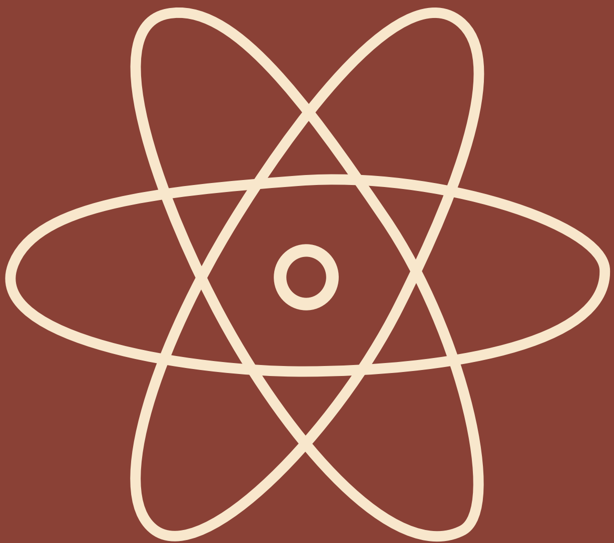
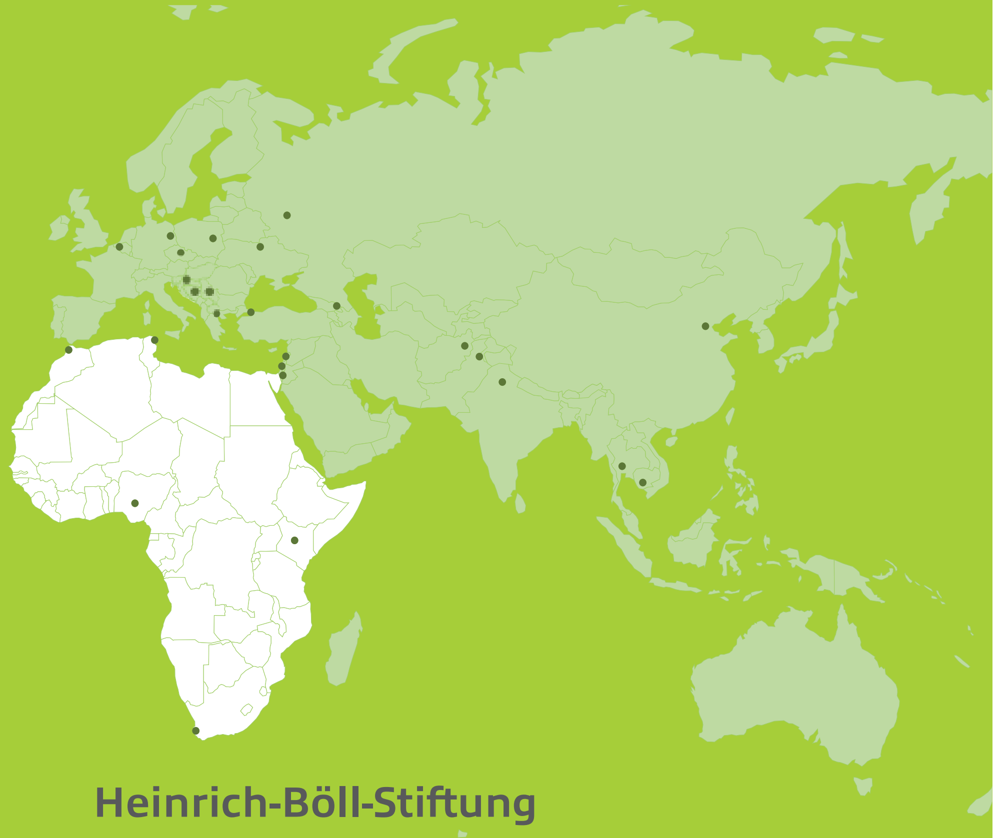
THE MYTHS OF NUCLEAR POWER





Heinrich-Böll-Stiftung

The Heinrich-Böll-Stiftung Foundation is a publicly funded institution that is affiliated to but intellectually independent from the German Green Party. From our headquarters in Berlin and 30 overseas offices, we promote civil participation in Germany and in more than 30 overseas offices. We promote civil participation in Germany, as well as in more than 60 countries worldwide. Our work in Africa concentrates on promoting civil society, democratic structures, gender democracy and social justice. Together with our partners, we work toward conflict prevention and search for solutions to the challenges of environmental degradation and the depletion of resources. To achieve these goals, we rely on disseminating information, creating a deeper understanding between actors in Africa and Europe, and supporting global dialogue.

THE MYTHS OF NUCLEAR POWER

HEINRICH
BÖLL
STIFTUNG

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CONTENTS

ABOUT THIS BOOK

While the international debate on whether nuclear power should form part of any country's low-carbon energy future is raging on, a number of African countries are considering nuclear energy generation as part of their future energy plans. South Africa is the only African country that already has an active nuclear power plant; a few other countries, including Nigeria, Kenya, Ghana and the Democratic Republic of the Congo have started research-oriented nuclear reactors.

The increasing demand for electricity on the continent coupled with the global pressure to reduce emissions makes nuclear energy an attractive option to many African governments. However, although nuclear power has been touted as the silver bullet to Africa's power supply crisis, this assertion needs closer examination as most of the arguments in favour of nuclear power fall short of its promise.

The growing interest in nuclear energy generation has prompted the Heinrich Böll Foundation to develop a publication that takes a closer look at nuclear energy from an African perspective and presents emerging information in relation to nuclear energy supply in South Africa, Nigeria and Kenya.

The following pages outline key myths of nuclear power generation that need to be considered prior to investment in nuclear infrastructure on the continent, and outline alternatives more suitable to meet Africa's energy needs.

AFRICA NEEDS POWER

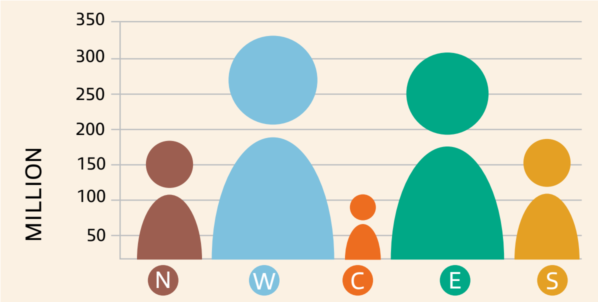
Africa Rising

According to a 2015 forecast by the United Nations Population Division, more than half of global population growth between now and 2050 will occur in Africa. This means that the continent's current population of approximately 1.3 billion is set to double to 2.6 billion in just 35 years. It is widely acknowledged that the relationship between population growth and energy consumption is directly proportional. More people means more energy demand.

Africa's growing economies are also thirsty customers for energy. Between 2000 and 2010, the continent achieved average real annual GDP growth of 5.4 percent. With economic growth, energy consumption also increases in a directly proportional way. While many African economies are still vulnerable to the vagaries of forces such as drought and volatile commodity markets, the International Monetary Fund (IMF) forecasts that Africa will be the second-fastest growing region in the world between 2016 and 2020, with annual growth of 4.3 percent.

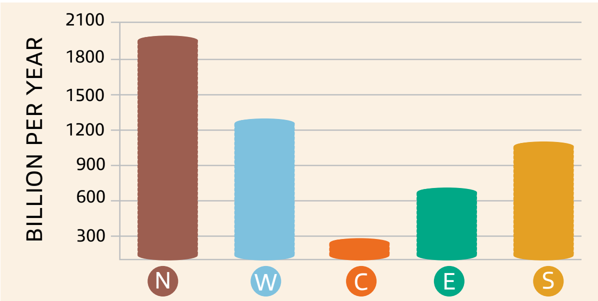
Against this backdrop, energy demand and consumption are expected to rise dramatically in the coming decade, with some predictions estimating a 40 percent increase. Satisfying this demand will require the development of an appropriate policy landscape and significant investment in a suitable mix of technologies and energy-supply options.

POPULATION

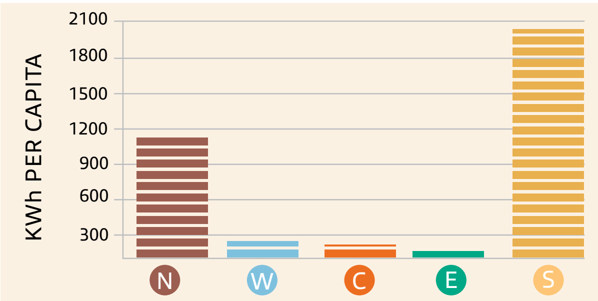


ACCESS TO
ELECTRICITY

GDP

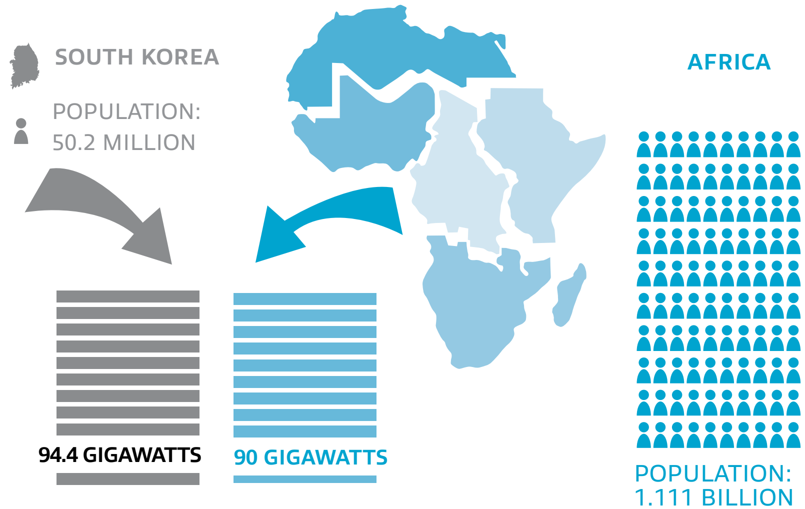


ELECTRICITY
USAGE



Current Status of Power Generation in Africa

Africa's population, particularly in the sub-Saharan region, faces serious challenges with regards to energy security and access. According to the International Energy Agency (IEA), the total electrical power generation capacity on the continent is currently in the region of only 90 gigawatts – roughly the same amount of power that is available in Spain. Of that, approximately 40 GW is generated in one country alone: South Africa. While electricity demand can be reduced through passive design approaches, appliances that are powered directly from natural sources (e.g. solar cookers), and strategies for energy efficiency, most modern energy services still rely on electricity – and this is unlikely to change in the near future.



SOUTH KOREA, WHICH COULD FIT INTO AFRICA OVER 300 TIMES, PRODUCES MORE ENERGY THAN THE ENTIRE AFRICAN CONTINENT.

Source: US Energy Information Administration

It is estimated that 600 million Africans are currently excluded from the modern energy supply services that are fundamental to development. As many as 730 million people, particularly in rural areas and in poor urban settlements, still rely on traditional biomass for household energy, which is primarily used for cooking. In rural areas, especially where sparsely populated, even fewer households are connected to the grid or have access to alternative energy services.

ACCESS TO MODERN ENERGY SUPPLY AND SERVICES

- Saves time (especially for women) allows for more time with family / time to study
- Improves nutrition
- Increases literacy
- Increases safety
- Improves sanitation
- Easier irrigation
- Improves health care

At present, about thirty countries in Africa experience recurrent electricity outages. Power outages are common due to excessive demand and inadequate transmission and distribution technologies. The reasons for the chronic energy deficit are wide-ranging and can be attributed to a number of factors, including:

- aging power infrastructure
- lack of investment in generation, transmission and distribution equipment and networks
- widespread but ineffective policy reforms
- lack of institutional capacity to manage and implement power programmes
- fuel shortages.

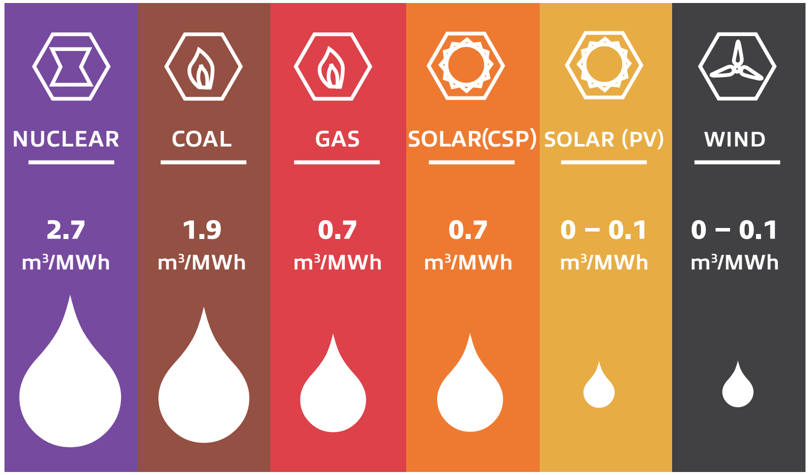
HOW CAN AFRICA FUEL ITS NEEDS?

Given these projections for economic and population growth, Africa will need an enormous amount of new energy-generation capacity to cover the existing gaps, fuel its economic growth, and cater for its growing population.

Africa's Power Generation Options

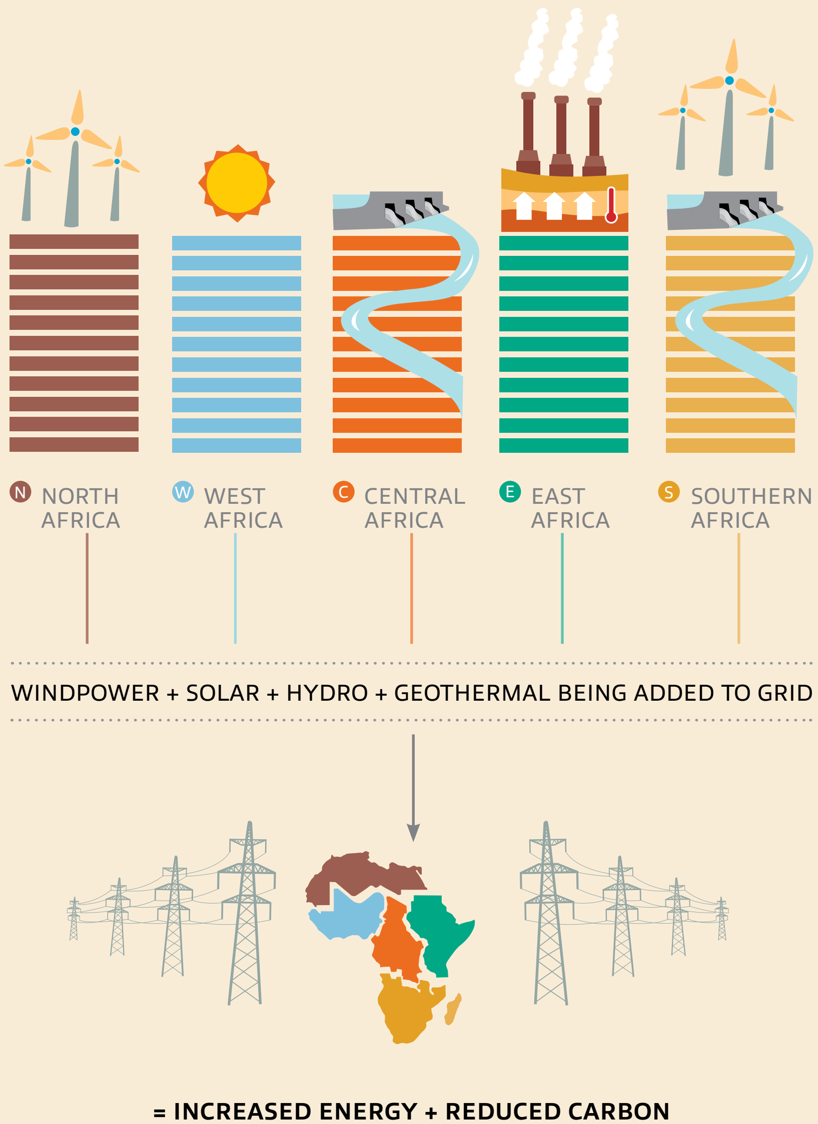
Africa has abundant reserves of fossil fuels in the form of coal and natural gas. However, given the need to limit greenhouse gas emissions that contribute to climate change, countries ought to consider low-carbon energy solutions in their national 'energy mix' – the chosen strategic combination of sources and technologies for power generation. These combinations also need to be considered in so far as they impact other critical resources such as water.

FRESHWATER CONSUMPTION OF ENERGY RESOURCES



Source: Egyptian Centre for Economic and Social Rights & Heinrich Böll Foundation

RENEWABLE ENERGY SOURCES WITH THE HIGHEST POTENTIAL PER REGION



Africa is also endowed with significant renewable energy (RE) resources, including solar, wind, hydro, bioenergy and biomass, and geothermal energy. According to the International Renewable Energy Agency (IRENA), RE options vary in type across the diverse geographic areas of the continent. Solar resources are generally available, while biomass and hydropower are good options in the wet and forested central and southern regions. The wind resource is good in the north, east and southern regions, and the Great Rift Valley in East Africa has excellent geothermal potential.

The Nuclear Option

Another option that a growing number of African countries view as part of the solution to the current energy crisis is nuclear energy.

Globally, nuclear power generation is on the decline. Thirty-one countries operate nuclear power programmes, with a total of 398 power plants between them. This is 40 fewer than in 2002, when 438 reactors were in operation – the highest number ever recorded. There has been a downward trend in nuclear reactor start-ups. In the last few years, the majority of new start-ups have been in China.

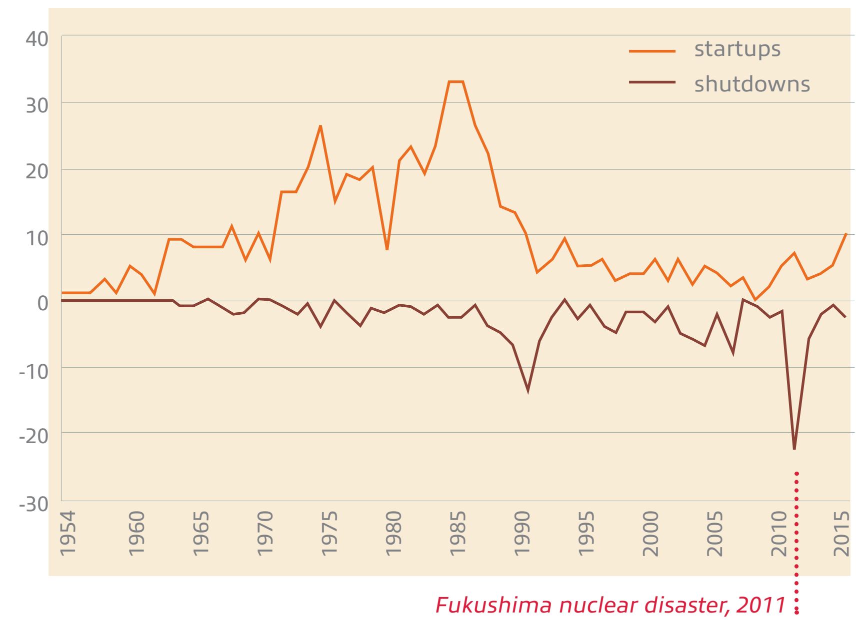
Nuclear energy contributes 337 GW of the global power generation mix, down from its 2010 peak of 368 GW. Its relative share peaked in the mid-1990s at around 17.6 percent and declined to less than 11 percent in 2014. The world's total electricity generating capacity is estimated at 3500 GW.

In contrast, the generation capacity of renewable energy has been growing. By 2014, it reached 1712 GW (including hydro), an increase of almost 48 percent from 2004. An additional generation of power, equivalent to 406 GW, comes from solar water heating. The number of countries with renewable energy targets increased from 48 in 2004 to 164 in 2014.

> **"Fukushima was a blow to nuclear power, but evidently not a fatal one."**

***Anton Khlopkov**, director of the Centre for Energy and Security Studies (Moscow)*

REACTOR STARTUPS AND SHUTDOWNS GLOBALLY 1954 TO 2015



AFRICA'S NUCLEAR AMBITIONS

Nuclear energy is not new to Africa, with the Democratic Republic of Congo (the Belgian Congo then) having built its first nuclear research reactor in the 1950s. South Africa is currently the only African country with an operational nuclear power plant. Its construction commenced in 1976 at Koeberg, Western Cape, and it was commissioned in 1984.

A total of 12 nuclear research reactors, for medical, scientific and industrial use, are hosted in eight African countries, with a growing list of countries stating their nuclear energy aspirations. In the sub-Saharan region, Ghana, Nigeria, Uganda and Kenya have expressed interest in building nuclear power plants, as have the North African countries of Algeria, Morocco and Tunisia. Some observers have termed the growing commitment to nuclear power generation on the continent 'the nuclear resurgence'.

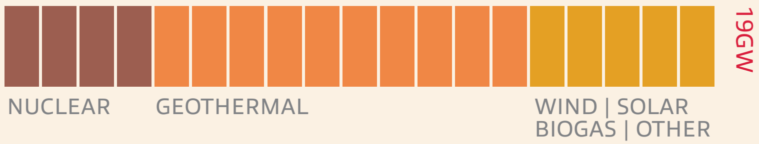
All the interested countries are at different stages of the development of nuclear power infrastructure. To date, Kenya, Nigeria and South Africa are rumoured to have signed international agreements with prospective vendors.

Kenya

Despite energy sector reforms, power supply in Kenya is still not reliable. According to the former chairman and chief executive officer of Kenya Nuclear Electricity Board (KNEB), Mr Ochillo Ayako, Kenya's energy strategy needs to meet two main criteria – "quick to set up and competitive" – in order to supply consumers with continuous power supply at affordable tariffs. In his view, Kenya's future energy infrastructure should also be useful to secondary beneficiaries in the region.

In 2010, Kenya announced its intention to develop nuclear energy as part of its energy mix. It proposes to build four nuclear power plants by 2030, each with an installed capacity of 1000 MW of energy, which will provide continuous electricity supply for the next sixty years.

PLANNED GENERATION CAPACITY BY 2030



Early in 2016, a ten-member team from the International Atomic Energy Agency (IAEA) conducted an Integrated Nuclear Infrastructure Review (INIR) in Kenya, and concluded that the country had made significant progress in its preparations to develop a nuclear power infrastructure. They identified progress in some areas, such as the establishment of key goals and requirements to guide the nuclear power programme and development of the necessary legal and regulatory framework. For this comprehensive review, Kenya completed a self-assessment, which is a prerequisite for an INIR mission, as well as a feasibility study that considered issues associated with infrastructure.

The country is still in the decision-making phase of the project, which addresses capacity building, development of the legal and institutional framework, and a feasibility study for the first nuclear power plant. The construction phase, which is planned to kick-start by 2017, remains a big hurdle.

Concerns have been expressed about the rationale behind Kenya's move to nuclear power generation, particularly in the presence of alternative, less complicated options. In 2016, members of the Kenyan parliament questioned the need to rush into a nuclear programme while other countries were pulling out of theirs. Further, only a half of Kenya's geothermal potential has been developed thus far, not to mention the country's lack of capacity and financial ability to develop nuclear power. For these reasons, a motion has been filed in parliament to stop the government's investment in developing nuclear energy.

Kenya currently does not have adequate capacity to develop nuclear physicists and engineers, which presents a challenge for the lifelong maintenance of reactors. To bridge this gap, it has signed a memorandum of understanding with China to "obtain expertise" by way of training and skills development, and technical support in areas such as site selection for nuclear power plants and feasibility studies. Kenya has similar nuclear power cooperation agreements with Slovakia and South Korea. More than ten Kenyan students are currently studying nuclear power engineering in South Korea.

Stakeholders have voiced other concerns with the planned nuclear programme, including:

- security threats and terrorism; e.g. nuclear material landing in the hands of extremist groups such as the Somalia-based Al-Shabaab, which has already launched attacks in Kenya
- lack of financing, particularly in a country perceived to have insufficient liquidity in the local market; at present, no country or prospective vendors have signed a financing agreement for construction of the power plants
- shortage of local skills and capacity to build, operate and maintain nuclear power infrastructure.

The KNEB has proposed a Nuclear Energy Regulatory Bill to facilitate the creation of a new regulator, whose sole mandate will be to ensure the power plants are safely run and maintained, and that contractors comply with the license conditions. However, the Bill has not yet been tabled in parliament and there are already indications that its passage through both houses is going to be far from smooth sailing.

Nigeria

Nigerian governments have repeatedly stated their aim to meet the nation's rapidly growing electricity demand, which the Energy Commission has estimated will rise to almost 200 GW by 2030. Despite billions of dollars in investments and several privatisation programmes, Nigeria's available electricity supply in 2016 hovers between 2000 and 4500 MW daily. This equals about 3 light bulbs per person in a country with a population of 170 million.

Nigeria's national electricity grid is highly vulnerable, with transmission losses estimated at 40 percent, and with technical collapse occurring when more than 5000 MW runs through the grid. Despite these challenges, Nigerian governments – including that of current President Muhammadu Buhari – still insist on big megawatt solutions, such as large hydro and nuclear, which the grid in its current state cannot transmit.

In May 2016, Nigeria signed an agreement with the Russian state-owned firm Rosatom to build two nuclear reactors, to be located in Kogi and Akwa Ibom states, which are meant to generate a combined 4 000 MW. The Russian company is expected run the plant for 75 to 90 years until decommissioning. Under former President Goodluck Jonathan, Nigeria committed about 14 million Euros annually to prepare the ground and train personnel until construction begins in 2019 (with Russian funding). Details on the Rosatom deal were not in the public domain, and some government officials in the two states were unaware of the projects shaping up in their backyard. It would be interesting to investigate whether nuclear-generated electricity can match the increasingly low prices of solar in Nigeria – but since the details, including the power purchase agreement, are not in the public domain, the debate had not even started.

Nigeria's Renewable Energy and Energy Efficiency Policy of 2015 commits to achieving 20 percent RE in its energy mix by 2030, but with no long-term energy vision, it remains unclear how many MW the country will boast of in the future. RE options, especially off-grid and large-scale concentrated solar, have been largely absent from the policy debate on power. While successive governments have tried (and failed) to launch big schemes like the Mambilla Dam of 2600 MW capacity and other nuclear or gas-to-power projects of a similar size and magnitude, there has been no net increase in the power supply.

Existing security concerns related to Boko Haram militants, who have vandalised and bombed grid infrastructure and oil and gas facilities in the Niger Delta, indicate a real threat, especially to large-scale power projects such as nuclear. Small-scale off-grid solutions – such as stand-alone gas power for factories or industrial clusters, and solar or biomass for small and medium business and the agricultural sector (where 60 percent of Nigerians make their living, mostly on rainfed agriculture) – are slowly being recognised as a potential key driver for economic growth.

South Africa

South Africa's primary energy mix is largely dominated by coal; RE was only introduced into the national grid as recently as 2015. In theory, the country has a maximum generation capacity of 42 000MW, but it struggles to meet peak demand of just over 30 000MW. Approximately 85 percent of the population is connected to the grid.

South Africa plans to have 9.6 GW of nuclear generation capacity by 2030, in addition to the existing nuclear power station at Koeberg. The government has already given the go-ahead for a nuclear procurement programme and is, according to various reports, in advanced stages of discussion with possible vendors. The media, civil society and experts have expressed serious concerns as to whether nuclear energy is the right answer to the current energy crisis, and whether the country can fund and afford the highly costly programme. In light of a recent supply crisis, nuclear proponents cite energy security as a primary justification. Since nuclear power plants take at least 10 to 15 years to come online, it seems unlikely that this programme will solve the immediate need for power.

The department of energy is presently updating its 2015 Integrated Resource Plan (IRP), which sets out South Africa's energy trajectory for the next 30 years. This key policy-planning tool will outline the proposed energy mix for South Africa and define the capacity allocations for different sources of energy and technologies.

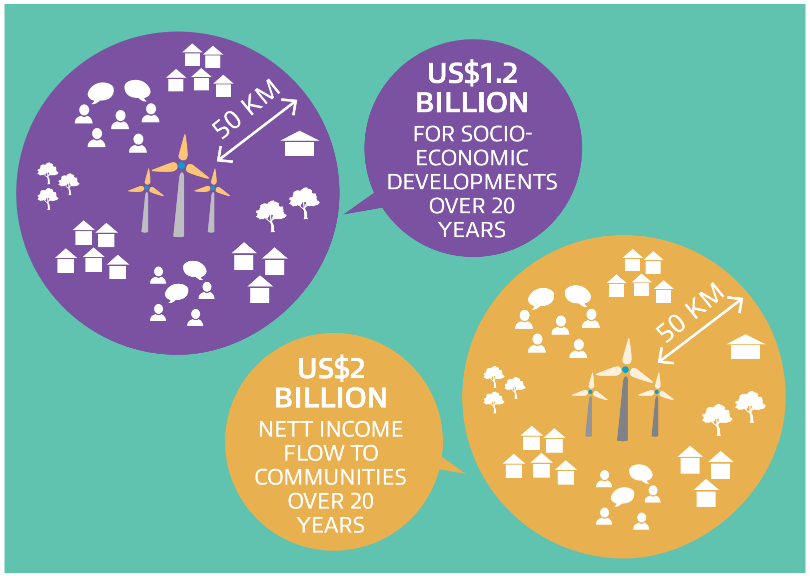
Electricity demand in South Africa is unlikely to increase as much as was predicted in earlier forecasts. Among other factors, this is due to increasing electricity tariffs and the introduction of demand-side measures to promote energy efficiency. Given that the economy has also been contracting, demand for electricity is likely to stabilise over the next five years.

GDP growth and electricity demand seem to have begun decoupling in 2007, which makes it challenging to predict future demand. However, sources suggest that even a spike in demand would not warrant the procurement of a 9.6 GW fleet of nuclear reactors – particularly given that the South African government is already committed to an estimated 16 GW of power from Medupi and Kusile Power Stations and other sources, including RE. This raises the question of whether it is prudent for the government to pursue a large-scale nuclear programme.

South Africa is also implementing a highly successful RE procurement programme. In the short space of four years and four competitive bidding rounds, it has already attracted 79 wind, solar, small hydro and biomass projects, constituting 6 GW of RE generation capacity. More than 2 GW of this is already online. These projects are entirely financed by the private sector to the tune of US$14 billion, of which 25 percent is foreign investment.

Through local community trusts and shareholding, nearly US$2 billion net income will flow to local communities for the 20-year lifespan of these projects. A further US$1.2 billion has been committed to related socio-economic development initiatives, most of them within a 50-kilometre radius of the power plants.

RENEWABLE ENERGY PROCUREMENT PROGRAMME: SOUTH AFRICA



BUSTING THE MYTHS OF NUCLEAR POWER

Proponents of nuclear energy call it a cheap, employment-creating, clean, and safe low-carbon source of energy for electrical power generation. All of these claims can be disputed.

MYTH 1

Nuclear Energy is Cheap

Historically, external costs such as the storage of radioactive waste were not included in the total cost of nuclear new-build, and nuclear looked like one of the cheapest sources of energy. However, with rapid advances in renewable energy technology (RET), this has changed. Wind has already become the cheapest energy source in a significant number of regions.

The cost of electricity generation has four main components: plant construction, operating and maintenance, fuel, and the proportion of the plant's lifespan that it stands idle. Except for maintenance periods, fossil and nuclear plants can generate a continuous supply of power for as long as they are supplied with fuel (e.g. coal or uranium). This means that they spend a smaller proportion of their lifespan standing idle, which impacts positively on their cost performance over time. The downside, however, is that nuclear and fossil plants need to be fuelled, which has a cost attached for the duration of the plant's lifespan.

RE power plants rely on freely available energy sources, such as the sun, wind, biomass, kinetic energy from flowing water, and heat from the earth's core. Except for biomass (which can be thought of as a renewable and sustainable fuel under certain conditions), these plants incur virtually no fuel costs over their lifespan.

Because of the variability of resources such as wind and solar (the sun does not shine for 24 hours a day and the wind does not always blow), these plants stand idle for a higher proportion of their lifespans than do fossil and nuclear plants. This has a negative impact on the overall cost of the electricity during their productive lifespan. But, again, RETs are advancing rapidly. The RE industry is getting better at locating sites for wind, solar and other RE projects. Developments in electricity storage technology are set to alleviate the issue of variability, and regional power grids are becoming more interconnected, thus affording additional 'storage' in the grid itself. In contrast to nuclear energy, which is only getting more expensive, all of these developments are reducing the cost of power from RE sources to the point where they are competitive with fossil-fuelled plants.

In addition to this, a paradigm shift is moving towards preferred energy services and away from a dogmatic focus on electricity generation. For example, rooftop solar water heaters deliver hot water at a far lower cost than electrically powered boilers – even if the electrical power comes from grid-connected RE sources, let alone nuclear.

By applying more intelligent design to our buildings and industrial processes, and using innovative and cheap insulation materials, we have also started to exploit the free, 'hidden fuel' that is energy efficiency, while nuclear fuel costs continue to rise.

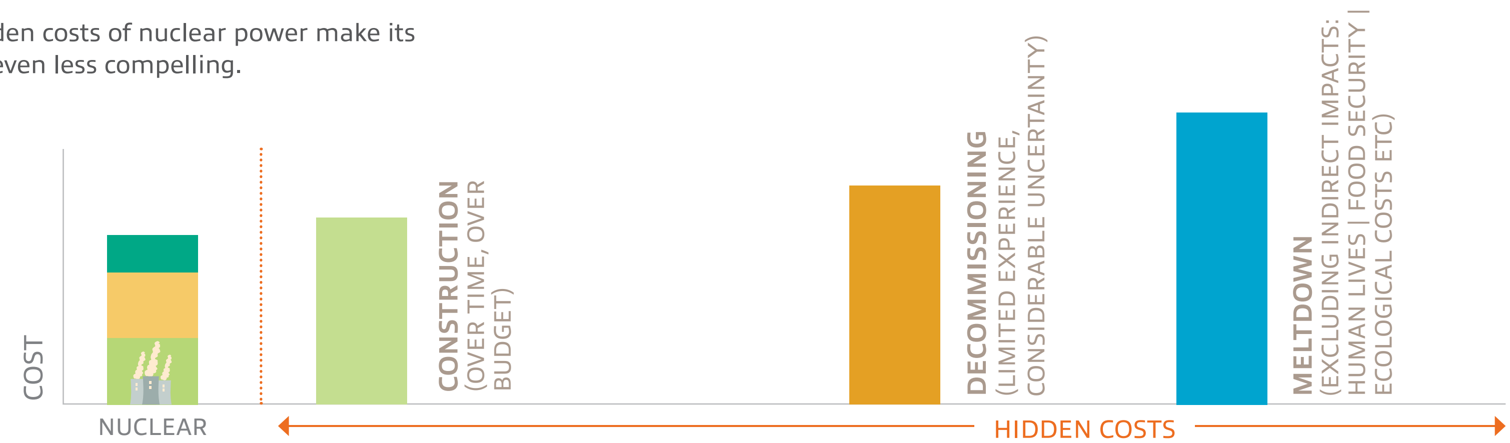
Digging deeper, the hidden costs of nuclear power make its affordability argument even less compelling.

Construction – over budget, over time, over and over again

The nuclear industry has a less than exemplary record when it comes to cost overruns and meeting deadlines. After a particularly bad run in the 1990s, designers introduced a new generation of nuclear power plants which, it was claimed, would be safer, cheaper and easier to build. These designs have fallen far short of such expectations. As of May 2015, 18 of the newly contracted plants were under construction, with only two on schedule, and the rest running two to nine years behind.

The new designs also promised lower construction costs, but the opposite has proved to be true. Initial estimates in 2000 pegged it around US$1000 per kW. By 2013, it had risen by a factor of 8 to about US$8000 per kW.

Much time, effort and massive financial resources go into nuclear procurement plans, but placing the order doesn't always result in power flowing to the grid! Between 1977 and 2015, 92 nuclear construction projects were cancelled or suspended.



Decommissioning – the cost of closing the plant

From now until 2040, around 200 nuclear reactors will be retired in the European Union, the United States, Russia and Japan. The IEA expects that the cost of decommissioning these plants will amount to more than US$100 billion, and points to 'considerable uncertainties' pertaining to actual cost due to limited experience in dismantling and decontaminating reactors and restoring sites so that they no longer pose a threat to public safety and the environment.

In fact, the industry's cost estimates appear more and more to be stabs in the dark. Between 2007 and 2012, the estimated cost of decommissioning nuclear facilities in the UK rose by 39 percent. The cost of decommissioning the Koeberg nuclear power station near Cape Town, the only operating nuclear power plant in Africa, has been estimated at about R34 billion (US$2 billion). Noting that the financial cost of decommissioning is always contentious and often understated, it is nevertheless a significant burden in the overall costs of nuclear energy.

Meltdown – the cost of disaster

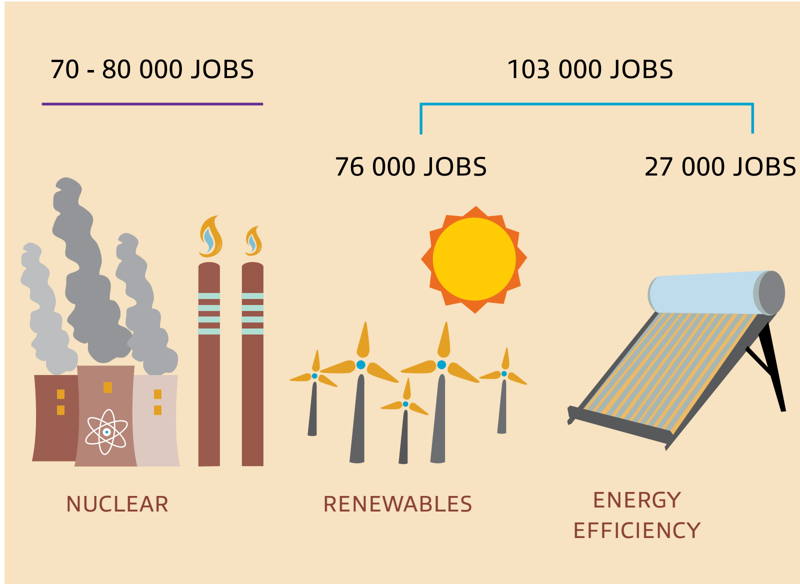
In 2011, the Tōhoku earthquake and tsunami in Japan disabled the Fukushima Daiichi Nuclear Power Plant. The estimated cost of the Fukushima meltdown currently stands at US$100 billion, roughly the same amount as is estimated to decommission the 200 aging nuclear plants by 2040. Japanese taxpayers will carry the bulk of these costs – as well as the indirect impacts on food exports, healthcare, tourism, etc.

With the benefit of hindsight, one can wonder what the inclusion of this figure into Fukushima's initial cost calculation might have done to its viability and, indeed, whether the plant would have been built at all.

MYTH 2

Nuclear Power Provides More Employment

PREDICTED JOBS CREATED BY SOUTH AFRICAN ENERGY SECTOR: 2030



Figures based on aggressive adoption of renewables versus planned 9.6 GW of nuclear power as per IRP2010

Due to the sheer magnitude and complexity of plant design, planning and construction, nuclear energy tends to favour larger, more established businesses to the exclusion of smaller ones. The nuclear sector also depends on an educated and highly skilled workforce, which is in short supply in much of Africa. Conversely, the RE sector spans a range of blue- and white-collar jobs, while also offering opportunities for smaller enterprises and scope for innovation and entrepreneurship.

Big, centralised nuclear power infrastructure can crowd out opportunities that would be available in an energy sector that is more technologically diverse and localised in its generation, supply and efficiency projects. A greater number of small and dispersed power plants using wind, solar and other renewable resources can also bring socio-economic benefits to rural communities.

In South Africa, it is estimated that the planned 9.6 GW of nuclear power will create 70,418 jobs in the construction and operation and maintenance phases. According to the University of Cape Town's Energy Research Centre, a comparable investment in wind energy would result in the creation of 80,027 jobs over the same period, and the same investment in solar would generate an estimated 144,153 jobs from solar photovoltaic (PV) and 114,361 jobs for concentrated solar power.

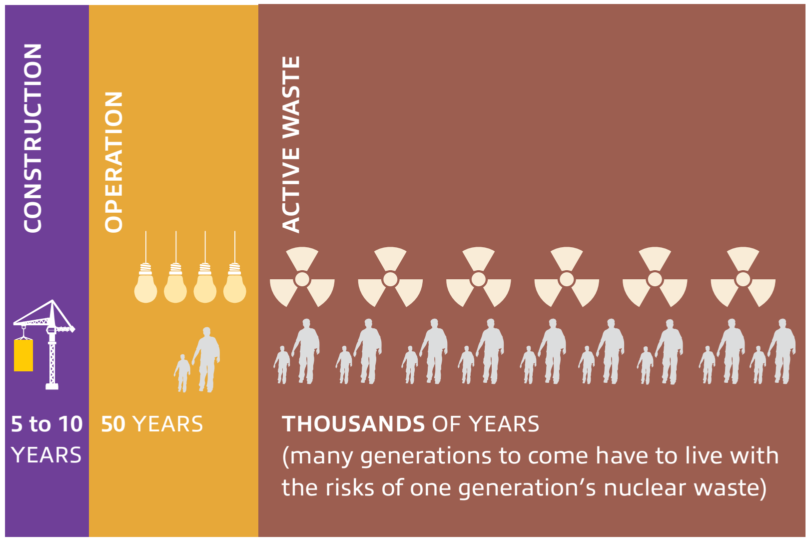
MYTH 3
Nuclear Energy is Clean

When compared with conventional fossil-fuelled plants, nuclear power generation looks good in terms of its carbon emissions. Along with RE, many see it as a viable option for a low carbon future. However, this does not mean that nuclear energy is clean.

Throughout its lifecycle, a nuclear power plant is responsible for significant levels of secondary greenhouse gas emissions. The mining and refining of uranium ore necessary for reactor fuel require huge amounts of (fossil) energy. The same is true of the large volumes of metal and concrete needed to build the power plants themselves. Decommissioning often involves encapsulating the facility in concrete, which is also energy intensive.

However, the radioactive waste that nuclear power produces is of much more concern. Uranium tailings, spent reactor fuel, and other wastes remain radioactive and dangerous for thousands of years.

THE LIFESPAN OF NUCLEAR RADIOACTIVE WASTE

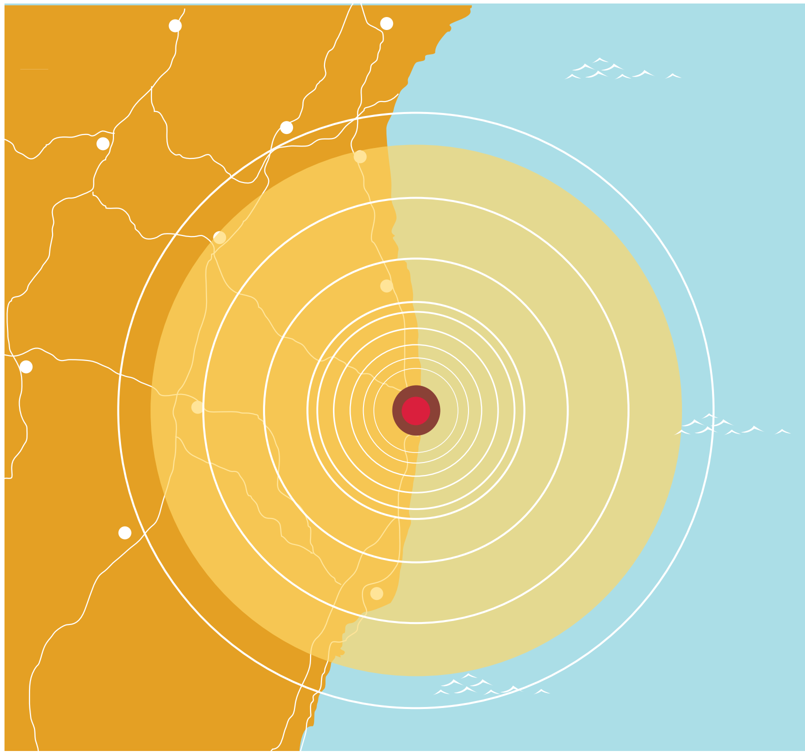


MYTH 4

Nuclear Energy is Safe

The prevailing message from the nuclear industry has been that the risks associated with nuclear power are relatively small and manageable when compared with the benefits. Yet an uncontrolled nuclear reaction can result in radioactive contamination of air and water for hundreds of kilometres around the reactor.

ESTIMATES OF EXTENT OF RADIATION FROM FUKUSHIMA SITE



■	0-1.5 km	death within weeks
■	1.5-3km	possible death in 2 months
■	3- 80 km	blood chemistry changes

based on graphic from The New York Times

Fukushima Meltdown

The view that nuclear energy is safe was upended by the accident at Fukushima. In its 2013 International Energy Outlook, the US Energy Information Administration acknowledged that Fukushima had 'substantially intensified concerns worldwide about the viability of expanding, or even maintaining, nuclear energy as a major power source'.

Following Fukushima, Japan shut down its 43 operating nuclear reactors, China halted approval processes for all new reactors until the country's nuclear regulator completed a safety review, and Germany and Switzerland announced plans to phase out or shut down their operating reactors by 2022 and 2034 respectively.

The full effects of the disaster remain unknown, and estimates of the actual death toll vary widely. Nearly 600 deaths were reported as a direct result of the incident and the resulting evacuation, mostly related to fatigue or the aggravation of chronic illnesses. The number of deaths resulting from exposure to radioactivity is more difficult to pin down. Stanford University researchers have predicted a total figure 310 cancer- and non-cancer-related deaths, with other research suggesting that this figure may be as high as 3800.

Added to the death toll are the effects on the 20,000 workers at the plant in the months following the accident. The cost in terms of human suffering is significant.

The threat of proliferation

Although some radioactive material is used in medical, scientific and industrial applications, power generation requires substantially larger quantities. This raises substantial geopolitical risks for the proliferation and use of nuclear weapons. The nuclear power industry potentially provides a convenient screen for organisations – whether state or terrorist – to traffic in radioactive material.

LET'S CHANGE THE PARADIGM

From big utilities to small, smart and distributed solutions

Countries have traditionally relied on a 'big utility' model to power their economies. This is characterised by massive, geographically centralised infrastructure and the transmission of electrical power over long distances via high-voltage power lines that constitute the backbone of the national power grid. This infrastructure is mirrored in the institutions that build, operate and regulate it: large monopolistic utilities with centralised top-down governance structures. Nuclear power fits neatly into this paradigm.

However, a new energy paradigm is being driven by the pressure to reduce our reliance on carbon-based fuel; advances in RE technology and reductions in its cost. Instead of a 'big utility', it prefers methods of energy generation and supply that are more dispersed, resilient, agile and efficient, and more socially and economically inclusive.

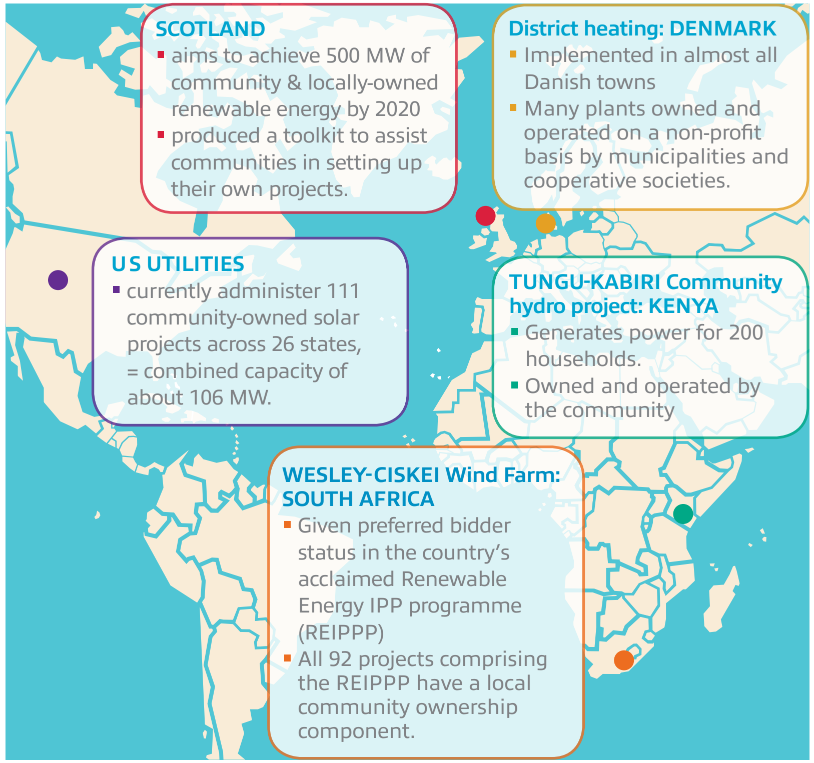
The decentralised paradigm involves many smaller plants, which are geographically distributed according to the available RE resources (e.g. wind, solar, hydro), together with even smaller distributed RE installations (e.g. a rooftop solar photovoltaic (PV) system).

Critics often argue that a renewable energy path does not support development and industrialisation. However, Germany provides an example of a major industrial country that has changed its paradigm. The country's *Energiewende* (energy transition) seeks to reduce and eliminate the risks of nuclear power, fight climate change, reduce energy imports, stimulate technology innovation, increase energy security, and strengthen local economies, which

in turn contributes to social justice. The share of electrical power generated from renewable sources of energy rose from 6 percent to nearly 25 percent in only ten years. Recent estimates suggest that Germany will surpass its target and source more than 40 percent of its power from renewables by 2020.

Improving economic inclusivity

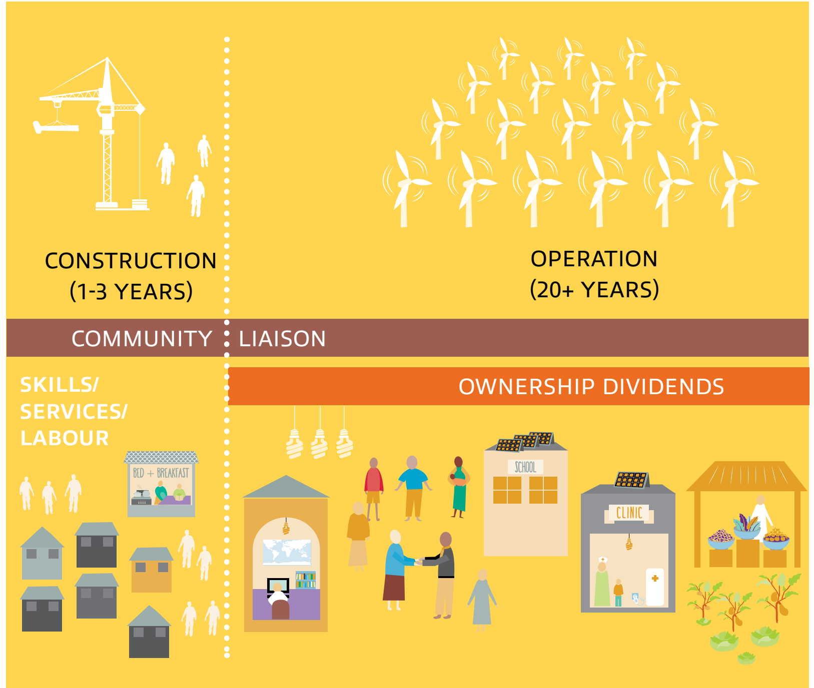
Because RE can be developed on different scales, it accommodates a much broader range of ownership models – from big listed enterprises to local cooperatives and even households. Community-owned RE can take the form of partial ownership, such as shareholding in a large wind or solar farm, or complete ownership through various forms, including cooperatives, community charities or development trusts.



Unlike the big utility model, where economic stimulus is confined to only a few areas, economic development in the decentralised model is widely spread. And because their distribution is determined by the availability of wind, solar, hydro and other RE sources, RE power plants are often built in underdeveloped areas. They can stimulate local economic development by, for example, reviving the depressed economies of small rural towns.

The construction of RE plants also requires a range of locally-available skills and services related to site selection, local stakeholder engagement, environmental impact assessment, logistics and transportation, site preparation, civil works (such as road preparation and trenching, perimeter fencing and security, assembling, cabling and grid connecting), operations, maintenance and environmental monitoring. There are also indirect, non-infrastructure related benefits to the local economy during the construction phase, such as accommodation and catering services and a general increase in trade.

While most of these activities are not specific to RE projects, the benefit of the decentralised energy paradigm is that economic opportunity is not concentrated geographically or institutionally, and there is much wider scope for economic participation by a broader range of stakeholders, including previously marginalised groups.



"The future clean energy system is going to be more open, more accountable, more answerable to the community, and more socially inclusive."

Michael Liebreich
Bloomberg New Energy Finance

Stimulating the Economy

The renewable energy industry also presents opportunities to develop 'green economy' industry, through local content and the growth of the RE component manufacturing sector. New wind and solar industries can easily absorb local content levels of up to 25 percent, especially in those parts of the plant not directly related to power generation (for example, on-site civil engineering for roads, trenches, foundations, mounting equipment, buildings and cabling).

Governments can provide further stimulus to local manufacturing in the RE value chain though firm policy commitments and RE targets as well as setting local content requirements in public procurement guidelines.

Within a supportive policy environment, local assembly of solar modules and the manufacture of module mounting infrastructure, tracking infrastructure and wind tower components can begin quite early in the development of these industries. More local manufacturing opportunities are likely to open up as RE industries become established, such as solar modules and inverters, and wind turbine blades and generation components. These could develop further into the export markets.

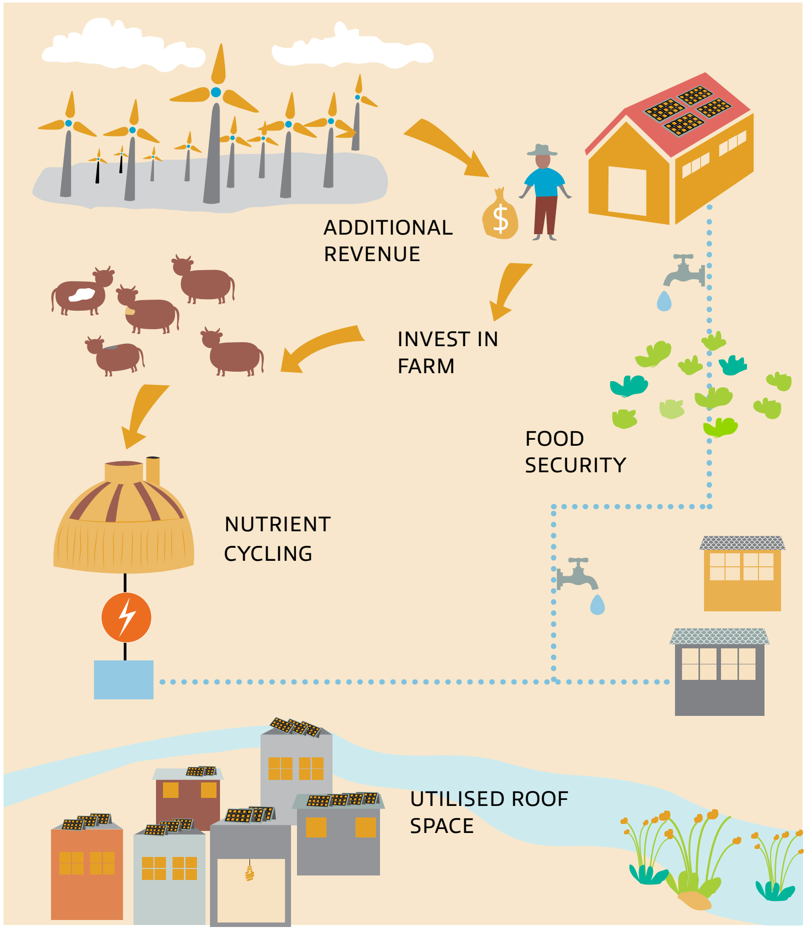
Increasing Efficiency of Space and Place

The decentralised paradigm is also more spatially efficient than the big utility model. Because power is generated from many sites around the country – often closer to where it is consumed – it is less prone to the transmission losses associated with transmitting power over long distances.

In urban areas, existing building rooftops provide ample space for RE deployment, particularly solar, alleviating the need to dedicate additional land for power generation. Such deployment can be coupled to a rental agreement, which further increases the economic potential of buildings.

In rural areas, renewable energy technology, particularly wind and bio-energy, can be deployed on productive agricultural land, giving farming operations an additional revenue stream that can enhance food security and ensure financial viability during times of drought. Biogas digesters use agricultural waste to produce electrical energy, either to feed into the grid for use elsewhere or to supplement the farm's power needs. Among many other benefits, the electricity produced can be used to treat wastewater and recycle nutrients – which is vital, especially in areas with limited water resources.

THE BENEFITS OF A DECENTRALISED MODEL FOR ENERGY PROVISION.



CONCLUDING REMARKS

Sub-Saharan Africa faces a number of energy challenges, including chronically insufficient and insecure supply and lack of access to modern energy services, particularly for remote or rural populations. The region is also likely to be one of the worst affected by climate change. Innovative approaches are thus urgently needed to meet the continent's growing energy demand.

Over the past five years, a significant number of African countries have looked to nuclear power to address the energy supply crisis, giving rise to the perception of a nuclear resurgence in Africa. In reality, the global nuclear industry has been in decline for a decade.

The risks associated with nuclear power energy are particularly high for Africa. Cost overruns, construction delays, and the potential proliferation of nuclear weapons – to mention just a few – are characteristic features of nuclear power generation. Nuclear power is not value for money by any standard, and the case for nuclear does not stand up to examination.

At the same time, paradoxically, the region is well endowed with an array of renewable energy resources whose potential is yet to be fully exploited.

For an array of social, health, environmental and economic reasons, the reliance of households and industry on biomass and other fossil fuels needs to shift towards low-carbon electrification or modern biomass or other suitable renewable energy technologies. While each country faces its own dynamic set of energy- and climate-change-related issues, the development of renewable energy provides a variety of solutions.

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