Renewable Energy Policies for Sustainable African Development

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Content:

1. Abstract

The access to energy is one of the key stones for social and economic development and poverty alleviation. In the rural areas of some African countries, the share of people with access to modern energy services is as low as 1 percent. In order to reach these rural poor, sustainable concepts for energy services will have to be developed. With volatile and high prices of fossil fuels and excessive costs for nuclear energy, the massive deployment of renewable energies is the only feasible solution. By now, many renewable energy technologies have reached the level of compositeness with conventional energy sources, provide social stability though local empowerment, and protect the environment.

Therefore, the World Future Council wants to pave the way for a favorable policy framework for renewable energies both for decentralized off-grid and mini-grid solutions and large scale, grid connected projects. Off-grid renewable energy systems can best be promoted via micro credits, which have to be tailored to the financial capacity of people in rural areas. In this paper, we are presenting the success story of Grameen Shakti which has managed to bring light to many remote villages in Bangladesh. In the case of grid-connected renewable energy deployment, so called feed-in tariffs have proven to be the most effective instrument, consisting of a fixed tariff payment over a long period of time. This policy paper gives an overview of feed-in tariffs in Africa and discusses important design options for developing countries. Moreover, feed-in tariffs for mini-grids represent an interesting and promising approach for electrifying rural villages and simultaneously extending the grid.

With this paper, the World Future Council aims to inform policy makers about best practice policies for the deployment of renewable energies in Africa and tries of offer guidance when it come to the choice of support mechanisms. In line with the basic policy principles of the World Future Council, renewable energies can contribute to a large number of political objectives, such as poverty eradication, a sustainable use of resources, the protection of human health and the eco-system and public participation. The shift from fossil fuels to renewable energies across Africa also has the potential of achieving all eight UN Millennium Development Goals.

2. Introduction

2.1. Energy-poor Africa today

According to the International Energy Agency (IEA), 1.6 billion people world-wide have no access to electricity. These people live primarily on the African continent. Moreover, 2.5 billion people use fuelwood, charcoal, agricultural waste, and animal dung to fulfil their daily energy needs. The consequences of the lack of access to modern energy technologies are severe. In many cases, fuels are burned in poorly ventilated or enclosed spaces leading to indoor air pollution. The World Health Organization (WHO) estimates that 1.6 million people die of indoor air pollution every year of which 400,000 occur in Africa (WHO, 2005). Through the unsustainable use of biomass, Africa is losing more than four million hectares of forest every year – twice the world's average deforestation rate. Up to 70 percent of the household income is spent on energy for electricity & cooking (diesel, kerosene, charcoal, etc.). At the same time, women invest a substantial amount of productive time in collection and transport of fuel wood.

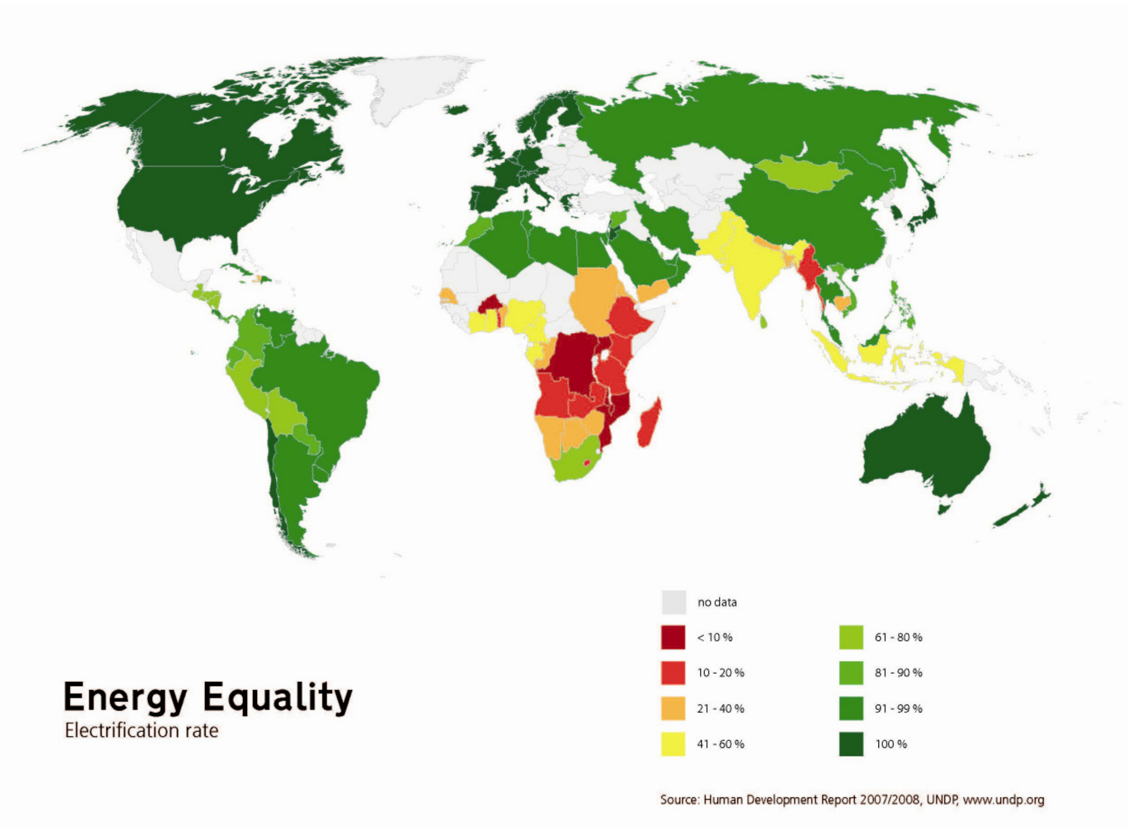
Fig. 1: Number of people without access to electricity and relying on fuelwood and charcoal for cooking in assessed sub-Saharan African countries

	Total population 2006 (million)	Number of people without electricity access (million)	(%)	Number of people relying on fuelwood and charcoal for cooking (million)	(%)
Angola	16.6	14.4	88	15.7	95
Cameroon	18.2	14.2	78	14.2	78
Chad	10.5	10.1	97	10.2	97
Congo	3.7	2.9	78	2.9	80
Côte d'Ivoire	18.9	11.6	61	14.7	78
Equatorial Guinea	0.5	0.4	73	0.3	59
Gabon	1.3	0.9	70	0.4	33
Mozambique	21	18.6	89	16.9	80
Nigeria	144.7	76.6	53	93.8	65
Sudan	37.7	26.9	71	35.2	93
TOTAL	273.1	176.9	65	204	75

Source: IEA 2008c: 358

With one billion people, the African continent is densely populated. However, only 4 percent of the world-wide produced electricity is generated here. On average, Africa consumes about 492 kWh per capita compared to the EU with over 3,000 kWh and the US which consumes 7,700 kW/h per capita. With a total installed capacity of 103 GW, Africa has less power generation capacity than, for instance, Germany with 120 GW. Of these 103 GW, 46 percent are located in South Africa and 34 percent in North Africa [JRC 2008].

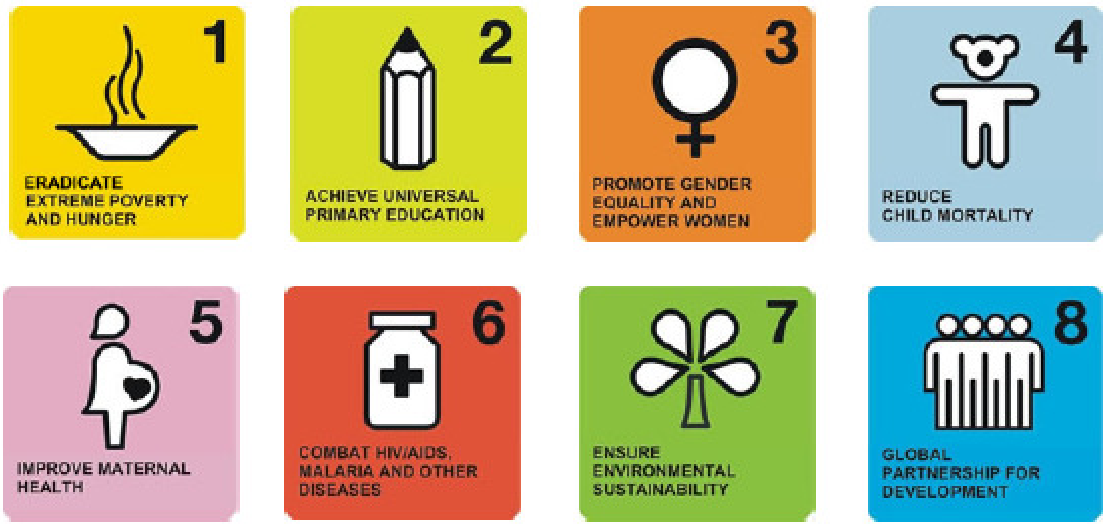
Despite its fast growing population and economies demanding ever more energy, Sub-Saharan Africa still has the world's lowest electrification rate at 25,9 percent. With only 8 percent the rural electrification rate is even lower. The high and ever increasing costs of fossil fuels lead to a situation where 80 percent of the African population relies primarily on traditional biomass, including fuel wood or charcoal.



2.2. Renewable energies Africa tomorrow

In order to meet the energy needs of African people in the future, massive new investments are required in the coming decades. The investment decision will decide upon the structure of the energy system in next 30 t0 40 years. Therefore, we will have to use this "window of opportunity" to transform the national energy systems from large-scale conventional power plants to decentralised renewable energy technologies.

The rapid expansion of renewable energies across Africa will have a positive impact not only upon the African people, its economical progress and the protection of its environment and ecosystems, but also on the world at large. Energy services have a significant role in facilitating both social and economic development - it underpins economic activity, enhances productivity, and provides access to markets for trading purposes. In addition, it enables fulfilment of the basic human needs of nutrition, warmth, and lighting; and enables access to education, health and information. Therefore, the implementation of Renewable Energy Technologies (RET) across Africa has the potential of giving a boost to the achievement all eight UN Millennium Development Goals (MDG).



In line with the basic policy principles of the World Future Council, which apply to all policies that are promoted by the WFC, renewable energies can assure that natural resources can be used in a sustainable way, poverty can be eradicated, and human health can be improved by simultaneously protecting the eco-system. In addition, public participation is assured since renewable energies are often applied in a decentralised and more democratic manner than conventional energy sources, human security is improved as renewable energy technologies can be considered as "non-violent technologies" [Schumacher, 1995]. Finally, the deployment of renewable energies can be seen as an integrated approach to solve social, economic and environmental problems.

3. Energy situation in selected African countries

Today, many African states stand at a crossroad in determining their energy policy for the upcoming decades. This opens a window of opportunity for technological transformation away from large-scale oil, gas, coal and hydro power projects or even nuclear power.

The WFC identifies the necessary political, social and economical frameworks needed for a massive deployment of renewable energy. To begin with, the WFC has determined three exemplary countries representing three Sub-Saharan regions: Nigeria (West), Ethiopia (East) and South-Africa (South). In the following, the basic energy data and policies will be presented in order to understand the challenges ahead of us.

3.1. Nigeria

Nigeria has the largest population of all African countries. According to the World Bank, more than half of the 145 million Nigerians live below the poverty line of 2 dollars per day. Nonetheless, the national GDP increases between 7 and 9 percent per year. Nigeria heavily dependents on the national oil sector, making up 95 percent of the country's total export revenues. In 2007, oil production decreased by 40 percent due to sabotage and political conflicts.

In 2004, the energy consumption in Nigeria was largely based on oil (58 percent), followed by national gas (34 percent) and hydro power (8 percent). The share of renewable energies was only marginal. Between 1984 and 2004, the share of oil in energy consumption was reduced from 77 percent to 58 percent [IEA 2007]. In the electricity sector, the total installed capacity was of 5.9 GW of which only half is available.

Power outages occur frequently as the installation of new capacity does not keep pace with increasing demand. In addition, power losses in the electricity distribution system account for 34 percent of total power generation. Consequently, commercial and industrial consumers, as well as wealthy citizens prepare for power cuts by privately operating diesel generators. This privately owned capacity exceeds by far the public electricity supply. Only in Lagos, the biggest Nigerian city with 15 million people, one million large diesel generators are in operation.

Due to the shortcomings of the national energy system, the Nigeria President Yar'Auda plans to decarbonise the Nigerian economy. The Government is eager to tackle the energy crisis and is drafting a Masterplan for renewable energies. Besides, the Ministry for the Environment is extended by a pro-active Climate Change Unit. But with the Yar'Auda Government now in office for two years the energy situation has not significantly changed to better.

3.2. South Africa

South Africa has the strongest African economy. In 2007, the GDP grew by 5 percent. Because of its economic success it can be considered a role model for other African countries.

Besides, the nation has the largest energy production capacity and the highest per capital consumption. It disposes of a good infrastructure to build on and a favourable investment framework for foreign companies.

The country has limited resources for natural gas and oil and supplies large parts of its energy need by national coal reserves. Coal covers about 88 percent of total primary energy demand and support almost 90 percent of the country's electricity generation capacity. Due to the large coal deposits, the power prices in South Africa are very low. Therefore, power demand has risen by 50 percent since apartheid ended in 1994. In 2008, South Africa faced a power crisis as generation capacity was not sufficient to meet demand. This crisis increased the pressure on the government to diversify the energy mix. Besides renewable energies, energy efficiency measures will play a crucial role as the demand for electricity is intended to be reduced by about 3,000 MW by 2012 and a further 5,000 MW by 2025 [IEA 2008b].

Besides the use of coal for electricity generation, South Africa also runs one of the largest project for coal-to-liquid technologies. With these synthetic fuels, the coal reserves shall also be used for the transport sector. The costs for the environment, however, are very high, since the burning of liquefied coal emits even more climate gases than conventional oil.

In December 2008, South Africa gave up its plans to build several nuclear power plants to meet future electricity demand, thus paving the way for a large increase of renewable energies. By 2013, the national renewable energy white paper has set a target of 10,000 GWh renewable electricity. To make this happen, a feed-in tariff scheme has been implemented in March 2009. According to the former nuclear plans, South Africa wanted to produce 20,000 megawatts from nuclear power reactors by 2025, more than 10 times today total power generation. Total costs were estimated to be of $12 billion. In the bidding process, the French Areva proposed two 1,650-megawatt reactors, where as Westinghouse planned with three 1,140-megawatt reactors [Derby & Lourens 2008]. The decision to scrap the plan for nuclear power plants was largely due to the global financial crisis, increasing capital costs for such large-scale investments. The national power company ESCOM expected to meet future energy demand nonetheless, as demand is to rise less steeply and other power plants, including renewable energies, are being built.

3.3. Ethiopia

The Ethiopian economy grows rapidly. In 2007, the GPD increased by 11.1 percent. While the national economy is characterised by subsistence agriculture, the national energy demand is almost exclusively covered by traditional fuels (wood, charcoal, agricultural residue and animal waste). 90 percent of all energy is consumed in the household sector, of which 98 percent are used for cooking purposes. Petroleum products account for 5 percent of energy consumption and the electricity sector for only 1 percent.

At the same time, Ethiopia is highly depended on energy imports, resulting in serious problems for the national economy. When the prices for fossil fuels sky-rocketed in 2007 and 2008, the Ethiopian economy came under pressure as the costs for oil imports for the first time surpassed the income from all exported goods. In the electricity sector, new generation capacity does not keep pace with the growing demand. Electricity demand increased due to programs for rural electrification and economic growth. Power shortages are frequent, especially due to low water levels in hydro power stations [Peters-Berries 2008].

In order to confront this energy crisis, the Ethiopian government planned the massive expansion of hydro power capacity and biofuels. This, however, led to conflicts with environmental issues. Due to population pressure, deforestation in the high lands already results in the loss of fertile soil. Now, the massive expansion of biofuels might lead to new conflicts of interests with food supply – the government has accounted 22 million hectares, i.e. one fifth of the country arable land for biofuels feedstock.

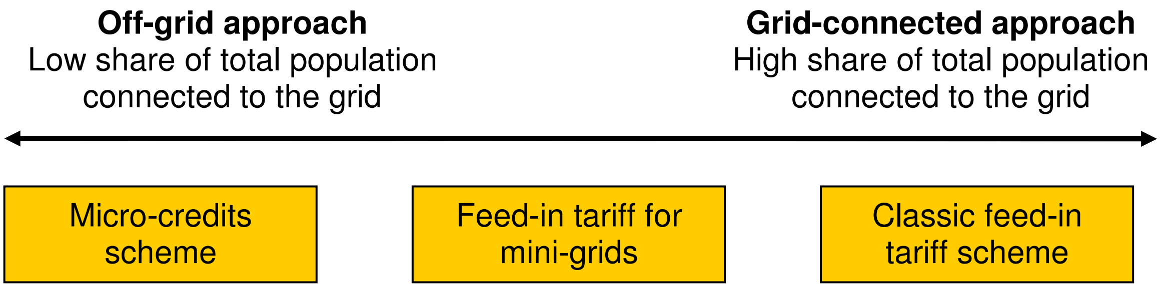
3.4. Conclusion

The analysis of the energy situation in the three countries shows large similarities. Generally, almost all African countries went through sever energy crises in the past, as energy demand increased more rapidly than energy supply. In addition, rising prices for fossil fuels and very high costs for nuclear power plants leave politicians with little alternative to renewable energies. In many cases, even large scale hydro power projects is no feasible alternative to "new" renewable energies, such as wind power, solar PV, biomass or geothermal power. In a lot of countries, the potential for hydro power has already been tapped and due to environmental and human rights concerns the focus is laid on smaller projects. Moreover, global climate change has led to decreasing rain fall in many African regions.

Empirical evidence in leading African countries in the development of “new” renewable energies such as Kenya and Mauritius has shown that diversification allowed for a stabilisation of the power sector. Typical risks related to volatile prices for fossil fuels and droughts in the case large hydro power capacity were reduced without high subsidies or increases in the electricity price [Karekezi et al. 2007]. By promoting renewable energies, policy makers can fulfil different basic needs of their people at the same time. Energy can be provided in a cost-effective way, social stability can be increased through job creation, and the environment can be protected.

4. Policies for renewable energy deployment in Africa

In the following we are going to present different approaches and support instruments to support renewable energies. Basically, renewable energies can be promoted in off-grid or grid-connected areas. Depending on the grid-infrastructure in your country and the share of the total population that is connected to the national electricity grid, you may either choose micro-credit schemes, feed-in tariffs for mini-grids or classical feed-in tariffs. If you can, we recommend becoming active in all three areas at once.



In countries with underdeveloped grid-infrastructure, a large rural population and a relatively small number of citizens connected to the national grid, micro credits cushioning the upfront cost for Renewable Energy Technologies [RET] might be your instrument of choice. This instrument can be appropriate for countries with high proportion of citizens living in rural communities. It has proven to be very successful for rural electrification and biogas production for cooking in Bangladesh. The Grameen Shakti model is presented in section five.

Classic feed-in tariffs (see section six) have shown to be the most effective support mechanisms for grid-connected renewable energy projects. Several African countries, including South Africa and Kenya, have already implemented feed-in tariff schemes. They work both in monopolised and liberalised electricity markets. Under this approach, a large number of grid-connected electricity consumers is important as costs are generally shared amongst all final consumers. The larger the number of grid connected consumers, the smaller the top-up on the electricity bill of each one of them. This approach is especially promising in areas with a wide-ranging national electricity grid, as for instance in South Africa or Ghana.

An intermediate solution is offered by feed-in tariffs for mini-grids. They consist of interconnected small, modular generation sources in one small scale distribution systems. Even though this instrument has so far not been implemented anywhere, it is a promising instrument for renewable electricity generation in remote villages. In the mid-term, single village grids can be connected with each other, leading to grid extension in remote areas. Therefore, this approach constitutes a link between the micro-credits (individual off-grid systems such as Solar Home Systems) and classic feed-in tariffs (grid-connected).

5. Micro credits for off-grid RE deployment

Large distances to the national electricity grid normally prevent rural electrification taking place. Grid extension is often not an economic viable solution. In 2000, the World Bank and the UNDP calculated that grid extension on average costs between $8,000 – 10,000 per km. In difficult terrain, the costs can go up to $22,000. In addition, villagers' electricity consumption and population density is usually low, thus making long-term cost-recovery for grid operators even less probable. Due to extensive costs, many countries and organization have promoted off-grid solutions to satisfy energy needs.

In the case of off-grid renewable energy technologies, micro credits which allow end consumers become energy producers while purchasing individual RE home systems have proven to be an effective tool. Often, the main barriers to the implementation of off-grid renewable energy installation are the high upfront costs and the lack of awareness amongst the people. With financing schemes which are adjusted to the financial conditions of poor, rural people these barriers can be removed. An impressive example is presented by the Grameen Shakti initiative in Bangladesh.

5.1. Grameen Shakti, Bangladesh

Bangladesh is a densely populated, low-income country. However, it is an ideal place for renewable energy generation, with high solar radiation ranging from 4.0 until 6.5 kWh per square meter. In order to power the rural poor, Grameen Shakti (meaning "village power" in Bengali) has invented a new scheme to promote renewable energies in rural areas which is entrepreneur and community driven instead of donor driven. Grameen Shakti won several international prices for their commitment, including the Right Livelihood Award in 2007.

Awarded in recognition of "bringing sustainable light and power to thousands of Bangladeshi villages, promoting health, education and productivity."[1]

Even though it is registered as an NGO, it is run as a for-profit enterprise for the most part. The Grameen Shakti, established in July 1996, has installed more that 210,000 Solar Home Systems (SHS) in rural Bangladesh. By January 2009, more than 8,000 SHS were installed every month. Besides the business with Solar Home Systems, the company has managed to diversify its product portfolio, including biogas plants and improved cook stoves. The biogas case is especially interesting as it offers an intelligent and simple method to combine agricultural production with increased comfort for cooking. For this purpose, animal dung is collected in domestic or larger size biogas plants. The gas enables women to prepare the food in a pollution free environment, without the smoke of charcoal or wood. Owners of domestic size biogas plants can also sell this gas to their neighbours in the village. The residues from biogas production can be used as fertilisers for agriculture.

Source: Grameen Shakti

Thanks to the success of Grameen Shakti, international donors like the World Bank, Global Environment Facility and KfW Bank were eager to replicate and scale up this approach in Bangladesh. Therefore from 2002 onwards the Infrastructure Development Company Ltd. (IDCOL) granted soft loans for Grameen Shakti and other organisations working on rural

[1] See http://www.rightlivelihood.org/grameen_shakti.html

electrification projects. From January 2009, IDCOL is providing US$ 285 as loan and € 35 as grant for each Solar Home System on average. The currently interest rate on soft loan is 6% with a payback period of 8 years.

The future plans of Grameen Shakti are even more ambitious. The organisation states that by 2012 about 1 million Solar Home Systems will be installed in Bangladesh, together with 500,000 biogas plants. By 2015, Grameen Shakti intends creating 100,000 “green” jobs in rural areas.

Number of villages covered	38,000
Total beneficiaries	More than 2 million people
Unit offices	527
Installed Solar Home Systems	210,000
Installation of biogas plants	6,000

Source: Shakti homepage[2]

A typical 20 kW stand-alone solar system costs about US$ 400. In Bangladesh, this translates to 20 years of electricity consumption in one single payment. A typical villager who has never possessed or not even seen a solar panel will be very reluctant to invest such an amount of money in an unknown technology. Therefore, Grameen Shakti has developed several credit schemes for Solar Home Systems in order to give rural people the opportunity to finance the relatively high investment costs. For instance, the user can pay 25 percent of the total cost upfront. The remaining 75 percent are paid on a monthly basis within 2 ½ years as a 6 percent flat rate service charge. Alternatively, purchasers of Solar Home Systems can opt for shorter payback times and higher costs. In this case, the user pays 25 percent upfront. Additionally, 85 percent of the total costs will have to be paid in the following 24 months with a 4 percent flat rate service charge [Barua 2007]. This way, renewable energy technologies become affordable for a larger group of clients.

One of the major advantages of Grameen Shakti over other, similar programs is its grass-route approach. Over the year, the initiative has won the heart and minds of the rural people in Bangladesh by providing excellent services and meeting the clients needs. One of the key marketing strategies was to focus on the more affluent people in villages in the first place. By

[2] See http://www.gshakti.org/glance.html

doing so, Grameen Shakti managed to spur “competition” amongst villagers that wanted to keep up with their neighbours [IFC 2008]. Besides, Grameen Shakti focuses on women as the main actors and agents of change in the Bangladeshi society. Grameen Shakti has set up 45 Grameen Technology Centers and trained more than 1,500 women as solar technicians. They are working independently and with Grameen Shakti to assemble, repair and maintain solar accessories. Many of them have also set up their own businesses at their homes. Grameen Shakti plans to create 100,000 Green Jobs for women by 2015. Eventually, they will become full-fledged energy entrepreneurs.

Key to the local acceptance are the so-called Unit Offices, the local “branches” of Grameen Shakti in a given area. Each of these offices is staffed by a unit manager and a technician, and is supervised by a division manager who report to the general manger of the Grameen Shakti initiative. The skilled employees in these Unit Offices make frequent visits to all costumers and are prepared to repair and maintain all installations. The employees also serve as trainees for the local population. If necessary, credit schemes can be adjusted in times of financial difficulties. There are more than 500 of these Unit Offices all over Bangladesh. Moreover, Grameen Shakti offers extensive warranties and even offers a buy-back deal in case that the national electricity grid is to be extended to the costumer. Besides, the warranty includes free maintenance for the first three years, training seminars for clients, routine system maintenance, and monthly inspections. [IFC 2008].

5.2. Conclusion

In sum, the micro credit scheme does not include any direct subsidy from governmental or other third party institutions. Only in the recent past, soft loans and marginal grants have been offered. It simply puts the costs within the reach of the rural people. If the costs are perceived to be too high then the rural people will not be interested. Owners of renewable energy installation often sell energy services to neighbours or other villages, thus linking energy production with income generation. This allows owners to pay back the micro credits in time. As a general rule, effective After Sales Services are key for long-term success as other villager are aware of whether a renewable energy system are maintained properly. This is going to be the ground for investment decisions of future generations. Over the time, the good will and the trust of people have to be earned [Barua 2007].

If you plan to provide off-grid electricity services to rural people in your country, there should be no plan for connecting the village to the electricity grid in the near future. If, unexpectedly, a village should get connected to the grid, the provider of solar home systems or other renewable energy applications should include a buy-back deal in its warranty. For successful rural electrification, it is indispensable that local people are informed about the advantages of renewable energies (awareness raising). Besides, there should be sufficient purchasing capacity in a given area in order to ensure profitability. In a first step, the more affluent villagers might have to be targeted, thus creating "competition" in the local community [Barua 2007].
Another key to success is the fact that the total ownership concept of Grameen Shakti. Donor driven programs risk failing because the end users are tempted to sell their SHSs.

6. Feed-in tariffs for grid connected RE deployment

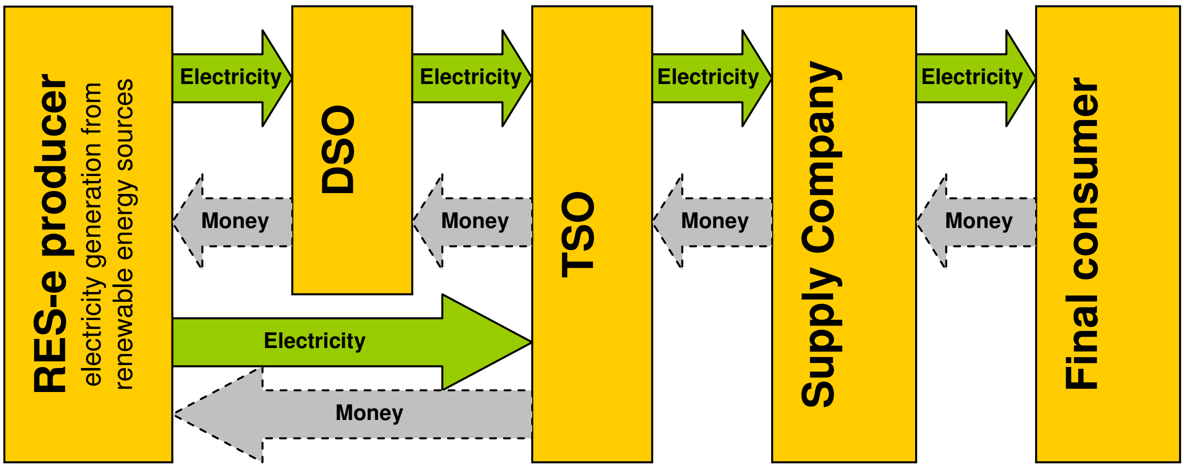
In the past, national governments in Africa made little effort to promote grid-connected renewable energy technologies. Moreover, international donors like the World Bank or the UN also focused on off-grid solutions as they wanted to reach to rural poor which usually lack access to national electricity grids [Hankin 2008]. However, the situation has changed because the generation costs for some renewable energy technologies are already compatible with conventional energy sources. Besides, many industrialised countries have made a lot of progress in shifting their energy systems towards renewable energies. This is especially true for countries that have implemented so called feed-in tariffs.

Feed-in tariff scheme, basically consisting of a fixed payment for renewable electricity over a long period of time (usually 20 years), have proven to be the most successful support mechanisms to accelerate the deployment of renewable electricity [cf. EU Commission 2008; IEA 2008a; Ragwitz 2007]. The main advantage of feed-in tariffs over other support instruments is its high degree of investment security. As renewable energy projects are to a large part financed by bank loans, a feed-in tariff offers the producer the opportunity to get favourable financing conditions due to the guaranteed revenues. This drives down the costs for the final consumer.

6.1. Standard financing mechanisms

In many industrialised countries, the additional cost for electricity generation from renewable energy sources is generally evenly distributed amongst all electricity consumers. In Germany, for instance, all electricity consumers indirectly support renewable electricity generation by a small increase in their electricity bill. At the moment, the 15 percent share of renewable electricity in the German power generation portfolio (more than 80 TWh) costs each consumer an extra 1.2 €cent/kWh. Considering an average electricity price of 20 €cent/kWh, the increase is marginal and research shows that the economic and environmental benefits outweigh the additional costs.

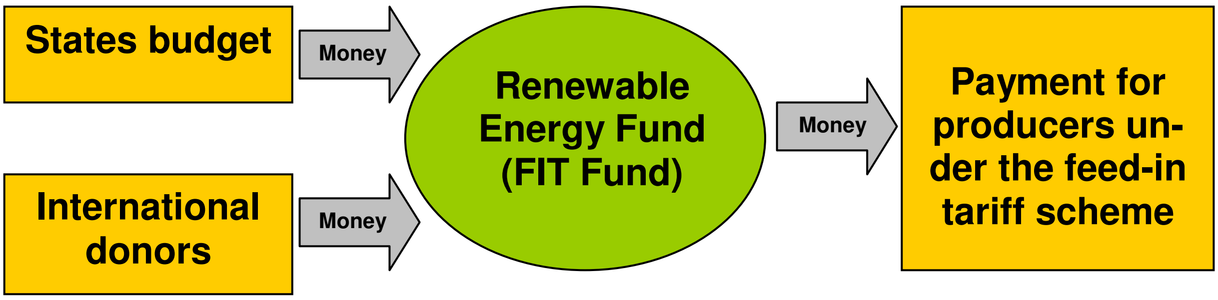
To share the costs between all consumers, the producer receives the tariff payment from the grid operator who is obliged to connect and pay. Generally, this is the local grid operator, i.e. the Distribution System Operator (DSO). Only rarely, as in the case of large-scale wind power projects, the producer may decide to directly connect to the Transmission System Operator (TSO). Subsequently, the grid operator passes the costs for tariff payment and the respective accounting data to the next higher level in the electricity system until it reaches the level of the transmission system operator(s). At this stage, the total amount of renewable electricity produced under the feed-in tariff scheme is aggregated and the total costs divided by the amount of renewable electricity produced. Finally, each supply company receives the same share of renewable electricity in relation to total amount of electricity that is provided and thus the costs can be equally distributed amongst all consumers. It has to be clear that this financing mechanism does not include any state subsidy. No taxpayers' money is used for renewable energy support. All costs are passed from the renewable electricity producer to the final consumer. The feed-in tariff law only arranges the interaction of private actors, i.e. renewable electricity producers, grid operators and final consumers.



Another, more simple approach for cost distribution is to add the additional costs for renewable energy deployment to the pass-through costs of the electricity system operator (see Kenyan FIT scheme, section 6.5).

6.2. Feed-in tariff fund

Since increases in the electricity prince are a politically very sensitive issues – especially in developing countries where a large share of private income is already spend on energy services – alternative financing mechanisms might have to be considered. One major alternative is the financing of the feed-in tariff scheme through national funds for renewable energies. The primary sources of these funds generally come from the national budget. Theoretically, international donors could also make contribution to these funds, thus promoting thousands of renewable energy projects at a time. In this case, it has to be assured that contributions are safeguarded and funding is not used for any other purposes.



It has to be stressed, however, that financing trough funds bears certain risks. For a sustainable development of renewable energies it is recommended to separate the support instruments from the state budget, because otherwise a change in government or macro-economic data might lead to stop-and-go policies. Therefore, the sources of the fund have to be sufficient and steady. In addition, a fund model requires the fund manager to set aside large reserves as tariff payment is generally provided for a long time, i.e. 20 years. From this perspective, renewable energy projects can appear very expensive and thus put the whole support mechanism at risk.

Alternatively to a national fund, it is also possible to establish an international fund for renewable energy projects in developing countries. This fund could be administered by the newly established International Renewable Energy Agency (IRENA). It could provide a solid foundation for financial transfer from the North to the South. In contrast to the volatile carbon price under the CDM mechanisms this fund could provide a reliable and stable source of revenue for a large number of renewable energy projects.

Fraud proof metering is a key precondition for FIT and a particularly relevant question for developing countries.

6.3. Optional limitation of eligible plants (capacity cap)

Feed-in tariffs are a very successful instrument for technology development. In contrast to R&D funding and investment subsidies which generally focus on a niche market, feed-in tariffs have the potential to spur large-scale investment and the creation of a new industry. Therefore, it is usually recommended not to include a cap on the overall installed capacity. The complete shift from fossil or nuclear based energy systems, to renewable energy systems can best be achieved without any limits for the growth of the renewable energy sector. For developing countries, however, an overall capacity cap might be necessary in order to control the additional costs for the consumer. Moreover, technology development is not the primary objective of developing countries. With their access to capital, industrialised countries can massively deploy renewable energies and drive down costs for that they come into the financial reach of developing countries. This approach allows for some kind of burden sharing between industrialised and developing countries.

Caps in developing countries require corruption free allocation mechanisms. The installed capacity can be guided through the level of the FIT. It may be better to adjust the FIT once in a while.

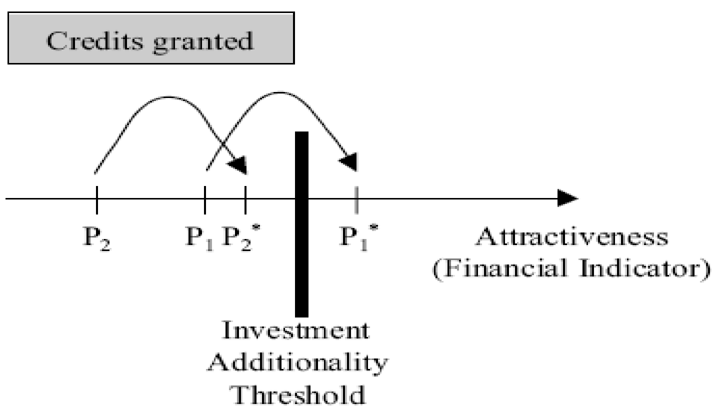
If you plan to implement an overall capacity cap, i.e. a limit on the number of projects that is eligible for tariff payment, it might be wise to also limit the maximum size of each plant. If, for example, you want to limit tariff payment for solar PV to 150 MW, you should limit the tariff payment to installation with a maximum capacity of 10 MW. Otherwise, only a small number of producers might benefit from the support scheme.

When you wish to implement a capacity cap, the feed-in tariff legislation should include a provision for revising this cap before it is reached. Otherwise you risk to stop-and-go cycles which could hinder the sustainable development of your national industry. The feed-in tariff law should state that if, for instance, 80 percent of the cap or target is reached, the Ministry or organisation in charge has to revise the support mechanisms and especially the capacity caps and targets. Based on this assessment, the legislator should consider whether an increase in the capacity cap or target is feasible.

6.4. Combining feed-in tariffs with the CDM mechanism

In developing countries, large scale renewable electricity projects (particularly wind energy) are more and more often co-financed by the so-called Clean Development Mechanism (CDM) set up by the Kyoto Protocol. Besides International Emission Trading and Joint Implementation, the CDM mechanism is one of the three flexibility mechanisms for green house gas reductions established under article 12. Industrialised nations (Annex I countries) can fulfil their legally binding green house gas emission reduction targets through projects in developing nations (Annex II countries), e.g. in the field of renewable energy deployment. Each tonne of reduced CO2 equivalents can be traded on the international carbon market in the form of Certified Emission Reduction Units (CER). This way it is believed that emission reductions can be achieved in a cost-efficient manner. In short, the CDM mechanism is a financing tool for investments in renewable energies [Streck 2004].

As a matter of fact, financial income from the certificate trading on the international carbon market is generally marginal in comparison with the overall costs of a project. Therefore, CDM projects will have to be very close to the profitability threshold (Investment additionality threshold) in order to become interesting for investors. The graph below shows that project P_2 is too far away from this threshold, as the additional incomes from certificate trading will not allow profitability of the project (P_2^*). However, CDM mechanism allows overcoming the profitability threshold for project P_1/ P_1^*.



Source: Bode & Michaelowa 2003: 509

There are two potential barriers towards renewable energy deployment through the CDM mechanism. First, the generally high project and transaction costs might hamper project development, as green house gas reductions can be achieved more cost effectively in other sector, such as energy efficiency. Second, the requirement for “additionality”, as set out in the general rules for CDM projects, can lead to difficulties when combining CDM mechanisms with other support mechanisms, such as feed-in tariffs.

Project and transaction costs are generally high for the deployment of renewable energy plants. An investor will compare the project and transaction cost with the expected volume of certificates which can be traded on the international carbon market. This ratio is usually better for other CDM projects. This is partly due to the fact that the six green house gases are weighted differently according to their effects on climate change. While the prevention of one tonne of Fluor form (HFC-23) accounts for 12,000 certificates, a project which leads to the reduction of one tonne CO2 only receives one certificate. Consequently, developers tend to choose large CDM projects, offering a large quantity of tradable certificates. By contrast, most renewable energy projects are small-scale, leading to high transaction costs and a relatively limited number of certificates for the international carbon market [Schröder 2009: 239].

The “additionality” criterion is one of the crucial features of the CDM mechanisms as set out in the Marrakech Accords. Accordingly, projects can become eligible under the CDM mechanism if they would not have been put in place without the additional financial incentive offered by the certificate trading on the international carbon market. The requirement of “additionality” was implemented in order to avoid the participation of “free riders”, i.e. project that would have been realised anyway. In general, this makes sense since it assures that industrialised countries can only transfer emission reductions to their national targets if these projects have an effect on global green house gas reductions.

In the past, the additionality criterion sometimes led to the perverse effect that governments of developing countries decide not to implement successful national policies for renewable energies or energy efficiency in order to profit from the international carbon market. The CDM Executive, however, took measures to prevent this pitfall by clarifying that national policies implemented after November 2001 are not accounted into the baseline calculations [UNFCCC 2005]. Therefore, the combination of CDM and feed-in tariffs is now possible without any risks.

When calculating the tariff payment under the feed-in tariff scheme, the legislator has to decide whether the potential incomes from carbon trade under the Clean Development Mechanisms will be taken into consideration. Theoretically, one could argue that the additional income can be subtracted from the tariff payment. However, the South African regulator decided not to include carbon revenues from CDM into the tariff calculation as the Kyoto Protocol will expire in 2012 and there is large uncertainty about the international climate protection regime in the post Kyoto era. Besides, the income from carbon trading is very hard to anticipate since the price for Certified Emission Reduction Units is rather volatile. Therefore, we recommend excluding potential revenues from CDM when calculating the tariffs. The feed-in tariff scheme should be "self-sufficient", i.e. guarantee enough revenues for the producers in order to operate renewable energy units in a profitable manner.
One hindrance for the use of CDM for small scale projects are the bureaucracy costs. The UNFCCC should find ways to reduce these costs for those projects and facilitate bundling of projects.

6.5. Feed-in tariff in Kenya

Currently, the electricity in Kenya is mainly produced by large hydro power dams (60 percent). In addition, about 10 percent of the electricity stems from geothermal, and 30 percent from fossil-fuel based power plants. Peak demand is of 1,050 MW while the total installed capacity is of only 1,185 MW. On average, electricity demand growth by 8 percent annually.

For technology diversification and in order to meet the future energy needs, the Kenyan government implemented a feed-in tariff scheme for wind power, biomass and hydro power in March 2008. Besides technology specific tariffs, the remuneration for hydro power and biomass differs for firm and non-firm renewable electricity generation, i.e. fluctuating or steadily produced electricity. The tariff scheme includes capacity limits for each installation and for the overall installed capacity. Tariff payment is granted for 15 years.

Technology	Tariff	Maximum size of power plant
Wind	9 US cent/kWh	50 MW
Biomass (firm)	7 US cent/kWh	40 MW
Biomass (non-firm)	4.5 US cent/kWh	40 MW
Hydro (firm)	8-12 US cent/kWh	500 kW – 10MW
Hydro (non-firm)	6-10 US cent/kWh	500 kW – 10MW

In order to finance renewable energy projects under the feed-in tariff, the grid-operator can increase the pass-through costs. The law states that all costs higher than 2.6 $cent/kWh can be added to the pass-through costs.

One year after the implementation, several power producers have expressed their intention to start projects for renewable electricity generation. According to the responsible Ministry, already 6 possible producers are carrying out site-specific feasibility studies for wind power. Altogether, these projects have a capacity of 500 MW [Ondari 2009]. However, the Kenyan feed-in tariff has been criticised for establishing maximum tariffs. According to the law, grid operators and producers have to agree on a tariff which shall not exceed the tariffs established by the government. This, however, contradicts the basic principle of feed-in tariffs, i.e. investment security through a minimum tariff which reduces transaction costs by avoiding lengthy tariff negotiations. Likewise, the law allows for exceptions from the essential priority purchase obligation. Hence, the effectiveness of the feed-in tariff might be seriously hampered. Maybe one should therefore name this scheme differently (i.e. in the headline).

6.6. Feed-in tariff in South Africa

In December 2008, the National Energy Regulator of South Africa (Nersa) issued a consultation paper for a feed-in tariff scheme [Nersa 2008]. The initial draft was criticised by the renewable energy industry as tariff payment was considered being to low. In the case of wind power, Nersa proposed a tariff 75c/KWh (about 5.8 €cent/kWh). Mainstream, an Irish wind energy company, however argued for tariff of at least 1 Rand per kilowatt hour (about 7.8 €cent/kWh) in order to make project economically viable [Njobeni 2009]. Moreover, it was criticised that Eskom Distribution, the branch of Escom dealing with all grid issues, was to become the purchasing agency under the feed-in tariff scheme. Since the national utility Eskom is also engaged in electricity generation in South Africa and might, in the future, engage in renewable energy project, conflicts of interest with independent power producers could arise.

After a consultation process including a large number of stakeholders, the South African feed-in tariff scheme was approved by Nersa in March 2009 [Nersa 2009]. In comparison to the first draft, the final version includes significant modifications. Tariff payment is granted for a minimum of 20 years. Before, Nersa had stipulated a tariff payment duration of 15 years. Eligible technologies are landfill gas, wind power, concentrating solar power (CHP), and small hydro power (less than 10 MW). Not included were biomass pulp and paper and bagasse from sugar cane as they are already promoted under another support program. Other technologies might be included in six months time. The tariff calculation methodology was based on full cost recovery and reasonable returns on investment. The calculation was based on the following assumptions:

Financial parameter	Unit	IPP REFIT
Debt	%	70
Equity	%	30
Nominal cost of debt	%	14.9
Inflation	%	8
Real cost of debt after tax	%	6.39
Tax rate	%	29
Real return on Equity ROE after tax	%	17
Weighted Average Cost of Capital (WACC)	%	**12**

Source: Nersa 2009

In contrast to the first proposal, the automatic reduction of tariffs for new plants (tariff degression) was excluded from the final version as this design option only makes sense for rather mature markets. As depicted in the table below, the feed-in tariff level has increased significantly in comparison to the first draft, also due to the increase of capital costs due to the global financial crisis. For new installations, every year the tariffs will be adjusted to the inflation.

Technology	First tariff proposal (2008) in Euro cent	Tariffs as approved in 2009 in Euro cent
Landfill gas	3.3 € cent/kWh (43.21 c)	7.5 € cent/kWh (90 c)
Small hydro (less than 10 MW)	5.7 € cent/kWh (73.76 c)	7.8 € cent/kWh (94 c)
Wind power	5.1 € cent/kWh (65.48 c)	10.4 € cent/kWh (1.25 R)
Concentrating Solar Power (CHP)	4.7 € cent/kWh (60.64 c)	17.5 € cent/kWh (2.10 R)

6.7. Single technology feed-in tariff in Mauritius

Mauritius offers an example of how a fixed price per kWh can spur investment, even though only one single technology is targeted. The government set a feed-in tariff for co-generation, i.e. simultaneous production of electricity and heat in a single power plant. Historically, sugar cane production is one of the main pillars of the Mauritian economy. About 80 percent of the arable land is used for sugar cane production. The accumulated bagasse – a by-product of sugar cane production – is co-fired in thermal power plants, thus contributing to the countries energy supply. Today, co-generation accounts for close to 40 percent of the total national power generation capacity, of which 25 percent are based on bagasse. Interestingly, sugar cane producers make more money with energy generation than with the export of sugar [Bristow 2007].

The feed-in tariff for co-generation is indexed to the coal price, the cost of living in Mauritius and the exchange rate. In 2000, the government set the tariff at 1.72 Rs (6.0 US$cent/kWh). Higher tariffs are paid for more efficient power plants. The revenues from this economic activity are shared between all stakeholders, including small farmers. [Karekezi & Kithyoma 2008]. Despite the success of the Mauritian feed-in tariff, it is recommended to include a large number of technologies under a feed-in tariff scheme. In order to meet a large share of future power demand by renewable energies, several technologies will have to be developed at national scale. This way, some "firm" renewable energy technologies, such as biomass, solar thermal, geothermal and hydro, can provide backup for "fluctuation" and whether dependent technologies such as wind and PV.
This Mauritius FIT is featured in the BBC / WFC Earth Report documentary 'Payback Time'.

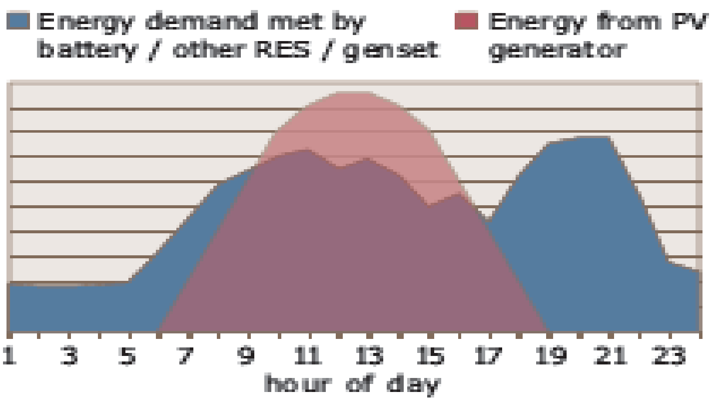
6.8. Conclusion

Feed-in tariffs are an effective and flexible instrument to spur the development of grid-connected renewable energy plants. Some African countries, Kenya South Africa and Mauritius, have already successfully implemented a feed-in tariff scheme while other countries are currently working on it, including Ghana and Nigeria. When implementing feed-in tariffs in African countries, some special design options have to be taken into account, especially with respect to the financing of the support scheme. Modifications of the tariff calculation approach are also necessary when combining feed-in tariff with the CDM mechanism of the global climate change regime. One major shortcoming of these schemes is to exclude solar PV, given the high irradiation.

7. Feed-in tariffs for mini-grids

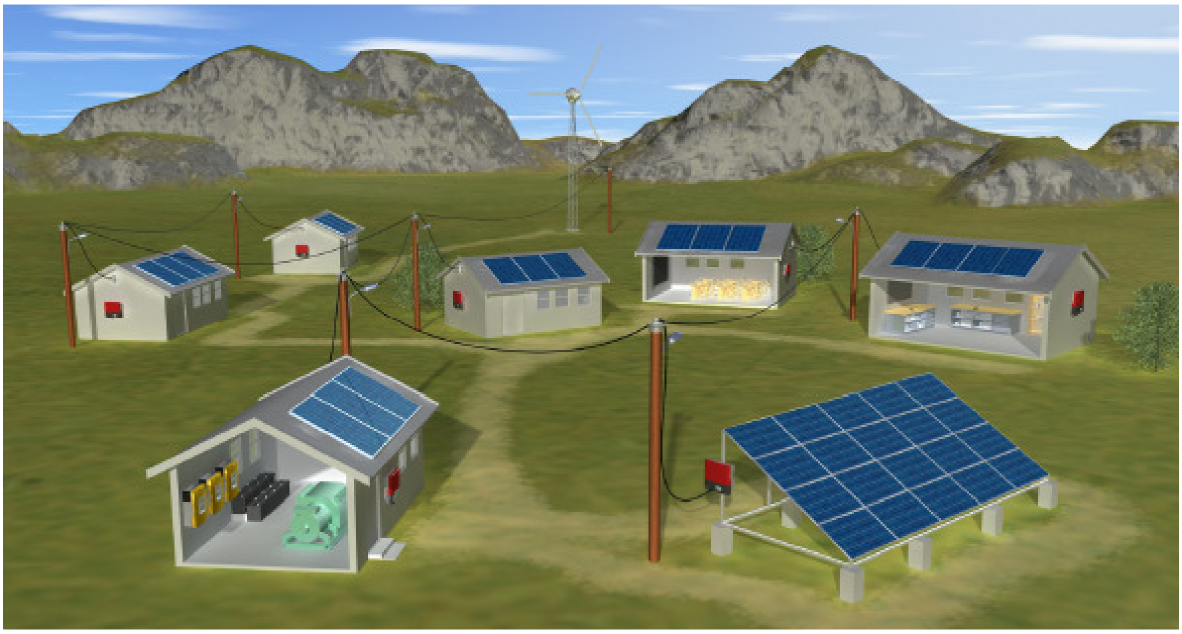
Mini-grids are interconnected small, modular generation sources in one small scale distribution systems. Originally, feed-in tariff schemes have be designed to support grid connected renewable electricity generation. Generally, this takes place in countries or regions with a well-establish grid infrastructure. Many developing countries, however, have a large potential for the use of renewable energies but do not dispose of a highly interconnected electricity grid. Therefore, several researchers have tried to modify feed-in tariff schemes according to the requirements of mini-grids. Lately, the Joint Research Centre of the European Commission has proposed different ways of how to modify standard feed-in tariffs for mini-grid applications [JRC 2008].

In a mini-grid, electricity can be provided to the consumer by a variety of technologies, including fluctuating renewable energy technologies such as wind power and solar power. As shown in the graph below, solar PV alone cannot fully match electricity demand.



Source: Alliance for Rural Electrification (ARE)

Therefore, mini-grids are usually operating with a combination of generation sources, including renewable energy technologies, batteries and backup capacity from conventional energy sources (genset) such as diesel generators. In times when renewable energy technologies cannot fully supply electricity demand, the other technologies start to be used. Ideally, fluctuating renewable energy technologies such as wind power or solar PV are backed by other renewable energy technologies, including hydro power and biomass. At a community-level, such hybrid systems can provide reliable village electrification equipped with a diesel generator as fall-back solution.


Source: SMA, Germany – Alliance for Rural Electrification, 2009

Feed-in tariffs for mini-grids have to be adjusted according to the ownership structure of the power market and the general regulatory framework, i.e. a regulated, monopolistic structure versus liberalised markets. Important actors in the field of electricity generation in mini-grids are independent power producers, rural energy service companies and, co-operatives.

Independent Power Producer (IPPs) can generate electricity in a liberalised or regulated market. In contrast to utilities, they are not legally or economically linked to transmission or distribution activities. The interaction of IPPs with utilities or grid operators is usually determined by long-term Power Purchase Agreements (PPA). Rural Energy Service Companies (RESCOs) are quasi-governmental organisations that usually have a partial monopoly for energy services and other public services in a given area. If RESCOs operate renewable energy installations, they are usually responsible for the full chain of services, including operation, maintenance, and repair. Co-operatives are usually locally grounded and serve their members as a not-for-profit organisation. Examples are so-called solar communities. If a co-operative is in place, it usually is the exclusive provider of electricity [JRC 2008].

According to the actor constellations and the regulatory framework, financial flows have to be adjusted. The general methodology of distributing costs amongst all national electricity consumers can, per definition, not be applied to mini-grids. The Joint Research Centre of the European Commission has elaborated financing schemes for three different scenarios of actor constellations.

- First, feed-in tariffs under regulated service concessions.
- Second, feed-in tariffs for IPPs.
- Third, feed-in tariffs for power producers which are at the same time electricity consumer [JRC 2008].

7.1. Feed-in tariffs under regulated service concessions

In this case, the government offers a service concession to a certain company for a given period of time. The company is usually selected via competitive bidding. This company then has the right to exclusively supply energy and is obliged to offer services to everyone who requests it. Energy service concessions in rural areas can be fulfilled through a combination of technologies, including renewable energies and diesel generators.

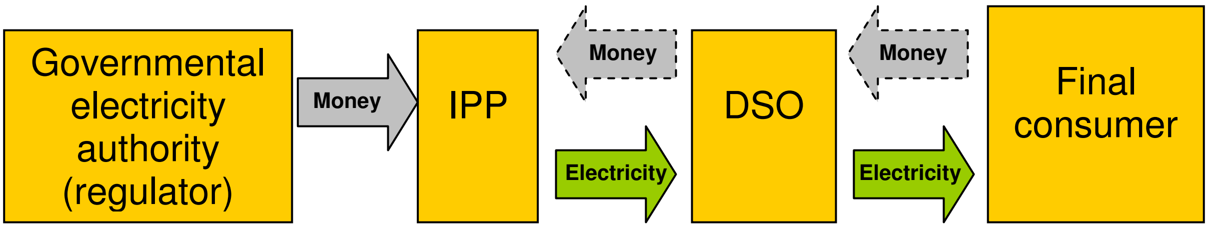
The RESCO usually charges the final consumer below the generation costs in the mini-grid at a fixed and affordable price. In order to compensate for the incurred losses, the RESCO receives additional money from the local Energy Development Agency which is general financed by the local government.

Source: Own elaboration based on JRC 2008

The combination of payment from the end-user and the Energy Development Agency shall cover all costs and even guarantee for reasonable returns on investment. If the Energy Development Agency does not dispose of sufficient financial means, money from international donors might be necessary.

7.2. Feed-in tariff for IPPs in mini-grids

More than 25 developing countries have so far established frameworks for Independent Power Producers. If governments want to incentivise new investment into renewable energy capacity from IPPs, the most important measure is a clear regulatory framework including a purchase agreement. This feed-in tariff is usually set by the national regulator, the governmental electricity authority. The IPP is connected to the mini-grid which is managed by the local Distribution System Operator (DSO) who offers energy services to the final consumer. Since the regional DSO usually sells the electricity to the final consumer at a nationally or regionally predefined rate the IPP will need additional revenue sources from the governmental electricity authority, which is set at national level.

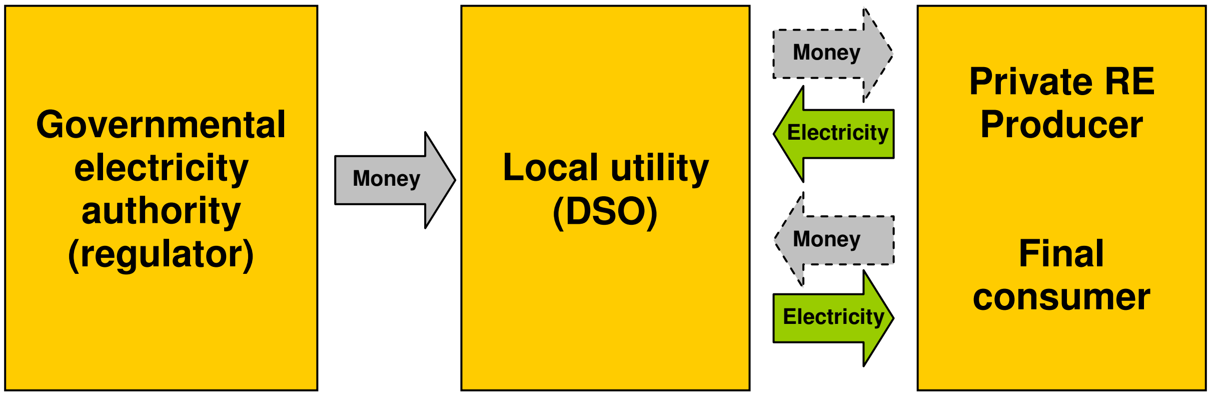


Source: Own elaboration based on JRC 2008

The combination of the feed-in tariff payment from the governmental electricity authority and the regulated tariff from the DSO should guarantee the profitability of renewable energy projects run by independent power producers.

7.3. Feed-in tariff for power producers/consumers

If a household can afford buying a small scale renewable energy production unit, e.g. a solar home system, it can become producer and consumer at the same time. The private ownership of renewable energy production units can be supported with micro credit schemes (see section 5). Since the unit is connected to the local mini-grid, the generated electricity can be provided, thus increasing stability of the entire network. The local utility, the Distribution System Operator, purchases the electricity at a preferential rate, a feed-in tariff determined by the governmental regulator.



Source: Own elaboration based on JRC 2008

Similar to Independent Power Producers, the private producer of renewable electricity can sell the power to the grid at a preferential feed-in tariff. At the same time, the private producer receives electricity at a lower price from the grid operator, as all other consumers in the mini-grid. The difference is paid by contributions from the governmental electricity authority (regulator). The final consumer/private RE producer can use the revenue, i.e. the difference between sales prices and purchase price, to pay of the initial investment cost of the installation.

7.4. Conclusion

Even though the concept of feed-in tariffs in mini-grids has so far not been tested in any country or region, it represents an interesting an promising approach for linking off-grid and grid-connected renewable energy support. The most challenging issue is to set up a stable and reliable transfer of money from the state level to the local level in order to compensate for the additional costs of renewable energies.

8. Summary

Africa has an enormous potential for renewable energies, both for rural off-grid applications and larger scale grid-connected projects. The continent is at a crossroad with respect to energy policy. The decisions taken today will determine the structure of the energy system in the coming decades. With renewable energies being economically compatible with conventional energy sources today, and even more so in the future, the choice for policy makers is rather simple. Besides, they can help to provide social stability though local empowerment and protect the environment. Prerequisites for successful renewable energy policies are transparent policy frameworks for producers and strong governance both at national and regional level. Besides sufficient administrative capacity to deal with application it is also important to fight corruption at all political levels. If support is granted for renewable energy projects it has to be assured that the money is not used for any other purposes.

Micro credits, generally working without any direct subsidies. They simply provide a mean to distribute the costs over a longer period of time and therefore within the reach of the rural people. As a general rule, effective After Sales Services and individual ownership are key for long-term success as other villager are aware of whether a renewable energy system are maintained properly. This is going to be the ground for investment decisions of future generations.

Feed-in tariffs are an effective and flexible instrument to increase the share of grid-connected renewable electricity. Many African countries have either already implemented them or are about to do so. In contrast to feed-in tariff in industrialised countries, some modifications are recommended. Even though the concept of feed-in tariffs in mini-grids has so far not been tested in any country or region, it represents an interesting an promising approach for linking off-grid and grid-connected renewable energy support.

In line with the basic policy principles of the World Future Council, renewable energies can contribute to a large number of political objectives, such as poverty eradication, a sustainable use of resources, the protection of human health and the eco-system and public participation. The shift from fossil fuels to renewable energies across Africa also has the potential of boosting the achievement of all eight UN Millennium Development Goals.

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