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RENEWABLE ENERGY IN EAST AFRICA

TEXTILE SECTOR LEARNINGS FROM THE INDIAN EXPERIENCE

TECHNICAL REPORT

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RENEWABLE ENERGY IN EAST AFRICA

Textile Sector Learnings from the Indian Experience

PREFACE

The adoption of renewable energy in the textile sector is being catalysed on two fronts. On one hand, the value chain being extremely cost-sensitive, renewables promise manufacturers a significant reduction in expenditure on power. A 2019 Supporting Indian Trade and Investment for Africa (SITA) survey of 112 textile and apparel companies in East Africa revealed high power costs to be one of the principal deterrents to technology upgradation. On the other hand, large international clothing brands are increasingly trying to introduce sustainable elements in their supply chains, and clean energy is one of the principal focus areas. In an industry-wide trend, these brands are favouring suppliers who abide by international environmental standards while making concerted efforts to incorporate sustainable production practices, including renewable energy. It is thus in the economic interest of East African textile and apparel companies to go green.

The Indian experience in popularizing renewable energy for industrial production offers many lessons that can be incorporated and improved on in East Africa. In the Indian state of Tamil Nadu, the textile industry was one of the earliest adopters, drivers and, hence, beneficiaries of using wind power. The success story of wind power in Tamil Nadu is one of active cooperation between the industry, the state government and the central government. In the last decade, the growth of solar energy capacity in the Republic of India has been remarkable. This was made possible thanks to a conducive institutional and legislative framework, coupled with complementary growth in physical infrastructure to render the use of solar energy economically viable.

The five countries studied in East Africa (the Federal Democratic Republic of Ethiopia, the Republic of Kenya, the Republic of Rwanda, the United Republic of Tanzania, and the Republic of Uganda) each has unique elements in their power market. Additionally, they differ in terms of the size and significance of the textile and apparel value chain in their national economies. These differences imply that a uniform policy solution to drive the use of renewable energy in these countries does not exist. The solutions need to be local and adapted to the operating constraints in each of these countries, involving thorough stakeholder engagement.

The majority of the countries studied have a commitment to completely phase out the use of electricity generated from non-renewable sources by 2050. At the same time, a large section of their population remains to be connected to the grid. These two factors, combined with the sharp downward trend in the cost of solar-powered technologies, present a unique opportunity to these countries in achieving universal electrification through a clean, cheap tool, such as solar energy. In some countries, wind energy is also a viable alternative, which can facilitate faster overall adoption of clean energy.

Based on specific aspects of India's renewable energy ecosystem, including the legislative, institutional, and financial support it entails, this report proposes recommendations for East African countries to boost the share of wind and solar power in their energy mix. The findings and recommendations presented in this report are of a preliminary nature and are intended to inform further study in the potential of driving growth and competitiveness in the East African textile sector through clean energy.

About SITA

Supporting Indian Trade and Investment for Africa (SITA) is a project funded by the United Kingdom of Great Britain and Northern Ireland's Foreign, Commonwealth & Development Office (FCDO), implemented by the International Trade Centre (ITC), and runs from 2015–21.

SITA's outcome is to improve the competitiveness of select value chains: textiles and apparel (T&A), pulses, spices, sunflower oil, leather, and emerging sectors of five East African countries (Ethiopia, Kenya, Uganda, Rwanda, and the United Republic of Tanzania) through the provision of partnerships from institutions and businesses from India.

The programme's key objective is to increase the value of trade and investment flows between India and the selected African countries to create jobs and income opportunities, while also allowing for technology and knowledge transfer. Despite an enormous untapped potential for trade expansion between India and Africa, data reveals that a limited number of products are currently being traded. India's trade with Africa is concentrated in certain sectors and countries, and it is dominated by exports of primary commodities. While the potential for export diversification exists, it may not be realized without targeted intervention.

India is well positioned to improve the productive and export capacities of African partner countries. With the growing importance of South–South cooperation, India's expertise can be leveraged to build trade capacities in African partner countries through the sharing of knowledge, technology and lessons learned.

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ACRONYMS AND ABBREVIATIONS

Unless otherwise specified, all references to dollars ($) are to United States dollars (USD) and all references to tons are to metric tons.

CAGR	Compound annual growth rate
GDP	Gross domestic product
IPP	Independent power producer
IREDA	Indian Renewable Development Agency
MNRE	Ministry of New and Renewable Energy
PPA	Power purchase agreement
PV	Photovoltaic
SECI	Solar Energy Corporation of India
TUFS	Technology Upgradation Fund Scheme

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Photo by Nadeem Jafar from Pexels.

EXECUTIVE SUMMARY

Over the last few decades, thanks to serious efforts by national governments and private industry, renewable energy has enjoyed steady growth. With private and public investments, the infrastructural and technological hurdles thwarting large-scale deployment of renewables are gradually being overcome. At the same time, conducive legislative and institutional support by governments is providing an enabling environment for unfettered growth in the adoption of clean energy, for domestic as well as industrial purposes.

In the textile industry in particular, the prospect of renewable energy is enjoying two pivotal boosts. It promises a significant reduction in the cost of procuring power and, in an industry as cost-sensitive as textile, it is in the business interest of the industry as a whole to drive a wider usage of renewables. Additionally, global brands and buyers in the fashion industry are increasingly moving towards cleaner supply chains and are preferring suppliers that employ sustainable production practices, including renewable energy. In order to benefit from global value chains, manufacturers in the textile and apparel sector thus need to favour renewable energy over conventional sources.

This report studies five East African countries (Ethiopia, Kenya, Rwanda, Tanzania and Uganda), their power market characteristics, and their textile and apparel value chains, and presents bespoke recommendations for each based on specific learnings from India's experience in popularizing renewable energy. In all of these countries, the share of renewables in the energy mix, both in terms of total capacity and generation, vastly exceeds that of India's share. Nevertheless, the per capita availability of renewable energy in India is much higher than the five countries studied. The majority of these countries have also pledged to completely phase out the use of non-renewable energy by 2050. Furthermore, vast swathes of many of these East African countries still need to be electrified. An exclusive use of renewable energy to fill the gap in grid connectivity will thus serve the twin purposes of achieving universal electrification, while remaining aligned to the goal of complete eradication of non-renewables by 2050. It will also improve per capita energy availability and enhance energy security, and the continuously falling costs of electricity generated through renewable sources can make industries in East Africa more competitive.

Chapter 1 discusses the renewable energy landscape in India and the salient features therein, which drove the growth in adoption. From the 1980s, the government has taken legislative steps, and created nurturing institutions that provided the necessary policy support to a nascent renewable sector in the country. The case of the state of Tamil Nadu has been highlighted as one of the major success stories in using wind energy to achieve industrial competitiveness, and it is a testament to a productive collaboration between the central government, state government and private enterprise. In recent years, the use of solar energy has grown significantly in India, thanks to developments in physical infrastructure and photovoltaic (PV) cell technologies. Solar energy has also enjoyed much support from the government, in terms of specific policy instruments to boost its uptake and financing.

Chapter 2 demonstrates the power market characteristics in the five East African countries and the peculiarities therein. While renewables make up the bulk of the energy mix in all of these countries, the share of solar and wind energy is very little. All five countries, lying in the tropical zone, are endowed with rich solar resources, which renders solar energy one of the most efficient tools towards achieving clean universal electrification. Some countries, like Kenya, also have exploitable wind resources, making wind energy another viable option in the energy mix.

Chapter 3 presents the case of the textile and apparel sector in particular, identifying renewable energy technologies that can be used to improve the sector's competitiveness and efficiency, while adhering to international sustainability guidelines. Case studies from India have been discussed.

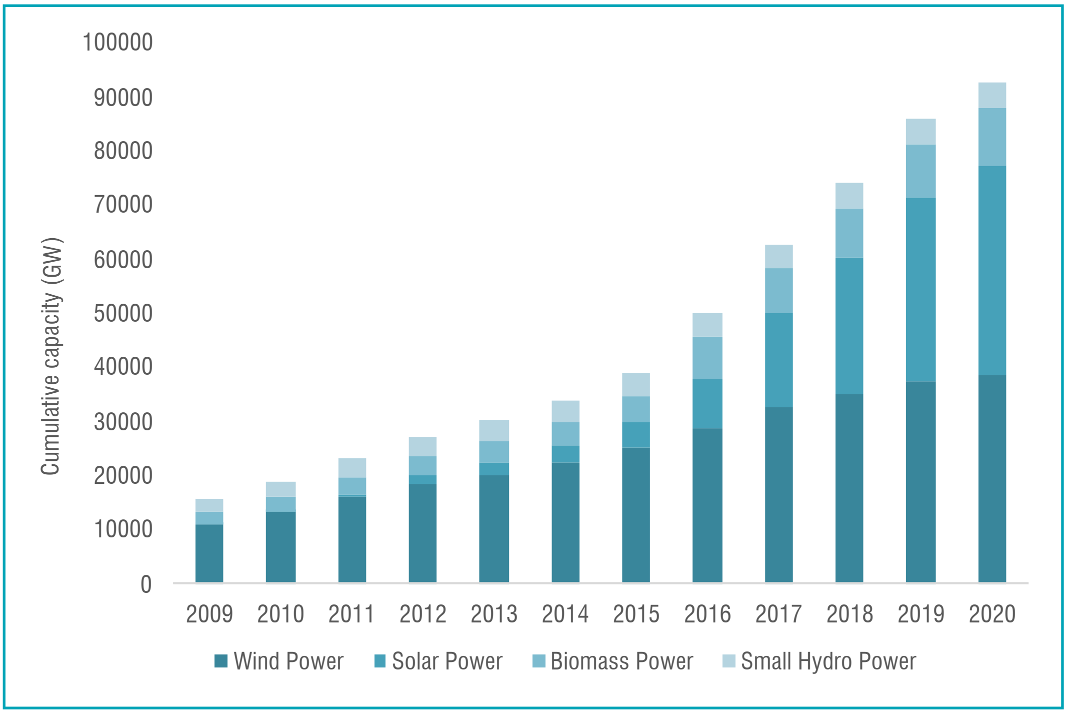
Chapter 4 lays out individual recommendations for each of the five countries in adopting specific aspects from the Indian model, based on their power market and textile sector peculiarities. While a concerted policy, legislative and institutional support to the renewable energy sector is a universal lesson in catalysing growth, the choice of policy and legislative instruments is a function of a country's operating context and constraints. The recommendations presented are preliminary and exploratory, designed to stimulate a productive policy and business discourse on renewables in the five countries.

CHAPTER 1. RENEWABLE ENERGY IN INDIA AT A GLANCE

Introduction

Renewable energy installation in the Republic of India has experienced remarkable growth in recent years (see Figure 1). In 2014–19, the capacity installations increased at an impressive compound annual growth rate (CAGR) of 20.5%. Annual capacity installations in 2016–19 have been more than 11 GW.[1]

Figure 1: Renewable energy installations trend in India



Source: Central Electricity Authority (CEA); Ministry of New and Renewable Energy (MNRE).

1.– GW = gigawatt.

Until 2020, wind power had the biggest share in renewables. However, in 2021, solar photovoltaic (PV) development has taken centre stage and become the main growth engine of renewable energy capacity addition in India. The current total installed renewable energy capacity has reached 92.5 GW and solar photovoltaics comprises 38.8 GW and has recently surpassed wind in 2021, which has an installed capacity of 38.7 GW. Solar installations have increased by a mammoth 80-fold in the last decade and eight times in the last five years.


(cc0) Image by Tilo254 from Pixabay.

In India, renewable energy (RE) has enormous backing from the government. India has a vision of "electrifying the economy and greening the electricity". The government has a target to install 175 GW of RE (including 100 GW of solar, 60 GW of wind, 10 GW of biomass and 5 GW of small hydropower) capacity by 2022 and enhance it to 450 MW[2] by 2030. The government is confident that India will install 180 GW–190 GW by 2022 based on the installed and under-progress projects, and that the country will also achieve the 2030 target.

In the last few years, a conducive policy environment has improved the attractiveness of the power sector in general, and the renewable energy sector in particular. In 2018, India's power sector saw investments of $35 billion in the generation subsector, led by renewable power generation, another $20 billion in the grid network, led by transmission, and approximately $2 billion in battery storage.[3] The power sector featured amongst the top 10 sectors attracting foreign investment in India, with approximately $1.1 billion in 2018–19. The India Economic Survey (2018–19) highlighted renewable energy investment plans (without transmission lines) of $80 billion until 2022 and a cumulative investment opportunity of approximately $250 billion to achieve 175 GW and 450 GW of RE capacity by 2022 and 2030 respectively. British Business Energy has ranked India 3rd on renewable energy investment and future plans.

This transformation in the Indian renewable energy sector is a result of a series of government initiatives that have adapted and evolved with the changing needs of the market and requirements of the country. These include the mainstreaming of renewables in the power sector through the Electricity Act of 2003, declaration of the national solar mission in 2010, and creation of a separate entity – Solar Energy Corporation of India (SECI) – which regulates and releases tenders, signs power purchase agreements (PPAs) with the renewable energy generator, and ensures timely payment. While incentives like appreciated depreciation (AD) and generation-based-incentive (GBI) have helped the wind sector to grow exponentially from 1992 onwards, falling prices of renewables, especially solar panels, have also aided in the exponential expansion. The levelized cost of electricity (LCoE) produced by solar has fallen more than 80% in the last decade, making it the cheapest source of electricity at present.

2.– MW = megawatt.

3.– Renewable Energy and Electricity Price Dynamics in India.
See https://rbidocs.rbi.org.in/rdocs/Bulletin/PDFs/1RENEWABLE45374363C0DD47A58FAD7BD5F475482C.PDF.

Key factors driving Indian renewable energy

The renewable energy sector's development can be attributed to various factors that have impacted the sector in both positive and negative ways and how the country continued its endeavour in this direction.

INSTITUTIONAL FRAMEWORK AND SPECIALIST AGENCIES

In the early 1980s, India started to establish an institutional framework to develop renewable energy in the country. Since the 1980s, India has been paying attention to the growth of renewable energy to ensure the objectives of ensuring energy security, energy self-sufficiency, sustainable development and extending energy access to remote parts of the country. Different institutions for capacity building and research and development (R&D) were set up to promote renewable energy sources, which include wind power, solar power, small hydropower and biogas. The Government of India periodically upgraded both the role and authority of its renewable development agency, IREDA, resulting in the formation of a ministry in 1992.

1981

Commission for Additional Sources of Energy

Entrusted to promote the development of renewable energy technologies.

1982

Department of Non-Conventional Energy Sources under the Ministry of Energy

To develop non-conventional energy sources.

1992

Ministry of Non-Conventional Energy Sources (MNES)

In 2006, renamed the Ministry of New and Renewable Energy (MNRE).

Since 2006, the Ministry of New and Renewable Energy (MNRE) in India has been facilitating the implementation of a very wide range of programmes, including harnessing renewable power, renewable energy for rural areas for lighting, cooking and motive power, use of renewable energy in urban, industrial and commercial applications, and development of alternate fuels and applications. Besides, it supports research, design and development of new and renewable energy technologies, products and services. The MNRE makes optimal use of a combination of subsidies, fiscal incentives, preferential tariffs, market mechanisms and affirmative action such as renewable purchase obligations by way of legislation and policies for the deployment of renewable energy systems. It also extends financial support to research and development (R&D), information and publicity, and other programmes.

The development of Indian renewables has been characterized by the creation and support of a series of specialist agencies with specific goals and market roles. The following section discusses the roles and influence of the key agencies of concern.

Indian Renewable Development Agency (IREDA)

In 1987, the Indian Renewable Energy Development Agency (IREDA), a wholly government-owned non-banking financial company (NBFC), was established to finance renewable energy projects. It was once the largest source of financing for the sector. The MNRE allocates funds to IREDA under budget. IREDA also raises funds from domestic and multilateral banks. The agency has sanctioned loans worth INR 547.73 billion ($7.5 billion) during the period of the financial year 2015/16 to 2019/20 (financial year in India is observed from April to March) and disbursed INR 373.5 billion ($5.1 billion) against it during the same period.

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Solar Energy Corporation of India Ltd (SECI)

In 2011, the Solar Energy Corporation of India Ltd (SECI) was set up as a central public sector undertaking (CPSU) under the administrative control and authority of the MNRE. Its purpose was to aid the development of solar projects under the Jawaharlal Nehru National Solar Mission (JNNSM). However, recently, the company's mandate has been broadened to cover the entire renewable energy domain. SECI was instrumental in developing India's renewable energy sector. SECI operationalizes various MNRE schemes, administers auctions, and develops solar parks and trade power. SECI is responsible for implementing the Viability Gap Funding (VGF) scheme for large-scale grid-connected projects, the Grid-connected Solar Rooftop Scheme, and a host of other specialized schemes such as a defence scheme, a canal-top scheme, etc. SECI has also ventured into the field of the development of solar energy projects for several public sector undertakings (PSUs) on a turnkey basis.

International Solar Alliance (ISA)

The International Solar Alliance (ISA) is an inter-governmental body, set up to work for efficient consumption of solar energy to reduce dependence on fossil fuels. India proposed this initiative in November 2015. So far, 200 countries have signed the framework agreement. This initiative is a testimony of India's efforts in the direction of the developing nations towards their concern about climate change and to switch to a low-carbon growth path, through the adoption of solar and other renewables.

National Institute of Solar Energy (NISE) and National Institute of Wind Energy (NIWE)

The National Institute of Solar Energy (NISE) and the National Institute of Wind Energy (NIWE) are autonomous bodies instituted under the MNRE to technically support it in developing newer technologies, developing standards, and catering to changing needs in the industry. The NISE and NIWE are respectively involved in solar and wind in the following areas:

- Resource assessment;
- Research and development;
- Design, development and demonstration of technologies for various applications;
- Testing, certification, and standardization;
- Monitoring and evaluation;
- Economics and policy planning;
- Human resource development;
- Active collaborations with prominent national and international organizations.

LEGISLATIVE AND REGULATORY FRAMEWORK

The Electricity Act, 2003

The 2003 Electricity Act was one of the earliest legislative interventions that acknowledged the usage of renewable energy resources and technologies for producing electricity. It is instrumental in the development and promotion of grid-interactive renewable power, because, among other things, it provides for regulatory interventions through:

- Determination of tariff;
- Specifying renewable purchase obligation (RPO);
- Facilitating grid connectivity;
- Promotion of market development.

The implementation of captive renewable power plants (i.e. independent generation of power for personal use) was also admitted under the Act. The Act paved a path for the independent regulatory regime and led to the promulgation of Open Access Regulations (2004) and Tariff Based Competitive Bidding Process for Procurement of Power (2006).

The 2003 Electricity Act resulted in some specific policy instruments, which include preferential tariffs, renewable purchase obligations (RPOs) and tradable renewable energy certificates (RECs).

National Electricity Policy, 2005

The 2005 National Electricity Policy reinforced the commercialization and industrialization of renewable energy. It aimed to promote competition to reduce the cost of energy generated through renewables. It also encouraged adequate promotional measures for the development of technologies and the sustained growth of these sources.

National Tariff Policy, 2006

The 2006 National Tariff Policy laid down guidelines for the state electricity regulatory commissions (SERCs) to fix renewable purchase obligations (RPOs) based on the regional availability of renewable energy resources while considering their impact on retail tariffs. The policy permitted SERCs to determine preferential tariffs for renewable power purchase by the distribution companies, with an intention of initial support to expedite the journey of renewable energy to achieve grid parity. For ensuring the financial viability of the renewable project, the Central Electricity Regulatory Commission (CERC) has set up yearly feed-in tariffs, which also incentivized the grid connectivity.

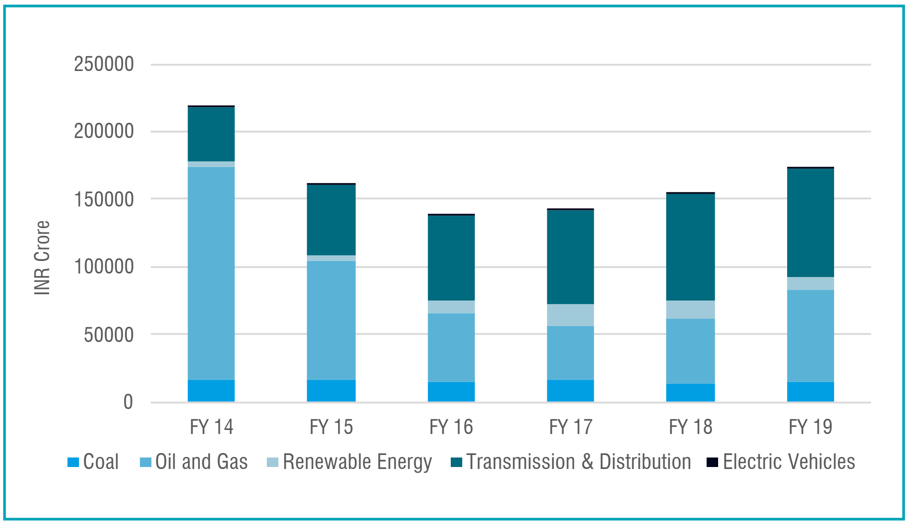
Guidelines for Power Exchange in 2007

The 2007 Guidelines for Power Exchange became one of the most important steps in the democratization of the Indian power sector. This marked the beginning of market-determined electricity price discovery at competitive rates. The power exchange facilitated the proliferation of market-based short-term contracts, which has consistently increased in the last decade, though long-term contracts remain the mainstay for the fulfilment of bulk power requirement by distribution licensees. Power exchanges provide a platform to both open-access generators and consumers, but some impediments in terms of the imposition of additional surcharges and high transmission charges are still hampering the development.

Subsidies

The support to renewable energies through subsidies is not a new phenomenon. India has developed efficient subsidy models, especially for promoting the distributed renewable energy, such as solar rooftop, solar pumps and solar lanterns, etc. From April 2014 to March 2020, India has offered subsidies worth INR 558.35 billion ($8.56 billion) to its renewable energy sector (see Figure 2). However, this is less than 6% of the total subsidies given to the energy sector.

Figure 2: Energy subsidies in India



Source: Mapping India's Energy Subsidies, 2020, the International Institute for Sustainable Development (IISD) and the Council on Energy, Environment and Water (CEEW).

Feed-in tariff (FiT)

The feed-in tariff (FiT) has been one of the best performing policy or regulatory instruments that have significantly improved renewable deployment in India. Along with upfront capital subsidies like 100% depreciation benefits, FiT has helped wind sector development in the country. The scheme was discontinued, as the renewable energy sector has steadily attained commercial parity with the conventional power and migrated to a tariff-based bidding system controlled mostly by the Solar Energy Corporation of India (SECI).

RPOs and RECs

The renewable purchase obligation (RPO) ensures off-take of renewable power generated at preferential tariffs determined by the state electricity regulatory commissions (SERCs). This strengthens the market for renewable power. The National Tariff Policy, 2006 was amended in January 2011 to prescribe that solar-specific RPO be increased from a minimum of 0.25% in 2012 to 3% by 2022.

The renewable energy certificate (REC) framework facilitates a developer to sell the electricity generated and the associated environmental attributes of the clean energy separately. These RECs are purchased by entities from any part of India that are obligated under the RPO regime to meet their RPO targets. The MNRE undertakes an exercise to track and analyse the issues in fulfilment of RPOs and the REC framework in India. This would help various stakeholders to understand the challenges and opportunities in the development of renewables.

“Must run” status

All renewable energy power plants, except biomass power plants with an installed capacity of 10 MW and above and non-fossil fuel-based cogeneration plants, are given a “must run” status as per the Central Electricity Regulatory Commission (CERC) (Terms and Conditions for Tariff Determination from Renewable Energy Sources) Regulations 2017.

Waiver of interstate transmission costs

The scheme for Inter-state Transmission System (ISTS) allows independent power producers (IPPs) to develop the project and generate power at one location and sell to any preferred party; i.e. IPPs are distribution licensees across the country. For generation projects based on solar and wind resources, no interstate transmission charges and losses are levied on transmission of the electricity through ISTS for sale of power by projects commissioned until 31 March 2022 for 25 years from the date of commissioning. This eliminates a major risk of power off-take while keeping open the option of choosing the best site anywhere in the country.

Green Energy Corridor Project

To synchronize electricity produced from renewable sources, with conventional power stations in the grid, the Green Energy Corridor Project was sanctioned by the MNRE in 2015–16. Eight renewable-rich states of Tamil Nadu, Rajasthan, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Himachal Pradesh and Madhya Pradesh are implementing the Intra-State Transmission System (InSTS) project, through respective state transmission utilities. The project comprises approximately 9,400km of transmission lines and 19,000MVA[4] substations capacity. The project is purposed to evacuate 20 GW of large-scale renewable power along with improvement of the grid in the implementing states. The total project cost is INR 10,141 crores. The funding mechanism consists of a 40% Government of India grant (total INR 4056.67 crores), 20% state equity and 40% loan from KfW Development Bank, Germany (€500 million).

4.– Megavolt amperes (MVA) power is used to measure apparent power.

Impacts of policies on the market for solar technology

Jawaharlal Nehru National Solar Mission (JNNSM), named after the first Prime Minister of India, was inaugurated in January 2010 to establish India as a global leader in solar energy by creating the policy conditions for its deployment across the country. In the last 10 years, the National Solar Mission has gone through various experiments and policy refinements that have progressively helped the solar market grow. The target has been revised twice and now boasts a target of 100 GW of solar PV by 2022 – five times more than the initial target. The Programme on Off-grid and Decentralized Solar Applications under the JNNSM attempted to provide solar-powered lights, study lamps, pumps, solar photovoltaic (SPV) power plants and even mini-grids to increase energy access. The mission has been impactful in creating a solar energy revolution in India.

Utility-scale solar sector

Grid-connected localized large-scale solar plants have played a big role in the Indian solar success story. The initial development from 2010 was based on a high feed-in tariff that attracted investors in a new sector. Subsequently, the scheme of bundling (costly solar power at that time was bundled with cheaper coal power and sold to distribution companies) was introduced to reduce the cost of power.

In the next stage, the SECI started to administer auctions – act as the off-taker, sign PPAs with developers and sell the power to state distribution companies (discoms). This mechanism protected developers from direct involvement with the financially stressed discoms. This, along with provision for viability gap funding (VGF) and reverse bidding, helped to reduce the benchmark tariffs. The competitive bidding regime has instilled competition, and market response led to a continuous decrease in the tariffs. The policy of opening and maintaining the adequate letter of credit as a payment security mechanism under power purchase agreement by distribution licensee has enthused trust among developers.

In 2014, the concept of the solar park was introduced, which provides land, basic infrastructure and evacuation network to developers. This minimizes project risks and allows very large-scale solar plants or solar parks at one location.

In 2015, the solar programme target was increased from 20 GW to 100 GW. It entailed scaling up the auction capacities. Meanwhile, the narrowing bids in the auction results indicated the development of a competitive market. Also, the continuous decrease in the solar photovoltaic module prices has helped to reduce capital costs to a level that developers started to bid on negative viability gap funding (VGF) by mid-2017. The tariffs have continuously seen a downward trajectory.

In 2020, SECI came up with some innovative tenders – peak power supply and round-the-clock supply. The tenders tweak the conditions of a project to safeguard the supply during peak power with the support of storage technology, and ensure the round-the-clock supply of power through bundling of renewables with coal or other power sources.

In December 2020, India realized the lowest solar tariff of INR 1.99/kWh, which is an outstanding figure. The utility-scale solar sector is staying strong despite some risks. It is also attracting significant foreign investment.

Solar rooftop

Solar rooftop in India has not yet become viable for large-scale generation. The development of solar rooftop comes largely under states' purview. States have declared different policies and incentives – caps on system sizes, types of metering and subsidy. For instance, Delhi's solar policy provides a generation-based incentive (GBI) of INR 2/kWh of the total solar energy generated. The more recent (2019) state policies of Rajasthan and Tamil Nadu have relaxed the system size limits so that 100% of the sanctioned load can be installed. However, the effectiveness of these policies is not yet clear.

Some states are making it compulsory to install rooftop solar. Chandigarh has made it mandatory to install solar energy in residential housing measuring more than 500 square yards; Haryana has introduced a similar policy. States are introducing net metering so that customers can sell surplus energy back to the distribution companies. At the last count, some 36 states and union territories had introduced this and paid INR 2.5 upwards for the surplus power. The commercial and industrial sector seems to be in a favourable position to gain from solar rooftop.

(CC BY-NC-ND 2.0) PRI's The World, Putting up new solar panels Idodi Health Center.

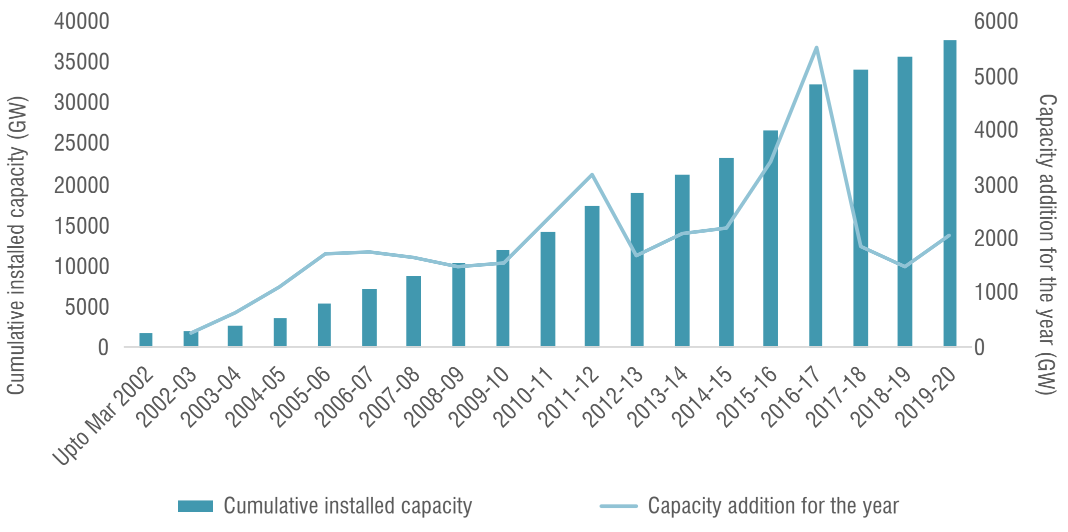
Solar pumps

India is currently running one of the biggest solar agricultural pump programmes in the world. The Government of India is implementing the Pradhan Mantri Kisan Urja Suraksha evam Utthan Mahabhiyan (PM-KUSUM) scheme, which is meant to empower farmers and to ensure that they have access to reliable and affordable power for their farm activities. It also encourages farmers to earn extra income by the saving and selling of extra electricity generated. The programme aims to install 35 GW of solar through standalone solar pumps, grid-connected solar pumps and the installation of small solar plants (0.5 MW–2 MW). Solarization of stand-alone and grid-connected agriculture pumps receive central financial assistance (CFA) of 30% of the benchmark cost (or tender cost, whichever is lower); special category states receive 50% CFA. Adding state financial assistance to that takes the total subsidy offering to up to 90%. Hence, the farmer pays 10%–40% of the total cost. The distribution companies receive an incentive of INR 0.40 per kWh for five years. The scheme also helps farmers and the country to minimize the use of diesel generator pump sets and associated carbon emissions. Currently, India has approximately 10 million diesel pump sets.

Impacts of policies on the market for wind technology

The wind power sector development has experienced a roller coaster ride (see Figure 3). The sector got traction in the last century. With the inception of the government's Department of Non-Conventional Energy Sources (DNES) in 1982, wind energy promotion took form and has subsequently received the maximum impetus among all renewable energy technologies. The reasons include a short gestation period and better commercial viability of projects. Gujarat and Tamil Nadu were pioneers in installing experimental wind turbines; the best wind sites, classified as Class 1, which have high wind speed and density, were available in these states. For the initial two decades from the early 1980s until approximately 2000, the progress was slow, but steady.

Figure 3: Indian wind capacity by year



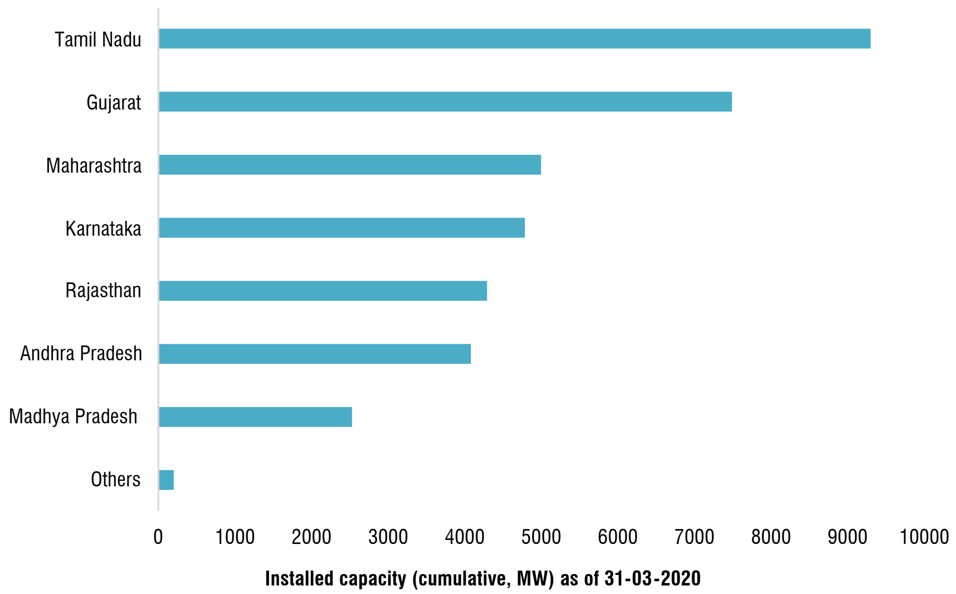
Source: MNRE.

The government incentivized individual investors through a variety of inducements, which include income tax holiday, accelerated depreciation, concessional excise and customs duty, and provision of borrowing at low-interest rates, etc. State governments also help investors by signing a power purchase agreement for 20 years, allowing the sale of energy to third parties and captive use of energy. Some state governments also provide subsidy for the initial investment in wind energy and sales tax benefits. The state governments of Tamil Nadu, Gujarat, Maharashtra, Karnataka, Andhra Pradesh, Madhya Pradesh, Rajasthan, Haryana and West Bengal provide a feed-in tariff for purchasing wind energy. A feed-in tariff provides the minimum price at which wind energy-based power must be sold to electricity distribution companies. This tariff is higher in comparison to the other conventional energy sources. Apart from the above-mentioned incentives, the state government also mandates distribution companies to buy a minimal per cent of power from renewable energy sources. This policy is called the renewable purchase obligation (RPO).

Of these, one of the incentives that have determined the course of the wind power sector is accelerated depreciation (AD). The AD scheme, introduced in 1992, was particularly attractive for investors who had large taxable incomes: they benefitted from the scheme's tax benefits. Wind projects no longer needed to rely on traditional funding sources such as banks, but could access a large number of private investors. Hence, the AD benefits stimulated the growth of wind energy in Tamil Nadu.

The wind energy sector development in India has followed a pattern, with individual states dominating for a few years before the focus shifts to another state. Different states promoted wind energy in their capacity by having state-level policies and incentives. In the first phase, before 2004–05, Tamil Nadu was responsible for the majority of the capacity addition: in March 2005, its share of the country's total wind energy capacity was approximately 56%. Subsequently, Maharashtra, Gujarat and Karnataka began making sizable investments in wind energy. Rajasthan was the next state to show rapid growth, beginning in 2009–10, followed by Andhra Pradesh, whose installations increased sharply post-2012–13. In 2014–16, Madhya Pradesh was the clear leader. Installed wind capacity in various states can be seen in Figure 4.

Figure 4: Wind capacity by state



Source: MNRE.

The recent decreasing trend in wind installations can be attributed to the government's technology-agnostic approach while implementing a competitive bidding procedure. Distribution companies have a preference for solar, as it is cheaper. Wind power has been constantly compared with solar, which has adversely impacted the former's development. The policy of repowering of the old wind turbines with newer technology and larger-capacity wind turbines has, so far, not given the intended result.

India is currently assessing offshore wind resources and planning to kick-start this sector soon. By acknowledging the benefits of hybrid solar and wind power plants in terms of increased plant load factor and, hence, better usage of the grid assets, the country is also shifting the focus on developing more hybrid plants. Lowering the price of storage technologies also aids in these types of ventures.

Use of renewable energy in micro- and mini-grids

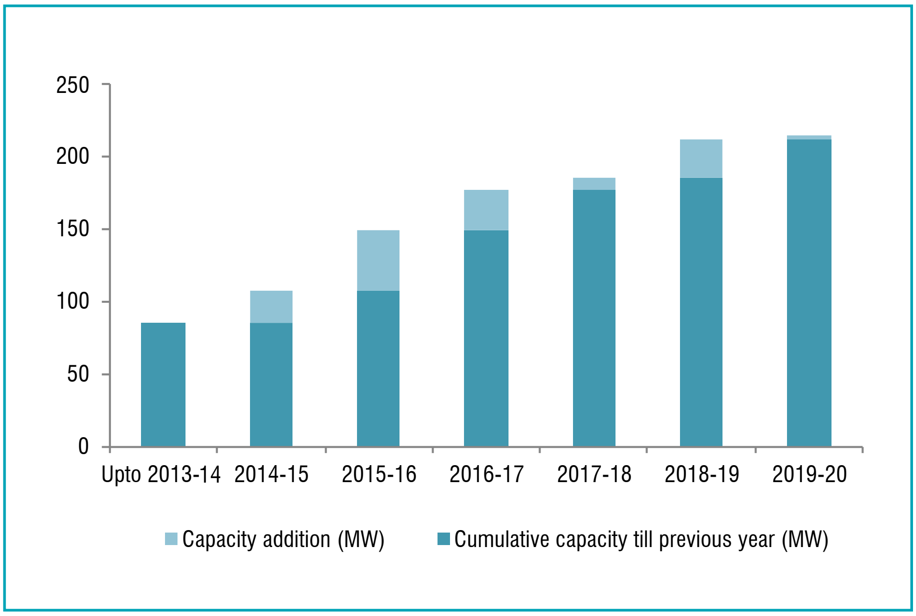
Grid connectivity in India has reached almost every household; however, accessibility to reliable power is still a challenge. The mini-grid/micro-grid offers a solution to this problem – but the absence of a related policy at the national level has kept the mini-grid business in India a costly affair. Only two states (Uttar Pradesh and Bihar) have state-level policies.

India has more than 400 functional mini-grids located mostly in three states (Uttar Pradesh, Bihar and Jharkhand). Households, local shops and microenterprises are benefitting from the availability of clean and dependable electricity. Falling prices of solar and rising prices of diesel have further enhanced the case for the mini-grid against other backups.

As per the MNRE, a 214 MW capacity equivalent of off-grid power plants – which include micro-grids and mini-grids (see Figure 5) – and 10 million-plus off-grid solar-based systems (including solar lamps and pumps, etc.) were deployed in India by March 2020.

A central government policy or regulation that clearly defines the role of distribution companies and works on a model of mutually beneficial coexistence of both grid and mini-grids will reduce the risks for mini-grid operators and would be a win-win-win situation for the government, operators and consumers.

Figure 5: Off-grid installed capacity



Source: MNRE.

Corporate power procurement of renewable energy in India

Renewable power procurement from a third party (open access)[5] or through a captive plant[6] for operations is a cost-effective solution for businesses in managing their electricity expenditures, improving visibility over future costs, and contributing to renewable energy and/or carbon reduction. One option for companies to purchase renewable electricity is through a corporate renewable power purchase agreement (PPA), which is a contract between the corporate buyer(s) and the power producer (developer, independent power producer or investor) to purchase renewable electricity at a pre-agreed price for a definite period. Such contracts comprise commercial terms for the sale of the electricity, which include the contract period, point of delivery, delivery schedule, volume, price and product. These corporate renewable PPAs are becoming an increasingly important instrument for fast-tracking renewable energy deployment.

(CC BY-NC-SA 2.0) James Anderson @flickr, Solar salesman in Gulu, Uganda With a small solar lamp charger in the foreground.

In 2017, members of the World Business Council for Sustainable Development (WBCSD) formed the India Corporate Renewable PPA Forum to increase the adoption of corporate renewable PPAs in India. This entailed the exchange of practical knowledge on the effective implementation of corporate renewable PPAs for both utility-scale and rooftop installations.[7]

Rising electricity tariffs for commercial and industrial consumers, falling prices for solar photovoltaic technology and corporate sustainability goals are driving this sector. A 2019 BloombergNEF (BNEF) report indicates that, with an addition of 1.4 GW of PPA capacity, India is the second-largest growth market for corporate renewable PPAs after the United States.

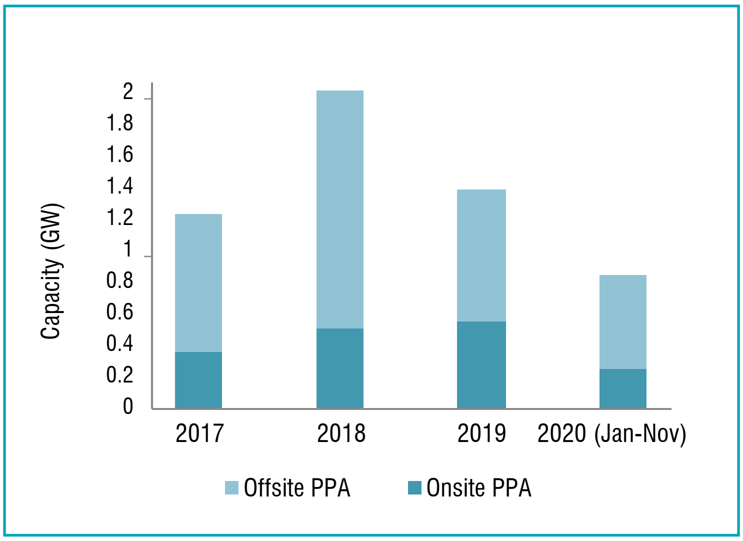
However, state-level regulatory changes in 2020 have hindered growth and the first 11 months have seen only 800 MW of PPA capacity additions in India. For instance, the state of Karnataka has experienced a strong influence of state-level regulatory changes on total PPA capacity additions in India. The state accounted for nearly 81% of PPA capacity additions in 2018, as it offered a 10-year waiver on most open access charges. In 2019, after the state government withdrew these exemptions, the market in India contracted and the impact was exacerbated in 2020 due to COVID-19 (see Figure 6).

5.– Third-party open access is the freedom given to consumers with a connected load greater than 1 MW to choose their own supplier of power. In other words, they are not restricted to buying power from the utility and can instead buy power from any third-party power supplier.

6.– A captive power plant is an electricity generation facility managed and used by a commercial or industrial energy user for their own energy consumption.

7.– World Business Council for Sustainable Development (WBCSD) (January 2021). Corporate Renewable PPAs in India: Market & Policy Update. Available from https://www.wbcsd.org/contentwbc/download/11241/165820/1.

Figure 6: Capacity additions from corporate PPAs



Note: Data includes all captive, group captive and third-party sale solar and wind PPA projects.
Source: JMK Research & Analytics.

The capacity trends are a function of several evolving market dynamics. In Haryana, the regulatory changes are in the form of the reversal of distribution company approvals for open access projects and the imposition of additional surcharges on group captive models. These changes limit the uptake of corporate renewable PPAs. In Rajasthan, the government waived the cross-subsidy surcharge (CSS) for all solar plants commissioned from April 2014 to March 2019. However, the non-extension of the exemptions beyond 31 March 2019 hampers the corporate PPA market. Under its Captive and Renewable Energy Generating Plants Regulations 2019, the state of Uttar Pradesh has provision for a 50% exemption on wheeling and transmission charges for captive and third-party sale renewable projects. It also has provisions for a complete waiver on transmission for interstate sales and a full exemption of state CSS for interstate sales of power for captive and third party use.

India has been termed the sixth most challenging market for corporate sourcing of renewables by RE100[8] companies in December 2019. A fragmented policy and regulatory framework that differs from state to state, along with uncertain charges and taxes on the procurement of renewable power, have been attributed as the main barriers. Therefore, continued evolution and robust implementation of proactive policies and the regulatory environment at both the national and state levels will determine a longer-term uptake of corporate renewable PPAs in India.

Going forward, there are reasons for a positive outlook for 2021. The government is implementing various reforms and undertaking a large number of measures in the electricity sector that will facilitate the uptake of corporate renewable PPAs if successfully executed. These include the new draft Electricity Amendment Bill and the privatization of India's electricity distribution companies. The Corporate Renewable PPAs in India – market and policy update (January 2021) (World Business Council for Sustainable Development report)[9] highlights several evolving market dynamics observed in 2020 that are expected to favourably impact the market in 2021:[10]

8.– RE100 is a global initiative committed to 100% renewable electricity. For more information, see https://www.there100.org/.

9.– Corporate PPAs in India. Available from https://www.wbcsd.org/Programs/Climate-and-Energy/Energy/REscale/Resources/Corporate-Renewable-PPAs-in-India-January-2021.

10.– Positive outlook for corporate renewable PPAs accelerating India's energy transition. Available from https://www.wbcsd.org/Programs/Climate-and-Energy/Energy/REscale/News/Positive-outlook-for-corporate-renewable-PPAs-in-India.

- Commissioning of the first wind–solar hybrid corporate PPA, supported by waivers on open access charges for hybrid projects in some states. This will serve as a model for others to follow.
- Solar rooftop PPAs, which accounted for almost one-third of cumulative on-site solar installations in India.
- Launch of Green Term Ahead Market in the final quarter of 2020, as an alternative platform for companies to procure renewable power.

Despite limited capacity additions in 2020, corporates' interest in renewable PPAs remains high. Power demand in India has rebounded to pre-COVID levels. The PPA negotiations that were paused in 2020 due to COVID-19 are also expected to resume in 2021. The demand for corporate renewable PPAs will see incremental share due to increasing sustainability ambitions and actions by leading corporate buyers operating in India that have voluntarily pledged to meet 100% of their electricity demand with renewables under the RE100 initiative. These include Dalmia Cement, Infosys, Club Mahindra Holidays, Tata Motors, Accenture, Adobe, IKEA, Panasonic, Sony and Starbucks.

TECHNOLOGY UPGRADATION FUND SCHEME (TUFS) FOR THE TEXTILE SECTOR

India's textile sector is the second-largest provider of employment after agriculture, providing direct employment to more than 45 million people and indirect employment to 60 million people in allied industries. The sector contributes 14% to industrial production and, indirectly, 5% to gross domestic product (GDP). The share of India's textiles and apparel exports in mercantile exports is 11% for 2019–20.[11] To financially support the sector and leverage investments in technology upgradation with a special emphasis on balanced development across the value chain, the Government of India and the Ministry of Textiles launched the flagship Technology Upgradation Fund Scheme (TUFS).

1 April 1999 to 31 March 2007	*1 April 2007 to 28 June 2010*	*1 April 2011 to 31 March 2013*	*1 April 2013 to 31 March 2017*	*13 January 2016 to 31 March 2022*
TUFS	*Modified TUFS*	*Restructured TUFS*	*Revised and restructured TUFS*	*Amended TUFS*

The scheme has been modified and restructured a few times since its inception in April 1999. It provides the domestic textile industry with capital for modernization of existing units and to set up new units with state-of-the-art technology to enhance the industry's viability and comprehensiveness in the domestic and international markets.

TUFS is administered through 3 nodal agencies, 36 nodal banks and 108 co-opted postal life insurance (PLI) policies. Since inception, the scheme has propelled investment of more than INR 2.44 trillion as of March 2013. Overall, in 1999–2015, the scheme provided $3 billion in subsidies. It propelled investments worth approximately $37 billion, created job opportunities for nearly 5 million people and supported investments for a sustainable

11.– Employment News. New Textile Policy to Boost Employment. Available from employmentnews.gov.in/newemp/MoreContentNew.aspx?n=Editorial&k=70.

future.[12] The states of Gujarat, Tamil Nadu, Punjab, Maharashtra and Rajasthan are the major beneficiaries.[13] There is also the Amended Technology Upgradation Fund Scheme (ATUFS), a credit-linked capital investment subsidy (CIS) scheme in 2016–2022 with an outlay of INR 178.2 billion, to catalyse capital investments for technology upgradation and modernization of the textile industry. The scheme promotes ease of doing business in India and aims to achieve the vision of generating employment and promoting exports.[14]

To make green energy a part of the textile industry, the state of Tamil Nadu, with one of the highest spinning capacities, formulated a model in the late 1990s. The state government identified five clusters to develop wind farms and encouraged manufacturers or investors to invest capital for the installation of windmills. The government then distributed the generated power and credited units generated from each windmill into the investor's account and deducted according to usage. A banking facility was also provided to the generators. In the process, the investor paid the government wheeling charges for the transmission and distribution of power. The investor could claim 100% depreciation in the first year post-investment as an incentive given by the government for the investment in green energy. Soft loans were also provided to encourage investment.[15] This led to a proliferation of wind energy through captive power plants and wind farms, resulting in a significant fall in power costs and, hence, production costs. The below case study discusses the story in detail.

Box 1: Green energy in the textile industry: The case of Tamil Nadu, India[16]

B. Lakshminarayana, Executive Committee Member, Southern India Mills Association Cotton Development and Research Association (SIMA CD&RA), India

Green energy has been a key area of discussion in several countries for the past three decades. Predominantly, it was the governments that invested in establishing the infrastructure for green energy and in distributing the power. However, with lofty investment outlays and fluctuating budgetary priorities, the development of green energy was put on the back burner in many countries. The state of Tamil Nadu in India formulated a model in the late 1990s, which saw the active participation of manufacturers in the investments to finance the move towards green energy and thus partially shifted the investment burden from the government to the industry.

Tamil Nadu currently contributes more than 35% of spinning capacity in India. In the 1990s, the state's contribution was more than 40%. Power is a major cost for the industry, representing typically 10%–13% of sales for a spinning mill. As India opened up its economy in 1991, the high power costs were a veritable threat to the long-term survival of the industry in the face of foreign competition. Moreover, power was almost entirely procured from conventional sources, while renewable energy sources like wind promised a significant reduction in costs. Wind energy and the allied technology, though nascent, was beginning to be seen as a viable alternative, and Tamil Nadu had some of the country's most promising wind sites. Thus, in 1996, the Southern India Mills Association (SIMA) took the initiative and discussed the opportunity of generating wind power with the Tamil Nadu State Government. The state government put together an attractive investment model for the industries that were committed to set up wind mills, route the energy produced through established networks and consume it in their factories. The following are the salient features of the 1990s' investment model that exists to this day:

12.– The scheme ended in 2015 and was refurbished as the Amended Technology Upgradation Fund Scheme (ATUFS) from 2016.

13.– Lok Sabha Secretariat Reference Note: No. 19/RN/Ref./2014: Technology Upgradation Fund Scheme (TUFS) for Textile Sector (TUFS.pdf).

14.– Press Information Bureau (2020). *Encouragement to Research and Innovation in Textile Sector*.
Available from https://pib.gov.in/PressReleseDetail.aspx?PRID=1606086#:~:text=The%20Government%20is%20implementing%20Amended,modernization%20of%20the%20textile%20industry.

15.– *Technology Upgradation in East Africa's Textiles and Apparel Sector.*
Available from https://bsm-india-itme.s3.ap-south-1.amazonaws.com/Technology_Upgradation_v3_web-ITC.pdf.

16.– This thought piece was first published in the Supporting Indian Trade and Investment for Africa (SITA) technical report, Facing the Future (2020). Available from https://bsm-india-itme.s3.ap-south-1.amazonaws.com/Technology_Upgradation_v3_web-ITC.pdf.

- Green energy zones were identified by the government for producing wind energy and wind farms were created in five clusters.
- The investor could buy land in these zones and use it to install wind mills as part of their own capital investment.
- The government then generated power from these wind farms and distributed it.
- The units generated from each wind mill was credited into the investor's account and deducted according to usage.
- The investor paid the government "wheeling charges" for the transmission and distribution of power.
- The investors could claim 100% depreciation in the first year post-investment as an incentive given by the Government of India for the investment in green energy.
- Soft loans were also provided to encourage investment by the firms.

Merits of the above policy for the government:

- Investment for the capital equipment is zero, thereby reducing fiscal pressures on the government budget.
- Investors tend to stay invested longer, as their cost of power normally flattens as they recoup the investment expenditure after the initial 5–7 years post-investment.
- This model could also be exploited to attract potential investors from industries beyond textiles that have power-intensive production functions, like foundries and steel mills, etc.
- Looping in more investors translates to more job creation without active investment by the government.
- From an environmental standpoint, 1 MW of green energy reduces annual $CO2$ emissions by approximately 2,000 tons, thereby reducing greenhouse emissions, while achieving better energy security.

Wind energy can be profitably and efficiently tapped only during 5–6 months in a typical year in Tamil Nadu. The power generated during these active months could be banked for future use by the factories, based on unit credits. The above model worked very well for the investor in Tamil Nadu due to this "banking of power", which ensured a steady, year-round supply of energy. From 2018, the power banking facilities were terminated in favour of facilities to forecast power needs and consume the power generated immediately, in order to improve grid functioning. Power costs, which are usually 8.5–9 cents per unit, can be brought down to 3 cents per unit if it is generated via wind energy, entailing enormous cost savings for power-intensive industries. Moreover, the central government policy that allowed investors to claim 100% depreciation on the back of their capital expenditure for installing windmills ran for the initial five years after the roll-out of the model and was a significant factor towards its success.

Evacuation infrastructure and the availability of sites with the ideal wind speed are other physical factors that contributed to the model's success. The wind speed needs to be optimal to efficiently produce electricity, but also preserve the blade quality for a long period of time. Similarly, without an effective evacuation infrastructure, much of the power generated in the wind-rich months cannot be used during the rest of the year. Private investors from all over the country have invested approximately $6 billion to reach an installed capacity 10,000 MW of wind energy as of 2019 in Tamil Nadu, a huge increase from the 200 MW generated in 1996. The reduced power costs have motivated investors to expand their business and, perhaps more importantly, allowed smaller firms to remain financially viable. A system of "group captive usage" enables smaller firms to buy a stake in the wind power generation facilities of a larger firm and use the energy. This ensures that firm size is not a prohibitive factor in setting up wind power facilities for industrial usage.

As this model has shown, a key recipe for success is concerted investments made by both the public and private sectors. The state government in Tamil Nadu provided the evacuation infrastructure for routing the power generated, which otherwise would have been a challenge for private investors to undertake efficiently. Similarly, the central government schemes of allowing 100% depreciation claims on the investment cost and the availability of soft loans acted as a catalyst for the expansion of the model, allowing mills of all sizes to invest in generating wind power. On the other hand, private investment was channelled towards buying land and erecting the windmills as part of their capital expenditure, which averted fiscal pressures on the public budget.

Going forward, to optimize land usage with newer, more efficient windmills that take up a larger acreage, SIMA has proposed the installation of solar panels on the ground, thus creating hybrid green energy zones. Rooftop solar power generation is already growing in popularity across the state and, in coming years, it will represent an even higher percentage of industrial power supply.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CHAPTER 2. POWER MARKETS IN EAST AFRICA: SUMMARY CHARACTERISTICS

Introduction

In most of the East African countries studied, the government has committed a 100% move to renewable energy by 2050. At the same time, in 2018, apart from Kenya, all other East African countries studied had more than half of their population lacking access to electricity (see Table 1). As the price of renewable sources like solar and wind power continue to fall, these become viable tools for East African countries to achieve universal electrification, while remaining aligned to their commitment to clean energy. Currently, solar and wind power represent a miniscule portion of the energy mix in most of the countries studied (see Table 1). The renewable energy available per capita in India is 2.8–7.4 times more than the African countries in the discussion.

The African countries studied can replicate and improve upon relevant lessons from India on large-scale deployment of renewables, making power accessible and making more renewables available to its population.

Table 1: Power market characteristics of selected countries

	India[17]	Kenya[18]	Ethiopia[19]	Uganda[20]	United Republic of Tanzania[21]	Rwanda[22]
Population (2019) (million)[23]	1 366	52.57	112.07	44.26	58	12.62
Population CAGR (2015–19)[24]	1.3%	2.8%	1.5%	2.9%	3%	2.6%
GDP per capita (2019) (USD)[25]	2 099	1 816	855.8	794	1 122	820
GDP per capita CAGR (2015–19)[26]	6.6%	7.7%	7.2%	2.6%	4%	3.2%
Population with access to electricity (2018)[27]	95.2%	75%	45%	42.6%	35.5%	34.7%
Capacity (2019)						
Installed capacity (MW)	424 051	2 929	4 554	1 212	1 761	255
Share of non-renewables	70%	26%	2%	11%	61%	46%
Share of renewables	30%	74%	98%	89%	39%	54%
Share of hydro	11%	29%	84%	75%	33%	39%
Share of solar	8%	3%	0%	7%	1%	15%
Share of wind	9%	11%	7%	0%	0%	0%
Generation (2018)						
Total generation (GWh)	1 501 175	13 860	13 261	4 175	7 085	855
Share of non-renewables	84%	38%	0%	5%	71%	55%
Share of renewables	16%	62%	100%	95%	29%	44%
Share of hydro	9%	24%	96%	87%	26%	39%
Share of solar	2%	1%	0%	2%	1%	6%
Share of wind	4%	0%	4%	0%	0%	0%
Energy access (2017)	92.6%	63.8%	44.3%	22%	32.8%	34.1%
Renewable energy per capita (W) (2017)	78.6	33.0	41.0	20.5	12.4	10.6
Renewable energy target (2050)	40%	100%		2 240 MW (2030)	100%	100%
Potential of solar energy	750 GW					
Potential of wind energy	700 GW					

Source: As per related footnotes.

17.– International Renewable Energy Agency (IRENA). Energy Profile: India. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Asia/India_Asia_RE_SP.pdf.

18.– IRENA. Energy Profile: Kenya. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Kenya_Africa_RE_SP.pdf.

19.– IRENA. Energy Profile: Ethiopia. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Ethiopia_Africa_RE_SP.pdf.

20.– IRENA. Energy Profile: Uganda. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Uganda_Africa_RE_SP.pdf.

21.– IRENA. Energy Profile: United Republic of Tanzania. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/United%20Republic%20of%20Tanzania_Africa_RE_SP.pdf.

22.– IRENA. Energy Profile: Rwanda. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Rwanda_Africa_RE_SP.pdf.

23.– World Bank. Population, total – Ethiopia, Kenya, India, Uganda, Tanzania. Available from https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ET-KE-IN-UG-TZ.

24.– Focus Economics. Economic Data by Region and Country. Available from https://www.focus-economics.com/countries.

25.– World Bank. GDP per capita (current US$) – Ethiopia, Kenya, India, Uganda, Tanzania. Available from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ET-KE-IN-UG-TZ.

26.– Focus Economics. Economic Data by Region and Country. Available from https://www.focus-economics.com/countries.

27.– World Bank Data. Available from https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=UG-RW-KE-IN-TZ-ET.

Kenya

In 2015–19, the Republic of Kenya's population grew at a compound annual growth rate (CAGR) of 2.8% and the GDP per capita increased at a CAGR of 7.7%, making it a fast-growing economy. To sustain the growth and ensure electricity access to its residents, the country has to constantly upgrade and strengthen its power sector. The reforms of the 1990s and early 2000s in the Kenyan electricity supply industry paved the way for a stable market that can attract foreign capital.

INSTITUTIONAL, POLICY AND REGULATORY APPROACH

Kenya has developed a stable institutional framework. The Ministry of Energy and Petroleum is responsible for issuing energy policies and creating an enabling environment for the efficient operation of the power sector, with goals for long-term growth. On the generation front, Kenya Electricity Generating Company (KenGen), with 70% government holding, is managing approximately one-fourth of the country's total generation and owns more than 60% of the installed assets. The government-owned Kenya Electricity Transmission Company Limited (KETRACO) manages the entire country's transmission. Kenya Power Company (KPC) plays an important role in onwards transmission, distribution and supply to the customer. The Energy Regulatory Commission is entrusted with the duty of tariff regulation, coordinating and monitoring enforcements, and the Energy and Petroleum Tribunal for dispute resolutions increases transparency. The efforts are attracting private players. As of July 2019, independent power producers (IPPs) account for 991 MW of on-grid capacity, of the total installed on-grid capacity of 2,545 MW.[28] Meanwhile, the Rural Electrification Programme is undertaken by Rural Electrification Authority instituted in 2007.

However, there are still many gaps that need to be addressed. The country increasingly relies on the import of electricity for its growing needs. The share of imports increased from 22% in 2012 to 32% in 2017. In 2018, 25% of the population lacked access to electricity.

RENEWABLE ENERGY TRENDS

The use of renewables can effectively support Kenya's growth. The country has some policies that support renewables, which include the second revision of feed-in tariffs for renewable energy (2012), tax incentives for renewable energy (2015), and the National Energy Policy (2018). Renewables account for the country's 74% of installed capacity, dominated by hydro (29%) and geothermal (28%). Solar and wind account for only 3% and 11% respectively, and biofuels account for the rest. In 2014–19, solar installed capacity increased by 3.8 times to 95 MW and wind capacity went up by 55.4 times to 336 MW. Despite this, the two technologies are yet to make inroads into the electricity sector given that their share in the total generation is negligible (1%) as of 2018.

Further, only 7% of the total renewables are consumed in electricity generation. This indicates that the country has vast opportunity for electrification, especially in the heat,

28.– Business Wire. Kenya Power Report 2019-2020: 15-Year (2010-2024) Trends on Installed Capacity, Broken Down by Fuel, Technology, Provinces, and More – ResearchAndMarkets.com (2019). Available from https://www.businesswire.com/news/home/20190930005730/en/Kenya-Power-Report-2019-2020-15-Year-2010-2024-Trends.

transport and industry sectors. Although there are specialized government agencies such as the Kenya Nuclear Electricity Board (KNEB) and the Geothermal Development Company (GDC) for the development of the nuclear and geothermal sector, Kenya lacks such a company/organization for promotion and development of renewables, especially solar and wind.

FUTURE PLANS AND PRIORITIES

Kenya has a target of 100% electricity generation through renewables by 2050. The Government of Kenya is already working towards increasing power generation capacity along with transmission and distribution capacities. To meet its population's growing electricity needs, Kenya has stepped up its efforts to enhance regional trades by inter-connecting regional networks. The use of new technologies (e.g. geothermal) in power generation is becoming mainstream. Kenya is also promoting renewable energy and the government is keen to ensure access to clean, reliable and affordable energy.

Kenya Association of Manufacturers, together with the Ministry of Energy, has taken several steps to go beyond renewable energy and institutionalize resource efficiency in the industrial sector. The following box describes some of these initiatives in detail.

Box 2: Centre for Energy Efficiency and Conservation (CEEC), Kenya

Kenya Association of Manufacturers (KAM) in partnership with the Ministry of Energy established the Centre for Energy Efficiency and Conservation (CEEC) in 2006. The Centre runs energy efficiency and conservation programs designed to help companies identify energy wastage, determine saving potential and act on recommendations.

The Centre provides professional technical services for developing, designing, and implementing energy efficiency projects to suit the needs of commercial, institutional, and industrial consumers. The principal objective is to reduce cost and enhance competitiveness and profitability while promoting a cleaner environment.

1. Energy Cost Savings

Since its inception, CEEC has conducted over 1,500 energy audits. The audits have contributed to 10-30% energy cost savings. The energy audits have encouraged the adoption of modern technologies, which has increased local and foreign investment in energy efficiency and renewable energy. Some examples of good practices are presented below:

- Motors – rightsizing, replacement with higher efficiency motors, installation of variable speed drives, etc.
- Lighting – replacement with more efficacious lamp technologies such as LED, skylights, de-lamping, etc.
- Power Factor Capacitors (PFC) for power factor correction, maximum demand control and related measures.
- Fuel switching – solar PV (standalone or grid-tied), solar water heating to replace electric heating, biomass/biogas to replace fuel oil, etc.
- Refrigeration and cooling –refrigeration/cooling compressors, installation of air curtains, operation optimization, maintenance, insulation of cold bare pipes, chillers/cooling modifications.
- Compressed air – leakage repair and pressure reductions, rightsizing, distribution systems optimization, etc.
- Energy management – energy management systems, efficient operation of equipment and processes such as switching off, tariff change, automation of operations, driving good practices, behavioural changes, better policies, accountability, etc.
- Boilers and kilns – boiler and kiln efficiency improvement, steam, hot water and drying systems related energy conservation measures, insulation of bare hot pipes and surfaces, refractories, waste heat recovery, etc.

An energy audit impact study carried out in 2020 revealed that for every KES 600,000 spent in energy audits, facilities gain KES 6.3 million worth of energy savings annually and 411.5 tonnes of carbon dioxide equivalent per year of GHG (greenhouse gas) offset. It also revealed that out of 101 facilities, 26.4 GWh of power, 3.7 million litres of heavy fuel oil, 0.4 million litres of industrial diesel oil, 15.8 million kg coal and 3.5 million kg of biomass was saved annually.

CEEC work has also contributed to the Kenya NDCs (Nationally Determined Contributions); the Energy Efficiency (EE) audits anticipated an annual CO2 emission reduction of 143,560 tonnes.

2. Water efficiency

KAM, in partnership with the Resource Conservation and Management (RCM) Group of the Federation of Indian Chambers of Commerce & Industry (FICCI) conducted

Resource Audits for 'Water & Wastewater Management' in Kenya, representing industries and government institutions like the Water Service Board, hospitals and institutional buildings. In addition to the water & wastewater audits, three-day training courses were held for industry representatives drawn from the audited companies and local energy auditors, with the aim of building their auditing capacities.

Additionally, hands-on training to 15 consultants was provided during the site audits to build local capacity and overcome expertise barriers that result from a lack of qualified resource auditors. The trainees were mainly local energy consultants. It is because of these trainings and hands-on exposure that, water audits are now successfully carried out by local resource auditors. Significant savings were achieved across different sectors:

- 15% water savings were achieved in the largest dairy in Kenya with a discounted pay-back period of under 1.5 years.
- 10% water savings were achieved in the paper and pulp sector which amounts to a saving of
- water and wastewater management costs by 14%.
- Water and sewerage companies increased treated water production by 10% and achieved a reduction in their energy consumption of 13%.
- 20% water savings were achieved in one of the largest hospitals in Kenya with a discounted pay-back period of under 2.5 years.
- 25% water savings were achieved in a five-star beach resort in Kenya with a discounted pay-back period of under 3 years.
- 20% water savings were achieved in one of the foundries with a discounted payback period of under 2 years, which amounts to a saving of water, wastewater, and associated energy management costs of 30 %.

3. Skill upgrading through specialized trainings and knowledge sharing forums

CEEC offers specialized technical trainings to industries. This enables staff to implement measures that help save on operation costs. About 1,650 industry professionals have been trained in different areas including solar T 3, boilers and steam systems, pneumatic conveying and compressed air systems, Certified Energy Manager (CEM), Carbon Footprint Analyst (CFA), Certified Measurement and Verification Professional (CMVP), as well as financial training. Exchange visits are also undertaken in facilities utilizing modern energy efficient and renewable energy technologies to promote peer learning.

Through the Clean Energy Conference & Expo and the Energy Management Awards (EMA), companies are given an opportunity to learn from experts and showcase their innovations in energy and water efficiency. As of 2019, 363 companies have participated in EMA with recorded savings of about KES 13 billion.

4. Promoting capacity of industries to invest in green technology through feasibility studies

Quick facts:

- 16 feasibility studies fully supported on alternative energy sources like solar, hydro, biogas, biomass, etc.
- 72 million USD disbursed towards resource efficiency
- 19 renewable energy and 21 energy efficiency projects undertaken
- 28.7 MW of capacity installed
- 3.8 GWh saved, in other words, 5.1 MW freed
- Project portfolio of over 500 million USD

KAM, through the Centre of Green Growth and Climate Change is supporting industries towards green and sustainable manufacturing, through the following:

- Carbon Footprint Assessment helps organizations understand and reduce carbon footprint and sets them on a carbon-neutral path. Local and international markets have increasingly become more environmentally conscious, and these assessments reflect the trend.
- Process Optimization Audits are in-depth analyses of industry processes to identify areas of inefficiencies and wastage and to recommend areas for optimization with a keen focus on industrial engineering concepts, process equipment optimization, operating procedures, process control optimization, end-to-end material optimization and energy utilization units.
- Circular Economy Resource Mapping helps industries reduce waste and negative impact on the environment while strengthening re-generative processes and creating industrial symbiosis loops in production processes. Recommendations with justification and appropriate means of introducing circular economy within the specific facility are provided with this service.
- Equipment Audits helps facilities assess the operation of specific equipment and guides machinery replacement. This functions for equipment such as motors, boilers, HVAC systems, pneumatic conveying system and air compressors, solar water heaters, etc.
- Environmental Compliance Training aims to fill the capacity gap in both technology and regulatory requirements that govern environmental compliance in the country.

5. Support to the textiles and apparels sector

- Energy and Resource Efficiency Audits have drawn the attention of the manufacturers to available opportunities in and savings through resource efficient practices.
- Financing support has been extended to companies to do machine retrofitting and invest in new, efficient machinery.
- Support has been provided in process redesign to reduce waste and achieve better resource efficiency.

Source: Kenya Association of Manufacturers

Ethiopia

The Federal Democratic Republic of Ethiopia is another fast-growing nation that has experienced population growing at a CAGR of approximately 1.5% and GDP per capita growth at a CAGR of 7.2% in 2015–19. With more than half of its population not having access to electricity, electricity demand will increase by approximately 30% per year.

INSTITUTIONAL, POLICY AND REGULATORY APPROACH

Ethiopia's electricity sector has been driven by the National Energy Policy 1994 for almost two decades. The policy aims to address the issues of energy supply and its usage, but failed to address rural electrification. It supported the development of hydrological energy resources for the power sector, energy efficiency, and transition to modern energy services. In 2013, the second draft of the National Energy Policy underscored the need to diversify the energy mix with other renewables. It targeted the availability, accessibility, affordability, safety and reliability of energy services. The Ministry of Water, Irrigation and Energy is responsible for planning and implementing the policies.

The country has pushed renewables through its Scaling-Up Renewable Energy Program for Ethiopia (2012), Climate Resilience and Green Economy Strategy (2012) and Growth and Transformation Plan II (GTP II) 2016–2020. Ethiopia has experienced great progress in electrification and GDP growth in the past two decades.

Through the Ethiopia Solar Auctions (2017) programme, the government encourages partnership with the private sector via IPP agreements for power generation. Ethiopian Electric Power (EEP), a state-owned electrical producer, has developed procurement processes to select contractors and awards projects using a competitive bidding process. In the process, Ethiopia receives grants from the United States Trade and Development Agency (USTDA) for the development of a procurement manual for EEP that incorporates full life cycle cost analysis. The United States Agency for International Development (USAID) has assisted the EEP to develop IPP tender documents and the legal and regulatory frameworks.

In 2018, Ethiopia enacted a proclamation to regulate public–private partnership (PPP) arrangements, which recognized the private sector's role in supporting economic growth and improving the quality of public services. It aimed to attract investment, particularly in infrastructure. Following this proclamation, the PPP Directorate under the Ministry of Finance identified 14 power projects to be pursued by the government, which includes a cumulative capacity of 3,000 MW against five major hydro and eight solar IPPs at a cost of $5.3 billion.

RENEWABLE ENERGY TRENDS

Ethiopia is endowed with renewable energy resources (hydro, geothermal, wind and solar). The combined potential is more than 60 GW, with significant potential for solar and wind. More than 99% of the solar and wind potential is yet to be exploited. Hydro dominates the total installed capacity (84%), followed by wind (7%), bioenergy (6%) and non-renewable (2%). Wind accounts for 324 MW, while solar has a minuscule presence, with an 11 MW capacity. In 2019, the generation from hydro accounted for 96%, and 4% of electricity was generated from wind. However, the hydro projects are prone to climate change and droughts, which affects energy security. Therefore, the country is now diversifying into solar and wind. Some 350 MW of large-scale solar projects are either ready to generate or under development.

FUTURE PLANS AND PRIORITIES

In 2017, Ethiopia launched the National Electrification Program, which aims for universal access to electricity by 2025, with 35% of the population to be supplied power through off-grid solutions. The country also aspires to address the electricity needs from renewables.

Uganda

The Republic of Uganda has a population of approximately 40 million and has grown at an annual rate of 2.9% in 2016–20. The annual growth of GDP per capita for 2018 and 2019 has been 3.5% and 5.1% respectively. Uganda is one of the power surplus countries in Africa and there have been very few incidences of load shedding since 2013.[29] However, in 2018, only 42% of the population had access to electricity.

INSTITUTIONAL, POLICY AND REGULATORY APPROACH

The Ministry of Energy and Mineral Development of Uganda is a key ministry that implements policies. The energy sector has been driven by the Electricity Act, 1999, which provides the regulatory framework for the electricity subsector. The Energy Policy for Uganda 2002 kick-started important reforms, significant achievements and technological advancements. The revised Energy Policy, 2019 aims to consolidate these achievements, and align the policy framework with recent international, national and regional developments and commitments. It also addresses the energy sector's new and emerging socioeconomic challenges that the government will face in the coming decade.

The Renewable Energy Policy 2007 aims to increase the share of renewable energy in the national energy mix. The Renewable Energy Feed-in Tariff 2011, implemented for 20 years, supports renewable energy deployment and feed-in rates are annually adjusted.[30]. The Global Energy Transfer Feed-in Tariff (GET FIT) Programme Uganda 2013 was initiated to fast-track a privately promoted portfolio of small-scale renewable energy generation projects with a cumulative installed capacity of approximately 125 MW. This, along with clean generation capacity addition, will strengthen regional grids and reduce CO2 emissions by 11 million tons.[31] The Uganda National Climate Change Policy (2015) is also backing up the energy policy implementation through the promotion and development of new clean energy technologies for the reduction of greenhouse gas (GHG) emissions.

RENEWABLE ENERGY TRENDS

The average solar radiation is 5.1kWh/m^2/day and it is the renewable energy resource on the market with the highest adoption rate in Uganda. As Uganda is located near the equator, the solar energy generation potential is high throughout the year, with a maximum monthly variation of 20% (from 4.5–5.5W/m^2). The drier area of the north-east receives high insolation, while it is quite low in the mountains in the east and south-west.[32] The country does not have enough exploitable wind resources.

29.– RMI (2020). *Achievements and Challenges of Uganda's Power Sector.*
Available from https://rmi.org/achievements-and-challenges-of-ugandas-power-sector/.

30.– EA/IRENA Renewables Policies Database (2014). Renewable Energy feed-in tariff.
Available from https://www.iea.org/policies/5069-renewable-energy-feed-in-tariff.

31.– EA/IRENA Renewables Policies Database (2016). Global Energy Transfer Feed-in Tariff (GET FIT) Programme Uganda.
Available from https://www.iea.org/policies/5636-global-energy-transfer-feed-in-tariff-get-fit-programme-uganda.

32.– Uganda National Renewable Energy & Energy Efficiency Alliance (UNREEEA). *Overview of the Ugandan Energy Sector.*
Available from https://unreeea.org/resource-center/overview-of-the-ugandan-energy-sector/.

In 2019, Uganda had total capacity of 1,212 MW, of which hydro accounted for three-fourths, followed by non-renewables (11%), solar (7%) and biomass (7%). The generation from solar energy however, in 2018, was only 2%.[33]

High upfront costs and limited access to affordable credit and financing for renewable energy projects often restrict the growth of renewable technologies. Limited enforcement of quality standards and inadequate legal, regulatory and institutional frameworks are also some roadblocks that hamper renewable adoption.

FUTURE PLANS AND PRIORITIES

The Uganda Vision 2040 states that "Ugandans aspire to have access to clean, affordable and reliable energy sources to facilitate industrialisation". This commitment was further confirmed in the National Development Plan II (NDP II) (2015/16 to 2019/20), as it prioritized energy as a critical Ugandan aspiration for Vision 2040 and also for the attainment of upper-middle-income status.[34]

The government should facilitate the promotion of technology transfer and local financing, support small and microenterprises and develop comprehensive legal, regulatory and institutional frameworks for effective and sustainable renewable energy development and usage.

United Republic of Tanzania

The United Republic of Tanzania has a population of more than 56 million, growing at a rate of 3% per year, while the GDP per capita is growing at a rate of approximately 4% a year. As of 2019, only 38% of its population has access to electricity. The country has an installed capacity of 1,761 MW, of which non-renewables account for more than 60%. Hydro accounts for another one-third. Solar and wind are almost negligible in the energy mix. The country meets 71% of its electricity needs (electricity generation) through non-renewables, which include fossil fuel-based sources.

INSTITUTIONAL, POLICY AND REGULATORY APPROACH

The Tanzanian electricity sector was dominated by the Tanzania Electric Supply Company (TANESCO) since its inception in 1964. The Electricity Act of 2009 allowed for independent power producers (IPPs) to participate in electricity supply through public–private partnership to promote efficiency, quality and reliability of the power supplied. The bidding process is expected to facilitate competition and drive down prices. The electricity rules (feed-in tariff) of 2010 helped to regulate the tariffs.

33.– IRENA. Energy Profile: Uganda. Available from https://www.irena.org/IRENADocuments/Statistical_Profiles/Africa/Uganda_Africa_RE_SP.pdf.

34.– Ministry of Energy and Mineral Development (2019). Draft National Energy Policy. Available from http://energyandminerals.go.ug/site/assets/files/1081/draft_revised_energy_policy_-_11_10_2019-1_1.pdf.

In 2014, The Electricity Supply Industry Reform Strategy and Roadmap (ESI-RSR) was introduced to drive the sector for the upcoming 11 years up to 2025. It was estimated that more than $1 billion would be required to reform the electricity supply industry – to get rid of TANESCO's debt, encourage IPP participation, and facilitate horizontal and vertical unbundling. However, so far, the electricity supply industry has been unable to realize intended reforms. Lack of finances, technological support and skill has largely kept the power sector lacking the required investment.

RENEWABLE ENERGY TRENDS

In 2018, hydropower accounted for 26% of the total electricity generation, while solar accounted for just 1%. The United Republic of Tanzania had been hesitant to invest in relatively new technologies to serve as the country's basic power infrastructure. The Scaling-up Renewable Energy Programme for Tanzania (SREP Tanzania) was announced in 2013, but limited progress has been made.

FUTURE PLANS AND PRIORITIES

Despite the institutional, infrastructural and financial roadblocks, the United Republic of Tanzania aims to produce 100% of its electricity from renewables by 2050. The country's renewable energy potential allows for an increased share of clean energy in its power mix without having to compromise its energy security needs. The country plans to include renewable energy as a factor in its National Development Vision 2025.

Rwanda

The Republic of Rwanda experienced a negative GDP per capita growth in 2015. After that, the country slowly started to grow at a compound annual growth rate (CAGR) of 3.2%, and the population increased at a CAGR of 2.6%. As of 2018, approximately two-thirds of the population lacked access to electricity. The country has an installed capacity of 255 MW, of which 46% is non-renewable energy capacity. Hydro and solar account for 39% and 15% respectively.

INSTITUTIONAL, POLICY AND REGULATORY APPROACH

The main laws and regulations connected to the sector are the Electricity Act (2011), the law establishing and determining the mandate of the Rwanda Utilities Regulatory Authority (2001) and revised (2013). The Ministry of Infrastructure (MININFRA) is the lead ministry responsible for developing energy policies and strategies, and for monitoring and evaluating projects and programme implementation.

The Ministry of Finance and Economic Planning enables resource mobilization to support energy investments and related financing requirements. Rwanda Energy Group Ltd (REG Ltd) has been accorded a legal mandate to implement energy sector policies and programmes, and translate them into tangible projects and efficiently operate and maintain the country's power transmission system. The Rwanda Development Board (RDB) acts as a gateway and facilitator that mobilizes investment and promotes the energy sector. It assists private investors, including local financial institutions, to participate in the energy sector. It leads to the facilitation of foreign direct investment (FDI) into strategic energy generation projects, as well as other programmes and activities involving cleaner, more energy efficient technologies. The RDB also monitors quality and progress, and issues environmental impact assessments for energy projects. It is expected to also host a centralized authority or advisory agency for public–private partnerships across government.

The Rwanda Utilities Regulatory Authority (RURA) is mandated to regulate public utilities involved in renewable and non-renewable energy to protect consumers from uncompetitive practices while ensuring that such utilities operate in an efficient, sustainable and reliable manner. RURA also has the important role of updating the electric grid code, ensuring the quality of service standards for power, assessing and reviewing energy tariff structures, and licensing all power generation, transmission and distribution companies, as well as retail petroleum filling stations and related storage facilities.

The Rwanda Standards Board (RSB), under the Ministry of Trade and Industry, develops national technical regulations, including national technology and performance standards. The RSB plays an increasingly important role in establishing, publishing and disseminating national standards for energy technologies such as biogas digesters and solar appliances.[35]

RENEWABLE ENERGY TRENDS

In 2014–19, solar capacity increased by 275%. On the generation side, hydro and solar account for 39% and 6% respectively of the total 855 GWh. Rwanda faces the issue of inadequacy of data about the potential of indigenous renewable energy sources, as well as insufficient incentives, including financing mechanisms, to invest in modern, efficient technologies and practices and to introduce fuel/technology substitution.

FUTURE PLANS AND PRIORITIES

The government has a target to generate 100% of power through renewables by 2050. In this direction, the Energy Policy 2015 aims to increase the share of renewable energy in the power mix by exploiting indigenous resources, including solar, by enhancing attractiveness. This is done by initiating public-funded exploration and risk mitigation mechanisms, funding energy resource mapping, pre-feasibility studies, and piloting of projects. The country also encourages and incentivizes major energy users, particularly industries, to be energy efficient and shift from thermal to off-grid PV.

35.– Ministry of Infrastructure (2015). Rwanda Energy Policy.
Available from https://ngoma.gov.rw/fileadmin/_migrated/content_uploads/rwanda_energy_policy_17th_march_2015__2_.pdf.

CHAPTER 3. RENEWABLE ENERGY AND THE TEXTILE SECTOR

The business case for renewable energy in textiles

The business case behind renewable energy in the textile sector is linked to two major drivers. On one hand, major fashion brands under pressure from consumers and investors are increasingly setting carbon reduction targets for their supply chain, which will require increased contribution from renewable energy to be delivered. On the other hand, renewable energy technologies, in particular, solar photovoltaics, have been demonstrated to provide cost-effective energy solutions for textile manufacturers.

FASHION BRAND SUPPLY CHAIN CARBON REDUCTION TARGETS

In 2018–21, nearly 100 international fashion brands set carbon reduction targets for their supply chain, principally under the UN Fashion Industry Charter for Climate Action[36] or the Science Based Targets initiative (SBTi).[37] As part of these public targets, one requirement is the reduction of the manufacturing carbon footprint associated with the production of the brands' products. As a result, increasing the share of renewable energy consumed by manufacturing operations remains an essential component of each brand's implementation strategy. A summary of relevant targets from major brands sourcing from East African operations is presented below.

- PVH Corp. – 30% supply chain emissions reduction.
- H&M – reduce Scope 3 greenhouse gas emissions from purchased raw materials, fabric production and garments by 59% per product, and achieve a climate-positive value chain by 2040.
- VF Corporation – an absolute reduction of Scope 3 greenhouse gas emissions by 30% by 2030.
- Gap, Inc. – reduce Scope 3 greenhouse gas emission from purchased goods and services by 30%, from a 2017 baseline, by 2030.
- Levi – reduce greenhouse gas emissions by 40% throughout its global supply chain by 2025.

36.– United Nations, Climate Change. Participants in the Fashion Industry Charter for Climate Action. Available from https://unfccc.int/climate-action/sectoral-engagement/global-climate-action-in-fashion/fashion-industry-charter-for-climate-action/participants-in-the-fashion-industry-charter-for-climate-action.

37.– Science Based Targets initiative: https://sciencebasedtargets.org/.

Brands are moving forward to promote renewable energy in their supply chains, particularly in Asian markets. Although the trend is in an early phase, the following approaches have been observed:

- On-site rooftop solar photovoltaics: A number of brands, including Adidas and Nike, have promoted solar PV with suppliers to reduce the manufacturing carbon footprint. Given the economic attractiveness of solar PV in Asian markets, at least to companies that can secure appropriate financing, few incentives have generally been offered and the programmes have been more focused on promoting the advantages of the technology. One example includes collaboration with government-funded programmes such as the Clean Energy Investment Accelerator, which has developed standardized models for assessing solar PV potential and procurement of solar PV systems for manufacturers in the Socialist Republic of Viet Nam.
- Renewable energy certificates (RECs): Where available, RECs can offer low-cost opportunities for securing renewable energy and reducing accounted carbon emissions. While this approach represents a small annual cost to suppliers, it avoids the need for complex or capital-intensive on-site installations. Some brands, such as Decathlon, have encouraged their suppliers to procure RECs as part of their carbon reduction strategy.
- Virtual power purchase agreements (VPPAs): VPPAs offer a method to secure renewable energy power and certificates via a long-term contract between an off-taker and a generator. The number of major textile sourcing countries where this has been possible is limited, with India being the most notable example. In Viet Nam, where VPPAs are currently unavailable, brands have actively been working with the Vietnamese Government and the United States Agency for International Development (USAID) to develop new regulations to make VPPA structures available to their suppliers.[38]

Applicability of renewable energy technologies in textile manufacturing

Based on an Indian market research, a number of opportunities exist, in particular for solar technologies, to be used in textile facilities. These include solar PV for electricity generation, solar thermal for process heat and water heating, and parabolic solar collectors for industrial cooking. Examples of these technology options are provided below.

SOLAR PV ROOFTOP

A renewable energy service company (RESCO) solar rooftop (SRT) project developer has assessed and developed a 4 MW solar rooftop power project for a reputed manufacturer and exporter of cotton yarn in Punjab, India. The annual mean solar radiation has been observed to be approximately 5.25kWh/m^2/day at the factory location. The SRT plant was designed based on the roof space available on the premises (three specific factory sheds).

38.– Fashionating World (2020). *Fashion brands urge for DPPA in Vietnam.*
Available from http://www.fashionatinGWorld.com/new1-2/fashion-brands-urge-for-dppa-in-vietnam.

The project is designed to be standalone, with no provision to supply or export excess generation to the grid. The power purchase agreement (PPA) between RESCO and the consumer has been executed on a deemed generation basis. The net energy generation from the project, after deducting the alternating current (AC) losses, has been observed to be approximately 6,100 MWh/year or 6.1 million units.

Project's financial details (as invested by the RESCO project developer)

Total cost of the project	INR 186.18 million
PPA tariff	INR 4.7/kWh – flat for 25 years
Debt–equity ratio	70:30
Bank interest	9%
Average debt–service coverage ratio (DSCR)	1.41
Minimum DSCR	1.25
Equity IRR	16.16%

The above PPA rate gives an approximate savings of INR 2/kWh, in comparison to the grid tariff (variable component – energy charges, as per prevailing tariff), amounting to approximately INR 12.2 million ($166,350).

Process heating with solar thermal technology

Installation	Frontier Knitters Private Limited
Location	Tirupur, India
Textile subsector	Garment – cut; sew; pack
Project objective	To reduce the fuel (high-speed diesel) consumed and reduce carbon emissions from their processes in a cost-effective manner.
Solution	A.T.E. Solar recommended a process heating solution using compound parabolic concentrator (CPC) technology. CPC technology is ideally suited for process applications that require heat in the range 80°C–120°C.
Project implemented by	A.T.E. Solar
Project description	An array of high-efficiency CPC modules has been mounted on the factory's rooftop in a closed loop, with an expansion tank, pump and thermal hot water storage. The storage is sized to meet the specific daily requirements of the operations at this factory. This system is integrated with the existing fuel-fired boiler that produces the steam necessary for the unit's ironing operations.
Results	The solar hot water heating solution based on CPC technology has reduced Frontier Knitters' dependence on conventional diesel-fired boilers.
Cost and financial benefits indicators	• Annual diesel savings – 6,600 litres • Carbon reduction – 17 tons per annum • Payback – less than three years

Concentrated parabolic solar cookers for industrial cooking

Installation	Tirumala Tirupati Devasthanam
Location	Tirupati, India
Key highlights	The Tirumala Tirupati Devasthanam at Tirumala in Andhra Pradesh installed the world's largest solar steam cooking system in September 2002 for 30,000 meals per day.
Technical information	The system was designed to generate more than 4,000 kg of steam per day at 180°C and 10 kg/cm^2, which is sufficient to cook two meals for approximately 15,000 persons. It is modular, consisting of 106 automatically tracked parabolic concentrators arranged in series and parallel combinations, each of 9.2m^2 reflector area. Each unit of concentrator is connected to a central steam pipeline going to the kitchen. The system is made of indigenous components and the reflectors of acrylic mirrors have a reflectivity of more than 75%. The system has been functioning satisfactorily since 1994 and is expected to save approximately 118 thousand litres of diesel per year.
Cost–benefit analysis	1. Initial investment – $166,00 2. Payback – approximately four years
Recommendation	The case study finding indicates that, through nature's gift of solar energy for large quantity cooking, a large amount of fossil fuel and a huge sum of money could be recovered within a period of five years. Thus, universities, colleges, hospitals, hostels, hotels, canteens and large industrial facilities must come forward to install the compound parabolic solar concentrator (CPSC) in order to save fossil fuels.

Solar power looms support programme

The Indian Ministry for Textiles has developed a programme to provide capital subsidies for the installation of an on-grid solar photovoltaic plant (without battery back-up) and off-grid solar photovoltaic plant (with battery back-up) for small power loom sites, designed to support manufacturers in areas where the grid is unreliable or unavailable.

Sites of up to eight looms can apply for subsidies of up to INR 5,60,000 for on-grid or INR 7,20,000 for off-grid locations to offset initial capital costs.

The main Indian states to take advantage of the subsidy have been Gujarat and Tamil Nadu. In Tamil Nadu, a net metering scheme was also set up to provide additional potential revenues via sale of excess power to the grid.[39]

Selected African countries – textile industry snapshot

In order to better understand opportunities for replicating the Indian textile sector technology experiences in the selected African countries, a short review of the industry situation was conducted and is presented below.

39.– *The Times of India* (2019). Solar power scheme now open for Tamil Nadu small powerloom units. Available from https://timesofindia.indiatimes.com/city/coimbatore/solar-power-scheme-now-open-for-tn-small-powerloom-units/articleshow/70165572.cms. Ministry of Textiles. Solar Energy scheme for Powerlooms. Available from https://ipowertexindia.gov.in/solar-energy-scheme-for-powerlooms.htm.

ETHIOPIA

In the last 5–6 years the textile and apparel industry has grown at an average of 51%. During this period, more than 65 international textile investment projects have been licensed for foreign investors.

The growth in the textile industry is directly linked to the Ethiopian government's industrial development strategy. This step to prioritize designing incentives and policies to attract investment in view of worldwide competition has played a big role in the development of their economy. The textile industry in Ethiopia appeals to foreign investors mainly due to the three major components of a successful investment: low workforce cost, availability of raw materials, and low energy costs.

KENYA

The textile industry is the second-biggest manufacturing activity in Kenya, providing employment to 200,000 families. Kenya produces 7,000 tons of cotton out of a potential of 200,000 tons. The exports of product segments related to apparel and clothing accessories (excluding knitted or crocheted products) are steadily growing to an average of 7% in 2018 and 8% in 2019.

The Kenyan government supports the textile industry by introduction of industrial-oriented policies and entities such as the Export Promotion Council, Manufacture Under Bond (MUB) and the Export Processing Zone Authority (EPZA).

Kenya has the advantage of duty-free access to the United States of America under the African Growth and Opportunity Act (AGOA) and to the European Union (EU) under the EU and East African Community (EAC) economic partnership agreements. Kenya has well-developed export channels and infrastructure and good historical performance for large apparel brands based in the United States. Relatively speaking, cotton, textile and apparel sector investors in Kenya benefit through the following areas:

- Preferential market access;
- Abundant labour availability;
- Better infrastructure;
- Stable political policies;
- Investor-friendly policies.

UGANDA

The cotton, textile and apparel (CTA) industry in Uganda is the third-largest export industry after coffee and tea. It is the main income source for approximately 250,000 households. At least 95% of lint is exported, mainly to neighbouring countries and Asia.

There are two operational textile firms (Southern Range Nyanza Limited, and Phenix Logistics), and local apparel and garment production is mainly dominated by small and medium-sized enterprises.

UNITED REPUBLIC OF TANZANIA

The local government's objective is to develop the cotton, textile and apparel industry, which targets annual exports of $150 million and 10,000 jobs by 2021. The current textile and apparel segments are comparatively small, though there is some evidence of growth in the knitted segments (both fabrics and apparel).

The sector faces constraints in terms of capacity, product differentiation and value chain integration. The sector has high energy costs relative to its competitors, comparatively low labour productivity rates and a lack of access to finance due to high borrowing costs. Imports of textiles for use in garment production for export markets are cheaper and of better quality than those produced domestically.

RWANDA

Rwanda has a relatively small textile and apparel value chain, with limited cotton production and one fully integrated factory that largely serves the domestic and regional markets for uniforms. As part of the government's strategy to build up its textile and apparel sector, Rwanda currently maintains a ban on the importation of second-hand clothing. The government has identified textiles and apparel as a priority sector and has provided incentives to the industry.

The time and cost of transport has historically been a challenge for operators in Rwanda, given its landlocked status. However, stakeholders noted that these challenges have been reduced markedly with government subsidization of transport costs in recent years.

Labour is not seen as a major challenge from a cost perspective. Nevertheless, most stakeholders noted a skills gap and the need for training as a critical variable. Lack of technical expertise locally to service machines and of local supply of spare parts present potential challenges to smaller operations.

Labour and power cost competitiveness

Table 2: Power cost comparison

Cost element	Unit	India	People's Republic of Bangladesh	Viet Nam	Myanmar	Ethiopia	Kenya	Rwanda	Uganda	United Republic of Tanzania
Labour cost	USD/ month	160–180	110–110	170–190	130–180	60–80	125–150	80–100	80–100	60–70
Power cost	USD/ kWh	0.10–0.12	0.09–0.12	0.08	0.09	0.02–0.03	0.09	0.096	0.156	0.102

Source: Reset Carbon data analysis.

CHAPTER 4. PRELIMINARY RECOMMENDATIONS

Mapping Indian renewable energy technologies to East African textiles sector in selected countries

Kenya

Solar and wind energy can play an important role in Kenya's clean energy transformation. Given that the country has a stable market, it can implement some of the lessons from the Indian electricity market and the growth of solar and wind.

Development of an incentive mechanism for scaling up capacity through government schemes like the Viability Gap Funding scheme will create a market for independent power producers. Establishment of a competitive market that features competitive bidding procedures is needed, along with strengthening of the regulatory framework to ensure that contracts can be enforced. Kenya Power and Lighting Company can be mandated to buy a set per cent of generation through solar and wind. This will improve the energy mix. Further, a process for strengthening of the grid infrastructure along the lines of the Indian Green Energy Corridor will make sure that the network constraints are avoided when the share of solar and wind increases.

The corporate sector can be well supported with some mini-grid projects with islanding. Proper regulations will enhance investor trust and help to provide the corporates with electricity at better prices. This will also create avenues to replace diesel generator sets. Such projects will have co-benefits and will improve the accessibility of power in the localities. Further, the Government of Kenya can support industries similar to how TUFS does, where the industries can be encouraged to develop captive power plants based on renewable energy technologies of solar and wind, to improve both the power profile and the cost. In both cases, PV could be expected to deliver cost savings compared with the current tariff. In mature markets such as India, rooftop solar PV delivers at a levelized cost of $0.06/kWh vs estimated tariffs of $0.09. Conservatively, power cost savings of 20% should be realizable on this basis.

Given the wind resources available in the country, the Government of Kenya can develop an institutional framework for assessment and customizing of the technology for the optimum usage of wind. A systemic development of the sector along with offshore explorations can help develop self-sufficiency and energy security in the country.

In terms of textiles, Kenya appears to be the only country in the group with significant fabric manufacturing that could support solar thermal technology for process heating or preheating. In addition, the larger scale of the textile sector and the export focus implies the presence of larger Tier 1 manufacturing sites. Additional research should be conducted on the presence of major brands such as PVH Corp. and H&M, which could potentially be brought in to support their strategic manufacturers to participate in mini-grids or captive plant projects. Brands could be engaged through the UN Fashion Industry Charter for Climate Action, which is hosted by the United Nations Framework Convention on Climate Change (UNFCCC) Secretariat.

(cc0) Image by Jose Antonio Alba from Pixabay.

Ethiopia

Enhancing power generation capacity and electrification of other sectors that are currently using biomass should be made a priority. Development of the grid will not just improve the electrification prospects overall, but also stability in the corporate sector. It will improve ease and affordability for the sector to enhance productivity. The recent development of procurement procedure can gain a lot from the creation of a centralized agency such as SECI that can oversee the whole process and avoid the need for private players to engage with multiple agencies, which is a complex process.

Given that solar is already making positive strides, Ethiopia can learn from India's experience to develop innovative tenders that incorporate the demand curve. This type of experiment will help Ethiopia in terms of energy supply, and will customize generation and make it more stable as per the requirement. Also, incentivizing wind development and solar–wind hybrid projects will help to grow the renewable energy sector.

Given that the agriculture sector accommodates approximately 85% of the labour force, electrification of agriculture and the rural areas can be implemented through the use of solar pumps. This will, to some extent, aid in spurring development and growth.

Currently, the Ethiopian tariff appears very low due to government subsidies. While a detailed exploration of the country's tariff policy was beyond the scope of this analysis, unsubsidized solar or wind will not be able to compete with a subsidized grid power. Therefore, tariff reforms or subsidy extensions are required to encourage independent power producers to develop projects for industrial users.

Uganda

Uganda lacks a regulatory framework for the export and sale of surplus captive power from self-generation by facilities attached to the national grid. Enabling this through proper mechanism and strengthening of the grid infrastructure will open opportunities for corporates to generate and sell power. It is important that the finances be directed for conducting technical studies that ensure that the national grid has adequate flexibility to absorb the generated power. Procurement through this route, while implementing net metering, will enhance permanency and stability for the industry sector.

The lessons from TUFS and the Tamil Nadu experience can help both the power sector and the industry sector to grow in tandem. In particular, Uganda appears to have the highest power costs of the countries included in this analysis, with rates in the region of $0.15/kWh. At these rates, in mature markets, rooftop solar PV can be expected to have a levelized cost saving of 40%–50%. The challenge, however, is in whether a sufficient number of large installations exist to build a significant captive market of industrial consumers that would justify investments in an on-site PV programme or a ring-fenced market structure.

Uganda can also learn from the Indian experience of standardization of systems and projects. Creation of an agency that checks system standards and ensures the quality of installations would support high-quality projects. Through policy intervention, the government could consider promoting optimal development of grid-connected solar photovoltaic with integrated resource planning. However, to ensure accessibility, additional support for distributed generation, mini-grids and energy efficiency must be integrated alongside solar photovoltaic considerations.

United Republic of Tanzania

High apparent costs of solar and wind technologies appear to be the biggest impediments. Intensification and strengthening of the bidding process will increase competition and bring down costs. The United Republic of Tanzania can learn from India's success in creating the space and market for IPPs and scaling up the installation, especially in the solar sector. Encouraging the public–private partnership model and providing a feed-in tariff mechanism for off-take of power will improve the sector's growth. Renewables also provide an alternative and incentive to shift away from thermal-based power plants.

Reforms in the transmission and distribution sector would create a stable framework that can attract investments. The United Republic of Tanzania can develop a transparent environment for the power sector that can attract foreign capital. The country's young infrastructure presents a unique opportunity to develop an efficiently managed grid, if the necessary investments are made available.

Given that more than 60% of the population is yet to be electrified, a larger share of power from renewable energy would be beneficial. Distributed renewable energy sources for the majority of the population in terms of development of mini-grids will improve accessibility of power for its people.

The corporate and industry sectors can be supported to take up captive power plants through credit-linked capital subsidy schemes similar to TUFS. This will help develop a renewable energy sector and improve the country's energy mix.

Rwanda

Rwanda has developed an institutional set-up for driving the solar and wind sector. In addition, it is now considering working towards developing agencies like the National Institute of Solar Energy (NISE), which can assess and analyse data on solar resources, is involved in research and development, and can devise customized solutions for the country and particular sections, including industry and rural areas. It is of utmost importance for the country to develop localized solutions to improve power accessibility. Monitoring and evaluation of initial projects is also recommended.

Rwanda is generating more than half of its electricity from coal. The country can create a bundling mechanism similar to Indian solar bundling with coal. This will be an incentive to mainstream solar. Further, creation of a market and transparent mechanism will help attract finances required to make advances in the power sector.

The government can develop the distributed renewable sector with the help of industry, which will be a win-win situation for both. This can be done on the lines of the Tamil Nadu green energy development scheme. A share of the soft loans availed to improve the energy access situation can be diverted to the industry sector.

Further observations

Renewable energy policy in East Africa can build on specific examples from the Indian experience, however, the below constraints need to be addressed through long-term, comprehensive planning:

- Opportunities for solar thermal for process heating are likely to be limited at this stage due to the apparent lack of large-scale textile wet processing in the selected markets.
- Parabolic solar cooking technology opportunities are likely to be limited to larger manufacturing facilities with significant-sized canteens. Lack of familiarity with parabolic technology, which is generally not common in the sector outside of India, could also be a barrier. This is a fertile ground for South-South knowledge transfer with India.
- On-site wind technology opportunities (which are not commonly seen in Indian textile facilities) are also likely to be limited due to limited wind resources, at least outside of Kenya, coupled with relative technological complexity compared with solar alternatives.
- Larger-scale solar rooftop opportunities, which can be expected to contribute a significant share of electricity consumption, especially in garment/cut/sew/packing facilities, require significant capital investment and/or reliable credit ratings for corporate borrowers or off-takers. This could limit opportunities in countries other

than Ethiopia and Kenya, where the sector appears less mature, and necessitates robust access to finance.

- The above issue is reinforced by the fact that brand pressure and incentives are likely to be directed towards larger, more strategic suppliers where brands tend to concentrate on outreach efforts and collection of environmental performance data. This implies a greater likelihood of focus on the Ethiopian and Kenyan markets and with a limited number of larger manufacturers. Complementary national policies need to ensure that the entire industry is capacitated to benefit from the move to green energy.
- Small-scale PV applications, for example, solar PV with power looms, could be best suited for countries seeking to support small and medium-sized enterprises, particularly if the grid is unreliable or expensive.

Table 3 provides a summary of the potential of each technology per country.

Table 3: Technology potential per country

<table>
<tr><th>Technology</th><th>Application</th><th>Business sector</th><th>Ethiopia</th><th>Kenya</th><th>United Republic of Tanzania</th><th>Uganda</th><th>Rwanda</th></tr>
<tr><td rowspan="5">Solar PV</td><td rowspan="5">Electricity generation</td><td>Spinning</td><td rowspan="5">Potential for Implementation for large-scale units located in industrial parks and clusters and micro/small industries</td><td>Potential for large-scale units</td><td></td><td></td><td></td></tr>
<tr><td>Weaving</td><td>Potential for large-scale units</td><td></td><td></td><td></td></tr>
<tr><td>Wet processing</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Integrated</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Garment – cut/sew pack</td><td>Attractive for small-scale units; Kenya has 70 thousand micro and small industries</td><td>Attractive for micro and small-scale units</td><td>Attractive for micro and small-scale units</td><td></td></tr>
<tr><td>Solar thermal</td><td>Hot water requirements for boiler feed water and dyeing process requirements</td><td>Wet processing</td><td>Large wet processing plants for steam requirements</td><td>Large wet processing plants for steam requirements</td><td>Large wet processing plants for steam requirements</td><td>No. of units and capacity is small</td><td>No. of units and capacity is small</td></tr>
<tr><td rowspan="2">Solar cooker</td><td rowspan="2">For cooking</td><td>Integrated facility</td><td rowspan="2">For large-scale facility in canteen</td><td rowspan="2">For large-scale facility in canteen for food preparation</td><td rowspan="2">For large-scale facility in canteen for food preparation</td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>Garment cut/sew pack</td></tr>
</table>

ANNEX

East African textile markets summary

Kenya is the largest import market, approximately double the size of the United Republic of Tanzania and Ethiopia. From an export perspective, all the markets remain small in global terms, with Kenya approximately double the size of the United Republic of Tanzania and four times the size of Ethiopia.

Table A.1: Trade in articles of apparel and clothing accessories, knitted and crochet

	Kenya		Uganda		United Republic of Tanzania		Ethiopia		Rwanda	
Year	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
	In thousand USD		In thousand USD		In thousand USD		In thousand USD		In thousand USD	
2011					9 567	14 448	9 567	51 457		
2012	125 497	14 236	574	12 185	11 015	18 594	11 015	89 693	0	4 895
2013	141 405	13 075	338	14 322	15 427	25 710	15 427	1 03 073	35	2 983
2014	126 388	13 788	589	13 369	21 203	28 924	21 203	1 07 080	212	3 995
2015	103 619	13 119	2 291	10 137	17 470	20 934	17 470	97 175	781	5 330
2016	96 237	21 366	2 365	12 794	15 219	23 651	15 219	93 691	989	12 041
2017	123 271	28 933	3 275	15 405	17 506	22 848	17 506	1 18 975	1 872	8 400
2018	120 903	47 878	2 751	20 513	19 837	27 717	19 837	63 757	3 042	11 867
2019	109 673	39 907	1 855	22 058					2 250	13 112

Source: ITC Trade Map.

Table A.2: Trade in articles of knitted and crochet fabrics

Year	Kenya		Uganda		United Republic of Tanzania		Ethiopia		Rwanda	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
	In thousand USD		In thousand USD		In thousand USD		In thousand USD		In thousand USD	
2011					132	11 116	353	1 642		
2012	1 657	66 981	1	337	101	13 846	1	1 434	0	284
2013	385	98 392	44	281	1 077	8 827	575	2 500	2	159
2014	791	106 714	5	157	2 540	7 654	1 933	2 533	14	132
2015	530	91 388	329	297	1 464	7 157	748	6 146	0	439
2016	907	66 647	206	246	4 239	7 759	126	6 692	0	575
2017	502	78 458	22	736	4 114	7 984	15	7 058	0	854
2018	440	85 347	58	1 015	4 853	10 207	190	59 788	45	1 782
2019	430	101 881	63	1 204					25	891

Source: ITC Trade Map.

Table A.3: Trade in Cotton

Year	Kenya		Uganda		United Republic of Tanzania		Ethiopia		Rwanda	
	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
	In thousand USD		In thousand USD		In thousand USD		In thousand USD		In thousand USD	
2011					69 813	4 114	20 061	11 371		
2012	3 046	62 103	76 934	5 262	1 71 259	4 621	22 301	2 910	76	969
2013	2 892	67 040	32 869	6 133	1 15 981	16 406	39 207	2 028	501	1 681
2014	1 994	74 177	22 631	6 225	65 283	8 995	19 886	6 962	865	2 161
2015	2 237	65 878	21 263	8 478	43 237	14 140	17 646	3 128	558	1 616
2016	2 078	66 553	34 023	10 109	63 640	40 164	11 492	3 997	91	2 597
2017	2 003	61 124	54 065	13 979	53 562	37 586	19 675	6 501	49	2 805
2018	1 356	80 934	47 906	12 457	85 683	47 120	8 346	48 630	43	4 268
2019	1 810	88 164	61 138	6 698		4 114			90	4 253

Source: ITC Trade Map.

Table A.4: Trade in articles of apparel and clothing accessories, not knitted or crocheted

	Kenya		Uganda		United Republic of Tanzania		Ethiopia		Rwanda	
Year	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports	Exports	Imports
	In thousand USD		In thousand USD		In thousand USD		In thousand USD		In thousand USD	
2012	117 407	28 788	1 819	24 389	944	20 309	18 220	125 228	2	5 226
2013	140 292	34 199	3 418	22 925	1 273	31 519	10 889	135 543	65	7 152
2014	201 496	30 694	750	23 200	2 366	33 097	11 357	168 191	271	11 617
2015	183 651	17 884	1 093	21 224	4 317	31 747	25 859	224 575	56	22 182
2016	206 149	34 907	1 786	22 197	32 365	29 978	20 481	239 305	502	15 045
2017	190 319	82 931	894	27 064	19 529	28 227	27 139	212 434	1 597	11 742
2018	218 262	94 083	1 500	35 777	13 476	27 278	27 843	229 766	1 803	12 668
2019	231 122	92 748	2 142	35 234	27 191	124 877	141 482	154 885	2 950	20 404

Source: ITC Trade Map.

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