POLICYbrief

AFRICA INSTITUTE OF SOUTH AFRICA • BRIEFING NO 103 • JANUARY 2014

The Future of Emerging Economies' Energy Mix:

Lessons from Mauritius

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One of the least understood but potentially important trends in the energy field is the way in which the development priorities of small developing islands and emerging economies are shaping energy markets. Given that climate change is likely to influence the energy policies and investment of many countries, does the solution lie in the development and deployment of renewable energy? This brief contends that a future energy-mix landscape for Mauritius is key, and should underpin the policy direction of the island. Like most small island developing states (SIDS) with no indigenous reserves of fossil fuels, and no electricity interconnection, Mauritius is vulnerable to the risk of being without power and transport in the event of geo-political, economic or natural crisis. It is striking to note that the Mauritian government, through its Central Electricity Board (CEB), has developed an integrated electricity plan (IEP) that strives to balance the supply and demand of electricity for the next decade. The island remains a unique case in that it has reached consensus with its private sector to make better use of bagasse, leading to the genesis of independent power producers such as Terragen and Omnicane with co-generation plants (bagasse and coal), supplying to the grid about 60 per cent of the national electricity demand. The total percentage share of energy sources is projected to range from 20 to 35 per cent between 2010 and 2025, while the use of non-renewable fuels, in particular coal and oil, should range between 65 and 80 per cent over the same period. Despite the huge efforts by the CEB, future projections based on business-as-usual scenarios typify (as in many developing countries) the continued use of imported petroleum and fossil fuels rather than the proliferation of renewable energy technologies. This brief contends that policy development to ensure energy security should ensure diversification of energy resources to attain a sustainable future.

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Given that climate change is here to stay, yet a reliable supply of energy is a crucial success factor for development, the solution to this paradox lies in the development and deployment of renewable energy

Introduction

In the coming decades, emerging economies are expected to make up the bulk of growth in demand for energy, with countries outside the Organization for Economic Cooperation and Development (OECD) accounting for 83 per cent of expected growth in energy demand between 2008 and 2035. Not surprisingly, the growth in size of emerging economies has been accompanied by a shift in their energy consumption patterns, witnessing a growth in oil consumption by 90 per cent, of natural gas by over 200 per cent, and of coal by 150 per cent.[1] SIDS such as Mauritius are no exception to this trend.

The recent surge in the area of renewable energy technologies in the face of over-reliance on the declining stock of fossil fuels,[2] together with climate change apprehensions, has for the first time validated the search for alternative sources of energy.[3] No doubt the challenges associated with global environmental change are a cause for concern. Given that climate change is here to stay, yet a reliable supply of energy is a crucial success factor for development, this brief argues that the solution to this paradox lies in the development and deployment of renewable energy.

Mauritius's energy sector landscape

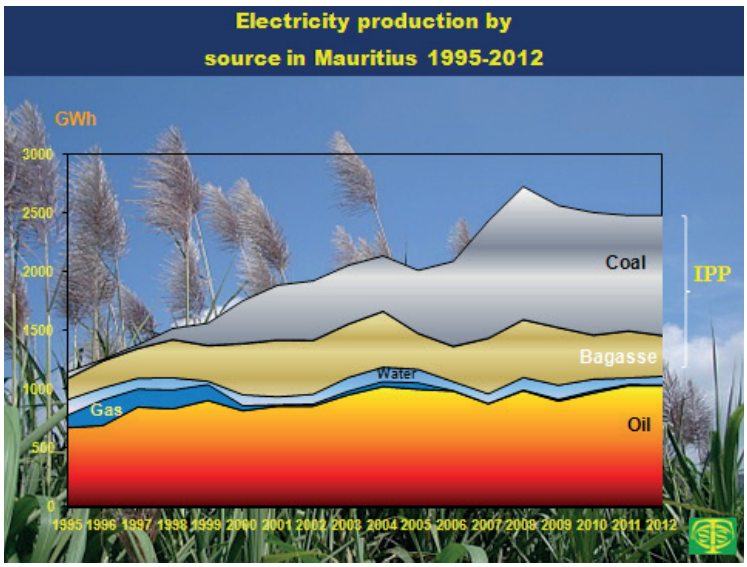
As in many emerging and developing economies, the energy sector has been identified as a major pace setter for social and economic development in Mauritius. Like other SIDS, Mauritius has limited known exploitable energy sources; hence approximately 83 per cent[4] of its energy is derived from imported fossil fuels in the form of fuel oil, diesel and coal. Among these, coal and oil still play a significant role and are the dominant sources of energy, as shown in Figure 1. The principal energy needs include electricity production and transportation, and these are purported to have driven the island's economic growth. The stability of the energy sector is, however, threatened by the declining stocks of fossil fuels and ever-increasing prices, exacerbated by the current global financial crisis and the high cost of transportation, which makes the importation process very expensive.

Institutional framework

The following section provides a brief overview of the organisational structure of Mauritius's energy sector.

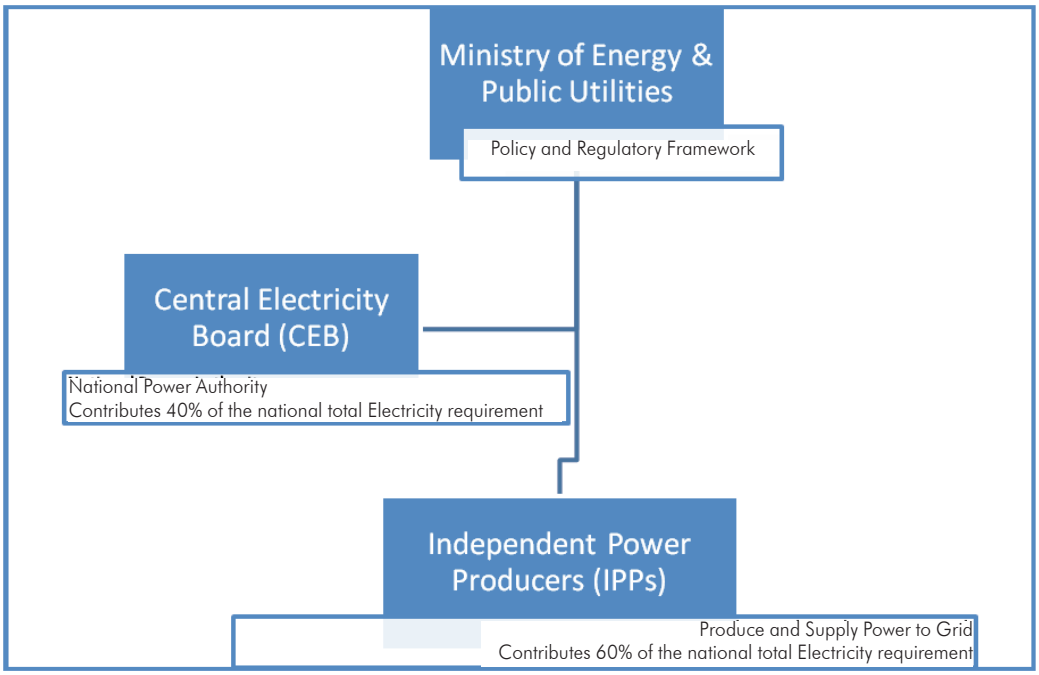
The main stakeholders are the Ministry of Energy, responsible for the regulation of the energy sector, the CEB, which is the national power authority, and the independent power producers or IPPS, as shown in Figure 2. The country's power plants are owned by either the CEB or the private companies. Approximately 52 MW of Mauritius's 364 MW installed capacity is installed in independent thermal capacity at sugar estates. Other stakeholders include the Maurice Ile Durable Fund and the Mauritius Sugar Authority, Outer Islands and Rodrigues and the following line ministries: Finance and Economic Empowerment; Public Infrastructure; Land Transport and Shipping; Environment and National Development Unit; Agro-Industry and

Figure 1: Mauritius's electricity production by source



Source: Terragen 2013[5]

Figure 2: Organisational structure of Mauritius's energy sector



Source: Author

The energy sector has been identified as a major pace setter for social and economic development

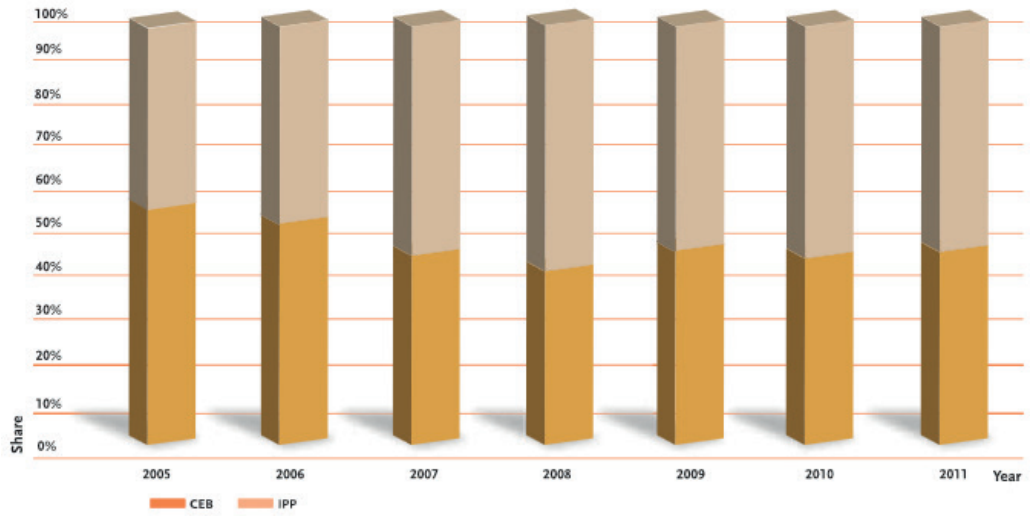
Fisheries; Industry, Science and Research; and the Ministry of Local Government.

The CEB is currently managing power purchase agreements (PPAS) with five IPPs, three of which employ the take-or-pay principle. This means the CEB pays for the contractual energy amount while the power plant is available, even if the energy is not dispatched. The other option for the remaining two is a negotiated part-tariff model which treats capacity and energy charges as two different cost elements. In 2011 the IPPs produced 55 per cent, equivalent to 1 337 GWh, of the total electricity consumption in Mauritius,[6] as shown in Figure 3.

Matching the electricity demand with generation capacity forecasts shows that IPPs will still play a major role in the energy sector, providing over 60 per cent of the national demand by 2022.[7]

IPPs have invested in power generation projects for supply of electricity to the national grid. By so doing they have been diversifying their revenue from the sale of electricity to the CEB for onward sale to consumers. In addition co-generation is advantageous in that the sugar factory obtains steam and electricity required for its operation, and in return the power plant obtains the bagasse produced after the milling of canes at no cost.

Figure 3: Percentage share of energy sources



Source: IEP 2013–2025[8]

Mauritius's main economic pillars being tourism and the restructured sugar industry

Policy framework

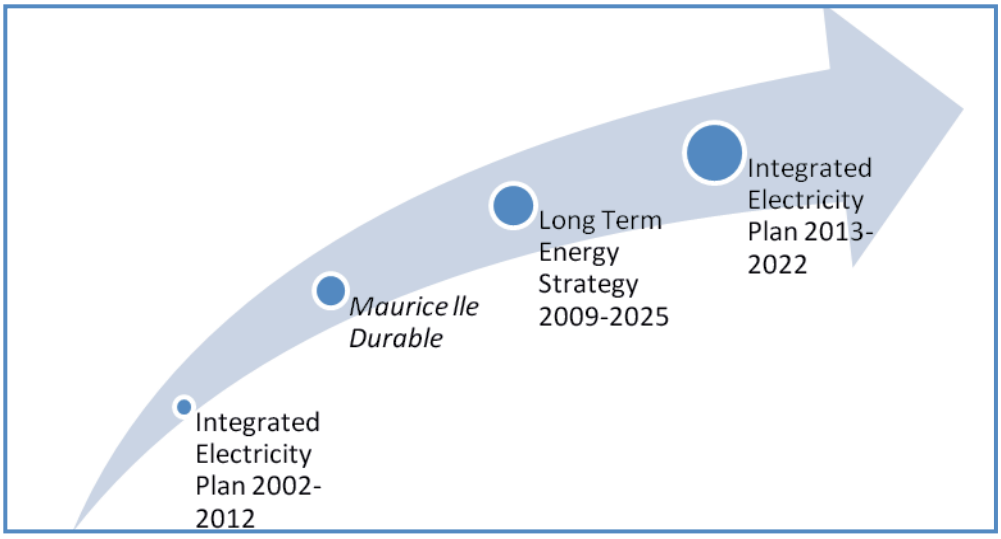
Central to Mauritius's energy sector policy framework has been the integrated electricity plan of 2002–2012, followed by the Long Term National Energy strategy plan which supported the national strategies such as the Maurice lle Durable (MID) and the current integrated electricity plan of 2013–2025 (in this brief known as the IEP).

- **First integrated electricity plan, 2002–2012**
  The first such plan of 2002–2012 by the CEB was earmarked to provide reliable, affordable and sustainable electricity supply for Mauritius and Rodrigues. This meant providing a stable electricity future to support socioeconomic development. In support of the sugar-sector reform, and with the objective of optimising the use of indigenous energy sources, bagasse for energy generation was a key priority of the plan. Major milestones of this plan included expanding the electricity generation capacity from 237 MW to 664 MW, commissioning 6,3 MW efficient engines, upgrading of the electricity network, and scaling up renewable energy with a 4,8 MW increase in production.[9] Arguably the 4,8 MW has been just too low, in view of the environmental concerns and the national imperative to create a sustainable island.

- **The vision of MID**
  The Ministry of Energy and Public Utilities developed a strategy to make Mauritius a sustainable island with a vision entitled 'Maurice Ile Durable', or MID. To achieve this a seed fund of 1,3 billion rupees was injected, to support the promotion of a more efficient use of energy, and scale up renewable energy technologies.[10] A number of historical players in Mauritius's energy industry had played a key role in the generation of electricity. The dominance of the sugarcane industry in the economy had contributed significantly to the use of bagasse for electricity generation, allowing the country to have a better proportion of renewable energy in its energy mix. Subsequently, the government's expectations on renewable energy also crystallised in the MID concept.

- **Long Term Energy Strategy 2009–2025**
  The energy policy framework adopted in 2009 underpinned the government's energy strategy. The framework was based on an emerging economic model, with Mauritius's main economic pillars being tourism and the restructured sugar industry. Environmental concerns, primarily climate change, have also influenced the policy framework to move towards a low-carbon future, given that energy accounts for 80 per cent of greenhouse gas emissions, hence increasing the island's vulnerability to climate change. This therefore meant a shift in energy policies and strategies. On the other hand, the viability of the sugar industry was threatened by the declining prices in sugar, which cumulated to 36 per cent, propelling innovation to optimise the use of the island's once booming economic pillar. The main objectives of this energy strategy were to reduce the island's vulnerability to imported fossil fuels and their volatile prices, create employment opportunities and promote

Figure 4: Major highlights of Mauritius's energy-sector policy framework



Source: Author.

economic growth, and safeguard the financial stability of the electricity utility, while providing affordable energy and long-term development in line with the MID.

Considering the world's move towards a globalised economy, Mauritius had to encourage competition in the energy sector. The government's strategy avoided a monopolistic situation, while encouraging competitiveness. Operationalisation of the multi-sectoral regulatory authority paved the way for the Electricity Act of 2005, with the latter providing reform, inter alia. Subsequently, the Utility Regulatory Act, promulgated in 2008, became active in 2009. The Long Term Energy Strategy also considered the provision of an energy efficiency act, which brought forth a specialised energy efficiency unit complemented by energy audits to designated consumers/sectors, and promotion of education and training and demand-side management strategies. Other initiatives included the construction of sustainable buildings while promoting energy efficiency in the tourism industry.

The Long Term Energy Strategy also advocated a renewable energy development strategy. Apart from producing sugar, energy generation from bagasse complemented by coal (co-generation) has been a major activity of the sugar industry. The long-term strategy thus fully supported the IPPs' taking advantage of the historical trend which needed to support the sugar-sector reform.

The government also developed targets for electricity generation from renewable and non-renewable energy sources, as shown in Figure 5. From the predictions it is crystal clear that fossil fuels, especially coal, still play a key role in meeting the energy demands. However, as this brief has argued, this poses a threat to the sustainability of the island; hence innovation to scale up renewable energy is key. Equally, government priorities such as the MID would require clean coal technologies.

The predictions did not fully consider mini- and micro-hydropower plants

IEP 2013–2022

The CEB has developed yet another IEP with the aim of guiding Mauritius and Rodrigues towards a stable electricity future. The cornerstone of the master plan has been to optimise the use of the existing power system, keep the cost of electricity very low, encourage demand-side management and provide continued private-sector opportunities in the energy sector, as well as taking due cognisance of environmental concerns. Highlights of the IEP reveal that forecasted peak power demand will increase to as high as 574 MW under the base-case scenario and 702 MW under the high-case scenario, implying an annual increase of 14,4 MW for the period 2013–2022.[12] The accelerated growth in demand can be explained by the structural changes in the domestic economy, which was predominantly a mono crop (sugarcane) economy,

Figure 5: Major highlights of Mauritius's energy sector policy framework

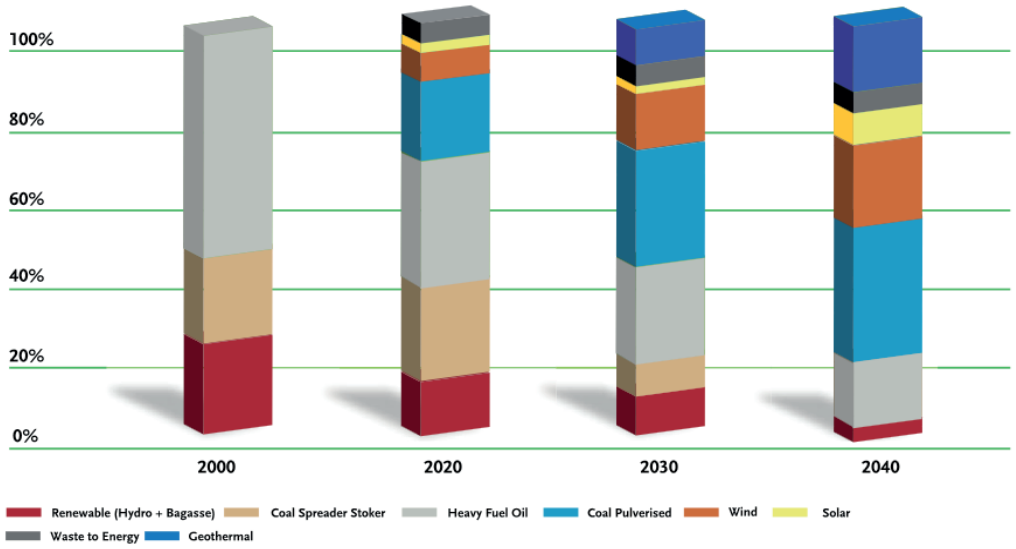
Fuel source		PERCENTAGE OF TOTAL ELECTRICITY GENERATION			
		2010	2015	2020	2025
Renewable	'Bagasse'	16%	13%	14%	17%
	Hydro	4%	3%	3%	2%
	Waste to Energy	0	5%	4%	4%
	Wind	0	2%	6%	8%
	Solar PV	0	1%	1%	2%
	Geothermal	0	0%	0%	2%
	Sub-total	20%	24%	28%	35%
Non-Renewable	Fuel Oil	37%	31%	28%	25%
	Coal	43%	45%	44%	40%
	Sub-total	80%	76%	72%	65%
	Total	100%	100%	100%	100%

Source: Long-Term Energy Strategy 2009-2025

Source: Long Term Energy Strategy 2009–2025[11]

This brief therefore argues that more urgent and dedicated efforts are required to explore the potential of renewable energy sources in small developing islands such as Mauritius

Figure 6: Energy mix evolution 2000–2040



Source: Long Term Energy Strategy 2009–2025[13]

towards diversification through industrialisation, and the bolstering strategies in the tourism and hospitality industry.

The IEP also acknowledges the pressures to shift technology in order to diversify primary energy sources with the expectation of benefiting from lower long-run marginal costs, and to promote more environmentally friendly power stations. However, according to the energy mix evolution analysis, renewable energy approaches, in particular bagasse and hydro power, show a declining trend by 2040, except for wind, solar and geothermal strategies, as shown in Figure 6. This trend is not surprising in view of the changes in the sugar industry, which has witnessed a drastic change in land use from primarily agriculture (sugar) to infrastructure development, following the booming tourism sector. This raises concerns about the promise of renewable energy sources which had crystallised in the government's MID concept.

Notwithstanding the fact that modelling of hydro potential shows that it has reached its limit with an effective total capacity of 55,8 MW, which accounts for 9 per cent of the island's total effective capacity, this brief argues that the predictions did not fully consider mini- and micro-hydropower plants, which have gained momentum and been helpful in reducing pressure on the main grid. Success story initiatives have been witnessed,[14] and these have been echoed by the World Bank's new draft energy strategy, which highlights small-scale hydropower as an important component of the future World Bank activities in Africa,[15] the Belgian support for small hydropower developments in Mozambique,[16] and the European Union (EU) support for small regional hydropower development in the Southern African Development Community (SADC) countries.[17] This brief puts forward the view that bagasse could still play a critical role, even in 50 years to come, if the supply of bagasse is maintained and innovative approaches encouraged, such as the introduction of new crop varieties of sugarcane that would not depend on massive tracks of land, and the utilisation in the island of biomass, which could be useful in co-generation plants.

In addition, the latest IEP acknowledges the fact that renewable energy generation will continue to be more expensive than fossil-fuel based electricity unless environmental costs associated with fossil-based fuel generation are quantified and factored in (which would admittedly be a challenging exercise). Making a policy recommendation based on such an analysis rests on the view that renewable energy is viable, reliable, and ready to go; many of its proponents blame governments for lacking the political will to kick-start an energy revolution.[18] A Sydney team analysing Australia's energy resources has shown that electricity could be supplied from a new wind farm at a cost of AU$ 80/MWh (US$ 83), compared with AU$ 143/MWh from a new coal plant or AU$ 116/MWh from a new baseload gas plant, including the cost of emissions under the Gillard government's carbon-pricing scheme. The analysis goes further to reflect that even without a carbon price (the most efficient way to

reduce economy-wide emissions), wind energy is 14 per cent cheaper than new coal and 18 per cent cheaper than new gas.[19] This brief therefore argues that more urgent and dedicated efforts are required to explore the potential of renewable energy sources in small developing islands such as Mauritius.

Conclusion

Mauritius, like many developing and emerging economies, grapples with the challenge of attaining an effective energy mix. The island has witnessed an exponential demand for energy following the re-engineering of the economy, accompanied by the booming tourism and hospitality sector, growing the commercial and manufacturing sector at the expense of sugarcane production, which consequently has an effect on energy production from bagasse. Future projections based on a business-as-usual scenario typify continued use of imported petroleum and fossil fuels rather than the proliferation of renewable technologies. However, Mauritius remains one of the few developing countries to provide an enabling environment and competitive platform to the private sector for investing in the energy sector. Indeed, IPPs have over the last decade been supplying, reliably and competitively, a significant share of the total electricity generated in the island.

Some policy recommendations

- IEPs should encapsulate all costs, technical and environmental, in modelling future scenarios for energy generation. More urgent and dedicated efforts to promote a renewable energy mix would reduce the island's vulnerability to imported fossil fuels and their volatile prices.
- The reformation and centralisation of the sugar manufacturing industry has been a crucial step in optimising production costs; this, however, needs multi-sectoral support from all key stakeholders and line ministries.
- Rapid land use change has a net effect on bagasse supply; hence the need to consider alternative cane varieties to increase bagasse potential and also develop a decision-support tool to ensure sustainable utilisation of the limited land.
- Increased investment in flexi sugarcane industrial ecosystems is essential. Lessons can be drawn from Omnicane, an IPP, and these methods could be extended to other power plants.
- Technology transfer with other small developing island states such as Trinidad/Tobago, Cape Verde and the Seychelles could help the island achieve its MID ideal.

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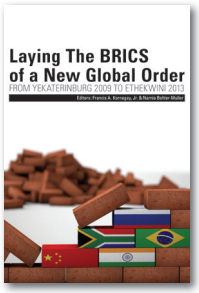

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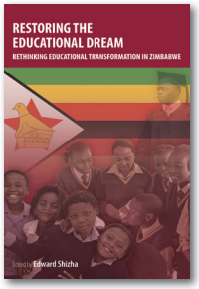

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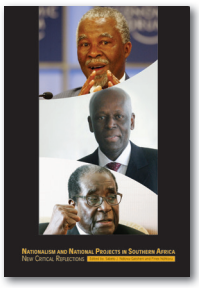

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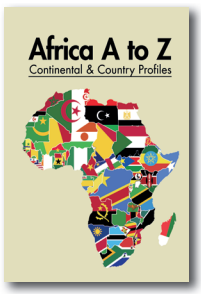

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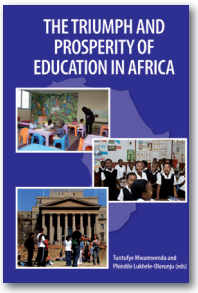

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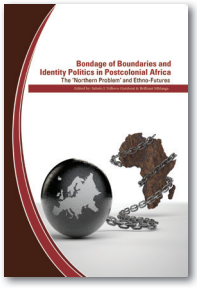

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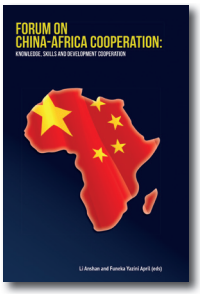

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ISSN 1998-7994