and that it is likely to end in catastrophe if drastic action is not taken to change our patterns of production and consumption.[21]

Simon won the bet, as commodity prices stabilised or halved in value. However, 'when economists later ran simulations for every 10-year period between 1900 and 2008, they found that Mr Ehrlich would have won the bet 63 percent of the time'.[22] Another bet in 2005 involved Simon's widow, where investment banker Matthew Simmons bet her $5,000 that oil prices would more than triple from around $65 per barrel to over $200 per barrel in 2010. He lost. Adjusted for inflation, the price rose less than 10% over those five years. Current oil prices are hovering around $80 a barrel, despite the peak oil hypothesis. And after a decade-long boom at the beginning of the 21st century, commodity prices are beginning to decline once again. These kinds of realities and the tenacity of fossil fuels disappointed efforts to move towards a green economy. Sabin is worth quoting at length on the importance of resolving the apparently conflicting views of biology and economics on the question of environmental stewardship:[23]

> Government policies have an important long-term role to play in shifting the United States away from fossil fuels toward solar and wind energy and energy efficiency. In the short term, however, dour predictions that key resources, such as solar-grade silicon, would grow increasingly scarce, and that fossil fuel prices would rise substantially, led to overly ambitious business plans and exaggerated estimates of how many new jobs would be created. Major solar power companies in the United States went bankrupt, while, at the same time, the green jobs economic programs did relatively little to stimulate job creation and spur short-term economic recovery. Aggressive subsidies by the Chinese government, of course, complicated this story by also helping competing Chinese manufacturers undercut American suppliers. Simon's victory in his bet with Ehrlich drove home an important insight relevant to these energy markets: scarcity and abundance are in dynamic relationship with each other. Abundance does not simply progress steadily to scarcity. Scarcity, by leading to increased prices, spurs innovation and investment. Efforts to locate new resources and design cheaper methods yield new technologies. New periods of abundance occur, even overabundance or a glut. Understanding this cyclical process can be vital to crafting successful public policy. Exaggerated fears of resource scarcity can easily lead to poor economic management, including stifling price controls, panicked efforts to limit production or consumption, and national investment strategies predicated on high resource prices that turn out to be ephemeral. In other words, excessive pessimism has a cost.

It is clear, however, that the current rate of resource consumption cannot be sustained without deeply altering the planet. The question thus becomes one of how to allocate scarce financial capital efficiently in a way that does not treat natural capital as a free good. Sabin is correct to warn of inefficient economic management. However, what is commonly understood as inefficient may be viewed somewhat differently if a higher value were placed on ecosystem services.[24] Debates over exactly how to value these services are ultimately political. So too is the question of purportedly inefficient subsidies. If, for instance, subsidies for research and development expenditure led to the creation of technologies that rendered fossil fuels obsolete, the immediate inefficiency might ultimately prove to be worthwhile. Inefficient subsidisation might be an excellent means by which to mitigate the risks associated with climate change.

Economist Daron Acemoglu and his co-authors show that technology will endogenously respond to scarcity,[25] and address the above question directly. 'How to

control and limit climate change caused by our growing consumption of fossil fuels and to develop alternative energy sources to these fossil fuels are among the most pressing policy challenges facing the world today ... until recently the response of technological change to environmental policy has received relatively little attention by leading economic analyses of environment policy.'[26] Using a simple two-sector model, their results focus on the types of policies that can prevent environmental disasters, 'the structure of optimal environmental regulation and its long-run growth implications, and the costs of delay in implementing environmental regulation'.[27] Most existing models treat technology as exogenous. The most influential policy implication from the work of economists such as Nicholas Stern is that extensive and immediate technological interventions should be in place permanently, even though they may entail significant cost. Acemoglu *et al*. offer a different approach. They point to the importance of substitutability between the two sectors (clean and dirty inputs) as a determining policy factor.

When the inputs are highly substitutable, for instance, immediate intervention to prevent dirty inputs is necessary. Without intervention, the *market size effect* – encouraging innovation toward the largest input sector – would direct production toward the dirty sector because of the initial productivity advantage in that sector. This would lead to environmental disaster. 'However, even simple suboptimal policies just using carbon taxes or profit taxes/research subsidies, would be sufficient to *redirect* technical change and avoid an environmental disaster.'[28] This is the price effect, which directs innovation toward the sector with the higher price inputs. The policy intervention would only need to be temporary, as there is effectively a tipping point at which sufficiently advanced clean technologies would attract private sector research and employment under ordinary market conditions, negating the need for further subsidies.

If the inputs are not sufficiently substitutable, a more permanent policy solution is required if environmental disaster is to be prevented. If they are complementary, long-run growth may have to be stopped altogether in order to prevent catastrophe.

Acemoglu *et al*. contend that the likelihood of an environmental disaster is reduced if the dirty sector uses an exhaustible resource input, 'because the increase in the price of the resource as it is depleted reduces its use, and this encourages research toward clean technologies'.[29] However, in a complementary paper[30] they note that:[31]

> If dirty technologies are more advanced to start with, the potential transition to clean technology can be difficult both because clean research must climb several steps to catch up with dirty technology and because this gap discourages research effort directed towards clean technologies ... Theoretically, carbon taxes and research subsidies encourage production and innovation in clean technologies ... The key question ... is whether optimal policy will indeed secure a transition to clean technology, and if so how rapidly, and whether it will do so using carbon taxes or a combination of carbon taxes and research subsidies. A naive intuition would be that only carbon taxes should be used because externalities are created by carbon ... In contrast ... we find that optimal policy heavily relies on research subsidies.

Although a carbon tax would discourage research in the dirty sector, using it to both reduce emissions and influence the direction of research towards clean technologies would 'lead to excessive distortions. Instead, optimal policy relies less on a carbon tax and instead involves direct encouragement to the development of clean technologies.'[32] Importantly,

delayed intervention is costly. The transition phase necessarily includes the pain of slow growth. This pain can be minimised through immediate and decisive implementation of the tax–subsidy combination.

Interestingly, and of particular relevance for Botswana given its coal abundance, 'the use of an exhaustible resource in dirty input production helps the switch to clean innovation under laissez-faire'.[33] However, as Acemoglu and Robinson point out in a follow-up blog, the definition of exhaustibility is important: 'The real problem is not the world running out of oil, but the world frying itself with all sorts of fossil fuels, not just oil but also coal. And coal does not look like it will run out anytime soon.'[34] The threat of continued global reliance on coal is evidenced by Europe's return to coal-fired power, nullifying the myth that China and India are the last remaining offenders.[35]

CHAPTER 3

THE HIDDEN COSTS OF COAL

Physician Alan Lockwood provides an extensive review of the evidence that quantifies the negative externalities of coal mining and coal-fired power generation.[36] He argues that our collective global demand for cheap electricity does more harm than good. In terms of its impact on human health, *The Lancet* estimates that 24.5 deaths are expected for each terawatt hour of electricity generated by coal. An application of that data to the US alone indicates that 50 000 deaths a year may be attributable to burning coal. The author notes the difficulty of attributing health impacts to an environmental pollutant, but points to the best evidence available to show that the exercise should not be avoided. In a retrospective cost-benefit analysis (examining data from 1970 to 1990), 'economic modelling predicted an annual reduction of 184,000 premature deaths, 674,000 cases of chronic bronchitis [and] over 22 million lost days at work'[37] as a direct result of the Clean Air Act in the US. The Environmental Protection Agency estimated a value of between $5.6 trillion and $49.4 trillion for the monetised health benefits over that 20-year period. The interval is understandably large, but even the conservative estimate is significant, given that the cost of complying with the act has been estimated at only $0.5 trillion. Lockwood's book provides weighty evidence against the economic imperatives to mine and burn coal. However, as the author himself is quick to note, political time cycles and pressures are often incongruent with the policy implications of scientific findings.

Although technology endogenously responds to scarcity, 'provided there are other sources of dirty energy such as coal, this will not change the trajectory of fossil fuel consumption and climate change'.[38] This is largely due to the initial degree of productivity advantages (lower costs) involved in the fossil fuel sector, and its relative lack of substitutability with cleaner technologies at this stage. Moreover, new discoveries of coal across the globe effectively shift it into the 'non-exhaustible' category for short-run policy purposes. The oil price also continues to decline, which would ordinarily result in an increase in quantity demanded. However, the global economy is struggling to recover from the 2008 financial crisis. A recent article in *The Economist* suggests that 'a 10% change in the oil price is associated with around a 0.2% change in the global GDP [gross domestic product]'.[39] This is destructive to the environment in immediate terms, but it also means that new exploration activities are unlikely to begin, as lower prices will discourage investment in the supply side. The Organization of the Petroleum Exporting Countries (OPEC) has refrained from reducing supplies – its standard response to declining prices – precisely because the global economy is stagnating. Moreover, North American production of new types of oil (tar and shale sands, for instance) limits the cartel power of OPEC to determine the global oil price merely through reducing supply.

Left to its own devices, in light of the current global trajectory toward environmental disaster, the market will not create sufficient incentives toward clean technologies. To overcome market failure, government policies can leverage the endogeneity of technology. There are increasing returns to initial subsidisation. Once the technologies become

competitive, a tipping point is reached where private incentives that were previously directed toward fossil fuels are now redirected toward cleaner energy generation. Market power can again take over. The research by Acemoglu *et al*. effectively resolves the polarised positions exemplified by Ehrlich and Simon. Economically and biologically, the policy recommendations make sense. However, whether they will be adopted politically is another question altogether; and one that is heavily under-researched.

CHAPTER 4

THE POLITICS OF DIRECTED TECHNOLOGICAL CHANGE

Technology does not exogenously drive society forward, as Marx would have it. Technological innovation is an endogenous function of the incentives generated predominantly by the political system.[40] In terms of climate change, the politics are particularly challenging. Reaching consensus at a global level is difficult.

Developing countries resent being dictated to by developed countries, which developed in no small part through fossil fuel production and consumption. Developed countries, in the wake of the global financial crisis of 2007/08, are reluctant to provide the technical and financial support that developing countries require for transitioning to low-carbon growth. Their position is also complicated by domestic politics. Existing fossil fuel producers are politically powerful and reluctant to accede to profit redistribution towards cleaner technologies. Coal abundance and associated opportunities for large-scale export and local power production reinforce developing countries' reluctance to sign any binding global agreements to reduce carbon emissions. The US and China are still the two single largest emitters of carbon dioxide per capita, but neither seems willing to move first – only to take the risk that the other will not respond in kind. 'This looks like a classic game of chicken or war of attrition, each side waiting for the other to make a concession while we get closer to the abyss.'[41] As one excellent paper puts it: 'The "brinkmanship effect" works through a reduction in the other region's payoff when the negotiation fails; it changes the region's threat point in the negotiation and enables it to extract more of the surplus; it is particularly potent when the region has substantial bargaining power in the negotiation.'[42] Given that emissions are higher when negotiations break down, countries with a weak bargaining position can afford a lower immediate investment in pollution control. 'These two effects both imply that a delay in negotiating a global agreement increases post-negotiation pollution and not only the pre-negotiation one.'[43]

For Southern Africa in particular, one apparently obvious comparative advantage in favour of transitioning to low-carbon growth is an abundance of sunlight hours, wind and natural gas. However, commitment to global climate change agreements is unlikely to be incentive-compatible with the political dynamics in the region. For instance, Botswana is unlikely to agree to emission reductions given the potential for domestic coal-fired power generation. Eskom, the South African state-owned entity (SOE), given its regional monopoly of coal-fired power generation, is also unlikely to accept serious carbon-emission reduction regulations. A more compelling argument is therefore likely to be that 'strict anti-pollution policies give the country's industry a technological edge by stimulating R&D [research and development] in green technologies and help create tomorrow's "green growth". This strategic trade-off might alleviate the impact of the strategic effects of delayed negotiation.'[44] There are further complicating dynamics at a regional level that will be examined in greater detail below.

The developing world's political position on climate change is bolstered by arguments that current policies to address global warming make energy more costly, harming the world's poor more than climate change is likely to do.[45] Political scientist Bjørn Lomborg laments the use of inefficient subsidies. Solar and wind power, for instance, was subsidised to the tune of $60 billion in 2012. The total climate benefit was estimated at a paltry $1.4 billion, which made the subsidies effectively a waste – according to Lomborg. Of course, this view does not consider how 'inefficient' subsidisation may be worth the initial costs given its potential benefits for long-run growth. However, Lomborg points to something that few other commentators have mentioned: the opportunity costs of energy poverty that result from increased electricity prices (as a function of green subsidies). He writes:[46]

> Climate policies carry an even larger cost in the developing world, where three billion people lack access to cheap and plentiful energy, perpetuating their poverty. They cook and keep warm by burning twigs and dung, producing indoor air pollution that causes 3.5 million deaths per year – by far the world's biggest environmental problem.

OECD countries generally oppose coal-fired power in these countries. Yet for all its efforts the developed world is able to acquire only 1.2% of its energy from wind and solar sources. Germany will spend EUR[47] 23.6 billion ($25.93 billion) on green subsidies in 2014. From 2014 to 2015, it will also build 10 new coal-fired power plants.

Theoretically, Acemoglu *et al*. are undoubtedly correct in emphasising the importance of carbon taxes and research subsidies toward renewables. Unintended negative consequences are almost impossible to control, but the opportunity costs that Lomborg points to should not be ignored. Fossil fuels, particularly coal, are not immediately exhaustible. Therefore scarcity is unlikely to drive up their prices, making the horizon for endogenous technical responses too far away to be of any practical value in preventing climate change disaster. At the same time, energy poverty, in both the developed and developing world, inadvertently leads to continued income poverty, especially in the latter.

A 2014 analysis by the Center for Global Development offers helpful policy advice in light of the above. The Overseas Private Investment Corporation – the main US development finance institution for delivering President Barack Obama's Power Africa initiative launched in June 2013 – has a GHG emission limit on its investment portfolio. This necessarily moves investment in favour of wind and solar technologies. However, the inclusion of natural gas in the portfolio – based on the allocation of $10 billion – could make a substantial difference to a number of countries in sub-Saharan Africa: 'A targeted mix of two-thirds gas and one-third renewables would increase access for 70 million people and generate approximately 25,000 MW of additional capacity.'[48]

Southern Africa is endowed with extensive natural gas and coal deposits. These resources are currently under-utilised. A window of opportunity exists between the future economic feasibility of large-scale renewable power and the immediate prospect of electrifying the region through fossil fuel deployment. Policymakers need to think about how to harness new technologies for fossil fuel extraction and power generation in a way that makes economic and environmental sense. Political co-operation is a prerequisite for creating and executing such a plan. Policymakers should consider how to amalgamate coal and natural gas for regional electrification. Electrification is a primary channel

through which to industrialise, and ameliorate poverty. Using the latest technology to provide abundant regional electricity in itself creates economic opportunity, upon which the transition to low-carbon growth can be made. Improved transport and electricity transmission infrastructure are crucial ingredients of any development plan for the region.

CHAPTER 5

BOTSWANA'S POLITICAL ECONOMY

HISTORICAL OVERVIEW

Botswana's economic and political progress has been eulogised as exceptional. Many pundits proclaim it as the African success story that has managed to escape the so-called 'resource curse'. Influential economists Acemoglu, Johnson and Robinson note that Botswana outperformed every other country in the world in terms of per capita income growth from 1965 to 1998.[49] Table 1 provides a comparative overview of Botswana's economic and social performance since 2001.

Table 1: Botswana in comparative perspective, 2001–2011

Country	Botswana	Ghana	South Africa	Mozambique	Namibia	Zambia
GDP per capita growth (annual %)	3.03	3.71	1.97	4.59	2.44	2.62
Household final consumption expenditure per capita growth (annual %)	6.23	n/a	2.43	2.62	3.14	4.39
Government effectiveness	0.57	-0.053	0.55	-0.48	0.12	-0.79
Regulatory quality	0.58	-0.10	0.56	-0.44	0.17	-0.51
Rule of law	0.61	-0.05	0.087	-0.62	0.17	-0.50
Control of corruption	0.93	-0.08	0.31	-0.49	0.24	-0.67
Mortality rate, under-5 (per 1 000)	52.66	88.85	70.07	139.59	63.55	124.28

Source: Author's compilation using World Bank data: World Bank, 'World development indicators', http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators; World Bank, 'Worldwide governance indicators', http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=worldwide-governance-indicators, both accessed 25 May 2015

Typical accounts of why some nations develop more successfully than others, such as geography, struggle to explain Botswana's relative success. Those who favour geographical explanations must note that Botswana has both a high disease burden and is landlocked (making international trade difficult due to high transport costs). Botswana's initial

economic conditions were clearly unfavourable for development: 'When the British left [in 1966], there were 12 kilometres of paved road, 22 Batswana who had graduated from university and 100 from secondary school.'[50]

Acemoglu, Johnson and Robinson convincingly argued that Botswana developed differently due to a number of combined (predominantly structural) factors, in which individual agency also played a significant role.

First, the impact of colonial history is increasingly understood to account for persistent underdevelopment in African countries.[51] In Botswana, this historical colonial impact was minimised, partially through three Batswana chiefs' approaching Queen Victoria to prevent the advance through Bechuanaland of Cecil John Rhodes and his British South Africa Company.[52] The queen acted in their favour. The London Missionary Society sponsored their journey, negating the view that Christian missionary activity was primarily bound up in imperial pursuit. Botswana also happened to be relatively peripheral to British colonial interests.

Second, as was the case in most African countries, pre-colonial institutions such as the *kgotla* were remarkably inclusive. 'The integrative nature of traditional Tswana political institutions reduced the likelihood that alternative groups would aggressively contest the power of the new unitary state.'[53] This remained intact largely because colonialism did not distort the existing institutions. Upon independence, this translated into the establishment of formal rules that upheld private property rights and placed constraints on executive power. Of course, this did not occur by structural accident, nor was it a teleological guarantee. Leaders such as Seretse Khama and Quett Masire – the country's first two presidents – also played a crucial role.

Third, at independence, it was in the interests of the political elite to enforce property rights, as they themselves were cattle owners. 'Tswana elites, because of their control of the cattle economy, had a vested interest in institutions which would help them make money.'[54] However, by the mid-1970s the income from diamonds exceeded the income from ranching, 'so one needs to account for why this did not induce the political elite to change its strategy and expropriate the revenues from diamonds'.[55] Many authors also point out that the existence of a cattle-owning elite was not specific to Botswana at the time of independence.

Fourth, there is a growing consensus in the 'resource curse' literature that institutional quality prior to discovering mineral or oil wealth is a determining factor in whether a country's natural resource endowment will produce development benefit or not.[56] This is where individual agency and leadership integrity appear to have been so important to Botswana, in addition to the factors mentioned above:[57]

> For example, it appears plausible that had Seretse Khama not transferred the property rights over sub-soil diamonds away from his own tribe, the Bangwato, to the government, there could have been much greater conflict among tribes over the control of the wealth from diamonds. Or had he not reduced the political powers of tribal chiefs shortly after independence, tribal cleavages may have been more important … In Botswana, Seretse Khama and subsequent leaders consistently chose to take the democratic path.

Fifth, the breadth of the Botswana Democratic Party (BDP) coalition ensured that diamond rents were broadly distributed. The extent of wealth from diamonds (unusual, as Jwaneng

is anomalous as far as diamond mines go)[58] was sufficient to render the opportunity cost of undermining the path of institutional efficiency too high to do so. No group within the coalition appeared to attempt to extract more rents at the potential expense of political stability. This accords with the latest thinking in new institutional economics, which argues that the key to development is the rule of law among elites. Co-operation replaces competition for rents, and a consequently larger rent pool becomes available to all, provided political stability is maintained.

By most accounts, Botswana has withstood the test of resource wealth since its independence in 1966. 'Botswana has had no coups, no political instability, no civil wars, no threats of secession, and excellent, dedicated, uncorrupt [sic] leadership.'[59] Although it could have spent diamond rents more efficiently, and reliance on diamonds has arguably inhibited economic diversification, 'exploiting the diamonds rationally and allocating the resulting rents to developing the economy has been a major achievement'.[60]

It is not that Botswana is exempt from difficulty or immune to criticism. Poverty, especially in rural areas (where the majority of the population still lives), is extensive and inequality is high. As Acemoglu, Johnson and Robinson put it in 2003, 'While the economic achievements of Botswana have been impressive, there remain serious problems, particularly with respect to the incidence of AIDS, the persistence of inequality and high urban unemployment. It remains to be seen if Botswana's institutions will be strong enough to address these issues and sustain growth.'[61] The Gini coefficient, a standard global measure of inequality, is 0.61 (where 1 reflects a highly unequal wealth distribution and 0 a more equal distribution). This is among the highest in the world. Coupled with an unemployment rate of 17.8%, 18.4% of the population living below the poverty line, and an HIV prevalence of 23.4%, more inclusive, labour-absorptive economic growth is necessary to sustain Botswana into the future.

Most importantly, although diamond wealth has not resulted in the kinds of elite capture and socio-economic dysfunction associated with other mineral-wealthy states in Africa, the economy has been unable to diversify away from diamond dependence. With diamond revenues likely to decline in the near future, and criticism of Botswana's democratic credentials increasingly loud, there are pressing questions about the country's economic and political future.

CHAPTER 6

BOTSWANA'S ECONOMIC STRUCTURE

A recent article in *The Economist*[62] notes that Botswana's 2014 elections were free and fair. For the first time since 1966, the BDP won less than 50% of the vote, although it retains a parliamentary majority. But the party has been accused of abusing its power under Ian Khama (son of independence leader Seretse Khama), evidenced by the dramatically expanded state security agencies. In urban areas, support for the opposition Umbrella for Democratic Change (a coalition) grew substantially.

Beyond politics, the stability of which is intimately connected with diamond rents, the economy is on a precipice: '[T]he diamonds that made the country rich are quickly running out … There is much talk of diversifying the economy, but little sense of urgency among politicians. Discoveries of iron ore and coal will not be enough to replace diamonds. Neither will tourism … Unless new sources of growth are found, Botswana's politics may turn uncharacteristically nasty.'[63] A 2014 Mineral Accounts Report notes that:[64]

> The mainstay of Botswana's diamond production, the large Debswana mines at Orapa and Jwaneng, can keep producing on the basis of current investments for another 10–15 years. However, there are reserves that can be exploited beyond this time, although this will require significant investments to deepen and broaden the pits, or to go underground. With an anticipated upward trend in real diamond prices over the next two decades, driven by emerging supply–demand imbalances as major deposits are worked out, such investments should be worthwhile. Nevertheless, production is likely to remain well below historical peaks of 30-plus mcts [million carats] a year; and, as production costs rise, the rents generated and mineral revenues earned by the government are expected to decline as a proportion of gross output value. Although new mines have opened in recent years, these are much smaller than Orapa and Jwaneng, and are more marginal economically. There is extensive prospecting taking place for diamonds, and although many kimberlites[65] have been discovered, their economic viability is yet to be established.

The Economist article shows, despite its perhaps unnecessarily pessimistic tone, that political stability is dependent on new sources of economic growth. Diversification and new growth is therefore more important than ever.

In 2009, Scholar Amy Poteete criticised the work by Acemoglu, Johnson and Robinson on a number of levels, and – in contrast to *The Economist* – surprisingly argued that 'Botswana's economy has diversified, multiplying the investment possibilities available to politicians, international investors and the public'.[66] There is some evidence for this claim, insofar as government revenue is concerned. Table 2 distinguishes only between 'mineral revenue' and 'non-mineral revenue'. It shows that the former constitutes just under a third of total government revenue.

Table 2: Botswana's government budget 2012/13–2014/15 (BWP[67] million)

	2012/13			2013/14		2014/15
	Budget	**Revised**	**Final**	**Budget**	**Revised**	**Budget**
Revenue	42 906	41 911	41 658	44 022	45 426	50 183
Mineral revenue	12 038	12 038	12 076	13 254	13 257	15 241
Non-mineral revenue	30 868	29 873	29 582	30 768	32 169	34 942
Expenditure	**41 755**	**41 076**	**40 736**	**43 242**	**45 039**	**48 857**
Recurrent expenditure	31 751	31 772	32 106	32 194	32 977	36 693
Personal emoluments	12 128	14 290	14 548	14 481	15 128	15 749
Grants and subventions	–	7 049	8 088	8 350	8 350	9 809
Public debt interest	1 592	1 592	672	778	778	907
Other charges	18 032	8 842	8 798	8 586	8 721	10 228
Development expenditure	10 058	9 357	8 280	11 103	12 118	12 240
Net lending	−54	−54	351	−55	−55	−76
Balance	**1 151**	**835**	**922**	**779**	**386**	**1 326**

Source: Bank of Botswana, *Annual Report*, 2013, p. 72

Acemoglu, Johnson and Robinson made the point that diamond rents are sufficiently large to sustain the government's fiscus, and thus prevent unproductive rent-seeking by elites. They do argue, however, that rent-seeking is a risk in the context of over-reliance on one source of government revenue. Poteete argues, on the contrary, that the government's dependence on diamond revenues is not significant, given that it is no longer the single largest contributor to government revenues. One assumes – it is not stated in the bank's report – that the sale of polished diamonds also counts as mineral revenue.

Diamonds do, however, constitute a significant portion of Botswana's exports, as Table 3 demonstrates.

In 2013, diamonds accounted for 82.6% of Botswana's total exports, up from 78.8% the previous year. Dependence on diamonds for generating foreign exchange revenue is growing, not diminishing. One cogent proxy of a country's overall dependence on a commodity is the ratio of exports (of that particular commodity) to total imports. This indicates the extent to which domestic purchasing power is supported by that commodity. In Botswana's case, this ratio is 85:1. Diamond exports account for 85% of Botswana's import purchasing power. However, diamonds also constitute 28.5% of total imports, suggesting that this proxy may be somewhat misleading. The fact that Botswana imports some diamonds is evidence of its efforts to add value to rough diamonds. The government convinced De Beers to move its Diamond Trading Centre from London to Gaborone, and invited private investment in cutting and polishing to set up shop in the capital.[68] This has definitely been a form of diversification and value addition, although it is fundamentally dependent on an exhaustible resource. Either way, Table 3 provides stark evidence of Botswana's over-reliance on primary commodity exports and exposure to associated price volatility. A diversification strategy therefore necessarily involves the question of how

to minimise this dependence. Simply diversifying into coal and iron ore exports is not a sustainable option in the long run, given that these are also finite resources.

Table 3: Botswana's exports, 2012–2013 (BWP million)

	2012	2013	Percentage share		Percentage change
			2012	2013	
Total exports	45 861	63 859	–	–	39
of which					
Diamonds	36 143	52 768	78.8	82.6	46.0
Copper–nickel	3 393	4 604	7.4	7.2	35.7
Beef	523	996	1.1	1.6	90.5
Soda ash	645	723	1.4	1.1	12.2
Gold	618	451	1.3	0.7	–27.1
Textiles	613	362	1.3	0.6	–40.9
Vehicles	989	658	2.2	1.0	–33.5
Other goods	2 937	3 297	6.4	5.2	12.2

Source: Bank of Botswana, *Annual Report*, 2013, p. 78

In 2012, Botswana's level of stock foreign direct investment (FDI) was worth BWP 15.8 billion ($1.58 billion) in mining, with the closest competitor, finance, only worth BWP 4.9 billion ($490 million). As a proportion of total FDI, this was 72.2%.[69] Credit rating agencies Moody's and Standard & Poor kept their outlook for Botswana stable, reflecting relatively political stability in the region and the government's strong financial position. However, as the Bank of Botswana aptly notes: 'Nevertheless, concerns remained that, despite efforts to diversify the economy, the rating agencies were concerned about the country's vulnerability to shocks and the fact that not much progress had been achieved in diversifying the economy.'[70]

The Economist's claim that tourism growth is simply not rapid or large enough, and that discoveries of iron ore and coal will not be enough to replace diamonds, requires further scrutiny.

TOURISM

Tourism's contribution to GDP is notoriously difficult to capture in national accounts. 'International tourism is a major and growing contributor to national output, employment and foreign exchange earnings. However, it is primarily wilderness based and not adequately measured in national accounts.'[71] One paper states that 'tourism has become Botswana's second most important economic activity after diamond mining and is currently the fastest growing sector in the economy'.[72] The *African Economic Outlook*

Report for Botswana in 2014 also noted that tourism has significant potential for growth in terms of tapping into global value chains. The report does not go into detail as to how this could be accomplished, but one of the challenges is how to retain higher levels of tourism revenue within the country:[73]

> According to Botswana Tourism Statistics, only 10% of the tourism revenue is retained in the country. This is partly because the bulk of Botswana's tourist bookings are handled in South Africa, and partly because the sector's supply chain is foreign-dominated.

Aside from being difficult and expensive to access, Botswana's local tourist market is limited in size, and faces paradoxical environmental limitations – many tourists pay precisely to avoid a mass tourist experience. The challenge is therefore to diversify available tourism packages without compromising ecological integrity.[74] As pristine wildernesses become increasingly valuable assets, the inherent potential for tourism can only grow. However, creating a greater regional market is crucial for realising this potential. Such markets do not appear overnight. Part of their development requires improvement in other economic sectors that place more wealth in the hands of more people. Addressing the HIV/AIDS pandemic is also imperative, along with tackling other health issues such as poor sanitation in rural areas.

Given that diamond revenues will eventually be depleted, can coal and iron ore provide sufficient replacement value? If so, what are the most sensible economic options in this respect? How can the growth of the minerals sector contribute to the development of a larger potential tourist market, if at all? These questions will be addressed in the following chapters.

CHAPTER 7

COAL

The earlier discussion on ecological economics showed that subsidies towards renewable energy may appear inefficient in the short run, but would ultimately serve to create greater energy efficiency in the long run. Private sector investment under ordinary (undistorted by taxes or subsidies) market conditions would ultimately remove the need for subsidies once the new technologies became economically viable to supply base-load power. Continued fossil fuel subsidies, however, extend the time horizons for when that switching point could occur. The latest World Energy Outlook's Special Report records that:[75]

> Accelerated action towards a partial phase-out of fossil-fuel subsidies would reduce CO_2 emissions by 360 million tonnes (Mt) in 2020 and enable energy efficiency policies.

In 2011, fossil fuel subsidies amounted to $523 billion, six times the level of support provided to renewable energy. On average, 15% of global CO_2 emissions receive an incentive of $110 a tonne. Significant global pressure is building to remove these subsidies, although the primary obstacles occur at a domestic political level. The narrow interests of coal producers or consumers in individual countries often hamstring international agreements. Nonetheless, the Congress of the Parties 2015 will be under serious pressure to ensure that no new subcritical coal-fired plants are built in the future. This would reduce global emissions by 640Mt in 2020 and serve to curb local air pollution.[76]

Botswana possesses an estimated 208 billion tonnes of coal. Much of this (about 77%) is likely to remain categorised as sub-economic (speculative and hypothetical).[77]

> Although there is no publicly available comprehensive and up-to-date survey of Botswana's coal resources, it is widely agreed that there are extensive deposits spread throughout much of eastern and central Botswana.[78]

Eleven coalfields have thus far been identified. Only Morupule is currently being mined, and only two (Mmamabula and Morupule) have been extensively explored.

Reserves for these two fields were measured during the 1970s and totalled 7.2 billion metric tonnes. Indicated reserves in other coalfields ran to 28.8 billion metric tonnes. Inferred resources totalled 176 billion metric tonnes.[79] Regional energy shortages and the potential channel through which to diversify the economy have revived interest in these fields.

According to Jefferis, current production at Morupule Coal Mine (MCM) averages slightly less than 1 million tonnes per annum (Mt/a). 'The Morupule coal mine is expanding to meet the needs of the new Morupule B power station, but this is expected to reach only 2.5 mtpa.'[80] A resource sector overview by Capital Resources, however, indicated that output had increased to 3.2 million tonnes by 2012 on the back of a

BWP 1.7 million extension project.[81] It supplies coal to adjacent power stations and to Botash and the Bamangwato Concessions Limited (BCL) copper-nickel smelter.

MCM has been operational since 1972. It started as an underground mine using a 'room and pillar' method, which leaves roughly 50% of the coal seam behind but makes for a much safer operating environment. It is a highly mechanised operation, employing fewer than 400 people in total. Morupule A (decommissioned) and Morupule B power stations are adjacent to the property. Plans are in place for the mine to build an opencast pit, which is economically more efficient but likely to be more environmentally destructive.[82] The mine was originally a subsidiary of Anglo American Corporation, built to supply coal to BCL and a Botswana Power Corporation power plant situated in Selebi-Phikwe. In 2000, Debswana acquired MCM as a 100% owned subsidiary.

Table 4: Botswana's coal reserves (millions of metric tonnes)

	Measured reserves	Indicated reserves	Inferred resources	Total
Morupule	2 864	2 706	15 574	21 144
Mmamabula	494	20 215	5 005	25 714
Eastern	–	339	17 809	18 148
SE	–	9 283	132 810	142 093
Total	**3 358**	**32 543**	**171 198**	**207 099**

Source: Paya B, 'An overview of Botswana's coal resources and future plans', Presentation, Ministry of Minerals, Energy and Water Resources, Gaborone, 2012

Entrance to Morupule Coal Mine

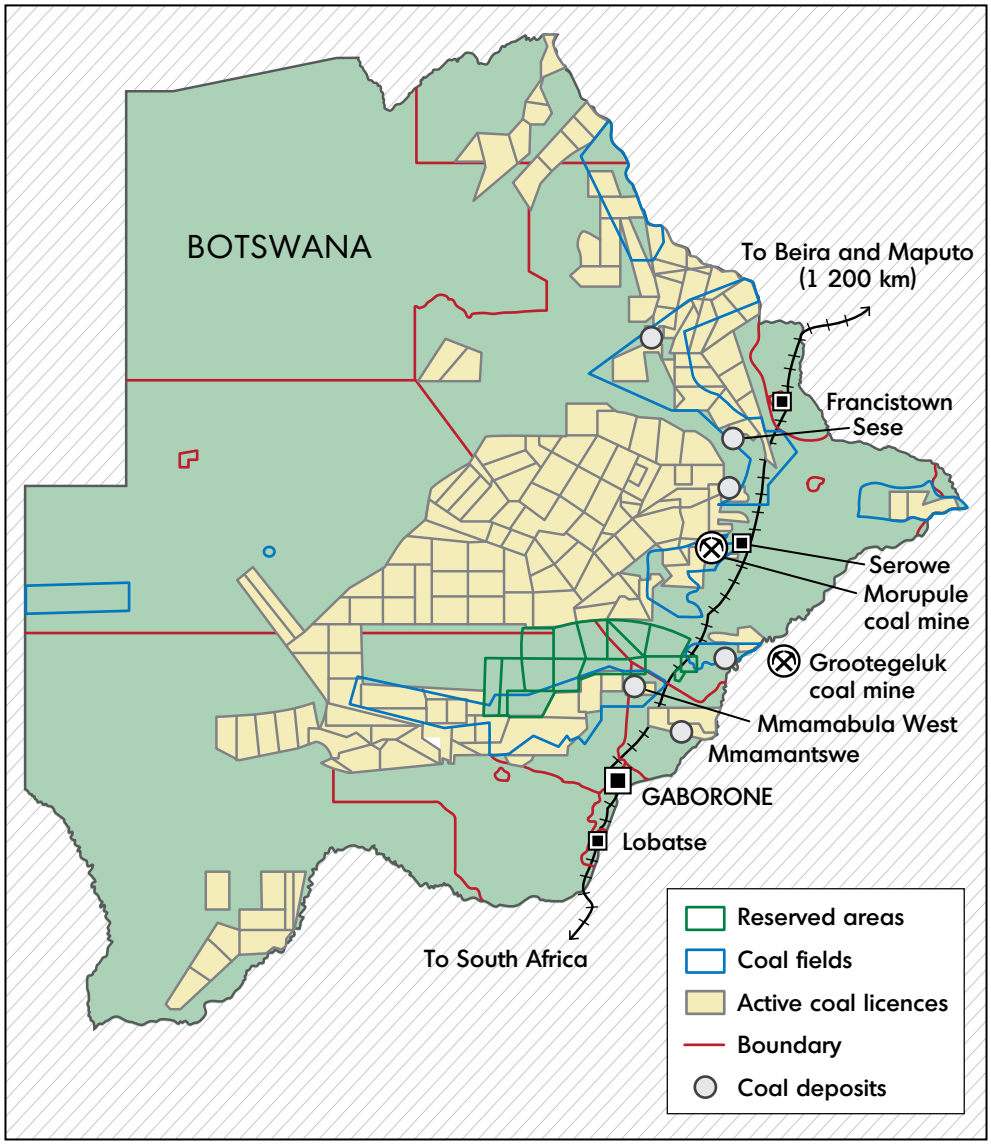
MCM. The coal is extracted from about 80m underground and brought to the surface by a conveyor belt. It arrives (far right) at ground level to be sorted into its different component parts. Some is loaded onto trains for export, while the best quality coal is transported by conveyor belt to Morupule B Power Station

The conveyor belt that moves coal from MCM to the adjacent Morupule B Power Station

Coal being loaded onto trains destined for Namibia, South Africa and Zimbabwe. The smoke stack chimneys of Morupule B Power Station can be seen in the distance

Morupule B Power Station, 14 km west of Palapye, on the road to Serowe

Figure 1: Map of Botswana's coal resources



Source: Government of Botswana, Ministry of Minerals, Energy and Water Affairs, http://photos.state.gov/libraries/botswana/19452/pdfs/Botswana_s%20Coal%20Roadmap.pdf, accessed 9 December 2014; African Energy, 'Projects: Botswana; Sese, Coal & Power Project', Subiaco: African Energy Resources ARBN, http://www.africanenergyresources.com/display/index/sese-coal-power, accessed 9 December 2014

According to the Botswana Institute for Development and Policy Analysis (BIDPA), approximately 23% (47.63 billion tonnes) of Botswana's coal is economically extractable (depending on the assumptions made regarding future prices, demand and technological improvements). This raises interesting policy questions for Botswana, foremost of which is whether it is prudent to export a portion of it. According to Table 5, the Botswana government's 'Coal Road Map' expects that 90 million metric tonnes a year can be exported.

Table 5: Potential uses of Botswana's coal resources (million metric tonnes per annum)

Potential use	Potential annual volume (Mt/a)
Coal exports	90
Export power generation	30
Domestic power generation	3
Coal-to-liquid	3.5
Cement	0.05

Source: Botswana Coal Road Map, in Jefferis K, 'Economic accounting of mineral resources in Botswana', *Final Report WAVES Partnership Botswana Program*. Gaborone: Econsult Botswana, 2014, p. 22

The world is under pressure to reduce carbon emissions, but many countries, especially in Asia, continue to build coal-fired power plants. This suggests that future demand may continue to rise, especially amid speculation that 'peak coal' production (measured in terms of energy generation) will occur between 2011 and 2047.[83] These assumptions and speculations must be interrogated in more detail before any meaningful recommendations can inform Botswana's decision-making. Knowing who the main competitors are and which export markets will be available for the next 30 years, is critical for arriving at a credible, implementable diversification strategy that will not saddle the country with obsolete infrastructure and an unmanageable debt burden. The next section deals with the external considerations and constraints that Botswana faces, much of which is beyond its control. The section thereafter will address internal considerations and constraints.

EXTERNAL CONSIDERATIONS

Mapping future demand for coal

According to global energy giant British Petroleum (BP),[84]

> coal is extending its competitive edge in power generation and the competitive balance has begun to shift. Coal was the fastest-growing fossil fuel [in 2013], with China and India combined accounting for 88% of global growth, while natural gas consumption growth decelerated and grew at a below-average rate.

This is somewhat counter-intuitive, given expectations of a supply contraction against the backdrop of declining prices. It also does not bode well for climate change mitigation. Part of coal's resurgence is attributable (in addition to fossil fuel subsidies) to hyper-innovation and the economic process of rapidly increasing efficiency as a means of warding off competition (in this case from renewable energy producers).[85] Substitutes for coal-fired power, such as solar base-load, are not cost competitive yet. Moreover, the search for

cleaner coal technologies has a competitive advantage over the search for better energy storage technologies (which would make solar power more reliable, for instance). Using the Acemoglu framework from earlier, coal producers have initial productivity advantages that competitors in alternatives such as solar and wind do not possess. Analogously, this is why traditional car manufacturing companies are more likely to produce carbon-neutral cars than technology companies such as Apple. Coal remains king in this respect.

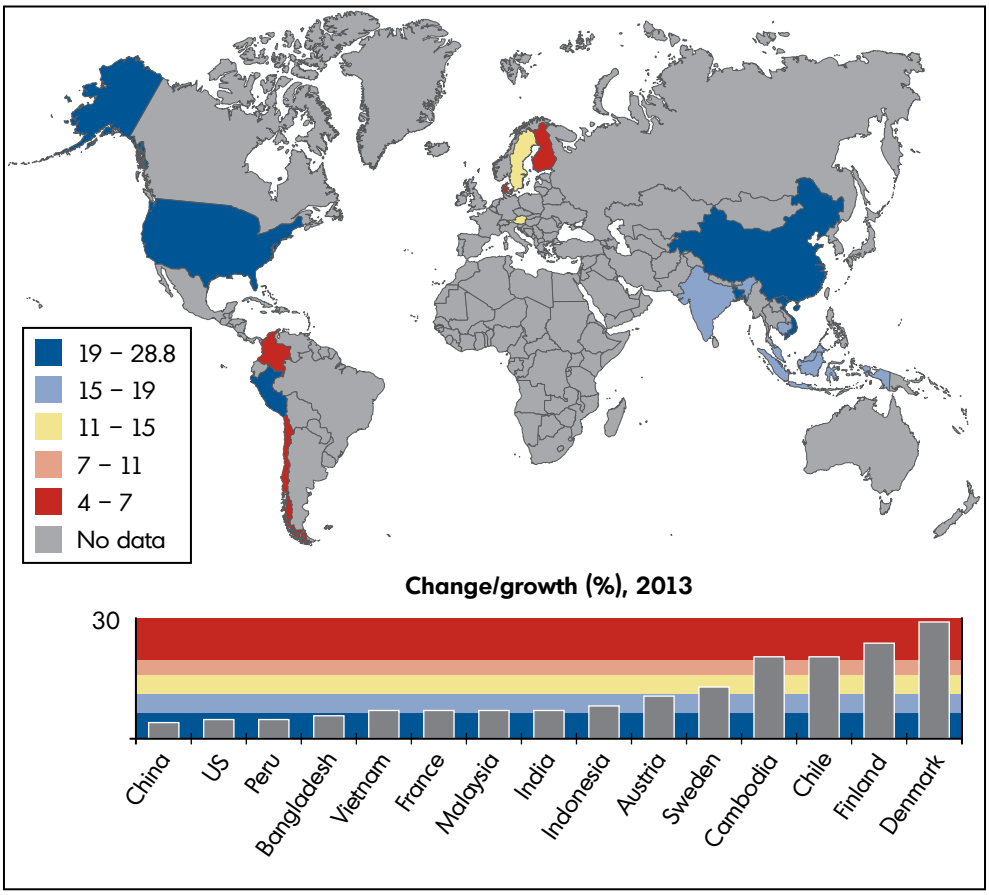
Coal's share of global primary energy consumption reached 30.1% in 2013, its highest level since 1970. Despite weak internal coal consumption growth, China still accounted for 67% of the global growth in coal consumption, with India at 21%. Overall, 89% of global growth emanates from non-OECD countries.[86] A World Energy Council Report from 2010 projected that coal use would rise by over 60% by 2030, in which China and India would account for 85% of developing countries' contribution to this demand (97% of the total).[87] However, a recent article in the *New York Times* provided strong evidence that China may move towards a climate change agreement that would result in both limited local production and imports. India might well follow China's lead on this, as both countries face increasing domestic political pressure to reduce airborne and river pollution.[88]

Notwithstanding the climate implications, the potentially good news for Botswana is that despite obviously rising demand, global coal production only grew by 0.8% in 2013, and Botswana possesses one of the last remaining 'greenfield' deposits in the world. This suggests a window in which Botswana could viably export some of its coal. However, global reserve-to-production (R/P) ratios are phenomenally high: 'World proved coal reserves in 2013 were sufficient to meet 113 years of global coal production, by far the largest R/P ratio for any fossil fuel.'[89] Botswana would by no means be a unique producer either. The argument in favour of exporting its top-quality coal would be far stronger if it were a monopoly supplier closer to its potential export markets. Botswana will be competing with many other potential suppliers (Figure 2) for relatively few export markets (Figure 4). Moreover, global prices – on an average trend – have been declining since 2008.

Figure 3 indicates the average price of coal across five different international benchmarks.[90] Botswana's coal is not of coking quality, and thus it would not gain from the anomalous pricing of that particular type of coal. Steam coal prices have become increasingly volatile since 2003, raising significant price risks for Botswana's coal. This risk is intense, especially in the context of the other factors already mentioned. Roman Grynberg, of BIDPA, makes the case that with the correct supporting infrastructure, 'and the dramatically decreased freight costs associated with such a dedicated service it would be possible to export at Fob [free on board] Maputo prices of USD70–75/tonne, which would mean that Botswana would be able to withstand increased price volatility in the steam coal market'.[91]

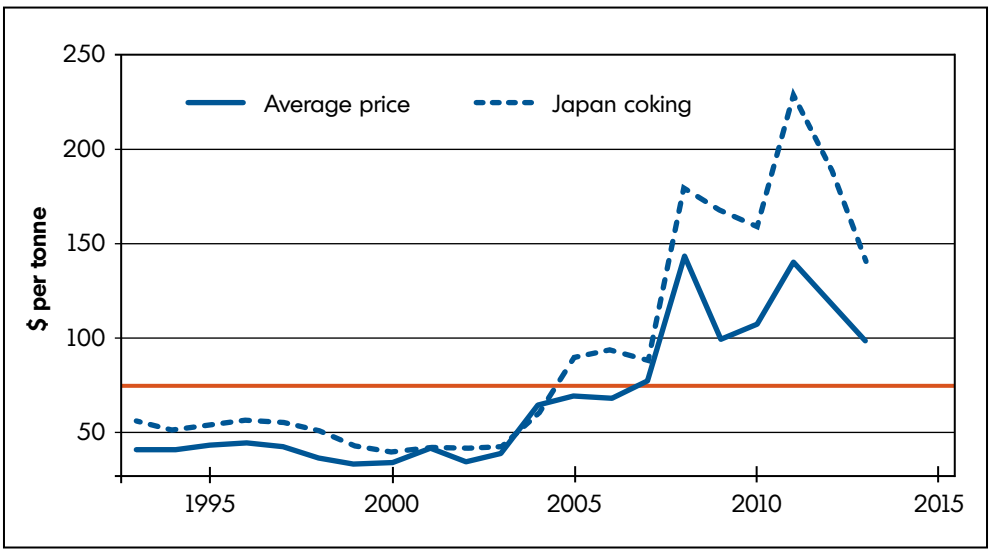
Botswana could presumably tie its coal export fortunes to long-term contracts with electricity utilities in countries such as India that are looking for dedicated import markets. Ironically, the highest recent consumption growth is found in countries that have a reputation for leading the charge against climate change. Denmark and Sweden, for instance, exhibited high growth rates from 2012 to 2013. However, this is evidently a short-term trend and long-term demand should not be deduced from such small changes.

Figure 2: Sources of global coal consumption growth



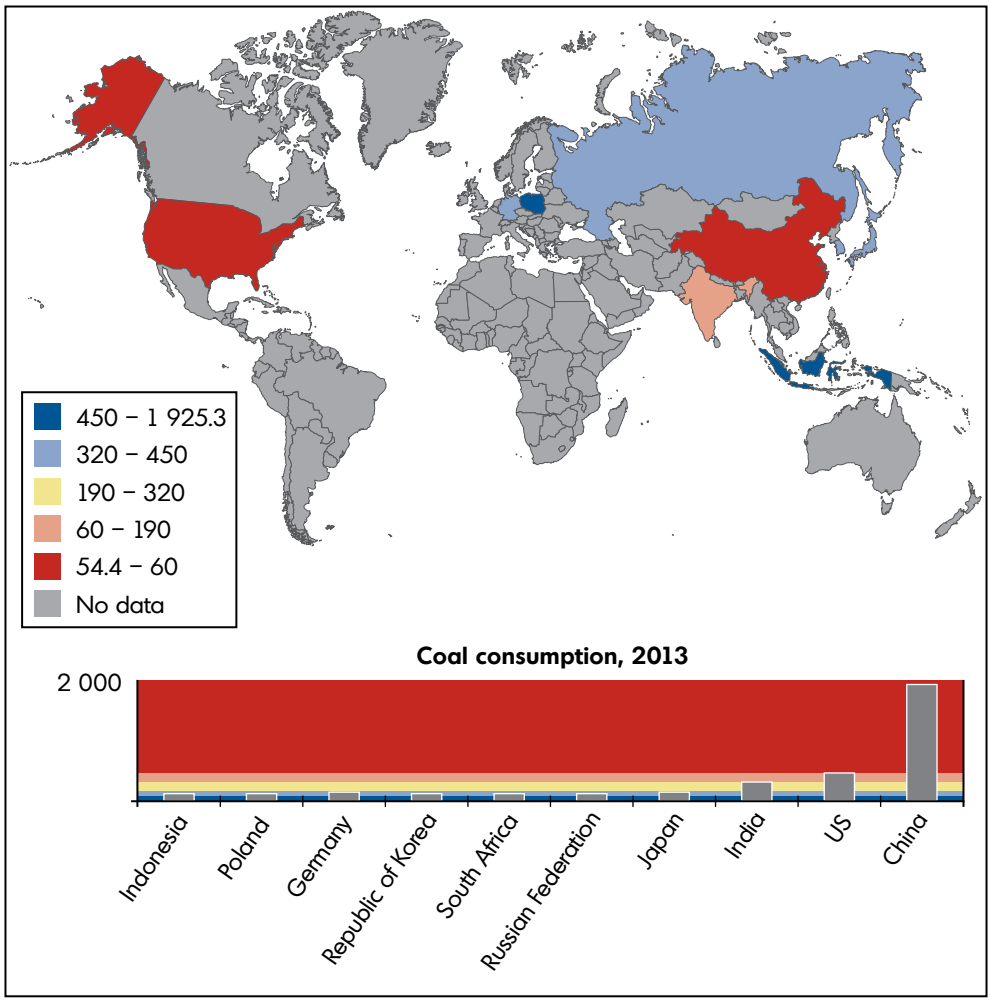
Source: BP Statistical Review of Energy, 2014, p. 33

Figure 3: Global coal prices, 1993–2013



Source: BP Statistical Review of Energy, 2014, p. 30. Author's compilation

Figure 4: Global coal consumption levels (millions of tonnes)



Source: BP Statistical Review of World Energy, 2014, p. 33

The highest levels of consumption do not necessarily correspond to the highest growth increases, although the countries in which there is overlap do offer export potential for Botswana. In the case of the latter, China, the US and India appear to offer the greatest opportunities. However, the US is itself a significant producer (904 million tonnes in 2013), as is China (3.5 billion tonnes in 2013).[92] This means that there is no genuine supply-side deficit into which to export. Both countries are also under serious global pressure to reduce their carbon footprints. Unless they do so, climate catastrophe will in all likelihood ensue. China also faces internal constraints – most of its coal is in the weather-difficult northern regions, in which environmental pollution is also a serious concern. Transport costs from there to the main coal-fired power stations in the south are also high. From Figure 4, then, it seems clear that India is Botswana's best option. India produced 228.8 million tonnes in 2013 but consumed 324.3 million tonnes, indicating an authentic internal supply shortfall. BIDPA noted in 2012 that,[93]

> given the increased interest of Indian investors in Botswana mining assets it is likely that existing supply will be tied to Indian firms with supply contracts with electricity utilities. This would leave Botswana little option but to supply one market and therefore to tie its economic development to the prosperity of that country.

For instance, Indian miner Jindal BVI Limited bought the Canadian CIC Energy Corporation in September 2012. It purchased coal assets that it viewed as profitable for the next 50 years, with projected production at roughly 45 million tonnes a year. This is dependent on the construction of an export-facilitating railway line by 2020. Jindal has trade arrangements in place with India to export roughly 20 million tonnes a year exclusively to that market.[94] Botswana's 'Coal Road Map' also places substantial emphasis on the suitability of its coal for export to the Indian market.[95]

All of these considerations of course depend on Botswana's overcoming a number of internal constraints.

Cohering with the above analysis, a 2009 pre-feasibility study for rail infrastructure links – that would have to be built to facilitate exports – makes the important point that,[96]

> [f]or Botswana's coal to be transported on the [proposed] TKR [Trans-Kalahari Railway], a sufficiently large global thermal coal import demand must exist to be able to absorb such large volumes of coal. Botswana must also be able to beneficiate or process the coal to meet the quality the market is looking for. From an initial review of available material regarding world coal import demand, it is not entirely clear whether such a large global import demand exists.

An analysis of whether the TKR is feasible follows below. The important point for now is that it is unclear whether sufficient global import demand exists to warrant an economic focus on exporting coal. And even if that demand could be shown to exist, a relative consensus is emerging that the demand window will be open only a short time, placing substantial time pressure on the construction of the necessary infrastructure. This raises concerns over what purpose this infrastructure will serve beyond the coal-export window. It seems likely to be a sunk cost, which is not easily recoverable and therefore possibly unwarranted in the long run.

INTERNAL CONSIDERATIONS

This section considers the infrastructural, geographic (water and distance) and political constraints that coal faces as it seeks to become an economic mainstay in Botswana. These constraints point to the importance of an integrated mineral and base metal diversification strategy that focuses more on regional energy security and building a local steel industry than on exports per se.

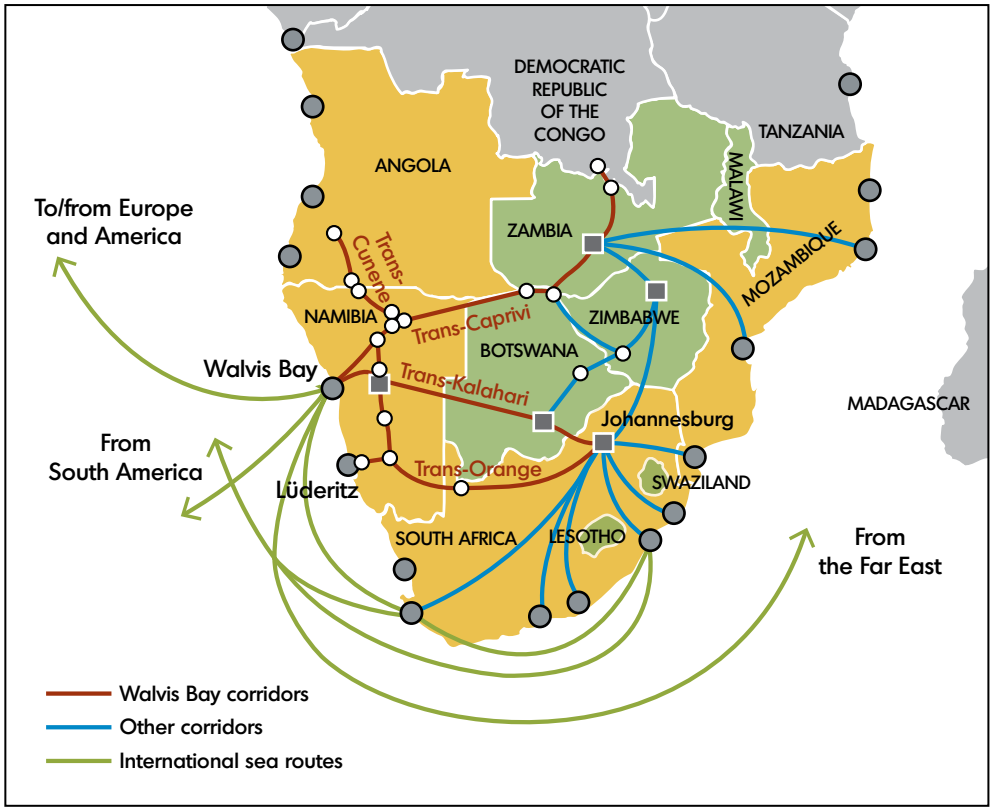
Infrastructure constraints and the Trans-Kalahari Railway

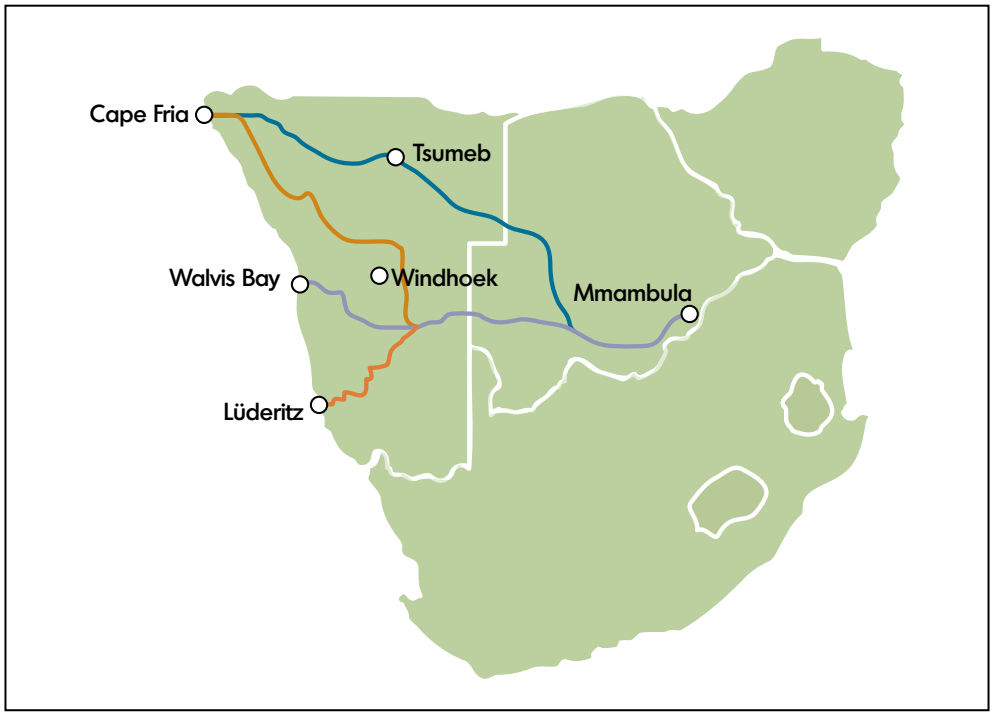
'Due to Botswana's infrastructure, being landlocked and with insufficient rail network, direct export of coal has not been considered economically feasible until recently.'[97]

In late March 2014, the governments of Botswana and Namibia, as a means of overcoming this constraint, signed a TKR line bilateral development agreement.[98] It was initially expected that this agreement would be signed in April 2013, but it was delayed without explanation. One potential reason is that CIC Energy Corporation was expected to be a major private sector partner in what would ultimately be a major public–private partnership (PPP). However, Jindal bought CIC in 2012 and it is not clear whether Jindal will contribute to the costs of constructing the TKR. In 2009, the same governments had signed a memorandum of understanding for the construction of the TKR. 'The estimated cost of the port and loading facility is US$3.7 billion and the estimated route costs are between US$8 billion and US$11 billion, depending on the chosen route.'[99] However, operational costs are expected to be in the region of $27 billion over 30 years.[100] The government's Integrated Transport Policy White Paper of 2011 envisages the TKR as 'the most significant development project in the transport sector for the next 30 years'.[101]

A TKR line would run for 1 500 km from Mmamabula to Walvis Bay in Namibia (see Figure 5). The Botswana government expects that it will take three years to build and that two new cities will be built on its route over the next 25 to 30 years, 'creating 100 000 new jobs for the Motswana and the rest of the region'.[102] The line would complement the existing Trans-Kalahari Corridor, which was opened in 1998 and consists of 1 900 km of paved roads from Walvis Bay through Botswana and into Johannesburg.

Figure 5: The Walvis Bay Corridors





Source: i) Brundige D *et al*., 'An economic development strategy for the Trans-Kalahari corridor', Walvis Bay Corridor Group, 4 May 2011, p. 6; ii) Prefeasibility study of three rail links: Trans-Kalahari Railway, Mmamabula-Ellisras and Mosetse-Kazungula, *Phase I Inception Report*, prepared for Ministry of Works and Transport, Republic of Botswana, by CPCS Transcom International Limited, October 2009, CPCS Ref: 08154

However, the costs of such a line are potentially prohibitive when weighed against the potential benefits. Table 6 shows the results of a study commissioned by BIDPA to ascertain the economic value of exporting thermal coal.

These projections – generated by University of Botswana researchers Peter Freeman and Khaulani Fichani – assumed a 'high price scenario' and the appropriate transport infrastructure to facilitate exports. However, the export revenue depicted in their table assumes a selling price of roughly $30/tonne of coal (mine gate prices, excluding transport costs). According to these projections, Botswana's coal exports would earn a total of BWP 146 billion ($15.46 billion) over 15 years (at an exchange rate of BWP 1 to $0.1039). That is only BWP 9.73 billion a year on average, or $1.03 billion. Estimating peak production at 72.9 Mt/a is also conservative. However, it is not clear whether the substantial extra shipping costs of exporting from Walvis Bay (rather than through Mozambique, for instance) were factored into the projection equations. Also, the envisaged future employment of 6 756 people in the coal industry alone seems unrealistic, especially in a conservative model. Increased mechanisation, low global coal prices, and distance from export markets render this employment scenario highly unlikely.

Table 6: Coal production, exports, employment and revenue projections

	Production (Mt/a)	Exports (BWP billions)	Employment	Nominal government revenue (BWP millions)	Real government revenue BWP millions)
2012	0.2	0	83	–	–
2013	1.1	0	324	59	55
2014	6.2	1	1,177	126	112
2015	13.2	3	1,911	1,201	1,015
2016	19.1	5	2,652	1,790	1,441
2017	31.6	8	3,825	2,699	2,079
2018	43.4	12	4,743	2,933	2,142
2019	48.7	10	5,177	2,000	1,391
2020	57.5	11	5,707	1,789	1,185
2021	62.4	13	5,945	1,898	1,197
2022	62.4	13	5,943	2,018	1,212
2023	67.9	16	6,391	2,815	1,610
2024	72.9	17	6,759	3,173	1,729
2025	72.9	18	6,756	3,191	1,656
2026	72.9	19	6,756	3,246	1,605

Source: Freeman P & K Fichani, 'Minerals and energy export and revenue projections', Report commissioned by BIDPA for the Botswana Confederation of Commerce, Industry and Manpower (BOCCIM), 2012

In the same study for which the above projections were commissioned, Grynberg writes that: 'With a new railway and the dramatically decreased freight costs associated with such a dedicated service it would be possible to export at Fob [Free-on-board] Maputo prices of USD 70-75/tonne.'[103] If, at peak production, Botswana exported 100 million tonnes a year (as the Chamber of Mines reckons it could)[104] and received $70/tonne,[105] total annual revenue earned would be roughly $7 billion. Provided that the window for coal exports remains open (and the price less volatile than in recent years), this seems a more plausible figure than the projections presented above. To avoid indebtedness, the expected revenue should far exceed the costs of building, operating and maintaining a dedicated railway.

The capital and operational costs of a wide gauge TKR line are projected at a total of $38 billion over the next 30 years ($11 billion for construction and $27 billion for operation). If the Freeman and Fichani figures (Table 6) are used, the total net loss to Botswana (if coal exports alone were to sustain the TKR line) would be in the region of $22.54 billion. However, if peak production is reached by 2020 and continues for 30 years, total revenue generated would amount to $210 billion. This figure yields a projected net profit of $172 billion. Clearly this kind of disparity is economically unworkable, and more work needs to be done to provide credible earning projections under different scenarios.

A bankable feasibility study is yet to be completed in the wake of the initial 2009 pre-feasibility study. Under the conservative scenario (Freeman and Fichani), real government revenue accruing to the state would average BWP 1.23 billion ($125 million) a year. A more optimistic scenario would yield even higher government revenues. While this is significant, it should be a relatively minor consideration when weighed against the cost of servicing debt incurred on a potentially obsolete infrastructure project. Freeman and Fichani themselves caution 'that due to the scale and possible risks involved, government should conduct a thorough due diligence ahead of any participation in such large infrastructure projects'.[106]

In order for the line to warrant the capital and operational expenditure, it would have to carry other products, but this might detract from the efficiency gains that would accrue from a dedicated line. The viability of adding iron ore and other base metals will be examined later.[107]

However, there are five further disadvantages to the TKR route, the costs of which must also be considered against uncertain future benefits (see Box 1).

Box 1: Disadvantages of the proposed TKR line

- Walvis Bay is not a natural deep-water port and would thus require extensive dredging at substantial cost over the coal-exporting window.
- The route would add roughly six days' worth of shipping transport costs en route to India. When the initial pre-feasibility study was undertaken, the dominant assumption was that Botswana's coal would be exported primarily to European markets, in which case the TKR would ostensibly have made more economic sense.
- Walvis Bay is an important fishing centre and coal shipping is likely to pose an environmental risk to fishery stocks along that coastline, undermining Namibian livelihoods and export revenues.[108]
- Beyond 2030, when energy storage technology for solar power seems likely to have advanced sufficiently to supply reliable base-load power, the TRK line might become obsolete. Stranded economic assets, otherwise known as white elephants, can indebt future generations. This is something Botswana should work hard to avoid. In the context of the high uncertainty over the future of coal and the short time frame within which to reap relatively few economic benefits, policymakers should weigh this consideration disproportionally to the others.
- The economic spillover benefits envisaged by the strategy for building a Trans-Kalahari Development Corridor seem overstated. The combined populations of Botswana and Namibia (about 4 million people) are roughly similar to the population of Cape Town, one South African city. A single-purpose railway line traversing two deserts and servicing small populations does not appear – on this reading – to make economic sense. Another important consideration under this disadvantage is that the Kalahari itself may become increasingly valuable (both intrinsically and in terms of tourism revenue generation) by virtue of its being a pristine wilderness.

For instance, a recent economic study indicated that tourists increasingly 'prefer more pristine recreational opportunities, increased chances of seeing predators and disapprove of granting the local Khomani San communities access to grazing opportunities inside the Kgalagadi Transfrontier Park'.[109] The relevant reported willingness to pay suggests that significant opportunities exist for a payment-for-ecosystem-services scheme to be initiated.

In a world where population densities will only intensify (as the global population moves to 9.6 billion by 2050), the future premium on wide-open spaces cannot be overstated. It would appear myopic to undermine this potential value by constructing a heavy railway through the region for relatively short-term gain that did not include other spillover benefits.

Alternatives to the TKR

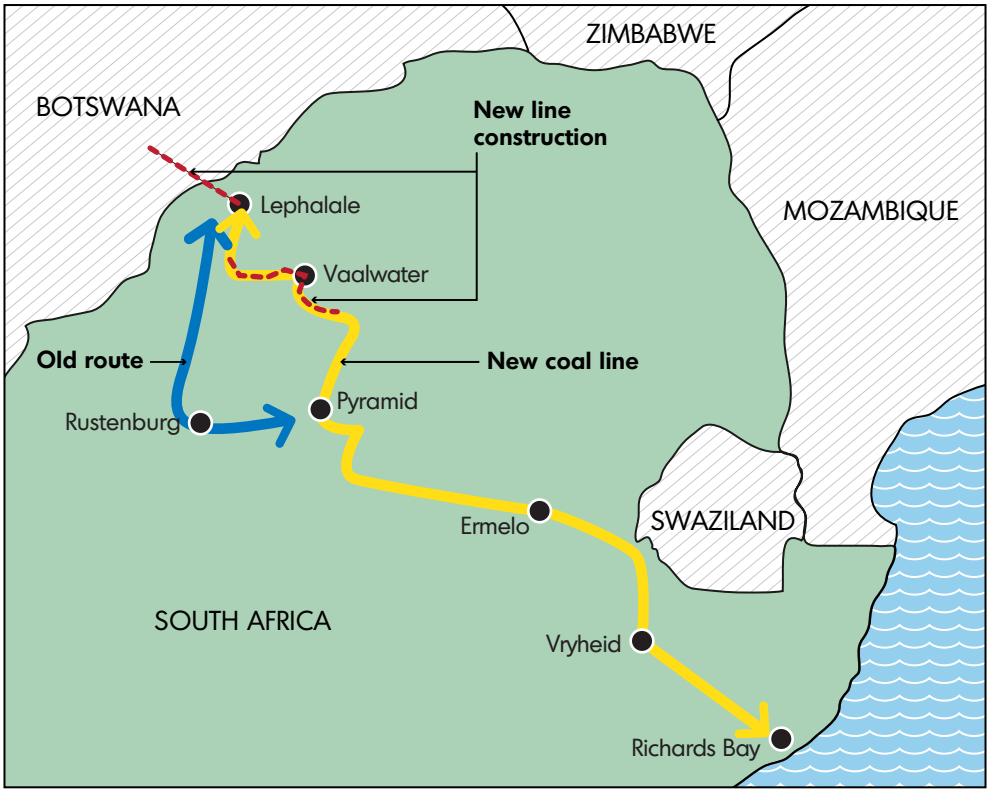
There are two alternative options to the TKR, neither of which appears particularly compelling. Existing lines through South Africa or Mozambique are narrow Cape gauge lines, incapable of transporting the kind of volume necessary to sustain an export industry.

A line through Zimbabwe to Ponta Techobanine, south of Maputo, at a cost of $11.6 billion, has a number of comparative economic benefits (relative to the TKR). First, the route would be shorter (but only by 1 100 km). Second, it would use Selebi-Phikwe as a staging point for all coal coming from Zimbabwe and Botswana, which would provide a much needed boost to the third-largest town in the country. Third, Ponta Techobanine is a natural deep-water port, avoiding the dredging costs that would be associated with the Walvis Bay terminal. However, there are environmental and political risks to this alternative that have rendered it highly unlikely. Environmentally, it would traverse the Lubombo Transfrontier Conservation Area and the Maputo Elephant Reserve, which seems an unnecessary risk to incur. The main problem, however, is political – the sovereign risk associated with running a dedicated rail link through Zimbabwe is high.

Or else, a rail spur could simply be run to link the Mmamabula and Morupule coalfields with the Waterberg fields in South Africa. This option may go ahead regardless of whether the TRK is built. However, it would not be able to accommodate the volume of planned exports envisaged by Botswana at peak production:[110]

> The current bottleneck on this route is the rail line to the terminal, which can handle only up to about 70–75 million tonnes. This capacity has been allocated to the cartel of [South African] coal mining firms.

Figure 6: Waterberg extension and Transnet route to Richards Bay



Source: Presentation by Transnet Freight Rail for Transnet Freight Rail Road Show, June 2009

South African firms apparently intend to increase exports to 100 million tonnes. It is therefore unclear whether Botswana's coal could permeate this route to any significant degree. In an interview with Jindal, however, executives were confident that at least initial small-volume exports could go through South Africa using Transnet.[111]

Final matters to consider on transport constraints are the environmental and health and safety risks associated with transporting coal over large distances by train. Diesel engines, which would presumably be used, emit particulate matter and nitrogen oxides into the atmosphere, important sources of pollution that contribute to global warming.

Water constraints

Botswana is water-scarce, and likely only to become drier as climate change advances. Intensive coal mining will exacerbate this constraint. After coal is mined, it is washed before being shipped. Washing is necessary to remove dirt, rock and sulphur from the actual coal to improve its thermal efficiency and reduce carbon dioxide emissions when burnt. 'Large centrifuges, fluid media with different densities, and other physical techniques are employed. Washing makes the product cheaper to ship and cleaner to burn and is one of several elements of what some refer to as "Clean Coal". Disposal of the resulting waste or slurry, however, is a substantial challenge.'[112] Lockwood used, among others, an accident at Buffalo Creek, West Virginia in 1972 to demonstrate these

challenges. Three dams collapsed that had been built to contain coal-wash slurry. The floodwaters rushed down Buffalo Creek Hollow, releasing an estimated 132 million gallons (almost 500 000 m^3) of the waste. 'Within minutes, 125 people were dead, 1 100 were injured, and 4 000 were homeless.'[113] Most coal slurry is stored either by impoundment in dams or injection into abandoned mines. The health effects of the chemicals present in the sludge – due to leaching into the groundwater – are severe. One study undertaken by a team from the US Geological Survey found 'a significant association between a number of coal-associated elements and chemicals found in well water and cancers of the kidney'.[114]

Moreover, washing coal invariably leads to the loss of coal itself, which is economically inefficient. The adoption of new technologies could reduce the need for washing, but these considerations do not appear to be part of the conversations among Botswana's stakeholders as yet. Fluidised bed combustion and gasification is one such technological option. Fuel is suspended in boilers by jets of air containing controlled amounts of oxygen and steam to produce synthesis gas (or syngas), which is then burned.

In addition to the environmental and health risks associated with coal washing, there is the sheer shortage of water availability in Botswana to consider. Scarcity naturally increases the opportunity costs associated with each individual use of water. For instance, scarce water supply would arguably be more efficiently allocated to activities such as agricultural production, increasingly important to attain food security in a food-uncertain world. These opportunity costs must be properly accounted for in any feasibility study for a TKR project, as water supply is a fundamental aspect of the equation informing the viability of a coal export industry.

On one reading, exports of 72 Mt/a would require 5 756 400 m^3 of water a year, in addition to 216 MW of power each year.[115] On another reading, 'if one takes the Mmamabula deposit, the expected exports from the mine when in full operation are in the vicinity of 23 Mt/a. According to company estimates, the amount of water required for such an operation is in the vicinity of 10.5 million m^3/a for a period of 35 years'.[116] A countrywide 72 Mt/a export industry would thus require 32.8 million m^3/a. The large variance between the two readings is to be expected, given that differing coal types will require varying degrees of washing. Moreover, the size of the mine also determines how much water is required for cooling, dust suppression and cleaning of plant equipment. However, the pre-feasibility study for the TKR notes that 'a total of 40–75 million tonnes of export coal per year will require 3.2 to 5.6 billion litres of water per year, taking full allowance of available recycling technology. Supply of water for washing could thus limit the volume of export-grade that can be mined, processed and shipped.'[117]

Water would have to be piped from the Zambezi River, as the abstraction of ground water for coal mining is unsustainable. The government of Botswana has riparian rights to access 495 million m^3 a year from the Zambezi, apparently more than sufficient for coal mining needs. The infrastructure costs of building such a pipeline must, however, also be factored into the equation. Capital availability for mega infrastructure projects will remain highly competitive for the foreseeable future, given global economic stagnation.

Power constraints

Southern Africa is in the midst of a power crisis. Few SADC countries have sufficient supply to meet local demand. Any efforts at improving intra-regional trade and promoting

industrialisation in the region are therefore subject to this significant constraint. The paradox is that regional coal and natural gas deposits could provide sufficient power for the region if they were harnessed in a more efficient and co-ordinated manner. However, doing so requires a level of political co-operation that appears difficult to attain. In Botswana, the power requirements for mining coal may not be met under current circumstances. The country's only functional power station, Morupule B, has experienced multiple problems and is often unable to supply the 600 MW that it was designed to. If coal mining will consume around 216 MW per year, this may be an imprudent use of a limited resource unless other power stations are built and old ones re-commissioned.

South Africa is in the process of completing three large coal-fired power stations. Eskom, the state-owned entity responsible for power generation, in partnership with the national Department of Public Enterprises, promised that the first of these, Medupi, would go live by the end of 2012. However, it now seems it will still not be producing power by the end of 2015.[118] In an effort to compensate for the foreseen supply shortage after the 2008 blackout crisis, Eskom embarked on a programme of procuring power from independent power producers. In 2009 the Department of Energy changed the regulations governing the programme and made itself the purchaser of power (rather than Eskom). In 2011 'South Africa's second integrated resource plan (IRP 2010) was completed and unfortunately did not provide any opportunity for [Mmamabula Energy Project] MEP to supply power to South Africa prior to 2019, and then only in smaller amounts than [the planned] 1 200 MW'. The Integrated Resource Plan was updated in 2013 and still contains no purchasing agreement with MEP, nor has the update been made publicly available.

The reasons for South Africa's lack of co-operation on the Mmamabula project remain unknown. In hindsight, it would have lost nothing either politically or economically. Political and economic 'losers' would normally attempt to block the advance of new initiatives and technologies to protect their own rent streams, but in this case the mutual benefit from co-operation seems obvious. Meanwhile, the South African government is finalising plans to procure 9 000 MW of nuclear power, which is patently unwarranted in the light of the country's capital borrowing constraints and the time lag of 10 years before any of the six proposed stations could come into operation. The purchase of 1 200 MW from MEP would provide revenue for Botswana and sufficient electricity supply in the short run for both countries, especially when considered alongside the existing 600 MW generated by Morupule B Power Station.

Even in the absence of South Africa's co-operation, coal-to-liquid and gas-to-liquid technologies could potentially be harnessed regionally to provide energy security for Namibia, Botswana and Mozambique. More urgent research is required into how this could work and where the stations could be optimally located. Coal bed methane in Botswana, and natural gas from Mozambique and Namibia, along with coal in Mozambique and Botswana, could power at least these three countries into the foreseeable future.

Global demand for coal is uncertain. There are significant cost and environmental risks associated with building a 1 500 km TKR to facilitate large-scale coal exports out of Botswana. For a water-scarce country, the water demands of coal mining and washing are staggering. The risks of post-washing groundwater contamination are also high. The cumulative effect of these considerations indicates that coal exports should not be treated as a panacea for Botswana's development. What then are the available alternative options?

CHAPTER 8

IRON ORE AND OTHER BASE METALS

Given the uncertainty associated with a large-scale coal export industry, the country could instead seek to complement coal with other minerals and base metals to build a steel industry[119] in Selebi-Phikwe to supply the growing SADC region. Revenue generated by this activity could supply part of the infrastructure capital required for large-scale coal and iron ore exporting, provided the constraints noted above can be alleviated. Policymakers could thus consider a 'vent-for-surplus' trade model rather than a static 'comparative advantage' model.[120] Raw coal and iron ore could first be consumed locally to produce higher value products such as pig iron or steel. Surplus raw material could then be exported. By that stage, policymakers may also have a clearer idea of how much longer the window of coal export opportunity will remain open in the light of the technological advances made by alternative energy sources.

IRON ORE

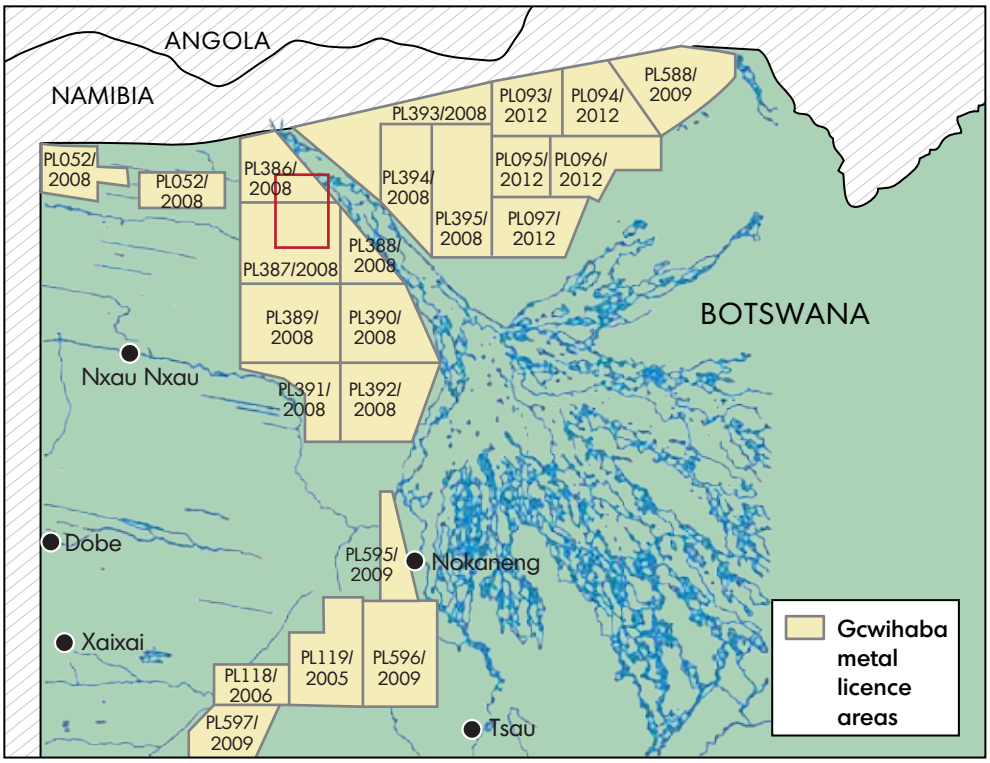
Second to Simandou in Guinea, Botswana probably possesses one of the last remaining major 'greenfield' iron ore deposits in the world. Gcwihaba Resources (Pty) Ltd. (Gcwihaba) has been sampling near Shakawe, in the north-western region of Botswana, since 2008. A mineral resource estimate produced for Gcwihaba by an independent consultant (SRK Consulting UK) in August 2014 reported: 'In total, SRK has derived an Inferred Mineral Resource of 441 Mt grading 29.4% Fe, 41% SiO_2, 6.1% Al_2O_3 and 0.3% P.'[121] This essentially means that high-grade iron ore deposits have been discovered through sampling and drilling. 29.4% Fe is a relatively high iron composition within the banded magnetite rock outcrop. Mineral resources are categorically sub-divided in order of increasing geological confidence from 'inferred' to 'indicated' to 'measured'. An inferred resource is therefore that part of a resource for which grade and quantity are estimated in the light of limited geological evidence. 'Geological evidence is sufficient to imply but not verify geological grade or quality continuity.'[122]

This significant deposit could – in conjunction with coal and copper – be the beginning of the economic game-changer that Botswana requires. However, it is neither 'measured' nor 'proven' as yet. Higher levels of geological confidence would be required before any serious policy decisions can be made. Moreover, the location of the iron ore deposit is potentially environmentally sensitive. This report argues that this need not be an obstacle to its extraction, provided it is proficiently governed and forms an integral part of a cohesive strategic development plan.

Figure 7 indicates the location of Blocks 1 and 2. Block 1 is outlined in blue, while the red lines indicate the location of inferred iron ore. Formal independent inference for Block 2 has not yet occurred, and capital for funding further geological exploration in that block will probably be generated from the proceeds of mining Block 1 first. However,

Block 2 is larger by an expected order of magnitude of 10, with an expected 5 to 7 billion tonnes of high-grade ore.

Figure 7: Gcwihaba's prospecting licences in north-western Botswana



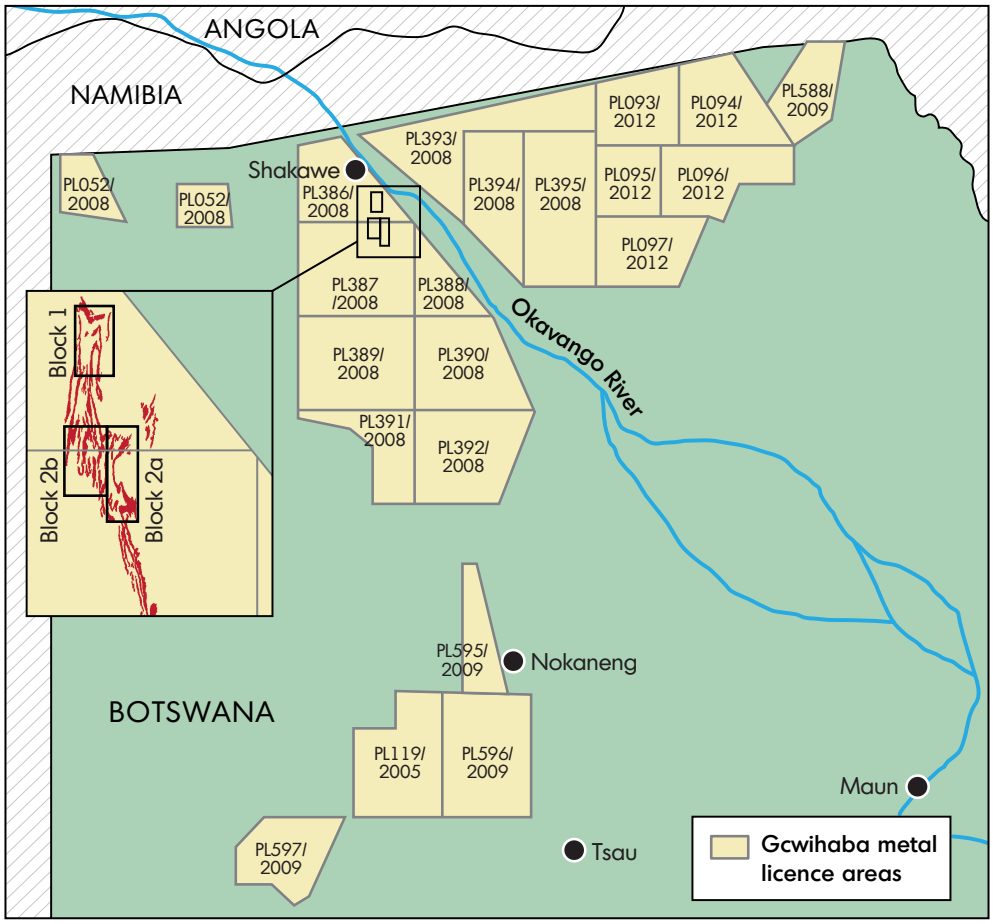
Source: Presentation by Tsodilo Resources Ltd, 'The tip of the iceberg', Maun, 6 September 2014

When the report was released in late August 2014, the estimated value of the 441 million tonne deposit in Block 1 was about $14.8 billion. This was built on two key assumptions. First, post-processing tonnage would be 146.2 million tonnes (after DTR[123] magnetic separation), in which the iron concentrate would be larger than 67.2% on average. Second, the iron ore price at the time was $100.9/tonne.

The first assumption is geologically valid. Prices, however, as with all minerals and base metals, are volatile. After the commodity boom of the first decade of the millennium, prices of most major commodities have plummeted. Iron ore peaked at $159/tonne in February 2013. It has declined rapidly since then to less than half that value. Optimistic outlooks expect the price to trough at just under $70 in 2015, recovering to a more stable $75/tonne by 2020.[124] However, Roubini Global Economics, (in)famous now for accurately predicting the 2008 global financial crisis, foresees a price decline to less than $60/metric tonne in 2015.[125] JP Morgan Chase & Co. expect that '[a] slowing Chinese economy may reduce consumption growth in iron ore, used to make steel for buildings and appliances. The raw material will extend losses as supply growth outpaces demand.'[126] Imports of iron ore by China fell 15% from October to 67.4 million tonnes in November,

its lowest level since February 2014. A slowdown in the Chinese economy should come as no surprise, ever since the Chinese Communist Party announced its 12th five-year plan in 2011. This plan sees a diversion from manufacturing-led export growth to a more balanced internal consumption and service-orientated economy. Moody's Investors Service expects growth in China to have slowed to 6% by 2018.

Figure 8: Location of Blocks 1 and 2 overlaid against prospecting licences



Source: Baker, H, 'Mineral resource estimate for the Xaudum Iron Project (Block 1), Republic of Botswana', Report prepared for Gcwihaba Resources (Pty) Ltd. by SRK Consulting (UK) Limited UK05835, 29 August 2014. Author overlay: Figure 3-3 on p. 5 on Figure 3-2 on p. 4

Of import for Gcwihaba is that it will likely be a relatively low-cost producer of high-grade iron ore, and by the time it actually begins production the price may once again have climbed. Large companies are currently over-producing, presumably to force high-cost producers out of the market so that they can be bought out at a lower price. There is every incentive for large producers such as Vale, Rio Tinto and BHP Billiton to eventually collude to cut production in the hope of raising the price. However, given the current political battle between Rio Tinto and Vale over Simandou in Guinea,[127] this scenario may not come to fruition. Moreover, once stockpiles are depleted, and assuming that the global

economy will recover at some point in the next decade, prices should rise once again. There are no feasible substitutes for iron ore as an input to steel, and demand for steel should remain relatively robust. An article in the *Journal of Cleaner Production* put it this way: 'The ever increasing global demand for consumer goods means that the production of primary metals can be expected to increase well into the future, despite society's best efforts in recycling and dematerialisation.'[128]

Gcwihaba will therefore not be overly deterred by the grim price projection of the next few years. Mining is a long-term game, and commodity prices at the time of raising capital for new projects constitute a relatively minor weighting in the future viability equation. In any event, large deposits will typically have increasingly lower costs of production as mining is ramped up over the years, due to economies of scale. 'Iron ore from Australia's Pilbara region costs just $20 to $25 a tonne to extract. Even with freight costs and royalties, the final cost comes in at around $50 to $60 a tonne.'[129] That is a marginal cost of extraction that is still lower than the lowest projections for the iron price through 2015. For as long as marginal costs are lower than marginal prices, production will continue.

Gcwihaba will, however, face other constraints that will place pressure on both costs of production and costs of shipping the iron ore to potential export markets (if it chooses to go the export route). Its Xaudum Report, referenced above, makes the following observations:[130]

> Botswana has a large coal mining industry which provides most of the country's electricity. Despite this supply, the country is still not self-sufficient and currently demand is outstripping supply, causing power shortages throughout the country. There is access to mains electricity to the Project from the town of Shakawe. As the country is landlocked, the nearest port is Walvis Bay, Namibia, 900 km (direct) to the west. Currently, there is no rail link from northern Botswana to Namibia. However, there are plans to extend railways and roads into Botswana in order to service the area.

As discussed above, the coal mining industry is not that large yet. Production is only at 3.2 Mt/a. It is true, however, that if Morupule B Power Station operated at optimal capacity, the country would not experience the kind of power outages that currently leave it in occasional darkness. It is also the case that, as mentioned above, Botswana's coal resources mean that the country could export a significant amount of power to the region. For the economics of iron ore to be viable, however, transport is a more immediate concern. The question of where to take the iron ore, and how to get it there, is now critical. Before that question can be answered, the potential environmental risks to the project must be evaluated.

Environmental concerns

Immediately to the east of Block 1 (as shown in Figure 7) is the panhandle of the famous Okavango Delta, recently declared a UNESCO World Heritage Site. The entire area to the south-east is the delta itself, with the blue lines (in figures 7 and 8) indicating the main river stream.

Okavango Delta from the air

Sunset over the Thamalakane River, Maun

A hippo appears just above the water, near Seronga, Okavango Delta

Near Seronga, Okavango Delta. A view from a mukoro boat

Ecologically sensitive, the delta is a regional treasure. Namibia, Botswana and Angola cannot afford to compromise its integrity. When news broke of iron ore prospecting near the delta, it sparked fear among environmentalists (and at the US embassy in Botswana)[131] that another Everglades disaster was in the making.

A 2005 paper on the Everglades restoration project in Florida, US, euphemistically wrote that 'the biotic integrity of the Florida Everglades, a wetland of immense national importance, is threatened as a result of decades of human manipulation for drainage and development'.[132] The Everglades restoration plan required substantial geochemical and hydrological intervention, which entailed a number of difficult trade-offs. As Botswana seeks economic growth to sustain itself beyond the life of diamonds, it should take every precaution to avoid an Everglades-type crisis. Prevention is clearly more efficient than cure, especially given the future potential of tourism to the area. Increased tourism presupposes the preservation of the delta's biotic integrity, which sustains its teeming wildlife.

In Botswana, environmental considerations in mining are part of an iterative process between the company possessing a prospecting licence and the Ministry of Minerals, Energy and Water Affairs. An environmental impact assessment (EIA) is only required once the prospecting licence is upgraded to a mining licence. Prior to that, environmental management plans are developed in partnership with the relevant government ministries.[133] Thus far, no mining licence applications in Botswana have been denied on the grounds of a submitted EIA. Given the importance of mining to the country's economic wellbeing, this is perhaps to be expected. However, it does suggest that caution should be exercised. The proximity of Block 1 to the panhandle of the delta is a different scenario altogether to previous mining activities in the country. No other mining activities occur in areas as environmentally sensitive as the delta.

A study to 'determine the life cycle-based energy requirement and associated greenhouse gas emissions of selected mining and mineral processing operations'[134] found that the 'GHG emissions were 11.9 and 4.9 kg CO_2/tonne of ore for iron ore and bauxite respectively'.[135] This is not particularly high and is unlikely to be a risk to the delta. Loading and hauling made the largest contributions to these figures. Further technological advances for improving the efficiency of diesel engines would help to diminish these emissions. Water requirements are a more obvious concern, but the question should not be viewed in isolation from competing water interests upstream:[136]

> A number of future threats to the wetland are apparent. These are linked mainly to the development of the upstream basin and to climate change … The Okavango River Basin is an international basin, with conflicting interests of the riparian states. Angola has a large potential both for hydropower and irrigated agriculture. The land area suitable for irrigation is estimated at 104,000 ha. Agricultural intensification and its detrimental impact on the Okavango Delta with respect to both water quantity and quality are to be expected.

Extraction from the main river systems and critical tributaries that feed the delta would damage the hydrological flow and pulse of water volumes that the delta requires. Fortuitously, iron ore mining consumes considerably less water than agriculture, and forms a relatively low proportion of the mining industry's total consumption. Comparable statistics from Australia, however, show that magnetite ore bodies (contrasted with less water-intensive haematite ore bodies) do have considerable water requirements. In July

2011, the government of Western Australia estimated that haematite iron ore mining would consumer 62.2 gigalitres per year, two-thirds of the total required by the mining industry in that region.[137]

It is not clear how much groundwater is available in the Tsodilo Hills area (near the town of Shakawe). Borehole water is normally the main supply source for iron ore mining operations. Given the risks of extracting water from the Okavango River, Gcwihaba should not consider transporting its iron ore concentrate via a slurry pipeline. Slurry pipelines also carry inherent risks, as it is incredibly difficult to extract the water prior to shipping, increasing liquefaction risk once on board a shipping vessel.

Working in Botswana's favour, with regard to environmental protection, is the corporate structure under which Gcwihaba operates, in addition to the delta's internationally recognised World Heritage Site status. Gcwihaba currently owns the rights to explore for metals in the project area depicted in Figure 8. It is a wholly owned subsidiary of Tsodilo Resources Bermuda Ltd, which is itself wholly owned by TSX-V [Toronto Securities Exchange]-listed Tsodilo Resources Ltd ('Tsodilo', TSX-V code TSD). First Quantum Minerals (FQM) Ltd. has signed an earn-in option agreement with Tsodilo and Gcwihaba, which bestows on it the right to earn up to 70% interest in metals prospecting licences in Botswana granted to Gcwihaba. 'FQM's equity investment [worth about CAD[138] 2.5 million, or $2.02 million] has enabled Tsodilo to accelerate the exploration and evaluation of the project.'[139] Both Tsodilo and FQM are internationally listed companies. Listing on the TSX obliges companies to adhere to strict domestic Canadian rules governing environmental management.[140] The company is also in partnership with the International Finance Corporation – the private arm of the World Bank – further encouraging it to play by stringent environmental rules.[141]

Such institutional factors are neither a necessary nor sufficient condition to guarantee the sound environmental governance of projects. However, the reputational risk to these companies if Gcwihaba were to contaminate the delta or otherwise damage its ecology is significant. Given the potential alternatives, this is the best scenario for Botswana. Its policymakers should harness the commitment to transparency exhibited by Tsodilo (and the constraints under which it operates internationally) to help preserve the delta. Sceptics are entitled to point out that, historically – to put it euphemistically – mining has rarely contributed to preservation. Mining could, however, play an unexpected role in helping to maintain the ecological integrity of Botswana's delta. But because institutional arrangements are not a guarantee of co-operation, it is also important to examine endogenous motivation for adherence to sensible rules, and how this might be enhanced.

From a governance perspective, two approaches are possible. The first is to punish defection (environmental degradation) with heavy penalties, such that companies are negatively incentivised to comply with regulations. The second is to positively incentivise co-operation (environmental preservation) by enlisting mining companies as allies in an integrated management approach. Land-use planning and community-based natural resource management, for instance, are governance mechanisms to which mining companies could lend their support. These two strategies are, of course, not mutually exclusive and could be used in combination. The latter is preferred, but the credible threat of severe penalties should also induce motivation for rule adherence.

Mining and environmental sustainability need not be mutually exclusive, especially in a world that requires creative solutions to pressing problems. In Botswana, the government

Shikawe, Okavango Delta

Herds of buffalo and a lone elephant in the Okavango Delta

needs to carefully consider its policy framework on mining in ecologically sensitive areas. Community engagement should also begin well in advance of mining operations. Iron ore mining could, in the longer term, provide high levels of employment for local communities (notwithstanding the difficulties of immediate skills shortages). There is an opportunity for the government to partner with Gcwihaba to promote local skills development, even as the company awaits approval of its mining licence. Moreover, opportunities for labour and skills migration from the declining diamond industry may also exist. The resultant

population growth poses a different set of infrastructural, environmental and food security challenges. In this respect, as mentioned above, upstream agriculture already poses a potential threat to the delta:[142]

> Potential upstream developments in Angola and Namibia can pose risks to the hydrological functioning of the Delta's entire Basin system, and if not regulated appropriately, can decrease the capacity of the system to be biologically productive, store and filter water, replenish groundwater and perform flood control functions. Any development that could cause a variation and reduction of hydrological flow, increase sediment yield, alter the abundance and distribution of fauna and flora, and/or cause a deterioration of water quality in the Delta, needs to be carefully considered by OKACOM [the Okavango Commission] and [its] member countries. This is particularly urgent given some of the proposed developments in the near vicinity of the Delta and its upstream tributaries. Proposed plans include large-scale irrigation schemes and commercial agriculture, and mining and proposed water storage projects. Also, unauthorised water abstraction and pollution is taking place in all three countries and deforestation and overgrazing are causing ecological destruction in the buffer zone. Pressures on the Delta are also likely to increase given the growth of the region's population, which is expected to reach 1.28 million by 2025. Climate change-related impacts are also expected,[143] such as increased temperatures and changes to rainfall patterns.

Lets and Tebi of the Seronga Polers' Trust, who take customers into the heart of the delta on mukoro boats. A significant problem at present is that business administration is entrusted to the only member of the trust who has a business qualification. However, there is no transparency as to what customers pay and what proportion of that a poler will net at the end of a day's work. Mining's CSI activities could seek to support sound business management and marketing skills among all members of the trust

In the midst of these challenges, mining brings with it enterprise opportunities for local retail and other services. Local procurement guidelines could transform the Shakawe area from a developmentally difficult place into a thriving service centre (provided the provision of those services is not water-intensive). Greater capital accumulation for local people positions them to benefit from tourism activities in the delta, through either individual consumption or service provision. It also means more potential capital available for community-led enterprises (both in tourism and natural products), of which too few exist at present.

If communities were to benefit in a tangible way from mining they could become the most effective allies in the endeavour to preserve what Frans Lanting famously called the 'Last Eden'.[144] In the final analysis, mining may ironically provide the means necessary to sustain the delta for future generations. This argument is of course contingent on the completion of a thorough, independently verified EIA.

CHAPTER 9

OPTIONS FOR DIVERSIFICATION

This report has argued that the prospects for exporting coal, using the proposed TKR, are economically and environmentally challenging. A caveat is that the TKR line may become more viable if iron ore from Shakawe can also be transported (an option briefly considered below) to Walvis Bay. The report has also argued that iron ore mining may be part of a changing Botswana's economic endgame, contingent on an independent EIA and that it comes at zero cost to the delta. With coal and iron ore in abundance, Botswana appears to have a naturally endowed comparative advantage in at least some forms of iron ore processing. The country is also rich in copper-nickel. The remainder of the report will examine the prospects for iron ore and copper-nickel beneficiation, using locally supplied thermal coal as a heating input. Development is best served in the long run by building as many inter-industry links as possible, and Botswana appears to have at its disposal the opportunity to build these essential links.

EXPORT A COMBINATION OF COAL AND IRON ORE BY RAIL?

Transporting goods with a low value-to-weight ratio (such as coal) is more suited to rail than other types of transport. Iron ore in its raw form has a low value-to-weight ratio, as does raw coal (even after being washed). Given this, and the abundance of both commodities, it may be feasible for Botswana to build a rail extension from Shakawe to Ghanzi that combines coal and iron ore for export through Walvis Bay. However, it is not clear that the high capital costs of a rail link addition to the TKR, through pristine wilderness, is efficient in either economic or environmental terms. Gcwihaba itself makes the point that this option would require high capital sunk costs, along with high operating costs.[145] There is also a significant risk of iron ore fines liquefaction once on board a shipping vessel, as the presence of any moisture may interact with the fines, changing the composition of the cargo and destabilising the vessel.[146]

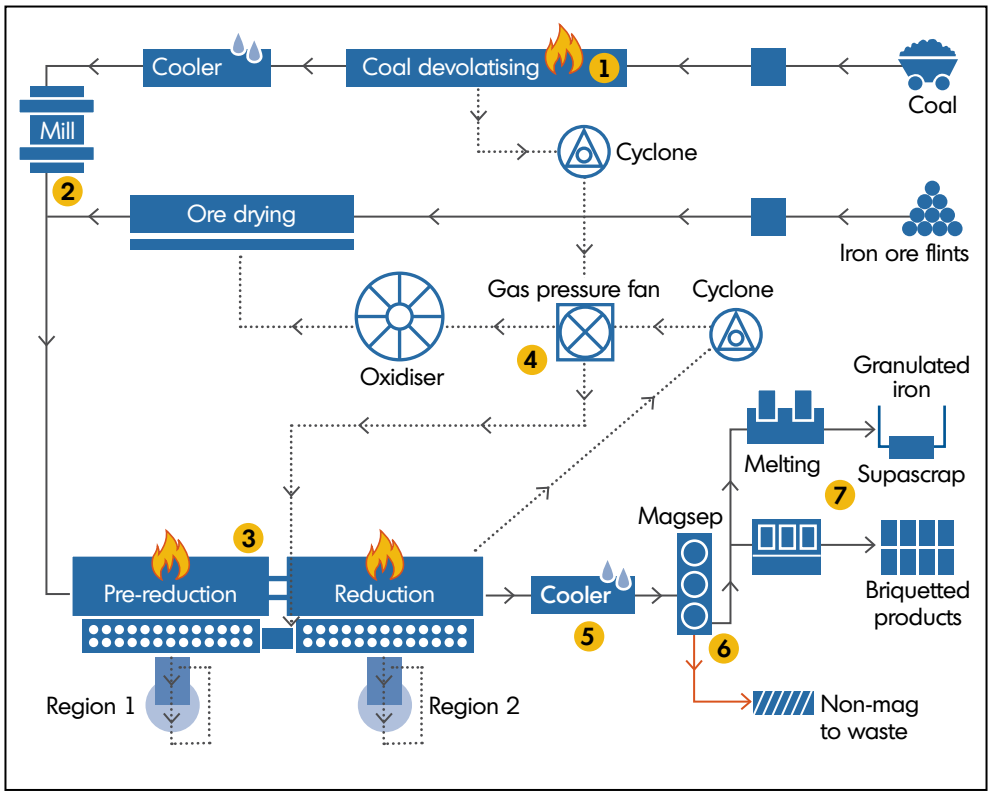
IRON ORE BENEFICIATION

A first step in building inter-industry linkages and developing complementary aspects of each of Botswana's large mineral endowments would be to process iron ore locally. There are strong economic arguments in favour of this approach, although the processing should not take place in Shakawe, as the probability of transmitting sufficient power to Shakawe is limited. Moreover, irrespective of the current power constraints, it does not appear sensible to transport coal from Morupule to Shakawe for some form of processing to take place, only to transport it back to Selebi-Phikwe for further processing. Selebi-Phikwe, only 141 km from Morupule, already possesses smelting infrastructure. Pula Steel

invested BWP 89 million ($9.06 million) in July 2014 to build a fully integrated steel manufacturing plant, which is currently lying dormant. Botswana's Competition Authority recently announced a merger between Pula Steel and BCL, expected to create 2 000 new jobs.[147] Transport cost considerations thus suggest that any iron ore processing should take place in Selebi-Phikwe. Coal can be collected from Morupule en route to Selebi-Phikwe to provide the required energy. Gcwihaba has proposed two options in respect of these considerations.

First, a small-scale modular plant could be constructed at a cost of $15 million to produce Supascrap, a low-cost metallic iron in granulate form. Production from the first such plant in the world was expected in the second half of 2014 in Phalaborwa, South Africa. 'IMBS technology requires relatively cheap and abundant thermal coal and process energy is provided by recovered reaction energy.'[148] As such, plant locations are not dependent on electricity availability, as electricity is only required for auxiliary equipment. This provides Supascrap with a significant production advantage over pellets, which are energy-intensive. The chief executive officer of IMBS expects that Supascrap will sell at a premium to scrap metal, which is currently priced at between $350 and $450/metric tonne.[149] Supascrap has an iron content of 99.9%. Iron briquettes, with a 90% iron composition, are also produced in the process. The coal to product ratio is 58%.

Figure 9: Process flow



Source: IMBS, 'IMBS technology', http://www.imbsworld.com/process.htm

Second, using Prodilux furnace technology, manufactured by GLPS, iron ore from Shakawe could be processed into pig iron, currently selling at roughly $400/metric tonne.[150] Such a plant would only require start-up capital of between $8 million and $10 million. Similarly to Supascrap, pig iron production uses thermal coal, and has a 49.5% coal to product ratio.

Both pig iron and Supascrap (or briquettes) would constitute beneficiated inputs to the steel plant at Selebi-Phikwe. These small-scale options appear to offer an economically sensible means of generating revenue from iron ore in a relatively short time period, using the abundant thermal coal supply available at Morupule, which is in the process of extending its operations to a vast open-pit mine. The major benefit is that both options would negate the price volatility associated with exporting raw iron ore, even at content of more than 60%. The price differential is substantial and prices for the processed products are far more stable. To begin with, the iron from Block 1 could be transported by road train from Shakawe to Selebi-Phikwe, a distance of 1 094 km. The revenue generated from this activity could provide some of the capital necessary to explore Block 2 more thoroughly, in addition to raising market confidence in the grade and quality of Botswana's iron ore. Significant quantities of its thermal coal would also be employed in the process, generating a new revenue stream in that respect.

An alternative would be to establish an IMBS plant at Ghanzi, which is only 469 km from Shakawe. Coal would have to be supplied from Mmamabula on the TKR, however. Two major disadvantages are inherent in this approach. The first is that it would have to wait until the TKR was actually built, which might be some time away, if it does happen (and it is not guaranteed that the TKR would go through Ghanzi). Second, one of the strongest arguments in favour of a wide-gauge TRK line is the efficiency gain embedded in a service dedicated to transporting a single commodity. It is therefore unclear whether it would be logistically sensible to offload coal in Ghanzi and add iron products such as Supascrap or pig iron to the same set of carriages. Of course, the option should not be discounted. It would increase the value-to-weight ratio of the cargo being transported, which could then be sold for further processing in Walvis Bay. This would be similar to the set-up between Sishen mine and the Saldana Bay steel plant and port in South Africa. In this option, Selebi-Phikwe may, however, be deprived of the opportunity of becoming a regional steel producer. This seems too high an opportunity cost to incur, especially given the uncertainty of Ghanzi as a viable processing hub, and the time delay in coal supply from the Mmamabula fields.

CHAPTER 10

CONCLUSION AND RECOMMENDATIONS

Botswana is at a critical historical juncture. It has enjoyed a stable democracy and strong economic growth since 1965. Its political institutions are relatively advanced and inclusive. This in large part accounts for its having escaped the worst aspects of the 'resource curse'. However, diamond revenues, on which the country has depended, are likely to decline in the near future. Although these revenues currently constitute only a third of government revenue, the diamond industry is inextricably linked to other industries, both upstream and downstream, that provide much of the remaining revenue. Some analysts argue that diamond rents have not been efficiently allocated. Thus, despite a stable democracy and growing economy, investments in human and physical capital have been insufficient to ensure the creation of alternative industries to diamonds. Others argue that this is attributable to a minor case of Dutch disease, where demand for diamonds has increased the value of the currency, jeopardising the price-competitiveness of manufacturing. However, a strong currency allows relatively inexpensive imports of technology-laden equipment. It is thus difficult to attribute the lack of economic diversification to this hypothesis. Either way, the report has shown, in line with the current consensus, that economic diversification is a pressing imperative if Botswana is to remain politically and economically stable.

Botswana's options are, however, relatively limited. It does not possess a large, well-educated population. Inequality is also a problem – the distribution of wealth is heavily concentrated among the top 10% of income earners. Moreover, its primary comparative advantage remains in the natural resource sector. With an abundance of coal, copper-nickel and inferred iron ore deposits, mining will likely remain the bedrock of the country's economy for the foreseeable future. Tourism, founded on pristine wilderness preservation, is the second largest contributor to GDP. Technically, mining poses a threat to this foundation. However, with the availability of new technology and cogent EIAs, iron ore mining could serve as a potential ally in preserving pristine wildernesses such as the Okavango Delta. This is conditional on no mining being allowed within the core delta area itself, and the mines not drawing down water from critical tributaries that feed the delta.

Coal mining faces a different set of challenges and internal domestic constraints. The Botswana Chamber of Mines is strongly in favour of building a dedicated TKR export line to Walvis Bay to supply the Indian market. However, the pre-feasibility study raised caution about this approach, as this report elucidates. Better and more exhaustive modelling of future scenarios must be carried out. At present, the assumptions contained in the only publicly available revenue and employment projections appear problematic. Coal will likely be more lucrative than suggested in that model. However, the assumption that Botswana will be able to export coal for 30 years at a price of $70–75/tonne also seems somewhat unrealistic. Solving energy storage problems associated with solar power appears imminent, thus narrowing the window of opportunity for Botswana to export its coal. The negative environmental externalities associated with coal mining and

shipping also pose a threat, not only to the local environment but also in terms of water contamination. Burning coal also poses a threat to the global commons by contributing to climate change. Climate change itself is likely to have a severe impact on the future size of the Okavango Delta, reducing it significantly. Botswana would therefore do well to limit its contribution to global climate change.

The future of the coal market is uncertain, while preserving Botswana's pristine wilderness for tourism and alternative livelihood purposes is important. A TKR line, built on weak assumptions (not controlling for a potentially narrow export window), and at significant capital and operational cost, may become a white elephant. This report has therefore argued that Botswana's policy focus in the immediate term should be orientated towards the possibility of combining coal, iron ore and copper to forge a local steel industry at Selebi-Phikwe. More modelling will have to be done to ascertain the extent of regional steel demand, but the infrastructure backlog in many growing SADC countries suggests this would be strong. This could generate the capital necessary to support a TKR line in the future, if the dynamics of the coal market still render it profitable. Either way, a bankable feasibility study on the TKR should be conducted as soon as possible, including a thorough environmental impact assessment, given some of the concerns raised above in this respect.

In the light of this report and the above conclusions, we offer the following policy suggestions for the diversification of Botswana's economy:

- Prioritise eco-tourism to become the country's primary revenue generator. It is inherently sustainable as it is dependent on a non-exhaustive supply of pristine wilderness. Community-led natural resource management is a tried and tested model for preserving pristine wildernesses. This entails the marketing and sales of natural products and services, in addition to conservation agriculture. This model is likely to generate sustainable livelihoods that simultaneously serve to preserve the environment.
- View mining as a means to forging a higher-value industry that would endure beyond the available exhaustible supply of minerals. Coal, iron ore and copper-nickel should be viewed as complementary minerals, the combination of which could support a local steel industry. More modelling and research need to be undertaken before this becomes a realistic option, but that work should start now. Such modelling should ideally be informed by pilot projects that, for instance, combine iron ore from Shakawe with coal from Morupule, and smelt it at the existing refinery in Selebi-Phikwe. Even if a fully-fledged steel industry does not materialise, significant domestic opportunities exist along the value chain. Given the relatively minor capital and operational costs entailed in such ventures, detailed in the report, these should be explored as a matter of urgency.
- Any mining ventures should be viewed as partnership opportunities with local communities. Skills transfer and local procurement should feature prominently in the agreements on which mining licences are negotiated, within the rational parameters of economic efficiency. Appropriate timelines should therefore be negotiated. In the case of mining near environmentally sensitive areas, mining companies should seek to contribute to the preservation of those areas. For instance, Tsodilo could partner with local communities to ensure that they benefit from tourism initiatives, both as consumers and as service suppliers.

- Botswana should use its remaining diamond rents to invest widely in human and physical capital. The most compelling economic models for economic diversification centre on the specialisation that can be developed through these investments.[151] Downstream beneficiation of minerals should not be viewed as a panacea for development, as competitiveness in this arena cannot be guaranteed. Investments in new technology, especially renewable energy such as solar power, should also be seriously considered given the country's perennial abundance of sunshine.

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81 McCammon R, Pickering D & M Bausinger, 'Botswana resource sector overview 2013/14'. Gaborone: Capital Resources, 2014.
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99 McCammon R, Pickering D & M Bausinger, 2014, *op. cit.*, p. 11.

100 *Ibid.*

101 Republic of Botswana, 'National Integrated Transport Policy White Paper'. Gaborone: Ministry of Transport and Communications, July 2011, p. 150.

102 *Ibid.*

103 Grynberg R, *op. cit.*, p. 25.

104 Interview with Charles Siwawa, CEO of Botswana Chamber of Mines, 14 August 2014.

105 Coal sold to the domestic Botswana market would earn roughly $38/tonne – this is the price currently paid by Morupule B Power Station. See Grynberg R, *op. cit.*, p. 26.

106 As reported in the *Sunday Standard*, 'The Trans Kalahari Rail Project – a grim tale', 5 February 2015, http://www.sundaystandard.info/article.php?NewsID=22031, accessed 9 March 2015.

107 This possibility was raised by both Tsodilo Resources and the CEO of Botswana's Chamber of Mines, Charles Siwawa. The interview with Tsodilo took place on 4 September 2014. Discussions with Siwawa took place on 3 April and 14 August 2014 respectively.

108 In our discussions with various stakeholders in Botswana in April and September 2014, these risks were downplayed. They would have to be more objectively evaluated in an environmental impact assessment, which would presumably form part of a bankable feasibility study.

109 Dikgang J & E Muchapondwa, 'The economic valuation of nature-based tourism in the South African Kgalagadi area and implications for the Khomani San "bushmen" community', *Journal of Environmental Economics and Policy*, 3, 3, 2014, pp. 306–322.

110 CPCS Transcom International Limited, *op. cit.*, p. 7.

111 Interview with chief executives of Jindal, Gaborone, 3 September 2014.

112 Lockwood A, *op. cit.*, pp. 52–53.

113 *Ibid.*, p. 53.

114 *Ibid.*, p. 54.

115 These figures were extrapolated from Debswana, 'Morupule Colliery Expansion Project', Environmental Impact Statement, 1, 2008, http://www.ecosurv.com/sites/default/files/project_files/ESIA%20Morupule%20Colliery%20Expansion%20Executive%20Summary.pdf, accessed 24 April 2014, and assumed to be similar for other mines.

116 Grynberg R, *op. cit.*, p. 21.

117 CPCS Transcom International Limited, *op. cit.*, p. 10.

118 Eberhard A, 'Realise that Eskom alone cannot solve our power crisis', *Business Day*, 26 November 2014, http://www.bdlive.co.za/opinion/columnists/2014/11/26/realise-that-eskom-alone-cannot-solve-our-power-crisis, accessed 26 November 2014.

119 Concern has been raised that excess steel supply capacity in China renders this an exercise in futility. Chinese efficiency, combined with this subsidised excess capacity, will make it difficult for Botswana to become a globally competitive steel producer. However, the country has readily available coal, and its SADC importers would not have to incur the large transport costs currently entailed in importing from China. After the initial learning costs have been overcome, a viable steel industry could conceivably emerge. Excess coal and iron ore could then be traded globally as a 'vent for surplus'. Moreover, China is in the process of shifting its economic focus away from export-led manufacturing towards increased consumption and services. This opens a window of opportunity for other countries to compensate for the consequent manufacturing contraction in China.

120 The 'vent for surplus' trade theory argument is famously expressed in Adam Smith's *Wealth of Nations*: 'When the produce of any particular branch of industry exceeds what the demand of the country requires, the surplus must be sent abroad, and exchanged for something for which there is a demand at home. Without such exportation, a part of the productive labour of the country must cease, and the value of its annual produce diminish' (chapter V of Book II, v.33) … Between whatever places foreign trade is carried on, they all of them derive two

distinct benefits from it. It carries out that surplus part of the produce of their land and labour for which there is no demand among them, and brings back in return for it something else for which there is a demand. It gives a value to their superfluities, by exchanging them for something else, which may satisfy a part of their wants, and increase their enjoyments (Chapter I of Book IV, i.31.).' David Ricardo's theory of comparative advantage has gained much deeper normative traction. Ricardo argued that the key to gaining from trade was not surplus productivity, but relative efficiency – if one country is relatively more efficient at mining iron ore than at producing steel (within itself), it should export the iron ore and import steel. However, criticism of static versions of comparative advantage theory notes that commodity-exporting countries become stuck in a commodities trap, exchanging low-value exports for high-value imports. In Botswana's case, there might not be a sufficiently strong case for coal and iron ore to be exported in raw form, even under comparative advantage theory (given the high prerequisite infrastructure costs and potentially small window of opportunity). A vent for surplus model may therefore make sense for the country, provided sufficient regional demand for steel exists, and that it can be efficiently produced. Surplus iron ore and coal can then be exported.

121 Baker, H, 'Mineral resource estimate for the Xaudum Iron Project (Block 1), Republic of Botswana', Report prepared for Gcwihaba Resources (Pty) Ltd. by SRK Consulting (UK) Limited UK05835, 29 August 2014, p. 100.

122 *Ibid.*, p. 84. The process of independent verification and the evidence required for making inference is rigorous. The author was frankly surprised at the lengths to which the company had to go before it could even release an inference resource statement. It does demonstrate that mining is a long-term industry. The statement was only released six years after sampling and drilling began. In conversation with chief geologist Alistair Jeffcoate (PhD), the researcher discovered that this intense verification process is to avoid the famous Bre-X case. In that case, geologist John Felderhof was alleged to have salted a purported gold deposit in Busang, Indonesia. The company's stock price had climbed from next to nothing in 1993 to over $280 a share at its peak in 1997. It was then discovered that the resource was worth nothing. A report released 10 months later concluded that the samples used by Bre-X to support its claims had been fraudulently salted. Salting refers to the practice of adding small amounts of gold dust to rock samples prior to geological testing. See Williams J, 'Reflections on the private versus public policing of economic crime', *British Journal of Criminology*, 45, 2005, pp. 316–339.

123 DTR stands for 'Davis Tube Recovery', which is the industry standard for the quantitative analysis of the magnetic minerals in the metallurgical sample. It is used to determine the magnetic content of iron ore.

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126 *Ibid.*

127 *The Economist*, 'Mining and corruption: Crying foul in Guinea', 6 December 2014, http://www.economist.com/news/business/21635522-africas-largest-iron-ore-mining-project-has-been-bedevilled-dust-ups-and-delays-crying-foul, accessed 8 December 2014.

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130 Baker H, *op. cit.*, p. 8.

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132 Sklar F *et al.*, 'The ecological-societal underpinnings of Everglades restoration', *Frontiers in Ecology and the Environment*, 3, 3, 2005, pp. 161–169.

133 This was confirmed in interviews with both the Chamber of Mines, 3 April 2014, and Jindal, 3 September 2014.

134 Norgate T & N Haque, *op. cit.*, p. 271.

135 *Ibid.*

136 Milzow C *et al.*, 'Regional review: The hydrology of the Okavango Delta, Botswana – processes, data and modelling', *Hydrogeology Journal*, 2009, 17, pp. 1297–1328.

137 Government of Western Australia, Department of Water, 'Capacity of water resources in the Mid West to meet mining and industrial growth', Hydrogeological Record Series Report, HG55, December 2011, http://www.water.wa.gov.au/PublicationStore/first/101314.pdf, accessed 26 May 2015.

138 Currency code for the Canadian dollar.

139 Baker H, *op. cit.*, p. 5.

140 Despite such listing, FQM has not escaped controversy. See Abadie D, 'Canada and the geopolitics of mining interests: A case study of the Democratic Republic of Congo', *Review of African Political Economy*, 38, 128, 2011, pp. 289–302: 'Eight Canadian companies have been cited by the United Nations Panel of Experts as having participated in one way or another in the looting of Congolese resources during the war … One month before they arrived in Kinshasa, the Kabila clan signed three contracts with First Quantum Minerals (FQM) for the Kansanshi and Lonshi mines in Katanga, worth Can$1 billion. According to the Lutundula Commission (2006), the Lonshi concession was given to the Canadian company without any counterpart. FQM is alleged to have proposed a thin US$100 million to the Congolese state, and in particular, cash payments and shares for some public officers. Between 1997 and 2001, the value of its stocks on the Vancouver Stock Exchange (VSE) grew from zero to close to US$140 million. Since the mid 1990s, when the Foreign Affairs Minister and former Conservative prime minister Joe Clark became the company's special advisor on Africa, FQM has become more active in many parts of Africa.' First Quantum was also a majority shareholder in Anvil (an Australian company). When the MRLK forcibly occupied the Kilwa concession in October 2004, Anvil allegedly provided logistical support to soldiers of the Congolese Army sent to subdue the MRLK.

141 As shown above, none of this is to suggest that listed companies necessarily operate with ethical integrity. Reputation effects are only as effective as the vigilance of civil society and shareholders' personal concerns. Investing in a portfolio of companies is a relatively impersonal transaction, which tends to distance shareholders from caring about the behaviour of the companies in which they invest. However, the potential reputation effect is a more compelling

constraint than that faced by some other companies, which operate under no accountability mechanisms whatsoever.

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144 Lanting F, *Okavango: Africa's Last Eden*. Cologne: Taschen, 2013.

145 Presentation by Tsodilo Resources Ltd, 'The tip of the iceberg', Maun, 6 September 2014.

146 See a series of articles published by Gard, 'Liquefaction of solid bulk cargoes', January 2014, http://www.gard.no/ikbViewer/Content/20651223/Cargo%20liquefaction%20January%202014.pdf, accessed 15 December 2014.

147 See Competition Authority, *Botswana Competition Bulletin*, 2, 2, 2014, http://www.competitionauthority.co.bw/sites/default/files/Botswana%20Competition%20Bulletin%20Issue%202%20Volume%202.pdf, accessed 15 December 2014.

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149 Scrap Register, 'United States scrap metal table', http://www.scrapregister.com/scrap-prices/united-states/260.

150 Metal Prices, 'Steel/iron scrap', http://www.metalprices.com/metal/steel-iron-scrap/fe-scrap-pig-iron-steelbb-brazil.

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South African Institute of International Affairs
Jan Smuts House, East Campus, University of the Witwatersrand
PO Box 31596, Braamfontein 2017, Johannesburg, South Africa
Tel +27 (0)11 339-2021 • Fax +27 (0)11 339-2154
www.saiia.org.za • info@saiia.org.za

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