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Electricity Generation:
A Driver of SADC Regional Integration?

EXECUTIVE SUMMARY

The 2014 SADC heads of state summit in Harare adopted industrialisation policy as a means of strengthening regional integration. Greater regional co-operation is also emerging as a means towards diversifying SADC economies and boosting international partnerships. Access to energy, however, remains a challenge for most SADC countries. Although industrialisation demands an adequate energy supply, heavy reliance on fossil fuels has encountered widespread opposition – prompted by climate change concerns – driving the need for sustainable energy solutions. This paper advocates strengthening regional power pools to enhance effectiveness and efficiency in resource utilisation. A power pool can promote energy security and increase service reliability through shared, interconnected electricity systems. It may also help promote larger regional markets as a basis for future economic growth. The paper maps SADC's electricity access, role players, energy technologies and technological investment within the bounds of its industrial policy; and suggests ways in which the electricity generation industry might support efforts toward regional integration.

INTRODUCTION

The 34th Annual Summit of Heads of State and Government of SADC was held in Harare,

Zimbabwe in August 2014. The communiqué issued after the meeting endorsed the importance of industrialisation for regional integration.[1] Member states agreed that the manufacturing industry is one of the central pillars of economic development through creating enough jobs to reduce poverty and setting regional economies on a growth path;[2] at the same time it is critical to economic diversification and the development of productive capacity.[3] The statement was issued at a time when sub-Saharan Africa was moving sufficiently away from resource dependency to entertain aspirations of becoming a hub of global economic growth, with some countries' annual growth rates thought to be as high as 5%.[4] The World Bank estimates that five sub-Saharan African countries have already attained middle-income status.[5] A major challenge, however – notably in the SADC region – is providing the reliable supplies of electrical energy that are needed to drive industrialisation. Unfortunately, not all countries in SADC are equally capable of meeting this need. Even South Africa, the most advanced of them, is grappling with energy shortages.

Mainstream economists consider land, labour and capital as primary factors of production, with goods such as fuel and materials as intermediate inputs.[6] They seldom stress the part played by energy in economic growth. The present study, however, recognises that energy constituents such as fuels are reproducible factors,[7] while laying emphasis on the part played by energy availability in economic growth and industrialisation.

To realise their industrialisation objectives SADC countries could and should use energy production as a key platform for regional integration. An industrialisation framework can be developed based on present opportunities,[8] the first of these being the exploitation of existing renewable sources as part of a transition to the wider use of renewable energy. The second is a strengthening of the science, technology and engineering capabilities of SADC members, most likely through collaborative research and development. The third is to promote harmonisation of the energy sector through regional power pools.

1 Mureverwi B, 'SADC Summit's Emphasis on Industrial Development: Implications on Practical Policy Formulation', Tralac (Trade Law Centre), Trade Brief. Stellenbosch: Tralac, September 2014.
2 SADC (Southern African Development Community), *Industrial Development Policy Framework*. Gabarone: SADC, 2014.
3 *Ibid*.
4 WEF (World Economic Forum), *Delivering on Africa's Promise*, Report. Geneva: WEF, 2013, http://www.weforum.org/events/world-economic-forum-africa.
5 *Ibid*.
6 Stern DI, 'Energy use and economic growth in the USA: A multivariate approach'. *Energy Economics*, 15, 1993, pp. 137–150.
7 Stern DI, 'A multivariate co-integration analysis of the role of energy in the US macro-economy', *Energy Economics*, 22, 2000, pp. 267–283.
8 Juma C, 'The new harvest', in *Agricultural Innovation in Africa*. London: Oxford University Press, 2011.

BACKGROUND AND POLICY CONTEXT

SADC industrialisation policy reflects the fact that since 2000 industrialisation has been understood as a primary element in establishing sustainable growth and development. The SADC Protocol on Trade, which came into effect in that year, called for an industrialisation strategy alongside the implementation of the SADC Free Trade Area. In addition, the SADC Regional Indicative Strategic Development Plan (RISDP), adopted in 2003, reflected member states' commitment to a number of priority areas, including industrialisation policies, with a focus on promoting industrial linkages and the efficient utilisation of regional resources. The RISDP called on member states to pursue national industrial policies and strategies informed by the need to foster regional coherence and reduce regional development imbalances.

Sector-specific analysis – including value chain analysis – was conducted with a view to promoting sector-specific strategies. This in turn led to the adoption in 2009 of a programme to upgrade and modernise existing industries, as well as to reinforce institutional support for infrastructure in order to improve productivity and competitiveness; in itself an admission that SADC needed to strengthen its industrial infrastructure. For this objective to be realised, however, SADC must intensify its regional integration efforts. The energy sector is one of the means through which this can be achieved.

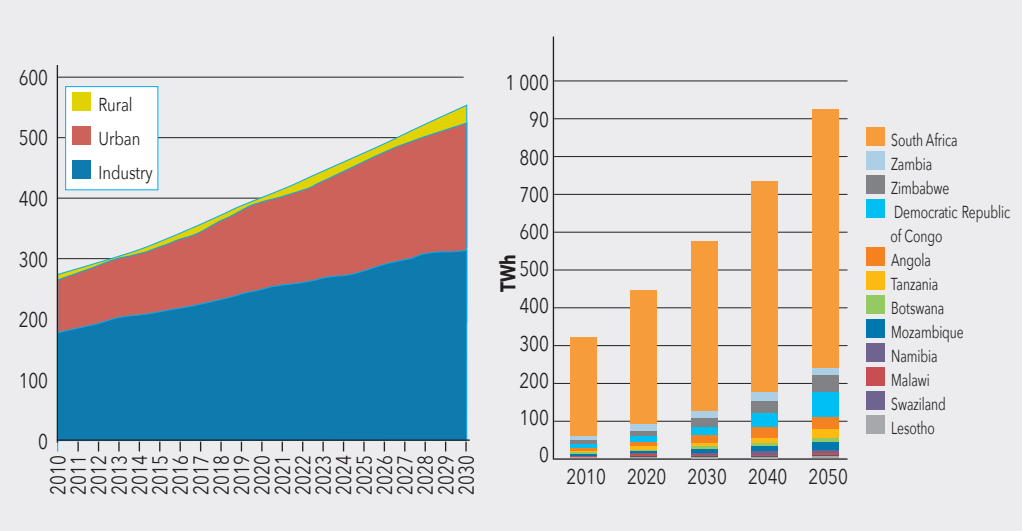
SADC'S ENERGY LANDSCAPE

Energy security is inextricably linked to industrialisation, but along with other regions of sub-Saharan Africa, SADC members have the world's lowest access to energy.[9] Rolling blackouts are already common and energy demand is rising: the World Bank anticipates a 40% increase over the next 10 years,[10] which if realised will probably widen the existing supply gap between household and industrial consumption. Figure 1 illustrates how energy demand in Africa at present is skewed towards the industrial sector and urban areas.

9 Eberhard A *et al.*, 'Underpowered: The State of the Power Sector in sub-Saharan Africa', World Bank Background Paper, 6, Africa Infrastructure Country Diagnostic. Washington, DC: World Bank, 2008.

10 World Bank, *The World Bank and energy in Africa*, fact sheet, 2013, http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/0,contentMDK:21935594~pagePK:146736~piPK:146830~theSitePK:258644,00.html.

Figure 1: Energy demand projections by country and category



Source: IRENA (International Renewable Energy Agency): Southern African Power Pool. Planning and prospects for renewable energy, IRENA, 2013

Projections from the International Renewable Energy Agency (Irena) indicate that by 2030 electricity demand in the SADC region is expected almost to double, from 300TWh[11] to 580TWh; and to reach 920TWh by 2050.[12] As of 2010 installed capacity fell well short of this at about 52GW;[13] 72% is based on coal-fuelled power generation, 18% on hydropower and the remainder on oil and nuclear fission.

The South African system dominates the Southern Africa Power Pool (SAPP) and accounts for 80% of regional capacity.[14] For all SADC countries to reach the level of industrialisation already attained by South Africa, member states will have to provide consistent energy output far beyond their present production capacity. At today's production and supply levels, SADC faces a series of problems. These include the limited scope and coverage of energy infrastructure in terms of both geographic area and users; a large shortfall in generating capacity; technical obsolescence and poor state of the energy infrastructure; low levels of resource efficiency, leading to high unit costs; and widespread politically motivated manipulation of electricity prices.

This array of obstacles reflects overall inefficiency in planning and policy, as well as the unsustainable finances of government-owned utilities and a resultant lack of essential investment in the energy sector. A critical feature is the domination of state-owned national

11 IRENA (International Renewable Energy Agency), *Southern African Power Pool: Planning and Prospects for Renewable Energy.* Abu Dhabi: Irena, 2013, https://www.irena.org/DocumentDownloads/Publications/SAPP.pdf, IRENA 2013.
12 *Ibid.*
13 *Ibid.*
14 *Ibid.*

power utilities, which has hampered – or altogether excluded – the participation of privately owned energy producers. The existing system of energy production and supply lacks the incentives and flexibility to provide easy and equitable grid and market access to privately owned power producers. A further implication is that the dominance of parastatals renders energy provision susceptible to political manipulation; hence the achievement of greater industrialisation within SADC implies more participation from independent energy producers.

Coupled with the question of production and supply of sufficient energy is the promotion of its efficient use. Governments should long ago have developed sound policies to promote the efficient use of available energy, together with the means to implement them properly. Efficiency improvements can yield performance rewards at a fraction of the cost of increasing energy production per se. While it is true that policies can alter behaviour, laying down a framework for more efficient use of energy may not of itself bring about the desired result. Regional policymakers, political leaders and communities should emphasise 'using less to do more' as a common value.

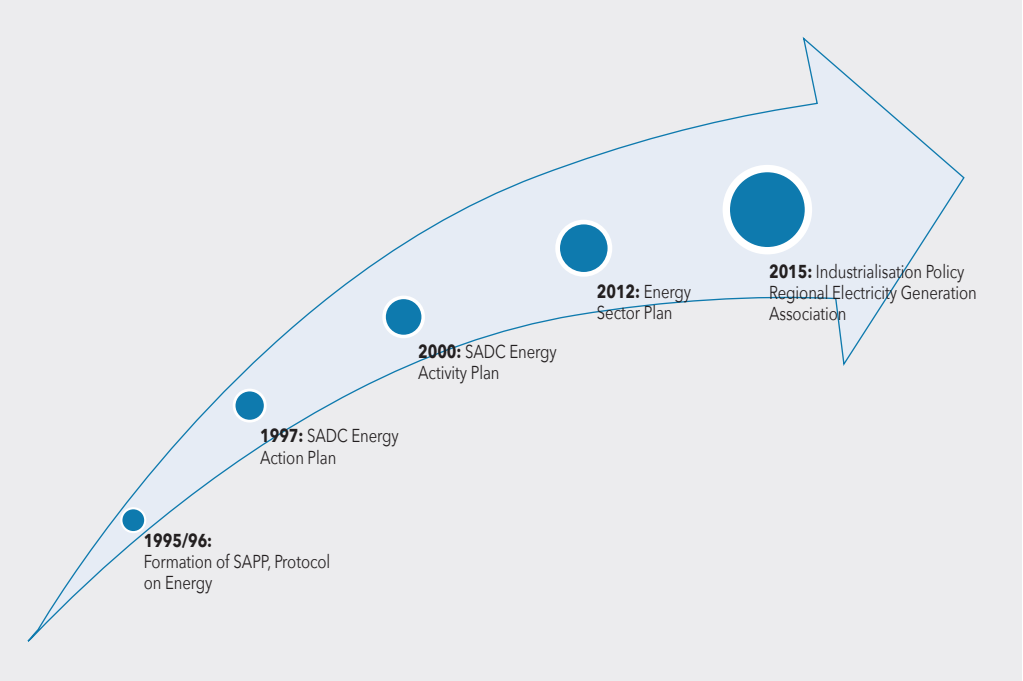
CO-OPERATION IN THE SADC ENERGY SECTOR

Given the significance of energy production in SADC's industrialisation, the sector could well become a catalyst for regional integration.[15] The formation of the SAPP in 1995 illustrates precisely this. In particular, energy experts in the region share the broad view that a co-operative approach offers opportunities for exploiting the very high hydropower potential in certain countries within the region – notably the Democratic Republic of the Congo (DRC) and Mozambique – which would lie dormant without the assurance of the substantial export market provided by a regional power pool.[16]

In 1996 SADC adopted a Protocol on Energy that provided a framework for co-operation on energy policy. This was followed in 1997 by an Energy Action Plan, in which the ministerial task team concerned recognised the need to reduce SADC's (then) power surplus capacity and put in place measures for regulating energy and exploring alternative energy sources. Subsequent developments centred on the need to enhance regional integration through the energy lens (see Figure 2). Each country derives mutual benefits from co-operation between member states. This is especially important insofar as a significant element in the success of newly industrialised nations is their ability rapidly to learn how to improve performance in a variety of sectors, including institutional development, technological adaptation, trade organisation and the use of natural resources.[17]

15 IEA (International Energy Agency), 'Extended World Energy Balances'. Paris: IEA/OECD Library, 2010.
16 Mbirimi I, *Electricity Mixes in the Context of Global Climate Change Mitigation Pressures,* IISD (international Institute for Sustainable Development), Series on Trade and Energy Security, Policy Report 5. Winnipeg: IISD, 2010.
17 Juma C, *op. cit.*

Figure 2: Evolution of SADC energy policy



Source: Authors

Despite SADC's promising policy frameworks and strategic direction, studies have highlighted the slow pace of developments in the energy sector. Member states fail to comply with regional energy guidelines partly because their national interest trumps the broader interests of the region. In addition, many of them prefer bilateral over multilateral agreements.[18] Largely for these reasons, value chains within the energy sector have remained untapped.

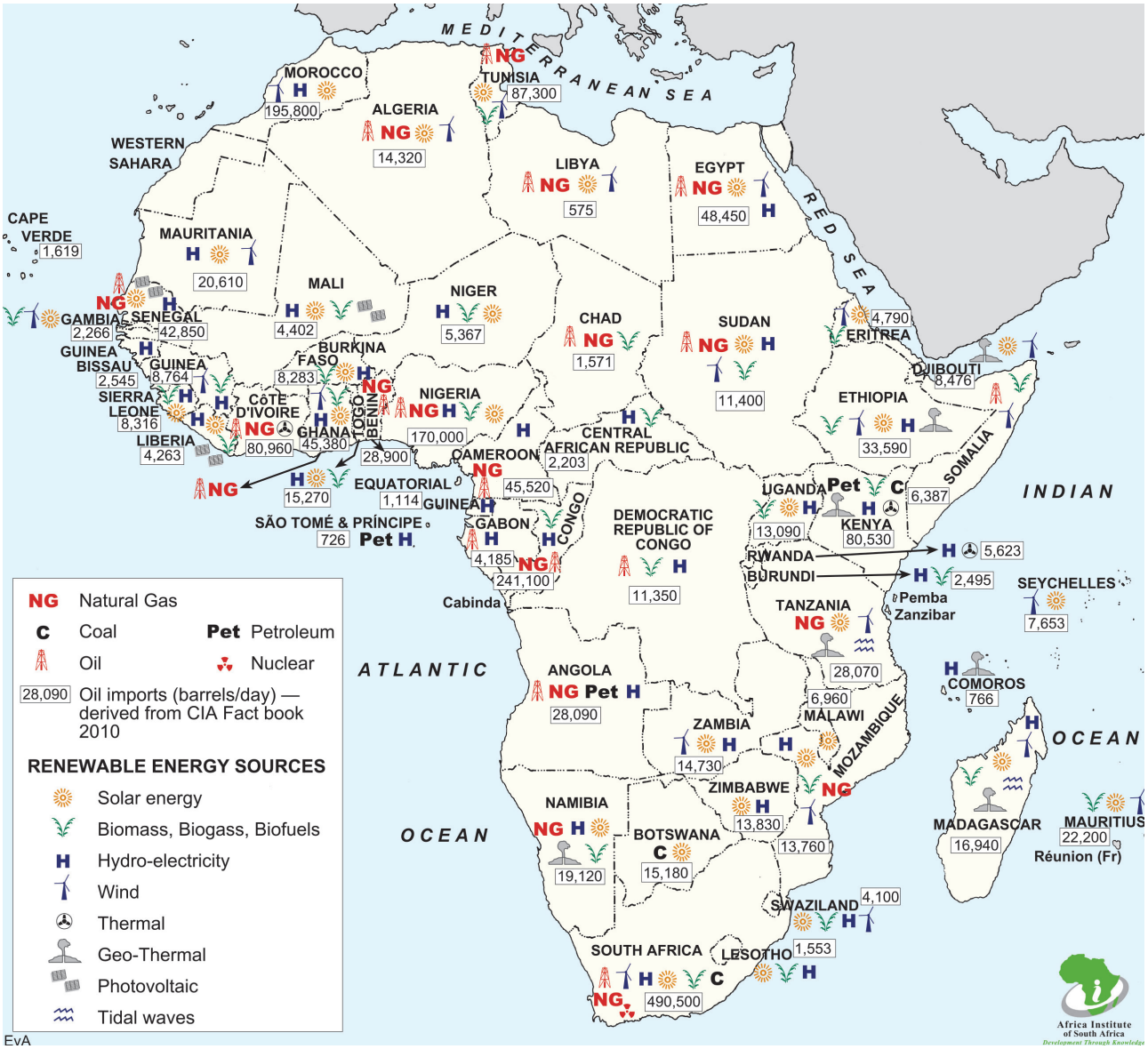
REGIONAL STRENGTHS: RENEWABLE ENERGY

SADC is endowed with a heterogeneous mix of fossil and renewable energy sources (see Figure 3). Most countries in the region possess enough renewable energy potential to meet present demand through proven technologies. Many parts of sub-Saharan Africa enjoy daily solar radiation of between 4kWh/m2 and 6kWh/m2. The Great Rift Valley alone has largely untapped geothermal resources estimated at 9 000MW;[19] elsewhere, mainly around coastal regions, there is much potential for wind power.

Hydropower, wind and biofuels together may make a significant contribution to the SADC energy landscape.

18 Mhaka G, 'Energy power development SADC's top list of priorities', *The Chronicle* (Harare), 21 January 2015.
19 UNEP (UN Environmental Programme), *Financing Renewable Energy in Developing Countries: Drivers and Barriers for Private Finance in sub-Saharan Africa,* UNEP Financing Initiative. Nairobi: UNEP, 2012.

Figure 3: Africa's renewable energy mix



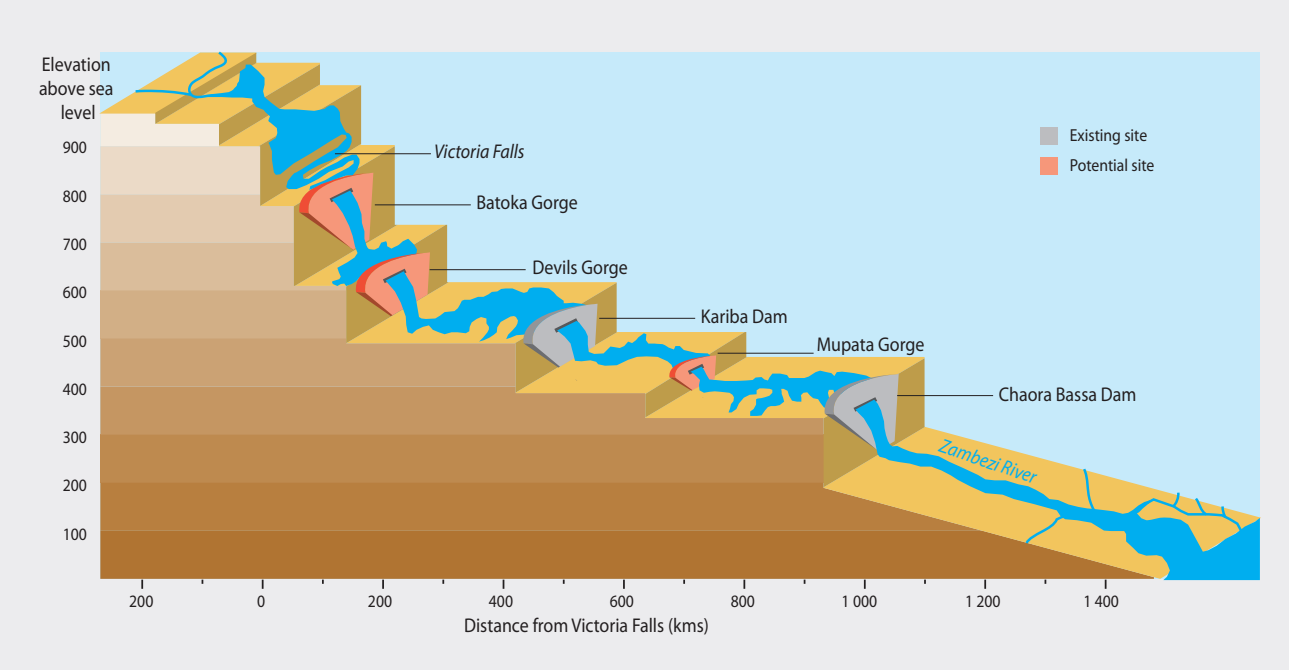
Source: Kaggwa M, Mutanga S & T Simelane, 'Factors Determining the Affordability of Renewable Energy', AISA (Africa Institute of South Africa) Policy Brief, 65. Pretoria: AISA, 2011.

Hydropower

Hydropower is the world's largest renewable energy source, producing around 16% of all electricity and more than 80% of renewable electrical power. The most flexible source of power generation, it can respond to demand fluctuations in minutes, deliver base-load power and (in reservoir installation) store electricity over weeks, months, seasons or even years.[20]

20 Brown A, Müller S & Z Dobrotková, 'Renewable Energy Markets and Prospects by Technology', IEA Information Paper. Paris: IEA, 2011; Edenhofer O, *Renewable Energy Sources and Climate Change Mitigation,* UN Intergovernmental Panel on Climate Change (IPCC) Working Group III. Cambridge, UK: Cambridge University Press, 2011.

Figure 4: Existing and potential hydropower projects: Zambezi River



Source: SADC and Zambezi River Authority, 'Rapid Assessment Report: Integrated Water Resources Management Strategy for the Zambezi River Basin'. Gaborone: SADC Water Division, 2007

The Zambezi River basin alone probably has enough capacity to power the entire region, if harnessed as shown in Figure 4. The SAPP estimates that although the Zambezi could produce more than 20 000MW,[21] at present only 23% of this is being harnessed, most of it from the Kariba Dam between Zambia and Zimbabwe and the Cahora Bassa Dam in Mozambique.[22] The Grand Inga hydropower project on the Congo River in the DRC offers a further opportunity for regional integration. It is a multi-phase hydropower station that might generate as much as 40 000MW, enough to power half of Africa.

Development to this level of output will require a phased approach. South Africa has signed a treaty with the DRC providing a framework for facilitation of power generation and delivery to South Africa; the third phase of Grand Inga (Inga 3) will provide 2 500MW to South Africa while contributing to regional integration, energy security and economic growth in an environmentally sustainable manner.[23] Energy experts envisage a new transmission line from the DRC to South Africa to be constructed after the completion of Inga 3, most likely cutting across Zambia, Zimbabwe and Botswana.

21 SADC & Zambezi River Authority, *Rapid Assessment Report: Integrated Water Resources Management Strategy for the Zambezi River Basin.* Gaborone: SADC, 2007.

22 GRID-Arendal, *Existing and potential hydropower projects on the Zambezi River.* Arendal: GRID-Arendal, 2013, http://www.grida.no/graphicslib/detail/existing-and-potential-hydropower-projects-on-the-zambezi-river_2995.

23 South Africa.info, 'South Africa pushes for Grand Inga hydropower project go-ahead', http://www.southafrica.info/news/grand-inga-hydropower-project%20.htm#.VcCZVPmWaAU.

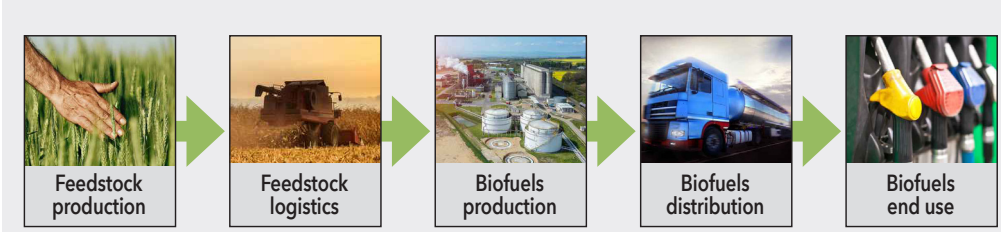
Biofuels and wind

SADC has been relatively successful in scaling up biofuels as part of the renewable energy mix. The Southern African Development Commission developed a strategy for biofuels initiatives within SADC, to be implemented through a biofuels task force, which in turn developed a policy support tool (the Crop Decision Making Tool) that culminated in a 'State of Play Study' under the Basic Energy Co-operation programme. This triggered a series of innovations with the potential to promote industries that can help realise SADC's industrialisation aims (see Table 1).

Among SADC countries, South Africa has displayed exceptional technological innovation. Some of the most notable examples include:

- discovery and characterisation of new yeasts, such as *Candida shehatae*, which can convert pentose sugars derived from the hemicellulose fraction of bagasse into ethanol;
- development of a consolidated bioprocessing process that offers the largest potential cost reduction so far of any research-driven improvement in biomass-to-bioethanol conversion;
- sunflower-based technology under which the chemical process of transesterification with methanol and alkali has proved successful in producing biodiesel fuel;
- Sasol's model for initiating a commercial biomass conversion industry; and
- Sasol's technology for gasification, synthesis and separation, originally developed for coal conversion and later adapted for biomass feedstock, either stand-alone or in combination with biological processing.

Figure 5: Value chains on bio-derived energy production and distribution



Source: Authors

Figure 5 illustrates the potential for industrial development across energy production and distribution. In Mauritius, for example, biomass-based electricity co-generation (ie, combined heat and power production) from sugar estates now accounts for 40% of total annual electricity production.[24] A further success in this field is the $437 million investment by South Africa's Industrial Development Corporation and the South African National Development Institute in two biofuels projects that by 2009 were together producing 190Ml of bio-ethanol from sugar cane and sugar beet.[25] In employment terms a 10% supply of such fuel relative to total consumption has been estimated to be the equivalent of a new sugar industry, creating some 110 000 jobs.[26]

EMERGING OPPORTUNITIES FOR THE ENERGY SECTOR

Declining cost of renewables

Generation costs for some renewable energy technologies are falling steadily and some are now comparable with those of conventional generation. Solar photovoltaic generation, for example, has become almost competitive with power from coal over the past few years[27] and wind power in good locations can deliver electricity at a cost below $69/MWh, against $67/MWh for coal-based generation.[28] Recent analyses of hydropower show that average investment costs for large hydropower plants (with storage) typically range from $1,050/kW to $7,650/kW, with small hydropower projects at $1,300/kW–$8,000/kW. Small or 'mini' hydropower projects therefore offer proven viability, particularly in off-grid, remote and rural areas. The cost of additional capacity at existing hydropower schemes, or installing generators at dams with no hydropower plant, can be as little as $500/kW.[29]

Some countries in SADC (South Africa among them) have an average annual rainfall of 500mm, which is low by world standards and which, combined with the seasonal flow of rivers and frequent droughts or floods, limits hydropower opportunities. Nevertheless, many of them possess enough hydrological potential to benefit substantially from small and mini hydropower plants.

24 Ramjeawon T, 'Life cycle assessment of electricity generation from bagasse in Mauritius', *Journal of Cleaner Production,* 16, 16, 2008, pp. 1727–1734.

25 Van Zyl WH & BA Prior, *South Africa Biofuels,* IEA Task Group, 39, Progress Report, 2009, http://academic.sun.ac.za/biofuels/Media%20info/South%20Africa%20Biofuels%20May%202009%20Progress%20Report.pdf.

26 Mosiah N *et al.,* 'Southern African Energy-Investment Flows and Challenges', paper presented to the South African Portfolio Committee on Energy, Cape Town, 24 August 2012.

27 Stuart B, 'South Africa: Grid parity within sight, but Refit needs to be implemented soon', *PV Magazine,* 24 August 2010, http://www.pv-magazine.com/news. /details/beitrag/south-Africa--grid-parity-within-sight--but-refit-needs-to-be-implemented soon_100000754/, accessed 21 November 2011.

28 Morales A, 'Wind turbine prices below 1 million euros a megawatt', *Bloomberg Business,* 7 February 2011, http://www.bloomberg.com/news/2011-02-07/wind-turbine-prices-fall-below 1-million-euros-per-megawatt-bnef-says.html.

29 Irena, 'Hydropower', Working paper 1 3/5, Cost Analysis series. Bonn: Irena, 2012.

Table 1: Hydropower cost analysis

	Installed costs ($/kW)	Operations and maintenance costs (%/year of installed costs)	Capacity factor (%)	Levelised cost of electricity (2010 $/kWh)
Large hydro	1 050 - 7 650	2 - 2.5	25 to 90	0.02 - 0.19
Small hydro	1 300 - 8000	1 - 4	20 to 95	0.02 - 0.27
Refurbishment/ upgrade	500 - 1 000	1 - 6		0.01 - 0.05

Source: Irena, 'Hydropower', Working paper 1 3/5, Cost Analysis series. Bonn: Irena, 2012

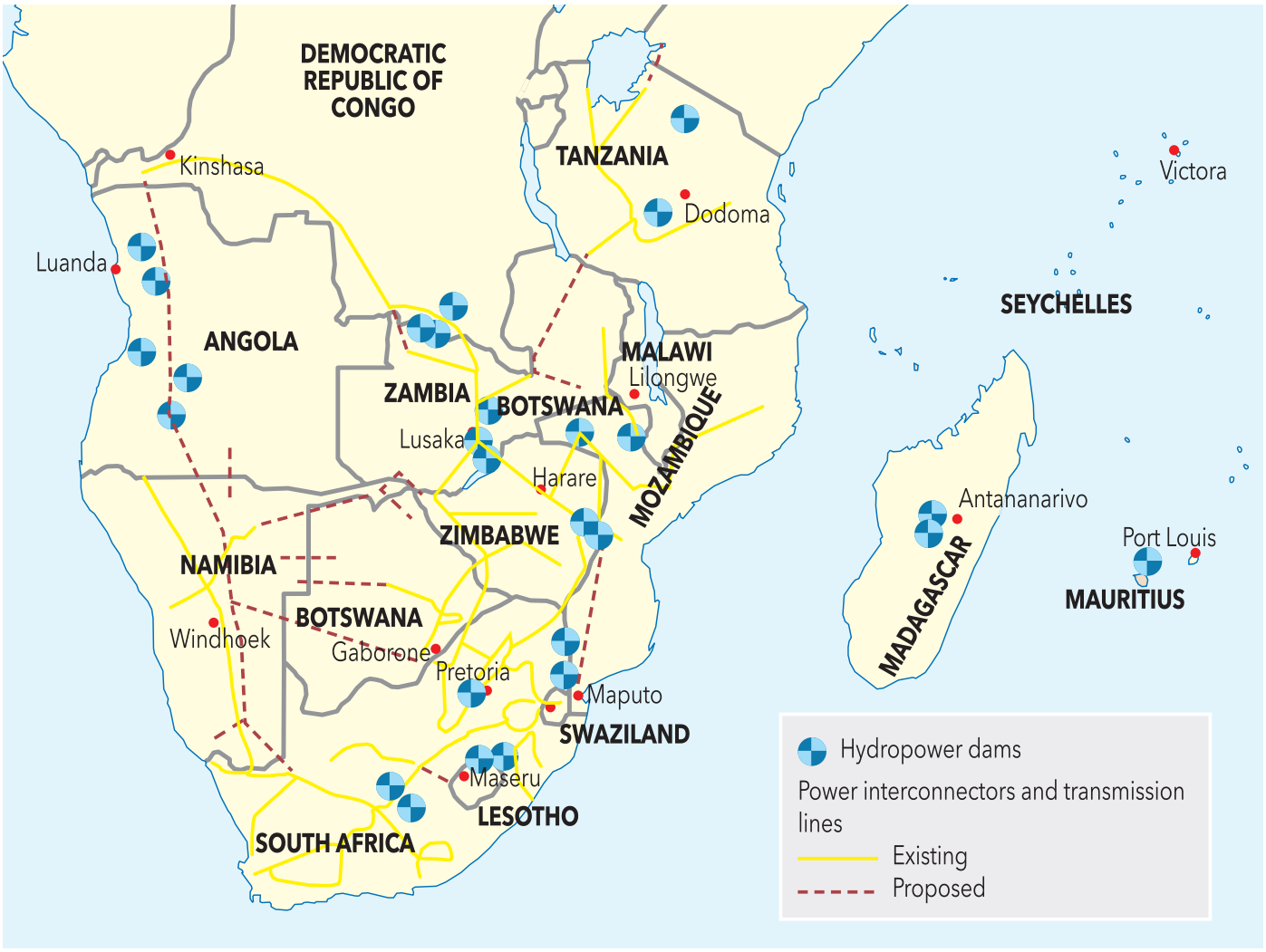
Cross-border transmission

The SADC region has made significant infrastructural improvements in the electricity sub-sector, evidenced by the interconnection of nine SADC member states to the SAPP (see Figure 6). What clearly is now urgent is connecting the remaining three mainland member states (Angola, Malawi and Tanzania) to the SAPP, in line with the 1996 Protocol on Energy.

Power lines, existing and planned

Measures taken under the SAPP together with bilateral agreements have seen the construction of power lines between member states; the largest of them, between South Africa and Mozambique, transmits more than 3 000MW (see Table 1). Additional power lines in the planning stage include Zizabona (Zimbabwe, Botswana, Namibia and Zambia) with 600MW capacity; Westcor (DRC, Angola, Botswana, Namibia and South Africa) with 1 500MW capacity; and '765Kv' (DRC, Namibia, South Africa, Zambia and Zimbabwe) with 1 500MW capacity.

Figure 6: Distribution of energy infrastructure



Source: Authors, redrawn from SADC data, http://www.sadc.int/themes/infrastructure/en/electricity-generation/, accessed 15 April 2015

Table 2: SADC: Existing power lines

Country 1	Country 2	Line capacity (MW)
Botswana	South Africa	800
Botswana	Zimbabwe	650
Lesotho	South Afrca	230
DRC	Zambia	260
Mozambique	South frica	3,850
Mozambique	Swaziland	1,450
Mozambique	Zimbabwe	500
Namibia	South Africa	750
South Africa	Swaziland	1,450
South Africa	Zimbabwe	600
Zambia	Zimbabwe	1,400

Source: Irena, 'Hydropower', Working paper 1 3/5, Cost Analysis series. Bonn: Irena, 2012

Foreign direct investment

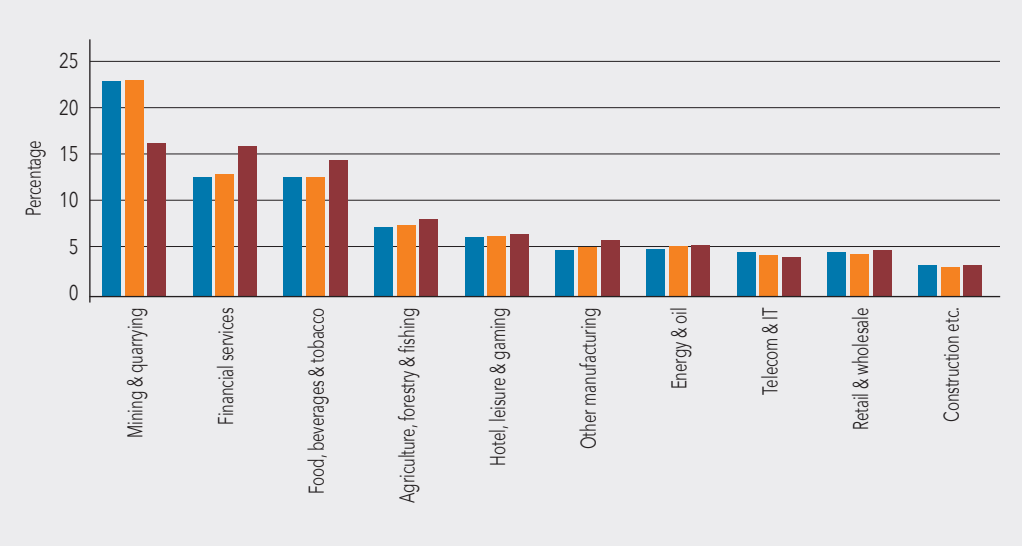
Flows of investment into the SADC region's electricity sector have been rising. From 1998 to 2008 sub-Saharan Africa witnessed a 70% growth in electricity generation, from 73TWh to 123TWh, which translates into an average annual region-wide growth rate of 6% (although very unevenly spread).[30] Expansion in renewable energy has been equally strong, with total generation from renewable sources growing annually by 72%, from 45TWh to 78TWh, in the decade to 2008;[31] hence 66% of all new electricity generated in sub-Saharan Africa since 1998 has come from renewable sources.

Southern Africa is the leading region south of the Sahara judged on the number of projects funded through foreign direct investment (FDI) on the continent; South Africa remains the largest destination for FDI projects and its lead is widening.[32] There are an increasing number of intra-African transnational companies with a growing share of intra-regional investment.

30 *Ibid.*
31 *Ibid.*
32 Ernst & Young, *Attractiveness Survey: Africa 2014: Executing Growth*, February 2015, www.ey.com/attractiveness.

Since 2007 FDI projects of that kind have shown a compound annual growth rate of 31.5%,[33] with South Africa emerging as a major investor in the region. The SAPP has played an important part in the process of heightened regional integration and development; it has helped increase market size, added to the attractions of the region for FDI and boosted the positive determinants for foreign investment. A key issue is the volume of FDI inflows into infrastructure development, given that low levels negatively affect the lagged value of revenues.

Figure 7: FDI within SADC, by sector



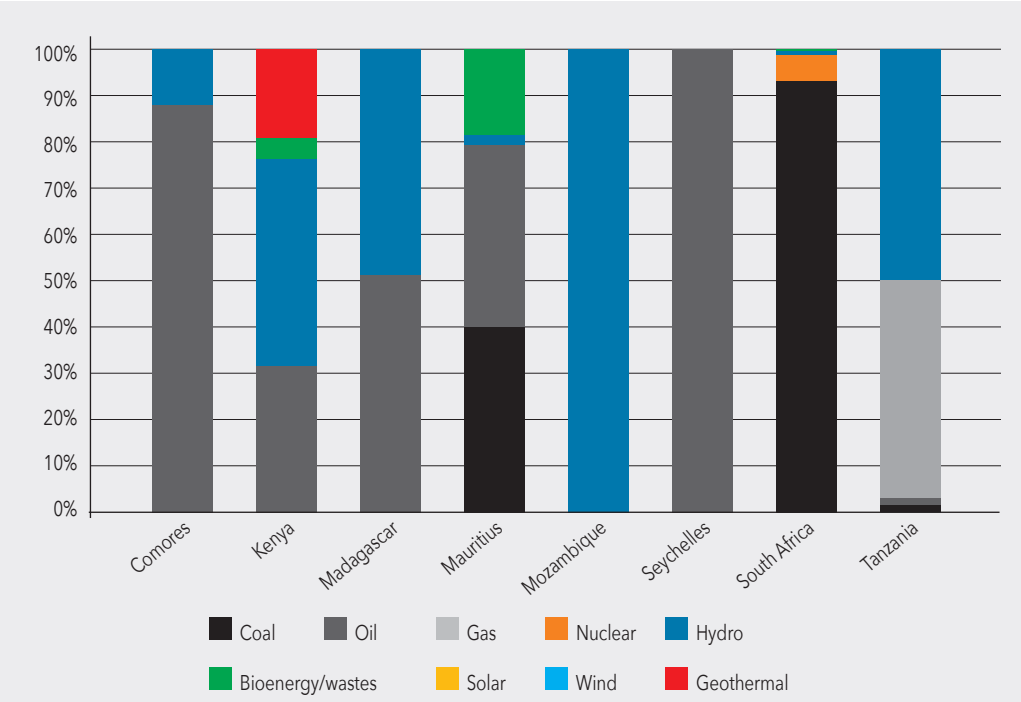
Source: Mupimpila C & FN Okurut, 'Determinants of Foreign Direct Investment in the Southern African Development Community (SADC)', Botswana Journal of Economics, 9, 13, 2012

Indian Ocean Rim Association

The Indian Ocean Rim Association (IORA)[34] offers prospects for improving regional integration and could be a binding force through co-operation in harnessing oceanic energy resources. This could in turn become a pillar of SADC regional development, with benefits extending beyond the SADC region to countries in the AU as a whole.

33 *Ibid.*
34 The IORA members are Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, South Africa and Tanzania.

Figure 8: Energy sources, IORA member states



Source: Attri VN, Energy Transitions and Corporation in Indian Ocean Region, IORA (Indian Ocean Rim Association), http://www.hsrc.ac.za/uploads/pageContent/5863/ENERGY%20TRANSITIONS%20AND%20CORPORATION.pdf

CONCLUSION

Energy production can be a catalyst for regional integration. Such a function, however, demands the cross-pollination of capabilities, resources and technological skills. In addition, the scattered nature of renewable energy sources across the region necessitates regional co-operation and integration, through energy pooling and cross-border interconnection of electricity grids and gas pipeline networks. Successful initiatives in the region thus far demonstrate that regional infrastructure can be utilised to make best use of energy systems and improve reliability, as well optimise the exploitation of renewable resources.

The reality, however, is that the SADC region still relies heavily on technologies developed elsewhere. These are often very costly; in addition they are not fully understood by local communities and are therefore often rejected, thereby failing in their aim of alleviating energy scarcity. In consequence the region continues to be energy deprived, a situation that has a direct negative effect on industrialisation. SADC member states nevertheless are endowed with abundant resources of renewable energy. To exploit this competitive advantage to the full member countries should commit themselves to existing frameworks and guidelines and in addition should consider developing:

- clear internal market policies and guidelines;
- cost-of-service policies and guidelines;
- financial planning policies and guidelines for energy utilities;
- cross-border energy trade guidelines;
- benchmarking programmes for transmission and distribution utilities;
- greater regularity agency capacities;
- policies to promote the participation of small and medium enterprises in the energy sector; and
- policies and guidelines to promote 'Green' economies.

If harmonised across the SADC region, such a process would serve to strengthen regional integration, using energy and energy industries as a basis and focal point for enhanced industrialisation.