

# ENHANCING THE RENEWABLE ENERGY TRANSITION IN ZAMBIA

---

## POSITION PAPERS

November 2018



## Contents

<b>Position Paper 1</b> Zambia Country Profile	4
<b>Position Paper 2</b> A feasible roadmap to integrate non-dispatchable renewable energy in the national electric system of Sub-Saharan region	12
<b>Position Paper 3</b> Best practices for successful auction program: Connecting public sector and investors in emerging RE markets	22
<b>Position Paper 4</b> Managing local content requirements in renewable energy projects	34
<b>Position Paper 5</b> Renewable energies, sustainability, and human development: a multifaced relation	44
<b>Position Paper 6</b> Addressing financial risks in RE investment in South and Central Africa	48
<b>Position Paper 7</b> Managing environmental & social risks to achieve bankability for renewable energy projects in Africa	60
<b>Position Paper 8</b> Decentralized renewable energy solutions to foster economic development	70
<b>Position Paper 9</b> RES and energy storage: new opportunities for emerging markets	94
<b>Position Paper 10</b> Innovation and Africa: an opportunity not to be missed	116
<b>Position Paper 11</b> Construction models for renewable plants in Africa: a flywheel for sustainable development	122
<b>Position Paper 12</b> Leading capacity development: a key driver for the streamlining of ODA funding for renewable in Africa	128

---

## Country profile Zambia

---

This paper has been prepared by:



---

Cristian P. Lanfranconi\*, Arera - Andrea Renzulli, Poyry - Daniele Paladini, RES4Africa

### Zambia at a glance

---

The Republic of Zambia is a landlocked country in Southern Africa region surrounded by 8 countries: Democratic Republic of Congo to the north; Tanzania to the north-east; Malawi to the east; Mozambique; Zimbabwe; Botswana; and Namibia to the south; and Angola to the west. With a population of almost 17 million people and with a territory of 752,614 km<sup>2</sup> (three times the size of the United Kingdom) Zambia represents the geographical center of the Southern Africa region.

Zambia has maintained peace and political stability from its independence in 1964. 2011 signed a peaceful political transition with the Movement for Multiparty Democracy (MMD)

defeated by the Patriotic Front at the legislative election. Today, Zambia is governed by President Edgar Lungu who won the election in 2016.

According to the World Bank, Zambia is a resource-rich, lower-middle-income country: Zambia's Human Development Index (HDI) value for 2015 is 0.579 - in the mid-range of HDI rankings - positioning the country at 139 out of 188 countries and territories. In 2017 Gross Domestic Product (GDP) was US\$25.8 billion, equal to a per capita income of around US\$1,509. The country has made significant socio-economic progress over the past two decades and achieved important average GDP growth of 7.4% between 2004 and 2014. However, since mid-2015, economic growth has slowed considerably to 2.9 percent. National economic performances are strongly related with the price of copper considering that copper mining is the most important activity

---

\*The opinions expressed in this document are those of the author. They do not necessarily represent views or official positions of ARERA and do not commit ARERA to any course of action in the future.

and accounts for around 85% of country's exports. In 2015 Zambia faced a critical economic crisis due to the concomitance of the lowering of the price of copper and a strong energy crisis caused by a shortfall of rain. Today the situation has stabilized and macro-economic outlooks for next years are positive and optimistic.

The rapid and sustained growth achieved from the early 2000s to 2014 has been insufficiently inclusive and despite the doubling of GDP Zambia continues to deal with high unemployment rates as well as low revenues of its population. As a result, poverty remains widespread and it's an urgent priority for the country's current development strategy.

**ZAMBIA AT A GLANCE**

Zambia	
Government type	Presidential Republic
Population	17 million; growth rate ~ 3%
Currency	Kwacha (ZMW)
Total GDP 2017*	25,81 billion USD
Per capita GDP 2017*	1.509 USD
Expected GDP growth 2018	4,10 %
Index of political stability	0,18 (on a scale +/- 2.5) (2016)
Index of corruption perception	Score 37/100; Ranking 96/180
Economic freedom	Ranking 132/185
OCSE country risk rating	6 (on an increasing scale 0-7)

Sources: CIA, IMF, World Bank, Transparency International, Heritage Foundation, OCSE,

Figur 1 Zambia at a glance

**Zambia's Energy Governance**

One of the main aspects the government of Zambia is trying to address to improve life-conditions of its population is increasing access to energy across the country. Access to power in Zambia, especially in rural areas, is dramatically low. The overall national electricity access rate, defined as connection rate to the grid, is around 31 %: 67 % in urban areas, and only close to 4%<sup>1</sup> in rural areas.

Increasing access to energy is a key priority of the national development strategy and the government has set electrification targets at 90 % for urban areas and 51 % for rural zones by 2030. However, at the current pace, these targets are not expected to be achieved.

The electricity supply industry in Zambia is dominated by the vertically integrated utility company ZESCO Limited (ZESCO). The utility is wholly state-owned through the Industrial Development Corporation (IDC), the holding company for the majority of state-owned enterprises in Zambia. ZESCO owns and oper-

<sup>1</sup> Project Work – Zambia, Lanfranconi, ARERA, 2018

ates over 90 % of the generation, transmission, and distribution assets in the country and supplies electricity to all grid-connected consumers, with the exception of some mining consumers in the Copperbelt Province, which are served by the Copperbelt Energy Corporation (CEC), a private company that purchases bulk power from ZESCO for onward supply to the mines.

The electricity sector is overseen by the Ministry of Energy (MoE), which provides policy guidance.

The independent Energy Regulation Board (ERB) created in 1995 under the Energy Regulation Act to balance the needs of the consumers with the need of the undertakings is responsible for licensing, tariff setting, and quality of supply and service standards for all segments of the energy sector (including fuel and electricity) in accordance with the provisions of the 1995 Energy Regulation Act as amended in 2003. ERB sets electricity tariffs for all consumers with the exception of the mining industry and other large consumers, which are set through long-term power purchase agreements (PPAs).

The Rural Electrification Authority (REA) is responsible for electrification in rural areas and manages the Rural Electrification Fund (REF), both established by the Rural Electrification Act No. 20 of 2003.

The rural electrification target is based on the electrification of Rural Growth Centers (RGCs) through grid extensions, mini-hydro, and solar installations as outlined in the Rural Electrification Master Plan (REMP) of 2008.

Since 2004, REA has been the government's Special Purpose Vehicle (SPV) for managing the required resources for the rural electrification programme. REA's primary aim is to provide electricity infrastructure to the rural areas using appropriate technologies in order to in-

crease access to electricity and achieve 2030 targets.

Zambia identifies grid extension as being the main strategy to expand access to rural areas as highlighted in the 2008 in the REMF. It consists of the following items:

- Rural Electrification Plan up to 2030;
- Financial Plan for Rural Electrification;
- Policy Recommendations for Acceleration and Dissemination of Rural Electrification;
- Development of Comprehensive Rural Electrification Program.

REA started to implement rural electrification projects in 2006. The Rural Electrification Master Plan (REMP) is the main strategic guideline of rural electrification projects. A total amount of US \$1.1 billion (equivalent to US \$50 million annually) is required for achieving REMF targets.

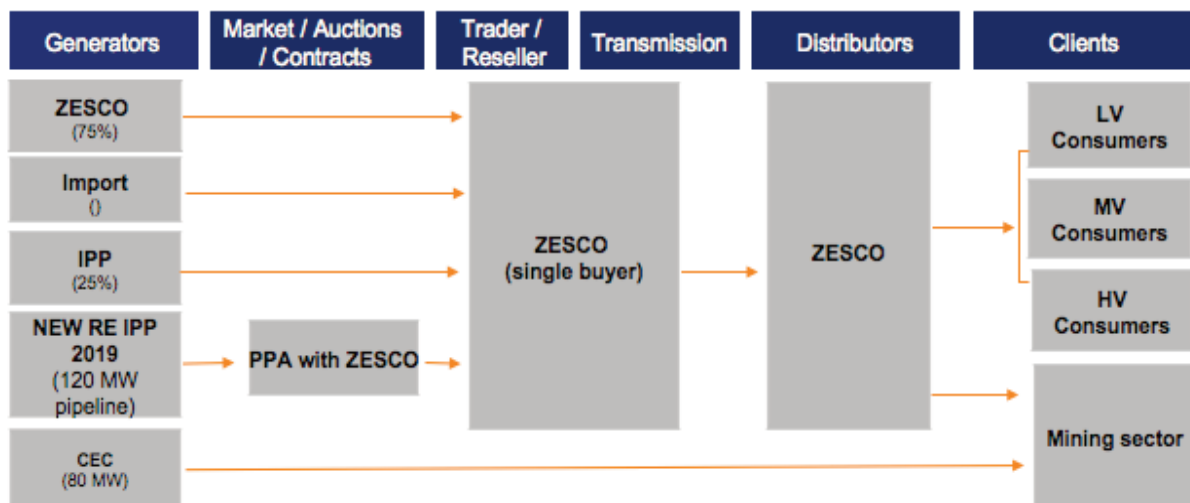
Zambia is also interconnected with the neighbouring countries by the Southern African Power Pool (SAPP). The organization created in 1995 is playing a key role for the energy sector of Southern African region. The SAPP has twelve country members (Angola, Botswana, Democratic Republic of Congo, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania and Zambia) represented by their utility company. Its aim is to optimize the use of available energy sources in the region and enhance energy exchange between countries by promoting an interconnected regional power market.net

## Electricity Generation and Demand

Zambia's generation mix is largely driven by hydro power, which accounts for 84.5 percent (2,388.3 MW) of total national installed capacity. Coal generation accounts for 10.6 percent (300 MW) of the national capacity, followed by diesel at 3.1 percent (88.6 MW), while Heavy Fuel Oil (HFO) accounted for 1.8 percent (50 MW) and solar photovoltaic (PV) for less than 0.1 percent (0.06 MW). In 2016, electricity output decreased by 13.0 percent, to 11,696 GWh from 13,440 GWh recorded in 2015, signaling the starting point of an energy crisis in the country. The decrease in electricity output has been the consequence of the shortfall of rainfall experienced during the 2014/2015 and

2015/2016 rainy seasons, which resulted in low water levels for the hydro power plants.

As reported also by ERB; "the dominance of hydropower generation puts the country at risk due to changes in climatic conditions; such as global warming leading to insufficient rainfall and drought. These challenges pose a risk of inadequate water resources available for hydropower generation. Unfortunately, this risk graduated into reality in 2016 as the consequence of insufficient water resources manifested in load-shedding averaging eight (8) hours a day and, in an increase in power imports by 178.26 percent, to 2,184 GWh, from 785.2 GWh, in 2015."



Figur 2 Zambia power market structure

ZESCO exports and imports electricity through the Southern African Power Pool (SAPP) and the bilateral market. A significant decrease in electricity exports of 32.5%, to 794.1 GWh in 2016 from 1,175.9 GWh was recorded in 2015.<sup>2</sup> The decrease in exports was ascribed to a reduction in the utility's hydro power generation

output. Meanwhile, electricity imports increased exponentially by 178.3 % to 2,184.9 GWh in 2016 from 785.2 GWh recorded in 2015 because of the reduction in the utility's generation capacity.

The drought seasons of 2015 and 2016 clearly modified Zambia's future energy scenarios. After a long period of a positive balance of import-export of energy, in 2015 for the first time

<sup>2</sup> Energy Sector Report, 2016. Energy Regulation Board (2017)

Zambia became a net importer of energy and in 2016 the import rate grew even more.

Following this energy crisis the country accelerated the development of new renewable energy generations to reduce the dependence of the whole electric system to hydro power plants.

Zambia energy's demand is clearly dominated by the mining sector that contributes for 49% to the internal consumption. Other industrial activities cover 20% of the local demand and residential activities account only for around 23% as showed in the figure 3.

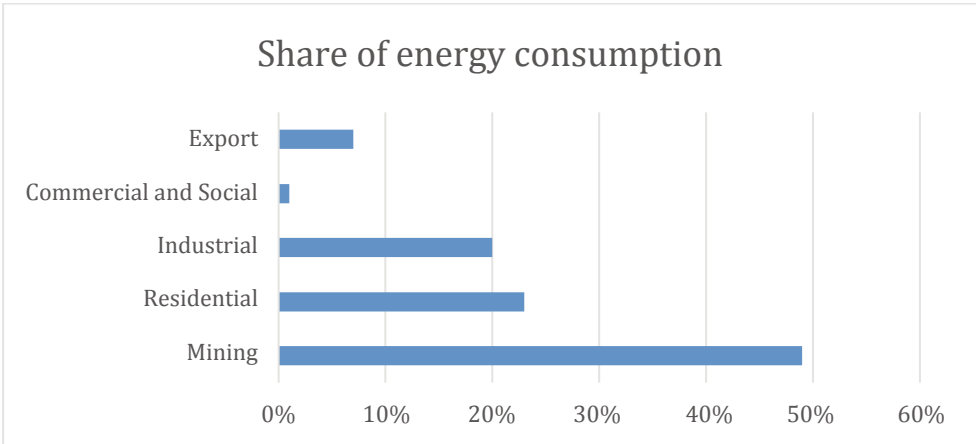


Figure 3 Share of internal energy consumption - 2016

According to ERB, in 2016 national electricity consumption decreased by 5.2 %, to 10,857.5 GWh from 11,449.9 GWh in 2015.

Nevertheless, electricity demand is expected to increase strongly in the coming years. Considering the study for Power System Development Master Plan in Zambia (2010):

- in the base case electricity demand will reach 2800 MW by 2020 and 4066 MW by 2030 (average annual growth rate 4.3 % until 2030),
- In the low scenario electricity demand will reach 2670 MW by 2020 and 3544 MW by 2030 (average annual growth 3.7% until 2030),
- In the high scenario electricity demand will reach 3300 MW by 2020 and 5.406 MW by 2030 (average annual growth rate 5.7 % until 2030).

The electricity sector in Zambia faces numerous challenges and its poor reliability and quality of supply, combined with the low levels of access to electricity services, have a significant adverse impact on the national economy. In response to power shortages, firms have been forced to invest in self-generation solutions, mostly diesel-fuel generation, resulting in significant additional costs and increasing of GHG emissions.

To support a pathway to sustainable economic development, Zambia will need an efficient and dynamic energy system. For this reason, ZESCO foresees to upgrade existing transmission infrastructures and develop new transmission capacity to ensure stability for the new power plants that are currently being built. In addition to these projects, the country has planned a further expansion of the national grid to the north-western province to new mining areas



and developing new interconnectors with neighbouring countries to increase power trade with Southern African Power Pool (SAPP).

Zambia is also planning to add new generation capacity in 2019. At least 120 MW will be added onto the grid through IPPs signed between ZESCO and IPP such as Enel Green Power, NEOEN, CEC, First Solar and IMPALA.

### **Renewable Energy in Zambia resources and new projects**

---

Today in Zambia renewable energy sources (excluding hydro) cover less than 1% of the energy mix. The historical role of hydropower generation slowed down the development of others RE sources but the energy crisis of 2015/2016 pushed the government to diversify the generation mix. Non-programmable renewable energy will play a key role in the country in the years to come. Zambia's renewable energy sources are widespread into the country:

- Hydropower resources are estimated around 6,000MW;
- The country has an average 2000/3000 hours of sunshine per year with an irradiation of 5.5 kWh/m<sup>2</sup>/day an average;
- Forest and agricultural waste have huge energy potential estimated at approximately 2.15 million tons and 498 MW, respectively;
- Geothermal energy potential can also be considered relevant, with Zambia having more than 80 hot springs, of which 35 were rated highly in terms of surface temperature, flow rate, and proximity to power lines, indicating ease of access and relative energy potential. To date, these springs have not yet been tapped for industrial or energy provision purposes.
- Wind energy potential is more limited. Wind data collected at 10 meters above the ground indicate speeds between 0.1 to 3.5

meters per second with an annual average of 2.5 m/s.

In recent years, the country showed strong political commitment in developing its national renewable energy sector, becoming a best-in class example in developing an attractive investment framework for renewable energy private investors with a smart approach in benefiting from international programs to help public institutions building successful renewable energy policy. It is worth acknowledging the initiative born under the GetFit program sponsored by KfW and the Scaling Solar program sponsored by IFC.

GET FiT is designed to assist the Zambian Government in the implementation of its REFiT Strategy. In line with this strategy, GET FiT Zambia aims to procure 200 megawatts (MW) of renewable energy projects. GET FiT supports small- to medium-scale Independent Power Producer (IPP) projects up to 20 MW, in line with the REFiT Strategy.

- The GET FiT Program consists of three instruments:
- The GET FiT Premium Payment Mechanism (top up per kWh),
- A Guarantee Facility to secure against off-taker and political risks, as well as
- A Private Financing Mechanism that will offer debt and equity at competitive rates.

More in detail, GET FiT consists of several related components designed to help create an attractive environment for private investors and systematically support Zambian government and ZESCO efforts to meet the objective of providing affordable and stable power to the Zambian population.

The International Finance Corporation (IFC), together with Zambia's Industrial Development Corporation (IDC), has conducted an in-

ternational tender, for two utility scale solar power projects of up to 50 MW each. The program called Scaling Solar initially attracted 48 developers, of which 11 were prequalified for the subsequent bidding process. 7 bidders submitted final proposals. NEOEN S.A.S. / First Solar Inc. (50 MW) and Enel Green Power S.p.A. (34 MW) were the two winning bids at tariffs of 6.02 \$/kWh and 7.84\$/kWh respectively. These proposed tariffs will remain fixed for 25 years thanks to a fixed-tariff PPA signed between the winner of the tender and the single buyer, ZESCO. Scaling solar is providing the winning bids with a package of competitive financing and insurance products to ensure rapid financial close post-tender as well as public land, risk management and credit enhancement products to lower financing costs, which is the reason that the price is lower than the expected commercial rate for Zambia<sup>3</sup>.

such as the World Bank and KfW, and the IPPs already active in the country. This process will result in a drastic decrease of the cost of energy in Zambia, making affordable and competitive access to energy an achievable result in the years to come.

## Conclusion

---

As previously highlighted, the government of Zambia is working hard to reduce the number of people that still lack access to energy. Renewable energy will play a key role in the country's social and economic development and the government should continue on the path of exploiting its huge renewables potential. Renewable energy will sustain not only the development of Zambia's national economy but will also enhance the energy security of the whole southern energy market thanks to new interconnections and the sharing of valuable resources among the bordering countries. All relevant energy actors of Zambia's power sector, such as the Ministry of Energy, ZESCO, ERB, IDC and REA, have to continue in ameliorating the investment framework for renewables to attract more private investors in partnership with the international financing institutions,

---

<sup>3</sup> Project Work – Zambia, Lanfranconi, ARERA, 2018



---

# A feasible roadmap to integrate non-dispatchable renewable energy in the national electric systems of Sub-Saharan region

---

This paper has been prepared by:



---

Silvia Piana, *Enel Green Power* – Andrea Renzulli and Riccardo Siliprandi, *Pöyry* – Arturo Sferruzza, *Norton Rose Fulbright*

---

## Abstract

---

*This paper focuses on the concept of “power system design” to enable the integration of renewable energy sources (RES) into the energy mix, from a regulatory point of view. Generally speaking, power system design requires a stable and reliable set of rules governing the interaction of all the players (private and public persons) involved in electricity generation, transmission and distribution (and – where existing - retailing and trading), as well as rules governing investments; this certainly does apply to renewable energies. However, the ultimate and specific barrier concerning RES integration is the use of the grid. After an overview of the general enabling framework for an attractive and reliable market design for renewable energies, focus will shift to the necessary regulatory framework governing grid integration, to ensure long-term efficient investments.*

## Introduction

---

In the past few years, the implementation of greenfield energy projects fuelled by RES overtook newly installed projects powered by fossil fuels and it is expected that the growth of RES will rise steeply in coming years. The

progressive transition from fossil fuels to RES

is due to several convergent socio-economic factors:

- 1 Availability of RES resource worldwide.
- 2 Technology improvements, with the consequential drastic reduction of RES costs, such that they are close to achieving competitiveness against other sources of power gener-

ation at global level.

### 3 Environmental and climate change concerns.

Governments of both OECD and developing countries have taken measures to increase the deployment of renewable energy technologies, mainly in order to:

- 1 Improve energy security, providing for enough capacity to satisfy electricity demand;
- 2 stimulate economic development associated with innovation and high-tech manufacturing and/or with rural sectors, and
- 3 protect the environment and climate from the impact of the use of fossil fuels.

The adoption by Governments of a clear policy towards renewable technologies and a stable and clear regulatory framework is one of the key macro-enablers to ensure the de-risking of private and public investments in renewable projects and therefore, foster the deployment of renewable energy technologies.

This entails the following:

- a) setting out targets for the production of electricity from renewable sources, and planning the future generational capacity;
- b) regulating access to the transmission and distribution networks to minimize infrastructure barriers – granting for instance priority of access/priority of despatch to RES - and ensure that the power grid supports enough flexibility to integrate intermittent renewables, while providing for back-up capacity when needed;
- c) giving the right consideration to various barriers that may hinder the development of renewable energy. Particular reference is made to techno-economic barriers such as

the cost of renewable technology in comparison to traditional energy and other competing technologies, or to non-economic barriers such as:

- i Regulatory uncertainty – e.g. constitutional protection of investments, retrospective change in the law;
  - ii Institutional and administrative barriers – e.g. complex, too long or unclear permitting procedures;
  - iii Market barriers – e.g. inconsistent pricing structures disadvantaging renewables, subsidies to fossil fuels;
  - iv Public acceptance and environmental barriers - linked to complex planning regulation and “not on my back-yard” syndrome.
- d) Last but not least in this non-exhaustive list, establishing the most suitable procurement framework for renewable energy, which may involve adopting a support scheme that takes into account the overall regulatory and economic environment.

### RES support schemes

Hallmarks of successful support schemes are:

- a) relatively simple and not excessively burdensome for local administrations;
- b) contributed with priority of access to the grid/priority of dispatch over generation from fossil fuels;
- c) be robust enough so to create a developer/investors market;
- d) backed by policy and regulatory signals mitigating the change in law;
- e) long term visibility.

The most widely adopted support schemes have involved feed-in tariff mechanisms (**FIT**), tradable renewable energy (or “green”) certificates and auctions. Support schemes based on tax credit for generators and/or investors have also been adopted in certain jurisdictions, mainly in the USA.

Under a FIT scheme, the tariff project is guaranteed a certain price per KWh of energy fed into the grid, usually for a period of 15-20 years. The scheme may be set such that the tariff is the duly remuneration for the producer (effectively a “set price” for the electricity) or a “premium” paid on top of the electricity price that the generator receives from the energy sales on the market (Feed-in premium). The premium may in turn be fixed or vary depending on the market price such that the sum of the premium and the market price does not exceed a fixed threshold.

FiTs are often adopted during the early stages of RE development in a certain country. Indeed, FIT allows for a fast development process, provided the latter is clearly mapped, controlled and transparent. However, FIT schemes have proved relatively unsuccessful in a number of countries and are not always suitable for large-scale projects or certain technologies. Certainly FITs are expensive for Governments and Tax payers, and their main drawback aspect is that they are not easily and timely adaptable to the decreasing cost of the technologies that they are meant to support; this is the main reason why FIT schemes have often been hit by retrospective changes in law aimed at reducing the tariffs (es. Spain and Italy).

Support schemes that contemplate the use of tradable renewable energy certificates (REC) are based on the obligation imposed onto generators (or traders) of electricity to obtain a fixed quota of the electricity from RES installations. To comply with this obligation, generators or traders may use RECs, that are issued and sold by owners of power plants fu-

eled by renewables. The remuneration that renewable energy producers receive from the sale of the RECs represents the incentive. To ensure the scheme works, sanctions are imposed to market participants that are unable to comply with this obligation in a particular year.

Unlike FIT-based schemes, under this scheme the determination of the price of the REC's, is driven by the market.

Auctions are another market-driven instrument, more widespread in Sub-saharan Africa than REC. Participants to an auction submit bids on the basis of price and sometimes other components which may be specified by the entity running the action (economic development, job creation, local content,...).

In several cases countries interested in RES developments begun with FIT policies and after a few years switched to auctions, which are inherently more sustainable in the long run from a financial point of view, and also tend to ensure that the most efficient and technologically advanced players enter in the market.

### **Case study: Zambia**

---

Zambia has somehow a hybrid combination of policies. The country did not follow the common path of “first-Fit, then-auctions”.

Its renewable energy policy implementation started in 2015 with the Scaling Solar, a particular case of “supported” auctions.

The Scaling Solar Program is a World Bank Group program that supports governments across Sub-Saharan Africa to roll-out utility-scale PV power plants.

IDC – the Industrial Development Corporation in Zambia - appointed the International Finance Corporation IFC Advisory to assist it in

structuring and implementing an open and competitive Tender Process to select a suitable developer for Projects under the Scaling Solar.

The Scaling Solar Program has been designed for fast implementation. It uses fully developed template legal documentation which have been market tested for acceptability to investor and financing parties and adapted to the specific requirements of the Projects. Documentation include:

A Power Purchase Agreement (PPA), under which the Project Company will, subject to a set of operational performance standards set out in the PPA, sell all of the electrical energy generated by the Project to ZESCO ( the state-owned utility company), reflecting the pricing and other details included in the Winning Bidder's proposal. The PPA is for 25 years with fixed tariff.

- A Government Support Agreement (GSA) with the Government of Zambia, under which the latter will undertake to provide certain protections to the Project Company;
- A template Direct Agreement, for any financed bids; and
- A template legal opinion to be given by the Attorney General, Zambia's chief legal officer, in favour of the Seller, and, if applicable, its Lenders.
- These documents will be supplemented by a Land Agreement between each Project Company and IDC, as well as an Investment Promotion and Protection agreement with the Zambia Development Agency (the "IPPA").

With such supporting structure, the Round 1 of the Scaling Solar Programme was able to select two winners for a total of 81 MW. Round 2 began in Feb 2017, targeting 500 MW; so far, the prequalification for the first 200 MW has been completed.

In 2014 Zambia had also started developing a REFiT policy, which envisaged a feed-in-tariff for renewable energy projects. However the REFiT was never implemented, and was eventually replaced by the Get-Fit. The Get-Fit is a hybrid program aiming at commissioning new solar PV projects through auctions, whilst a proper

FiT would be used for other renewable technologies. The program's goal is commissioning 200 MW of renewable energies through IPPs projects between 1 and 20 MW. Round 1, launched in April 2018, will be a competitive auction for up to 100 MW of solar PV. Final awarding is expected by end 2018.

### **Enabling conditions for an efficient RES integration in Sub-Saharan power markets**

As of today, achieving high penetration of renewable energy is no more a question of costs. Renewable auctions have demonstrated worldwide their ability to optimize the cost of new RES capacities. Nevertheless, the setting of clear political ambitions and a favourable market framework, in terms of procurements rules and supporting schemes for RES, are not sufficient to secure the efficient development of renewables.

System operators and power sector ruling institutions are showing increasing concerns for renewables system integration and power system flexibility. Addressing those issues is fundamental to ensure an effective renewable penetration and fully exploit the benefits of growing shares of RES.

The intermittent nature of solar and wind energies can challenge the stability of power systems and international experiences show that a not properly managed development of non-programmable renewables (VRE) could result in:

- Grid frequency and voltage disruptions;

- Increase in flexible back-up capacity needs due to production forecasts errors;
- Grid congestions surge and curtailment.

Moreover, increasing the shares of VRE impacts on the operations of the conventional power generation fleet by reducing their contestable market, endangering their economic sustainability.

The severity of those impacts depends firstly from the penetration degree of VRE into national power system<sup>1</sup>, but it is also bounded to the intrinsic characteristics of national power systems in terms of:

- Structural factors (size of the market, demand evolution, capacity mix, grid development, regional market integration);
- Market design and Regulation (governance framework, power market structure, system operating rules).

Being characterized by limited power generation installed capacity, underperforming power grids and immature regulatory frameworks, Sub-Saharan countries could face those challenges sooner than most advanced power markets.

Nevertheless, those countries could rely on the available international experiences in order to adapt their market structures for the forthcoming changes brought by renewables. Shaping from the beginning a market design “fit for RES”, able to accommodate high shares of non-programmable renewables, is today a feasible task. As a result, Sub-Saharan countries have the opportunity to avoid the costly retrofits and reconfiguration that EU countries had to bear.

---

<sup>1</sup> The IEA recognizes four phases of VRE integration, each one characterised by a progressive share of VRE in power generation mix resulting in incremental impacts on the grid stability and on the existing generation fleet.

As an example, in Europe most of solar PV capacity was previously connected to the Medium and Low voltage grids, making harder for the TSO to control them remotely and increasing the need for back-up capacity and the cost for keeping the system balanced. That’s why a “fit and forget” approach, where new VRE plants get connected regardless of the need for grid reinforcement, is doomed to failure and should be avoided.

Moreover, the fast-growing energy demand and the need to accelerate energy access to the whole population offer a great opportunity to Sub-Saharan countries to increase VRE penetration while reducing the challenges of VRE to system stability, especially at the first stages of renewables development.

A cost-effective and reliable integration of increasing shares of VRE is possible by enhancing power system resiliency, avoiding the commissioning of new synchronous (fossil-fueled) generators or regulatory barriers to hinder RES development. The increase of power system resilience could namely be achieved by intervening on three different aspects, not mutually exclusive but rather cumulative:

- a) Improving grid operations;**
- b) Enhancing system flexibility;**
- c) Reviewing ancillary services regulation.**

*a) Improving grid operation: defining a grid code fit for RES*

Grid codes (GC) are a central piece of the functioning of a power system, since they ensure a proper coordination of all its components. They cover main aspects of system planning and operations: grid access rules, operating aspects, planning codes and market codes for power exchanges.

GCs are traditionally designed to regulate a



power system built on centralized synchronous, mostly fossil-fuel power plants connected to HV power grids with one-directional power flows. They are rarely adapted to the different conditions of a power system with increasing shares of VRE. The connection rules defined for new RES plants have often been less binding than those for conventional generation. In the early stage of VRE development, for instance, no fault ride through capability for voltage control is generally considered for renewables. However, this is not sustainable with increasing RES penetration: connection rules must then be reviewed to avoid the risk of PV and wind farms disconnections at the occurrence of huge frequency disruptions, with cascade effect leading eventually to large blackouts.

Indeed, an appropriate drafting / revision of national GC has to be ensured and overseen by power sector ruling institutions, in line with RES deployment. Key actions for National System Operators (NSO) would be:

- Adjust grid access rules and grid cost allocation schemes in parallel with RES development plans.
- Define a transparent and technology-neutral regulatory process for grid connection, to avoid costly retrofitting efforts to adapt RES plants performances to the new connection rules.
- Establish common Technical Performance Standards for connection and define technical requirements for non-programmable renewables to suit specific system requirements, as for:
  - communication system;
  - remote control systems;
  - power quality;
  - voltage and frequency ranges of operation;
  - frequency and voltage controls.
- Establish a framework for forecasting,

scheduling and deviation settlement for non-programmable renewables - and require to adopt the necessary tools - in order to increase forecasting capacities of NSOs.

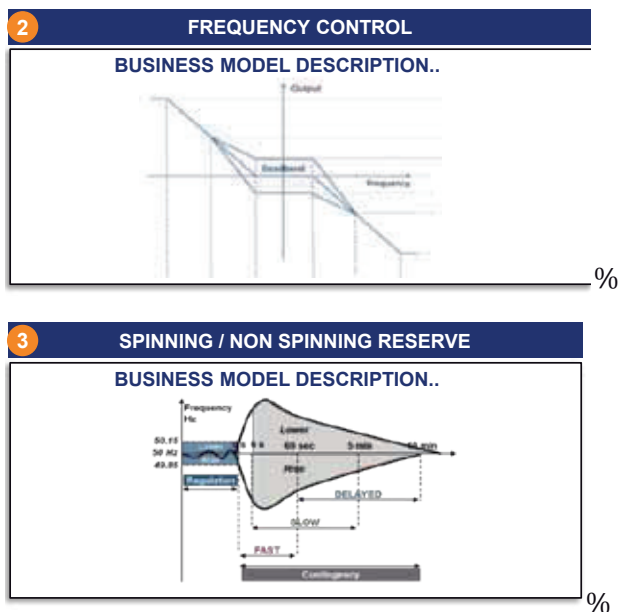
- Require the adoption of tools for monitoring, control and simulation of RES.
- Ensure the provision of a secure and reliable communication system between generators and NSOs.
- Define TSOs/DSOs coordination rules.

#### *b) Enhancing system flexibility: opening to new solutions*

Enhancing power system flexibility is the second key aspect to increase system resilience, especially in markets where grids are already stressed to the limit of their capabilities. By flexibility we mean the ability of the system to adapt to continuous and rapid changes in loads and consumptions profiles, ensuring appropriate quality of energy supply by limiting congestions and avoid curtailments.

As some grid portions do not have sufficient transport capability in hours of high load, a large presence of intermittent RES generation could lead to grid bottlenecks. Power curtailment is a most-used defensive measure of Network System Operators to avoid, or solve, those events. Without an adequate grid planning, RES curtailment ratio could be very high affecting revenue streams of renewable generators and, finally, resulting in a net loss of value for power consumers.

Strengthen network lines capability in line with development of generation capacity is fundamental. This could be done by constructing new lines (new “poles and wires”), including new cross-border interconnections, or by improving the existing ones (cable replacement, substation reinforcement).



**Figure 2. BESS with RES business models (Source: Enel Green Power and Pöyry)**

The whole system will benefit from those solutions, giving:

- To generators the possibility to optimize market inefficiencies, letting VRE plants to overcome the inherent limitations in terms of flexibility and dispatchability.
- To Network Service Operators the capability of performing grid services from VRE plants, reducing the need of synchronous generation required to balance the grid, and of matching the system needs injecting/withdrawing energy when it is required.
- To end-users the ability to enhance security of supply and eventually reduce energy bills, reducing polluting and costly back-up supply from the grid, particularly if they are equipped with solar rooftop home systems integrated with storage solutions, or supplied by hybrid mini-grids (VRE generation capacity coupled with BESS). A well-functioning power market should be able to cre-

ate the right price signals for flexibility investments. This is particularly evident in advanced, fully liberalised, power markets where price signals drive investment decisions. In Sub-Saharan Africa, where most of power markets are organized under a single-buyer system managed by a vertically integrated utility, regulation could play a prominent role in sustaining the development of such services aimed to reinforce system flexibility.

*c) Reviewing ancillary services regulation: including non-programmable renewables in the provision of ancillary services*

Ancillary services pertain specifically to the need for network system operator to balance demand with supply in real time, while maintaining grid frequency at its nominal value without compromising grid stability. Ancillary Services (AS) may include a number of different operations, such as:

- frequency support,
- voltage support,
- system restoration.

Various types of reserves (primary, secondary and tertiary reserves<sup>2</sup>) ensure the provision of those services.

Before the introduction of proper AS regulations, congestion are usually managed by network system operators in real time by applying congestion charges. In such configuration, all entities upstream and downstream of the congested corridor are impacted.

The implementation of a proper Ancillary Services regulation provides a mechanism for re-dispatch of generation reserves before imposing congestion charges.

<sup>2</sup> The definition of primary, secondary and tertiary reserve varies from country to country.

Although necessary, however, extending power grids capability requires huge investments from NSOs and could take many years. Other cost-effective solutions are available to enhance system flexibility, including:

- Enhance power plant flexibility and the optimization of operating reserves.

- Support the development of new flexible solutions, as storage and demand-response.

As shown in the table below, VRE are technically able to provide some services in order to ensure the stability of the power system, with different degrees of efficacy.

Ancillary services	Considerations on the effectiveness of the service	Upward	Downward
Primary reserve	<ul style="list-style-type: none"> <li>• Less precision, although negligible, in the provision of the service as a result of the variability of the primary resource.</li> <li>• For the "upward" mode, the risk is linked to actual availability depending on the aleatory nature of the primary source</li> </ul>		
Secondary reserve	<ul style="list-style-type: none"> <li>• Limited amount of secondary reserve band.</li> <li>• Less precision, although negligible, in the provision of the service as a result of the variability of the primary resource</li> <li>• For the "upward" mode, the risk is linked to actual availability depending on the aleatory nature of the primary source</li> </ul>		
Tertiary reserve	<ul style="list-style-type: none"> <li>• For the "upward" mode, the risk is linked to actual availability depending on the aleatory nature of the primary source</li> </ul>		
Balancing	<ul style="list-style-type: none"> <li>• The supply only close to real time minimizes the risk related to the availability of primary source, both "to rise" and "to fall"</li> </ul>		
Voltage regulation by reactive power	No critical issues for the plants.		
Remote switching	Necessary to minimize the load shedding in order to limit the possible "breakages"		

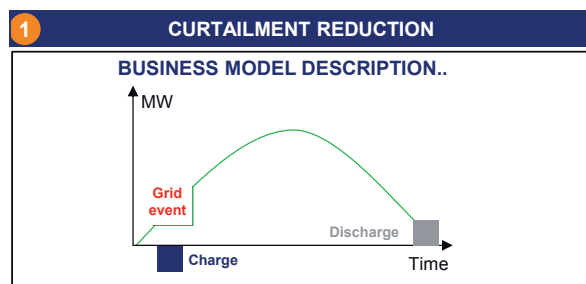
**Legend**  
 High Medium Low

**Figure1. Efficacy of system services provided by non-programmable renewables (Source: Pöyry analysis)**

Battery electric storage systems (BESS) coupled with RES maximise the possibility to integrate VRE into power system, further enabling the provision of flexibility solutions, and securing revenue streams for RES generators:

- Recovery of lost energy / revenue due to grid curtailment.
- Provision of a range of ancillary services to TSO (frequency control and spinning/non spinning reserve) to help grid stability fol-

lowing a grid event in order to bring back system frequency within safe parameters.



To encourage the market players to provide these services, AS are procured by compensating the providers through a regulatory mechanism or through markets. Pricing is typically given by the shadow price of the Ancillary Services, i.e. the lost opportunity of the generator forgone in energy market. Under most conditions a generator that is supplying reserve, for example, must reduce output and forgo a profitable energy sale in order to stand ready to respond to a contingency. Therefore, the price would be calculated as the cost of the marginal resource providing the ancillary service. Such opportunity costs are best discovered through the markets.

Analysis of international experience reveals that the market design options for AS broadly differ based on techno economic considerations (such as service definition, assessment of AS required for the system...), on different approaches for procurement of AS (who can participate, how the service is charged,...) and also for market clearing and settlement mechanism. Nevertheless, the development of VRE worldwide is pushing many countries to adjust AS regulation to consider renewables in the provision of system services and to better manage their intermittency.

In Sub-Saharan power markets a proper AS regulation is often absent. This provides a unique occasion to implement such regulation in a way that already include renewables avoid-

ing thus future retrofitting adjustments. Moreover, Sub-Saharan countries could benefit from international experiences and define best regulations in order to support the development of new flexible solutions, as storage, which will furthermore increase the ability of non-programmable renewables to offer system services.

### References:

Arrhenius Institute for Energy and Climate Policy, "Incentives to Invest in Electricity Production from Renewable Energy under Different Support Schemes", Discussion paper, 2008

IEA, "Renewable Energy: Policy Considerations for Deploying Renewables", Information Paper, 2011

GET FIT Zambia, Solar PV Tender up to 100 MW – Request for Qualification, April 2018

TERNA, "New frontiers for grid management: the TSO perspective", RES4Africa Workshop on Non-dispatchable renewable energies integration into the grid, Lusaka, September 2018

IEA, "Status of Power system Transformation 2017 Report", OECD/IEA, 2017

IEA, "Getting wind and Sun onto the Grid. A manual for Policy Makers", OECD/IEA, 2017



---

## Best practices for successful auction program: connecting public sector and investors in emerging RE markets

---

This paper has been prepared by:



in collaboration with:



---

Paola Brunetto, *EGP* – Valeria Centorbi, *EGP* – Ginevra Biadico, *NRF* – Luigi Costa, *NRF* – Thomas Harris, *RINA*

### Abstract

---

*The successful implementation of renewable energy infrastructure depends on effective market designs that provide a suitable framework for reducing energy tariffs as well as creating a sustainable market that aligns with a country's broader goals. Auction programmes enable stimulation of the renewable energy industry through encouraging investment from the private market at the best price for the buyer. This paper analyses four countries (three cases in Africa and one internationally recognized as worldwide best practice) – South Africa, Zambia, Ethiopia and Mexico – all of whom have recently utilised auction programmes as a way of stimulating the growth of their renewable energy industry. The analysis aims at highlighting the effectiveness of these programmes whilst outlining the ways in which they are adapted to each country's specific needs, thus providing an analysis of the strengths an auction-style programme can bring to the renewables sector in terms of its flexibility, attractiveness, credibility competitiveness and socio-economic benefits.*

## Background

---

Renewable energy (RE) markets have undergone rapid developments in recent years. This change has been fuelled by the need to meet increasing energy demands whilst moving towards more sustainable energy sources to combat the effects of climate change and providing a wider range of energy access.

Previous models aimed at stimulating renewables growth have involved feed-in tariff (FIT) mechanisms that offer attractive tariffs for the integration of renewables into the energy mix. Although the government's support of RE through the FIT was initially necessary to fight the competition with conventional technologies and to accelerate the technological change in the field of energy production, the FIT schemes often yield slow growth results and have proved relatively unsuccessful in a number of countries.

Governments, unable to afford the costs of subsidizing the renewables markets, are relying on the private sector to deliver the investment required to drive renewables programmes. Reliable frameworks are essential to ensuring proper viability for private market participants to invest in the initiative. Many countries have experimented with ways to stimulate socio-economic growth through the renewables sector. This is particularly prominent in developing countries, as the benefits of investment in this industry can include increases in trade balance, industrial development and job creation. However, a problem exists in encouraging investments as there are large up-front costs required for renewables to be financially successful.

The use of auction programmes to procure RE infrastructure has become increasingly commonplace because they provide a positive and reliable framework for reducing energy tariffs, meeting RE targets whilst increasing investments.

## Case Studies

---

### • South Africa

To promote renewables, South Africa explored the option of FIT (the REFIT programme) with a specific policy approved in 2009 but an operative procurement process was never implemented and no power purchase agreements (PPA) were signed. After consultations with possible investors, lawyers and financial institutions the government launched a refined alternative in the way of the Renewable Energy Independent Power Procurement Program (REIPPPP). The REIPPPP consists of a three-phase system with a capped capacity for each bidding round and for each technology which leaves no room for a competition between technologies. The first phase is technical and financial qualification (pass/fail), the second phase is an evaluation of price and economic development criteria which results in Preferred Bidders being invited to reach financial close before a pre-arranged common deadline in the second phase.

The program immediately attracted the attention of the global energy industry, particularly because of the transparent evaluation criteria, the bankable suite of request for proposal (RFP) documents and the program's size implying multiple bid winners and future prospects for the investors.

Formed in 2011, it has seen the electricity prices of wind power decreased by 46% and solar by 71% and US\$19 billion invested by the private sector by 2016. South Africa's RE target for 2030 is 18,800MW (megawatts) and the initiative secured a quarter of this after just four years. The majority of the technology share lies with wind and solar generation with smaller amounts for concentrated solar, biomass, biogas, landfill gas, and hydro.

The structure of the REIPPPP is weighted 70% on pricing and 30% on job creation, local content, preferential procurement, rural develop-

ment and communities involvement, education and the improvement of skills, enterprise and socio-economic development, etc., using the former to influence socio-economic growth, particularly in local communities and in more remote areas where these kinds of opportunities would usually be few and far between<sup>1</sup>. One of the main characteristics of this program is that the awarded projects must include local communities into their equity share. The observance of obligations related to the commitments on the above mentioned economic development criteria are monitored by the REIPPPP authorities through quarterly reports produced by the awarded bidders and in case of failure to meet the commitments under the PPA contracts are terminated.

Among the auction transaction documents, the Implementation Agreement, to be signed by the independent power producers (IPPs) and the Department of Energy (DOE), provides a sovereign guarantee of payment to the IPPs, by requiring DOE to make good on the payments in the event of an Eskom (the monopolist state utility and sole off-taker) default. South Africa's rather strong international credit standing makes banks and investors quite comfortable about the sovereign country risk without requiring specific insurance products. The developers are expected to identify the sites and pay for early development costs at their own risk. A registration fee is due at the outset of the program and bid bonds has to be lodged.

A report from the Department of Energy about the success of the REIPPPP (up to June 2015) claims the following figures:

- 4,294 Gigawatt-hours of power generated;
- R4 billion more in financial benefit than its cost;

---

<sup>1</sup> Foreign firms have set-up local factories that export internationally, with some of the world's leading PV module producers now active in South Africa.

- 1.2 million homes powered by electricity generated from renewables projects; and
- 19,050 employment opportunities for South African citizens during the construction and operation phases of the 37 projects under the umbrella of the programme.

In addition, the bid window function of the REIPPPP has seen committed investments R192.6 billion from developments in the first four rounds of bidding, of which R53.2 billion was from foreign investors and financiers. As a result of the targets for local content some international production facilities set up local production units and specialized skills were transferred from international to national firms.

The REIPPPP is also proving to be a significant help to the Broad Based Black Economic Empowerment (BB-BEE) policy, something which is a strong contributor to the argument of socio-economic benefits in South Africa. 47% of the equity shareholding in the first four bid rounds belongs to South Africans – 7% above the stated target of 40%.

The nature of the REIPPPP is allowing the country to move forward to clean energy technologies that are also bringing a new wave of economic opportunities, not only boosting employment with regards to construction, but also the continuing maintenance required over the life of RE plants.

Worries over the future of the REIPPPP supposedly lie with the financial stability of Eskom. This is a current and ongoing issue and the impasse created is affecting the presence in the country of the already established international investors. The programme ran smoothly for the first 3 rounds but the fourth and fourth point five rounds have seen several delays spanning nearly two years. These delays have particularly impacted the local manufacturing and training industries which responded to the local procurement requirements by establish-



ing state-of-the-art facilities to supply, amongst other things, solar modules, inverters and wind turbine towers. Almost all of these ventures have now ceased to operate and a number of international investors and construction companies have reduced their presence in the country or have left it.

Recent support from the government has expedited the backlog but projects are not expected to reach financial close imminently.

#### • **Zambia**

Many African countries looked at the South African case trying to replicate the initial successful experience and certainly Zambia, with less than a quarter of the population having access to electricity, was one of them.

In 2015, the Industrial Development Corporation (IDC), an investment company wholly owned by the Zambian government, was directed by the government to target the procurement of solar energy power in view of the energy crisis Zambia was experiencing. It was in this context that the Southern African country signed up to join Scaling Solar, a World Bank Group program designed to make it easier for African Governments to quickly procure solar power and to minimize all financial transaction risks through competitive tendering and pre-set financing and insurance products. IFC, the World Bank development institution, handled the legal and regulatory analysis, the technical and economic studies for the selection of the optimal size and location of the two solar plants.

The winner selection criteria were based exclusively on the minimum price offered for each project and the same bidder didn't have the possibility to be awarded the 2 projects.

The execution of the first round of the program in Zambia proved the effectiveness of Scaling Solar in reducing the lenders and bidders perceived risks thanks to the transparent award

process and the fully bankable transaction documents included in the RFP package. More specifically the investors' confidence was fostered by the PPA provisions on the off-taker payment obligations and the credit support mechanism based on the purchaser requirement to maintain a liquidity of an amount equal to 6 months' revenues. In addition to the above mentioned provisions, the introduction of the Government Support Agreement bringing in a primary obligation for the Zambian Government to provide PPA credit support, if not in place, furtherly encouraged the bidders' participation to the program.

The first round of the tender, with the aim to secure the development of two solar projects of up to 50 MW each, initially attracted 48 developers, of which 11 top tier bidders were prequalified for the subsequent bidding process. Seven bidders submitted final proposals and the winning tariffs were 60.15 USD/MWh and 78.89 USD/MWh making Zambia the Sub-Saharan Africa's country with the cheapest solar power at that time.

Although the official awarding took place in May 2016, the process to achieve the financial closing of one of the two projects was finalized in December 2017, whereas the second one is still on-going, leading to an inevitable postponement of the scheduled commercial operation date.

Second Round of the Zambian Scaling Solar auction for up to 300 MW is currently on-going.

#### • **Ethiopia**

Ethiopia is undertaking an important expansion of its power sector targeting to increase the today installed capacity of 4 GW up to 17GW by 2020. The country has abundant hydropower resources, and this technology accounts for more than 70% of generation. Nevertheless the government seeks to differentiate the production technology considering, in addition to further hydroelectric power

plants, other renewable sources to cover the energy plan requirements.

So far much of the development is driven by the government through the company Ethiopian Electric Power (EEP), the state-owned power producer, which is now trying to create an environment suitable for the participation of IPPs.

The first renewables auction in the country was launched by EEP, advised by Nexant, in 2016 with the scope of assigning a 100 MW solar project located in a site selected by the government.

The launch of the RFP initially attracted tens of investors but only five international energy firms presented their offer.

The final score was weighted 70% on proposed tariff, 20% on bidder's and manufacturers' track record, 5% on local ownership and 5% on local content. The entire auction duration was approximately 1 year with many postponements to the original submission date. This was mostly due to the time needed to address the bidders concerns related to financing difficulties to raise private investment with the initial RFP conditions. Among the main concerns raised by the bidders it is worth mentioning the absence of the sovereign guarantees on off-taker payments and the access to foreign currency which could be very constrained as in Ethiopia the foreign reserves are low and access go to priority sectors.

The selection of the bidder was finally announced last October (winning tariff of 58.98 USD/MWh and the lowest 56.98 USD/MWh) and the power plant is expected to enter into operation in 2019. In addition to the first auction, the Ethiopian government launched a second auction to assign the PPA of two solar projects of 100MW each and joined the Scaling Solar program for the development of 2 solar projects of 125MW each. The RFP is expected to be issued in January 2018.

## • Mexico

The Mexican Energy reform approved in 2013 and the secondary legislations adopted in August 2014 provided for a transformation of Mexico's energy sector.

On the basis of the legislative changes it was created a wholesale power market requiring the acquisition of clean energy certificates by suppliers and users, in proportion to their annual energy consumption, and a system of medium and long-term auctions, to be held at least once a year.

As in the South African case, the clear schedule and periodicity of auctions, in the context of a well-defined target for renewables (35% clean energy by 2024), gave investors clear indications of the roadmap for the sector encouraging investments.

Through the Long Term Auctions, market participants offer to sell or buy a combination of three products: energy, capacity and Clean Energy Certificates (CEs). Successful participants secure fully bankable PPA for the sale of one or more of these products at a fixed price for either 15 years for energy and capacity or 20 years for CEs. Winner selection criteria are highly sophisticated, the winners are selected based on an optimisation model that maximises the economic surplus of the buyer.

The process is designed for the possibility of iteration, based on pre-defined criteria regarding the economic return of the offers, but for the first 3 auctions it was not applied.

Mexican auctions are not site-specific, and bidders are responsible for identifying suitable project sites and producing the relevant documentation (resource assessment, grid connection, etc.) and are being conducted three years in advance of the time for delivering energy, so as to provide sufficient time for the development of projects.

Another important characteristic of the Mexican auction is the introduction of the nodal price adjustments designed to incentivise the construction of new projects in regions where the supply-demand balance is tight. The price adjustments are determined a few months before the prequalification phase and in the first and third auctions decisively affected the selection of winners.

The first auction was run in 2016, 227 offers from 69 bidders were submitted by local and international companies and 5.4 TWh/year of energy were assigned. In the second auction 8.9 TWh/year were awarded and the minimum price was one of the lowest clean energy prices anywhere in the world and 30% lower than the average price from the first auction. The third auction saw the awarding of 5.5 TWh/year of energy and further remarkable reduction of the prices.

	First Auction	Second Auction	Third Auction
<b>Minimum Price</b>	Wind 38.8	Wind 32.0	Wind 17.8
<b>Energy + CELs (USD/MWh)</b>	Solar 32.1	Solar 25.7	Solar 18.9
<b>Average Price</b>	Wind 52.7	Wind 35.3	Wind 18.5
<b>Energy + CELs (USD/MWh)</b>	Solar 45.1	Solar 31.6	Solar 20.8

In the first and second auctions the only permitted buyer was the Federal Electricity Commission (CFE), the regulated government entity responsible for providing energy to basic users. In the third auction other Load Serving

Entities could present purchase offers thanks to the introduction of the Cámara de Compensación, or the Clearing House, an entity acting as the counterparty in the Power Purchase Agreement for both sellers and buyers which assesses the financial credibility and administers the Individual Guarantees and the Reserve Funds (the Safety Network) reducing the parties' risk exposure.

The 15-year duration of the energy and capacity contracts, which is shorter than the useful life of the plants represents a risk to investors and makes the tender strongly affected by each participant's view on the Energy, CELs and Firm Capacity forward curves as any products surplus can be traded in the Spot Market.

The Mexican auction represents one of the best examples of effective and successful renewables auctioning program.

**Major best practices**

To date, around 55 countries have implemented auction programs, some of these countries, however, lack the regulatory framework to support the proper functioning. Among the major best practices for a successful program it is worth mentioning:

- An auction program must be well-structured, planned and transparent, ideally linked to an energy master plan that is underpinned in the energy ministry's policy;
- Auctions must be conducted on a regular basis;
- A stable and comprehensive legal and regulatory framework is required to support the auction program;
- The set of contracts/agreements need to ensure the bankability of the entire transaction;
- Requirements for the eligibility of the participants are essential to guarantee the timely execution and to reduce the risk of disrupt competition;
- Rules and regulations of the auction program must be clear, credible and enforceable in

order to avoid delays and minimize the risk of overly aggressive bidding strategies; Attention may be required not only in reference to low prices achieved but also to other factors, such as, for example, the additional remuneration during periods of peak demand or for sale of energy in high marginal prices nodes.

Auctions for RE development should be implemented in combination with other measures such as, transmission grid expansion and continuously adaptation of the support policies (fiscal incentives, etc.,) in order to preserve a stable and attractive environment for investments and, at the same time, ensure the long-term reliability of the energy system in a cost-effective manner.

### **Detailed analysis of best practices for a successful auction program**

#### **1. Account for trade-offs between different design elements**

When designing an auction program it is necessary to select and combine different design elements in a way that is tailored to satisfy the purposes of the auction, according to the country's specific requirements and characteristics.

One of the first elements of an auction is the choice of the auction demand: only in case the country goal is the development of a specific technology, a technology-specific tender should be selected. A technology-neutral auction shall always be favored if the aim is to minimize the electricity costs and maximize the competitiveness.

It is essential to determine the volume of products to be auctioned according to government policies for RE development and in compliance with the existing system's technical capabilities to absorb the renewable energy. This can be done through a fixed volume method (the most common worldwide) or in a price-sensitive de-

mand curve mechanism where the auction's equilibrium prices affect the demanded quantities. In both cases, in order for the policy makers to increase investors' confidence for a cost-effective outcome, the total volume auctioned shall be divided into different rounds in a systematic auctioning scheme, with a cap on the volume auctioned in each round, which helps long-term planning. Systematic auction schemes attract a larger number of bidders and are beneficial to the country's RE industry and to the grid planning. Standalone auctions may be appropriate when the total quantity to be auctioned is small. They allow the government to adjust the auctioning schedule on the basis of the shifts in market conditions but do not favor the long term investments of international players and the growth of a proper local renewable market.

With reference to the nature of commitment held by the project developer, there are usually three alternatives:

- capacity-oriented agreements, where the project developer needs to ensure only RE capacity;
- energy-oriented agreements, which imply a commitment to deliver a given amount of RE; and
- financial agreements, entailing greater risks for the developer because the generator may be exposed to fluctuations in the electricity spot market prices.

The choice among the abovementioned alternatives depends on the desired risk allocation between generators and consumers.

Furthermore, the bidding procedure may be satisfied by three different approaches:

Sealed-bid approach, where all bid information is provided to the auctioneer beforehand;  
Iterative approach, where the economical bid is provided gradually during the auction;  
Hybrid approach, where an iterative phase is followed by a sealed bid phase.

In the case of sealed-bid mechanism, in order to ensure absolute transparency, the opening of the bid shall be executed at the bidders' presence.

## **2. Trade-off between reducing entry barriers and encouraging competition**

Although the requirements for a careful selection of the bidders, through an extensive legal, financial and technical track record in the field, can limit the participation of new and/or small players, it is important to guarantee the timely achievement of the financial closing and the projects' completion. Similarly, the requirement of a bid bond (i.e. an initial deposit to be lost in case the selected bidder withdraws the offer) with a price high enough as to discourage rash bids, may ensure reliability of bidders and of their submitted offers as proven in the *Zambian Scaling Solar* case.

In addition to bid bonds, rules related to project lead times, penalties for delays and the adoption of performance bonds (covering the entire construction period) are applied in order to discourage any construction delay in the achievement of the commercial operation date and to assure that the committed performances are met.

On the other hand, the assignment of liabilities to the transmission system operators (TSO) for delays in the construction of the grid or connection infrastructures owned by the TSO, contributes to the reduction of the investment risk.

## **3. Awarding selection criteria**

With reference to the awarding selection process, if the auctioneers aim to reach the lowest price, they shall opt for the lowest-price criterion. If instead it is in the country interests to focus on other selection criteria such as local content, local ownership, job creation, communities involvement, etc. (*South African case*) or such as bidders and manufacturers' track-

record or local ownership (*Ethiopian case*), the auctioneers shall very carefully select the awarding criteria as every non-monetary principle may lead to an increase in the final energy price to be paid by the off-taker and in a more complex selection process.

The auctioneers may also set a ceiling price above which bids are discarded but, in case this is not properly estimated, it could cause the awarding of a suboptimal amount of renewable energy.

## **4. PPA remuneration**

Remuneration scheme and the type of contract offered have a very high impact on the final energy tariff. The take-or-pay provision (whereby the off-taker has the obligation of either taking delivery of energy or paying a penalty) reduces the bidders and funders risk and shall be favored in order to ensure that no margin is included in the final offers and the energy price is the cheapest possible.

Another important factor is the tariff adjustment (to inflation, to exchange rate or a combination). Some programs, such as the *Zambian Scaling Solar*, do not foresee any indexation to the energy tariff, which remains flat for the entire duration of the PPA, but consider exchange rate adjustment of the tariff. In other cases full or partial indexation to CPI is considered (*South African REIPPPP* where instead no adjustment to currency is foreseen). In the case of the *Mexican auction*, on the contrary, the bidder can choose the option providing for a tariff partially adjusted for inflation and partially tied to the exchange rate for the US dollar. In those cases in which the offered tariffs are not corrected for inflation or foreign exchange rates, taking into account the possibility of high inflation rates over the PPA duration, the contract's value in real terms may be expected to substantially decrease and the bidder may decide to protect its investment return by increasing the tariff.

Contracts denominated in domestic currency

and without exchange rate adjustments are also generally seen as an obstacle for international players and can increase the cost of debt, especially in emerging countries facing devaluation. The off-taker guarantee of conversion to hard currency can reduce the risk perception as long as there's no risk of liquidity shortage.

#### **4. Reduction of risks perception**

The reduction of perception of risks may be achieved guarantying fair and transparent rules and obligations for all stakeholders. As mentioned in the previous paragraph, policy makers should simplify administrative procedures, set up an institutional and regulatory framework which ensures a predictable and stable environment for investments and mitigate the risks related to the financial market (inflation and currency exchange). Moreover, the reliability and creditworthiness of the off-taker, together with clear and balanced obligations and guarantees of both seller and purchaser in a PPA, play an important role in encouraging developers and lenders investments. Whilst in most mature electricity markets the government involvement can be minimized and the utilities are the contract off-takers without additional subsidies, in the countries where the off-taker cannot reasonably offer credible guarantees, the government support could be essential (see *Zambian and Ethiopian case*). A noteworthy example in term of risk perception reduction can be also the *Scaling Solar program*. The support of an international institution, such as the *World Bank Group*, to the auction program can foster the confidence of bidders and lenders as it happened in the *Zambian case*.

Finally, wherever possible, in order to promote investments from international players, governments and auction designers should limit restrictions on movements of capital and on repatriation of dividends and profits.

#### **5. Technical aspects of the auctioned projects**

In the auctions where the bidders are expected to identify the sites and autonomously develop the projects it is essential for the auctioneers to assess the maturity of the permitting status, grid connection, land rights, etc. More specifically, written assurance from the transmission and/or distribution grid provider that the substations/lines to which the projects are intended to be connected have sufficient capacity, may result in a higher project realization rate while avoiding unnecessary delays in the execution of the projects.

When, instead, the projects size and location are demanded to the auction authorities, it is very important to include in the bid package detailed studies of the selected project sites which will allow the participants to accurately evaluate the construction costs and related technical risks without adding any contingency costs impacting the final proposed tariff.

#### **Advantages of a successful auction program**

---

- **Credibility and financial attractiveness**

The scale of auction programmes attracts international investors and lenders and requires sovereign commitment. Therefore, the programme itself is seen as the investment framework rather than as individual projects and thereby market risk (or at least the risk perception) is reduced because all parties involved share risks and work collectively to mitigate these. Depending on the intended duration of the programme, international parties tend to establish local offices which may lead to further commitment to the credibility of the country.

- **Flexibility**

The flexible aspect of the design of auction pro-

grammes and their ability to be applied to a variety of different purposes is a strong advantage. This can be useful when adapting such programmes to the specific needs and targets of the country implementing the programme. For example, an auction programme can be used for procuring capacity or energy that is tailored specifically to the market structure of a country. Contracts can also be assigned and performed in a number of ways and can include a number of criteria at both the qualification and evaluation phase.

#### • **Competition**

Auction programmes can increase competition in the industry allowing the best, or lowest, price to be provided for a given product or service. Fair and open competition enables autonomous development, which accurately reflects potential and can lead to the creation of new industry sectors, stimulate the modernisation of infrastructure and create new employment opportunities. This of course requires regulations that are adequate and effective; however it is a good demonstration of the benefits of auction programmes.

The benefit of this is magnified by the nature of the renewables market, which is generally a rapidly changing context that is hard to predict. This makes aspects such as costs, market size and public awareness difficult to control through any fixed FIT schemes.

#### • **Social and Economic benefits**

One of the clearest advantages and strongest argument for auction programmes in the RE industry is the socio-economic aspects. Although this sits in the “second phase” part of the programme, it still forms part of the overall advantage of implementing such systems as the former brings the latter. Education and skills, welfare, management and planning, healthcare, and infrastructure development and employment are examples of the commitments these

auction programmes can bring.

The job creation aspect has enormous potential, with not only construction but also maintenance of renewables infrastructure. The potential is highlighted by its benefits to local communities where new infrastructure might be developed in places where these kinds of opportunities would usually be very limited.

### **References**

---

Anton Eberhard, University of Cape Town, Joel Kolker, World Bank Institute, James Leigland, Private Infrastructure Development Group, South Africa’s Renewable Energy IPP Procurement Program: Success Factors and Lessons

IFC, First ‘Scaling Solar’ Auctions in Zambia Yield Record Low Tariffs amid Electricity Shortages

Bloomberg New Energy Finance, Climatescope 2017

IFC Financing Advances Record-Setting Scaling Solar Project in Zambia

IEA, Mexico capacity and power auctions supported by clean energy certificates

Carlos Del Razo, A snapshot of the Mexican clean energy obligations system

José Maria Valenzuela and Isabel Studer, Climate change policy and power sector reform in Mexico under the ‘golden age of gas’

IRENA, Renewable Energy Auctions Analysing 2016 IRENA2016

IRENA and CEM (2015), Renewable Energy Auctions – A Guide to Design

Prof. Anton Eberhard and Thomas Käberger, ‘Renewable energy auctions in South Africa outshine feed-in-tariffs’ (2016) Energy Science & Engineering Journal 4(3) at 181-232.

Energy Intelligence (24 March 2016) 'REIPPPP: All you need to know!', available at <<http://www.energyintelligence.co.za/reipp-all-you-need-to-know/>> [accessed 10 December 2017].

Department of Energy (2015) Renewable Energy IPP Procurement Programme (REIPPPP) for

South Africa at 11, available at <[sastela.org/wp-content/uploads/2015/10/DoE-REIPPPP-for-South-Africa.pdf](http://sastela.org/wp-content/uploads/2015/10/DoE-REIPPPP-for-South-Africa.pdf)> [accessed 10 December 2017].

Lucy Butler and Karsten Neuhoff, 'Comparison of feed-in-tariff, quota and auction mechanisms to support wind power development' (2008) *Renewable Energy* 33(8) at 1854-1867.





---

## Managing local content requirements in renewable Energy project

---

This paper has been prepared by:

**McKinsey & Company**

---

Byron Ascott-Evans, *McKinsey & Company*

### Introduction

---

Many countries are endowed with natural resources, some of which are non-renewable (e.g., oil, minerals) and renewable (e.g., sunshine). To date, many examples exist of countries using their non-renewable resources (see Norway, Brazil, Qatar, South Africa, Australia) to propel themselves economically. Initially the resource is exported in its raw form generating export revenues (in generally strong currencies) but has resulting risks (e.g., revenues are susceptible to global volatility). Over time, a country shifts towards some form of local beneficiation to expand the extent of benefits (e.g., higher export revenues due to value-add). At both stages, a supply chain is needed that can provide the necessary goods, services and utilities. Given the magnitude of spend on goods, services and utilities, there is a significant economic opportunity for a country by instituting a local content policy.

Although traditionally renewable energy isn't exported (unless as electricity), the stages of development are similar – use the resource to generate revenue; over time, develop an ecosystem to expand the benefits. As many African countries start shifting their energy

mix to renewable energy given both their natural endowment and broader climate change objectives, significant investment will be required. This investment presents an economic opportunity for countries. As such, the importance of having a well-articulated and coherent local content policy will increase.

### A common understanding

Before proceeding, it is important to be precise on what is meant by local content as many definitions exist and different terms are used (e.g., local participation, indigenization, local sourcing). Simply, local content is the proportion of inputs to a product supplied from within a country. To be more specific this covers goods, services and utilities.

### Goods

- Manufactured locally
- Value-add activities conducted in the country
- Profit from sale of good retained in the country

## Services

- Compensation to locals for services rendered
- Value-add activities conducted in the country
- Profit from sale of service retained in the country

## Utilities

- Purchased locally
- Value-add activities conducted in the country
- Profit from sale of utility retained in the country

## Anchoring local content in a country's reality

As discussed before, renewable energy offers significant economic opportunity. If a country decides it wants to pursue renewable energy, any associated local content policy needs to be anchored in a country's overall energy policy so that it (i) accounts for the context and (ii) has a clear objective. This will ensure that the local content policy is specific, measurable, actionable, realistic and time-bound.

## Context

### Situation

Countries across the world are increasing renewables share of their energy mix due to the climate benefits and increased affordability of the technologies. This holds across the African continent (see South Africa as a significant adopter) as countries start to leverage their natural endowments.

## Complication

To leverage these natural endowments requires a few things. First, goods, services and utilities to build and operate these technologies. Many of these are not produced and/or found domestically. Second, a policy outlining the long-term energy needs of the country and the proposed energy mix to deliver this (e.g., an integrated resource plan). This policy doesn't always exist, or only in parts (e.g., across policy documents) leading to investment difficulties (e.g., unclear which technologies, when, what scale). Third, a government entity (or entities) that is performing well (on agreed KPIs, healthy balance sheet) to co-ordinate all energy stakeholders (public and private sector) and execute on agreed commitments.

There are three further considerations. First, the current and targeted future rate of electrification (and the split between urban and rural) given the resources and focus required to address gaps. Second, the quantity of renewable energy as there is a minimum threshold to justify the existence of local content. Third, the speed to have local content as it takes time to have the infrastructure, skills and know-how.

## Clear objective

Local content is one way to ensure a country captures the economic benefits of its renewable energy resources. There are others e.g., resource tax, local ownership requirements, job creation requirements. As such, a more specific objective is needed e.g., "create a centre of excellence in x by leveraging existing competence to achieve y and z". There can be several objectives. However, they should be the highest priority objectives (based on agreed criteria) and not overlap (e.g., issues should be discrete).

## Process to maximise local content benefits

---

Once the rationale for a local content policy for renewable energy is clear, the focus becomes how to design and then execute such a policy. There are four steps to follow: stipulate expectations on local content; establish supporting regulations; build local capabilities; and monitor progress and enforce rules.

Importantly, any local content policy should be designed and executed to minimize risk. Drawing on lean startup thinking, that is determining the minimum viable product on each step to test (i) whether the policy works and (ii) how well. This is critical because establishing a local content policy requires significant investment (e.g., time, money) and once started, is difficult to change. Further, if the first local content policy is unsuccessful (based on performance versus objective), it could not only jeopardize further local content policy in renewables, but also in other energy technologies and industries.

### Stipulate expectations on local content

Step 1: choose renewable energy technologies (e.g., solar PV, CSP, Wind) and average installed capacity (e.g., grid, mini-grid, home solution)

Step 2 (see exhibits 1-2): per technology, break down capex and opex spend into industry recognized components and sub-components. Using Solar PV capex as an example

- Components (examples): inverter; module; battery pack
- Sub-components (deep-dive on inverter): power electronics; power supply; assembly; casing

Step 3 (see exhibits 3-4): per technology, match each capex and opex sub-component (and hence component) to the value pools – goods, services and utilities

- Goods: basic materials; low-medium complex equipment and parts; highly complex equipment and parts; and integrated plant equipment and solutions
- Services: manual and low skilled labour; mid-tier skilled labour; technical support services; business support services; and management/EPCM
- Utilities: any good supplied by a utility (e.g., power, water, gas, fuel)

Step 4 (see exhibits 5-7): create assessment for local content potential. To do this, need to consider demand and supply dimensions, sub-dimensions and scoring on each

- Demand (applies to both goods and services): direct domestic demand; indirect domestic demand; and international/regional demand

- Supply

- Goods: skills capacity; manufacturing capacity; investment capacity; and regulatory capacity

- Services: skills capacity; people capacity; infrastructure capacity; and regulatory capacity

Step 5: conduct an audit on demand and supply dimensions and sub-dimensions for goods and services

Step 6 (see exhibits 8-9): using input from audit, assess local content potential of each capex and opex sub-component (using local content assessment) and roll this up to component and value pool. Using goods as an example

- Demand: determine at what level of aggregation the demand is sufficient

- Direct domestic demand: demand from renewable energy industry

- Indirect domestic demand: demand from other industries e.g., mining

- International/regional demand: direct demand

from neighbouring countries

- Supply: determine the time horizon (e.g., 0-3 years) to deliver goods based on current supply
- Skills capacity: level of skill and expertise in the economy
- Manufacturing capacity: capacity and experience of manufacturing facilities in the economy
- Investment capacity: extent of programmes and/or incentives to encourage investment
- Regulatory capacity: extent of conducive regulatory environment (e.g., encouragement of entrepreneurship and commerce)
- Step 7: agree on current local content requirement and evolution over time (including time to reach targets)

### Establish supporting regulations

- Step 1: assess the opportunity cost of regulatory intervention
- Ensure that local content policies aren't so strict that they damage buyer competitiveness
- Ensure that local content policies aren't so supportive of local suppliers that they dis-incentivize local companies to be competitive with multinationals
- Step 2: identify which existing regulations need to be changed (and how) and which need to be created. For example:
  - Require companies to produce "local content" business plans that include the following
    - Statement of commitment to objectives and regulations of policy
    - People and processes in place to communicate and monitor company's local content policy
    - Contracting policy for goods, services and utili-

ties from local sources

- Training plans, schedules, and skill-transfer programmes for locals
- Prohibit structuring of contracts that disfavor local companies (e.g., large bundled deals)
- Step 3: start process to change existing regulations and enact new regulations

Build local capabilities

Step 1: identify partners to address local capability gaps based on audit conducted previously. For example

- Consortiums for local sub-scale companies to pool resources
- Clustered allied industries to create network of mobile labour
- International renewable energy companies for direct knowledge and skill transfer, but also international training

Step 2: create a roadmap (highlighting priority 1, 2, etc. gaps) to address local capability gaps

Step 3: execute on roadmap

- Track progress and highlight issues or successes based on variance
- Conduct root-cause analysis to understand variance
- Adjust roadmap based on root-cause analysis

### Monitor progress and enforce rules

- Step 1: create quantity and quality key performance indicators (KPIs) and agree targets. For example
  - Quantity (not exhaustive): local procurement as a % of total procurement; total amount of spend on local suppliers; local supplier total sales; and total number of contracts awarded to local sup-

pliers

- Quality (not exhaustive): cost variance between contract unit price and international unit price; percentage of orders made under annual or several year contracts; percentage of orders in compliance with contract criteria; and percentage of orders delivered on time

- Step 2: develop standardized tools for companies to record, compute and track local content and progress versus KPI targets

- Step 3: establish

- Certifiers who will audit companies local content credentials and progress versus KPI targets using consistent and transparent methodology

- A regulator with enforcement authority to ensure that supporting regulations are adhered to

- A body to co-ordinate and track all local content efforts

- Step 4: consolidate data into dashboards (that can be aggregated at various levels) and draw insights

- Step 5: propose changes to policy design and/or execution including how to do this and the time over which this should happen

## Experience from other countries and industries

---

### Renewable energy: South Africa

- Successes

- The renewable energy independent power producer programme (REIPPP) had a 70:30 split between price and economic development when awarding bids

- The economic development component was further broken down – local content was only 25% of the 30% allotted to economic development

- Challenges

- Two-year (2016, 2017) freeze on projects led to the development of a local renewable energy supply chain not happening

- Four-year gap (2021-2024) in the future procurement of wind energy could lead to no/limited investment delaying the development of a local renewable energy supply chain further

### Oil and gas – success: Brazil

- Reached 60% local content in five years

- Clear definition by regulator for local content with targets that vary by sub-sector (targets applied in award of exploration blocks)

- National regulatory body with clear methodology for monitoring local content progress within the oil and gas sector

### Oil and gas – challenge: Nigeria

- No significant rise in local content for 10 years after implementing policy in 2000

- Very generic local content policies e.g., all operators are required to give preference to a local contractor

- No detailed target setting and tracking in place

### Key success factors

- Determine the extent of government's involvement and communicate this

- Government-enabled

o Any stakeholder (except government) is at the centre and does the work to make local content happen

o Government has a few tasks e.g., create and/or debottleneck policy, provide funding, enforce rules

- Government-facilitated

- Industry is at the centre and does the work to make local content happen

- Government has a few tasks over and above those in Government-enabled e.g., facilitate industry interactions, facilitate multiple stakeholder interactions (e.g., investors, government departments, universities)

- Government-led: government is at the centre and does the work to make local content happen

- Identify key stakeholders early and engage continuously. For example

- Ministry of Energy (co-ordinator if government-led policy)

- Other government departments/regulators: ministry of finance; ministry of education; energy regulator

- Energy industry: upstream and downstream players; industry organisations

- Other industries: clustered allied industries; basic supporting industries

- Academia/research: universities; research institutes; training institutes

- Public: labour force; public at large

- Other external stakeholders: foreign investors; DFIs; donors; WTO

- Provide policy transparency and stick to it. For example

- Explain rationale for local content target(s) and time frame

- Don't change local content target during and/or after a bid process

- Outline how policy can be challenged and/or reviewed and/or edited

- Determine levelized cost of electricity (LCOE) of renewable energy assuming various levels of local content vs. no local content and track over time

- Adjust policy over time based on learnings (according to outlined timelines and process)

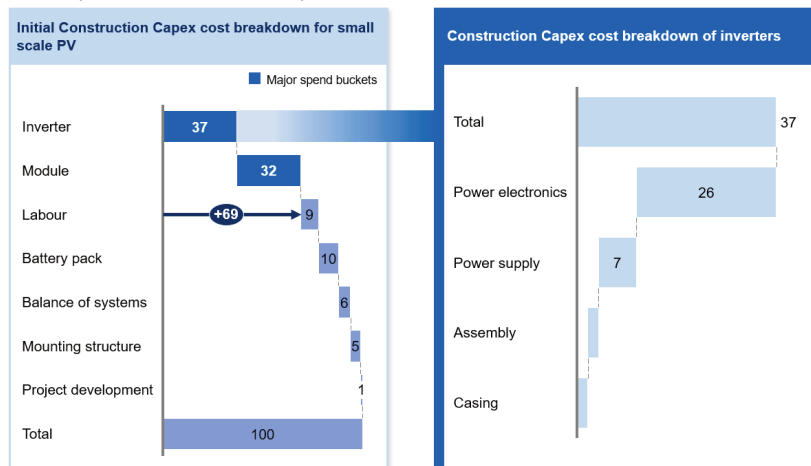
## Exhibit 1

SOLAR PV CONSTRUCTION CAPEX – TRADITIONAL VIEW BREAKDOWN

**The inverter and module account for a significant proportion (~70%) of initial Capex**

INDUSTRY VIEW

Percent (100% = ~RX/MWh LCOE)



<sup>1</sup> Excludes project contingency costs

SOURCE: Expert interviews; Team analysis; LCOE model (updated)



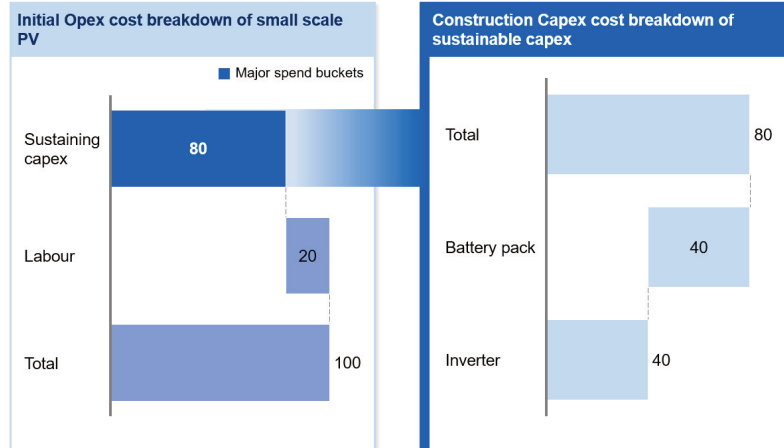
## Exhibit 2

SOLAR PV OPEX – TRADITIONAL VIEW BREAKDOWN

### Sustaining Capex accounts for a significant proportion (~80%) of total Opex

INDUSTRY VIEW

Percent (100% = ~RX/MWh LCOE)



SOURCE: Expert interviews; Team analysis; LCOE model (updated)



## Exhibit 3

SOLAR PV CONSTRUCTION CAPEX – VALUE POOL BREAKDOWN

### Splitting capex in the value pools shows that low to medium complex parts account for ~90% of initial Capex

Major spend buckets

Percent (100% = ~RX/MWh LCOE)

Cost categories		Examples	
Goods	1 Basic materials	0	
	2 Low to medium complex equipment and parts	91	<ul style="list-style-type: none"> <li>Modules</li> <li>Inverter</li> <li>Mounting structure</li> <li>Nuts and bolts</li> </ul>
	3 High-complex equipment and parts	0	
	4 Integrated plant equipment solutions	0	
Services	5 Manual and low skill labour services	2	<ul style="list-style-type: none"> <li>Installing cables across roof</li> <li>Mounting the modules</li> </ul>
	6 Mid-tier skilled labour	5	<ul style="list-style-type: none"> <li>Assembling the modules and inverter by an electrician</li> </ul>
	7 Technical support services	0	
	8 Business support services	2	<ul style="list-style-type: none"> <li>Designing the installation solutions across different areas</li> <li>Managing of IT system to track progress on large installation projects</li> <li>Acquiring customers</li> </ul>
	9 Management/EPCM	0	
Utilities	10 Utilities	0	
Total <sup>1</sup>		100	

<sup>1</sup> Excludes project contingency costs

SOURCE: Expert interviews; Press search; LCOE model (updated)





## Exhibit 4

SOLAR PV OPEX – VALUE POOL BREAKDOWN

### Low to medium complex equipment and parts account for ~55% of Opex

■ Major spend buckets

Percent (100% = ~RX/MWh LCOE)

Cost categories		Examples	
Goods	1 Basic materials	0	
	2 Low to medium complex equipment and parts	56	<ul style="list-style-type: none"> <li>Replacing modules</li> <li>Replacing mounting structure</li> </ul>
	3 High-complex equipment and parts	0	
	4 Integrated plant equipment solutions	0	
Services	5 Manual and low skill labour services	20	<ul style="list-style-type: none"> <li>Performing routine maintenance (cleaning solar panels)</li> </ul>
	6 Mid-tier skilled labour	24	<ul style="list-style-type: none"> <li>Replacing old/faulty components, by an electrician</li> </ul>
	7 Technical support services	0	
	8 Business support services	0	
	9 Management/EPCM	0	
Utilities	10 Utilities	0	
Total		100	

SOURCE: Expert interviews; Press search; LCOE model (updated)



3

## Exhibit 5

### Localisation potential matrix

EXAMPLE

		Sufficient demand			
		Direct domestic demand provides suitable size + lifetime for local industries (assuming 5GW installed capacity)	Indirect domestic demand can be developed from/to other sectors	SSA demand can be used to export skills technology + expertise	
Time Horizon <sup>1</sup>	Immediate (0 to 3 years)	Localised at 5GW	Potential to localise – Easy (Aggregate demand)	Potential to localise – Collaborative effort required	Do not try - Requires X to be globally competitive in an industry that can only sustain itself by supplying world-wide demand for industries requiring similar a technology
	Short-medium term (3+ to 7 years)	Potential to localise – Easy (Build local capacity)	Potential to localise – Collaborative effort required	Potential to localise – Sig investment required	
	Long term (7+ years)	Potential to localise – Collaborative effort required	Potential to localise – Sig investment required	Potential to localise – Sig investment required	

<sup>1</sup> Capacity includes skills, available investment, infrastructure and regulatory environment

SOURCE: Team analysis

4

## Exhibit 6

### Survey: Localisation potential of goods

EXAMPLE

Requirements for localisation			Scoring		
			1	2	3
Sufficient demand (D)	D <sub>1</sub>	Direct domestic demand	<ul style="list-style-type: none"> <li>Domestic demand can provide a suitable market size (critical mass) and lifetime for local industries to develop and grow</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>Domestic demand will not provide a suitable market size (critical mass) for local industries</li> </ul>
	D <sub>2</sub>	Indirect domestic demand	<ul style="list-style-type: none"> <li>Similar demand is already present in other domestic sectors, e.g., mining, manufacturing, etc</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>No similar demand in other domestic sectors exists</li> </ul>
	D <sub>3</sub>	International/regional demand	<ul style="list-style-type: none"> <li>Similar direct demand is already present in regional (SSA) markets</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>No similar direct demand in other regional markets</li> </ul>
Supply Capacity/ Time horizon (T)	T <sub>1</sub>	Skills capacity	<ul style="list-style-type: none"> <li>Already have an appropriate level of skill and expertise in the economy to provide goods and services locally</li> </ul>	<ul style="list-style-type: none"> <li>Can develop an appropriate level of skill and expertise over the short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can only develop appropriate level of skill and expertise over the long-term (at reasonable cost)</li> </ul>
	T <sub>2</sub>	Manufacturing capacity	<ul style="list-style-type: none"> <li>Readily available manufacturing facilities with sufficient capacity and experience to provide goods and services locally</li> </ul>	<ul style="list-style-type: none"> <li>Can develop manufacturing facilities with sufficient capacity over the short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can only develop manufacturing facilities with sufficient capacity over the long-term (at reasonable cost)</li> </ul>
	T <sub>3</sub>	Investment capacity	<ul style="list-style-type: none"> <li>Readily available investment requirements needed for local industry expansion</li> </ul>	<ul style="list-style-type: none"> <li>Can make investment requirements needed for local industry expansion available in short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can only make investment requirements needed for local industry expansion available in the long-term (at reasonable cost)</li> </ul>
	T <sub>4</sub>	Regulatory capacity	<ul style="list-style-type: none"> <li>Conducive regulatory environment that encourages entrepreneurship and commerce through limited bureaucracy and clear legislation</li> </ul>	<ul style="list-style-type: none"> <li>Can create conducive regulatory environment with small changes in short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can only soften a tough regulatory env that stifles entrepreneurship and commerce over the long term (at reasonable cost)</li> </ul>

SOURCE: Team analysis

5

## Exhibit 7

### Survey: Localisation potential of services

EXAMPLE

Requirements for localisation			Scoring		
			1	2	3
Sufficient demand (D)	D <sub>1</sub>	Direct domestic demand	<ul style="list-style-type: none"> <li>Domestic demand can provide a suitable market size and lifetime for specific service to develop and grow</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>Domestic demand will not provide a suitable market size for the specific service to grow</li> </ul>
	D <sub>2</sub>	Indirect domestic demand	<ul style="list-style-type: none"> <li>Can readily apply skills and expertise developed to other domestic sectors</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>No opportunity to apply skills and expertise developed to other domestic sectors</li> </ul>
	D <sub>3</sub>	International/regional demand	<ul style="list-style-type: none"> <li>Can readily export domestically developed skills and expertise to other regional markets</li> </ul>	<ul style="list-style-type: none"> <li>BLANK (demand can either be 1 or 3)</li> </ul>	<ul style="list-style-type: none"> <li>No opportunity to export developed skills and expertise to other regional markets</li> </ul>
Supply Capacity/ Time horizon (T)	T <sub>1</sub>	Skills capacity	<ul style="list-style-type: none"> <li>Already have appropriate level of skill and expertise for specific job in the economy to provide goods and services locally</li> </ul>	<ul style="list-style-type: none"> <li>Can develop appropriate level of skill and expertise for specific job in the economy over the short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can develop appropriate level of skill and expertise for specific job in the economy over the long-term (at reasonable cost)</li> </ul>
	T <sub>2</sub>	Supply capacity	<ul style="list-style-type: none"> <li>Already have appropriate number of people with level of skill and expertise for specific job in the economy</li> </ul>	<ul style="list-style-type: none"> <li>Can develop appropriate number of people with level of skill and expertise for specific job in short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can develop appropriate number of people with level of skill and expertise for specific job in the long-term (at reasonable cost)</li> </ul>
	T <sub>3</sub>	Infrastructure capacity	<ul style="list-style-type: none"> <li>Already have appropriate infra in place to teach and develop skills and expertise for specific job (e.g., college, teachers, etc)</li> </ul>	<ul style="list-style-type: none"> <li>Can put appropriate infra in place to teach and develop skills and expertise in short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can put appropriate infra in place to teach and develop skills and expertise in the long-term (at reasonable cost)</li> </ul>
	T <sub>4</sub>	Regulatory capacity	<ul style="list-style-type: none"> <li>Already have regulations in place that encourages development of skills and expertise in specific job (e.g., tax exemptions, subsidies, etc)</li> </ul>	<ul style="list-style-type: none"> <li>Can implement regulations that encourage development of skills and expertise in short-medium term and at reasonable cost</li> </ul>	<ul style="list-style-type: none"> <li>Can implement regulations that encourage development of skills and expertise in the long term (at reasonable cost)</li> </ul>

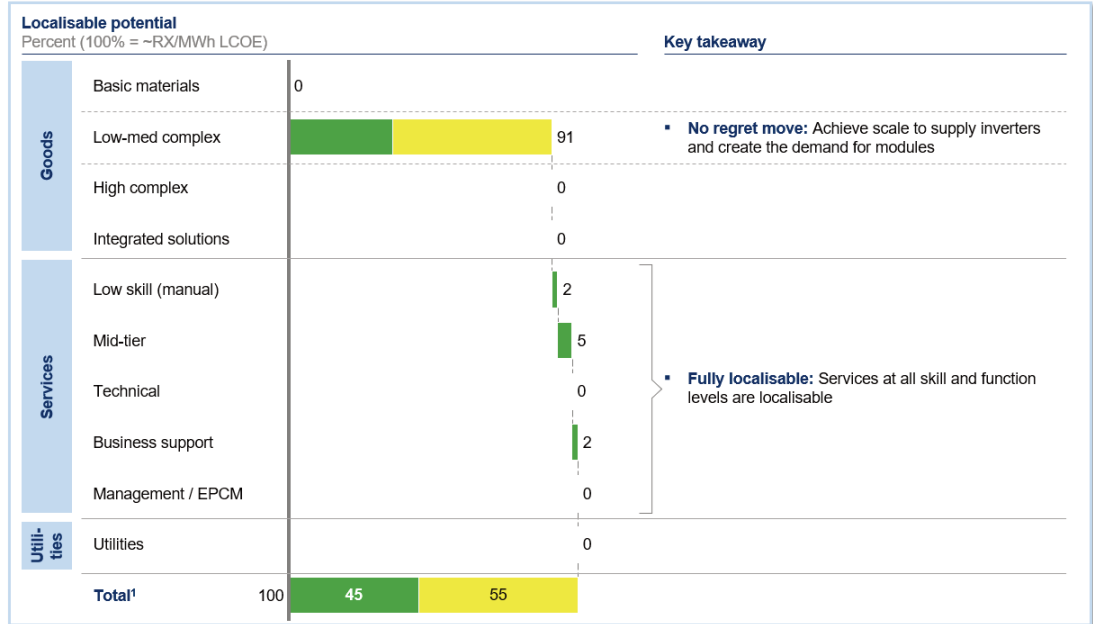
SOURCE: Team analysis

6

## Exhibit 8

SOLAR PV CONSTRUCTION CAPEX – VALUE POOL BREAKDOWN

**Capex is ~45% localisable with ~55% no regret moves in low-med complex parts and equipment**



<sup>1</sup> Excludes project contingency costs

SOURCE: Localisation potential workshop; Expert interviews; Team analysis

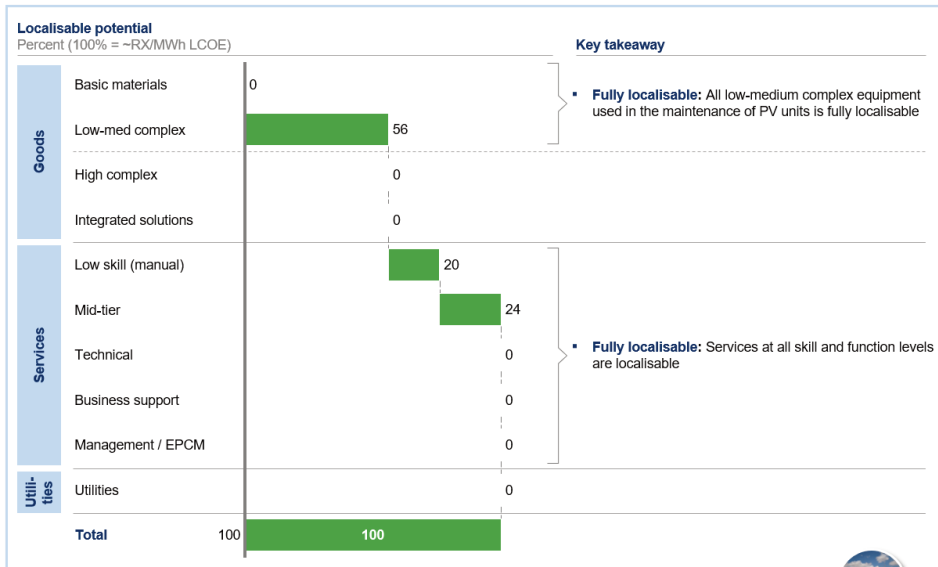
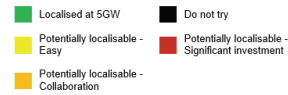


7

## Exhibit 9

SOLAR PV OPEX – VALUE POOL BREAKDOWN

**OpeX is ~100% fully localisable across goods and services**



SOURCE: Localisation potential workshop; Expert interviews; Team analysis



8

---

## Renewable energies, sustainability, and humandevelopment: a multifaced relation

---

This paper has been prepared by:



---

Antonella Santilli, EGP

### Abstract

---

*Abstact: In a world that is marked on one hand, by massive inequities in living conditions, and on the other, by real threats to the prospects of human life in the future, access to affordable, reliable and sustainable energy is deeply interlinked with human development. The renewable private sector can plays a real contribution in making the planet more sustainable, by integrating business with sustainability, profit within ethics, so to switch from a linear logic to a circular one that not only arrests the negative but also bring forward the frontiers of new possibilities, and reverse the course.*

### Sustainable energy is key for intergenerational welfare

---

In a world that is marked on one hand, by massive inequities in living conditions, and on the other, by real threats to the prospects of human life in the future, access to affordable, reliable and sustainable energy is deeply interlinked with human development.

On one side, access to energy is key for social and economic development, as it represents the building blocks empowering individuals, communities and economies by providing lighting, heating, communications, and transports.

This is why access to energy can be considered an instrumental right, enabling the pursuit of other fundamental human rights. Access to energy underpins many aspects of a healthy, sus-

tainable economy. Following this line of thought, governments worldwide have set global targets for energy access in Sustainable Development Goal 7, which aims to ensure “universal access to affordable, reliable, sustainable and modern energy for all” by 2030. Indeed, this is one of the global goals Enel Group has taken a public commitment on, under the UN Global Compact. Today, with twelve years to achieve to achieve this goal, almost one billion people still lack electricity, and 60% of them are located in Africa.

On the other, integration of human progress and environmental protection has emerged as one of the central challenges faced by the modern world. Recently, the last Intergovernmental Panel on Climate Change (IPCC) report has highlighted how limiting global warming to

1.5°C will require extreme changes, including substantially increasing the percentage of electricity from renewables by mid-century. The study presents a wide array of possible scenarios that would draw down emissions and keep warming below 1.5°C, including a middle range one, which requires that renewables make up 70 to 85 percent of electricity by 2050. Moreover, climate change will not hit all countries alike. Low-income ones will be on the frontline of human-induced climate change over the next century, experiencing gradual sea-level rises, stronger cyclones, warmer days and nights, more unpredictable rains, and larger and longer heatwaves, according to the same publication. In particular, East Africa can expect to experience increased short rains, while West Africa should expect heavier monsoons. Life in many developing country cities could become practically unbearable, given that urban temperatures are already well above those in surrounding countryside. Much higher temperatures could reduce the length of the growing period in some parts of Africa by up to 20 percent, the report said. Indeed, the global NGO Oxfam predicted that world hunger would worsen as climate change inevitably hurt crop production and disrupted incomes. They suggested the number of people at risk of hunger might climb by 10 percent to 20 percent by 2050, with daily per-capita calorie availability falling across the world.

If access to energy is fundamental for socioeconomic development, access to renewable energy plays a fundamental role in guaranteeing the future of it. Indeed, the transformational power of green energy – given also its competitiveness - lies in the fact that it provides a much needed balanced answer to the energy trilemma linking energy security and reliability, affordability and equity, and environmental sustainability. Renewable energy technologies are better placed than ever to contribute to individual prosperity by delivering reliable, affordable, and sustainable energy, considering not only today's generations but

also future ones. In this sense, it is a crucial element of sustainable development, defined as non declining welfare over time.

### **The role of private sector in sustainable development**

---

It becomes then evident then that the renewable private sector can create impact, that goes beyond, or better said together, the opportunity to do business.

Indeed, over the last years not only Governments, but also businesses have been increasingly including sustainability in their goals, starting from the assumption that, in order to change the world, a company must be compelled to first change the way it operates in its local turf.

The Enel Group was the world's first utility to set the ambitious task of reaching carbon neutrality by 2050. Enel is blazing the path of energy transition as it bases its business strategy on three pillars: the development of renewables, a push for digitalization and the mitigation of climate change. So far, this journey has led Enel to generate close to 50% of its energy from zero-emission sources.

Moreover, the Group has implemented sustainability at the core of its business model, by including it in the industrial plan, as well as taking public commitments at the UN Global Compact platform on SDG 4 (Quality education), 8 (Decent work and Economic growth) and 13 (Climate Action), besides the above mentioned SDG 7 (Access to clean, reliable, affordable Energy).

Our results show that integrating sustainability has become a competitive advantage to build our company's prosperity, that of communities hosting our assets, our suppliers and our clients, and to continue meeting our long-term business objectives along the way.

If universal access to energy is to be truly achieved, we have to consider it as an oppor-

tunity to do business as well as to advance human rights. A central point here is that ethics is not to be separated from economics. There is not profit on one side and moral duty on the other. This is not charity, greenwashing or cynicism using human rights to let the capital grow, because there is a dependency relation between the two: certainly sustainable economic development – brought forward also by renewable energies - can enhance human rights achievement, but also the attainment of human rights can boost economic growth. For example, human development, in the form of people being better educated, more healthy, less debilitated, and so on, is not only constitutive of a better quality of life, but it also contributes to a person's productivity and her ability to make a larger contribution to the progress of material prosperity.

However, it is important here to clearly distinguish the mean from the end. What has to be avoided is an inversion of objects and instruments that see human beings as merely the means of production and material prosperity, taking the latter to be the end of the causal analysis. The business price of not doing this, is taking a short term vision that on the long run will destroy, instead of creating, value.

Building on the apparently simple idea that our business is not and end in itself, Enel Green Power (EGP) has asked itself if is being renewable can be enough to be sustainable. This maybe trivial questions has triggered major changes, transforming all internal processes inside the company, particularly in the business value chain. In our opinion, the two concepts do not perfectly coincide. As stated above, it is true that renewable energies are a fundamental part of the answer to the threat menacing our future; however they still have environmental, social, and cultural impacts, no matter how comparatively smaller they can be.

This is the reason why we have started to rethink our basic value chain and underlying processes, i.e. business development, engineering and construction and operations and main-

tenance, through the lenses of Creating Shared Value (CSV) approach. This framework states that business opportunities can constitute at the same time answer to societal needs, thus reconciling the “doing well, by doing good”. A set of CSV tools has been created so to assist business developers, construction managers and site supervisors (among others) to perform their work in a sustainable way.

Moreover, if our impacts still need to be mitigated, in order to be not only green but also fully sustainable, we have created the so-called Sustainable Pillars that are to be applied in our offices, construction sites, plants. The starting point has been the thought that if we are sustainable in our workspaces, then we will be so in all the actions we perform in those places. These standards apply the same framework: measuring and ex ante mitigating impacts on water, waste, emissions and people, and offsetting those that cannot yet be eliminated. The first three categories need to be lowered, since the plant/office design phase. To make things a bit clearer, once we have completed a socio-economic environmental context analysis for each site, we can understand what areas need to be prioritized. Depending on this context analysis, we do not believe in universal solutions, we can for example install in desert construction sites water treatment systems allowing the reuse of grey waters. In order to lower CO2 emissions, we can provide clean energy to our site camp though PV panels thus drastically reducing diesel consumption.

Conversely, the latter impact, the one on people, need to be maximized, as it encompasses all those actions aiming at training and employing local people at our sites as well as strengthening the local supply chain.

By turning sustainability into a business strategy, we commit ourselves to perform our job, our core business, that it developing, building and operating renewable plant, in the most possible sustainable way.

By doing this, we have proven wrong two false myths on sustainability. The first sees it as

something episodic, like a touch of color. When we say sustainability, we are saying systematic. The sustainable construction site, plant and office models represent a systemic approach pervading all our spaces, all our activities.

The second false myth considers sustainability just as an added cost. Actually, by recycling water and avoiding diesel consumption we are saving money, even taking into consideration the investments for water and PV systems.

We have concentrated on environmental and social impacts of our plants, focusing on natural ecosystems preservation, education and job creation. However, thanks to the continuous dialogue with local communities hosting our plants, we are increasingly working also towards cultural dimension.

As we have already seen, we develop, build and operate renewable energy plants, in the belief that access to affordable, reliable and sustainable energy is not only our field of business but also a fundamental human right. However, these energy plants are not isolated but they occupy spaces rich in natural, social and cultural dimensions. Land is never just a physical concept, and this is even truer for some cultures. It can be a cultural space, where spirituality, traditions, history and rites are enrooted. Therefore, the place in which a plant is built is never neutral. If it is true that relationships among people can only exist when there is

recognition of the other, then giving space to other visions – visions that may be different but not necessarily incompatible to those held by a renewable company - is an integral part of our dialogue with the people who host us.

This is the reason why for example in Australia, visits to our solar farms are not conducted – as we usually would have done so far - by our technicians, but by Nukunu people living near our plant. Once we have acknowledged the cultural dimension of the land for Aboriginal people, we have preferred that they could guide visitors not only through the technical aspects (on which we have provided training to them), but also to the spiritual ones their land hosting our plants has got. Moreover, we have just published a photo on some of the Indigenous communities we relate with around the world. This publication combines photos and texts dwelling into the meanings of wind, sun, land and water (the energy sources for us) have in their respective cultures.

By answering a simple question regarding the relation between renewable energies and sustainability we have changed our way of doing business, taking into the picture the far-reaching nexus among economic, environmental, social and cultural dimensions.

Mary Wollstonecraft, the pioneering feminist “It is justice, not charity, that is wanting in the world”, and private sector can play a role in contributing to deliver it.

---

## Addressing financial risks in RE investment in South Central Africa

---

This paper has been prepared by:



---

Riccardo Biciato, *BonelliErede* – Patricia Pingarron, *EGP* – Andrea Renzulli, *Poyry*

### Abstract

---

*The cost of renewable energies technologies has decreased rapidly in recent years, making them more competitive with fossil fuel technologies. Despite this, global investments in renewable energies remains below its potential, above all for the perception that private investors have about potential financial risks. This paper identifies the potential financial risks and how to address them, focusing in guarantees and hedging instruments, that can reduce or reallocate investment risks. Furthermore, the paper assess the main criticalities to consider when structuring the project financing, ensuring the proper conditions for bankability.*

### Introduction

---

The electricity sectors of south-central Africa countries, which have historically suffered from a lack of efficiency, are progressively taking the path of the transformation towards a more competitive, sustainable and affordable model. This process is led mainly by two factors: first, the need to increase power generation capacity in order to sustain the growing demand and to extend the electricity access to all; second, the need to find new competitive and sustainable ways to ensure this growth. Renewable energies (RE) are at the core of this process, thanks to the high renewable potential of those regions. Renewable Technologies (wind, solar PV, geothermal) are becoming more and more competitive with fossil fueled power genera-

tion, with their costs expected to further decrease in the next future. As a result, direct public support is becoming less fundamental for the development of renewables globally. Moreover, renewables, and in particular solar PV, are interesting options for allowing electricity access in remote areas. In fact, due to its scalability, solar PV, fits perfectly with different types of off-grid solutions for the electrification of rural areas, from households systems to larger hybrid systems combining solar energy with diesel generators or storage solutions. Those factors explain the recent growth of RE in developing countries, which are progressively investing in such technologies: for example, Bolivia, Honduras, Senegal and Jordan are today among the top-five countries in terms of RE investments in proportion to national GDP.



However, the large investments required to face the increasing energy demands have to deal with the limited public expenditure capabilities of such countries. Therefore, private investors can play a pivotal role becoming the real enabler of the energy transition in such geographies.

Because of their high renewable potentials and captive local demands, developing countries are progressively gathering private investors' interest. There, however, investors have to cope with higher risks, which may undermine the bankability and profitability of their projects. In fact, the investment framework for renewables is at its preliminary stages, particularly in south-central Africa region, and there is still space for improvements.

As far as today, for instance, financial risks in south-central Africa countries remain particularly high for private investors, which struggle to find good conditions from moneylenders. In particular, country risk evaluations of African states remain mostly negative due to the general perception of local political and financial instability. Unstable legislative and regulatory frameworks also contribute to raise the risk perception of commercial money lenders. Moreover, the weaknesses of local financial sector reduce the possibility to find easy access to local banks.

From an investor perspective this situation results in higher risk price required from the money lenders, affecting the competitiveness of the potential projects. This situation becomes even more impactful for renewable capacities with respect to conventional ones. In fact, comparing the cost of generation (the so called Levelized Cost of Electricity, LCOE) of renewable and thermal plants, we notice that the former depends mostly on the investment costs while the latter is largely influenced by the costs of the fuel used for generation.

As a result, thermal power plants competitive-

ness depends mostly on the costs of fuels and is less exposed to the variability of project financing arrangements than renewables. Therefore, in a developing country where cost of equity and debt is significantly higher, the impact on the LCOE results much higher for a renewable plant putting at risk the competitiveness of RE and pushing them out from those markets.

Since its beginning, RES4AFRICA has pointed out that efficient and well-targeted de-risking strategies are key to enable RE development in south-central Africa countries. This paper goes in the same direction and investigates the financial risk environment in the south-central Africa Region, mainly in Zambia, in order to illustrate the best practices and the efficient strategies that public authorities and private investors could adopt to ensure the development of renewable in this region.

### **Financial risks analysis**

---

Investment in renewable energies require significant upfront investments. From an investor's perspective, this means in case of investments in developing countries they need to have mitigations in place against different risks. Investors usually prefer to have sixty to eighty percent of the investment financed through project finance.

Risk mitigation becomes paramount and the use of financial de-risking instruments coupled with a sound policy can reduce the financial overall costs of renewable energy investments and help attract both debt and equity capital at scale. Project risk can be of different nature: political and regulatory risks, credit and counterparty risks, operational risks (grid, transmission and resource), financial risks (currency, liquidity and funding). This chapter will be focused on financial risks affecting the structuring phase and, commonly, divided into the following categories:

- Counterparty Risks
- Long/short term financing availability
- Interest rate risks
- Exchange rate risks
- Currency convertibility
- Inflation risks

### *Counterparty Risks (Off-taker)*

One of the main issues to be considered when presenting a project for financing is the analysis of creditworthiness of the off-taker (counterparty) of the PPA. For ensuring best financing conditions minimizing financial risks and reducing financial cost, it is fundamental that the counterparty has a good credit quality (credit rating), normally measured by external rating agencies.

A good counterparty financial health ensures the possibility of giving the necessary guarantees, in terms of payment delays, termination clauses etc, requested either by the financing institutions or by the energy producers.

It is possible, that the counterparty is lacking or having an insufficient official rating. In this case, it is necessary to provide the proper guarantees, being possibly issued by state institutions, assuring the risk mitigation in case of an unexpected change in counterparty's solvency.

### *Long/short term financing availability*

Normally the limited availability of local project finance is a key obstacle in investing in renewable energy, especially in developing countries where the RES investments are a first time. This manifest itself through less favorable lending terms such as high cost, short tenor and variable rates along with corporate guarantees from the equity sponsors of the project.

In order to improve the access to affordable

capital, multilateral finance institutions may provide loans for renewable energy projects in developing countries. Development Finance Institutions aim to leverage private investment for projects that are close to commercial viability, have large potential developmental impacts, but are in sectors or countries where commercial banks are reluctant to invest due to perceptions of excessive risk. By investing their own resources in projects, Development Financial Institutions seek to mitigate these risks and so give private investors the confidence to invest. A number of instruments are employed to achieve this: investment (loans and equity), risk mitigation (for example loan guarantees), advisory services (to governments), and project preparation and development services.

Another type of mitigation could be the use of institutions as MIGA and IDA Parent Risk Guarantee:

- MIGA is an international financial institution, an arm of the World Bank group which offers political risk insurance and credit enhancement guarantees helping investors to protect foreign direct investments against political and non-commercial risks in developing countries;
- IDA, another arm of the World Bank Group through its Partial Risk Guarantee, covers private lenders or investors against the risk of a government (or government –owner entity) failing to perform its contractual obligations with respect to a private projects.

Given the nature of the RES projects with PPA from Government fixed for a tenure of 20 to 25 years, the investors prefer having long-term project finance available through the Development Financial Institutions for their investments.

The right government policies could help encourage more long-term investment in productive activities, but these activities should be

managed in a way that mitigates the need for additional financing sources, as there is no guarantee that a shortage of liquidity can be compensated by drawing new debt during the lifecycle of the investment.

A shortage of liquidity can happen for bad management or, likely, for low counterparty creditworthiness reasons. Moreover, in emerging Countries, there is a real possibility that revenues denominated in local currency cannot be converted into the functional currency having convertibility complications. This issue could be faced by entering into commercial agreements providing revenues denominated or indexed in the functional currency. For the reasons mentioned above, one of the most significant financial risks is the liquidity risk, which is the risk that a company, while solvent, would not be able to discharge its obligations in a timely manner or would only be able to do so on unfavorable terms owing to situations of tension or systemic crises (credit crunches, sovereign debt crises, etc.) or changes in the perception of company riskiness by the market. The risk management policies should be designed to maintain a level of liquidity sufficient to meet the obligations over a specified time horizon without having recourse to additional sources of financing as well as to maintain a prudential liquidity buffer sufficient to meet unexpected obligations. In addition, in order to ensure the discharge of its medium and long-term commitments, the company should pursue a borrowing strategy that provides for a diversified structure of financing sources to which it can turn and a balanced maturity profile.

#### *Interest rate risk*

The main source of exposure to interest rate risk is the variability of financial terms, in case of new debt, or the fluctuation in the interest flows associated with floating-rate debt. Investors can mitigate interest rate risk through financial contracts like forward contracts, in-

terest rate swaps and futures. The main scope is to reduce the uncertainty of changing rates affecting the value of their investments. Forward contracts are agreements between two parties with one party paying the other to lock in an interest rate for an extended period of time. This is a prudent move when interest rates are favorable. Of course, an adverse effect is the company cannot take advantage of further declines in interest rates. Interest rate swaps are agreements between two parties in which they agree to pay each other the difference between fixed interest rates and floating interest rates. Basically, one party takes on the interest rate risk and is compensated for doing so. Futures are similar to forward contracts and interest rate swaps, except there is an intermediary. This makes the arrangement more expensive but there is less chance of one party failing to meet obligations. This is the most liquid option for investors.

#### *Foreign exchange risk*

Loans in foreign currency could appear more attractive given that seemingly cheaper, long term, fixed-rate have the potential to reduce the cost of financing renewable energy investments significantly. When financing a renewable energy project by a foreign loan, the mismatch between the currency of debt obligations and the Power Purchase Agreement (or tariff revenue), normally denominated in local currency, exposes the project to the risk of devaluation of the local currency over time. The devaluation could imply lower returns for the project and, more important, the reduction of investments in the country due to currency risk.

Moreover, there could be also other currency risk coming from the following activities:

- cash flows in respect of dividend from foreign subsidiaries or the purchase or sale of equity investments

- financial liabilities assumed by developing company or the individual subsidiaries denominated in currencies other than the currency of account or functional currency of the company holding the liability
- financial assets/liabilities measured at fair value

It is necessary to use a currency hedge with a third party provider to protect against currency risk. Hedging solutions, usually in form of financial derivatives on over the counter markets, can be limited in availability but also expensive in emerging countries, increasing the financial cost of debt and therefore offsetting the initial benefit coming from cheaper foreign loans. Additionally, there are cases when counterparty risk and foreign exchange risk interact in a way that can make the hedging transaction ineffective (wrong way risk): in case of a severe currency shock, due to economic, financial or political reasons, the whole financial system might be affected and local banks could face difficulties in meeting their obligations under the derivative contracts. Governments in emerging countries need to recognize the role of currency hedging mechanisms could play in expanding renewable energy capacity and contribute to develop currency markets accordingly.

### *Inflation risk and TAX risk*

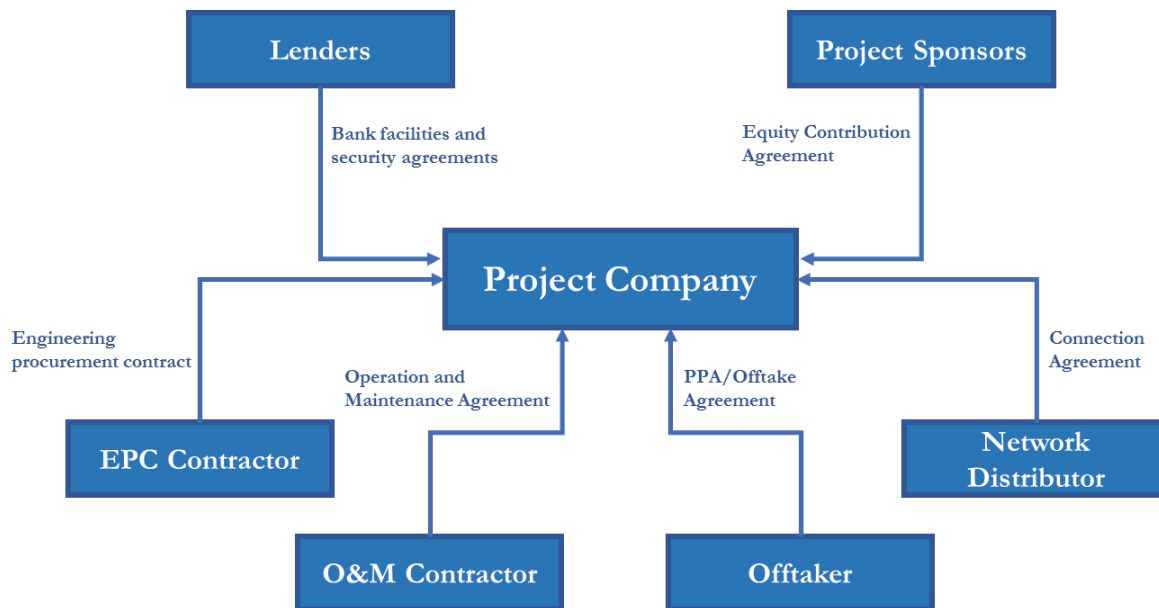
There are country-linked risks affecting the financial performances, though they do not lay completely within the financial risk management boundaries. Inflation risk (or Purchasing Power risk) is the chance that the value of the cash flows from an investment will change in the future because of changes in purchasing power due to inflation. In emerging Countries, inflation can be high and increasing, with a significant volatility, which in turn could drive the volatility of the returns. The most effective way of mitigating this risk is indexing the revenues to inflation.

Tax risk is the chance that the cash flows will suffer unforeseen tax consequences, such as additional tax payments, higher tax administration costs or lower deductibility of costs. Tax risk can arise from existing tax laws, from future changes in tax laws or from company practices. In emerging Countries, the tax risk is often linked to a political instability (political risk). The basic principles of tax risk management are seeking to address potential issues as soon as possible and allocating the proper Change in Law clauses in the formulation of the PPAs.

### **Bankability issues in project finance**

Securing financing for a renewable energy project in a developing country depends on a careful analysis of the bankability issues that will be faced throughout the project, i.e., from construction to operation. Although many structured finance mechanisms and capital market instruments are available, the most common form of financing large scale renewable projects in a developing country remains project financing. A project is bankable if the construction (or pre-completion) and the operational (or post-completion) risks have been appropriately allocated to the various players, in form and substance satisfactory to the lenders. To assess the bankability issues, lenders take a comprehensive view of the contractual network to be implemented by the project company. Lenders focus not only on the content of contracts but also on how they interplay (e.g., EPC and O&M), since many project risks may not be fully mitigated within the scope of just one contract.

Every project has its own contractual structure: the chart below shows a typical contract framework for a renewable project.



It is essential for a project sponsor to clearly identify the project risks after duly considering the peculiarities of the market where the project is to be developed (regulatory and political environment, foreign exchange volatility, transmission infrastructure, etc.) and to correctly allocating these risks in the contractual framework to limit the lenders' recourse to the sponsor and limit the financing costs as much as possible. This section analyses the main bankability issues – from a project finance perspective – that need to be addressed in the key contracts during the construction and operation phase and the impact on the financial structure if not correctly mitigated or appropriately allocated. For the purpose of this section, the analysis will be limited to the Engineering, Procurement and Construction Contract and the Power and Purchase Agreement, which by their nature are critical for the construction and operation phase of a renewable project.

### Engineering Procurement and Construction Contract (EPC)

The EPC Contract is a turnkey agreement by which the project company allocates the construction risks of the project to a third party, the EPC contractor. There are many contractual structures that a project company may consider for the construction phase, which will be influenced on a number of factors such as timing, whether the project costs will be financed by equity or through a debt financing, or whether the sponsor has the capability to perform part or all of the work. If the purpose of the facility is to finance the project costs rather than refinance costs already paid by the project sponsors, having only one EPC Contract is – from a strictly legal perspective – the preferable way to transfer, in one integrated package, all the risks that lenders want to see addressed before considering a project contract actually bankable. The following table lists some of the key risks that EPC contracts aim to cover, together with possible mitigations, which may trigger recourse to the project sponsors, or higher financing costs, if not satisfactory to the lenders.

<b>Risks</b>	<b>Key concern</b>	<b>Mitigation in case the risk is not addressed in the EPC Contract</b>
<b>Single point of responsibility</b>	The lenders want the project company to deal with a single point of responsibility	<p>If the EPC contractor is represented by a consortium: all members must be jointly and severally liable.</p> <p>If there is a split EPC Contract (e.g. balance of plant contract and supplying and commissioning contract) the following mitigations may be put in place:</p> <ul style="list-style-type: none"> <li>• wrap-up guarantee to be issued by one of the contractors guaranteeing the obligations of all the contractors</li> <li>• interface and coordination agreement to, among other things, deal with the interference risks among the contractors and to resolve and settle any disputes that arise in</li> </ul>

		performing the works
<b>Completion date</b>	<p>A fixed completion date or a date within a fixed period of time from the execution of the EPC Contract shall be guaranteed by the contractor.</p> <p>The project company shall often comply with timing obligations provided in other contracts (e.g. finance documentation and PPA)</p>	<p>Delay liquidated damages (DLDs) to compensate the project company for loss and damages due to the delay in completing the work.</p> <p>The payment obligations for DLDs shall be secured by a bond or a retention on each payment or a parent company guarantee.</p>
<b>Fixed price</b>	Avoid cost overrun	Specific provisions to prevent the revision of the contract price, as far as technically and legally possible, save for variations which will be subject to the approval of the lenders (so called reserved discretions).
<b>Performance</b>	Ensure that the plant performs as foreseen in terms of reliability and output	<p>Performance liquidated damages (PLDs).</p> <p>Right of rejection if the plant performs below the minimum level.</p> <p>The payment obligations for PLDs must be secured by a performance bond, a retention on each payment or a parent company guarantee.</p>
<b>Cap on liability</b>	To benefit from a large cap on the contractor's liability as most contractors refuse to accept an unlimited liability under the EPC contract	The cap should be at least equal to the contract price with a sub-cap for DLDs and PLDs to be appropriately allocated taking into account the features of the project.
<b>Warranties</b>	In renewable projects, it is essential that the project company directly benefits from the manufacturers' warranties and have them	Agreement by and between the contractor, the project company and the manufacturer.

	assigned on the project completion date or in case of contractor's default or bankruptcy.	Security over the warranties for the benefit of the project company and the lenders.  Insurance products that guarantee the required output to be considered if manufacturer warranties are not obtainable.
<b>Serial defects</b>	In renewable projects, which often use a large number of same components, it is critical to be protected against the same defect that may affect a group of components.	Provisions in the EPC contract specifically addressing this risk (e.g. testing procedure and replacement obligations at the cost and expense of the contractor).

*Power Purchase Agreement*

The other key contract which has a critical impact in the financing structure of a renewable project in a developing country is the Power and Purchase Agreement (PPA). A PPA is a long-term contract aiming at mitigating the market risk reducing the

volatility of the expected cash flows from the operation of the project. The following table lists some of the key risks that shall be addressed in a PPA to consider it bankable:

<b>Risks</b>	<b>Key concern</b>	<b>Mitigation in case the risk is not addressed in the PPA</b>
<b>Offtake</b>	Cover fixed costs of the plant, return on investment of the project sponsors and debt service	Off-taking obligations on a take-or-pay or take-and-pay basis
<b>Foreign exchange</b>	Protect the project from a currency risk to the extent the off-taker's payment obligations are in a currency different from the project company's financial debt	Off-taker's payment obligations denominated in or linked to the exchange rate of the same currency of the power producer to avoid/mitigate the currency risk
<b>Change in law (including tax)</b>	Protect the cash flow of the project from change in law	Allocate to the off-taker any change in law (including tax)



	that may reduce it	
<b>Termination</b>	Inability to repay the financial debt in case of termination / revocation of the PPA	Termination payment at least equal to the outstanding amount of the project financing and, in case the termination occurs due to a default attributable to the off-taker, the termination payment should also cover a return on equity
<b>Connection to the grid</b>	Failure / delays in providing the connection to the transmission system or to provide sufficient load and dispatch for plant  Testing	Clearly allocate this risk to the off-taker

The creditworthiness of the off-taker is another important bankability issue to be considered in a PPA. An inadequate creditworthiness of the off-taker, depending also on the size of the project and the maturity of the energy sector in the relevant country, may require a sovereign guaranty or other form of financial support (e.g. a short-term liquidity facility) to support the off-taker's payment obligation. In certain projects, in particular those guaranteed by and export credit agency, a sovereign guarantee will be the only instrument to enhance the bankability of a project when the reference energy market is at an initial phase of its development and when there is not enough confidence on the creditworthiness of the government entity that will purchase the energy.

### Impact on the financial structure

Bankability issues in a project, such as those mentioned above, have a direct impact on the financial structure of a given project in terms of higher recourse over the project sponsors, worse terms and conditions of the facility

agreement and higher financing costs related to the project.

### Recourse on the project sponsors

In principle, whatever risks that is considered excessive by the lenders or that cannot appropriately be assessed or mitigated within the contractual framework of a project must be backed by the project sponsors. The recourse on the project sponsors may be less or more limited - in terms of amount and tenor - depending on the nature of the risk to be mitigated. It may be in the form of a sponsor guarantee or in the form of equity contributions either by way of subordinated debt or capital injections. By way of example, an equity contribution may be used to cover overrun costs or in case of underperformance of the plant, to reimburse part of the outstanding debt to bring the debt to equity ratio to a more acceptable level for the lenders.

### Deterioration of terms and conditions of the facility agreement

The terms and conditions of the facility agree-

ment reflect the assessment of the overall risk-iness of the project by the lenders. Risks that cannot appropriately assessed or allocated may result in a deterioration of the terms and conditions of the facility agreement such as:

- More conservative debt to equity ratio;
- Shorter tenor of the debt;
- Need for a stand-by facility;

- Higher arranging and commitment fees; and
- Stringent representation and covenant.

*Financing cost related to the project*

The risk mitigation strategy may also result in an increase of the overall costs of the financing arrangement of the project.



---

## Managing environmental & social risks to achieve bankability for renewable energy projects in Africa

---

This paper was prepared by:



In collaboration with:



---

Antonella Santilli, *EGP* - Nicky Crawford, *ERM* - Stuart Heather-Clark, *ERM* - Shana Westfall, *ERM* – Lorenzo Facco, *Rina Consulting* - Alessia Gagliardo, *Rina Consulting* - Elena Schirinzi, *Rina Consulting*

### Abstract

---

*Interest in and support for renewable energy projects to address the energy supply gap in Africa continues to grow. Opportunities for investors within this space are plenty but come with unique challenges that require careful evaluation of ESG risks early in the project lifecycle. A key component to a successful project is making sure that it is 'bankable' from an ESG perspective, making it attractive to lenders and investors. The focus of this paper is specifically on how to address ESG risks to ensure that renewable energy projects in Africa are 'bankable' from the start of the project through to the construction and operation of the project.*

## Introduction

---

With energy demands continuing to increase across Africa, interest in power projects, particularly renewables, remains high with international developers and investors. Despite Environmental, Social and Governance (ESG) risks being addressed much earlier on in the project life-cycle than ever before, ESG risks often delay and, in some cases, derail financing of projects. To successfully navigate this process and secure funds, it is essential that projects demonstrate from an ESG perspective that they are 'bankable'.

A project is considered 'bankable' when its ESG risks are well understood and when effective measures and structures are in place to mitigate and/or manage these risks to an acceptable level for financiers.

The Environmental and Social Impact Assessment (ESIA) is typically the first step developers take in demonstrating how they have identified and will be managing ESG risks. However, it is at this stage that many projects fail because of the assumption that the ESIA needed by regulators to secure a permit through the national process will be largely sufficient to meet lender needs. Apart from this, in many cases the ESIA is initiated too late in the site selection or design process, often its importance is not fully understood (it might be considered as a mere formal requirement) and thus it is less effective in addressing ESG risks appropriately.

This position paper explores what 'bankable' is from an ESG risk perspective, shows that these risks are also associated with the renewable energy sector in Africa, and discusses some proactive approaches to addressing ESG risks in a way that allows a project to be 'bankable' and compete against the many other power projects in Africa for financing.

## Bankable projects

---

A project is considered bankable if lenders are willing to finance it. In the language of environmental and social consultants, the bankability of a project is not only determined by its technical and financial features but also from its environmental and social performance. Nowadays, it is getting more and more common that when applying for financing from international financing institutions, export credit agencies and commercial banks, companies are required to undergo an environmental and social due diligence in parallel to or following the assessment of other aspects (for example, of economic, financial or legal nature). The purpose of the due diligence is to identify and evaluate potential environmental and social impacts generated by the project and their compliance against applicable international and national laws and standards. The main international standards that usually apply for projects developed in Africa are:

International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012);  
Equator Principles (2013);  
European Bank for Reconstruction and Development (EBRD) Performance Requirements (2014);  
European Investment Bank (EIB) Environmental and Social Standards (2014); and  
African Development Bank (AfDB) Operational Safeguards (2014).

The purpose of the due diligence is to prevent project developers and financial institutions from being exposed to the following three types of risks arising from their client's potential environmental and social issues:

credit risk: when a client is unable to repay loan on account of environmental and social issues;  
liability risk: when a financial institution faces legal complications, fees, and/or fines in rectifying environmental and social damage by virtue of taking possession of collateral;

reputational risk: when the negative aspects of a project harm a financial institution’s image — in the media, with the public, with the business and financial communities, and even with its own staff.

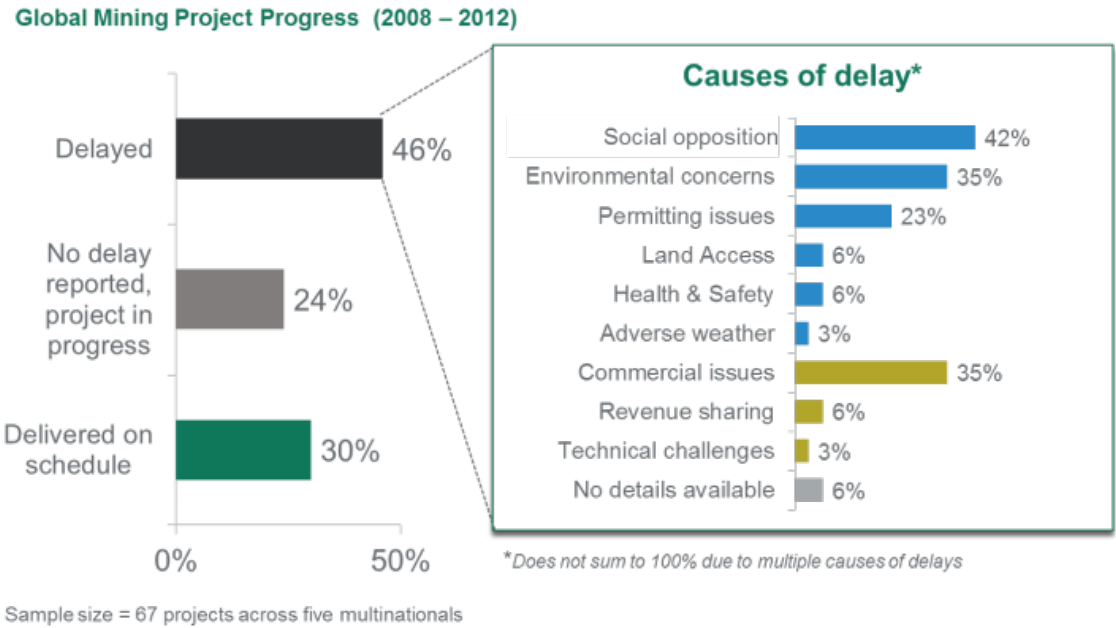
The correct implementation of these standards together with best practices have shown that this can assist project developers and financiers in reducing liability and reputational risks as well as economic risks caused by work stoppages resulting from social problems or environmental accidents.

**Are ESG risks real for renewable energy projects?**

Environmental and social impacts and risks are generally recognized as being relevant to the extractive industry as well as for the development of infrastructure, with only minor relevance to renewable energy developments. Initial perceptions are often that renewables have a significant positive environmental im-

impact through the reduction of greenhouse gas emissions and thus there is no requirement to ‘manage’ environmental and social risks. This perception is misplaced as all renewable energy developments have some negative impacts that need to be mitigated, while several of the benefits can be enhanced. These impacts are experienced locally through the construction and operation of the power plant and associated infrastructure, and impact both ecological and social aspects of the surrounding local environment. Ignoring these impacts, or potential risks, can have dire consequences for the project.

Research in the extractive industry undertaken by ERM (see Figures 1 and 2), clearly shows that environmental and social risks can directly impact the implementation of a project meaning they have the potential to cause delays, subsequent project overspending and potential reputational risks to developers. Is this the case for the renewable energy sector in Africa?



**Fig. 1 - Global mining project progress 2008 - 2012, ERM**

To answer this question, one only needs to consider two major renewable energy projects in East Africa that have been profoundly impacted by environmental and social risks. The first is the Kinangop Wind Project, which was ultimately abandoned on 25 February 2016. KWP Ltd and its shareholders announced that

the project would not be completed due to civil disturbances over a 21-month period in the local area of the project resulting in delays that led to a depletion of funds, as well as court cases and community hostilities. Another renewable project in East Africa, this

Power type	Most common high risk ESG issues
<b>Thermal</b>	<ul style="list-style-type: none"> <li>• Air quality</li> <li>• Physical and/or economic resettlement for land owners and land users</li> <li>• Project induced labour influx</li> <li>• Noise</li> </ul>
<b>Wind</b>	<ul style="list-style-type: none"> <li>• Biodiversity (in particular birds and bats)</li> <li>• Noise and visual</li> <li>• Physical and/or economic resettlement for land owners and land users</li> </ul>
<b>Solar PV</b>	<ul style="list-style-type: none"> <li>• Physical and/or economic resettlement for land owners and land users</li> <li>• Waste management (disposal of waste panels)</li> </ul>
<b>Hydro</b>	<ul style="list-style-type: none"> <li>• Physical and/or economic resettlement for land owners and land users</li> <li>• Project induced labour influx</li> <li>• Biodiversity (from the dam and inundation area)</li> <li>• Environmental flow and fisheries</li> </ul>
<b>Associated infrastructure</b>	<ul style="list-style-type: none"> <li>• Physical and/or economic resettlement for land owners and land users</li> <li>• Biodiversity</li> </ul>

one deemed a success, has not been immune to similar challenges. Whilst the Lake Turkana Wind Power Project is expected to inject 310MW from its 365 turbines into the national grid, the project has been held back for 6 months now by a controversy surrounding the completion of a 400KV, 428 km line from its fields at Loyangalani to Suswa.

These are just two recent examples where social risks have either totally stopped the project or resulted in significant delays. There are other examples where ecological issues have been the primary risk. For a renewable energy project to be considered bankable, ESG risks will need to be carefully identified and proactively managed throughout the project life-cycle.

**The importance of acting early**

Acting early is the key to success when it comes to managing ESG risks and impacts in order to secure international finance for

projects and ensure their smooth implementation. There are a number of actions project developers should take from an ESG perspective to make financing as easy and fast as possible, including:

*Perform early screening of potential high-risk E&S issues.* This could be in the form of a ‘red flags assessment’ or an early-stage due diligence. The table below illustrates the most common high-risk ESG issues for various power projects (note: this is not an exhaustive

list, as different projects will have different sensitivities). It is important to integrate the consideration of potential environmental and social impacts into early site selection and design decisions so that impacts can be avoided or minimized where feasible. International best practice should be applied where applicable at the design phase (e.g. compliance with the World Bank EHS Guidelines). It is also important to note that international finance standards require developers to demonstrate in the ESIA how environmental and social considerations have been included in the alternatives selection process (e.g. routing, siting, and technology selection).

*Engage early with potential lenders and government stakeholders.* This dialogue helps avoid unwanted surprises and is important to reassure lending institutions throughout the process that ESG risks are being robustly managed. This can also be an opportunity to discuss and agree on realistic mitigation measures where meeting specific international standards may not be that straightforward. Liaising with governmental stakeholders early is advised to discuss key differences between national requirements and lender requirements and to agree on an approach to bridge these gaps. There are a number of areas that often show key differences between these requirements, including the extent and nature of stakeholder engagement and compensation measures when dealing with physical or economic resettlement.

*Identify and engage early with key stakeholders.* Stakeholder engagement is a key aspect for all bankable projects. Beyond the fact that it is a requirement of all international standards and often of some national environmental legislation, its actual implementation from the early phase of project development allows the project to gain the social license to operate and prevent the outbreak of protests. The identification of project stakeholders should

start ideally at the beginning of the project design phase and, specifically for renewable energy projects, before the identification of the site. Project stakeholders are various individuals, groups or communities who:

- will be affected or are likely to be affected, positively or negatively, and directly or indirectly by the project ('Project Affected Parties'), particularly those directly and adversely affected by project activities, including those who are disadvantaged or vulnerable; or
- may have an interest in the project and/or the ability to influence its outcomes, either positively or negatively ('other influential/interested groups').

Project proponents should identify the different stakeholder groups to outline a continuous public information, consultation and communication strategy. This strategy is generally known as Stakeholder Engagement Strategy or Plan (depending on the project development phase). At first, proponents should undertake a detailed stakeholder identification analysis that specifies and enumerates which groups are most affected by the project, how, and to what degree. The proponent will map the key components, as follows:

- project activities, both on site and the surrounding area, that may result in local environmental or social impacts;
- impact zones (e.g. labor standards and employment, land use and acquisition, soil/air/water pollution, etc.) for each component; and
- directly affected, indirectly affected, and vulnerable groups in the impacted zones.

Following the preliminary stakeholder mapping, based on field surveys and desktop study, the proponent should verify this analysis through direct consultation with stakeholders



or credible and trustworthy representatives. The project's stakeholder engagement strategy should be based on meaningful and culturally appropriate interaction and good faith dialogue with interested parties. It should be commensurate with project impacts and development phase.

When starting stakeholder engagement at the early stages of project development, developers have the possibility, among others, to reach an agreement for a suitable location which minimizes social impacts and maximizes benefits, and to disclose correct and reliable information on the project which can prevent the spreading of false beliefs and expectations (in particular regarding employment). Engaging early will help the project to develop trustful relationship with local communities and authorities and identify, from the very beginning, local needs that could be addressed through a sustainable community investment strategy.

*Identifying from the very beginning opportunities that can create additional value to affected communities.* Bankability is achieved more rapidly when a careful assessment of the local and business context is performed in the earliest stage of the project. This allows a deeper understanding of the local communities that the business will be operating in and, subsequently, an effective management of ESG risks and opportunities. The screening of opportunities that can create additional value to the local community pushes the company to be proactive and meaningfully engage with local stakeholders as international standards require. This approach reduces the risk of poor ESG performance and of subsequent delay in achieving bankability status. For this reason, a number of project proponents have developed in recent years a thorough and strategic approach to the management of ESG risks, by developing a cross-functional coordination at the company level and by focusing corporate policies on external aspects such as local

hiring/procurement policies and community investment programs.

For renewable energy projects, the local hiring aspect is an issue that must be handled carefully to meet local expectations and possibly maximize the contribution of available local workforce. This is particularly important for renewable energy projects, as the number of available jobs in the construction and operation phases is lower than envisioned by local communities and generally largely based on skilled workers. In this regard, investment in capacity building or *ad hoc* community investment programs can successfully contribute to maximize local opportunities and, ultimately, contribute to a positive reputation at local and national level. A successful ESG management strategy focused on local and business context should be developed around achieving the following targets:

- target local people categories that might contribute in the most effective way to building the project's 'social license to operate';
- build capacities at local level that are recognized as beneficial in the Project context (either with direct and indirect impacts); and
- depending on project size and characteristics, consider a variety of capacity-building options to ensure diversification of the local workforce and supply chain.

### **The importance of social issues**

---

People are seldom straightforward and this means that measuring social impacts is often complex, making the full understanding and management of social risks prior to financial close a real challenge. This is exacerbated by the fact that social impacts are often excluded from consideration in many of the national ESIA processes in Africa. As a result, unless a project proactively incorporates international

finance requirements early in the process, as previously advocated, significant additional work on the assessment of social impacts is often needed to supplement a national ESIA. To further raise the stakes, as illustrated in the table above, social issues can often present some of the highest ESG risks to a project (e.g. physical and economic resettlement, and community conflict associated with physical environmental changes to air quality, noise emissions and water supply). Social issues can make or break a development; on one hand, they can stop a project dead in its tracks, and on the other hand, good social management can de-risk a project and generate value in the eyes of potential investors.

Below are several ways in which project developers can de-risk projects for social issues and avoid related delays in financing:

*Work to build trust with local communities at the outset.* Good stakeholder engagement should start early, as explained in the former sections. Once trust with stakeholders is lost, it is difficult to regain. It should be noted that social impact assessments need to include the community's consideration of perceived impacts, since these can often pose a very real social risk to projects. The only way to identify these risks is by engaging stakeholders early in the impact assessment process.

*It is essential to understand any potential impacts on people's livelihoods since these can pose a high ESG risk and will require a significant amount of management.* If land take is required for the development, the following should be considered:

- who are the current land owners and how will they be impacted?
- is land ownership clearly documented? Note that in many parts of Africa this may not be the case (e.g. community/tribal ownership of land).

are there any other users of the land who are dependent on the land to support their livelihoods? Note that this can include informal or even illegal use of the land.

- any compensation will need to be in line with international finance standards (e.g. IFC's Performance Standard 5), so it is important to understand how the national compensation process may differ. Note that there may be a requirement to 'top-up' national compensation.
- if the land has been allocated to the project by the government, this does not automatically mean that any government-led resettlement meets international requirements.

*Determine if the project has the potential to affect any indigenous peoples.* If this is a possibility, the stakeholder engagement process, and indeed the social impact assessment, will trigger additional requirements under the IFC's Performance Standards (IFC Performance Standard 7) and will introduce an added layer of complexity. Potential impacts on indigenous peoples also pose an increased reputational risk and NGOs are likely to focus their attention on the project. Engaging with indigenous peoples requires a deep understanding of their culture and livelihoods and must be led by appropriately qualified individuals that are known and trusted by the affected communities.

*Don't underestimate the capacity or influence of local NGOs.* NGOs have access to project information, permits and licenses and can be adept at identifying non-compliance. They can place considerable pressure on project developers, thereby increasing the risk of reputational damage. Additionally, with the increased role of social media in society, international NGOs often back local NGOs as part of targeted campaigns. This means that small, local NGOs often receive guidance and resources from larger, international NGOs. Additionally, potential local ESG issues are more likely to be communicated

to an international audience, thereby increasing the reputational risks both for a developer and their financiers.

*Appoint the right Community Liaison Officer (CLO).* This is a key decision in helping to manage local project risks effectively. A local individual with knowledge of international standards/protocols and hands-on experience in stakeholder engagement is ideal for this role.

*Ensure that a robust Environmental Social Management System (ESMS) will be in place for construction and operation.* From a social perspective, it is essential that this system also includes procedures and resources to manage social impacts, any labor working condition issues and community grievances on an on-going basis for the life of the project.

### **The importance of full project commitment to implementing ESG mitigation and enhancement measures**

---

Experience has shown that in order to manage ESG risks throughout the project life-cycle, a company needs to commit to the appropriate level of human resources to implement the necessary risk mitigation measures during both the construction and operational phases of the project. Showing this commitment prior to the start of construction has become more important to project lenders and financiers, as they require proof of qualified staff and appropriate organizational management systems to ensure implementation.

Two common situations have been observed in bankable projects, especially in small to medium scale projects, such as renewable energy projects:

- a full set of environmental and social documents is prepared in compliance with international standards (usually with the

support of external experts) but they remain a mere formal exercise without actual implementation. Site procedures and practice remain those generally applied by the developer on all sites and no personnel with specific environmental and social skills are deployed; and

- project developers appoint specialists within their staff responsible for the due diligence/compliance monitoring phase (specifically as company interface with lenders) as an additional task in addition to their normal workload without giving them the right tools, support and authority to set up a project-specific environmental and social management system.

An effective environmental and social management system aimed at mitigating environmental and social risks should be endorsed by the project's management team and become an integral part of the company procedures and day-to-day business operations. This implies that a dedicated organizational structure with adequate skills, resources, agreed upon strategy as well as a good monitoring system is necessary to ensure good environmental and social implementation and performance.

### **Related infrastructure**

---

The installation of supporting infrastructure needed for a power development is something that is often overlooked when conducting a national ESIA. Common examples include transmission lines, substations, access roads and pipelines. If these are essential to the project and would not exist without the project, they are considered 'associated facilities' and need to be considered as part of the scope for the international ESIA, even if they are not directly funded by the project.

### **Conclusion**

---

Using the appropriate mechanisms to integrate ESG risks into the project life-cycle will allow

project developers to help de-risk their projects, making them 'bankable' from an ESG perspective. This will increase the likelihood of securing international financing and receiving the funds more quickly. From previous forums that address power in Africa, it is evident that there is plenty of money for investment; how-

ever, there are not enough 'bankable' projects. With so many power projects in Africa competing to secure financing, managing ESG risks properly can make the difference between a successful development and one that never gets off the ground.



---

## Decentralized renewable energy solutions to foster economic development

---

This paper has been prepared by:



in collaboration with:



---

Giuseppe Artizzu, *ENGIE Eps* - Ilaria Rosso, *ENGIE Eps* - Luisa Frosio, *ENGIE Eps* - Anna Paola Minervini, *EGP* - Edoardo Patriarca, *EGP*, Emi Bertoli, *EGP* - Antonio Bonanni, *Enertronica* - Giovanni Pediconi, *Enertronica* - Tunde Morakinyo, *ERM* - Rachel Cochran, *ERM* - Alberto Berizzi, *Politecnico di Milano*

### Abstract

---

*Electricity supply and socio-economic development are closely linked. Innovative, sustainable decentralized energy solutions represent indeed the most efficient instrument to promote electricity access in remote and low load density areas.*

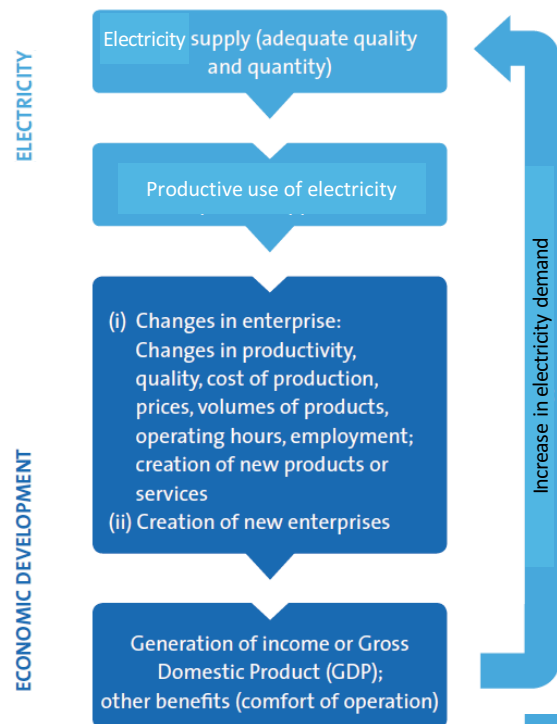
*Within this framework efficient generation technologies are crucial for the provision of electricity access and, in turn, to foster local development although not yet sufficient to directly spur sustained growth. Inclusive business models able to foster productive uses of energy are necessary, although the cycle jump-start requires many different inputs. The following study will therefore analyze the existing nexus between electrification and development, further highlighting the important role of having a holistic point of view and building strong partnerships to achieve the most efficient and sustainable business model. Finally, systematic know-how dissemination and a consistent regulatory framework for decentralized energy systems will represent key elements for an effective energy policy within emerging economies.*

## The fundamental role of electrification in economic development

Three key arguments underpin the case for access to electricity as a critical enabler for socio-economic development:

- (i) access to energy is of paramount relevance for the achievement of several of the United Nations' Sustainable Development Goals (SDGs);
- (ii) "productive use of energy", as opposed to "consumptive use of energy", would enable new income-generating activities for poor populations, igniting the activation of the capital accumulation cycle; and
- (iii) lack of access to energy is a direct indicator of poverty based on living standard's measurement criteria

The links between access to energy (in particular electricity supply) and poverty reduction through income generation can be presented as a step by step approach, as shown in the following figure<sup>1</sup>: a household/business benefiting from electricity supply is only the first step towards the user/entrepreneur's decision to make use of it. But it is only the actual use of the power supply, and the step changes that such use of power allows to the user/enterprise (mostly in the form of productivity improvements), that enables income generation and capital accumulation. The following figure is only an example of interaction between electricity supply and socio-economic development. However, it provides a useful conceptual framework for a systemic approach to investigate the benefits of access to energy.



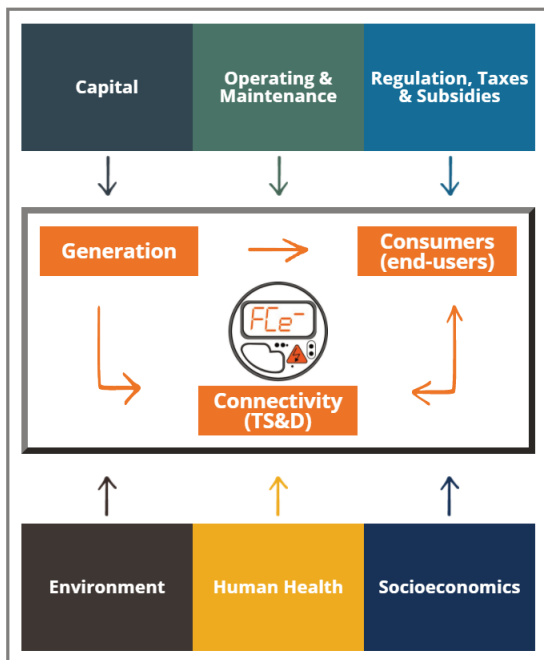
Once recognized the key role of electricity in economic development, criteria must be set out in order to comparatively assess alternative models for the design and implementation of energy systems.

### • Full Cost of Energy

The *Full Cost of Energy* approach pursues the systematic consideration of all the elements determining the total cost of generating and delivering electricity<sup>2</sup> to the end users, meaning all the direct and indirect costs associated with power generation and delivery, including generation capacity, fuel costs, environmental effects, Transmission & Distribution infrastructure investments, the cost of dispatching and flexibility, the cost of redundancy as well as the *time-to-market* of the different alternatives.

<sup>1</sup> Adaptation from PRODUSE, The Impact of Electricity Access on Economic Development: A Literature Review, page 6.

<sup>2</sup> The Full Cost of Electricity, The University of Texas at Austin



### • Centralized versus decentralized energy systems

Adopting the Full Cost of Energy approach enables, *inter alia*, the comparison of two general models to provide secure and sustainable access to electricity: i) centralized power generation and ii) decentralized energy systems.

The first model refers to the generation of electricity at large-scale centralized facilities, whose location is mainly determined by the efficient access to fuel and land availability. High Voltage (HV) networks need to be designed and deployed in order to efficiently transport electricity from the centralized plants to the load centres. Large conventional power stations, such as coal, gas and nuclear plants, as well as large renewable facilities, such as hydroelectric stations and utility-scale wind or solar power stations, are representative of the centralized model.

Decentralized generation refers instead to a variety of technologies to generate electricity at or near the end user(s). Decentralized energy systems are typically based on local renewable

energy sources, captured via mini-hydro, biomass, biogas, solar, wind and medium-enthalpy geothermal plants. They are either connected to a single load, such as a home or a SME or, through localized bi-directional medium voltage (MV) and low voltage (LV) networks, to multiple loads in the same area, giving rise to a mini-grid. Decentralized generation systems are modular and flexible, and can include multiple generation and storage elements (in *hybrid* configurations) in order to guarantee supply 24/7.

Historically, the full cost of a *delivered* kilowatt-hour was higher in distributed than in centralized systems. However, the rapid cost digression experienced by decentralized generation, storage and energy management technologies (as well as the quantification of the environmental effects of centralized generation) have bridged such gap, particularly in areas with low initial load density. Such cost advantage, coupled with rapid and flexible delivery, points to decentralized electricity systems as the most efficient instrument to foster access to electricity in areas of low load density. Furthermore, in case of future connection to the main grid, sophisticated and resilient mini-grids can play a fundamental role for the stabilization of the wider electric system.

### Distributed energy systems: the technological state-of-the-art

Decentralized energy systems are not a new concept: every day diesel and gasoline generators provide electricity to millions of people and businesses where there is no grid or where the grid is unreliable. What has changed is the emergence of a wide array of competitive, sustainable and reliable technologies for renewable energy generation and energy storage and management.

Today, decentralized energy systems comprise a variety of technological solutions for different



applications and with different performances in terms of dispatchability, availability, etc. such as:

• **Solar Home Systems**

SHS (Solar Home Systems) are stand-alone photovoltaic systems in rural areas, not connected to the grid, designed to meet a household’s basic electricity needs.

SHS consist of solar modules connected to a solar charge controller, an inverter and a battery. The energy is stored into the battery bank and supplied to the load via a DC/DC or DC/AC conversion system. They feed low-power appliances such as lights, radios and small TVs for about three to five hours a day.

SHS are a key instrument for basic access to energy (and the creation of initial loads) but not a tool for productive uses of energy, given their limited power and autonomy.

With cost as one of the biggest barriers for SHS uptake, optimizing the system size versus the energy needs is crucial.

While in 2003 only a SHS of 20 Wp was economically competitive with kerosene lamps, in 2015 this was true also for a 70-80 Wp kit. The main contributor of such cost digression has been the decrease in the cost of the photovoltaic modules. The cost of batteries has now also entered a steep descending path, while the cost of the Balance-of-System (BOS – inclusive of inverter, cabling and structure) is expected to significantly decrease with rising volumes.

Much of the challenge in the diffusion of SHS hinges on the successful optimization of battery lifetime. Battery can account for more than 50% of the total SHS costs, while having the least lifetime among the components.

The key advantages, disadvantages and relative challenges of today’s two mainstream battery typologies are set forth below:

<b>LEAD-ACID Batteries</b>		
<b>Advantages</b>	<b>Disadvantages</b>	<b>Challenges</b>
<ul style="list-style-type: none"> <li>- Mature technology</li> <li>- Low cost</li> </ul>	<ul style="list-style-type: none"> <li>- Restricted depth of discharge</li> <li>- Low energy density</li> <li>- Electrode corrosion limits useful life</li> </ul>	<ul style="list-style-type: none"> <li>- Battery file-cycle</li> </ul>
<b>LITHIUM-ION Batteries</b>		
<b>Advantages</b>	<b>Disadvantages</b>	<b>Challenges</b>
<ul style="list-style-type: none"> <li>- High energy density</li> <li>- Long life-cycle</li> <li>- High roundtrip efficiency</li> </ul>	<ul style="list-style-type: none"> <li>- High production cost (but falling)</li> <li>- Safety devices needed</li> </ul>	<ul style="list-style-type: none"> <li>- Cost-effective battery management system on small scale</li> </ul>

• **Single-user hybrid solutions**

Single-user hybrid solutions (mostly for SMEs) combine i) one or more renewable-energy sources, ii) normally a storage system to balance the system and time shift renewable energy production, iii) conventional back-up systems (usually diesel gensets) to ensure 24/7 energy supply; iv) a BOS inclusive of inverter(s) and an energy management system to ensure stable supply and optimize power flows.

Such single-user systems can be grid-connected (if so, they can source power from the grid when economically convenient and when the grid is considered sufficiently stable), but are designed not to rely on the grid, neither for energy supply, nor for voltage and frequency stabilization. By contrast, they are thought as independent power generation systems, able to provide 24/7 energy supply.

A hybrid solution can be characterized on the basis of the ratio between the capacity of renewable energy sources and the load to feed: low, medium and high renewable penetration require different architectures, different sizing of energy storage systems and the use of different control functions.

Hybrid solutions combine the environmental benefits and short time-to-market of renewable sources with a dispatchable, guaranteed, high-quality power supply.

#### • Mini-grids

Mini-grids can be defined as a set of generators and loads within a limited defined area, operated in a coordinated way. Mini-grids can be run as stand-alone localized electric systems, especially in rural areas, but can also be connected to the wider electric system, in order to efficiently exchange energy, balancing capabilities and cold reserve (*capacity*), i.e. they can be integrated as single active elements in centralized power systems.

Mini-grids cluster multiple loads and distributed generation systems via MV and/or LV by-directional localized networks. The elementary building elements of the mini-grids can be pure loads (households, SMEs), prosumers (households or SMEs with their own hybrid solutions), community or commercial mini-grid-level generation and/or storage facilities. A mini-grid can be privately or community-managed, or else utility-managed.

Presently, most micro-grids adopt conventional AC grid systems. Since many renewable sources generate DC voltages, converters are required to transfer power from these energy sources to the AC grid system. For example, wind turbines require back-to-back power converters to synchronize and adjust the output frequency and voltage level with the AC grid system. In residential and rural segments, grid connected equipment such as computers and battery chargers use DC power. Thus, these de-

vices require an AC-DC conversion stage for AC grid connection. Such multiple conversion stages reduce the overall efficiency and reliability of the systems. Hence a renewed interest in exploring DC grid systems.

#### **Inclusive business model: Productive uses of energy**

---

Fostering productive uses of energy is essential to ignite a virtuous circle of demand growth and increasing local availability to pay, which lays at the basis of mini-grid return on investment.

In fact, despite choosing the most efficient generation technology to provide electricity access is necessary to support local development, it is not sufficient to directly spur economic transformation and sustained growth. Indeed, a sustainable business model shall be created in order to couple electricity supply with other solutions and quality inputs to successfully unleash the community's inner capacity to develop and trigger a virtuous cycle.

#### **Opportunities and positive impacts related to mini-grid development**

Mini-grid implementation through the above mentioned sustainable business model has the potential to generate widespread and transformational benefits, such as:

- Providing critical employment opportunities, particularly in the agricultural/agro-processing industry and Small/Medium Enterprises (SMEs);
- Promoting growth of local economy and private sector, thus presenting opportunities for investors as well;
- Enabling households to achieve a better standard of living, which in turn would enable them to be more productive and generate additional income also used to buy

efficient electric equipment (e.g. fans, food processors, refrigerators etc.) that will improve their quality of life;

- Catalyzing training & development of skilled human resources as people acquire new competencies to run new businesses or to take advantage of new employment opportunities;
- Making the investment in electrification sustainable, thanks to the growing local consumption and to the increased community ability to pay.

However, the identification of the potential uses of electricity that could ignite this virtuous circle requires prior analysis and actions. In fact, local businesses development should be done during the whole lifecycle of the electrification project, since it helps both to design the infrastructure and to establish a sustainable business model, which has to be tailored to the specific socio-economic characteristics of local communities. Such characteristics vary from place to place and there is no one-size-fits-all solution that will suit all villages.

Such development should be performed in an inclusive way, building the demand bottom-up, as the involvement of local players is essential from an early stage to build trust between residents, local businesses, the mini-grid developer and operator.

The development model must consider the holistic system to be effective. For example, the identification of solutions to include productive use of electricity and electricity use needs to focus on different inputs, relationships, mechanisms, and dynamics at play, such as:

- 1) Supply-Demand of electricity, including aspects such as the reflectiveness of electricity tariff and the incurred costs for the electricity supply and the availability to pay for different uses of electricity

- 2) Competitiveness of mini-grids with existing solutions, such as kerosene, Solar Home System;
- 3) Desirability and attractiveness of electricity-enabled behaviors, products and services;
- 4) Business Acceleration, including the capability of the electricity supply to power devices for productive use (e.g. sewing machines, milling machines) and increase the economic productivity, the disposable income and the ability to pay;
- 5) Sustainability of the business model or all stakeholders, including local communities, investors and national governments.

Potential uses of electricity to foster socio-economic development in rural areas might include, among others: electric pumps for irrigation and increased harvests of crops; electric mills replacing more expensive existing diesel powered mills; fridges and food processors (for fish, meat, dairies..), and power for small roadside business centers providing photocopying, fax machines, and internet.

- Mini-grids have an impact on a wide range of stakeholders in rural and peri-urban areas, including:
- Rural/local community households;
- Community schools, clinics, health centers, NGO offices, local government offices and other public buildings;
- Farming/agri-food sector - for irrigation and food processing;
- Private sector and Small and Medium Enterprises (SMEs) as listed above;
- NGOs and the private sector as mini-grid developers;
- Rural electrification agencies – which may act as intermediaries between the mini-grids and consumers (or may be by-passed by them in some models).

For this reason, partnerships among organizations (private sector and NGO's) and local players with different fields of expertise are critical to address all the essential inputs concurrently and to support a sustainable growth of economic activity that drives electricity consumption and that will support the main consumption anchors. An appropriate support system could help villages to channel local resources into economic growth.

Italy, in particular, could provide a strong support with technical expertise and supply of advanced and robust machinery, which represent leading sectors of Italian economy.

### **Barriers to further development**

Decentralized solutions can play a central role in achieving universal electricity access, and represent today a proven, effective alternative to traditional grid expansion.

Policy schemes adopting decentralized energy systems, should compare, at equivalent levels of supply reliability, with the Full Cost of Energy (also in terms of time-to-market) of serving the same loads via a centralized electric system<sup>3</sup> and aim to offer the investor a fair risk-adjusted remuneration.

Policy-makers have historically regarded rural electrification with off-grid technologies as a philanthropic activity, giving priority, for industrial development, to the expansion of existing grids. Even though in the past years it has become clear that the development of off-grid projects does not prevent integrating them in future centralized power systems<sup>3</sup>, gaps in policy and regulation still persist. Therefore, it is necessary to define an enabling framework to scale up the use of decentralized systems as a

proper way of addressing the electrification challenge.

The widespread assumption that rural electricity supply is to be considered a charity rather than a commercial activity is erroneous, as studies show that spending power in rural areas is high compared with the long-run marginal cost of electricity supply.

The private sector is willing to invest but their generalized involvement is still challenging, because of the lack of a regulatory framework providing enough clarity on operational rules and on key critical issues, and for the absence of de-risking mechanisms. Permitting processes are still long and not streamlined, and too many authorities are involved in the electrification activity, creating overlapping responsibilities or lack of responsibility.

We can summarize in **three** categories the main building blocks of an effective framework to foster decentralized energy systems:

#### **1. Simplified permitting and licensing procedures**

Governments should keep mini-grids permitting process streamlined, providing a land registry and a standard set of permits on application form, inclusive of right of ways, environmental impact assessment, district authorizations, etc., enabling regulators to quickly assess projects viability. Such permits should be assessed in a reasonable - and well-known in advance - processing time, through a single window support channel (one-stop shop). In addition, a combined generation, distribution and supply license with an exclusive right of supply should be provided for a determined period of time to avoid the risk of developers paying the significant cost of project preparation and then finding themselves subject to competition from other developers. Permitting procedures should be linked to technical and safety standard requirements. Therefore, it is very important that countries

<sup>3</sup>The benchmarking has to consider *cost-reflective* electricity tariffs, *not* tariffs actually in place, that may be not cost reflective

develop a regulating body able to define Technical connection rules (Grid Codes), to be fulfilled also by mini-grid projects that, although initially off-grid, might be integrated into the main grid in the future.

## **2. Flexible tariff setting rules**

Financial and economic aspects also play an important role in promoting the development and safe operation of decentralized grids by private players.

Flexible tariff setting rules and financing mechanisms have to be in place to ensure reasonable return to investors and affordable prices for consumers.

Tariffs for mini-grids need to be set independently from the tariffs applied to main grid-connected customers, that are generally highly subsidized by the Government. The tariff level should be flexible enough and based on what will be affordable and acceptable to remote users (for example, for farmers it will be easier to pay electricity after harvest than in other times of the year), balanced with the developer's need to meet operating expenses, including depreciation, and deliver a fair return on investment.

Tariffs levels are therefore expected to provide developers with a suitable financial return, while accounting for the need to deliver high quality service. Governments and development partners can support lower mini-grids tariffs by providing grant subsidies that offset the high initial capital costs and thereby reduce investment risks.

## **3. Clear “Exit options” in case of main grid arrival**

The most critical risk in the development of decentralized solution is represented by the potential arrival of the main grid before the time needed to recover the investment.

Such risk can be mitigated by the diffusion of

official Governments plan providing more certainty on grid extension in the medium/long term, that anyway should be reliable and not abruptly changed.

Moreover, clear exit options in case of main grid arrival must be set in advance, identifying duties and rights on involved parties (i.e. developer, Distributor System Operator, Regulator), in order to provide to developers fair guarantees on the return of their investment.

Government regulation can help to mitigate this risk by mandating one of the following possible options: a) the mini-grid operator could become a power generator, selling energy to the main grid, through PPA with a guaranteed tariff, and distribution assets purchased by a DSO. b) the mini-grid operator could become a DSO, that purchases electricity from main grid and resell it to customers (disposing of the legacy generation assets in the mini-grid); c) a combination of power generator and DSO, with a specific regulatory regime for *embedded* generation.

According to the preferred choice done by the mini-grid operator, the DSO must have the obligation to purchase the distribution portion of the mini-grid assets that represents the most capital intensive portion of the total investment, provided that the latter are technically compliant with the Grid Code. A crucial element therefore is represented by the determination of the compensation value for the distribution assets. That value must be based on the expected return of the investors at the time of the investment decision, and therefore on the future cash flows that he was expecting to receive for the time of operating of the projects.

Anyway, the role of the Regulator in managing smoothly the exit option is crucial in order to ensure the fairest solution in the interest of consumers and mini grid operators.

While a consistent regulatory environment is a

requisite for decentralized energy systems to become a pillar of government's electrification strategies, in certain areas and applications the private sector is showing the ability to independently develop and fund the deployment of private mini-grids, mainly for captive and own consumption. Such initiatives should not be discouraged in any way: communities and businesses that autonomously mobilize capital to deploy sustainable and reliable decentralized energy systems are a valuable complement, not a threat, to centrally promoted schemes. Fostering entrepreneurship is itself a major contribution of clean energy technologies to economic development.

### Conclusions and call for action

---

The role of electrification in economic development is fundamental. Innovative, sustainable

decentralized energy solutions represent the most efficient instrument to promote access to electricity in areas of low load density or very far from existing national grid. Fostering productive uses of energy is essential to ignite a virtuous cycle of demand growth built on an inclusive business model, however, the cycle jump-start requires many different inputs.

Having a holistic point of view and strong partnerships will be important to activate all the inputs simultaneously to achieve the most efficient and sustainable business model, which will be beneficial both for local communities and investors. Systematic know-how dissemination, a consistent regulatory framework for decentralized energy systems, and an open mind towards entrepreneurship in the energy sector are fundamental elements of an effective energy policy for emerging economies.

---

## FOCUS: The relevance of decentralized solutions for the development of Zambia's power sector

---



There are five fundamental factors driving the relevance of decentralized solutions for the development of the power sector in Zambia:

- (i) limited potential load density outside urban centres and mining areas;
- (ii) consequently, the limited reach of the transmission grid;
- (iii) need to enable primary sources with a different seasonal profile than hydroelectric production;
- (iv) a mismatch between the aggregated load profile, dominated by baseload demand from the mining sector, and the typical

load profile of residential demand, exacerbating the challenge to cover peak demand by modulating hydro production;

- (iv) abundant renewable energy potential (in particular solar and biomass, in addition to hydro).

The prevalence of the mining sector in Zambia's electricity demand has fundamentally influenced the development of its power system, through the development of high-capacity transmission backbones serving mining areas and urban centers (whose growth is in turn highly correlated to the mining sector), and a limited reach of the main grid in other regions.

Rapid urbanization is exacerbating such dynamics, further reducing potential load density in rural areas.

This fundamental asymmetry makes an obvious case for a decentralized energy approach to rural electrification, relying on affordable solar technology (possibly complemented by biomass in agricultural areas generating material residues with energy potential) as main element of the primary mix, supported by conventional back up capacity (powered by diesel or, where economically sustainable, bio-fuels) and storage capacity for balancing and intra-day energy management purposes.

In this framework, Solar Home Systems are synergetic with a microgrid roll-out program, by *incubating* initial load.

### **Potential policy framework**

---

The key challenge to the systematic implementation of microgrids in this environment is the typical trade-off between i) the need of a cost-reflective tariff to remunerate the capital expenditure in generation and local distribution infrastructure, and ii) the depressive effect of a cost-effective tariff on initial load creation, required to ultimately justify the roll-out of a distribution infrastructure and foster network

economies.

Furthermore, historically low electricity tariff in Zambia, partly justified by the need to preserve competitiveness of copper mining in a land-locked country, set a challenging price benchmark for decentralized solutions.

Accordingly, a balanced mix of policy tools is recommended to foster the deployment of decentralized energy solutions.

1. A liberal framework for spontaneous private microgrid realization: entrepreneurs able to identify economically-sustainable load pockets should not be prevented to market unregulated schemes to villages and communities;
2. A transparent framework for the deployment of regulated microgrids, along the guidelines set forth in this paper, with a clear identification of any subsidy element required to secure remuneration of network infrastructure in a low load density environment (potentially with a digression scheme for such specific tariff components as load grows).
3. Favor for Solar Home Systems as a path to load creation.

---

## ANNEX

### RES4Africa members' Offgrid Projects Portfolio

---

Presented by:





## ASJA Colombia, Macondo



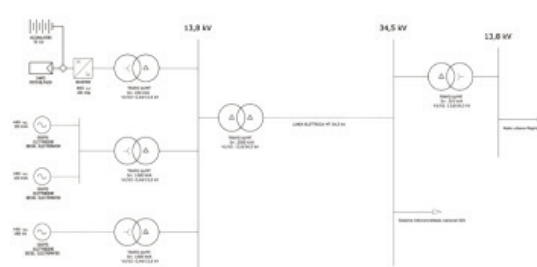
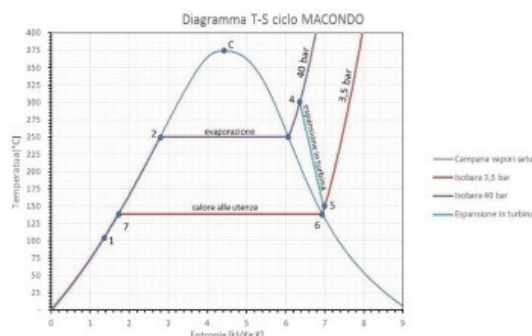
- **PROJECT LOCATION:** Macondo is a rural location in the municipal area of Mapiripan, a small urban center in the Meta region of Colombia.
- **CONTEXT:** Colombian policies favor the distributed generation of energy from renewable sources for the electrification of non-interconnected areas to the national interconnection electrical system. The project also meets the needs of a local production activity that guarantees work for the small rural community.
- **GENERAL DESCRIPTION:** Hybrid renewable energy source plant connected to a local distribution isolated grid. A cogenerative power plant uses residual biomass of palm oil production – Photovoltaic - Diesel for combined generation of electricity and heat. Heat, and part of electricity are used in a near palm oil production infrastructure. The remaining electricity is transported via a new electric transport line for electrification of a non-interconnected rural local distribution grid.



## ASJA Colombia, Macondo



- **TECHNOLOGY:** Rankine cycle thermoelectric plant with direct combustion of residual biomass of palm oil production, with a backpressure steam turbogenerator integrated with a PV plant and two Diesel generator sets.
- **POWER:** Steam turbogenerator 1.412 kWe and 17,7 MWt; PV plant 200 kW; Diesel generator set 265 kW + 530 kW.
- **CONTEXT:** Colombian policies favor the distributed generation of energy from renewable sources for the electrification of non-interconnected areas to the national interconnection electrical system. The project also meets the needs of a local production activity that guarantees work for the small rural community.
- **COST:** 4,1 mln USD
- **ENERGY:** Electricity 7800 MWh/year; heat 105000 MWh/year



# ENGIE Eps Somalia, Garowe



## 5.9 MW wind and solar-powered minigrid

**Hybrid Power Plant** built by EPS for **NECSOM (National Energy Corporation of Somalia)** to power the town of Garowe. Located in the North-East of Somalia, **Garowe** (50,000+ inhabitants) is the administrative capital of the autonomous Puntland region and a fast-growing city.

Somalia has no national grid, so every town is a de facto minigrid. On a pure commercial basis, EPS provided engineering, supply, turnkey installation and operation of a renewable and storage solution (with conventional back-up) allowing a **reduction in diesel consumption of more than 3,000 liters per day**.

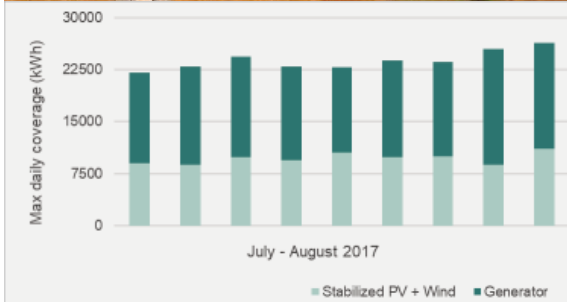
With PV capacity of 1MWp, wind capacity of 750kW, and 3MW of conventional diesel-fueled generation, the Hybrid Power Plant serves a peak **3.5MW load**, securing power supply 24/7 with world-class power quality.

In the current operating regime, EPS is still conservatively keeping one genset running at all times, capping the instant contribution of the renewable energy source to load cover to approx. 90%.

Over the next few months, EPS plans to extend to the Garowe mini-grid the operating technics already proven in other microgrids in Latin America and Europe, allowing the complete switch-off of conventional spinning capacity under favorable wind and solar conditions.

	<b>PV</b> 1 MWp
	<b>Wind</b> 750 kW
	<b>Storage</b> 1 MW/1.8 MWh Lead acid and Lithium-ion batteries
	<b>Diesel Gensets</b> 3.2 MVA
	<b>Power Conversion System</b> 1 MW Full Virtual Inertia DROOP Control Technology
	<b>Master Controller</b> Pool Algorithms & Black Start Function
	<b>Connected Users</b> 50,000+ people
	<b>Reduction</b> 600 tons/year
	<b>Immediate electricity Bill reduction</b> 17% immediate, 50% target

# ENGIE Eps Somalia, Garowe



<b>90%</b>	MAX INSTANT LOAD COVER WITH RES	<b>50%</b>	LOAD COVER IN ENERGY DURING WIND SEASON	<b>1.1 MLN</b>	LITERS DIESEL FUEL SAVED PER YEAR
<b>20%</b>	DUE TO PV + WIND DIESEL REPLACEMENT	<b>+31%</b>	DUE TO INCREASED DG EFFICIENCY	<b>= 51%</b>	FUEL SAVINGS



# Enel Paratebueno, Colombia



The Non-Interconnected Areas (ZNI), defined in Colombia by the Article 11 of the Law 143/1994, are areas “where the electricity public services is not provided through the National Interconnected System (SIN, national electric network).

- **52% of the territory of Colombia**
- 90 municipalities, 1448 towns (8% total municipalities)
- **1,8 million inhabitants** (3,7% of Colombian population)
- Long distance to main urban areas, very low population density
- Rugged geography, climate diversity
- Difficult and expensive connection to SIN
- High biodiversity

### Technical Alternatives:

- Interconnection to SIN (High cost, environmental and legal obstacles)
- Electrification through micro-grids (Lower cost, less impact, less troubles)



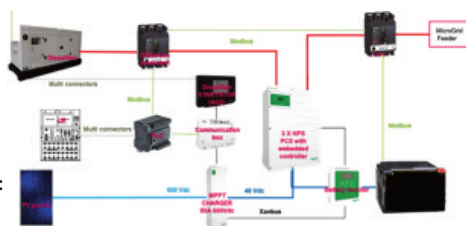
# Enel Paratebueno, Colombia



## Electrification of Vereda Buenavista in Paratebueno, Cundinamarca, Colombia

Context and Technical data

- Number of beneficiaries: 80
- 18 households, school, public buildings and cheese factory
- Generation capacity:
  - **1 Diesel Set** connected 2 hours per day
- Estimated daily consumption per household: 1.300W



Project objectives

- Provide continuous electricity service, mainly renewable, to every single house and building
- Provide public lighting in streets and play grounds

Technical solution

- **New renewable (PV) generation (17,5 kW) + storage (96kWh) + complementary diesel generation (13kW)**
- **Distribution network to every single house and building + smart metering**
- **Public lighting in streets and play ground**

Project benefits

- Quality of service improvement, 24 hours - 7 days/week. Improved welfare.
- Possibility of using domestic appliances (refrigerator, mixer, lighting, etc.) and technology (telephony, TV) in households and school (computer, projectors, tablets)
- Increase production in cheese factory (economy growth)
- Increase safety due to public lighting



# Enel Green Power Chile, Ollagüe



- **PROJECT LOCATION:** Ollagüe is a small cut off village, originally a mine one, 160 km far away from Calama, at the border with Bolivia. Its little more than 200 inhabitants live at an altitude of 3700 m and the village is not connected to the network; previously there was a micro grid circuit powered by a 450 kW diesel generator, supplying electricity for 16 hours a day – none was provided from 1:00-8:00 am. The changes in temperature are extreme, reaching a delta of 22°C in a day time, with minimums of -20°C.

- **SYSTEM CHARACTERISTICS:**

Solar PV: 205 kWp (Thin film modules)

Storage: 752kWh (Sodium Nickel Chloride tech.)

Mini Wind turbine: 30 kW

Diesel generator: 450 kW

Dish Stirling Engines (2): 1 kWe +3kWt.



- **AIM OF THE PROJECT:** Supply 24hs/day 7 days/week energy, removing the restriction of the village to having no access to energy during night time, testing advanced renewable technologies and storage system in a harsh environment and developing technical solutions for fast growing market.

# Enel Green Power Chile, Ollagüe

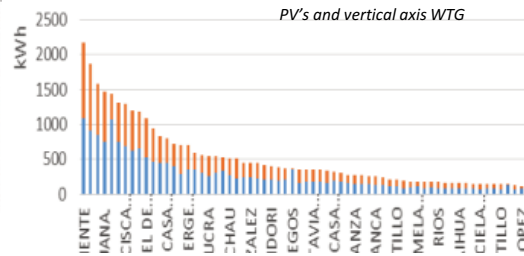
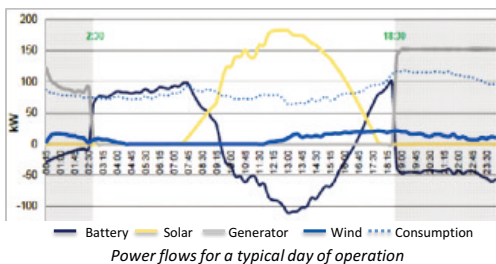


**RESULTS:**

- Hybrid system construction completed in December 2014; in full operation since Q1 2015;
- Installation of the hybrid drastically changed the habits of the inhabitants, also with promising economic benefits;
- The operation of such advanced plant is giving deep knowledge about such kind of systems and possible business model in remote area;
- Advanced technology, fully monitored and managed remotely with local Community for O&M support;
- The Metering & Billing system allows to enhance Hybrid performance, providing a pre-paid service based on real consumption data, it also sensitizes population in terms of electricity consumptions; collected money is used by the Community to partially cover maintenance costs;
- Microgrid stability has been assessed through dedicated monitoring campaigns, demonstrating that installed generators guarantee a power quality level similar to that accepted in the usual Public Distribution networks and also transients due to connections/disconnections, load variation, etc. are quickly and effectively managed by the BESS control.



PV's and vertical axis WTG

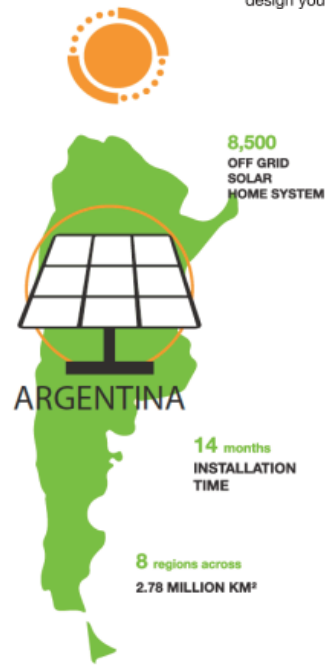


## Enel Green Power South Africa – Projects under development

- EGP is committed to supporting corporates in capturing business value and tackling climate change while marching corporate energy needs.
- Sharing our global expertise, we are keen and able to offering our project development capabilities by supplying private sector business with reliable renewable solutions.
- Focusing on large energy intensive customers such as mines as well as commercial and industrial customers such as automotive, food & beverage, etc. EGP is well positioned to negotiate and conclude such long-term private PPA's.
- We are currently in the final stages of negotiating ground breaking on-site captive power project for a private off-taker
- The Polycrystalline photovoltaic solar PV facility will be located within the Gauteng province and expected to generate approximately over 70GWh/year of electricity.



## SECI Energia - Plug the Sun Argentina - the PERMER project



## SECI Energia - Plug the Sun Argentina - the PERMER project



### RURAL ELECTRIFICATION IN ARGENTINA

Plug the Sun has been awarded with an important **Off Grid tender** in Argentina, included in the renewable energy program **PERMER** issued by the **Ministerio de Energía y Minería** on September 2016. The offer, submitted on November 2016, turned out to be the most competitive both under technical and financial point of view leading to the award notification on January 2017



**PERMER**  
PROYECTO DE ENERGÍAS RENOVABLES  
EN MERCADOS RURALES

"PERMER LPN 03/2016" is the third edition of national projects aiming to extend the electrical access to the largest part of the Argentinian territory.



THE WORLD BANK



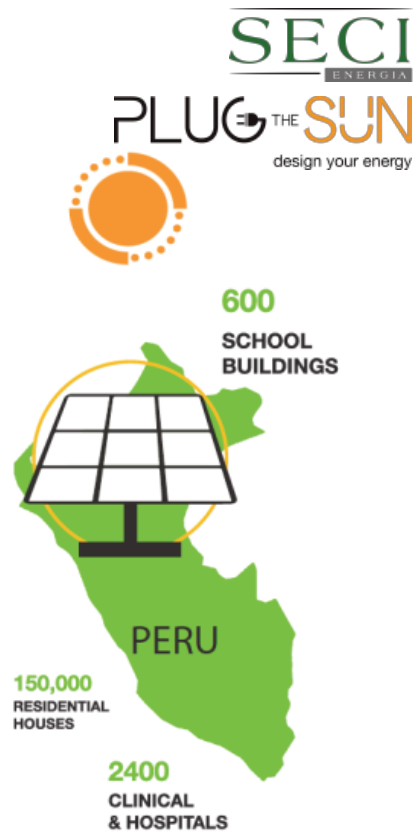
Ministerio de Energía y Minería  
Presidencia de la Nación

The **International Bank for Reconstruction and Development**, a World's Bank institution, is granting a 200 MUSD\* loan to the República de Argentina in order to guarantee and manage the overall energy programs.

The project includes the supply, installation and maintenance of **8,500 off grid SHS (Solar Home Systems)** that will be located across 8 regions (SALTA, TUCUMAN, CORRIENTES, RIO NEGRO, SAN JUAN Y SANTA CRUZ, NEUQUE, CHACO).

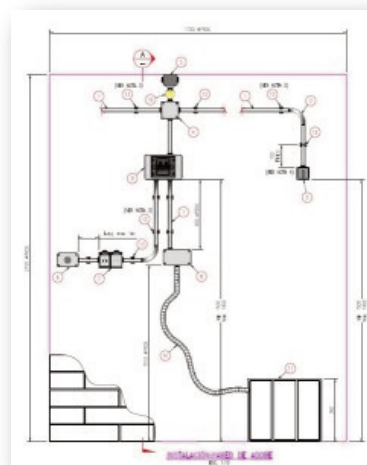
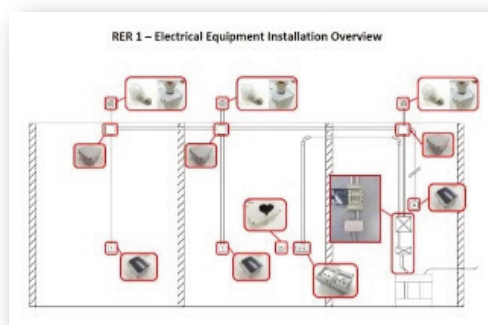
The SHS kits have peak powers of **200 Wp** and **300 Wp** and are equipped with energy storage system of approximately 1,5 kWh, depending on the solar irradiation of the installation areas.

## SECI Energia - Plug the Sun The Peru case



## SECI Energia - Plug the Sun The Peru case

### RURAL ELECTRIFICATION IN PERU



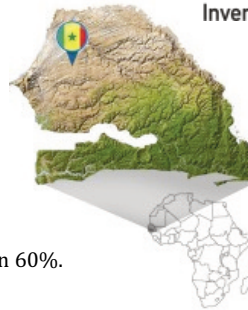
Plug the Sun provided a technical solution to this problem thanks to the **DC ENERGY BOX system**, which provides **free, green and fast energy**, avoiding expensive infrastructures.

# FIMER S.p.A.

## District of Cochari, Senegal



Inverter for Life



➤ **GENERAL DESCRIPTION:**

Commissioned by: WSS Senegal  
 Plant Size: 10 MVA  
 Year: 2014  
 Plant Topology: Hybrid System  
 (composed by PV Installation + Storage Conversion Unit)

➤ **PROJECT PURPOSE:**

1. reduce the fuel consumption of the Diesel Generating Sets by more than 60%.
2. give stability to the minigrd in the Cochari District.

➤ **SCOPE OF SUPPLY:**

- nr. 1 PV Conversion Unit (equipped with 3-Phases TL / MV Inverter)
- nr. 1 Storage Conversion Container (equipped with 2 Bidirectional MV Inverter + BMS & Batteries)
- nr.1 Power Plant Controller for managing the PV System & Storage System in coordination with the Fuel Generator System



# FIMER S.p.A.

## District of Cochari, Senegal



Inverter for Life

➤ **TECHNICAL FEATURES:**

According to the technical specifications of the plant the Hybrid System, equipped with a Spinning Reserve was embedded in Senegal, in order to:

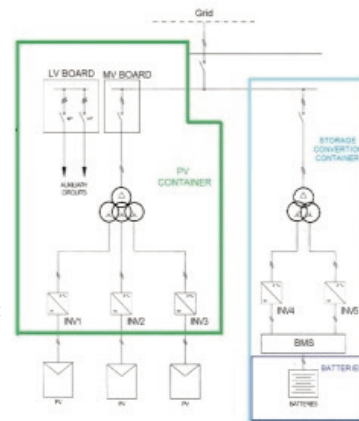
1. reduce the consumption of the Generators;
2. ensure a Time Shifting System of power loads installed for managing the night-time hours consumptions request.

The implementation has also reduced the absorption and production required for the Generating Sets.

The Diesel Generator System has also been equipped with a Synchronization controller for data exchange with the PV Power Plant Controller.

➤ **FINAL RESULTS:**

- The 10 MVA hybrid plant has reduced the consumption of the generators by 62%.
- The Storage System installed in aggregation to PV generator is able to ensure the functionality also during night a guarantee to feed in energy in the local grid also during low solar irradiation time.
- The improved stability of the grid has reduced to zero the possibility of undesired black out and it has ensured the continuous and not interruptible basic and vital services.





## FIMER S.p.A. Nigeria



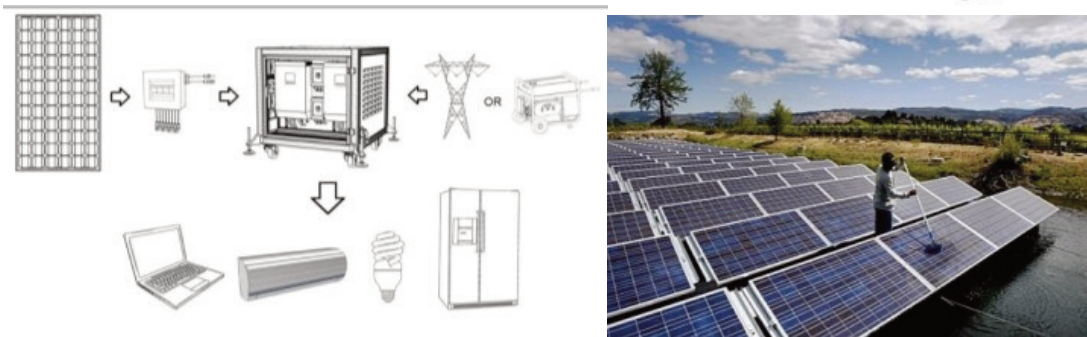
Inverter for Life

We used our application Kubo 300 (3kW) and Kubo 600 (5.2 kW) in an application in cooperation with Etisalat Nigeria in 2013.

The Scope of the supply was finding a stand alone solution able to supply energy to the Telecom tower in Nigeria.

We installed Kubo in 118 Telecom station units.

The system allow to be shipped everywhere, simply assembled and simply get start up in order to guarantee in every condition and every location to feed energy into the small islanding local grid.



## FIMER S.p.A. Nigeria



Inverter for Life

### ➤ FINAL RESULTS:

- It was installed Kubo in 118 Telecom station units in Nigeria.
- The energy produced per year has been approximatively 618.250 kWh.
- It was avoid the consumption of traditional carbon fossil source and the reduction of 262,8 Ton of CO2 per year.
- The small islandig grid created established a safe communication network and the possibiity to guarantee the basic national safety national services.

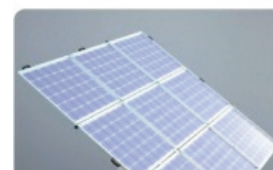
### IMPACTS OF THE PROJECTS:

Both Projects have had positive and concrete impacts from different points of view.

First of all, they gave the continuity to the electrical availability in both cases. Specially in senegal project, as has been pointed out, there has been a significant contribution to reducing fuel consumption.

The availability of electricity ha enabled, for example in Nigeria, to keep telecom towers in operation guaranteeing signal in many regions of the Country.

The further positive impact was the creation of specializations dedicated to the maintenance of the Plants.



# Politecnico di Milano Tanzania, Ngarenanyuki



## How to make social development and research join

- The hybrid microgrid is in **Ngarenanyuki, Tanzania**, a secondary **school**, involving about **200 people** living in the school and **400 students**. Starting from 2014, the microgrid has been upgraded and today it is also connected to the Tanesco public grid.
- The main power source is a **run-off-river** plant (also used for local farmers) based on a 3.2 kW Banki turbine, balanced by a 4 kW **dump load**. The school installed two back-up systems: a pack of 8 x 100Ah/12V **Chloride Oxide batteries** which can be charged by the micro hydro turbine through a 2.4 kW charger and a 5 kW **diesel generator**, used when the hydro plant is not in operation and the battery pack are unloaded or for special reasons (i.e. school celebrations, etc.).
- Starting from that situation, the E4G project combined the power systems already available with new installations of **PV panels** (3 kWp) and **lead-acid batteries** (30 x 200 Ah/12V lead-acid battery bank) connected by a **bi-directional Interface Converter** (5 kW) with specific control units and **EMS**.

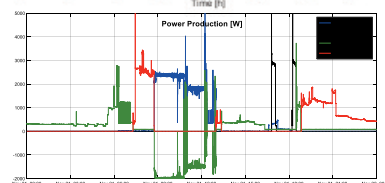
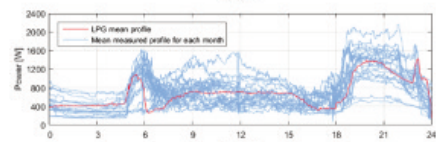
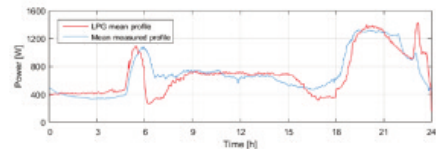


<https://it-it.facebook.com/energy4growing2014/>

# Politecnico di Milano Tanzania, Ngarenanyuki



- Provide the school with the needed electricity
- Carry out research activities:
  - Load forecasting and generation optimization
  - Frequency and voltage control
  - Battery optimal control
  - Requirements of Grid Codes to make it possible to connect microgrids to public distribution systems



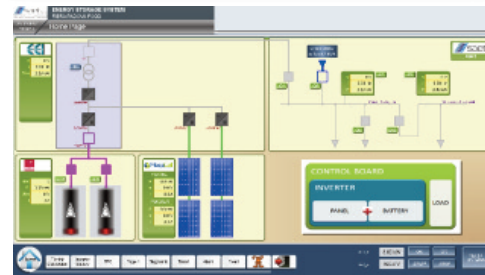
## SAET Hybrid microgrid prototype



In the context of continuous development of new solutions for the incoming needs of the electric market, SAET developed a prototype of a hybrid microgrid solution for electrification of rural areas suitable to provide access to primary needs like lighting and power for food preservation and other basic services.

Based on a standard 20' ISO container to allow easy transportation and installation, the system is characterized by following features:

- \_ 10kW PV power (installed both on rooftop and on the ground)
- \_ 20 kWh battery storage (both lithium and sodium chloride technology available)
- \_ smart EMS fully developed by SAET for microgrid supervision and control
- \_ on grid & off grid operation
- \_ arrangement for the integration of wind generator and can be easily scaled to properly match customer needs.



## SAET Hybrid microgrid prototype



SAET hybrid prototype supported the G7 Energy Ministerial Side Event: *"Africa 2030: empowering the continent through innovation, green tech solutions and capacity building"* organized by Enel Foundation, RES4Africa and the Africa-EU Energy Partnership (AEEP), that took place in Rome in April 2017.

It has also been the technical basis for the development of RES4Africa's **Micro-Grid Academy (MGA)** project, which foresees the implementation of a leading training platform in Eastern Africa to train young professionals on access to energy and decentralized renewable energy solutions.



**Installation of SAET prototype during G7 Energy Ministerial Side Event**







---

## RES and energy storage: new opportunities for emerging markets

---

This paper has been prepared by:



in collaboration with:



---

*Enel* – Matteo Neri, *TERNA* - Gabriella Preite, *ENGIE Eps* – Margherita Moreno, *ENEA* – Miguel Cipolla Ficarra, *CESI* - Ubaldo Bigossi, *Convert* - Marco Merlo, *Politecnico di Milano* – Barbara Rossi, *SAET*

---

### Abstract

---

*Renewable Energy Sources (RES) are a fast and reliable way for providing energy for Countries under fast development, and represent a competitive and economically sustainable solution when in presence of abundant natural resource, which is typically the case of such Countries. On the other hand, in a context of increasing RES penetration that is becoming more and more common in many Countries around the Globe, the random and non-predictable electricity production coming from renewables can affect grid management bringing: (i) Unbalance issues; (ii) Increase of power flow on critical section of the grid; (iii) Regulation issues due to lower system inertia and lower regulating capacity compared to traditional generators scenario (iv) consequently need of back-up and costly generation. Thus new solutions to increase grid safety and reliability as well as a better exploitation of green generators are required.*

*In this context Energy storage -in particular as part of integrated hybrid generation systems - providing the possibility to receive and store electrical energy and release it in a different moment with controllable time delay and power modulation, are one of the key enabling technologies to foster 100% Renewables penetration in the system. Moreover, this ability can be even more useful in presence of weak grids in remote areas. In the next paragraphs, an overview of technology, applications and current regulatory frameworks together with the description of some projects already deployed will be presented.*

## Main Acronyms utilized

- Battery Energy Storage System (BESS)
- Compressed Air Energy Storage (CAES)
- Concentrating Solar Power (CSP)
- Distribution System Operator (DSO)
- Electric Vehicle (EV)
- Energy Management System (EMS)
- Energy Storage System (ESS)
- Liquid Air Energy Storage (LAES)
- Power Conversion System (PCS)
- Pumped Hydro energy Storage (PHS)
- Renewable Energy Source (RES)
- Thermal Energy Storage (TES)
- Transmission System Operator (TSO).

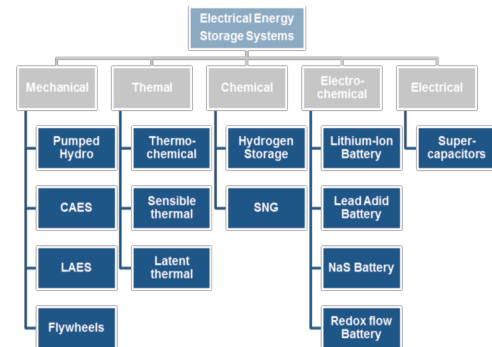
## Technology overview

Energy storage is not a single technology, but rather refers to a suite of diverse technologies, able to provide different services. Due to the wide range of technologies, it is important to begin by outlining the main characteristics of the main typologies that may be deployed.

### Pumped Hydro energy Storage (PHS)

PHS has been dominating energy storage for over a century and represent the vast majority of current installed energy storage capacity worldwide. The operating principle is simple and efficient. PHS stores and generates electricity by moving water between two reservoirs at different elevations. Thus, a special nature of the site is required, needing both geographical height and water availability. During off-peak periods an electric motor drives a pump or pump turbine, which pumps water from a lower reservoir to a higher storage basin. When electricity is needed, the water is directed downwards through turbines. The *round-trip efficiency* of these systems (calcu-

lated as the ratio between the net energy given back from a storage and the energy consumed to fill it up) typically ranges from 70 % to 85%.



**Fig. 1 - Scientific categorization of storage.**  
Source: PwC, 2015.

- Compressed Air Energy Storage (CAES)

CAES technology is a mechanical storage in which energy is stored by compressing air at very high pressures. The compressed air is then released, preheated either with natural gas (diabatic CAES) or with the heat stored during compression (adiabatic CAES) and used to drive a turbine-generator system, to produce electricity when required.

The *round-trip efficiency* of these systems typically ranges from 42% to 50% for diabatic CAES and aim at values around 60%-65% for adiabatic configuration.

Although the main CAES plant components, i.e. compressor and turbine, are technologically mature and are able to treat large amount of air to enable high power storage systems, the energy capacity of CAES plant depend on the availability of large scale storage reservoirs for compressed air. This makes CAES economically interesting only if geological reservoirs, such as mines, aquifers or salt caverns, are available, while, aboveground pressure vessels tend to be too expensive for economic viability.

The geo/site dependency of CAES strongly limited its deployment so far. Indeed, the only ex-

isting commercial plants are a 321 MW plant in Huntorf, Germany, and a 110 MW plant located in McIntosh, USA and a new 330 MW project is under development in Northern Ireland.

- Liquid air energy storage (LAES)

Sometimes referred to as Cryogenic Energy Storage (CES), LAES is a promising storage alternative to CAES and PHS, currently at the demonstration stage. Air is compressed and cooled down to liquefaction in a refrigeration plant, using cheap, off-peak energy, and stored in a relatively large insulated tank or vessel. The liquid air is then converted back to gas, expanded in volume, heated and used to drive a turbine to generate electricity on demand.

Thanks to the much lower volumes needed to store liquid air instead of gaseous air, LAES is not prone to geological constraints or public resistance and can be particularly suited to locations where there is a source of low-grade heat or cooling, such as an industrial process.

In case of stand-alone applications or use without sources of heat or cold, heat is stored during compression to be used in the expansion phase, reaching efficiencies up to around 60-65%.

All main components of LAES plants are commercially available and suited for large scale plants, while heat and cold storage systems as well as the full plant integration has to be successfully validated. The absence of significant capacity or efficiency degradation with cycling appears one of the main advantages of LAES versus lithium batteries, however LAES competitiveness will depend on capability to significantly decrease its costs in order to compensate also for the relatively low roundtrip efficiencies.

- Flywheels

Though flywheels have been in existence for decades, they have only recently gained attention for large-scale stationary energy storage.

They store kinetic energy in rotating discs or cylinders, suspended on magnetic bearings. Their main advantage over other storage technology is the absence of capacity degradation over lifetime and low maintenance costs.

Flywheels are normally suited for applications requiring high power for short periods, however some suppliers are offering flywheels also up to 4 hours storage periods.

Flywheels tend to be very small in their basic modules, so that no large scale-effect on cost reduction is to be expected.

- Batteries

Whilst electrochemical devices have been used for energy storage since the 19th century, up to some years ago they mostly found use so far in small-scale applications, such as mobile power sources, and in the automotive industry.

In the last years, the growth of electric vehicles and the need to integrate renewable power technologies such as solar and wind driven huge investments in the development of battery technologies, that nowadays represent the most competitive set of technologies that are being introduced to support renewable integration into the electric grids worldwide.

In particular, the recent period clearly showed that Lithium based technologies are gaining majority of market share for Renewable Integration applications and for ancillary services for grid support. This happened thanks both to many impressive technological improvements (i.e. lifetime, energy conversion efficiency, response fastness) and a fast decreasing in costs, which have been in the range of 15 - 30% YoY (depending on the application) and lead to an overall 80% price per kWh drop from 2010 to 2017.

Many other possible battery chemistries alternative to lithium-based ones are under development or in initial commercialization phase, and could suit specific applications in the fu-



ture. As an example, long term storage applications (8-10 hours or more), that will be needed to manage the electricity networks with very high renewable permeation, will be a market suitable for flow batteries, provided that they manage to achieve significant cost reductions.

The *round-trip efficiency* of batteries depend on the chosen chemistry and technology, ranging from 75% (flow batteries) to 90% (best lithium ion). For some batteries (NaS) efficiency is also influenced by operational conditions as they need to be kept at high temperature even in standby mode.

A key issue the battery industry is beginning to deal with is how to manage battery circular economy, from raw materials (many are rare for the most diffused lithium based batteries) to end of life management.

In this framework, batteries from electric vehicles which no longer meet the requirements of this application may well still have a 'second-use' in static applications, as detailed later in a dedicated chapter.

- Superconducting Magnetic Energy Storage (SMES)

SMES stores energy in the magnetic field of a coil. The coil is superconducting in order to reduce the electrical losses, and therefore requires a cryogenic cooling system. The response time is extremely fast, and the technology is suited for short-term power applications such as improving power quality.

- Supercapacitors

Supercapacitors are an established technology which stores much more energy per unit volume or mass than traditional capacitors. The response time is extremely fast. The costs per unit of energy storage capacity are higher than for batteries, though supercapacitors can withstand much higher numbers of charge/discharge cycles. Supercapacitors therefore are suitable for very short-term power applications.

- Hydrogen

Power to Gas (PtG or P2G) uses electricity to create hydrogen by electrolysis. Hydrogen can be stored as gas under pressure or liquid at low temperatures. It can then be used to create electricity in conventional reciprocating engines, gas turbines or in fuel cells, though in many cases it may be better to use the gas for industrial uses, space heating or transport.

Hydrogen is currently used today for applications that need no self discharge, like telecom tower UPS systems, and may well suite seasonal storages coupled to fast responding batteries, in order to supply 100% annual energy consumptions with renewables in remote areas, i.e. areas where diesel cost is very high due to transportation.

The *round-trip efficiency* of hydrogen-based storage systems today is as low as 30 to 35%. Some sources forecast that it could increase up to 50% with more efficient technologies, currently at an early development stage.

- Synthetic Natural Gas (SNG)

Hydrogen can be converted into methane (SNG). The main advantage in the context of energy storage is that the amount of hydrogen that can be tolerated in existing natural gas infrastructure is limited (of the order of 10% depending on technical characteristics of the infrastructure). There is no such restriction on the amount of SNG that can be injected into existing gas infrastructure. Methane, being a larger molecule, also has lower leakage losses than hydrogen.

- Thermal Energy Storage (TES)

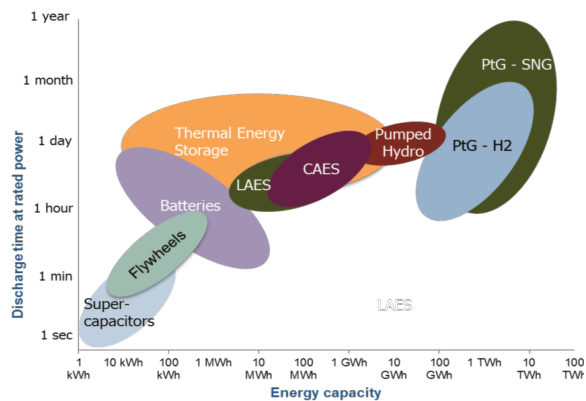
There are three fundamental forms of thermal energy storage:

- Sensible thermal storage - increase or decrease of temperature of a storage medium, such as water, oil, rocks or concrete.
- Latent thermal storage - phase transforma-

tion, e.g. molten salt, paraffin, or water/ice;

- Thermochemical storage - a reversible chemical reaction, which is energy demanding in one direction and energy yielding in the reverse direction (sorption and thermochemical), such as silica gel, zeolite, metal hybrids, or zinc.

Thermal storage can be used to produce electricity, by producing steam for a conventional thermal power plant. However the heat can also be used directly in industrial process or for space or water heating; this clearly requires less plant and avoids conversion losses, though the value of heat is substantially lower than the value of electricity.

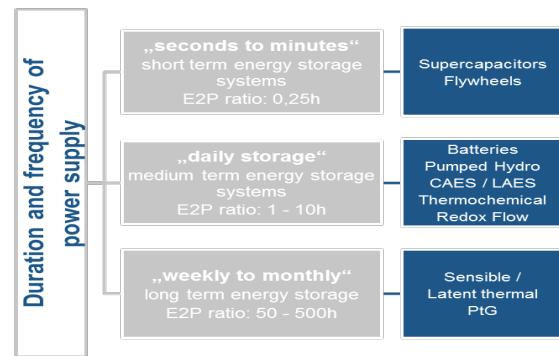


**Fig. 2 - Mapping of storage technologies to performance characteristics.**

Source: PwC, 2015, following Sterner et al. 2014

Note that thermal storage can also be used to provide ‘cold’, and this is currently a growing market for energy storage in the form of ice for deferring air-conditioning loads.

The application of energy storage can roughly be placed on a continuum of power and energy. In general, energy applications are defined as those that need a continuous supply of energy over a considerable length of time. In this case, the total energy flow is more important than



**Fig. 3 - Duration and frequency of power supply.**

Source: PwC, 2015, following ISEA Aachen, 2012 (\*)

the magnitude of the charged or discharged power. Typical energy applications include peak shifting, energy arbitrage, etc. In contrast, power applications require fast injection and absorption of energy, but durations for such operation are usually shorter. Power applications include frequency control, and ramp rate control for intermittent renewable generation. Electricity storage applications can usually be viewed as either primarily energy or primarily power applications, and this categorization can be applied to technologies as well, using the E2P ratio, also known as Discharge Time. If the E2P ratio is about 0.5 h or less, the technology can deliver or absorb significant power over a short time, such as flywheels, supercapacitors or, nowadays, many types of Lithium batteries. If the E2P ration is about 4h or greater, the technology can sustain energy delivery for a much longer period, like certain batteries, especially flow batteries. In addition, two large-scale technologies (PHS and CAES) are capable of providing significant levels of both power and energy, however they usually should be categorized as technologies suiting energy applications. Since each storage technology can serve a range of applications, other factors should also be considered for a detailed classi-

fication, like round trip efficiency, cycle and shelf life, and other physical limitations.

### **Battery Cost projection**

---

Cost information and projections for stationary battery packs are less available than comparable information for automotive batteries due to less spread, production and scale economics. There are numerous storage systems available on the market to match domestic 3 kW power plants. Costs are quite different comparing systems with same storage energy: nevertheless, it is important to specify that it is often not enough to compare the battery convenience by dividing their cost by nominal stocked capacity at full charge (i.e. \$ per kWh capacity). Although this method may be useful for comparing batteries of the same type by brand or model, the same estimation can be inaccurate and misleading when comparing batteries with different operating principles or, in the same type, with different chemistry. Please consider that this KPI (*key performance indicator*) can be also misleading with suppliers that, although are providing same technology (lithium, for example) have different performance based on their specific technical characteristics. In order to improve the estimation, a more appropriate valuation method, i.e. Levelised Cost of Storage (LCOS), needs to be introduced. It is necessary to divide the discounted total cost of the system (upfront and ongoing capex, yearly opex and charging cost to overcome the inefficiency of the system, etc.) for the discounted total amount of discharged energy throughput over the battery lifetime. This parameter returns a value much closer to the real cost of energy storage in batteries. The total discharged energy throughput can be calculated as the discounted integral of the useful storable energy vs time (from Beginning of Life to End Of Life).

In fact, the costs vary not only depending on the type of battery used but also depending on

the production volumes. The cost of lithium-ion battery for hybrid auto plug-in was dropped from about \$ 1000kWh<sup>-1</sup> in 2008 to \$ 268kWh<sup>-1</sup> in 2015, -73% in seven years, while the goal is to reach a cost of 125 \$ kWh<sup>-1</sup> by 2022 (an additional - 58% in seven years). Other studies estimate significant cost reductions: CE Delft estimates reductions from \$ 600 kWh<sup>-1</sup> in 2012 to \$ 320 kWh<sup>-1</sup> in 2020, up to \$ 210 kWh<sup>-1</sup> in 2030. On this basis, a lithium-ion of about 324 kWh (i.e. useful for running an electric bus) could cost about \$ 100,000 by 2020, with further reductions expected for 2030.

### **Electric vehicle batteries get second-life with Energy Storage Systems (ESS)**

---

The Electric Vehicle (EV) market has blow-up in 2017. EVs sales are growing up rapidly and consequently also the quantities of used batteries. Cost reduction in Li-ion batteries has enabled this revolution. Car companies and researchers are now studying how to reuse those exhausted batteries after they are used in EV. This is the common environmental criticism of EVs, and an important issue about the destination of these used batteries.

Second-life is the term used for when a retired or used EV battery is converted for use in an energy storage project. This process includes the following stages: retired batteries recovery, performance evaluations, and batteries pack reorganization, second use in energy storage system, and batteries disposal and recycling/reuse.

EU Regulations, require the makers of batteries to finance the costs of collecting, treating and recycling all collected batteries, are already encouraging tie ups between carmakers and recyclers. The fundamental problem is that the cost of recycling a battery is around €1 per kilo, the value of the raw materials that can be reclaimed is only a third of that. Cost of recycling is the current barrier, and rather than be recycled, it is useful to reuse it. The lack of recycling

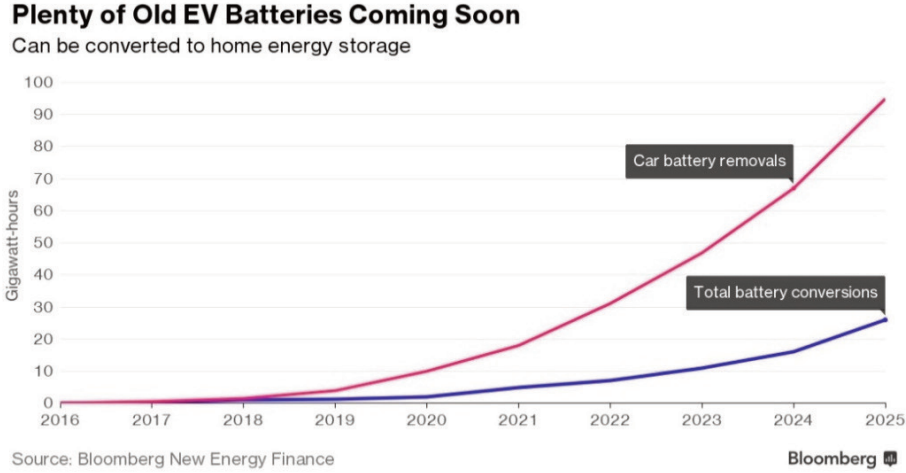
capacity is a real problem and for this reason lot of carmakers thinks the answer lies in reusing rather than recycling EV batteries. These batteries can still have up to 70%-80% of their capacity. Therefore, after broken down, tested and repackaged they are perfect for functions such as energy storage.

The batteries world is constantly innovating, and a second-life EV battery is an economical choice. This increasing Li-ion demand will help to continue to lower energy storage costs. Cost reductions from adjacent markets such as battery powered electronics like EVs and large scale renewable energy growth such as solar

and wind are paving the way for increased storage, while regulation around grid stability and renewable adoption has been extremely inviting as well.

There are markets around the used batteries and it is still not clear what benefits from that trade.

Forecast from Bloomberg New Energy Finance (BNEF) estimate volumes around 95 GWh of available used Li-ion EV batteries in 2025 that exceeds the size of the current stationary storage market, and probably 25 GWh will be reused in stationary EES.



**Fig. 4 - BNEF forecast of used battery availability and estimated volumes for a second-life in stationary energy storage 2016-2025 (GWh).**

Source: BNEF

All rechargeable batteries have a limited life. Li-ion batteries are common in EVs and its life is about 2000-3000 charge-discharge cycles. Li-ion batteries designed for EVs need high energy density to maximize range while minimizing weight. At the end of its useful life these batteries don't die completely. They just reduce its capacity making them unsuitable for EV usage but they can maybe get a second-life as stationary energy storage systems.

This second-life Li-ion battery is a complex and sometimes expensive process. To reuse them in other applications is not as simple as remov-

ing EV batteries and then installing them directly into a stationary system.

Before beginning its second life however each individual battery must be evaluated. To help ensure that EV batteries are safely deployed in their new applications, UL is developing the safety standard UL 1974 that will aims to provide users with confidence that a used EV battery will function effectively in a residential, commercial or utility-scale storage application. UL is developing the safety standard with input from carmakers, electric utilities and academic institutions.

The battery must be manually removed from an EV and the pack disassembled into individual cells. Then, these cells must be tested to determine the battery's state of health, sending batteries without sufficient remaining capacity to be recycled. Even within the batteries suitable for reuse, cells must be sorted by similar remaining capacity, or else the second-life system performance would suffer. These are labour and energy intensive processes, but efforts in both academia and industry are underway to reduce costs. Introducing automation in the process will reduce time and labour costs, as will convince battery manufacturers to use easy design for disassembly.

There are a number of invaluable partnerships on both the supply and demand sides of the process. Fostering relationships early on in the development of ESS with original suppliers such as Li-ion battery manufacturers and policymakers is the key to a lean, reliable supply chain.

At the moment, there are some limitations to our current understanding of the second-life battery opportunity because few vehicles have reached the end of their life; there isn't a clear indication of how much remaining capacity can be expected from these batteries after typical use. EV manufacturers by using more standard battery components could help to second-life users, and the design of the original EV battery can also minimize the cost of converting it for stationary storage. Pricing for second-life batteries are already very compelling with prices of €100 - 150 per kWh available and as EVs ramp up increasing numbers will come to the market.

There are different alliances and joint ventures, deals and solutions with large EV automakers advancing second-life usage including Nissan, General Motors, Daimler, BMW, and Renault.

### **Overview of the EU grid codes to point out best practices for emerging countries**

National grid codes are used to define the electrical performance requirements of generating

assets, operational and dispatch rules, and the technical requirements for interconnection to the grid. Appropriate grid codes updated can considerably reduce potential adverse impacts of grid-integrated variable RE.

During the last few years generation from Renewable Energy Sources (RESs) has grown considerably in European electrical networks. Transmission system operators are greatly concerned about the impact of RESs on the operational security and efficiency of their networks and more in general of the ENTSO-E interconnected system. Grid codes have been started to be revised in order to harmonize the rules regarding the connection of RES power plants, both directly to the grid and in *coupled with RES* configurations. A main issue concerns frequency control: frequency is greatly affected by RESs intermittency and its deviations must be limited as much as possible in order to guarantee a suitable level of power quality. To improve frequency stability, in the future, Grid codes could extend frequency control requirements also to RES units, whereas today they are applied only to conventional power plants. As some Countries (Australia, Germany, Korea, several US cases, just for example) are proving yet, energy storage systems can be a possible solution to increase the flexibility and performance of RES power plants: they allow generators to modulate their power injections without wasting renewable energy. In this paper, the authors studied the suitability of extending frequency control to RES units integrating them with energy storage systems. In particular, the paper focuses on the impact of frequency control on the storage lifetime by analyzing the power charge/discharge in response to real frequency oscillations. Actually, Grid codes set the rules and technical requirements for power system and energy market operation. The different types of grid codes facilitate:

- The operational flexibility;
- Operational stability;

- Security and quality of supply;
- Well-functioning wholesale markets.

In order to counteract this kind of problems, national and international authorities updated their standards and grid codes regarding the connection of active end users to distribution networks, including both distributed generations and ESS. Changing and evolving grid codes are necessary for changing and evolving grid supply and demand.

Grid codes traditionally focused on static reactive power control, power factor and dynamic requirements such as low voltage ride through capability. The codes are now evolving into more demanding requirements including dynamic control of reactive power, voltage and frequency at the point of connection, and power quality. To create these new functions, each interconnection code and technical rule must be analyzed for similarities and differences in data requirements, specified curve shapes and default values. Lately, storage industry is always looking for a quick solution but it must take around one year for implementation plus another one for network code changes. The grid requirements and codes are applicable in different area; though most of them were originally developed for generating systems and only a subset of these include specific function for ESS and Battery Energy Storage System (BESS).

Creating grid codes on the consumption side will help improve the storage system development scheme. For Countries with stringent grid codes, electricity storage can ensure that renewable power generators meet the required conditions. In order to counteract this kind of problems, national and international authorities updated their standards and grid codes regarding the connection of active end-users to distribution networks, including both distributed generation and electrical ESS.

Regardless of all the potential positive benefits

discussed, ESS still requires careful analysis of the costs and benefits issues in case of some technologies not so exploited so far. The introduction of ESS as a grid code requirement should be done in order to give freedom of choice to the power plant owners or the grid operators as regards the technology that matches the desired application.

### **Harmonization of standards, grid codes and testing procedures**

---

The Electricity Directive of the European Union 2009/72/CE regulates the unbundling of Transmission System Operators (TSOs), Distribution System Operators (DSOs) and the functions of electricity generation and supply. As energy storage is not mentioned in the 2009/72/CE, the position of energy storage in relation to the unbundling requirements is not clear. As a result, electricity storage is generally regarded as a generation system. The Directive also specifies that a TSO cannot “directly or indirectly exercise control or exercise any right over any undertaking performing any of the functions of generation or supply” of electricity. Nevertheless, a new European package (Clean Energy Package) is currently being finalized, which also defines a clearer framework for storage integration into electricity markets. In particular, the new framework includes provisions on ownership and management of storage facilities, setting boundaries on the role of regulated entities, which can own, manage or operate ESS only in case of a market failure.

A grid code serves the mission of defining the physical connection point requirements to be followed by energy production equipment in order to be connected to the grid; in addition a Regulatory framework defines the requirements for permanent connection and the relevant network parameters to be supported, in a way to secure system operation. The introduction of ESS as a grid code requirement should be done in order to give freedom of choice to

the power plant owners or the grid operators as regards the technology that matches the desired application. Grid codes and requirements must be aligned with the technical capability of the participating technologies. Care must be taken to ensure that new grid codes do not create barriers for new entrants, and that over specified requirements do not lead to an over-supply of services beyond what is actually required. Developing national and international standards for ESS are now essential and vital for the cost effective generation of this alternative power, and to the growth of grid-scale ESS. By using ESS it's possible to feed power to the grid so that production need not be scaled up and down repeatedly to adjust to changing demand levels. These systems also absorb the over generation from wind and solar power facilities and release that power when needed.

The goal of some organizations, alliances or laboratories is to accelerate harmonization of standards, grid codes and testing procedures to carry out interoperability, scalability, safety, quality, availability, and affordability in energy storage components and systems. ESS must be intelligently plugged into the utility's existing information and operations technology. Without established standards, components and systems will come with proprietary connectors, and the process of plugging them together becomes a laborious task repeated for each new project, which will add to project cost and lead time. Hardware that makes up an ESS: batteries, Power Conversion System (PCS), metering system, and the Energy Management System (EMS) can be intelligently plugged into each other and the electrical system. One of the most important processes is standardize communication and connections, which will accelerate interoperability and scalability of ESS. Also, reduce engineering costs, enabling a robust energy storage market, and improve standardization procedures for safety and efficiency. National and international standards and updated grid codes should be developed to reflect and to follow technology improvements

and advances in control systems networks.

Regulatory aspects and harmonization of network codes are needed on national and international levels. Standards must help fully deployment of inverter based capabilities to mitigate voltage impacts on distribution systems and provide useful services to support bulk system reliability and performance. Structural and technical harmonization of grid codes are needed to address standards for new emerging technologies like as wind, solar, storage and so on; principally inverter based distributed resources. Cooperation between TSOs/DSOs and international organizations (such as IEC, IEEE, CENELC, ENTSO-E) is necessary and should be supported to improve harmonization of grid codes. In many Countries and grid companies, different grid codes have been recently approved with the scope of defining the connection rules for passive and/or active end-users, updating their general grid codes, or developing separate standards documents such as requirements to meet the demands of fast-growing wind, PV power generation and ESS.

While there has been strong progress in EES in California, similar advance has not been observed in Europe represented by the UK, and Italy. Australia and United States have experienced progressive renewable penetration during the past two decades and started yet in enabling RES coupled with Storage equipments. Other Countries, that are experiencing great RES penetration, are not pushing a lot on these kind of technologies so far. Environmental concerns and political regulations, in parallel with available technology, are the main drivers for the change. Transmission power networks are well interconnected, robust and dimensioned with sufficient reactive power margins and spinning reserve to be correctly balanced. In addition, well known operational and market rules exist. All EU Member States and other European countries have their own Energy laws and Network Codes. These are in

a constant process of European harmonization. In general, there is no mention of energy storage in European electrical energy legislation or regulations; exceptions are Germany, UK and Italy. In Europe, electricity storage is increasingly recognised as being the vital tool to deliver the low carbon energy system efficiently and the European Commission are in the process of considering amendments to electricity market design.

Some generic principles should guide the future investment framework for storage:

- There is a need for a European legal and regulatory framework regarding general technical principles for storage;
- Storage should compete on a level playing field with other technologies, and the tariff structures should ensure neutrality of storage;
- Storage devices should not be restricted to a single service, as this would not be economically efficient;
- The TSOs should have access to data for central and distributed storage facilities for system security for all timeframes, as well as DSOs for facilities on their grids.

Progress has been made towards grid code harmonization in Europe, which has been a binding EU regulation since May 2016 and is in force under EU law. One of the elements recalled in the 2009/72/CE is the initiation of the Agency for the Cooperation of Energy Regulators (ACER), which has developed the Framework guidelines on electricity balancing directed at the TSOs. These guidelines do not specify any technology for balancing the electricity grid and leave the use of energy storage open. Also, closer definitions will be needed in local jurisdictions for electricity storage to meet exacting local regulatory requirements.

The European Network of Transmission System Operators for Electricity (ENTSO-E) has

published the European network codes or grid codes for electricity balancing based on ACER's guidelines that include the possibility for energy storage facilities to become balancing service providers.

There are a number of recent EU codes that already clearly make the distinction between generation and storage. In general, there is no mention of energy storage in European electrical energy legislation or regulations. Exceptions are Germany, UK and Italy.

The most recent versions of European standards report the recommendations for the connection of generating plants, CENELEC TS 50549-1 (LV) and CENELEC TS 50549-2 (MV) distribution networks, whereas CENELEC EN 50438 regulates LV micro generating plants with rated current under 16 A.

The EU launched in October 2017, the EU Battery Alliance (EBA) aimed to create a competitive battery value chain in Europe with sustainable battery cells manufacturing at its core, making Europe a global leader in sustainable battery production and use, in the context of the circular economy. Europe intends to prevent a technological dependence on foreign competitors and capitalize on the job, growth and investment potential of batteries. The initiative responds to the need of promoting battery production as a strategic imperative for the clean energy transition and the competitiveness of its automotive sector. The EBA is a cooperative platform that gathers the European Commission, EU Member States, the European Investment Bank and key industrial stakeholders and innovation actors from the whole value chain. Within this framework, the EU intends to step-up research and innovation support to advanced (e.g. Lithium-ion) and disruptive (e.g. solid state) technologies and to support the sustainability of EU battery cell manufacturing industry with the lowest environmental footprint possible, for example by using renewable energy in the production process. This objective should be notably im-



plemented through setting out requirements for safe and sustainable batteries production. Various instruments are being considered to drive robust environmental and safety requirements that could be a trend-setter in global markets. To this end, full advantage should notably be taken of the EU Batteries Directive, currently under review and the Eco-design Directive framework, where opportunities to design an innovative and future-proof regulation are being pursued. A prerequisite to the sustainability of a European battery value chain, notably in the context of the circular economy, is to analyse in detail the key determinants for the production of safe and sustainable batteries. This should also cover the entire value chain, from sustainable and responsible supply of raw materials to production processes, system integration and recycling.

In Germany, the grid codes make no special requirements on storage; however it shall meet both the requirements on load and on generation, depending on its operation mode. In this context, reference is made to the technical guidelines of the German Association of Energy and Water Industries (BDEW) and association for electrical, electronic & information technologies VDE on integration of distributed energy resources and electrical energy storage. The BDEW at 2014 has proposed definitions of energy storage:

An energy storage facility is defined as a facility which receives energy with the objective of storing it electrically, chemically, electrochemically, mechanically or thermally and making it available again for use at a later time.

- An electricity storage facility in the electricity supply system is proposed to be defined as an energy storage facility which receives electrical energy from a general supply grid, temporarily stores it and later feeds the released energy back into a general supply grid.
- About market integration, the German re-

newable energy sources act (EEG) covers storage of RE source and the transmission code explicitly mentions storage as an option for the reserve/balancing power markets without mentioning other applications of electrical energy storage.

European network codes and market design packages may be important for electricity storage in the UK. In the UK, storage is explicitly mentioned in the Capacity Market (CM) regulations. National Grid (the local TSO) held in 2014 a first CM auction which was also open for energy storage facilities. In 2016 a service concerning superfast response to grid frequency fluctuations - called Enhanced Frequency Response (EFR) - was tendered by National Grid and finally entirely awarded to 200 MW of BESS

In Italy, the ESS connected to the grid has to respect the regulation for the connection of a generator to the transmission/distribution grid. Italian grid codes CEI 0-16 (MV) and CEI 0-21 (LV) indicate technical rules for the connection of passive and active end-users to the network. Italy has stipulated that the TSO and DSOs cannot build and operate batteries under certain specific conditions are envisaged. At the moment, ESS connected to the grid have to respect the regulation for the connection of a generator to the transmission/distribution grid (Italian decree law 93/11). Italian network regulator (AEEGSI) passed a decision on provisions related to the integration of ESS for electricity in the national electricity system (574/2014/eel) defining network access rules for energy storage and tariff to be applied in the different ESS configuration (i.e. connected to a consumption unit, or a generation unit, or stand-alone).

However, the TSO shall justify, through a cost/benefit analysis, that the ESS is the most efficient way to solve the problem identified (e.g. compared to building a new line). In any case the TSO should not receive remuneration

higher than the (measurable) cost of alternative solutions. The installation of RE, particularly wind energy in the United States, has often required reinforcement of the transmission infrastructure. With regard to grid codes, there are some special provisions for renewable developers to comply with Federal Energy Regulatory Commission (FERC).

In USA, the 2017 edition of National Electrical Code (NEC) presents the latest comprehensive regulations for electrical wiring, overcurrent protection, grounding, and installation of equipment. Major additions reflect the continuing growth in renewable power technology; these items include dc loads, ac loads in stand-alone systems and battery storage systems.

In South America, the Middle East and Asia the networks continue to develop at the same time that a large integration of renewables is taking place, driven mainly by available technology, more accessible electricity prices, and investors bringing in successful experiences from other countries. The challenges of integration are:

- Stability issues due to limited margins of reactive power
- Lack of interconnection with neighbouring countries and limited spinning reserve
- Poor power quality levels due to low short-circuit ratios
- Networks generally weaker in the areas away from the main cities

For many power network providers, keeping up with the ever changing and increasingly demanding grid codes is a draw on resources. It takes time to keep up, and to interpret changing or new grid codes, and to then extrapolate how those codes may affect the situation and what may need to change in order to remain compliant. Changing and evolving grid codes are necessary for changing and evolving grid supply and demand.

As described above, ESS is a technology which can increase the reliability and resilience of the electrical grid, especially in the presence of unpredictable energy sources such as wind and solar. In particular, ESS based on electrochemical batteries probably will continue to be the case over the next decade due to their versatility, maturity and declining installation costs. A large diffusion of ESS, mainly based on electrochemical batteries, is expected to take place in the next future on both MV and LV networks. Recently, the integration of a BESS is investigated as an alternative solution instead of modulating the hydraulic power.

Both distributed generation units and ESS are required to contribute to the network stability; at the same time, in order to improve fault ride through capabilities, extended operating ranges have been introduced for voltage and frequency in the interface protection systems of local energy sources.

The ESS exploitation at the end-user level, in coexistence with distributed generations, is encouraged by a variety of different advantages and opportunities, such as:

- The forecasted decreasing cost of storage systems with a future diffusion involving increased production capacity.
- Economic advantages for active end-users, enabling the optimal self-consumption of locally produced energy, alternatively to incentivizing mechanisms and so on.
- Levelling the distributed generation power production, both in terms of daily peak shaving function (PV generators, wind turbines, etc.).
- Opportunities in the participation of ancillary services markets
- Local supply of end-users in the case of distribution network outage.
- Contribution in supplying the load peak

power, reducing the contractual value of admitted power absorption and consequently a consistent portion of the end-user bill.

The increased penetration of RE requires changes to the standards and grid codes to ensure that power grids remain reliable and robust, through the support on the technologies like these ones.

### **Barriers to effective energy storage exploitation**

---

Several studies have examined the barriers to energy storage in different Countries. These barriers lead to cost allocation issues, distorted compensation mechanisms, lack of price signals and bureaucratic issues and delays. The regulation complexity is due to the large number of benefits that ESS provides to electric grid as energy services, ancillary services, transmission infrastructure services, distribution infrastructure services, and customer energy management services. Such a large number of ESS benefits have provided a wide market challenges, regulatory bodies and regulatory barriers.

The impact of regulatory bodies on markets, services, technology and stakeholders varies considerably between Countries and/or Regions. European Union has a significant regulatory role and many other authorities have an impact on the regulation of energy markets. Standard organizations naturally affect which kind of technology is being utilized. Barriers exist related to the *legislation* and *standardization* of electricity markets and the related technologies. Legislation and standardization are distinct as legislation is set and maintained by governments while standards are issued by standardization bodies. This forms a quite complex field which requires careful consideration when developing new applications and business cases for ESS solutions.

Lately, several barriers to the large-scale de-

ployment of ESS solutions have been identified. Barriers to enter the market and a lack of a level playing field between different technologies have been identified as the most critical stumbling blocks. Covering the main factors limiting mainstream acceptance of energy storage solutions, the main barriers prohibiting market entry for ESS can be divided into *four categories*:

- the first includes *market barriers*, which place limitations on ESS usage and the associated energy trading due to a lack of market designs and business models.
- the second consists of *technological barriers*, which may limit widespread access to ESS solutions.
- the third consists of *legislative barriers*, which are controlled by the current political climate in each target country.
- the last consists of *financial barriers*. Typically, the difficulty of measuring and monetizing the value provided by energy storage in the market, often a consequence of the market barriers mentioned above. In particular ESS is a highly capital intensive investment that requires long term price signals to lower the risk and cost of capital, such as long term remuneration schemes based on payments for the availability besides payments for the energy exchanged.

Another barrier can be identified in the *classification* of energy storage technologies. Different markets have different classification systems, and therefore, different compensation mechanisms. This variety adds a further burden to energy storage providers because they have to make separate business cases for each market. Receiving proper revenue compensation for energy storage providers in the lack of a recognized remuneration scheme is problematic, especially in regard to providing *ancillary services*. Different wholesale power markets have different compensation mechanisms, many of which are far from providing just com-

compensation to providers. Certain technologies are much faster in responding to frequency regulation needs than others. In the absence of prices for ancillary services, it could be difficult to evaluate a provider's proposal that includes ESS (parties in fact could not look to other wholesale markets to estimate revenue streams).

By summarizing all described constraints, it results clear that an effective inclusion of energy storage in grids is bringing several challenges to regulators, some of them still to be overcome. However, an increasing number of regulatory bodies (especially in the EU, in the US and in Australia case) have found ways for storage inclusion in their grids. The result in the last couple of years is an exponential growth of storage applications (also at an utility scale level with multi megawatt plants realised) with a significant part of the investments coming also from the private sector. This indicates that a considerably improved regulatory framework and clear remuneration schemes have been put in place.

### **Current EES scenario in African regions**

Focusing on Africa's region all the topics previously discussed have to be correlated with the specific political and economic context. Actually in such a region the EES market is still limited by the following barriers:

- Limited renewable energy development;
- Limited local technical expertise and under-developed grid infrastructure;
- Political and/or economic instability, and access to affordable financing;
- Highly regulated, state-run energy markets;
- Low-cost fossil fuels.

However, in the latest years, due to the constant decrease of RES costs, renewable energy

development is rapidly increasing in Africa. Long-time forecasts clearly indicate that most of new energy consumed in Africa will come from RES, leading to a need of ESS in order to balance RES' main weakness (that is notably intermittency).

In South Africa, in recent years, a significant effort has been applied for the deployment of RES: PV, wind, and in particular Concentrating Solar Power (CSP) using molten salts as TES. Around 1.6 GW of grid-tied EES has to date been installed and 1.4 GW of this storage comes from PHS. South Africa, due to the impressive growth rate of RES penetration in the last decade, was expected to be the largest market for energy storage for hybrid systems, the integration of renewable generation being the key driver for energy storage. Some studies have estimated the possibility to increase production capacity with 25 GW of wind and solar by 2025, including the implementation of ESS to improve power supply and to reduce the frequent grid outages. There are also ideal applications for nano-grids and micro-grids (in particular mining sites, rural communities). BESS are expected to be included in remote power systems given the lack of grid connectivity and RES intermittency. On a larger scale however (utility scale), still there are no clear plans in South Africa for large scale battery storage coupled with PV (the only coupled storage systems are those associated with CSP plants). A first approach to utility BESS has been taken in 2017 by identifying the existing Research and Innovation Centre of Eskom in Johannesburg to be used to make comparisons between different energy storage technologies and solutions available on the market and by starting to install utility scale BESS for testing. The facility is undertaking tests on lithium-ion storage batteries and sodium nickel chloride battery technology, with plans to test "another three technologies" in the near future. In October 2018 Eskom announced the intention to deploy a portfolio of 360 MW / 1440 MWh of BESS across 90 sites with size ranging

from 1 to 60 MW. However, there is a lack of alignment with state energy policy since the draft “Integrated Resource Plan 2018”, defining the required additional capacity mix in the country up to 2030, does not anticipate the installation of any BESS.

The conclusion is therefore twofold: on the one hand it is clear that BESS will play an increasingly central role in the energy mix of South Africa. On the other hand, it isn’t yet clear whether its large development will be immediate or could be delayed due to the need of more awareness of decision makers over the reliability of BESS systems and an even faster acceleration of the price drop of BESS systems.

The same approach of South Africa is likely to be taken by the other African States in the coming future.

### Opportunity for energy storage in Africa

Current Africa’s weak power infrastructure and rapidly growing electricity demand create a unique environment for a future mass-scale adoption of energy storage across a variety of use cases. In many ways, the African market presents a more compelling business case than even the US and Europe. In addition to grid support and integration of renewables into the electricity system, current status of Africa’s power grids creates an opportunity to supply power either cheaper than diesel (when coupled with PV) or to bring “round-the-clock” electricity to remote, unconnected locations (e.g. mines, rural villages).

Bushveld estimates the addressable market for utility scale energy storage in Africa to be 80-90 gigawatt hours (GWh), or \$20-30 billion. Key facts include:

- Electricity demand in Africa will grow at 4.5% p.a., with commercial and industrial customers making up 2/3 of total demand.
- Diesel generators in Africa produce around

16 terawatt hours (TWh) of electricity annually, costing \$5 billion for fuel alone (or over \$0.31/kWh on average), showing that Africans are willing and able to pay for electricity. Combining solar PV with well sized storage systems can yield significantly lower unit costs than diesel, without taking into account further cost reductions expected in the coming years.

- Energy experts estimate that South Africa needs 4GW and 24 GWh of energy storage capacity already, on top of the 1.3GW of the Ingula pumped storage project.

Africa may benefit the most from energy storage, compared to other regions, as it offers over other regions several advantages:

- Excellent solar irradiation that suggests a wide use of this source in the future coupled with ESS;
- High reliance on costly diesel especially for off grid applications and for grid connected flexible generation (due to limited availability of gas);
- Around 600 million people that still do not have access to electricity;
- Easier project implementation (large space available);
- “Savvy” energy consumers, open to new solutions.

Energy storage will become also a key factor for customers in Africa where weak grids suffer of frequent outages (in particular blackouts and fluctuations of frequency or voltage). The installation at a consumer’s connection point of a BESS will constitute a defensive efficient tool against power outages in order to smoothly guarantee the continuity of the industrial production. In case of significant energy price fluctuations during the day it will

allow also to make savings on the energy purchasing costs.

Concerning on grid ESS, it is expected that they will be efficiently installed coupled with existing RES plants. Whether a grid will be unable to absorb the power instantly produced by the RES plant and frequent curtailments are likely happen during the plant lifetime, storage can overcome the problem. Storage combined with RES plants could also reduce the unbalancing caused by variability of RES power production, this would contribute to grid stability and allow a higher penetration of RES in the energy mix. A proper dimensioning of BESSs in this case is strategical in order to obtain the best economic performance of the RES+ESS plant.

### Storage in developed markets

Due to the geographical characteristics as well as the peculiar load-generators distribution (major industrial loads in the north, intensive RES deployment in the south) Italy has been one of the first country in the world to face the issues of RES introduction and to deeply test functions and potentiality of energy storage systems (ESS).

In the next paragraphs, an overview of some of the main ESS projects both on distribution and transmission grid will be performed.

### Energy storage for the Italian Transmission grid

Terna, the Italian TSO, launched in 2011 a huge program of ESS installations to address both congestions on HV grid (so called *energy intensive* projects) and safety of the electrical system (*power intensive* projects).

In the context of *power intensive* projects, in order to increase the safety of the electrical system of Italian major islands, two storage laboratories (called *Storage Labs*, one in Codrongianos' HV/MV Substation in Sardinia and

one in Ciminna's substation in Sicily) were developed. Several ESS systems were installed (about 8 in Sardinia and 6 in Sicily, about 1 MW power each), able to ensure *fast response* time and based on power intensive technologies and commercial chemistries (lithium ion of different types, sodium-chloride and vanadium). The target of the installations was to provide *reserve, frequency and power regulation* (support to low system inertia coming from traditional generators), *voltage regulation* and to work with integrated approach with TSO's grid management. In the picture below is shown an overview of Codrongianos' storage lab.



**Fig. 5 – Codrongianos installation**

S

*Storage Lab* experience also provided the possibility to deal with multiple technologies at the same time and their combined operation, testing their advantages and limits under different operating conditions. Multiple skills to manage specific battery characteristics (thermal management for lithium, high temperature operation for sodium chloride, chemical aspects for vanadium redox batteries) resulted to be a milestone of the project. Electrical simplified models have been elaborated and tested for the various storage systems, leading to the capability of predicting ageing of a storage system depending on chemistries and applications, making the Italian TSO prepared to know which type of storages (or aggregated group of

storages) will better fit to provide the specific grid services it will procure in the near future in the electricity market.

As far as *energy intensive* projects are concerned, a first step in the reduction of congestions on HV grid portions with high wind penetration required the installation in the Campania Region of three huge ESS (about 12 MW/80MWh each) based on sodium sulphate technology (NAS), having the capability to store energy for enough hours to reduce 150kV lines congestion as well as to support primary regulation, voltage regulation and increase tertiary reserve.



**Fig. 6 - Scampitella installation**

In the picture above, a detail of the installation in Scampitella. NAS battery modules are inside dedicated buildings, each of them connected to a PCS container. Additional four containers are required for auxiliaries, control system, MV devices. Since once heated up, sodium chloride batteries have to be kept continuously at high temperature (300°) up to the end of life, the required degree of redundancy on auxiliary feeding is 4. Scampitella SANC (Italian acronym for non-conventional energy storage system) was connected directly to the HV grid by means of a dedicated Substation built on purpose. Specific results of transmission grid ESS projects are available on public reports.

Both the *power intensive* and the *energy inten-*

*sive* projects are ongoing, with annual public reports of the results.

### **Energy storage for the Italian Distribution grid**

One of the first Italian ESS project, developed starting from 2012, promoted the improvement of distribution grid in Southern Italy regions with high RES penetration providing the possibility to test Energy Storage Systems in primary substations to:

- reduce the variability of power flow due to wind gusts or the passage of clouds;
- Make the exchange of energy profiles between HV/MV substations and National grid more predictable.

In the picture below, one of the three installations foreseen in the project, the 2MW/1MWh ESS in Campi Salentina (LE) is shown. Three 40 feet container were designed and equipped with proper auxiliaries to house batteries, PCS (inverter), EMS (Energy management system) and MV equipment to connect the storage to 20kV grid.



**Fig. 7 - Campi Salentina (LE)**

The flexibility of lithium-ion technology was adopted to allow both energy (time shift, peak shaving...) and power (frequency and voltage

regulation...) operating conditions. A modular structure based on 8 inverters allows high rate of availability. Proper and safe operating conditions are granted by a dedicated design of HVAC system together with a smart control and supervision system that collecting input from batteries and PCS allows the ESS to perform in a safe and accurate way according to the input coming from grid operator.

The multiple experiences that took place in the last 5 years on both Italian transmission and distribution grid result to be a unique milestone in the deployment of new assets for grid evolution. Capabilities and issues of different storage technologies were tested and are the basis for a further intensive deployment of storage in a context of further renewables spread.

### Renewable integration and Off-grid hybrid systems

EGP currently has 4 plants integrating Energy Storage System. These are currently in operation and incorporate different configurations of the proposed solution, including the use hybrid Renewables generation systems.

#### Catania 1 Storage

Location: Italy

Type: Grid-scale PV Solar+BESS

In operation since 2015



Catania 1 is a 10MW PV plant, MV connected, operated at 8MW due to DSO transmission line lower capability. The installation of a storage

system lets EGP store the energy produced at peak hours and put it on the Grid in the evening hours. The BESS is composed by 2MW/1MWh NaS battery, PCS (Power Conversion System) is a by-directional Inverter, LV/MV transformer with MV switchgear and a control system. The Manufacturer is GE ENERGY.

EGP added to the system an upper-level site controller, defined MASTER SCADA, in order to manage the PV plant and the BESS to act as a single energy production system in respect to the DSO.

Catania1 Storage can perform:

- Primary frequency regulation1a;
- Secondary and tertiary frequency regulation1b (reserve power);
- Power generation production time-shift2a, and;
- peak shaving2a.

#### Pietragalla Storage

Location: Italy

Type: Grid-scale Wind+BESS

In operation since 2015

Pietragalla is a 18MW WIND plant, HV connected. The BESS is composed by 2MW/2MWh SAMSUNG Lithium battery, PCS is a by-directional Inverter, LV/MV transformer with MV switchgear and a control system. The manufacturer is SAMSUNG SDI.

As in Catania1, EGP added a MASTER SCADA controller in order to manage the WIND plant and the BESS to act as a single energy production system in respect to the TSO.

Pietragalla Storage can perform:

Primary frequency regulation;

- Secondary and tertiary frequency (reserve power);
- Power generation production time-shift and peak shaving;



- Voltage regulation by absorption/delivery of reactive power.

Further developments EGP is trialing in Pietragalla Storage are:

- Island operation of portions of the network (like mini-grid composed by a portion of the grid, the storage and the wind farm);
- Participation in the black start of the power system (same as before, but especially after a blackout);
- Spinning reserve (provide synthetic inertia to contribute into grid frequency stability);
- In addition to standard Grid Services, we want to also develop a function for real-time efficiency calculation for DC/DC and DC/AC conversion.

## Ollagüe

Location: Chile

Type: Microgrid

In operation since 2015



Fig. 9 – Ollagüe

An off-grid hybrid system has been built in the desert of Chile aiming to supply energy to a high altitude village (3700 meters AMSL), limiting as much as possible the usage time of the existing Diesel generator. After the completion

of the construction during Q4 2014, the activities of monitoring and field testing are taking place since the beginning of 2015 with plant startup in April 2015.

While ensuring reliable energy supply to the village inhabitants, several possible models are being introduced and tested in the microgrid, starting from the installation of smart meters for the active management of the energy resources. The project presents effective synergies between innovation and sustainability with relevant positive impacts on the local community, meanwhile, enabling a broadening of on the field experience on such advanced plants which are experiencing fast growth, and are targeting emerging markets.

### Hybrid Power Plant:

- PV: 125kWp
- Hydrogen: ±50 kW 1MWh
- Storage: 120kWh SciB Toshiba
- Master Controller  
Pool Algorithms & Black Start Function
- Power Conversion System  
Full Inertia DR/OP Control Technology  
Full DC BUS system.
- PCS Power: C-HPP 125kW  
Peak load: 27 kW (Garita+TAS)  
Diesel reduction: 90%

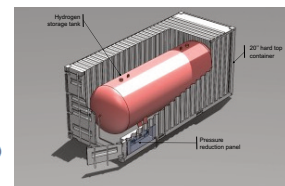
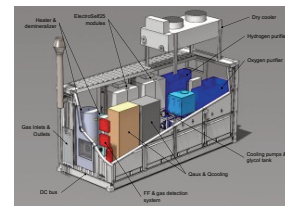


Fig. 10 – Cerro Pabellon Hybrid Storage System

The plant is installed in Ollagüe, a small cut off mine village, 160km from Calama, at the border of Bolivia. Ollagüe's little more than 200 inhabitants are mainly devoted to their domestic cattle, and modest catering at the border. The village is not connected to the SING (Systema Interconectado del Norte Grande) and there only existed a micro grid circuit powered by a 250 kW diesel generator, supplying electricity for no more than 16 hours a day (none is provided from 1 am to 8 am). The changes in temperature are extreme, reaching a delta of 22°C

in a day time, with minimums of -20°C.

The project is made up of a non-SING-connected hybrid off-grid plant, with PV solar and wind components, battery storage, and a backup diesel generator. Additionally, some thermodynamic cogenerating concentration systems have been connected to the same commune of Ollagüe, providing hot water and electricity to the school.

### **Cerro Pabellon Hybrid storage system**

EGP recently completed the construction of an hybrid storage system (Hydrogen for long duration + fast Lithium Titanate battery for dynamic compensation). System is able to provide 24 hours a day green energy and is completely diesel-free (even for back up, thanks to hydrogen storage), able to seamlessly connect to and disconnect from the grid, and containerized for fast “plug & play” deployment.

As a commercial application of Ollagüe and Cerro Off-grid systems, Enel recently completed the supply of a microgrid with 2 system consisting of 500kW / 1MWh ESS each to FormulaE plus grid monitoring and control devices, in order to improve green energy consumption of the Electric Race vehicles of the series. Moreover, EGP is currently working on other initiatives involving BESS, among which:

### **Cremzow BESS**

Location: Germany

Type: Integrated with wind park

Under construction

Batteries are sized 22MW/33.8 MWh. They are

designed to participate to the PCR1a (Primary Control Reserve) market. In addition, synergic services with around 60 MW wind farms connected to the same substation will be tested (e.g. unbalance minimization, curtailment reduction, ...).

The first 2MW section is already in operation from May 2018, while additional 20 MW will be commissioned between December 2018 and January 2019.

### **Wolisso PV+BESS**

Location: Ethiopia

Type: Integrated with CUAMM hospital

Under construction

CUAMM hospital in Wolisso is subject to around 6 to 8 electricity supply interruption daily. This causes risks to patient's health as well as high costs for diesel use.

Enel Green Power is building up a photovoltaic plant coupled to a lead acid battery system to guarantee 100% reliability of electricity supply and significant reduction of diesel usage, with consequent cost savings and lower environmental impact.

The plant is under construction and will be commissioned by November 2018, then donated to Wolisso hospital.

Training of local people for autonomous management of the plant is also part of the project and will guarantee CUAMM autonomous operation and management of the new plant.

## Appendix

**Table 1** Comparison of major energy storage technologies by technical characteristics

	Power rating (MW)	Discharge time	Cycles, or lifetime	Self-discharge	Energy density (Wh/l)	Power density (W/l)	Efficiency	Response time
<b>Pumped Hydro</b>	100–2500	4–16h	30–60 years	~0	0.2–2	0.1–0.2	70–85%	10 s–min
<b>Compressed Air</b>	10–1000	2–30h	20–40 years	~0	2–6	0.2–0.6	40–70%	min
<b>Flywheels</b>	0.001–20	sec–min	20000– 100000	1.3–100%	20–80	5000	70–95%	< sec
<b>Li-ion battery</b>	0.1–100	1 min–8h	1000–10000	0.1–0.3%	200–400	1300–10000	85–95%	< sec
<b>Lead-acid battery</b>	0.001-100	1 min–8h	6–40 years	0.1–0.3%	50–80	90–700	80–90%	< sec
<b>Sodium-sulphur battery</b>	10–100	1 min–8h	2500–4500	0.05–20%	150–300	120–160	70–90%	< sec
<b>Flow battery</b>	0.1–100	hours	12000–14000	0.2%	20–70	0.5–2	60–85%	< sec
<b>Superconducting Magnetic</b>	0.1–1	ms–sec	100000	10–15%	~6	~2600	80–95%	< sec
<b>Supercapacitor</b>	0.01–1	ms–min	10000– 100000	20–40%	10–20	40000–120000	80–95%	< sec
<b>Hydrogen</b>	0.01–1000	min–week	5–30 years	0–4%	600 (200bar)	0.2–20	25–45%	sec–min
<b>Synthetic Natural Gas</b>	50–1000	hour–week	30 years	Negligible	1800 (200bar)	0.2–2	25–50%	sec–min
<b>Molten Salt (latent thermal)</b>	1–150	hours	30 years	n/a	70–210	n/a	80–90%	min

Excludes technologies with limited experience to date from multiple sources.

(\*) Sources: Bradbury, K. (2010), “Energy Storage Technology Review”; IEC (2011), “Electrical Energy Storage. A White Paper”; Schlumberger Business Consulting (2013), “Leading the Energy Transition: Electricity Storage.” Schlumberger Business Consulting Energy Institute, FactBook Series, World Bank ESMAP Technical Report 006/15 ‘Bringing variable renewable energy up to scale: Options for grid integration using natural gas and energy storage’, and contributions from WEC Energy Storage Knowledge Network participants.

---

## Innovation and Africa: an opportunity not to be missed

---

This paper has been prepared by:



---

Domenico Fanizza, *International Monetary Fund and African Development Bank*

### Introduction

Africa faces a formidable unemployment challenge. Its demographic profile implies a major surge in the share of working-age population in the next two decades, while overall population will continue to grow rapidly. The issue on whether the continent's current economic growth trends will be sufficient to absorb at least a significant portion of the projected labor supply increase has been amply discussed, with an overwhelming negative answer<sup>1</sup>. This paper claims that innovation could constitute the key to exploiting the continent's demographic profile as an opportunity for economic transformation. In particular, it aims at conveying two messages:

- The new wave of technological innovation, the so-called Fourth Industrial Revolution

(FIR), provides a major opportunity for transforming the continent and generating the needed jobs, without necessarily following the structural change pattern experienced in South East Asia and Europe.

- Africa would not succeed to absorb a significant portion of the projected increase in its labor supply, even if the employment in industry were to grow at an average rate twice as high as that experienced by the Asian Tigers during the last 25 years. Thus, Africa cannot afford missing the opportunities offered by the FIR, and should embrace, not resist, the ongoing wave of technological innovation. Relying on old-fashioned industrialization will not deliver the needed jobs, even under most optimistic assumptions on industrial growth.

### Innovation and the new global economy

There has been much talk about the Fourth Industrial Revolution (FIR) and its impact on the global economy. The basic idea is that the new wave of technological innovation would not

---

<sup>1</sup> See for instance Louise Fox, Alun Thomas, and Clairy Haines "Structural Transformation in Employment and Productivity: What Can Africa Hope For?" IMF, Departmental Papers April 2017

only shift the production-possibility frontier through substantial gains in total factor productivity, but would also radically alter consumption, communication, and social organization patterns<sup>2</sup>.

It is clear that the new wave of innovation has a huge potential for improving productivity and living conditions. However, these benefits are unlikely to materialize without causing major disruptions. Vast portions of the existing productive capacity will become obsolete and many assets will become stranded. For instance, driverless cars and their sharing are likely to make individual car ownership obsolete, the way in which typewriters disappeared quickly in the early 1980's, or the production of cameras and fax machines did in the last decade. Similar changes are likely to take place in other key sectors, such as energy with the demise of traditional grids in favor of mini generation-consumption grids, and the financial sector, with the demise of traditional banking as the result of the adoption of block-chain technologies that can eliminate information asymmetries.

The process is unlikely to be smooth because of its very nature and dimensions. It is difficult to imagine that the automotive industry will re-convert to the new consumption and production models in its totality. There will be winners and losers. There will be a major impact on employment levels and on the skills that will be required. Many workers will not be able to re-tool themselves toward the skills required by the new production model.

Clearly, the adoption of new technologies will face opposition. In fact, this has already been the case for driverless cars on security grounds, which is difficult to make sense of, if one thinks of how insecure traditional cars are. The diffusion of Uber or Uber-like services

has encountered major hurdles in France, Italy, and most recently, Egypt, because of pressures from taxi drivers, who have managed to influence regulations in their favor.

These oppositions have the potential to slow down the pace of innovation. Their strength and their likelihood to be effective in slowing down the innovation will crucially depend on:

How large the sector that comes under threat is relative to a country's economy.

How young is a country's workforce. The younger the easier to adapt to the new skill requirements. Old dogs do not learn new tricks!

### Innovation and Africa

The notion that Africa is technological prone has been already discussed in the literature<sup>3</sup>.

The mobile-banking revolution, in particular the fact that Africa appears the most mobile-banked continent in the world, seems to be behind this idea. There are no doubts mobile banking is transforming the continent, by connecting previously excluded Africans to the formal financial sector and making a difference in providing opportunities for market participation even to people in most remote areas of the continent.

The continent is also seeing the onset and rapid expansion of, eHealth, edTech, agriTech, three solutions specifically adapted to the local needs related to some of the greatest challenges Africa faces: health, education and food security.

Drone technology already helps to deliver medical goods and constitutes a possible solution to the medical infrastructure deficiency, for in-

<sup>2</sup> See "The Fourth Industrial Revolution" by Klaus Schwab World Economic Forum 2015

<sup>3</sup> See for instance the WEF report "The Future of Jobs and Skills in Africa: Preparing the Region for the Fourth Industrial Revolution" May 2017.

stance, in Rwanda. This technology already helps to maintain portions of the electric-power grid that come under threat from the tropical vegetation in Cote d'Ivoire.

Well-structured web-based classes make basic education now affordable not only in the urban slums but also in the remote areas of Kenya.

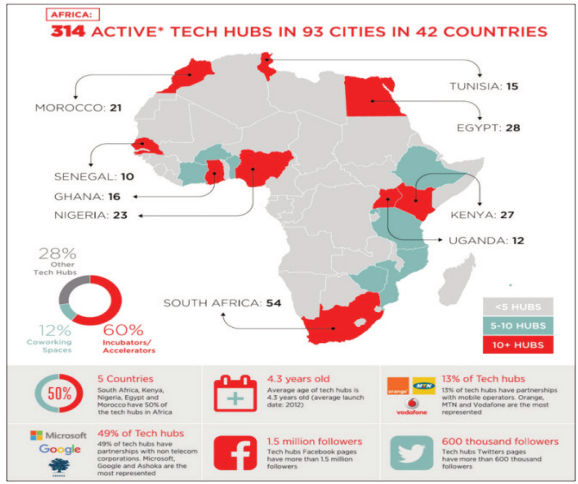
On-line platforms provide now customized advice on planting patterns and timing to many farmers in Nigeria. New technologies, such as block chain, in addition to limit information asymmetries in financial markets, can have a favorable impact on governance and corruption. Their use in managing public resources would greatly increase accountability by virtually making transparent and openly accessible all government transactions.

- Even plain-vanilla digitalization of payments businesses and people make to government has proved to have a favorable impact on reducing the scope for corruption. For instance in Tanzania it has already:
- Empowered its tourism sector by reducing economic leakage from cash payments, such as conservation-park entry fees, by over 40 percent, supporting investment and employment.
- Cut bureaucratic inefficiencies, including reducing import customs clearance times from nine days to less than one day.
- Increased transparency between citizens and governments in tax payments, by providing electronic proof of payments and protecting people against fraud.

The literature appears to explain the somewhat unexpected “blossoming” of creative applications of new-technologies in part of the continent with a more flexible regulatory environment than in industrial countries, where for instance the use of drones for delivering goods or gathering economic-relevant data is ham-

pered by strict security requirements. Quantitative evidence on this idea, together with an analytical framework, can be found on a recent paper by Fanizza and Boly<sup>4</sup>. Here, we use three graphs to illustrate the point.

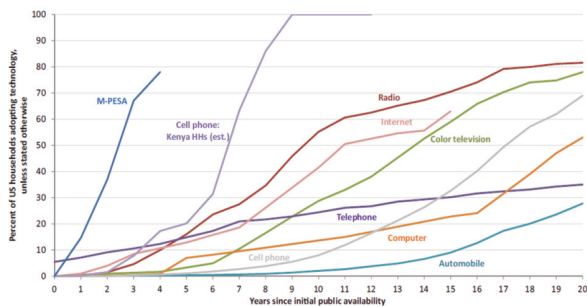
First, the map below provide provide<sup>5</sup> a sense of the extent to which innovation has spread around the continent.



There are encouraging signs in several countries, which have seen a significant numbers of technological hubs to emerge. Of course, the picture for the continent is not uniform, and there are countries that have lagged behind and do not appear quite technology prone.

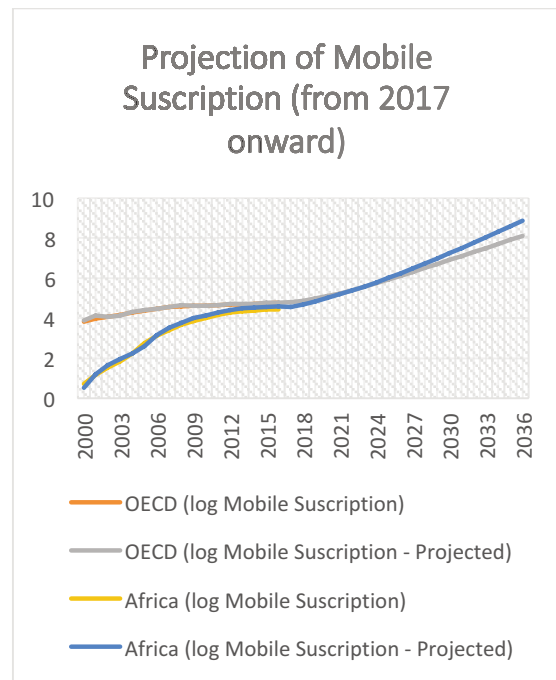
<sup>4</sup> See “Innovation and Africa: Much to Gain, nothing to Lose!” by D. Fanizza and A. Boly, African Economic Consortium, June 2018.  
<sup>5</sup> <http://www.visualcapitalist.com/africa-exploding-tech-startup-ecosystem>

Second, a comparison of the diffusion rates for Kenya's mobile-payments (M-Pesa) and mobile phones, and those of several historical innovations in the US. These two technologies have spread much faster than any other "transforming innovations" have in the US.

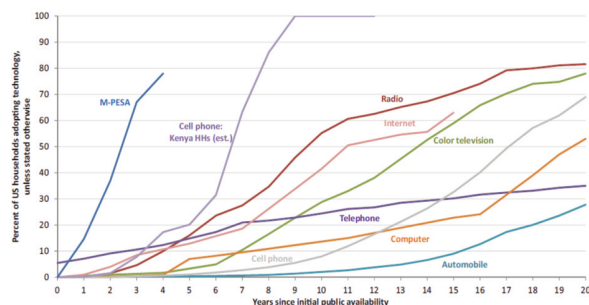


Third, the graph below compares the diffusion of mobile phones in Africa to those for the all OECD countries. If the experienced trend since 2000 continues, already in 2021 the number of mobile connections in Africa would equal those in OECD countries, and thereafter would it would become substantially higher. Of course, a caveat is needed, because there are no reasons why this trend should continue unabated over the years.

Third, the graph below compares the diffusion of mobile phones in Africa to those for the all OECD countries. If the experienced trend since 2000 continues, already in 2021 the number of mobile connections in Africa would equal those in OECD countries, and thereafter would it would become substantially higher. Of course, a caveat is needed, because there are no reasons why this trend should continue unabated over the years.



Second, a comparison of the diffusion rates for Kenya's mobile-payments (M-Pesa) and mobile phones, and those of several historical innovations in the US. These two technologies have spread much faster than any other "transforming innovations" have in the US.



Moreover, the fact that Africa has a relatively small "incumbent sector" (e.g. manufacturing), and a young population structure can make it a fertile ground for ongoing global wave of technological innovation. Based on estimated parameters from a cross-country panel data set for mobile- phone technology Fanizza and Boly (2018) have simulated the different impact that these two factors could have on the diffusion rates in Africa and in the OECD countries. The simulation shows that over time diffusion rates would increase substantially in Africa, whereas these would decline for the OECD countries, as shown by the graph below.

## Can Africa rely on traditional industry?

To illustrate how the “traditional” pattern of structural change would not succeed to address Africa’s employment demand we use a simple simulation. We call “traditional” the pattern that sees economic development driven by productivity gains in industry. These gains attract labor supply from agriculture boosting industry employment, which in turn generates productivity improvements in agriculture, which then allow further shifts in the work force from agriculture to industry. The presence of, however, a productivity gap in favor of industry vis-a-vis agriculture (or services, for that matter) would allow sustaining a virtuous circle that provides labor supply to industry as needed, forcing productivity improvements in agriculture as a by-product. This mechanism would allow transforming developing economies along the lines experienced by Europe and South East Asia. This is the old basic Lewis model<sup>6</sup>, which has been proposed as a viable path for Africa by both J. Lin and D. Rodrick<sup>7</sup>.

We have built two scenarios based on the China’s experience. The first assumes a 6 percent annual growth in industrial employment, which is what China experienced during the last 15 years. The second assumes twice as much, 12 percent per year.

Under the first scenario, it is clear the gap between overall labor supply would actually broaden over time. However, even under the quite optimistic second scenario, growth in industrial employment would not keep the pace of labor supply, still raising the gap between 2040 from 2016. These dynamics would reflect

the base effect, because industrial employment levels in Africa are in fact quite low, whereas working-age population grows not only quickly, but also from a high initial level.

The message from this simulation is that the continent cannot make it if it follows the Lewis-type bluebook for industry-led development. Of course, productivity improvements in industry are to be more than welcome, but the point is that the continent cannot deal with its employment challenge without expanding employment in services and agriculture. Economy-wide productivity improvements are key! These need to happen in services, agriculture, and industry as well. Innovation provides an opportunity to achieve the needed economy-wide productivity improvements.

## Conclusion

We have argued that Africa has virtually no alternative to embrace the new wave of technological innovations enthusiastically. Business as usual, even under the most optimistic assumptions, would not help to reduce the expected yawning gap between labor supply and demand in the continent. Our simulations suggest industry cannot create the necessary jobs by itself, agriculture and services need to play both major roles. This conclusion has implications for policy. First, governments should refrain from protecting economic activities that come under threat from innovation. Second, policies should aim at creating an enabling environment for technological innovation, and avoiding channeling resources toward the pursuit of industrial dreams. The fact that advanced countries have gone through years of heavy industrialization does not imply Africa should go through the same experience. There is no bluebook for economic development! In fact, the continent could use new technologies to avoid both the social and environmental costs industrial based growth.

---

<sup>6</sup> Lewis, W. Arthur (1954). "Economic Development with Unlimited Supplies of Labor". The Manchester School.

<sup>7</sup> See for instance J. Lin and A. Goldstein "Achieving an African Industrial Revolution" Project Syndicate February 2017; and D. Rodrick "Growth without Industrialization?" Project Syndicate October 2017.





---

## Construction models for renewable plants in Africa: a flywheel for sustainable development

---

This paper has been prepared by:



in collaboration with:



---

Antonella Santilli, *EGP* – Francesco Belfiore, *ERM* – Nicky Crawford, *ERM* – Deon Wessels, *ERM* - Mark Grundy, *RINA*

### Abstract

---

*Renewable energy can play a pivotal role in providing competitive and clean electricity, which Africa needs in order to fully realise its growth potential. Moreover, today the opportunity to overcome the development divide strongly depends on the availability of and access to energy. Thus, renewable energy projects can be key for the sustainable growth of the economies where they are deployed, and this can be supported by policies, taking into account the environmental and social impacts, also at local level. Moreover, the private sector can further unlock renewable potential for inclusive development, in particular by implementing sustainable construction and operation models.*

### Africa needs energy

Africa's energy sources are many and diverse and the continent experiences the kind of economic growth that G7 nations such as France and Germany, let alone Italy, can only dream of. To fully realise its growth potential

Africa needs a lot of energy as well as the infrastructure to ensure that it is delivered afford-

ably, safely, and consistently to households, as well as industry, businesses, and the public services sector. Although energy is not an end in itself, today the opportunity to overcome the development divide strongly depends on the availability and access to energy. Access to affordable energy can help reduce poverty; it can be instrumental for people living below the poverty line to reach a better quality of life. Researchers argue that access to electricity has a

positive impact on development through its effect on the three components of the Human Development Index: these are income, education and health.

Income generation is by far the most studied impact indicator and there is evidence of a significant increase in both the consumption of electricity and income levels of households. In some cases, such as in South Africa, income generation is linked to an increase in female labour supply. As far as education is concerned, the positive effects are to be found in the enrolment rates and the number of years of completed schooling, as well as facilitating the use of computers and in the general operation of schools. Health indicators derive from the reduction of kerosene, and the availability of electricity for health equipment (refrigerators for medication, sterilizers etc.) and for infrastructure (hospitals, emergency camps, etc.). The availability of electricity can also benefit other public services, as well as provide the energy needed for mobile communication systems, water pumping, etc.

### **Renewable energies can be a solution**

Electricity consumption in Africa is constrained by limited supply and by poor transmission and distribution infrastructure. Renewable Energy (RE) deployment, along with grid enhancement, energy storage and micro-grids, has the potential to accelerate Africa's socioeconomic transformation, linking prosperity with quality of life and facilitating the path towards sustainable growth. Bringing energy to those without access, means opening local communities up to new possibilities in education, healthcare, gender equality, and employment. Bringing clean energy can achieve this while respecting the environment and territory. Bringing clean and competitive energy means building a winning model where all aspects of sustainability can be integrated: renewable plants on an industrial scale can benefit the local communities, the environ-

ment, and market operators.

In terms of the energy divide and growth of renewables, Africa has long been the subject of reports and market analysis that repeat the same mantra: the continent has a unique potential and human resource capabilities, abundant resources, competitive technologies, and business models that are increasingly refined. African countries just need stable regulatory frameworks to unlock investments and thus give rise to a new era.

### **Benefits and risks of renewable energies**

Besides the obvious positive impacts on the environment and the economy, renewable energy offers three main key advantages.

Firstly, renewable generation is typically less concentrated and more decentralized. Moreover, the time required to build a power plant is shorter than for other conventional technologies. RE projects are inherently more scalable than conventional projects, and can be sized for current demand, and if required expanded as demand grows. Furthermore, it does not need the same infrastructure requirements of conventional power projects, offering additional flexibility for locating projects.

Secondly, renewables can be easily installed and maintained, and their deployment offers opportunities in terms of job creation and inclusive economic development. Finally, an abundance of resources alongside technological improvements, the subsequent reduction in costs and improvements in performance now make renewables competitive with fossil fuel generation. The IRENA report "The Socio-economic Benefits of Solar and Wind Energy" (2014) emphasises the importance of value creation in the renewable energy sector. A central question to the assessment of value creation in the RE sector is to what extent the value creation is being generated locally. This

depends on the maturity of the RE sector in the country where the project is being realised, as well as the presence of an electricity distribution network. The planning, construction, grid connection and operation phases are identified as the main aspects that are able to bring domestic value. As for the manufacturing process and supply-chain, this depends on the presence of such industries in country, and requires at least a certain degree of industrial capability in the country in order to generate local value creation.

The IRENA report further elaborates on value creation in supporting the processes included in the value chain of RE project development, such as policy-making, financial services, education, research and development, and consulting. Strengthening these processes may enable further value creation in the RE value chain, as well as other sectors. A focus on policy-making is key to creating an enabling environment for RE investments in a country. Hence, setting the right policies is considered a first step to facilitate RE investments and can therefore boost value creation at an early stage.

Increasingly, environmental and social performance influences the bankability and viability of renewable energy projects.

Although renewable energy delivers better performance in terms of environmental and social standards, their development may involve some negative impacts that need to be mitigated, whilst several of the benefits can be enhanced. These impacts are experienced locally on both ecological and social aspects through the construction and operations phases of RE projects.

The key factor in reducing the potential negative environmental and social impacts and maximizing the potential benefits associated with RE projects, as well as ensuring technical and economic viability lies in considering from the start, the entire lifecycle of RE projects,

from initial business development to their operation and maintenance.

Moreover, as large-scale renewable projects can occupy large areas of land, thereby restricting or limiting land access and use, consideration of land use and its ownership is essential when initially selecting sites. Furthermore, site selection can also determine the availability of local workforce, the ability for the project to bring direct benefits to local communities, may influence impact to local ecology, increase risk of natural hazards etc.

### **Policy can lower the risks**

---

In some African countries, environmental and social impacts have been taken into account at policy level, in order to enhance the intrinsic potential of renewable energy to support sustainable development.

This is the case of South Africa, where renewable energy projects are obliged to make a real contribution to local economic development in the immediate area of operation. The South African Government developed a clear policy on sustainable economic development within the renewable energy sector. This policy, although cumbersome to those that are less environmentally and socially inclined, has lured a number of investors who have integrated sustainability and shared value into their business. The obligations imposed by Government comprise of seven pillars, which include amongst others:

- Local equity ownership;
- Preferential procurement;
- Local job creation;
- Socio-economic Development (SED); and
- Enterprise Development (EnD).

These components, if appropriately imple-

mented in partnership with local actors, not only reduce environmental and social risks to the company, but also set the foundation for **Creating Shared Value (CSV)** within the local community.

### What the private sector can do

Over the last years, a number of business formulae have arisen, starting to take into account the social and environmental aspects of a project. In order for these models not to be just wishful thinking, or worst still green washing, social and environmental aspects need to be fully integrated into the entire business. In other words, sustainability needs to be linked to profits.

The goal of sustainability must indeed be to create value for all – the industry, civil society, and the environment – and to conduct business that leads to shared, widespread and lasting Value. It’s no coincidence that the United Nations (UN’s) 17 *Sustainable Development Goals* (SDGs) fully adopt this logic through “*doing well by doing good*”. They advocate that a truly sustainable business can help respond to the needs of education, healthcare, and gender equality by promoting economic development, employment, and energy access for millions of people around the world. Many private companies have adopted the **model of Creating Shared Value (CSV)**, making sustainability a fundamental driver for competitiveness. The sustainable construction site model is a practical, real, application of CSV which aims at reducing negative impacts on the local environment and communities, while maximizing positive ones on value creation.

In other words, by conceiving the deployment of renewable energy under a sustainable value creation model, further value for local development can be unlocked.

Construction is the phase when the presence of a large-scale RE project is most apparent, and is usually the most delicate phase, as the

impact on the environment and on people’s lives becomes perceptible and is realised by the community. The objective of the sustainable construction site model is to anticipate impacts in advance based on the knowledge already acquired during the development phase and then effectively manage these through mitigation, measuring, and mitigate reviewing, under the principles of a circular economy.

In the case of Enel, four major impact categories have been selected as more relevant to this phase: water, waste, emission and people.

### How the sustainable construction site works

The key to the model is the integration in processes of:



We measure our impacts in order to mitigate or enhance them; for example, among our indicators are:

- percentage of water reused
- percentage of waste recycled
- percentage of renewable energy used at the construction site/camp
- expenditure on local suppliers
- percentage of local workers trained and employed
- days of stoppage due to safety or social issues
- safety indicators, and
- number of biodiversity projects.

Mitigation measures are very context-specific. Through a series of analysis in the business development phase we obtain a thorough under-

standing of socio-economic and environmental contexts. We thereafter identify the actions to be implemented at the construction sites to create value for both Enel Green Power and the community. Furthermore, in order to improve the sustainability and quality of projects in the design phase, feedback from other projects is considered and implemented through technology improvements across-the-board.

Some examples of mitigation measures include:

- use of sustainable certified materials
- maximum reuse of all excavated ground and rocks;
- donation to the community of surplus wood, iron and cardboard.
- reuse of water from treatment of grey water
- use of electric vehicles
- construction site lighting powered by photovoltaic cells or mini wind-power plants
- renewable energy systems to meet the power demand of the on-site facilities
- improvements in local infrastructure
- training of local workers and knowledge transfer, and
- provision of on-site structures and services for workers.

A key part of a sustainable construction site is effective and on-going engagement with the local community, to ensure a positive relationship is fostered and maintained. It is essential that such engagement starts at the early stages of the project development in order to manage

community expectations, as well as to identify shared risks and values.

### **Is sustainability an added cost?**

---

The sustainable construction site model can certainly create value at a local level by sensibly decreasing consumption of resources, such as water, wood, rocks etc., reducing emissions, and providing the local population with infrastructure, jobs, training and knowledge transfer. It can thus can certainly enhance the capability of renewable energies to be a fly-wheel to local development.

Furthermore, implementing sustainability as a core part of the business model reduces risks, potential delays, and supports financing. However, some may argue that such a model can do so only by adding costs, thus making the business at the end of the day less financially sustainable. Our experience at Enel Green Power is that this is a misconception. Let us look in practice at the sustainable construction site model; how did this go? Here are just a few real examples.

By reusing wood from pallets, for example donating them to a community, you avoid the costs of disposal. You can invest this saving, depending on the local needs, by training people in eco-carpentry. And if there is the need, you can even buy this eco – furniture for your offices (they are good for the environment and the people but also they cost less than some industrial product delivered from miles away).

When water is scarce, filtering and reusing grey water to manage dust may be economically more viable than buying and using tons of clean water.



---

## Leading capacity development: a key driver for the streamlining of ODA funding for renewable in Africa

---

This paper has been prepared by:



RINA. Excellence Behind Excellence.

in collaboration with:



---

Lorenzo Facco, *RINA* - Cristina Migliaro, *RINA* - Matteo Cavadini, *EGP*

### Abstract

---

*The global new investment in renewable in 2016 registered the lowest total since 2013 despite the record installation of renewable power capacity worldwide. One of the main reasons behind this drop in the investments is the lower average capital cost for renewable projects starting construction in 2016 as well as the delays which occurred in some Country or regional level development program. In addition, Official Development Assistance (ODA) funding to developing countries were in some cases not fully exploited; addressing part of the ODA to the support for setting policies with clear targets is crucial in facilitating investments in renewable energy and so is also the adoption of policy instruments. The main goal of the present paper is to spot the existing barriers preventing the extension of the renewable electricity coverage of the area and identify a high level set of recommendations to facilitate the deployment of renewable energy related ODA. The guiding principles for ODA supported capacity development activities identified within the paper include: Supporting country leadership; Capacity development design and sequencing should fit specific country circumstances; Donor support should be provided in a coherent, coordinated, and programmatic manner, and changes in procedures and policies need to be accompanied by extensive on-the-job training to ensure that the new concepts can be implemented.*



## Background

---

Despite the record installation of renewable power capacity worldwide, in 2016 the global new investment in renewables fell by 23% to US\$241.6 billion (excluding large hydro) which is the lowest total since 2013; in this context the renewable energy investment in the developing countries fell overall by 30% showing a rate of decrease similar to the one registered by China (32%) and Africa had in 2016 its lowest level of renewables investment since 2011, approximately US\$7.7 billion, 32% lower than 2015. Several are the reasons behind this drop in the investments:

- one of the most important reason is the lower average capital cost for renewable projects starting construction in 2016, which was 13% lower than in 2015 for PV, while for onshore wind the drop was 11.5% and for offshore wind 10%;
- several projects in wind and solar were financed in late 2015 and only commissioned in 2016, in which case the investment associated with them were recorded in the earlier year and the GW addition in the later one; activities in some key markets have slowdown during the course of 2016 especially in Asia;
- several renewable energy markets in the developing world produced record investment figures in 2015 but then saw sharp falls in 2016 in response to scheduled pauses, or delays, in their auction schedules as for example in South Africa and Morocco.

In addition to the above mentioned, Official Development Assistance (ODA) funding to developing countries, including African Ones, were in some cases not fully exploited due to major barriers to the wider dissemination of renewable energy such as policy, regulation and institutional; as well as information and technical capacity; this highlights scope for an increased

focus on skills development in the public sector for better capitalizing on ODA.

## Objectives of the paper

---

Investments in the energy sector have been identified as a priority by many African Governments, Regional Organizations as well as the International Donors community.

As a result, numerous initiatives have been launched with the common goal to support the Continent in achieving a sustainable energy supply; this has led to an increasing need for exchange and coordination across the growing number of initiatives and programs in the sector.

The main goal of the present paper is to spot the existing barriers preventing the extension of the renewable electricity coverage of the area and identify a high level set of recommendations to facilitate the deployment of renewable energy related ODA with the final aim of improving the quality and stability of energy supply and therefore improve living conditions in the urban and remote areas, as well as fostering the ongoing efforts made by the National Governments of the Region and by the International players towards the sustainable economic development and achievement of the ambitious goals set by the United Nations Millennium Development Goals.

## Trends in Energy related ODA in Africa

---

Over the course of the last 15 years, ODA to the African energy sector has increased substantially and the energy sector accounted for approximately 10% of ODA in Africa. In the period multilateral donors provided nearly 60 % of energy ODA, while bilateral donors provided the remaining; the three largest multilateral donors in the energy sector in Africa are the World Bank, the EU Institutions and the African Development Bank.

The bulk of multilateral lending is disbursed via loans and grants to individual national governments. The EU institutions deliver their ODA via a mix of thematic and geographic programs with direct as well as indirect implementation modalities, including in particular blending instruments.

Similarly, the major bilateral donors channel a large part of their ODA through a variety of country-level delivery mechanisms such as the Agence Francaise de Développement (AFD), the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the Japanese International Cooperation Agency (JICA) which provide grants, loans and technical assistance in direct form as well as concessional lending and other financial instruments channeled through national development banks like the German Kreditanstalt fuer Wiederaufbau (KfW), or the Japanese Bank for International Cooperation.

North Africa, home to 16% of the total population on the continent and the only African region with close to universal access to electricity, and East Africa, where live the 23% of the African population of which more than half lacking access to a stable electricity supply, have received the largest volumes of energy sector ODA over the period, accounting for more than half of total ODA. West Africa represents the third largest destination (23.3%) and accounts for 30 % of the African population; while Southern Africa and Central Africa, follow by a wide margin.

The largest sources of donor funding in the African energy sector are the World Bank grants and concessional loans provided via the International Development Association (IDA) which represented almost 30 % of total energy ODA over the period.

The European Union was the second largest multilateral donor providing over 15 % of total ODA in the African energy sector; other major multilateral donors in the African energy sector are the African Development Bank (AfDB) and the Arab Fund for Economic and Social Development (AFESD).

The World Bank directs most of its ODA funding in the energy sector to East and West Africa. North Africa dominates the energy ODA of EU institutions and the AFESD while the AfDB channels most of its energy ODA to East Africa.

A list of the main ongoing initiatives supporting the deployment of renewable energy technologies and the provision of access to sustainable energy supply in Africa is presented in the following table.

Looking at the bilateral aid, France was the largest donor followed by Germany and Japan; together these three Countries accounted for approximately 30 % of total ODA to the African energy sector and 57 % of bilateral aid; the group of the ten largest bilateral donors furthermore includes Norway, Kuwait, the United States, Spain, the United Arab Emirates, United Kingdom and Korea.

High-level initiatives	
Africa Clean Energy Corridor	Africa Renewable Energy Initiative (AREI)
Africa Energy Leaders Group (AELG)	Presidential Infrastructure Champion Initiative (PICI)
Africa-EU Energy Partnership (AEEP)	Program for Infrastructure Development in Africa (PIDA)
Africa Power Vision	SE4ALL (Africa Hub)
High-level initiatives with an operative program	
Africa 50	New Deal on Energy for Africa
Africa Renewable Energy Access Program (AFREA I & II) - ESMAP	Power Africa
ElectriFI	Public Private Infrastructure Advisory Facility (PPIAF)
Energies pour l'Afrique	World Bank Guarantee Program
Global Alliance for Clean Cookstoves	
Operative programs and delivery mechanisms	
ACP-EU Energy Facility	GET FIT Uganda
AFREA Gender and Energy Program	Global Energy Efficiency and Renewable Energy Fund (GEEREF)
Africa Clean Cooking Energy Solutions Initiative (ACCES)	Green Mini-Grids Africa Regional Facility
Africa Energy Guarantee Facility (AEGF)	IRENA/ADFD Project Facility
Africa Enterprise Challenge Fund (AECF)	Lighting Africa
Africa-EU Renewable Energy Cooperation Program (RECP)	Mediterranean Solar Plan (MSP)
African Development Bank Partial Risk Guarantee (PRG)	NEPAD Bioenergy Programme for Africa
Africa Renewable Energy Fund (AREF)	NEPAD Continental Business Network (CBN)
Biofuels Programme for Household and Transport Energy Use	NEPAD Infrastructure Project Preparation Facility (NEPAD-IPPF)
Carbon Initiative for Development (CI-Dev)	PIDA Service Delivery Mechanism (SDM)
Clean Technology Fund (CTF)	Private Infrastructure Development Group
EEP Africa - Energy and Environment Partnership	Regional Energy Project for Poverty Reduction
Energising Development (enDev)	Regional Technical Assistance Program (RTAP)
Energy Access Ventures	Renewable Energy Performance Platform (REPP)
Energy Africa Campaign	Renewable for Poverty Reduction Program (REPoR)
EREF ECOWAS Renewable Energy Facility	Renewable Energy Solution for Africa (RES4Africa)
EU-Africa Infrastructure Trust Fund (ITF) / Africa Investment Facility (AfIF)	Scaling Solar
EU Development Finance Institutions (EDFIs) Private Sector Development Facility	Strategic Climate Fund - Scaling Renewable Energy Program (SREP)
EU Energy Partnership Dialogue Facility (EUEI PDF)	Sustainable Development Investment Partnership (SDIP)
European Union's Technical Assistance Facility (TAF)	Sustainable Energy Fund for Africa (SEFA)
Geothermal Risk Mitigation Facility	

In terms of beneficiaries, North Africa dominates the energy portfolio of Spain, Germany, the UAE and Kuwait. East Africa receives the largest share of energy ODA from France and Japan. Southern Africa is the region that receives most energy sector ODA from the US, Norway and Korea. The energy portfolio of the UK concentrates on West Africa and Southern Africa. It is important to note that none of the top 10 bilateral energy donors have a focus on Central Africa.

Italy was the eighth-largest donor country in 2016 overall, spending US\$4.9 billion on net official development assistance which represents 0.26% of Italy's gross national income (GNI) and an increase in ODA amount of more than 90% since 2012 mainly driven by the rising costs for hosting refugees in Italy; in parallel, however, funding for development programs abroad also increased by 5% between 2015 and 2016 as part of the Government's effort to use development cooperation to strengthen Italy's international standing. In this context Italy recently overhauled its development cooperation system, establishing its development agency (AICS) and development finance institution (CDP) in January 2016.

The creation of AICS and new development finance institution (CDP) is an opportunity to shape Italy's development agenda where the Italian Ministry of Environment, Land and Sea (IMELS) represents a key player with particular focus to climate change and clean energy; in particular, with specific reference to Africa, within the scope of the CoP 22, IMELS signed specific agreements concerning environmental cooperation activities with 5 African Countries (Ethiopia, Djibouti, Rwanda, Democratic Republic of the Congo and Sudan) and allocated about € 11 million for projects aimed at implementing the mitigation and adaptation targets set by the countries through their own NDCs.

Furthermore, IMELS, together with the International Finance Corporation (IFC) of the

World Bank Group and the United States, launched in 2010 the Solar and LED Energy Access Program (SLED) with the aim of bringing clean and high quality energy to the population without access to energy, at the same time alleviating poverty, improving health and reducing greenhouse gas emissions.

The first initiative launched was "Lighting Africa", whose goal is to accelerate the development of the market of "off-grid" lighting products in rural, urban and peri-urban areas without access to electricity in 10 Sub-Saharan African countries.

This initiative subsequently merged with others into "Lighting Global", the World Bank's platform that supports the international growth of the off-grid solar market as a means of rapidly increasing access to energy from those who do not have access to the electricity grid.

In 2015, an additional US\$ 7.25 million was paid into the program by IMELS and in 2017, in order to guarantee the impact of the program in the long term, IMELS has decided to support the program with a further US\$ 4 million with the aim of supporting market innovations, expanding the impact of emerging technologies as a basis for sustainable economic development, improving the quality of life and reducing greenhouse gas emissions. In addition the program have provided over 100 million people with modern services powered by solar energy, for home lighting and mobile phone charging, with an estimated 5 million tons of greenhouse gases emission avoided which is equivalent of removing one million cars from the road each year.

More than 100 products have already been produced within the program, of which Lighting Global certifies quality, with the aim of finding efficient applications for solar energy in the households or for small economic activities such as irrigation.

The Program also provides consulting services to companies and offers a wide range of services including: assistance in market access strategies, risk management and development of innovative models, promotion of economies of scale, assistance in the distribution and sale of products.

### **Barriers to Renewable Energy Investment in sub Saharan Africa**

Although major technical and financial breakthroughs have been achieved internationally with respect to renewable energy their contribution to Africa's energy problems remains minimal (excluding large Hydro). Major barriers to the wider dissemination of renewable energy on the African continent will need to be overcome. These barriers can be categorized as follows:

- policy, regulation and institutional;
- information and technical capacity;
- financial.

#### *Policy, Regulation & Institutional*

Consistent policy and regulatory frameworks are central to the successful dissemination of renewable energy in technologies in sub Saharan Africa, but in general such frameworks are absent in most of the African countries and where suitable policies for promoting renewable energy do exist, their impact is weakened by a lack of enforcement mechanisms which makes very challenging for the private and industrial sector to operate effectively and expand their renewable energy investments.

Furthermore, the lack of policy focus on the renewable energy is the relatively low budgetary allocations at Country level for the promotion of renewable energy in many African countries; the majority of energy projects are therefore

externally financed. Despite the recent development of several renewable energy policies in many developing countries, including African ones the successful development and deployment of any technology, especially relatively new ones, such as renewable energy technology, need several institutions covering the different technical, economic to market aspects; this institutional capacity is not always available in most parts of Africa.

Moreover ancillary technical institutions for testing, operation and maintenance of technologies have a limited presence in African countries especially with reference to National Systems of Innovation (NSI) which have proved to be crucial in increasing technological receptivity in most developed and emerging economies

#### *Information and technical capacity*

Ensuring secure sustainable commercial success of renewable energy depends on institutional and human capacities as well as business and market capabilities.

A major technical barrier is the unavailability of accurate and well organized renewable energy resource data. The data on renewable energy, especially for solar and wind, are very scanty and the poor technical skills in the continent affect the development of renewable technologies. Inadequate domestic technical skills account for poor maintenance of imported systems and lack of provision of adequate after-sales service. Hence, there is need for high and middle level technical manpower in business development, manufacturing and overall management. The public sector also lacks adequate personnel to undertake effective monitoring and evaluation.

#### *Financing and investments*

Scenarios developed by International Financing Institutions such as the African Development Bank has estimated at approximately US\$

550 billion the total investment required to ensure universal access to reliable and increasingly cleaner electric power in Africa by 2030 thus estimating an average investment of approximately US\$ 30 billion per year; at present the total funding to the energy sector in Sub-Saharan Africa has averaged only about US\$ 2 billion every year showing the seriousness of the challenges which shall be faced to mobilize financing for an effective deployment of the renewable energy potential in the area.

Moreover many economies in Africa are performing badly and this only makes the situation more difficult when seen in the context of the ongoing food and financial crisis, high volatility in oil prices and climate change.

Lacking of government support, the private sector remains a small player overall, and more prevalent in small-scale renewable energy systems; whereas the bulk of the private sector financing is “Foreign” and mostly linked with international financing institutions supporting the local beneficiary governments. On the other side, it is registered a scarce support from financial institutions such as insurance companies and broker institutions that assist to reduce the very high transaction costs of clean technologies in African countries.

In order to make ODA more effective, shared priority should therefore be put on to overcoming the barriers described above .

### **Recommendations**

---

Major technical progress and policy development along with financial and institutional innovations are needed to scale up the production of renewable energy in Africa and notably in Sub Saharan Africa where it should be recognized that renewable energy roadmap technologies are at different stages of development and deployment. In this context, addressing part of the ODA to the support for setting

policies with clear targets is crucial in facilitating investments in renewable energy and so are also the adoption of policy instruments such as public auctions and tenders, quotas, feed-in tariffs, capital subsidies or rebates, investment or other tax credits, tradable renewable energy certificates, and public investment loans.

Several national and international policies have so far been tailored to promote the use of renewable energy technologies; it is clear that policy successes are likely to be achieved when it is feasible&sustainable, customized on domestic and regional context, involving&empowering national stakeholders, adequately funded by resources both capital and human, all in view of finalizing the implementation and integration. Based on these experiences, policies to be considered for implementation at the national level are: regulation measures (i.e., performance standards, equipment standards, etc); subsidies and financial incentives (feed-in tariffs, rebates, grants, loans, production incentives, government purchasing agreements, insurance) that are targeted and have a clear sunset clause; voluntary agreements (e.g. between government and private sector). At regional and sub-regional levels, policy measures that have been successful and can be considered for development in Africa include focused use emission targets and trading systems; technology co-operation which can be supported by financial systems (ODA, FDI, commercial bank loans). In selecting appropriate policy options suitable to be supported by International Donors and Financing Institutions, it is important that these policy options are evaluated for their environmental impacts and cost effectiveness; distributional aspects; institutional feasibility; and suitability to the local context. In addition, renewable energy policy development should be well integrated into policies of other sectors, smaller-scale producers may need special policies such as using dedicated funds or project bundling which can be interesting options also for powering social infra-

structure such as schools & vocational training, medical centres, hostels etc.

ODA could lead and guide the support of the development of regional, sub-regional and national strategies to acquire renewable technologies by increasing local R&D capacity, skills of technology adaptation and manufacturing capability. Furthermore, funds should streamline capacity for policies' integration and effectiveness aiming at fostering technology transfer. African countries can exploit new financing options to improve investments in renewable energy in the continent. Local sources of funding that should be included in public offer of shares by power utilities to implement specific projects, practicing of pensions funds to leverage local bank financing for new projects, use of emerging local bond markets. An overarching principle that must guide ODA distribution in the future is that capacity development is primarily endogenous to a country, based on voluntary action and motivation. Exogenous aid initiatives can support capacity development, but they are not a substitute for it. Capacity development efforts should therefore be rooted in the partner country's goals and strategies. A set of guiding principles for ODA supported capacity development activities is summarized in the following points:

**1. Supporting country leadership** should be central to donor approaches. Capacity development is most likely to succeed when countries view it as serving their own self interests and are committed to taking the actions necessary to implement it. In this case the role of donors therefore is to facilitate rather than direct the process of turning broad goals and strategies into an actionable plan.

**2. Capacity development design and sequencing should fit specific country circumstances**, rather than reflect standard or imported solutions. Effective capacity development starts with a premise of building upon what already exists, rather than transplanting

entirely new systems. Capacity development should therefore make use of local knowledge, build upon existing values where possible and have a timing and scope of interventions designed to be consistent with the country's capacity to implement change.

Capacity development efforts must be **tailored to country circumstances** if they are to succeed, for example, have to take into account a country's existing structures and inter-linkages (i.e. of the political and administrative layers – central, regional, local, etc.) bearing in mind that the entry point for capacity development will vary country to country

**3. The institutional, organisational and individual levels of capacity development, including managerial and technical aspects, should all be taken into account in programme design and implementation. Capacity development must be viewed from a holistic or systemic perspective, and not merely as a transfer (e.g. of skills).**

**4. Donor support should be provided in a coherent, coordinated, and programmatic manner.** Therefore, as to the content of capacity development, the government's own action plan should be the focal point for determining support. Though donors may come with different areas of expertise within the overall programme, their support should be complementary rather than competitive or duplicative. Support should be phased over a multi-year horizon in order to take into account the long-term nature of capacity development. Likewise, interventions should be programmed in a way that reflects how they fit with the country's development objectives.

**5. Extract key concepts from previous experiences instead of replicating whole systems.** Effective capacity development attempts to build on what is already in place, rather than replace whole systems. Building on existing capacities, easy-to-handle instruments and pro-

cedures can be more easily implemented than sophisticated ones. Some advanced concepts can be introduced gradually, but only by extracting the elements that are most practical for the country.

**6.** Though the focus is often on improving organisational performance, **training individuals remains an important component of capacity development.** In other words, changes in procedures and policies need to be accompanied by extensive on-the-job training to ensure that the new concepts can be implemented.

**7. Effective capacity development requires well functioning organisations** consisting of trained, motivated and committed staff. This requires not only organisational restructuring, but also changes in personnel and a clear and reasoned allocation of project management roles in the program as well as a good balance of local and international expertise in the implementation team.

ODA Recipient Countries Government should stress on the need of Co-ordinated initiatives with and among donors to avoid duplication of programs or completion among them, this leads to separate funding mechanisms and pressure to show results within relatively short time-frames. Shifting to a need-driven approach within a co-ordinated donor context creates the flexibility government needs to decide how best to maximise donor support which optimally includes establishing an institutionalised platform for both donors and partner countries, in order to also deal with the design and monitoring of the reform process.

In this context, in addition to the usual support for the development of legal and regulatory framework and for building capacity and raising awareness, the following four main areas of support can be identified to be considered by ODA beneficiaries Countries Government and other stakeholders target for programs with

the aim of providing effective support to Renewable energy (and more broadly clean technologies) deployment in Africa:

- **Entrepreneurship and Business Acceleration;**
- **Innovation Finance Products;**
- **Market Development Mechanisms;**
- **Legal and regulatory Framework Strengthening.**

#### *Entrepreneurship and Business Acceleration*

Entrepreneurship and business acceleration are actions designed to assist entrepreneurs in turning ideas into sustainable businesses, or to scale up an existing initiative or business line. This has traditionally taken the form of programs involving consulting firms, business incubators or technical experts, in providing direct training and capacity building to managers and owners of entrepreneurial businesses, ranging from general financial and managerial skills to targeted support for technical aspects of the business. Alternatively, more recent types of programs aim to develop collaborations and networks to assist clean technologies providers and firms using such technologies to share knowledge and experience thus reducing transaction costs for the single company by pooling resources and potentially sharing R&D and intellectual property rights (IPR).

Collaborations between national governments, the private sector and the international community can also support the creation and sharing of technical knowledge, building upon existing entrepreneurial cultures; innovating and delivering new models for financing and intellectual property sharing, and supporting the demonstration of complex technologies with strategic value. Such international, public-private, collaborations are able to achieve these functions through education and capacity



building for companies, Business Clusters and agencies, and also through protections for intellectual property and the provision of economic resources and legal conditions required to enable commercial risk-taking.

Finally, public and private agencies can also conduct a facilitating and mediating role between entrepreneurs and their market clients. This role includes awareness raising activities, information sharing and simple communication of ideas and opportunities to clean technology providers and firms adopting these technologies within their processes. Such activities constitute the intangible assets of human capacity necessary to make markets work, beyond the more easily measured financial barriers. Here, governments, other stakeholders, and companies can draw upon technical support and advice from a range of international collaborations and networks to promote clean technology and small business development.

#### *Innovation Finance Products*

Innovation finance includes those instruments aimed at providing companies interested in clean technologies with early stage financing and risk capital not available from traditional financing sources, such as seed capital, venture capital, soft loans and loan guarantees.

In this framework, governments and investors can also provide funding to bolster private sector lending to firms interested in clean technology on preferential terms, like lower interest rates, more flexible collateral and repayment conditions, or by providing loan guarantees. Such form of support could help firms accessing to finance thus overcoming one of the most significant barriers to clean technology deployment in emerging economies where the high cost of capital and business financing for deploying clean technologies often reflects a lack of awareness on behalf of local banks about the related opportunities, which translates into

higher financial risk assessments, and the longer supply chains inherent to the market structure of many clean technology businesses.

Building upon the above described basis, government-backed support for concessional or flexible loans creates the risk that the deployment of clean technologies becomes dependent upon non-market financing; therefore, to mitigate this risk, and facilitate a longer-term transition to market-based financing, soft loans and credit guarantees must be issued through commercial banks which set their own financial and technical criteria. Innovation finance can also operate on the demand side. To this aim, the most important instrument to promote growth in clean technology markets is technology-specific consumer credit which can overcome the financial barriers surrounding high capital cost goods, such as off-grid renewable energy technologies (RETs). For example, a high demand for solar water heaters (SWHs) in Tunisia was stimulated by making available low-cost commercial loans, offered specifically for SWHs. These technology-specific credit markets have enabled, and were enabled by, greater awareness and acceptance for SWHs, lowering risk premiums.

#### *Market Development Mechanisms*

A range of instruments aim to increase demand for the products of local SMEs and facilitate the overall growth of the clean technology market. The main purpose of demand-side instruments is to reduce commercial uncertainties for businesses supplying clean technologies, thus reducing investment risk. Support for consumer financing, as discussed earlier, is an important mean to stimulate the growth of clean technology markets at the household level. Additionally, several measures to stimulate industrial demand for clean technology can be supported by governments with special focus on renewable energies such as feed in tariffs, renewable energy certificates.

The feed in tariffs are the most well-known instruments to strengthen market demand for grid-connected technologies in developed countries. However, given that FITs operate as a cross subsidy, where the cost of tariff-supported renewable energy technology is divided among all grid-connected consumers, this particular instrument becomes less economically viable and relevant in lower-income countries where levels of energy access remain low. Renewable energy certificates or obligations are government-imposed mandatory targets for utilities to generate a share of their power from renewables, that normally result in the creation of certificates which can be traded, providing a market-based subsidy.

While RECs are a market mechanism, their prices are largely influenced by the regulatory framework that creates them. Therefore, the penalties for non-compliance must be significant, and base prices should be set high enough to ensure energy companies are incentivized to invest in clean technologies.

## Conclusion

---

The energy sector, and in particular the development of renewable energies, has been often identified as a priority for growth in many African countries. Several initiatives have been launched by international organizations and

donors in cooperation with local governments to support its development. Examples of such initiatives span from the Geothermal Risk Mitigation Facility (GRMF), promoted by the German and UK governments and the African Union, that provide grants for geothermal surface studies and drilling operations in the most promising geothermal prospects in Africa, to the Scaling Solar program launched by World Bank/IFC to promote the development of solar energy with large-scale grid-connected solar plants via rapid, open and transparent tender processes. These successful initiatives launched in recent years helped the development of renewable energies in the continent and will keep supporting African countries in the coming years in achieving a sustainable energy future.

## References

SE4ALL & Africa EU Energy Partnership, “*Mapping of Energy Initiatives and Programs in Africa, Final Report*”, May 2016.

The World Bank et al. “*Financing renewable energy Options for Developing Financing Instruments Using Public Funds*”

Frankfurt School-UNEP Centre/BNEF, “*Global Trends In Renewable Energy Investment 2017*”.

The publication of these position papers was made possible thanks to the coordination efforts of RES4Africa's team members:

*Marco Aresti, Assia Bellaroto, Dario D'Angelo, Saverio Frullani, Luca Marena, Daniele Paladini, Ana Rovzar, Roberto Vigotti.*



**RES4MED&Africa**

*Renewable Energy Solutions for  
the Mediterranean and Africa*

[www.res4africa.org](http://www.res4africa.org)

Via Ticino, 14  
00198 Rome  
Italy