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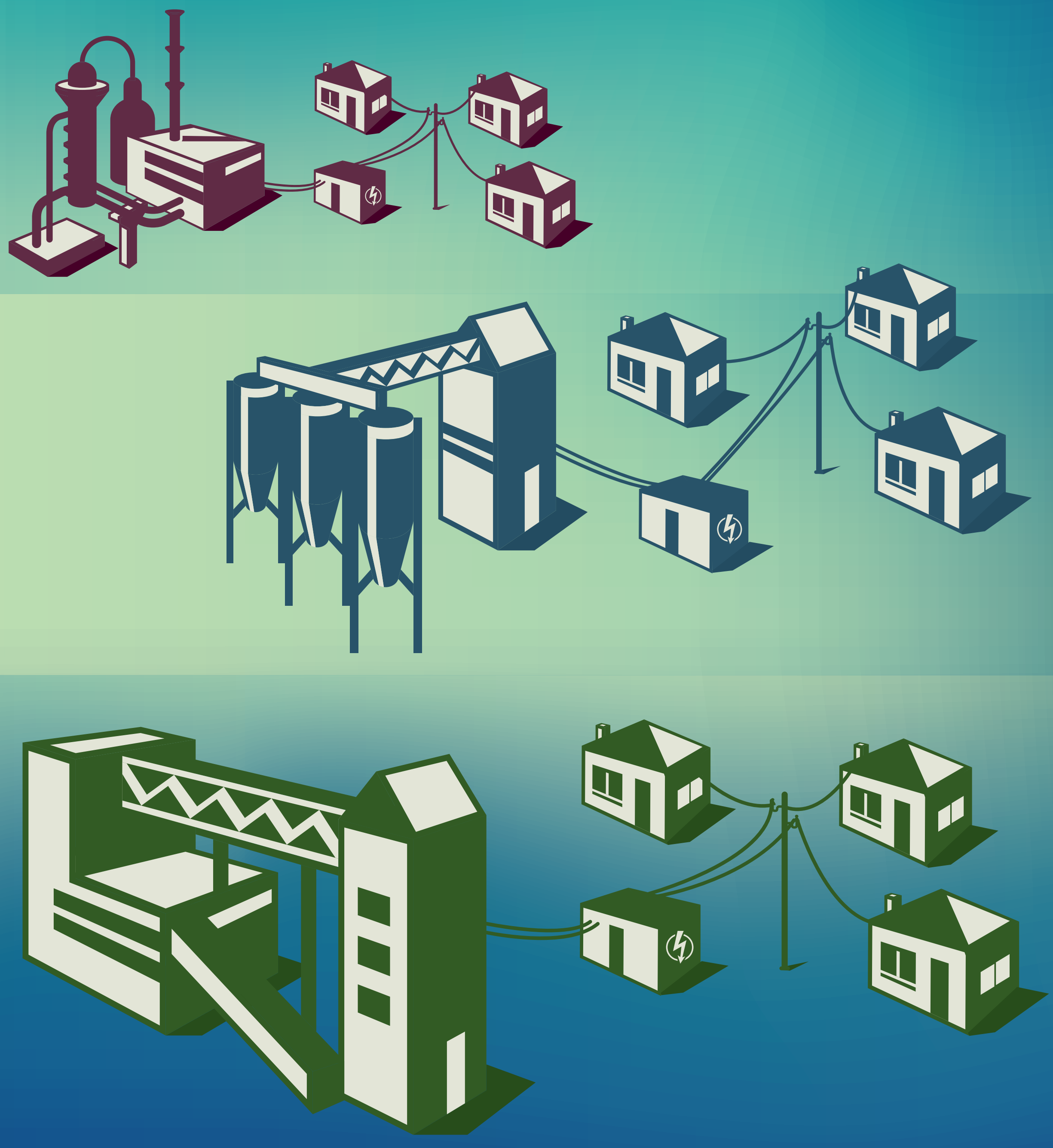
Industrial Prosumers of Renewable Energy

Contribution to Inclusive and Sustainable Industrial Development



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Foreword

The unique mandate and contribution of UNIDO in the post-2015 development agenda is to promote inclusive and sustainable industrial development (ISID). Energy has always been the driving force of industrialization and productivity increase in modern economies, and as the United Nations agency mandated to provide sustainable energy solutions for industrial development, UNIDO focuses on renewable energy for productive uses as a catalyst for income generation and increased industrial competitiveness.

UNIDO's renewable energy portfolio has proven that on-site energy generation by industries, typically through waste-to-energy technologies, is a financially and environmentally sustainable investment. UNIDO seeks to share this best practice by promoting the concept of "Industrial Prosumers of Renewable Energy" which, as this paper shows, is an innovative model for businesses, small and medium-sized enterprises and international conglomerates alike, to supply their own energy needs through on-site generation from renewable sources.

This concept of energy production and consumption transforms energy from a cost factor into a new business opportunity. Industrial Prosumers will not only experience reduced manufacturing costs due to minimal or near-zero energy prices, but may also be able to sell the excess energy generated to the nearby community or into the grid. More importantly, in many parts of the world where access to energy is limited, Industrial Prosumers will benefit from improved energy security, reliability and quality, which will result in higher productivity. The economic sustainability of Industrial Prosumers as businesses will therefore increase significantly, compared to the business-as-usual scenario with dependency on grid-connectivity and conventional fossil fuels. Moreover, the climate change mitigation impacts of renewable energy technologies compared to conventional fuels, and the implications of renewable energy use for environmental sustainability do not need further explanation.

Industrial Prosumers also have the potential to contribute significantly to the social inclusiveness of industrial development, as the possibility of a self-supplied low-cost energy option allows local households in rural communities to maximize their productivity and add increased value to their existing products. Industrial Prosumers can also give rise to decentralized energy systems providers, fostering entrepreneurship in new sectors and skilled employment creation.

UNIDO is pleased to present its experiences gained through its technical cooperation portfolio in promoting renewable energy solutions. The conceptualization of Industrial Prosumers as a new business model promises to be a key landmark in achieving ISID, and UNIDO will continue to play a pivotal role in leading the international dialogue on Industrial Prosumers, while at the same time delivering impact on the ground.

LI Yong
Director General
UNIDO

Executive Summary

Industrial Prosumers of Renewable Energy (Industrial Prosumers) are defined here as industrial operators that produce a portion or all of their onsite power needs with renewable energy technologies (RETs) and sell the excess to the national/local grid or local community. This includes renewable energy sources for heating and cooling needs, as well as for electricity generation. It also includes the use of certain bio-energy resources such as those from forestry, meat processing, agriculture, as well as the waste management sector. Accelerating renewable energy deployment and improving the use of existing waste streams, such as producing biogas with food and livestock wastes in agro-industrial operations, can yield clear win-wins by delivering on several related development priorities and financial returns simultaneously.

As this report highlights, increasing direct, onsite renewable energy use in the industrial sector directly contributes to ISID, the post-2015 sustainable development goals as well as the objectives of the Sustainable Energy for All (SE4All) initiative. It also provides a new way through which the industrial sector can lead by example in supporting climate change mitigation around the world, making it an important addition to UNIDO's vision for achieving ISID. Therefore, *Industrial Prosumers* are emerging as a central focus area of UNIDO's renewable energy Unit and an integral part of its strategy to achieve and Inclusive and Sustainable Industrial Development (ISID).

Agro-industrial prosumers in areas without grid electricity access can act as rural energy entrepreneurs, adding electricity to their product line by generating additional revenue while offering local energy benefits to the surrounding community. The importance of off-grid energy systems is particular significant in remote areas where expansion of the electricity grid is cost-prohibitive. This can enable local businesses to emerge in areas currently without access to modern energy services.

As renewable energy costs continue to decline, industrial power users have a growing number of reasons to begin to develop onsite renewable energy projects to serve a growing share of their onsite power needs:

- Turning energy into a business opportunity rather than merely a cost factor for businesses
- Ensuring the availability of a stable energy supply, especially electricity to ensure productivity
- Making use of existing waste streams (such as in agricultural operations)
- Adding energy as a new income stream to the enterprise
- Increasing production efficiency and reliability (reducing down time)
- Increasing price competitiveness of renewable energy technologies
- Reducing production costs, emissions and pollution (i.e. effluents)
- Promoting local development, particularly in rural areas by selling excess energy to the local community
- Advancing Corporate Social Responsibility (CSR)
- Creating local jobs
- Increasing the enterprise competitiveness by reducing power supply uncertainties and/or supply and volatility of fuel costs.

By introducing RETs into their processes, industrial prosumers can diversify their product range and incorporate energy as an additional revenue stream in their production line. This is clearly seen in modern sugarcane mills in countries like Brazil, where many operations have added electricity and ethanol to their traditional sugar production. These factors, combined with a wide range of other environmental, social, and sustainability concerns, including concerns over global climate change, the growing pace of resource depletion, as well as the importance of maintaining a strong social license to operate, are beginning to focus the attention of industries around the world on how they can reduce their environmental impacts, while improving their bottom line.

In certain markets, industrial prosumers are interested in exporting their surplus power to the surrounding region, potentially providing a wide range of benefits to local communities, while furthering the aims of achieving ISID. This applies in particular to the case of small and medium-sized enterprises in the agro-industrial sector, where the potential for increasing the use of renewable resources and benefiting local communities through improved access to energy services is considerable.

The case for promoting industrial prosumers can be applied globally but it is particularly important for countries with limited grid coverage, reduced energy access rates and an agricultural based economy with untapped waste streams. Therefore, this report will mainly refer to Sub-Saharan Africa (SSA) where most of these conditions are prevalent and industrial prosumers can have a high social and economic impact in the local population.

Power reliability remains a major issue for businesses and industrial power users in many areas of the world. A recent survey of businesses in Africa found that reliable access to electricity was the single largest issue that businesses had to deal with.[1] The response in the industrial sector to concerns over power reliability has often been simply to produce power onsite directly, mostly based on fossil fuel run generators. This is the approach taken by some mining operations around the world, as well as by many other industrial power users. However, until recently, most industrial operators have seen renewable energy sources as too costly, simply not yet mature enough to fulfill the important functions of producing reliable power supply to their operations. As renewable energy technologies improve and continue to come down in cost, it is becoming a clear business opportunity for many industrial sites around the world. Moreover, many industrial producers are well positioned to invest in renewable energy technologies in rural areas: they can often finance many projects directly, or in cooperation with donor agencies, removing (or significantly reducing) the need to rely on traditional lenders; they can often benefit from targeted incentives for business-related capital expenditures such as accelerated depreciation; and they often have a direct incentive to reduce energy costs, and reduce their environmental impact.

As the economics of on-site renewable electricity generation continue to improve in the years ahead, a new universe of possibilities is opening up for industrial energy users around the world to develop their own onsite renewable energy projects by making greater use of existing waste streams, such as in the agro-industrial sector, or to supply excess power to the surrounding community, as in the case of commercial or industrial solar photovoltaic projects in remote areas.

This report also highlights a number of barriers to industrial prosumers, including the lack of clear policy and regulatory conditions, and the absence of expertise in many industrial operations in how to integrate RETs on a stand-alone basis, or in a hybrid configuration with existing diesel generators. Other barriers relate to the lack of awareness and industry owners' perceptions, such as the outdated perceptions related to the costs as well as the performance and reliability of RETs. Taken together, these factors have thus far inhibited the development of industrial prosumers in many parts of the world, and remain as substantial barriers to a sustained deployment of RETs in the sector.

A further issue in many areas is that many industrial and agro-industrial operations operate in rural areas currently without grid access. In many such cases, rural electrification plans may not reach these communities for another decade or more. Moreover, onsite power generation using locally available resources has the added advantage of being able to provide power more sustainably and in many cases more reliably than power from the central grid or from diesel generators. Collectively, these factors underscore the need for more distributed, and off-grid, renewable energy solutions. With the right technical assistance and regulatory and policy conditions, industrial prosumers, including in the agro-industrial sector, can play a leading role in bridging this gap and boosting access to modern energy services in both the electricity as well as in the heating and cooling sectors.

In response to these and many other challenges, there is a clear role for policymakers to support the development of industrial prosumers in their jurisdictions. As the report highlights in greater detail, this can involve developing standard power purchase agreement (PPA) terms and conditions for industrial prosumers. Other approaches can involve allowing industrial prosumers to participate in net metering programs. Attempts in jurisdictions such as India have focused instead on offering up-front incentives to industrial power users,

1 World Bank 2014

while countries like Sri Lanka have attempted to encourage investment in RETs via feed-in tariffs.

Taken together, these new options provide a win-win solution for industries around the world to improve their business and at the same time demonstrate leadership on both climate change and on sustainable development by integrating renewable energy sources into their power supply, as well as their heating and cooling needs. Drawing on these many advantages, and in light of the increasing attractiveness of RETs for industrial power users, it is time for policymakers around the world to begin to recognize the significant potential that exists for industrial prosumers, to contribute to achieving ISID. A fundamental step will be the creation of right policy and regulatory conditions for this to occur.

Introduction 1

Faced with frequent power outages and low power quality from the national grid or simply located far from the limited national grid of most developing countries, many industries in the developing world produce part or all of their electricity needs with on-site diesel generators. In many cases, these rely on either diesel or heavy fuel oil, used either as a primary power supply source, or as an automatic back up when the national or regional grid network fails. Thus, there are many industries around the world have developed onsite generation technologies mainly to improve the quality and reliability of their energy supply.

Until recently, the most cost-effective way of doing so was via fossil fuel based technologies. However, these fossil fuel-based options exhibit a number of undesirable characteristics, such as high operating costs, significant price volatility, as well as greenhouse gas and other emissions. The shift now underway sees renewable energy technologies (RETs) as the most economically attractive option for new electricity supply in a growing number of countries.[2] With the right policy and regulatory conditions, such industries that are already investing to ensure self-supply and consumption of energy could play an increasingly important role in the transition to a more inclusive and sustainable energy system in the decades ahead.

1.1 Inclusive and Sustainable Industrial Development (ISID)

UNIDO's global mandate on "Inclusive and Sustainable Industrial Development" aims to promote sustainable and resilient economic and industrial growth for poverty reduction that goes hand in hand with the economic, social and environmental dimensions of sustainable development.

Industry plays a decisive role in stimulating economic growth. Global experiences have shown that countries have reached high levels of socio-economic development by having a developed and advanced industrial sector. However, industrial sector growth is conventionally linked with excessive environmental pressures such as resource depletion, pollution at the local / regional level and negative impacts in terms of global climate change. UNIDO is promoting ISID as part of a broader strategy to harness the full potential of industry's contribution to achieving sustainable and equitable human development.[3]

In order to minimise environmental damage while meeting the global objectives of eradicating poverty and reducing income disparity, industrial development must become sustainable and inclusive. Thus, UNIDO aims to achieve ISID which means:

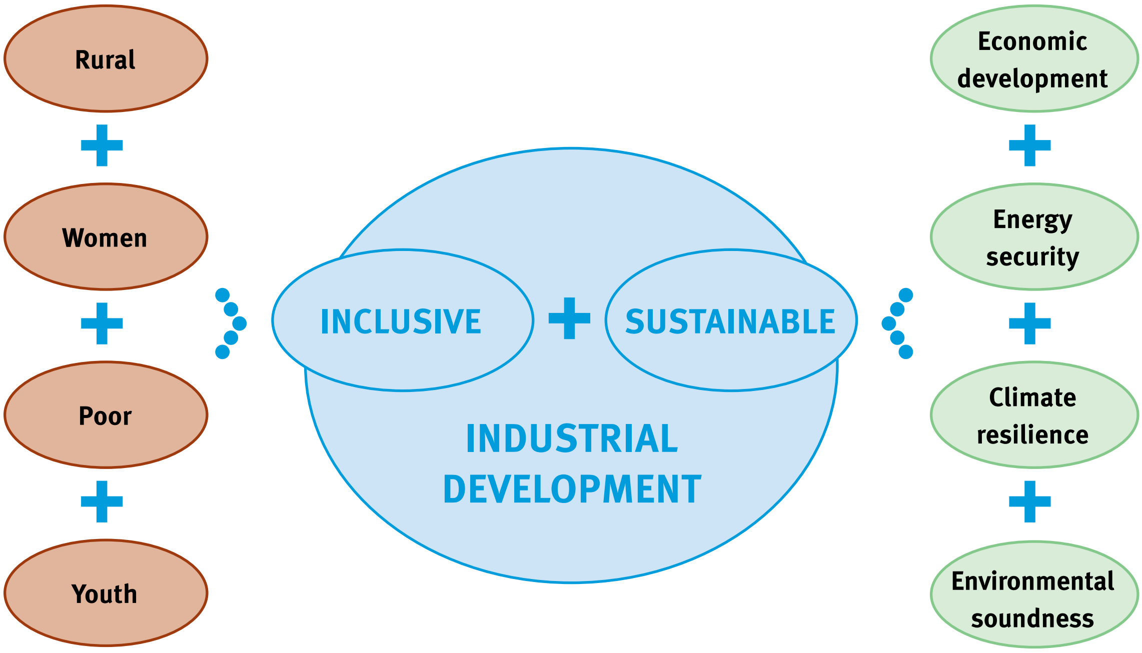
- Every country achieves a higher level of industrialization in their economies, and benefits from the globalization of markets for industrial goods and services.
- No one is left behind in benefiting from industrial growth, and prosperity is shared among women and men in all countries.
- Broader economic and social growth is supported within an environmentally sustainable framework.
- The unique knowledge and resources of all relevant development actors are combined to maximize the development impact of ISID.

2 IRENA (2014). "REMAP Project," Available at: http://irena.org/remap/

3 UNIDO (2014). "Inclusive and Sustainable Industrial Development," Available at: http://www.unido.org/fileadmin/user_media_upgrade/Who_we_are/Mission/ISID-Brochure-LowRes1_EN.pdf

The below figures provides an overview of the dimensions of ISID and how energy and RETs are related to it.

Figure 1 | Dimensions of Inclusive and Sustainable Development

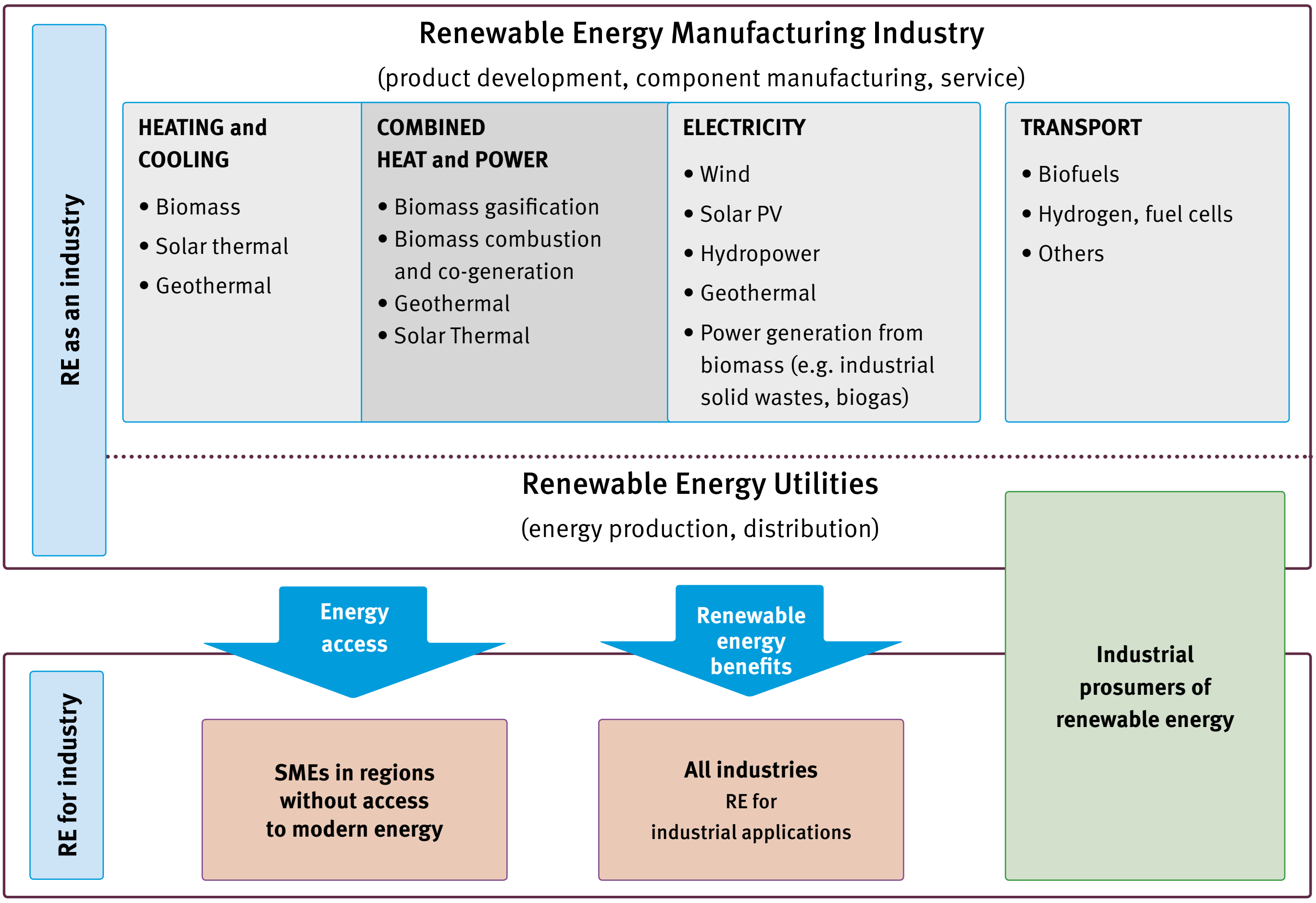


An industry sector that is solely dependent on energy from fossil fuels cannot be considered sustainable. In the long run, the volatile price of fossil fuel, coupled with continued environmental degradation from extraction activities and combustion-induced greenhouse gas emissions, will impinge on economic, social and environmental goals. RETs, as a substitute for fossil fuels, provide various benefits that greatly contribute to achieving ISID. The contribution of RETs to industry and industrial development can be summarized as follows:

1. Allowing energy to become an income opportunity for industries that become 'Industrial Prosumers" by producing and consuming renewable energy;
2. Reducing the overall environmental impact of industries;
3. Creating local green jobs;
4. Enabling the establishment of 'green industries';
5. Manufacturing of renewable energy components to the inclusion of RETs in the utility industry;
6. Increasing local productive activities through providing sustainable energy access;
7. Promoting renewable energy for industrial applications;
8. Developing the local economy by adding value to local resources and reducing dependency on imported sources of energy.

The below figure gives a detailed picture of RETs as an industry itself and RETs for industry, and how industrial prosumers are a linkage between these two areas.

Figure 2 | Renewable energy as an industry and for industry



Access to sustainable and affordable energy can therefore play an important role in achieving ISID, as energy (electricity, as well as heating and cooling applications) is a critical input in numerous industries. Access to reliable, efficient, and affordable energy is also an essential prerequisite for effective transportation, communication, and other systems that provide access to international markets. At a local level, energy access facilitates development by enhancing the productivity of existing economic activities (e.g. enhancing agricultural development by enabling irrigation, value addition through crop processing, and storage) and helping rural areas to evolve from mere raw material producers to producers of value added products, while providing opportunities for new income and job-generating micro-enterprises.[4]

Development of clean energy businesses (and the underlying infrastructure, work force, and value chains) presents an opportunity to increase access to affordable and sustainable energy that can both provide a sustainable source of jobs, income, and economic growth while also enabling growth in other sectors. Promotion of cost-effective RETs for productive uses in industry is therefore an integral component of sustainable development and presents a major opportunity for achieving the goals of ISID.

4 Oyedepo, 2012.

1.2 Potential for Renewable Energy among Agro-industrial SMEs

This report focuses on the potential for RETs to drive ISID, with a particular focus on small and medium-sized enterprises (SMEs) in the agro-industrial sector. Agro-industrial SMEs, such as rice or sugar mills, have significant potential for deployment of cost-effective renewable electricity and renewable thermal projects which can supply on-site energy needs while providing opportunities to generate additional income and benefit the local community through the sale of excess energy. As shown by the case studies and examples detailed in this report, renewable energy projects developed by agro-industrial SMEs can yield numerous co-benefits for both owners and the local community, including reduced energy expenditures; increased energy access in rural areas; avoided local air pollution and greenhouse gas emissions; reduced waste; improved health and sanitary conditions; creation of new income-generating opportunities; and local economic benefits such as creating higher-skilled jobs and facilitating development of clean energy industries.

Agro-industrial SMEs in rural areas can thus play an important role in supporting the objectives of SE4ALL of universal energy access and increasing renewable energy utilization, and in particular in furthering energy access. With the right policy incentives and local energy distribution infrastructure, agro-industrial SMEs can be incentivized to install RETs that can serve a larger portion of their own energy needs while providing excess generation (or heating and cooling supply) to the local community.

Industry—and agro-industrial SMEs in particular—can thus help accelerate access to sustainable energy at a larger scale and in areas currently underserved by existing energy infrastructure. Access to sustainable energy provides numerous economic, social, and environmental benefits: for example, lighting has been shown to significantly improve productivity and facilitate education in rural areas; cooling applications are critical for health and food storage; and heating and cooking with sustainable energy reduces reliance of sustainable energy, businesses can thus take a leadership role in furthering sustainable development and addressing local and global social and environmental challenges.

1.3 Industrial Prosumers of Renewable Energy

The term "prosumers" emerged in the early 1980s to refer to individual consumers who also produced goods and services. *Industrial prosumers* are emerging as a central focus area of UNIDO's renewable energy programme and an integral part of its strategy to achieve ISID. Types of industrial prosumers are numerous and can include, for example, agro-industrial operations including pork, beef, and poultry farms, mining operations, abattoirs, manufacturing plants, pulp and paper mills, solid waste management companies, or forestry-related facilities such as mills.

Box 1 | Industrial Prosumer Defined

'Industrial Prosumer of Renewable Energy': A Definition

An industry that produces and makes use of renewable energy sources such as solar, wind, bioenergy, etc. to supply a portion or all of its onsite energy needs. In many cases, this includes selling excess energy or electricity to the national/local grid or to the surrounding community.

In certain jurisdictions such as South Africa, industrial prosumers of renewable electricity are also referred to as "embedded generators", a term that underscores the fact that they remain connected to the main grid.[5]

However, industrial prosumers is not limited to systems that are connected to a grid, as highlighted earlier. In some cases, there is the potential for certain industrial operations to supply power directly to rural customers, or even be incentivized to invest in mini-grid infrastructure themselves, turning formerly independent industrial prosumers into rural electrification providers. Such arrangements could help support existing government efforts to increase rural electrification in off-grid and remote regions, and further accelerate the development of sustainable energy in the developing world.

Opportunities & Benefits of Industrial Prosumers 2

This section is divided into two components, one highlighting the benefits to individual industrial prosumers of adopting RETs, and the other highlighting the benefits to the communities and regions.

2.1 Benefits to Industrial Prosumers

2.1.1 Reduced energy costs

Due to persistently high fossil fuel prices, and rapidly declining renewable energy generation costs, the business case for increasing the use of RETs in the industrial sector is becoming stronger and stronger. Diesel generation costs in most regions ranges from USD $0.30/kWh to over USD $2.00/kWh in remote regions, while the transport and use of fuel to these regions presents a host of environmental risks (e.g. fuel spillage, air quality, carbon emissions, etc.) as well as supply chain risks (bottlenecks, inadequate road infrastructure, etc.) Taken as a whole, these factors make the continued use of fossil fuels for power generation as well as for heating and cooling for industrial purposes increasingly unsustainable, and inconsistent with the emergence of a truly sustainable, low carbon industrial sector. Fortunately, a new generation of technologies is now available to help substitute these various energy needs with more sustainable solutions.

With grid-connected renewable energy costs ranging from approximately USD $0.06/kWh to approximately USD $0.20/kWh depending on the technology and location,[6] there is now a wide range of available alternatives that can reduce, and potentially even replace, fossil fuel use in a number of industrial sectors. This can include the use of agricultural and forestry wastes for combined electricity and heat production (renewable CHP), as well as the use of waste energy resources at agro-industrial operations such as poultry, pork, beef, or dairy farms for biogas production. It could also include the direct use of wind power at industrial sites in certain regions, such as cement factories or manufacturing operations located along the coastline near major ports, where wind resources are generally stronger. There is also significant potential for the use of solar PV as well as solar CSP in many regions of SSA, whether to power local manufacturing and mining operations, or agricultural and livestock processing, and countless others.

5 Kukoyi, D. (2012) "The Concept of Embedded Generation – Prospects and Challenges." Presented at the Workshop On The Embedded Generation Framework In The Nigerian Electricity Supply Industry, (Nov 15). Available at: http://www.detailsolicitors.com/media/archive3/seminars/workshop_on_embedded_power/presentations/Embedded%20Generation%20-%20Prospects%20and%20Challenges.pdf

6 See: http://costing.irena.org/media/2769/Overview_Renewable-Power-Generation-Costs-in-2012.pdf

Box 2 | Case Study: Agrizone Solar Project, South Africa

Project	Project Type	Location
Agri-zone Solar Project	Phase1: 218kW Solar PV Phase 2: 492kW Solar PV	Durban, South Africa

This project in Durban generates its own power onsite using solar PV systems and exports its surplus to the grid under regulated conditions to the local utility company in Ethekwini Municipality. The project is used to supply power to the airport complex as well as to a nearby hydroponics facility.

It is estimated that the project currently saves the Dube TradePort approximately ZAR 765,000 (approximately EUR 54,000) per year in electricity costs, and will reduce CO_2 emissions by an estimated 830 tons per year.

Sources: The Solar Future South Africa (2014); National Energy Regulators of South Africa (NERSA) (2012). Standard Conditions for Small Scale (less than 100kW) Embedded Generators within Municipal Boundaries. Available at: http://www.kznenergy.org.za/download/projects/NERSA_Standard_conditions_for_embedded_generation_within_munic_boundaries.pdf

In addition to renewable electricity, a number of cost-effective renewable thermal energy technologies are available which are ideally suited to application by businesses in the agro-industrial sector. In particular, waste-to-energy solutions (such as biomass gasification and anaerobic digestion) can make use of agricultural and animal waste products to generate clean-burning biogas or produce heat for industrial processes and space heating. Examples include gasification of rice husks, rice straw, and sugarcane bagasse; and anaerobic digestion of waste from cattle feedlots and chicken farms to create biogas. By repurposing waste streams, agro-industrial prosumers can have readily available and inexpensive (or free) materials while providing additional benefits to the community by reducing waste and the unsanitary or unpleasant conditions agro-industrial waste streams have been known to cause.

Box 3 | Case Study: Rice Husk Gasification, Cambodia

Project	Project Type	Location
Rice Mill	Rice Husk gasification + rural electrification	Location: Charchuk Commune, Ankor Chum District, Siem Reap Province

Rural Cambodia suffers from a very low electrification rate. Furthermore energy prices are high as fossil fuels and also often diesel have to be imported.

Supported by UNIDO, a 150 kW rice husk gasifier replaced a diesel generator in a rice mill and connected an additional 300 households (700 people) to a local grid. Through this fuel substitution 900 tons of CO_2 per year and energy costs could be reduced. The biomass waste which was a problem before is now an income generation opportunity for the operator. Furthermore, the rice mill owner now receives income from supplying electricity to the surrounding communities.

2.1.2 Price hedging

In addition to directly lowering energy expenditures in the near-term, renewable electricity also allows businesses to hedge against future increases in fuel costs or grid electricity prices.[7] Because many on-site renewable energy systems have low operating, maintenance, and/or fuel costs, they effectively “lock in” a fixed energy price for the life of the system. This price certainty can serve as a hedge for the prosumer against the volatility of other fuels (e.g. electricity or diesel) and has quantifiable financial value.

7 Jenkin et al. 2013

2.1.3 Improved energy reliability

Disruptions in energy services are not uncommon in developing countries. Businesses in SSA experience an average of eight 5-hour electrical outages per month, compared to just 1.6, one-hour outages experienced by firms in Eastern Europe and Central Asia.[8] Disruptions in individual countries can be even more severe: between 2006 and 2009, the Republic of Congo, Guinea, Gambia, and Nigeria each report averaging at least 20 outages a month, each of which lasted an average of 6 hours or more.

Such unstable power supplies can create significant financial hardships for businesses. Between 2006 and 2010, more than 50% of the Sub-Sahara African firms identified electricity as a major constraint to their businesses compared to just 27.8% which face transportation as the most critical problem.[9] Losses due to electrical outages averaged about 7.4% of annual sales for businesses in the region, ranging as high as 25% for individual countries.

Common impacts of intermittent or unreliable power include lost productivity, disruption of services, and reduced employee and customer comfort. However, in certain industries impacts can be more severe: for example, even brief power disruptions in critical health care facilities could result in loss of life. Molten ore in an electronically heated oven can harden in 40 minutes, cause damage to the ovens, loss of material, and significant restart costs.[10] Finally in the agro-industrial sector, prolonged power outages can cause refrigerated food to spoil, resulting in significant, direct losses of saleable goods. The estimates of financial impacts on businesses in SSA range from $0.46 and $1.25 per kWh of unsupplied electricity.[11]

For these reasons, many businesses generate power on-site or install stand-alone back-up generators to mitigate the risks of power disruptions. The percentage of firms owning or sharing a back-up generator in SSA is 48.5%, the highest of any region in the world.[12] In some regions, this figure is over 80%, indicating a significant failure in the delivery of grid electricity.[13] Traditionally, backup power is provided by on-site diesel generators, the acquisition and operation of which represents a significant investment that could otherwise have been spent on more profitable business investments. Increasing access to renewable energy thus represents a significant opportunity for providing reliable, lower-cost, and sustainable energy source.

Box 4 | Case Study: Manisa Solar Power Project, Turkey

Project	Project Type	Location
Manisa Solar Project	Solar PV project + heat pump system	Location: Manisa, Turkey

In September 2013, a new manufacturing and industrial site on the west coast of Turkey has recently been equipped with solar PV and an integrated system of heat pumps to regulate the temperature in the building complex. It is estimated that the solar PV alone will be able to supply as much as 60% of the total facility's power needs, making it one of the most sustainable industrial and manufacturing sites in Turkey today. Demand for these kinds of systems is growing rapidly in markets such as Turkey, which benefit from an excellent solar resource and face an intermittent power supply from the grid.[1]

2.1.4 Additional revenue-generating opportunities

Small and medium-sized agro-industrial prosumers can also generate additional revenue by selling excess energy into the electricity grid or through other channels. Prosumers thus act as rural energy entrepreneurs, supplying excess power to local communities while increasing rural access to electricity and renewable thermal

8 World Bank (2014). Enterprise Surveys: Infrastructure. Available at http://www.enterprisesurveys.org/.

9 World Bank (2012). Enterprise Survey Online Database.

10 Oseni, Musiliu O. (2012): Power Outages and the Costs of Unsupplied Electricity : Evidence from Backup Generation among Firms in Africa: http://www.usaee.org/usaee2012/submissions/OnlineProceedings/IEE%20PAPER%20FRST%20YEAR%20EDITED%20LAST%201%20LATEST.pdf

11 Oseni, 2012.

12 World Bank, 2014.

13 World Bank, 2014.

energy for cooking and other domestic applications. Exporting excess generation from industrial energy producers to nearby residents can also offer additional synergies due to the fact that most of businesses energy demand occurs mid-day while household electricity use peaks in the evening during non-operating hours.

Box 5 | Case Study: Biogas plant at Nyongara Slaughterhouse, Kenya

Project	Project Type	Location
Biogas plant at Nyongara Slaughterhouse	Slaughterhouse waste for biogas production	Dagoretti, Kenya

Dagoretti is a suburb of Nairobi well known for its slaughterhouses, which were almost shut down in 2009, due to slaughterhouse waste polluting the Nairobi River. Moreover, apart from the waste pollution they create, frequent power cuts have forced the abattoirs to use diesel generators for their operation.

The project aimed at demonstrating the use of slaughterhouse waste in biogas production. A 15 kW biogas plant was installed at the Nyongara, with a high performance temperature controlled digester (using solar heating), replacing the diesel generator, and recovering waste heat to replace wood and charcoal for hot water to clean the abattoir.

Economic benefits include reducing the cost of energy from USD 0.20 to USD 0.09 per kWh. An addition, the process yields organic fertilizer as a by-product, bringing additional income to the abattoir. The project has cut CO_2 emission by 108 tons per year.

The project is co-funded by the GEF and is based on a public-private-partnership between the abattoir, UNIDO, UNEP, the Kenyan Ministries of Environment and Industrialization and the Kenyan Industrial Research and Development Institutes. Due to its success, the Government of Kenya is planning to adopt this approach as part of its policy on waste management for slaughterhouses throughout the country.

This is a small demonstration plant. Larger facilities could easily provide surrounding communities with electricity through their excess production.

There is also significant potential for larger-scale livestock businesses in SSA to generate and sell renewable energy from animal waste digesters. For example, a Clean Development Mechanism (CDM) project proposed by the Dundee Biogas Power in South Africa would generate 17,502 MWh/year of electricity annually by capturing over 5 million cubic meters of methane from cattle manure. Less than 1,700 (10%) of the power produced would be needed on-site, allowing the company to generate significant additional revenue by selling the remaining 15,823 MWh to the grid.[14]

Selling excess power into the grid or directly or through mini-grids to local residents and businesses provides financial benefits to prosumers even beyond the revenue obtained through energy sales. In particular, it allows the system to be sized at the scale that is most cost-effective rather than being limited by the on-site demand (see discussion of consumption ratio in Section 3.1). In the case of a building-mounted solar PV system, the project could be sized according to the amount of un-shaded roof space available. Biomass or biogas waste-to-energy systems could be sized based on the quantity of waste produced on-site. Removing the constraint of on-site load requirements thus allows for development of larger projects at lower per-kW installed costs due to economies of scale.

14 UNFCCC (2012). Clean Development Mechanism (CDM) Project 8047 : Dundee Biogas Power (Pty) Ltd. Available at: http://cdm.unfccc.int/Projects/DB/DNV-CUK1352193528.07/view

Box 6 | Case Study: ***Telecommunication Towers, The Gambia***

Project	Project Type	Location
QCell Telecommunication Towers	Hybrid Solar and Wind	10 sites in The Gambia

Qcell Company Limited is a mobile GSM operator in The Gambia. It started operating in July, 2009. Before the project intervention, Qcell estimated that it had 65% urban coverage and 40% rural coverage from approximately 100 mobile masts or transceivers. However, 80% of its operational costs are from running the transceivers at the rural areas using diesel generators.

The project installed solar PV and wind turbines (total 84 kW) to power Qcell transceivers in 10 sites, which means lower operational costs and no pollution to the environment compared to the use of diesel generators. The 4 x 1kW wind turbine is mounted on each tower while the solar PV systems are ground mounted, the hybrid system works 24hours per day. Qcell agreed to provide power to each of the 10 health facilities where their new facilities are located. The daily energy supply is enough to provide basic services for the critical areas within these health facilities including lighting, refrigeration, etc. By providing this regular electricity supply to rural health facilities, Qcell Ltd is contributing to the improvement of health service delivery in The Gambia.

The specific objectives of the Qcell-GEF/UNIDO project were as follows:

- ✓ Demonstrate the techno-economic viability of renewable energy projects in The Gambia particularly for the GSM companies.
- ✓ Besides reducing GHG emission, it is to provide case study for renewable energy best practices to support a case for scaling up renewable energy investment in The Gambia;
- ✓ Address the energy challenges of the company in the rural areas and at the same time help to redress part of the energy needs of the rural health facilities where their 10 sites are located.

Currently, The Gambia has four GSM operators. Most of these GSM operators still power their transceiver stations particularly in rural areas using diesel generators which are quite expensive to operate and maintain. Therefore, the solar PV/wind/diesel hybrid system installed by Qcell Ltd could be replicated throughout The Gambia to provide greater mobile coverage and also to provide electricity for more social needs such as electricity for health centres or schools which are not currently served by the electricity grid. In addition, the RET powered transceiver stations could be used to supply power to local internet cafes, mosques or community centres.

2.2 Benefits to Local Communities

In addition to offering attractive benefits to agro-industrial prosumers, renewable energy investments can yield significant benefits to local communities.

- **Increasing access to electricity in rural areas not currently served by the grid.** Agro-industrial prosumers in areas without grid electricity access can act as rural energy entrepreneurs, generating additional revenue while offering local energy benefits to the surrounding community. The importance of off-grid energy systems is particular significant in remote areas where expansion of the electricity grid is cost-prohibitive. This can enable local businesses to emerge in areas currently without access to modern energy services.
- **Green jobs and local economic development**. Development of renewable energy systems requires skilled workers to install, operate, and maintain. As the market for renewable energy grows, this translates to new, higher-skilled jobs, entrepreneurial opportunities, and local economic activity. Local power also means that more of a community's energy expenditures stay local as payments are made to smaller-scale prosumers rather than large utilities. This increases the local economic multiplier effect compared to energy systems which are owned and operated by external developers.
- **Access to more affordable energy**. The energy cost reductions realized by agro-industrial prosumers

can also be passed on to the community when excess generation is sold, depending on what competing energy options are available and the prosumer's goals in selling the energy (e.g. good community relations vs. maximizing revenues).

- **Higher quality and more reliable energy supply.** In many rural and remote areas, energy supply is intermittent and may be easily interrupted by a number of factors beyond the control of end-users (e.g. poor road infrastructure, grid failure, etc.) Introducing local RETs can help provide more stable and reliable electricity service in these areas, by reducing the risks of external disruption.

- **Decreased pollution.** Low- or no-emissions RETs greatly reduce air quality impacts associated with burning fossil fuels, in addition to decreasing greenhouse gas emissions.

- **Health and sanitation benefits.** Certain renewable technologies such as anaerobic digesters can also provide a productive application for waste products. Animal wastes, for example, are often stored in lagoons which create odor problems and have the potential to pollute groundwater. By repurposing animal waste, prosumers can improve public health conditions while reducing odors and unsanitary conditions.

- **Offer access to new sources of clean energy not previously available**. For example, anaerobic digesters generating excess biogas can be used in a domestic application to power for clean and efficient cook stoves, displacing traditional cook stove fuels like wood, coal, charcoal, and animal waste which generate harmful indoor air pollution.

Box 7 | Case study: ***Highland Tea Factory SHP, Nigeria***

Project	Project Type	Location
Highland Tea Factory	SHP	Kakara, Nigeria

The Highland Tea Factory in Kakara employs 350 to 500 workers. The related tea plantation consists of 6,000 farms where the adult men and women are engaged in primitive farming and husbandry.

Running on diesel generators and wood fuelled boilers for drying, the tea factory was economically drained by the energy costs involved. The lack of power supply meant no new businesses or industries could be established. In order to revive existing economic activities and create additional income generating opportunities for local communities, it was necessary to focus on providing reliable and cost-effective electricity for the area. In 2013 a small hydro-power plant with a capacity of 400kW started operation. It is owned by Taraba State and managed by the Highland Tea Factory, supplying clean electricity to the factory and local communities.

This allowed the tea factory to look at plans to expand its production capacity, a move that is expected to provide more employment opportunities in the area. Moreover, the plant has had a profound environmental impact in the area, leading to a drastic cut in greenhouse gas emissions as the tea factory no longer uses diesel generators. A large amount of trees have also been saved since clean power replaced the burning of wood to dry the tea.

The project provides clean and sustainable energy to communities that until recently did not have access to electricity. It facilitated local economic activities and provided new jobs, and is now helping communities set up small-scale businesses such as milk and meat processing.

2.3 Benefits to the Energy System

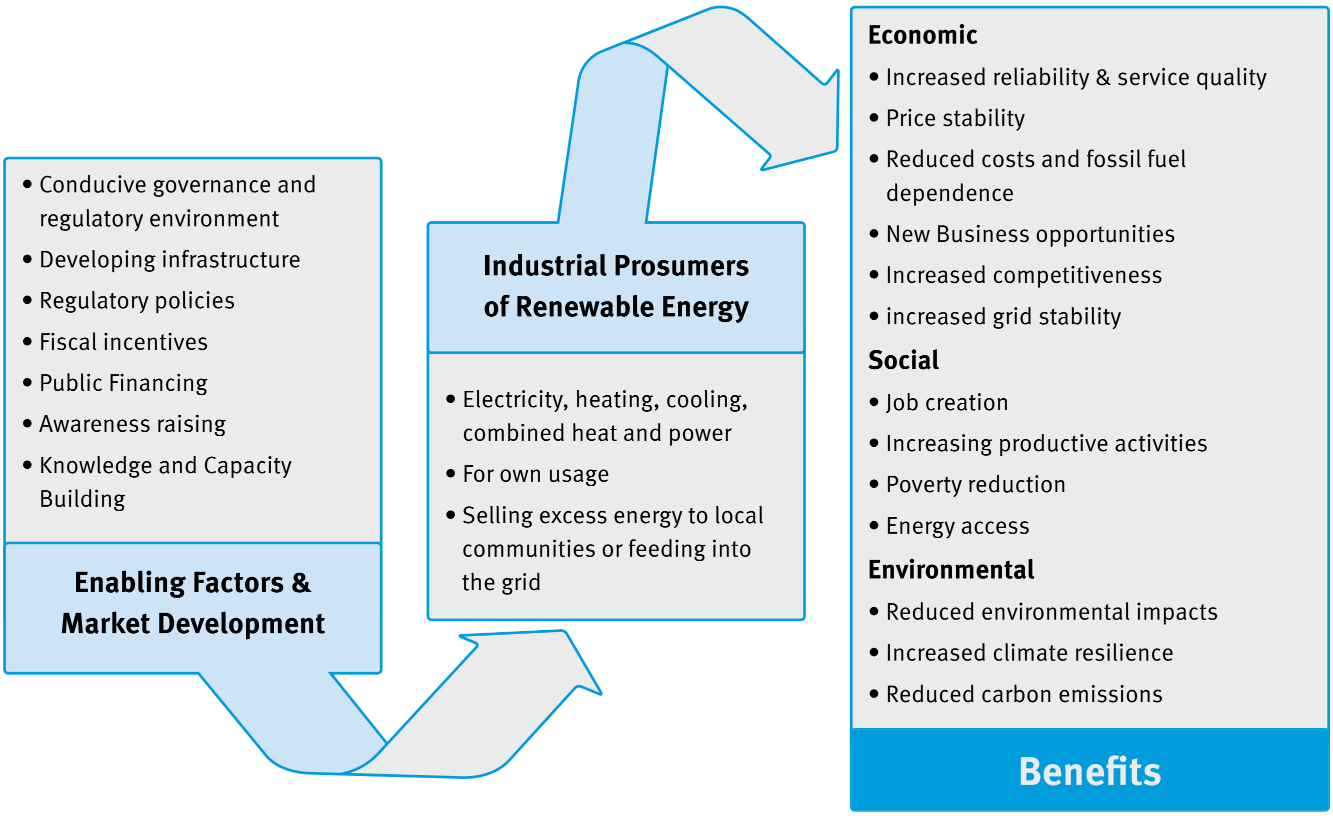
Grid-connected renewable energy systems installed by industrial prosumers can generate significant benefits for the larger energy system. By generating power onsite, prosumers help avoid transmission and distribution losses that typically occur due to inefficiencies in energy transmission infrastructure. In developed countries, these losses can amount to a 4-8% reduction in the electricity delivered to end-users, while the figure for developing countries can be as high as 30-40%.[15]

Significant investments in on-site generation can also help defer or avoid construction of new generation capacity and/or distribution infrastructure. Especially in countries with high summer peak loads which already strain the capacity of existing generators, this avoided cost can create significant savings for utility systems.

Where off-grid industrial prosumers generate excess energy for local consumption, local prosumer development may be a cheaper alternative than electrification by extending transmission system lines. This could allow the benefits of rural electrification to be realized without significant investment in large-scale grid infrastructure.

The below figures provides an overview of the linkages between industrial prosumers, the related benefits of RETs and how to support them.

Figure 3 | Industrial Prosumers of Renewable Energy, benefits and enabling environment.



15 Rickerson et al., 2014

3 Barriers to Industrial prosumers

Despite the considerable potential for increasing the use of renewable energy sources in industrial operations around the world, progress in this area continues to be hampered by a host of barriers and bottlenecks. This section discusses three of the main issues:

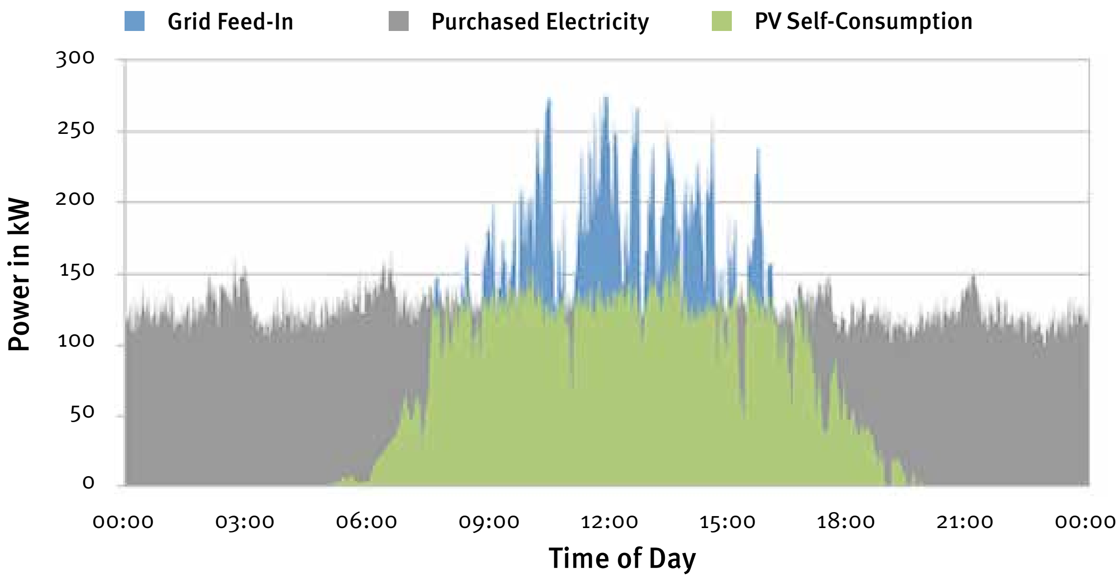
1. Lack of policies governing the sale of excess energy,
2. Opposition from incumbent energy system owners
3. Limited local capacities on RETs, and
4. Erosion of public utility revenue.

3.1 Lack of Policies Governing Sale of Excess Energy

In areas where there is no policy or regulatory framework governing the sale of net excess power generation to the grid, industrial prosumers will tend to scale systems down in size to ensure that onsite generation is not wasted.

One of the key concepts to understanding the opportunities and challenges surrounding industrial prosumers is the concept of "self-consumption ratio": this term refers to the share of total daily power needs that can be directly supplied by onsite RETs such as wind, solar, or bioenergy sources, including waste-to-energy. Over the course of an average day, onsite power demand will fluctuate as will the output of the onsite renewable energy system – when onsite supply exceeds demand, the net excess generation must be exported to the grid or sold to the local community. The graph below provides a depiction of this relationship.

Figure 4 | Solar PV Daily Supply and Demand



Source: SMA 2013

As the graph above demonstrates, supply and demand do not perfectly correlate at all times of the day. The ultimate self-consumption ratio will depend on a wide range of factors, including the onsite load profile, the configuration of the renewable energy system, as well as the choice of RET used. Naturally, for biogas or biomass systems in agro-industrial operations, the self-consumption ratio may be less important, as supply can typically be controlled. This notwithstanding, the self-consumption ratio can play an important role in determining the attractiveness of onsite renewable energy generation.[16] It also impacts the *applicability* of individual RETs to particular industrial or agro-industrial operations.

However, it is important to note that where supportive policies are in place, the self-consumption ratio becomes less important because systems need not be sized to the company's load in order to be cost-effective. In the case of grid-connected net metering systems, for example, the self-consumption ratio is less important because payment or credit is received for surplus power generated and can typically be banked for up to year. And in the case of feed-in tariffs, the self-consumption ratio is irrelevant because payment for generation is unrelated to on-site consumption. The renewable energy system owner supplies any excess power (possibly up to 100% of their generation) to the grid, and receives a fixed per-kWh payment for doing so.

Box 8 | Case Study: ***Biomass Industrial Prosumers in Thailand***

Biomass-based power generation is a fast-growing industry in Thailand, due in part to government targets and incentives encouraging energy production by entrepreneurs and industrial prosumers. The Thai Ministry of Energy has set targets to supply over 20% of its electricity with renewable sources by 2022, of which 84% is expected to come from biomass. In addition, the 91% of thermal energy electricity generation is expected to come from renewable sources. A number of policies promote renewable energy development, including a value-based, above-market rate for renewable electricity paid to prosumers and ensuring fair grid interconnection rules. In 2009, the country had 54 biomass gasification plants totaling over 1.1 GW of installed biomass electricity capacity, with about half of the associated production (574 MW) being fed into the grid. Many of these biomass plants are installed in large rice factories, paper mills and palm oil factories which can benefit from both the renewable electricity as well as the thermal energy provided by biomass systems. These facilities rely primarily on agricultural residues such as rice husks, rice straw, and sugarcane bagasse, and benefit from the ability to switch fuels as the market price of various potential inputs shifts.

Source: Salam, P.A., Kumar, S., and Siriwardhana, M. (2010). Report on the Status of Biomass Gasification In Thailand and Cambodia. Prepared for: Energy Environment Partnership (EEP), Mekong Region (October). Available at: http://www.eepmekong.org/_downloads/Biomass_Gasification_report_final-submitted.pdf

3.2 Opposition from Incumbent Energy System Owners

Many industrial operations that would like to use RETs to supply a portion or all of their onsite power needs often have to deal with opposition from the incumbent utility (which in some cases remains partly or fully government owned), and which perceives industrial power generators as a source of competition, or as a potential loss of future power sales.

This relates to a further set of issues that may be considered more "systemic" in nature and may be even more difficult to address than the various barriers and bottlenecks identified here. For instance, many municipalities in Africa rely heavily on their local power utility for revenues.[17] In many such jurisdictions, revenues from "high-end" users such as commercial and industrial users is often used to cross-subsidize lower income users and rural residents. A significant shift to industrial prosumer development in these regions, by reducing demand from the main grid network and introducing new financial obligations on already cash-strapped utilities, could therefore put the industry's own financial interests in conflict with those of the local distribution utility.

16 Rickerson et al., 2014.

17 Janisch, A., Euston-Brown, M., Borchers, M. (2012). The Potential Impact Of Efficiency Measures And Distributed Generation On Municipal Electricity Revenue: Double Whammies And Death Spirals. Sustainable Energy Africa. (September 2012). Available at: http://www.cityenergy.org.za/uploads/resource_23.pdf

For instance, in some jurisdictions such as Rwanda, fewer than 1,000 commercial and industrial customers represent over 40% of total national electricity demand.[18] A rapid rise in industrial or agro-industrial adoption of RETs in a country like Rwanda could put significant strain on the solvency of the national utility, which may limit the willingness of government policymakers to encourage significant development in this area.

A successful evolution toward a market where industrial prosumers survive and thrive will need to overcome these challenges, and find win-win solutions that help increase energy access, and gradually increase the role of non-utility generators in the electricity market. Some of these win-win opportunities may be greatest in agro-industrial operations in rural and remote areas of SSA.

Box 9 – Case Study: *The Potential of Industrial Prosumers in Lagos, Nigeria*

Within the Lagos District of Nigeria alone, there are over 2.000 industrial complexes and over 10.000 commercial business ventures requiring upwards of 12.000MW of generation capacity. These many industrial sites have ready access to capital, and can directly invest in onsite generation technologies. Unfortunately, in and around Lagos the primary technology being chosen for onsite power generation is standalone diesel-powered systems. Subsidies for diesel fuel effectively reduce the incentive for many industries in the Lagos District and beyond from seeking out more cost-effective and sustainable alternatives. With the right regulatory and policy framework, the Lagos District could become a fertile area for a wide range of industrial prosumer projects using RETs.

Source: Kukoyi, D. (2012). The Concept of Embedded Generation – Prospects and Challenges. Presented at the Workshop On The Embedded Generation Framework In The Nigerian Electricity Supply Industry, (Nov 15). Available at: **http://www.detailsolicitors.com/media/archive3/seminars/workshop_on_embedded_power/presentations/Embedded%20Generation%20-%20Prospects%20and%20Challenges.pdf**

3.3 Limited Local Capacities on RETs

In many countries there is limited local capacity or expertise on RETs. The result is that many industrial operations that have the potential to develop onsite renewable energy projects, such as biogas digesters or waste-to-energy systems, may be prevented from doing so due a lack of appropriate local expertise. Connecting the right technical and operational know-how individual industrial sites can help bridge this gap, and contribute to building the human capacity required to accelerate the adoption of RETs in rural and remote regions.

The barriers to industrial prosumers discussed above underscore the need for pro-active policy frameworks that allow prosumers to interact dynamically and constructively with the electricity system, enabling them to help improve local system reliability (e.g. providing black-start capabilities in rural regions using onsite biogas or biomass technologies, or supporting micro-grid supply) while continuing to contribute to its financial viability.

In order to demonstrate national leadership on climate change and to contribute to achieving ISID, governments should strive to focus on creating appropriate conditions for the use of RETs in such industrial applications. This requires developing appropriate legal, regulatory, and policy frameworks to allow this to occur, including the right contractual conditions to support industrial prosumers.

18 Energy, Water & Sanitation Limited (EWSA), Rwanda. See: http://www.ewsa.rw/index.php/En/products-services/energy/26-core-activities/124-energy-sector

Box 10 | Summary of Barriers to Industrial Prosumers

Social	• **Lack of awareness** of RETs • **Pre-conceptions or misunderstandings** about RETs
Financial	• **Limited prosumer access to cost-effective project financing** • **Limited awareness and understanding of banks for RETs** • **High interest rates hindering investments in technologies with high upfront investment costs but low costs of operations** • **Poor utility credit-worthiness** of existing power off-takers in many countries, both national utilities and regional distribution companies
Policy-related	• **Lack of supportive policy framework** • **Lack of incentives** • **Existing fossil fuel subsidies,** which continue to favor fossil fuel use, or blunt the incentive to shift to renewable alternatives • **Unfavorable or non-existent grid interconnection rules** • **Absence of a clear process** for industrial prosumers to obtain clear, bankable power purchase agreements for their net excess generation. • **Lack of incentive rate-setting expertise** among regulators and policymakers • **Licensing and permitting** for industrial prosumers • **Absence of local or national industry associations** to promote RETs and advocate for favorable policies
Technical/ local capacities	• **Poor renewable resources** (limiting certain types of RET generation) • **Constraints or congestion on local distribution wires** • **Limited expertise developing and installing** renewable energy projects • **Limited supply chain** for renewable energy equipment • **Lack of expertise integrating variable sources of on-site generation**, and aligning them with the strict timing and power quality requirements of industrial processes

4 Policy Options to Support Industrial Prosumers

A wide range of policy options can affect the development of industrial prosumers, both positively and negatively. Figure 4 summarizes major policy options that either constrain or enable prosumers, grouped broadly into seven policy areas. While an in-depth discussion of each policy option is beyond the scope of this paper, two categories of enabling policies are discussed in more detail in this section (indicated with green shading).

Figure 4 - Summary of policies that constrain or enable Industrial Prosumers

Policy Area	Policies that *constrain* industrial prosumers	Policies that *enable* industrial prosumers
	←	→
Grid access	• Prohibitions against grid interconnection • Onerous fees or review processes	• Standard interconnection rules • Transparent process • Interconnection costs shared or borne fully by ratepayers • Long term agreements offering investment security
Compensation mechanisms	• Restrictions on net metering or onsite consumption • Restrictive roll-over policies for excess generation (i.e. how long can excess power be banked?)	• Feed-in tariffs: full purchase for exported power at a fixed price • Net Metering: net excess generation credited at the retail rate • Net Billing: i.e. net excess generation purchased at a rate different from the retail rate (e.g. utility avoided cost)
Rate Design	• Increased customer charges or demand charges • Standby charges for onsite generation • Maintaining flat nation-wide electricity tariffs, regardless of geographic remoteness, or the avoided cost of supply	• Time-varying prices • Pure volumetric tariffs ($/kWh), i.e. without fixed charges • Rates that reflect the full avoided cost of supply, and therefore make it possible to profitably develop onsite generation
Market Reforms	• Regulations prohibiting onsite generation, or grid connection • Rules prohibiting onsite storage	• Allowing peer-to-peer power sharing (e.g. community-based net metering programs) • Encouraging new business models • Tenders or concession agreements for prosumer-powered mini-grids
Tax Reforms	• Tax on self-consumed generation • Tax on RET components	• Shift electricity sales tax to other income sources • Tax incentives or credits for RET components, or investments
National goals, policies, & programs	• Laws or regulations that prohibit private electricity generation • Laws or regulations that prohibit private sales of electricity to citizens, businesses, or local communities	• NAMAs • National registries and market data aggregation • Soft cost reduction initiatives (e.g. reducing administrative burden and cost of fees, permitting applications, and other review processes)

Source: Adapted from Rickerson et al., 2014.

Box 11 – Case Study: ECOWAS Renewable Energy Policy

The *ECOWAS Renewable Energy Policy* which was jointly developed by the ECOWAS Regional Center for Renewable Energy and Energy Efficiency (ECREEE), UNIDO, RECP and EUIE-PDF gives a good example for guiding principles for conducive policy development for industrial prosumers. The regional policy provides a framework for the soon to be developed National Action Plans.

For example, ECOWAS Members shall guarantee, through their Transmission System Operator (TSO) and Distribution system operator (DSO), the purchase and transmission of all available electricity from renewable energy-based electricity producers; grid operators have to contribute financially to necessary grid upgrades, provide a stable and long-term favorable pricing mechanisms and ensure unhindered access to the grid for renewable energy Independent Power Producers (IPPs) and Public Private Partnerships (PPPs), also adapting the grid code to incorporate RETs. Renewable mini-grid development and private investments in such shall also be supported and models for power PPA, FIT, quotas, rural electrification concession, mini-grid concession, credits schemes and RESCOs shall be developed.

The Regional Policy requires a reform of the legal and regulatory national framework for Member State power sectors. All this supports Independent Power Producers (IPPs) to which industrial producers belong.

Source: ECREEE (2012): ECOWAS Renewable Energy Policy http://www.ecreee.org/sites/default/files/documents/basic_page/151012_ecowas_renewable_energy_policy_final.pdf

5 Conclusions and recommendations

There is tremendous potential for industrial prosumers of renewable energy, and in particular in the agro-industrial sector, to contribute meaningfully to achieving ISID in many countries around the world. Industrial prosumers of renewable energy have been defined here as industrial operators that produce a portion or all of their onsite power needs with RETs and sell the excess to the surrounding community or national grid. As the momentum for industrial prosumers grows, they are emerging as a central focus area of UNIDO's renewable energy programme and an integral part of its strategy to achieve ISID.

As this report has shown, increasing direct, onsite renewable energy use in the industrial sector also contributes directly to the post-2015 sustainable development goals as well as the objectives of the SE4All initiative. It provides an innovative way through which the industrial sector can contribute to climate change mitigation around the world.

Moreover, it is time for policymakers to recognize the potential for the use of RETs for the sustainable development of the industrial sector. Increasing the use of RETs for industries' own production and consumption provide ideal candidates for Nationally Appropriate Mitigation Actions (NAMAs). They can also provide compelling new business opportunities, allowing industrial operators to develop new revenue streams by exporting power or energy into the surrounding community, or distribution grid. In this way, industrial prosumers in areas without grid electricity access can act as rural energy entrepreneurs, generating additional revenue while offering local energy benefits to the surrounding community.

The report has shown that industrial power users have a growing number of reasons to begin to develop renewable energy projects to produce a portion or all of their energy and electricity needs:

- Transforming energy from a cost factor into a new business opportunity
- Increasing the reliability of energy and electricity supply
- Reducing energy supply costs, due to the progressively declining costs of RETs
- Making productive use of existing waste streams (most notably in agro-industrial operations)
- Developing a new revenue stream
- Increasing the efficiency and reliability of the production (such as reducing down time cause by power outages)
- Reducing industrial production costs, emissions and pollution (e.g. effluents)
- Promoting local development, particularly in rural areas by exporting excess energy or electricity into the local community
- Supporting efforts to increase Corporate Social Responsibility (CSR)
- Creating local green jobs
- Increasing industrial competitiveness

As evidenced by the case studies included in this report, these factors point to a gradual transformation that is taking place among industrial managers around the world, a transformation in the perceived applicability as well as market-readiness of RETs to meet the needs of industrial operations. As the costs of RETs have plummeted in recent years, this confidence has been strengthened further, making it clear that the use of RETs in industries, and in particular in rural areas, is poised to grow rapidly in the years ahead. However, the use of RETs in industrial operations is often held back by a number of real and perceived barriers; this underscores the need for a pro-active policy framework, to provide the appropriate regulatory and institutional conditions required to help the sector grow.

In terms of specific policy recommendations, there are a number of important steps that policymakers can take:

- Developing standard interconnection codes for industrial prosumers, allowing them to connect to the grid and export power under regulated conditions.

- Designing and implementing clear policies that allow independent power production such as feed-in tariffs, net billing policies, or net metering schemes. This could involve customized arrangements for industrial prosumers involving a clear, guaranteed payment for power exported into the local grid. In other cases, such as under feed-in tariffs or net billing (where net excess generation is compensated at a rate that is different from the retail tariff paid), this could involve special incentives or tariffs to encourage industrial prosumers to export a certain share of onsite generation to the surrounding grid.

- Introducing incentives to reduce demand from the network. Some jurisdictions have begun offering an incentive for industrial operators to reduce their demand from the grid (in relation to an agreed-upon historical baseline), which creates an additional incentive to generate onsite electricity from RETs.[19] For instance, in South Africa, a per-kWh rebate of SAR 1,20/kWh is offered to renewable energy projects over a 3-year period for every kWh not consumed from the grid between 6AM and 10PM during the week.[20] This is designed to help mitigate the risk of power outages.

- Partnering with municipalities and local governments to increase the use of RETs in the municipal area. Regulators in South Africa are also beginning to create policy frameworks to support the development of industrial prosumers on the network. For instance, the Municipality of Durban in eastern South Africa (Ethekwini in the local language), in conjunction with the National Energy Regulator of South Africa (NERSA), have developed standard terms for so-called 'embedded generators'.[21] This standard form enables any eligible industrial or commercial power producer to connect the grid, and sell their excess power under standard contract terms. In this case, NERSA requires that embedded generators provide metering data on supply and demand to-and-from the network for every half hour once a month. This helps facilitate the proper monitoring and auditing of the power sales. The provision of a clear regulatory environment and a standard contract demonstrates a recognition of the potential role that industrial prosumers can play in increasing electricity access, and in improving the reliability of supply in certain regions.

Promoting industrial prosumers is important around the world but it is particularly important for countries with limited grid coverage, reduced energy access rates and an agricultural based economy with large and often untapped waste streams. In light of the significant benefits that can flow from increasing access to modern energy and electricity services in rural and remote areas, it is time for policymakers throughout the world to begin examining the growth of industrial prosumers as a priority policy area and to develop pro-active regulatory frameworks to support their growth.

19 Eskom (n.d.). Small-scale Renewable Energy Pilot programme. Available at: http://www.kznenergy.org.za/download/projects/Eskom_small-scale_renewable_energy_pilot_programme.pdf

20 KZN Energy (2012). KSEF Guide to Embedded Power Generation Application Procedures in in KwaZulu-Natal. (November) Available at: http://www.kznenergy.org.za/download/publications/ksef_publications/KSEF%20Guide%20to%20Application%20Procedures%20for%20EPG%20in%20KZN%20Final.pdf

21 No author (n.d.). Ethekwini Power Purchase Agreement. Available at: http://www.durban.gov.za/Resource_Centre/Current%20Projects%20and%20Programmes/energyoffice/Documents/PPA_for_Embedded_Generation_eThekwini%20Municipality_March_2012.docx

6 References

Bremdal, B. A. (2011). *Prosumer oriented business in the energy market* (IMPROSUME Publication Series #2). Narvik, Norway and Halden, Norway: Narvik University College and Norwegian Center of Expertise for Smart Energy Markets. Available at: http://www.ncesmart.com/wp-content/uploads/2014/01/Prosumer-oriented-business-in-the-energy-market-finale.pdf

Carbon War Room (2014). Sunshine for Mines, Available at: http://www.carbonwarroom.com/sites/default/files/reports/CWR14_MinesReport_singles.pdf

Colombo E., Bologna S., Masera D. Editors; (2013); *Renewable Energy for Unleashing Sustainable Development*; Springer

Database of State Incentives for Renewable Energy (2014). New Jersey Incentives/Policies for Renewables & Efficiency. Available at: http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ03R&re=1&ee=1

Engineering News (January 31 2014). How embedded electricity generation could shake up the system, Available at: http://www.engineeringnews.co.za/article/how-embedded-electricity-generation-could-shake-up-the-system-2014-01-31

ECREEE (2012): ECOWAS Renewable Energy Policy, Available at: http://www.ecreee.org/sites/default/files/documents/basic_page/151012_ecowas_renewable_energy_policy_final.pdf

Eskom (2012). Small-scale Renewable Energy Pilot Programme, Available at: http://www.kznenergy.org.za/download/projects/Eskom_small-scale_renewable_energy_pilot_programme.pdf

Eskom (n.d.). Small-scale Renewable Energy Pilot programme. Available at: http://www.kznenergy.org.za/download/projects/Eskom_small-scale_renewable_energy_pilot_programme.pdf

Fischer E., Schmidt, T., Höra, S., Giersdorf, J., Stinner, W., Scholwin, F., (2010). Agro-industrial biogas in Kenya: Potentials, Estimates for Tariffs, Policy and Business Recommendations. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and German Biomass Research Centre (DBFZ), Available at: http://www.giz.de/fachexpertise/downloads/gtz2010-en-biogas-assessment-kenya.pdf

GIZ (2011). Opportunités de développement de l'autoproduction électrique à partir de l'énergie éolienne en Tunisie. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Available at: http://tunesien.ahk.de/fileadmin/ahk_tunesien/06_Events/CDM-Windworkshop/Rapport_Final_de_l_atelier.pdf

GIZ (2010). Small-scale Electricity Generation from Biomass: Experience with Small-scale Technologies for Basic Energy Supply. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). Available at: http://www.gvepinternational.org/sites/default/files/resources/gtz2010-en-small-scale-electricity-generation-from-biomass-part-2.pdf

Gofran, M.A. (2008). "SOUTH ASIA WOMEN IN ENERGY (SAWIE)" presented at Second Application Workshop on Efficient Energy Management And Renewable Energy (Dhaka, 17 November 2008). Available at: http://www.sari-energy.org/PageFiles/What_We_Do/activities/SAWIE/SAWIE_11-2008/SAWIE_11-2008/9.MainstreamingGenderinpromotionofBiogasinBangladesh-MrMAGofran.pdf

Grameen Shakti (2009). "Biogas Plants: Offering Fuel, Health and Income Solutions" Available at: http://www.gshakti.org/index.php?option=com_content&view=article&id=75:biogas-plants-offering-fuel-health-and-income-solutions&catid=41:biogas-program&Itemid=56

Iken, J., (May 2014). "Self-consumption pays off," Sun Wind and Energy, pp.92-95. Available at: http://news.cision.com/propel-technology-ltd/r/viessmann-opens-green-production-plant-in-turkey,c9480176

IRENA (2014). "REMAP Project," Available at: http://irena.org/remap/

IRENA (2013). Renewable Power Generation Costs in 2012: An Overview. International Renewable Energy Agency (IRENA), Abu Dhabi, UAE; Bonn, Germany. Available at: http://costing.irena.org/media/2769/Overview_Renewable-Power-Generation-Costs-in-2012.pdf

Janisch, A., Euston-Brown, M., Borchers, M. (2012). The Potential Impact of Efficiency Measures and Distributed Generation on Municipal Electricity Revenue: Double Whammies and Death Spirals. Sustainable Energy Africa. (September 2012). Available at: http://www.cityenergy.org.za/uploads/resource_23.pdf

Jenkin T., Diakov, V., Drury, E., Bush, B., Denholm, P., Milford, J., Arent, D., Margolis, R., Byrne R. (2013). The Use of Solar and Wind as a Physical Hedge against Price Variability within a Generation Portfolio. National Renewable Energy Laboratory (NREL), Technical Report TP-6A20-59065. Available at: http://www.nrel.gov/docs/fy13osti/59065.pdf

Kukoyi, D. (2012). The Concept of Embedded Generation – Prospects and Challenges. Presented at the Workshop On The Embedded Generation Framework In The Nigerian Electricity Supply Industry, (Nov 15). Available at: http://www.detailsolicitors.com/media/archive3/seminars/workshop_on_embedded_power/presentations/Embedded%20Generation%20-%20Prospects%20and%20Challenges.pdf

KZN Energy (2012). KSEF Guide to Embedded Power Generation Application Procedures in in KwaZulu-Natal. (November) Available at: http://www.kznenergy.org.za/download/publications/ksef_publications/KSEF%20Guide%20to%20Application%20Procedures%20for%20EPG%20in%20KZN%20Final.pdf

KZN Energy (2012). KSEF Guide to Embedded Power Generation Application Procedures in KwaZulu-Natal, Available at: http://www.kznenergy.org.za/download/publications/ksef_publications/KSEF%20Guide%20to%20Application%20Procedures%20for%20EPG%20in%20KZN%20Final.pdf

National Energy Regulators of South Africa, NERSA (2012). Standard Conditions for Small Scale (less than 100kW) Embedded Generators within Municipal Boundaries. Available at: http://www.kznenergy.org.za/download/projects/NERSA_Standard_conditions_for_embedded_generation_within_munic_boundaries.pdf

Navigant Research. (2013). Renewable Energy in the Mining Industry, Accessed at: http://www.navigantresearch.com/research/renewable-energy-in-the-mining-industry

NERSA (2011). Regulations on embedded generation in South Africa within municipal boundaries:

Oseni, Musiliu O. (2012): Power Outages and the Costs of Unsupplied Electricity: Evidence from Backup Generation among Firms in Africa: http://www.usaee.org/usaee2012/submissions/OnlineProceedings/IEE%20PAPER%20FRST%20YEAR%20EDITED%20LAST%201%20LATEST.pdf

Oyedepo S. O. (2012). Energy and sustainable development in Nigeria: the way forward. Energy, Sustainability, and Society. 2:15. Available at: http://www.energsustainsoc.com/content/2/1/15

Rickerson W., et al. (2014). Residential Prosumers - Drivers and Policy Options (Re-Prosumers). IEA-RETD. Available at: http://iea-retd.org/archives/publications/re-prosumers

Rosen MA (2009) Energy Sustainability: A Pragmatic Approach and illustrations. Sustainability 1:55-80. Available at: http://dx.doi.org/10.3390/su1010055

Salam, P.A., Kumar, S., and Siriwardhana, M. (2010). Report on the Status of Biomass Gasification In Thailand and Cambodia. Prepared for: Energy Environment Partnership (EEP), Mekong Region (October). Available at: http://www.eepmekong.org/_downloads/Biomass_Gasification_report_final-submitted.pdf

Shandurkova I., Bremdal B. A., Bacher, R., Ottesen S., & Nilsen A. (2012). *A prosumer oriented energy market: Developments and future outlooks for smart grid oriented energy markets* (IMPROSUME Publication Series #3). Halden, Norway: Norwegian Centre of Expertise Smart Energy Markets.

Schroeder L. (2009). " Better lives in Bangladesh – through green power," Christian Science Monitor (June 24). Available at: http://www.csmonitor.com/Innovation/Energy/2009/0624/better-lives-in-bangladesh-through-green-power

SMA (2013). Commercial Self-consumption of solar power, Available at: http://www.sma.de/en/partners/knowledgebase/commercial-self-consumption-of-solar-power.html

Sustainable Energy Africa (2012). The Potential Impact of Efficiency Measures and Distributed Generation on Municipal Electricity Revenue: Double Whammies and Death Spirals, Prepared for the Association of Municipal Electricity Utilities (AMEU), South Africa. Available at:

The Solar Future South Africa, (2014). Commercial Project Examples. Available at: http://www.thesolarfuture.co.za/commercial-project-examples/

Tunisia (2007). Task Force MDP: Installation d'éoliennes pour la production d'électricité dans la cimenterie de Gabes. Ministère de l'Industrie, de l'Énergie et des Petites et Moyennes Entreprises and l'Agence Nationale pour la Maitrise de l'Énergie. Available at: http://www.mdptunisie.tn/pdf/NIP_scg.pdf

UK Department of Trade and Industry (2012). Embedded Generation: Technology Description. Available at: http://webarchive.nationalarchives.gov.uk/+/http://www.dti.gov.uk/renewables/publications/pdfs/tech12.pdf

UNFCCC (2012). Clean Development Mechanism (CDM) Project 8047: Dundee Biogas Power (Pty) Ltd. Available at: http://cdm.unfccc.int/Projects/DB/DNV-CUK1352193528.07/view

UNIDO (2014). "Inclusive and Sustainable Industrial Development," Available at: http://www.unido.org/fileadmin/user_media_upgrade/Who_we_are/Mission/ISID-Brochure-LowRes1_EN.pdf

US Department of Energy. (2010). $1/W photovoltaic systems: White paper to explore a grand challenge for electricity from solar. Washington, DC: US Department of Energy Advanced Research Projects Agency - Energy and Office of Energy Efficiency and Renewable Energy.

World Bank (2012). Enterprise Survey Online Database.

World Bank (2014). Enterprise Surveys: Infrastructure. Available at http://www.enterprisesurveys.org/.

UNIDO Global Renewable Energy Portfolio Some Examples:

AFRICA

Benin	Technical assistance in establishing a biomass gasification knowledge and technology centre in Songhai Centre in Port Novo
Cameroon	Promoting integrated biomass and small hydro solutions for productive uses in Cameroon
Cape Verde	Promoting market based development of small to medium scale renewable energy systems
Chad	Promoting renewable energy based mini-grids for rural electrification and productive uses in Chad
Côte d'Ivoire	Promoting renewable energy based mini-grids for rural electrification and productive uses in Côte d'Ivoire
Egypt	Promoting low-carbon technologies for cooling and heating applications
Gambia	Promoting renewable energy based mini-grids for rural electrification and productive uses in The Gambia
Ghana	Supporting green industrial development in Ghana: Biogas technology and business for sustainable growth
Guinea	Promoting development of multi-purpose mini-hydro power systems
Guinea Bissau	Creation of an enabling environment for small to medium scale renewable energy investments
Kenya	Sustainable conversion of waste to clean energy for GHG emission reduction
Kenya	Enhancing Clean Lighting Industry Project
Liberia	Installation of multi purpose mini-hydro infrastructure (for energy and irrigation)
Madagascar	Increased energy access for productive use through small hydropower development in rural areas
Mozambique	Joint programme of environmental mainstreaming and adaptation to climate change in Mozambique
Nigeria	Mini-grids based on renewable energy (small-hydro and biomass) sources to augment rural electrification
Nigeria	Scaling up small hydro power (SHP) in Nigeria
Regional (Eastern Africa)	UNIDO-KEMCO Africa sustainable energy &climate change capacity building project
Regional (EAC)	Establishment and first operation phase of the East African Centre for Renewable Energy and Energy Efficiency (EACREEE)
Regional (ECOWAS)	ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE)
Regional (SADC)	Establishment of a Southern African Development Community Centre for Renewable Energy and Energy Efficiency (SACREEE)
Rwanda	Support project for the Rwanda integrated development initiative
South Africa	Industrial organic waste-to-energy
Sierra Leone	Mini grids based on small hydro power for productive uses in Sierra Leone
Tanzania	Promotion of waste-to-energy applications in agro-industries
Tanzania	Mini-grids based on small hydropower sources to augment rural electrification
Zambia	Renewable energy-based electricity generation for isolated mini–grids in Zambia
Zambia	Upscale small hydropower mini-grid in Zambia

AMERICA

Argentina	Reducing Argentina's GHG emissions in energy generation through waste utilization solutions from agriculture and agro-industries
Chile	Promoting the development of biogas energy amongst select small- and medium-sized agro-industries
Cuba	Generation and delivery of renewable energy-based modern energy services on Isla de la Juventud, Cuba
Dominican Republic	Stimulating industrial competitiveness through biomass- based, grid-connected electricity generation
Regional (LAC)	Observatory for renewable energy in Latin America and the Caribbean: Towards centres of excellence in renewable energy in LAC

Regional (Caribbean)	Caribbean Centre for Renewable Energy and Energy Efficiency (CCREEE)
Uruguay	Towards a green economy in Uruguay: stimulating sustainable production practices and low-emission technologies in prioritized sectors

ASIA AND THE PACIFIC

Armenia	Sustainable livelihood for socially vulnerable refugees, internally displaced and local families - energy component
Armenia	CleanTech Programme
Bangladesh	Solar micro-utility enterprises for promoting rural energy and productive uses in Bangladesh
Cambodia	Biogas based rural electricity enterprises development in Cambodia
Cambodia	Reduction of GHG emissions through promotion of commercial biogas plants
Cambodia	Access to clean energy for productive uses in Cambodia
China	Upgrading of China SHP Capacity Project
India	Low-head micro hydropower technology for enhancing access to energy and promoting productive uses in rural areas
India	Promoting business models for increasing penetration and scaling-up of solar energy
India	Organic waste streams for industrial applications in India
Indonesia	Promotion and transfer of marina current exploitation technology
Kyrgyzstan	Renewable energy supply to rural first aid stations
Pakistan	Promoting sustainable energy production and use from biomass in Pakistan
Pakistan	Sustainable energy initiative for industries
Pakistan	CleanTech Programme
Regional (Pacific Island States)	Renewable energy development for electricity generation and productive uses in selected Pacific Island States
Thailand	Overcoming policy, market and technological barriers to support technological and South-South technology transfer: the pilot case of ethanol production from cassava
Thailand	Promoting small biomass power plants in rural Thailand for sustainable renewable energy management and community involvement

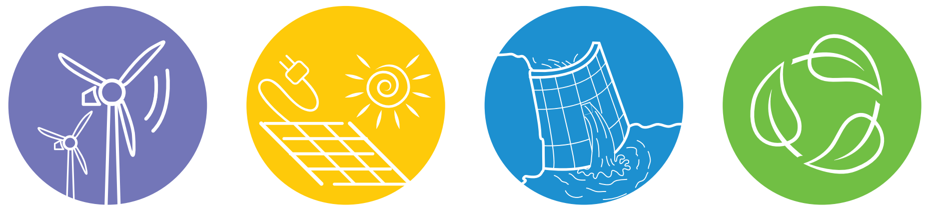
EUROPE

Albania	Bio-energy for productive use in the SMEs in the olive oil sector
Ukraine	Market development for sustainable production and use of liquid biofuels

GLOBAL

Global	Scaling-up SHP in Ethiopia, Nigeria, Myanmar, Kyrgyzstan, Peru
Global	Establishing sustainable liquid biofuels production worldwide (with UNEP and FAO)
Global	World SHP Development Report 2013 and Knowledge Platform
Global	Fostering women's empowerment through gender mainstreaming sustainable energy programmes and initiatives

UNIDO Renewable Energy Portfolio



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ENERGY BRANCH

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