Regional Centre for Renewable Energy and Energy Efficiency
Centre Régional pour les Energies Renouvelables et l'Efficacité Energétique
Centro Regional para Energias Renováveis e Eficiência Energética
www.ecreee.org

ECREEE Training Manual on Energy Policy and Incentive Schemes Schemes

iED
Innovation
Energie
Développement

Client ECREEE

Consultant
IED Innovation Energie Développement
2 chemin de la Chauderaie
69340 Francheville, France
Tel : +33 (0)4 72 59 13 20
Fax : +33 (0)4 72 59 13 39

Site web : www.ied-sa.fr

	VERSION 1	VERSION 2	VERSION 3
Date	03/04/2012		
Rédaction	JPL / PA		
Relecture			
Validation			

TABLE OF CONTENT

LIST OF TABLES

List of Table

LIST OF FIGURES

LIST OF ABBREVIATIONS

AfDB	African Development bank
AfD	French Development Agency
BOT	Build Operate Transfer
CDM	Clean Development Mechanism
ECOWAS	Economic Community of West African States
ECREEE	Regional Centre for Renewable Energy and Energy Efficiency
EECS	European Energy Certificate System
ERERA	ECOWAS Regional Electricity Regulatory Authority
ESCO	Energy Service Company
EU	European Union
FIT	Feed in Tariffs
IPP	Indipendent Power Producers
MW	Megawatt
MWh	Megawatt-hour
MWp	Megawatt peak
ODA	Official Development Assistance
RE	Renewable Energy
RET	Renewable Energy Technologies
RES	Renewable Energy Sources
PRSP	Poverty Reduction Strategy Papers
PPA	Power Purchase Agreements
REC	renewable energy certificates
RESCO	Rural Energy Services Company
SPP	Small power producer
SWOT	Strengths, Weaknesses, Opportunities, Threats
TWh	Terawatt-hour

UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organization
WAEMU	West African Economic and Monetary Union
WAPP	West African Power Pool
WB	World Bank

1 RE Policy, Planning and Regulatory Principles

1.1 RE concerns and energy policies in the ECOWAS

One of the main conclusions of the Earth Summit held in Johannesburg in 2003 was that energy was the forgotten MDGs. Many initiatives have been launched in order to mainstream energy in the national development agenda. At the same time, the different poverty reduction strategy documents became a reference for the multi and in particular bilateral donors.

Therefore the ECOWAS energy directorate in close cooperation with the WAEMU’s has issued a regional energy policy, called the Regional White Book, aiming at promoting modern energy access to the rural poor with obligation for the members states to develop a national policy and to secure that the objectives and targets of this new policy will be adopted by the national Poverty Reduction Strategy Papers (PRSP) document in order to secure its financing.

Renewable energies are not directly included as a target for the White Book. But it is expected as indicator 10 related to the achievement of the MDGs that : *‘At least 20% of new investments in electricity generation will be driven by local and renewable resources, including hydro-electricity, in order to achieve energy self-sufficiency, reduced vulnerability and sustainable environmental development in keeping the regional plan’.*

As the investment in RET are from twice to three time the investment in convention power supply, this indicator should lead to a RE penetration ranging from 7 to 10 %.

1.2 RE and the Regional/national white Book

In the table below, the tentative status is done, showing the level of implementation of the regional White Book and how energy access and particularly renewable energy are written in the PRSP documents.

Table 1 : Renewable Energy position in the PRSP documents

Access to modern enery	Benin	Burkina Faso	Cape Verde	Ghana	Guinea	Guinea-Bissau	Ivory Coast	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	The Gambia	Togo
Mention in PRSP		▨	🟩	🟩	🟩		▨	🟩	🟩	▨	🟩	🟩		🟩	
Nat. white book	▨	🟩	na	🟩	🟩	nil	na	🟩	▨	🟩	▨	▨	2012	2011	nil

🟩 Yes

▨ To some extent

☐ No or not available

Five countries have developed a strategic white paper for access to modern energy, following the regional guide line (Burkina Faso, Ghana, Guinea, Liberia and Niger). This exercise can be deemed as positive as many countries have been in position to interact positively with the national reference policy (PRSP) to modify significantly their energy institutional and regulatory framework and to mobilise financial means to implement their strategy.

Other country like Mali, Senegal have developed adequate tools and policies which have had similar results, i.e. mainstreaming of energy access and uses of renewable energy into the main reference policy documents, becoming part of the president programme (Senegal).

At that time Nigeria was developing its Renewable Energy Master Plan and creating an Agency for rural electrification (2006). In Benin, a study on 'Renewable Energy for Sustainable Development' has been elaborated in 2010 financed by the UNDP.

Few countries have not started or will start this policy exercise. It is the case of Guinea-Bissau and Togo which have not started and Sierra Leone and The Gambia which are now in the elaboration process.

1.3 Targets for Renewable Energy penetration

A summary of the targets to be reached in terms of RE penetration is given in the table below:

Table 2 : Targets for Renewable Energy penetration

Targets for RE penetration	*Benin*	*Burkina Faso*	*Cape Verde*	*Ghana*	*Guinea*	*Guinea-Bissau*	*Ivory Coast*	*Liberia*	*Mali*	*Niger*	*Nigeria*	*Senegal*	*Sierra Leone*	*The Gambia*	*Togo*
Medium term	2015		2010		2013		2015	2015	2010	2010	2020				
Targets	13.5%	nil	27%		2->6%	nil	5%	10%	6%	10%	15%		nil	nil	nil
Long term	2025		2030	2020	2019				2015		2030	2020			
Targets	14.4%	nil	50%	10%	8-25%	nil			25%		23-36	15%	nil	nil	nil

There are five countries that have not yet defined clear targets for the RE: Burkina Faso, Sierra Leone, Togo and The Gambia, although they are actively developing RE projects, like Burkina Faso (PV and biofuels), Togo (wind) and Sierra Leone (mini hydro) and the Gambia (wind and biofuels).

The RE champion is obviously Cape Verde seeking a penetration of 50% of RE in its power production, developing presently off-shore wind farms to reach its objectives. The target of 25% wind power and 2% solar electricity in 2011 was close to being fulfilled.

Nigeria is the next country having high targets for RE, followed by Mali, Guinea, Senegal and Ghana.

In average, the national targets lead to 14% penetration rate of 14% in 2020 and 20% in 2030. But the rate reflects in large extend this of Nigeria (15/25%). Without Nigeria the RE penetration rate remains at 11% level.

1.4 RE in the policy documents

Table 3 : Renewable Energy in policy documents

RE and Policy Documents	Benin	Burkina Faso	Cape Verde	Ghana	Guinea	Guinea-Bissau	Ivory Coast	Liberia	Mali	Niger	Nigeria	Senegal	Sierra Leone	The Gambia	Togo
RE /Energy Policy	▨	▨	🟩	🟩	🟩	▨		na	🟩	▨	🟩		🟩	🟩	
RE / Electricity bill				🟩					🟩			🟩	na	🟩	
Specific RE Policy			🟩	🟩				🟩			🟩	🟩			
Specific RE law			🟩									🟩			

🟩 Yes

▨ To some extent

☐ No or not available

In general, the focus of national policies of ECOWAS countries remains on conventional sources of electric power in a context of latent energy crisis due to the lack of capacity investments in a context of sector reform and increasing oil prices. However, the framework varies among the countries and becomes more differentiated in favour to RE during the period 2006-2011:

- There is one country that has CV has made of RE a priority for the development of the country. A strategy and action plan is approved with target for RE: "Cabo Verde 50% Renovavel em 2020": the objective is to attend 50% of RE penetration rate of the electricity production by 2020. The new approved legislative Decree No. 1/2011, establishes provisions for the promotion, incentives and access, licensing and exploration on the exercise of independent production activities and self-generation of electricity from renewable energy sources. It has to be noted that Cape Verde develop an operational approach with quite operational tool (DECRETO-LEI – PROMOÇÃO E INCENTIVO À PRODUÇÃO E USO DAS ENERGIAS RENOVÁVEIS 2010)The differences in the geographical and economical context make of Cap Verde an exception.

- A second group is composed by the countries that are currently making an effort to put RE high on the agenda: Senegal, Ghana, Mali, Liberia, Guinea, and Nigeria have a detailed RE policy at national/ Presidential level. However, only Ghana the Renewable Energy Bill is before Parliament and Senegal who has already adopted a law on RE seems to have a mature regulatory framework for RE development. Nigeria's regulator (NERC) is developing a regulatory framework for promoting renewable energy based power in Nigeria too.

- A third group is composed by countries where RE is not the focus, but is just mentioned as diversification of energy mix in order to reduce fuel dependence or increase access to modern energy services in rural areas. These countries are generally struggling with a recurrent lack of power capacity and are unfortunately quite focussed on the development of their conventional power system.

- We should add that also in the countries where a RE policy is adopted, the financial resources often do not correspond to the ambitious target set. As for example countries with high potential on hydro resources.
- Also, in many of the countries development of RE is hindered by lack of global planning that include them in a comprehensive strategy and allocation of financial means to implement it. The proper technical capacity is often lacking for RETs. Rural electrification is too often conceived as a natural grid based extension of the national electrification plan, giving little room for least cost mini-grid and stand-alone solutions powered by RE.
- Subsidies to conventional fuel hinder the development of RE, as constituting hidden costs into the electricity tariffs structure. Currently countries as Ghana have cut subsidies.

1.5 Forces and peculiarities for RE

- RE are often least cost solutions for rural areas, but in many case RE are in competition with uneconomic grid-based electricity where the hidden over-costs are paid by all the consumers as consequences of cross-subsidizing principles applied.
- They are very close to least cost solutions for grid connected production when the base-line is diesel power generation, particularly for biomass and hydro. For solar PV plants some incentives are required.

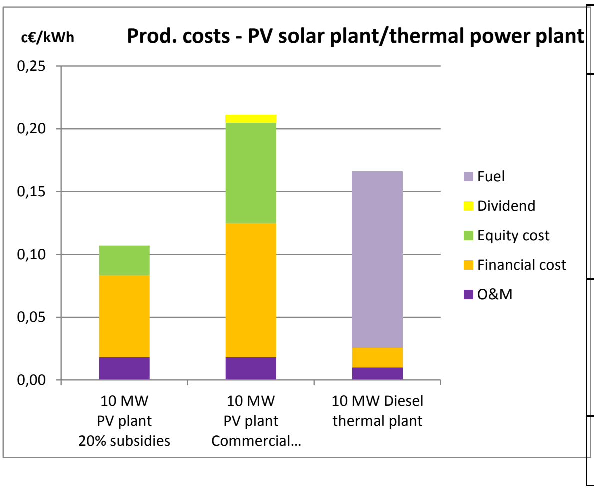


Table 1: Financial assumptions

Investment: 30 millions €	Equity	Grant	Interest rate loan	Equity remune-ration
Private developer	35%	0%	8%	15%
Public plant	20%	20%	3,5%	2,5%

Figure 1: Cost comparison PV versus Diesel

The figure simulates the resulting production costs for 10 MW PV plant compared to a 10 MW diesel plant with to different financing engineering as shown in the table. Based on soft commercial conditions (8% , 15 years repayment period), the private developed PV plant cannot compete with a reference diesel plant (0,611 €/l of fueloil). With a 20% grant and softer financial conditions (ODA conditions with longer repayment period) it is possible to lower the production to a level where it becomes competitive with a subsidized diesel power generation.

- Intermittency for wind and solar energy is a reality as generally energy storage is expensive. However the over-cost tied to stand-alone systems is estimated to 2-3 c€/kWh[1]

1.6 Technical options

Two large families:

- grid connected options to generated power to the grid or mini grids and
- the stand-alone applications that can produce either electricity or heat

1.6.1 Grid connected options

- Large and medium sized hydro. The average investments costs for large hydro plants is about 1 million Euro per MW, with generally a quite low production marginal cost at 3-4 c€/kWh.. The demarcation between large and medium sized hydro potential is generally fixed at 10 MW. But within the ECOWAS system the limit is raised to 30 MW. Investment cost for medium sized hydro is about 3,8 million € for all hydro plants analysed by the regional programmes. In West Africa the average costs of the hydro plants larger than 30 MW are estimated to 2,6 M€/MW. But all cases are specific depending on the inflow, the geography and the type of the water head.

- Wind farms. Wind energy is converted to power through wind turbines which unit capacity can reach up to date 5 MW. For logistical and practical reasons, the largest turbines installed in WA have a unit capacity of 850 kW. The overall cost inclusive erection and upstart is about 2,0 €/MW which is quite expensive compared with European or American benchmark of 1,1 to 1,3 M€/MW depending on the size of the machine (2 MW -1 MW)

- Biomass plants. For solid biomass, the plant consists in a boiler producing steam at a certain pressure (25-50 bars) and steam turbine for electricity production. The boiler can be built as a grate furnace with stocker/burner for the smaller capacity plant (5-10 MWe) or as fluid bed plant for larger capacity (50-100 MWe). The turbine can be of back pressure type to get the maximum power production or with steam outlets enabling cogeneration and use of heat water or law pressure steam to industrial processes. The investments costs of the technology are about 2,5 M€/MW for capacity larger than 50 MWe and almost the double for smaller capacity.

- Large biogas plants for slurry, slam and wet biomass (dump, manure ect) are available. The investment costs of anaerobic digestors with gas-engines for CHP are in the range of 3,000 to 5,000 €/kW.

- Large solar farms connected to the grid. Depending on the size of the farm a 33 kV or often en 90 kV line will be require to evacuate the power produced. The general benchmark for this type of equipment is about 2,7 M€/MWp, but recent projects in Mali and Burkina Faso show that the cost is closer to 3 M€/MWp, the connection cost to the grid are not included in the price. It is expected a cost reduction in an order of magnitude of 50% up to 2020.

---

[1] IED – Etude de cadrage du solaire photovoltaïque au Burkina Faso.

- Concentrating Solar Plants are winning in as thermal technology to exploit solar resources to power production. The first thermal solar plants had been built in the late seventies as an answer to the first energy crisis. The new technology develop more efficient fluids to transport the solar energy that is concentrated on a special coated glass pipe to an heat storage end en heat exchanger that convert the high temperature heat to steam. The remaining of the plant is a traditional steam turbine plants. Currently, all parabolic trough plants (US terminology) are "hybrids," meaning they use fossil fuels to supplement the solar output during periods of low solar radiation. Typically, a natural gas-fired heat or a gas steam boiler/reheater is used. Troughs also can be integrated with existing coal-fired. CSP cost is still high and needs financial incentives to face the market. The International Energy Agency (IEA) estimates a current investment cost for Parabolic Trough plants between 3000€/kW and 6300€/kW (depending on local conditions, solar irradiance and – not least – the maturity of the project, i.e. pilot, demonstration, commercial) and projects cost decline by up to 50% in 2020 due to a larger industrial production of CSP components. The Global CSP Outlook (Estela-Greenpeace, 2009) envisages steady declining investment costs from a today's level of 3700€/kW (2010) to 2500€/kW by 2030 plants.

1.6.2 Suitable RE technologies for mini-grid :

- Diesel generator sets with bi-carburation devices, enabling the use of vegetal oil as jatropha raw filtered oil. In some case the piston can be modified to ensure en better combustion of jatropha oil. The technology is the same than the diesel gensets. The extra costs are tied to the fact than an additional oil tank is necessary for the jatropha oil as the motor has be started and stopped on gasoil.

- Solar PV plants with three phase inverters and a battery storage capacity for the night consumption. The cost remains still high about 8 to10 € the Watt-peak installed. Hybrid system can reduce the cost of investment as the combination of solar PV production and diesel generation enables the down-sizing of the storage capacity. The cost for hybrid solar system with storage is about 6-7 M€/MWp (Mali) for the solar plant. Hybrid systems without storage are also experimented at a lower costs (4 M€/MWp) when the solar production is designed to cut the diesel production when the system is full loaded. For full load to 60% load the gasoil consumption is more or less proportional to the load, and the solar power injection is totally turn into gasoil saving. At low load (< 30%) the diesel motor is inefficient and has the same consumption independently of the load and the solar injection becomes useless.

- Shredded solid or loose biomass like shells and husks can be used in gasifiers to produce CO gas to supply gas motors or dual fuel motors. The size of this technology ranges from scale (30-200 kWe) well developed and used in the South-Eastern Asia and India where the technology is fully developed. Larger application are in development with capacity up to 1 to 1,5 MW (South Africa). For smaller technologies the price for the system including gas cleaning and motor ranges from 1,1 to 1,3 M€/MW and can produce at a price of 150/210 €/MWh.

1.6.3 Stand-alone technologies:

- Small wind turbine for battery charging in a range of 10-20 W to few kW.
- PV panels with battery and charge controller in a range of few W to charge solar lamps to few kW for institutions. Generally in the range of 30 to 100 W for households application. The present cost is about 6-8 €/Wc. Systems are becoming more cost effective due to the uses of LED lamps reducing the size of the panel.
- Solar water heaters producing hot domestic water are alternative to electrical water heater (1 to 2 kW electrical thermal patrons). Generally the cost remains high in regards to the electrical alternative (for 400 to 1000 € in regards to a 150-200 € for the electrical heater). The savings can be in the range of 60 to 115 €/year depending on the size of the heater and the level of tariff. The period of return is comprised between 7 to 10 years. Application for preheating process water up to 60-70 ^{o}C can also be considered.
- Solar dryers to be used in agro-processes (fruits, meat, steamed products) Extensive researches have been carried out in many West-African research centres (Niger, Ghana, Bamako) but generally the cost remains too high and drying processes are not always totally controlled by the users (air flow, temperature and moisture).
- Household biogas production for cooking and lighting and cooling energy. The digester is an underground tank built with bricks that needs to be airtight as the methane production occurs anaerobic. It has an inlet and outlet shaft for the fresh and the outgassed slurry. The gas needs to be purified before uses. The cost of a household biogas digester is about 85 €/m^{3} of tank, and the general size is between 3 to 6 m^{3}.
- Solar cookers for households. There are two different types of solar cookers, the first one is a solar oven (isolated plywood box covered with glass and with an adjustable mirror enabling some additional indirect exposition). Its price is around 30-45 € depending on the size. Food preparation can be started on traditional stoves. The second type is the parabolic concentrating one where the solar irradiation is concentrated on the cooking pots placed in the focal point. The price of this type of cookers is high about 110-135 €. Larger models can be developed for community kitchens (schools, barracks and hospitals) as combined wood and solar stoves.

1.7 Assessed barriers for RE

- Policy and regulatory barriers
  - The focus of national policy has until recently been on centralized conventional sources for electrical power. Incentives were established to promote investments in conventional power generation and subsidies in the conventional sector have been detrimental to promote RE power generation. The monopoly position of national utilities has not been in favour for RE and decentralised solutions, as non-discriminatory open access to the national electricity grid for renewable energy is not assured
  - There is generally little attention to RE in the national energy policy and a weak or no integration of RE in energy planning and in local development policies.

  - The absence of a full-fledged rural electrification strategy with a clear demarcation between grid and off-grid electrification leads to undefined or unquoted RE options for the off-grid electrification. Grid extension is done without much economic justification as it is considered as a structuring element of the local development. To a certain extend is true. But beyond a certain limit that is almost never assessed the cost of grid extension is often uneconomic at least for a certain period of time during which the served load is too weak to justify the investment. But generally the grid extension is realised for political reasons (social equity, administrative centres shall be supply by the grid, local influent people, etc). In that case RE solutions can never appear as least coast when the over-cost for a political decision becomes a hidden cost paid by all the consumers. Again, it is important to stress that grid-based supply will be over time the solution, but untimely and anticipated investment in grid extension freezes large amount of means that could be used for more productive and development-minded investment.

- Financing and investment barriers
  - The high upfront cost and the fact that RE are practically new technologies in WA increase the financial risk perception for the banking system and the investors. As long as there is a lack of regulation for RE applications this perception will last.
  - Technological barriers and weakness of the present RE market in WA lead to over-cost for acquisition of equipment / spare part supply / maintenance / services.
- Lack of conceptual capacity
  - There are few or none competent designers and operators of RE applications, leading to poor result and failure.
- Poor public awareness
- Poor or absence standards and quality control
- Inadequate resource assessment (Hydro – wind - biomass)
- Intermittency of resource availability
  - As long as national and regional networks are not well functioning and reliable, the penetration rate for intermittent RE sources will meet some technical barriers.

2 RE policy/master plan strategy

2.1 Policy – strategy

2.1.1 Assess the national RE resources

- **Solar**. Assessment of solar resources is generally not a problem, at least to get an order of magnitude of the resources. The online calculator 'PVGIS estimates of solar electricity generation' developed by the Joined Research Centre of the European Commission. (http://re.jrc.ec.europa.eu/pvgis/imaps/index.htm). The calculator gives you following information:

  - Average daily electricity production from the given system (kWh)
  - Average monthly electricity production from the given system (kWh)
  - Average daily sum of global irradiation per square meter received by the modules of the given system (kWh/m2)
  - Average sum of global irradiation per square meter received by the modules of the given system (kWh/m2)

The database used for the calculation is the PVGISHelioClim, giving more conservative values.

For CSP technologies, the normal direct irradiation (DNI in kWh / m ²/y) is an essential criterion to define the potential of sites. Consequently, in the region of interest, 4 ranges of DNI were defined:

- not suitable < 2.000 kWh / m2
- Acceptable 2.001 - 2.200 kWh / m2
- Well 2.201 - 2.600 kWh / m2
- Excellent>2.600kWh/m2

This range is specific to the region and is defined on the basis of the available DNI data for the region.

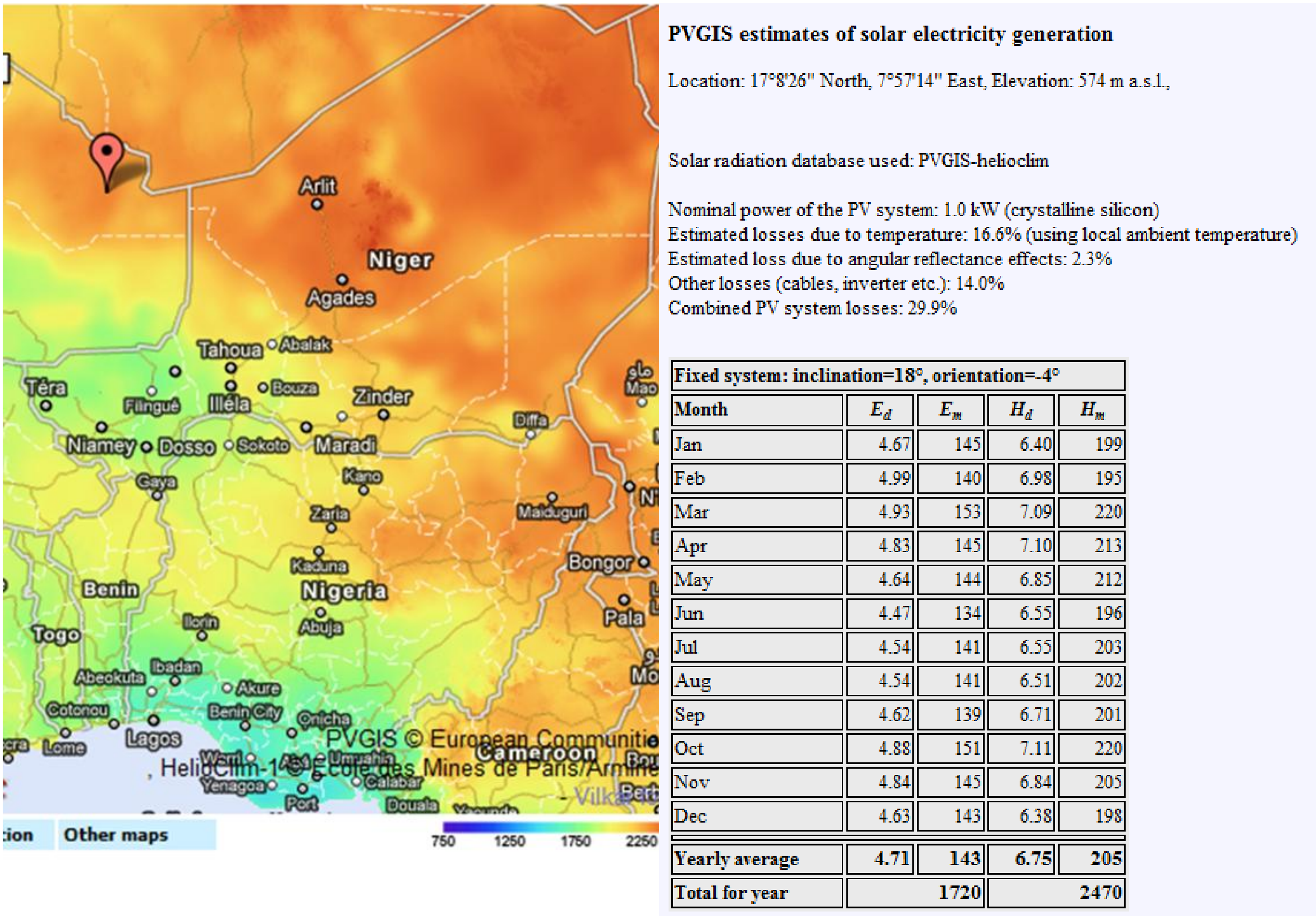
Another key parameter is the latitude which influences the losses of unit. The considered latitudes are 15 °, 20 ° and 25 °. The latitudes less than 10 ° are not considered because they are classified as "not suitable" in the range of DNI.

As an illustration, the map of Niger and Nigeria gives a good picture of the solar potentials. The highest irradiation is in the North (Niger and Mali) and in the Western part of Nigeria with an irradiation than is greater than 2300 kWh/m2/year.

In the South the potential is quite weaker with an average irradiation of 1500 kWh/m2/year. This situation is typical for a large part of Ghana and Cote d'Ivoire. The other countries benefit of an average irradiation around 2000-2100 kWh/m2/year.

In terms of energy the online calculator gives the following energy production for 1 kWp installed.

The energy production is given monthly as illustrated in the table (Screen picture of the calculator).



PVGIS estimates of solar electricity generation

Location: 17°8'26" North, 7°57'14" East, Elevation: 574 m a.s.l.,

Solar radiation database used: PVGIS-helioclim

Nominal power of the PV system: 1.0 kW (crystalline silicon)
Estimated losses due to temperature: 16.6% (using local ambient temperature)
Estimated loss due to angular reflectance effects: 2.3%
Other losses (cables, inverter etc.): 14.0%
Combined PV system losses: 29.9%

Fixed system: inclination=18°, orientation=-4°				
Month	E_d	E_m	H_d	H_m
Jan	4.67	145	6.40	199
Feb	4.99	140	6.98	195
Mar	4.93	153	7.09	220
Apr	4.83	145	7.10	213
May	4.64	144	6.85	212
Jun	4.47	134	6.55	196
Jul	4.54	141	6.55	203
Aug	4.54	141	6.51	202
Sep	4.62	139	6.71	201
Oct	4.88	151	7.11	220
Nov	4.84	145	6.84	205
Dec	4.63	143	6.38	198
Yearly average	**4.71**	**143**	**6.75**	**205**
Total for year	**1720**		**2470**	

	Fixed mounted equipment		Tracking system	
1 kWp installed	kWh/year	No hours/year	kWh/year	No hours/year
Best location	1730	2470	2295	3275
Average	1490	2060	1815	2510
Worst	1110	1540	1330	1840

For the best location an average production of 1750 kWh/year per kWh installed can be expected on fixed mounted equipment. Tracking system enabling the PV panel to follow the sun path gives a better use of the resources but are not recommended as vulnerable in a Sahelian environment.

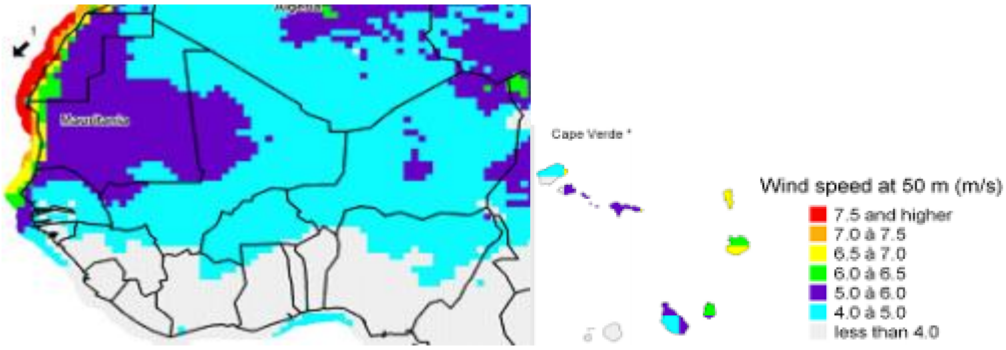
The propitious potentials are valid for the northern parts of Mali, the most of Niger except the western part and the north-eastern part of Nigeria.

The lowest potentials are located alongside the coasts from Nigeria to Liberia and on each side of the border between Ghana and Cote d'Ivoire. It is comprised between 1100 to 1200 kWh/kWp installed.

For the remaining areas and countries the potential is around 1450 kWh/kWp installed.

Wind (Wind atlas just gives indication. Local wind surveys and campaign measures is requested lasting a 6 months to one year period. Data are automatically recorded on a data logger, and have to be computed on specialised wind programmes to give a sufficient and solid background for a decision maker. Generally the atlas will give sufficient indications to take a decision on potential locations, where surveys have to be carried out. It is recommended to use the expertise from experimented companies as the local conditions play also an central role (landscape, relief, vegetation, building).

Figure 2 : Wind study for West Africa



Source: Canadian International Development Agency

A Strategic Study of Wind Energy Deployment in Africa has been financed by the AfDB and the Canadian International Development Agency (CIDA) in 2004. In West Africa two countries have been identified for having the best wind potentials: Cape Verde and Mauritania. The synthesis map shows clearly that the coastal countries alongside the Gulf of Guinea have poor wind resources (Average speed < 4.0 m/s)

The potential become interesting in terms of power generation alongside the coast of Senegal and the Gambia with wind speed close to 6,5 to 7 m/s.

There are some potential around 5 to 6 m/s north for Tumbuktu in Mali and in Niger. A detailed wind assessment is carried out for the Malian potentials by the Risø laboratory and the preliminary result seem to confirm that the potential is at the margin of what will be require for developing a fully commercial use of wind energy on large wind turbines. For commercial application of large wind turbines, the required average wind speed has to be higher than 6 m/s. And the production will depend also on the regularity of the wind. Generally off-shore wind turbine can produce about 50% to 70% more energy and a land-based turbine. Experience from Denmark shows that for a favourable location a wind turbine can produce up what correspond to 1700-2000 hours operation at its nominal effect. For offshore wind farm the production is about 2800 to 3500 hours of the installed capacity. In Cape Verde the wind regime is particularly favourable with an average yearly production corresponding to 4.000 hours operation at installed effect.

Biomass. Planning with biomass resources required detailed investigations as investments in biomass RET are high, especially if a cogeneration technology is sought for both power and process heat/low pressure steam. (questionnaire addressed to agro-industries producing agricultural wastes – oil mills – coffee plantations – rice production and so on)

General assessments of agricultural biomass residues or by-products based on a statical treatment of crop or animal productions give just a general indication of the potential but cannot be used for planning purposes. A lot of this potential is already used for different purposes like construction materials, feeding stuff for cattle and fish pounds (rice husks in Niger) and cooking fuel. Generally the logistic and transport cost are a huge barrier to the utilization of this type of biomass. For decentralised uses as for instance power local production, a specific detailed assessment is recommended with a special focus on the increasing unpredictability of the seasons especially for the Sahelian countries.

Generally the assessments and surveys have to target specific areas with concentrated crops production like rice (Office du Niger au Mali) or cotton areas or agroindustry like oil mills or fruit juice processing factories. Within milk and meat production, large dairies and slaughterhouses are also potential locations for medium to large scale biogas production and cogeneration. Traditional agro-industries like sugar plants, rice husking mills and oil mills have in the past produced their own energy based on bagasse, rice husks and groundnuts shells until it became easier and cheaper to use oil.

Hydro. The hydro resources considered by the RREP are medium sized and mini hydro. It is assumed that all large hydro potential are already included in the WAPP power capacity basket (7.083 MW). Further 5.670 MW have been identified in 2010 by the UNIDO during a conference of hydropower in Vienna. Generally most of the sites recorded by UNIDO have been identified or surveyed in the past. Unfortunately data are not always reliable in terms of inflows as practically no follow-up has been carried out since the mid-80ies and are often scattered between several entities. It is recommended to compile all existing data in one office in order to identify the sites that could be suitable for carrying out complementary surveys as data records are incomplete and not up-to-date, in order to provide more solid and consistent data that can constitute the basis for feasibility study.

Table 4 : Overview of re potentials in the Ecowas Countries

	Wind	PV	Mini-hydro	Biomass
BENIN	⬜	🟨	🟫	🟨
BURKINA FASO	⬜	🟫	🟨	🟨
CAPE VERDE	🟫	🟨	⬜	⬜
COTE D'IVOIRE	⬜	🟨	🟧	🟧
GAMBIE	🟧	🟧	⬜	🟨
GHANA	🟨	🟨	🟧	🟧
GUINEE	⬜	🟨	🟧	🟧
GUINEE BISSAU	⬜	🟨	🟧	🟧
LIBERIA	⬜	🟨	🟧	🟧
MALI	🟨	🟧	🟨	🟧
NIGER	⬜	🟫	⬜	🟨
NIGERIA	🟨	🟧	🟧	🟧
SENEGAL	🟧	🟧	⬜	🟧
SIERRA LEONE	⬜	🟨	🟫	🟧
TOGO	⬜	🟨	🟧	🟧
Mines	⬜	🟨	🟧	⬜

White : Nil or very small
Yellow : Satisfactory/acceptable
Orange: Good
Brown: Favourable

2.1.2 Assess feasible RE targets based on available RE resources.

In the UNEP report 'Financing renewable energy in developing countries' (2012), only two types of public intervention are considered, by a majority of survey respondents, to be "most powerful" in unlocking private investment and finance for renewable energy in developing countries:

- the establishment of clear national targets for renewable energy generation and
- the introduction of feed-in tariffs.

Therefore it is of first importance to demonstrate at the national policy level a strong commitment by developing a national RE policy with quantified and achievable targets. The RE targets have to be SMART:

- **S as specific**: for example a biomass target expressed through as single figure (100.000 ktoe) is not specific enough for potential projects developers to get interested by this type of information. In the opposite, if your target is specific, for instance 90.000 t of woody wastes available in a given location with a solid documented data background, a RE developer or boiler/steam turbine manufacturer will know that a 30 MW biomass thermal plant can be a solution to achieve this target and will investigate where there is a suitable grid access for this production (at least 90 kV)
- **M for measurable**, bodying the RE policy. For example, countries endowed with good solar potentials should be stated in MW installed capacity connected to the grid at different

horizons and the potentials in MW installed for stand-alone systems (SHS-community systems, smaller power plants to supply mini-grid)

- **A for attainable or achievable**. The target might remain realistic in regards to certain constraints or barriers. As for example, the overall wind energy penetration will depend on the quality of the national grid. And as long the overall synchronization of the WAPP electrical zone is not completed, the penetration ceiling will be limited to 20% of the minimum peak load on the national grid, a ceiling evolving over time. The same remark is valid for large PV plant. A 40 MW PV plant target will not be achievable now for a country having a minimum peak load of 100 MW, but will be achievable in seven years with a demand growth of 10%.

- **R for relevant**. As the conditions for financing RE are presently uphill it is important to remain focused on what is really relevant, on what really matters. For instance, wind energy seems very popular in many countries like Mali, Niger, Ghana and even in Burkina Faso. For some countries like Burkina Faso, the potential has to be demonstrated. For other countries, it will require some additional heavy investments in HV transmission line to bring the wind generated power to the main consumption areas.

- **T for time-bound**. The fifth term stresses the importance of grounding goals within a time frame, giving them a target date. A commitment to a deadline helps a ministry or an agency to focus their efforts on completion of the goal on or before the due date.

2.1.3 Set Targets for RE penetration

These targets should cover the following energy fields:

- **Power Generation**, for large grid connected applications, keeping in mind some technical barriers for solar and wind energy, and the logistics and the availability of the resources for biomass. Many country will face the dilemma between investing in short term diesel based solution waiting for the regional grid of for the completion of the large hydro power programme and some much more sustainable but more capital intensive solutions based on RE sources.

- **Off grid electrification target**, as RE solution for powering mini grids or as stand-alone solution. These targets will depend on the methodology applied to the rural electrification planning. A least cost planning including RE options as mini-grid and stand-alone solutions based on a GIS based planning tool will enable the decision maker to draw a boundary among the grid based electrification and the off grid RE based electrification domain. Even though this exercise is carried out, political viewpoints or decisions are sapping the rationale of these plans as for example all administrative centres have to be supplied by the national grid, or SHS is not providing the real service, even though the same consumer will use the grid connection for lighting and entertainment.

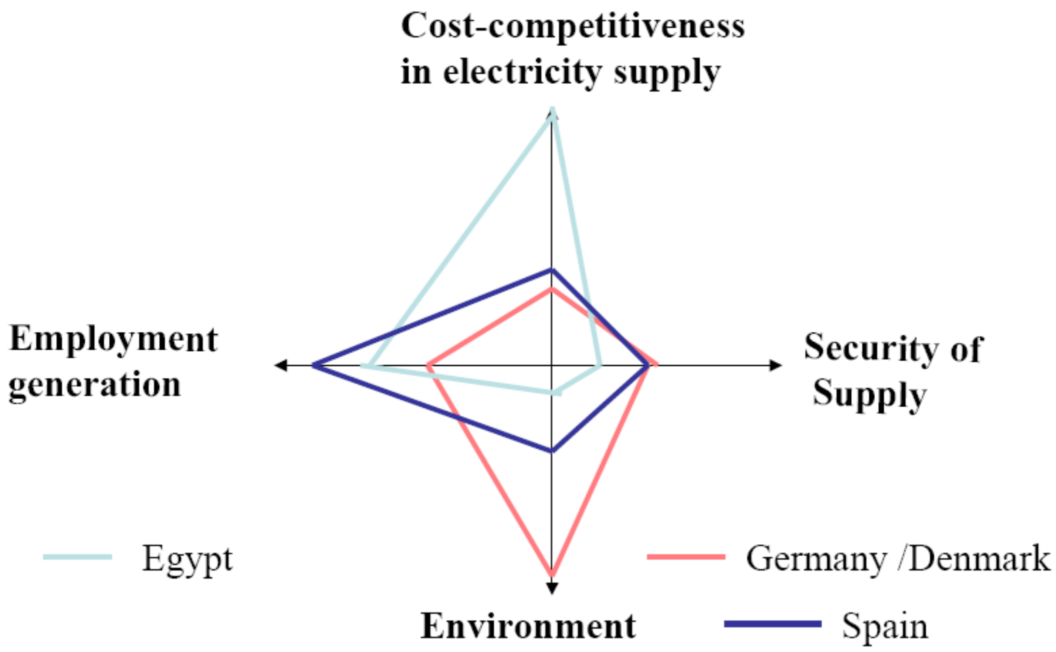
- **Energy Efficiency targets** have to be set in order to enable more access for the same amount of energy and somehow avoid additional capacity extension and give more room for smarter RE supply solution

- Finally targets should be set for **sustainable wood-fuel production**, for efficient use of this resource, for modern RE and LPG substitution strategy where is possible.

2.2 The key role of a strong RE sector support

In number of industrialized countries, renewable energy sources receive greater support from the governments. The production costs based on conventional sources are however generally lower but the justifications given are mainly the environmental advantages, the contribution to energy supply security and independence and the creation of jobs and exports opportunities they provide.

Figure 3 : Motivations Matrix of policy support for renewable energy



Source: Mostert W. : Danish Conference on Renewable Energy Sønderborg, (2003)

Developing countries without fossil energy resources, can also find in developing RE an economic goal, due to the high electricity production costs based on centralised plants supply the national grid and even more for decentralised off-grid power generation..

Indeed, it appears that within the ECOWAS, about 2/3 of the ECOWAS member states have neither oil nor gas, and bear some of the highest power production costs. More worryingly, the prospects for production cost trends according to a business as usual scenario, are not favourable. Therefore, regional projects like WAPP and IRED develop centralised regional solutions based on the development and the sharing large gas-based and hydro plants through the construction of a regional HV transmission grid. Considering the magnitude of these regional power infrastructure programmes, the present global financial crisis and the generally time-consuming implementation process for large hydro-plants and HV power lines, medium-sized and small RE solutions should be selected during the regional projects' implementation phase to secure the needs for power on the national grids and to support and promote the energy access policies for powering and empowering the rural areas.

The emergence of the renewable energy sectors in the ECOWAS thus addresses both an economic and environmental issue. The justification for firmly supporting these sectors cannot be simply perceived as a solidarity effort towards the coming generations, but also as a response to the immediate socio-economic requirements.

The renewable energy sectors are currently booming; however, these technologies are sometimes immature or have not reached a sufficient level of technological and/or economic performance. Depending on the energy position of the country, the renewable energy sources are not always able to compete directly with existing technologies that already benefit from series and learning effects. But the continuation of the dynamics of technical progress which has been under way for several years may enable them to compete with fossil fuels for grid electricity production. This is already the case, in many off-grid contexts, including replacement of small diesel with high operating costs by locally available renewable sources solutions.

By creating favorable frameworks for the adoption of renewable energy by electricity producers, the process of market opening aims to stimulate the technological change and the learning processes within energy policies allowing to a decrease in the costs up to the economic competitiveness level[2].

- **price-based approach** with the purchase obligation system imposed on electricity companies at guaranteed prices,
- **quantity-based approach** when the public authorities set a goal to be reached through competitive biddings, or by setting mandatory quotas to the electricity distribution utilities and organizing the RE electricity market through green certificates exchanges.

The development and consolidation of the renewable energy market assumes that governments intervene in its emerging phase to protect it from coarse competition with conventional technologies. Without this intervention, the market forces alone would only lead to a limited diffusion of renewable energies on a few niche markets. Dissemination would be insufficient to enable them to benefit from the dynamic learning process effects and to change the competitiveness conditions to their advantage.

2.3 A choice of instruments backed by a theoretical framework

Governments will face the choice between different families of instruments, those playing on prices – controlled purchase tariff - and those playing on quantities - national targets and competitive bidding, or imposition of quotas and trade of green certificates.

As noticed earlier, the goal of government intervention is very specific: it is to stimulate technical changes and accelerate the learning technology processes to bring renewable energy fully competitive with conventional energy sources, after internalizing of environmental costs. Comparison of instruments must be assessed in connection with the characteristics of innovative processes and conditions for their adoption - uncertainty regarding cost curves, learning dynamics etc.

---

[2] Ph. Menanteau (2001)

We will examine why effectiveness of various incentive schemes for RE development, both from a theoretical standpoint by comparing both approaches based on prices and quantities, and from a practical point of view by referring to the actual experiences of implementing these instruments.

2.4 Feed-in-Tariffs (FIT)

2.4.1 Definition of the theoretical approach

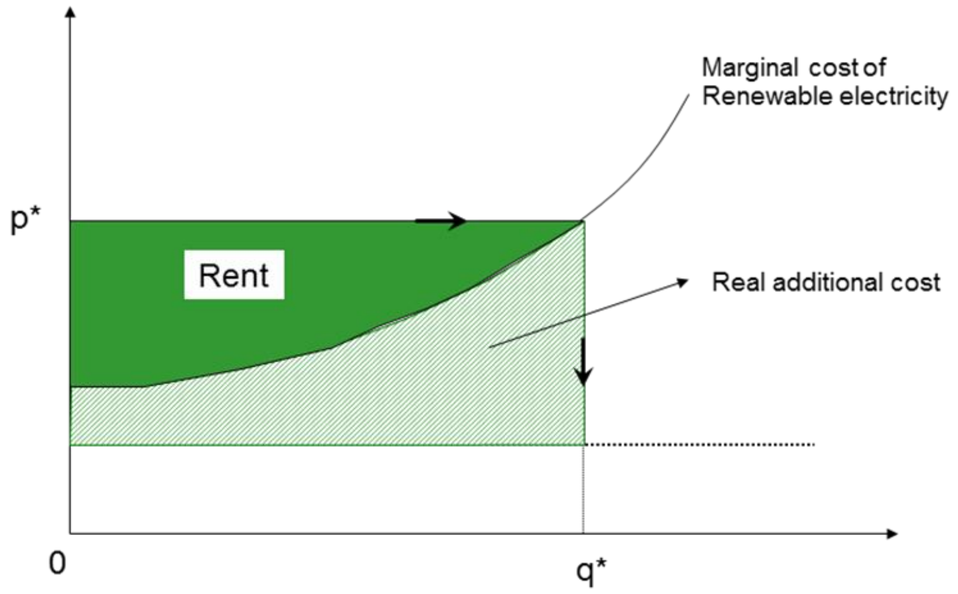
Feed-in-tariff (FIT) is a political mechanism seeking the emergence of private RE electricity generation through the fixation of incentive purchase tariff stimulating the private investments in this sub-sector.

FIT will secure a RE Independent power producers (RE-IPP) developing a power production based on solar PV, wind power, biomass, ... access to a guaranteed market as well as an acceptable return on investments. It includes generally three main measures:

- Guaranteed grid access,
- Long-term contracts for the generated electricity,
- Purchase prices which are calculated on RE generation cost.

This system makes obligation to the utility to buy renewable electricity produced by the RE- IPP on its grid, at a fixed price, decided by public authorities and guaranteed over a certain period. The purchase price calculated on the basis of the generation cost insures the investors their projects profitability and allows at the same time the development of the RE sector on a entrepreneurial basis. These incentive prices may represent generally an additional cost imputable to the consumer (or sometimes to the taxpayer via a solidarity fund or a contribution to the public service).

Figure 4 : Feed-in-Tariff system



The theoretical curve for RE marginal costs covers a panel of RE solutions from the cheapest solution to more expensive technologies (following the merit order principle). By fixing a price at p* level the planner or the regulator expects to mobilise through private investments an electricity quantity q*, that will be generated by the panel of RETs for the cheapest to a RET which marginal production cost is equal to the FIT p*. The total overcost to mobilise private investments corresponds to the cost difference between p*and the reference cost for conventional power generation multiplied by the RE electricity volume q*. The portion of the rectangle below the RE marginal costs curve expresses the reall additional cost (light grey) and the remaining portion (shaded dark grey) is the Guarenteed income paid to the investor. Therefore the fixation of the FIT has to be based on detailed marked analyses for both technologies and financial markets in order to avoid too generous FITs resulting into a quite bigger numbers of projects than planned with additional costs and consumer tariff increase as consequences.

This system is very incentive but does not manage the uncertainties on the quantity launched on the market. The fixation of FITs is a sensitive issue as a rent effect can be expected for producers whose marginal cost is appreciably lower than the guaranteed price. Therefore mechanisms to revise the FITs have be considered in relation the RETs market prices evolution.

2.4.2 Examples of implementation [3]

Among the policies employed by governments, feed-in tariffs (also called premium payments, advanced renewable tariffs, and minimum price standards) remain the most common. By early 2011, at least 61 countries and 26 states/provinces had FITs, more than half of which had been enacted since 2005. In Europe, this system has been firstly presented in the German law in year 2000, then followed by Denmark, Spain and France among others.

Additional costs generated by these purchase tariffs are financed, in the example of France, by a levy 'the Contribution to the Electricity Public Service (CSPE)': a tool for financing of the liberalized market of electricity. The CSPE was established by the law in year 2003.

There are many variations of FITs, and no single definition can be applied. In one variation of a new FIT, the U.S. State of Louisiana's Public Utility Commission announced in 2010 that electric utilities would be required to implement a limited "standard offer tariff" that is undifferentiated by project size, technology, or resource intensity. This type of tariff represents the utility's "avoided cost" of generation plus an "environment" premium fixed at U.S. 3 cents/kWh. The tariff also sets total floor and ceiling prices of 6 cents/kWh and 12 cents/kWh, caps total capacity at 30 MW per utility, and applies to projects between 25 kW and 5 MW. The additional costs are passed on to ratepayers through a fuel adjustment clause, an approach normally used to cover increases in the cost of fossil fuels.

Several of the existing FIT policies around the world are presently under review. In particular, many countries are revising solar PV FITs to dampen the booming rate of installations, which in many cases are far exceeding expectations due to the unprecedented price reductions in solar PV that occurred in 2009 and 2010. In late 2010, the Czech Republic passed new legislation to slow the rate of PV installations as total capacity increased from 65 MW at the end of 2008 to nearly 2 GW by the end of 2010 – in part out of concern for the impact of the FIT on average electricity prices. Effective from March 2011, the country cut all FIT rates for ground-mounted PV installations that were not yet interconnected with the grid. In May 2011, Italy cut tariffs for solar PV by 22–30% for 2011, by 23–

---

[3] Exemples majoritairement tirés de la publication Renewables 2011 Global Status Report (REN21)

45% for 2012, and by 10–45% for 2013 (ranges apply to different scales of installation). A project ceiling of 1 MW on rooftops and 0.2 MW for ground mounted systems was also imposed to limit the total cost to EUR 6–7 billion by the end of 2016, when roughly 23 GW are expected to be installed.

Many other FIT changes took place in 2010. In Spain, the EUR 0.42/kWh FIT level for solar PV, as set in 2007, still remains, but new legislation now caps the annual hours rewarded by the FIT, and some uncertainty arose regarding retroactive cuts to existing systems.

Greece's financial problems led to the government blocking a backlog of project applications for support incentives worth over EUR 2 billion, but the restriction was lifted in September 2010 and new projects continued.

The United Kingdom decided in 2010 to replace its existing quota policy with a FIT, starting in 2013, for "low carbon generation."

Table 5 : FEED in Tariff (FIT) for the UK and Scotland

System size etc	FIT rate
Solar Photovoltaic with total installed capacity of 4kW or less, where installed on a building which is already occupied	21 pence per kilowatt hour
Solar Photovoltaic with total installed capacity of 4kW or less, where installed on a new building before first occupation	21 pence per kilowatt hour
Solar Photovoltaic with total installed capacity greater than 4kW but not exceeding 10kW	16.8 pence per kilowatt hour
Solar Photovoltaic with total installed capacity greater than 10kW but not exceeding 50kW	15.2 pence per kilowatt hour
Solar Photovoltaic with total installed capacity greater than 50kW but not exceeding 250kW	12.9 pence per kilowatt hour
Solar Photovoltaic with total installed capacity greater than 250kW but not exceeding 5MW	8.9 pence per kilowatt hour
Stand-alone (autonomous) solar photovoltaic (not attached to a building and not wired to provide electricity to an occupied building)	8.9 pence per kilowatt hour

Bulgaria, through its new Renewable Energy Act of June 2011, put an annual cap on new projects receiving the FIT prices by applying a quota.

And Turkey enacted a long-awaited renewable energy law that replaces the existing single-rate FIT with technology-specific FIT rates over a 10-year term for wind, geothermal, biomass, biogas, and solar, with bonus payments if hardware components are made in Turkey.

In Africa, Kenya's FIT policy[4] has as its objectives to:

a) facilitate resource mobilization by providing investment security and market stability for investors in Renewable Energy Sources (RES) electricity generation
b) reduce transaction and administrative costs by eliminating the conventional bidding processes, and

---

[4] UNEP www.unep.org > Green Economy > Success Stories > Feed-in tariffs in Kenya

c) encourage private investors to operate the power plant securely and efficiently so as to maximize its returns.

By taking a long-term commitment to the development of renewable sources of energy and stipulating a long-term power purchase agreements of a minimum of 20 years, the Kenya Government has taken a critically important step in the development of the country's significant potential for renewable energy generation, while pursuing equally important economic, environmental and social policy objectives.

In January 2010, Kenya revised the FIT policy, which resulted in the addition of three renewable energy sources: geothermal, biogas, and solar energy resource generated electricity. In addition, the revised policy extended the period of the power purchase agreements from 15 to 20 years and increased the fixed tariffs per kilowatt-hour for pre-existing wind and biomass under the FIT. It is expected that the FIT policy in Kenya could stimulate about 1300 MW of electricity generation capacity.

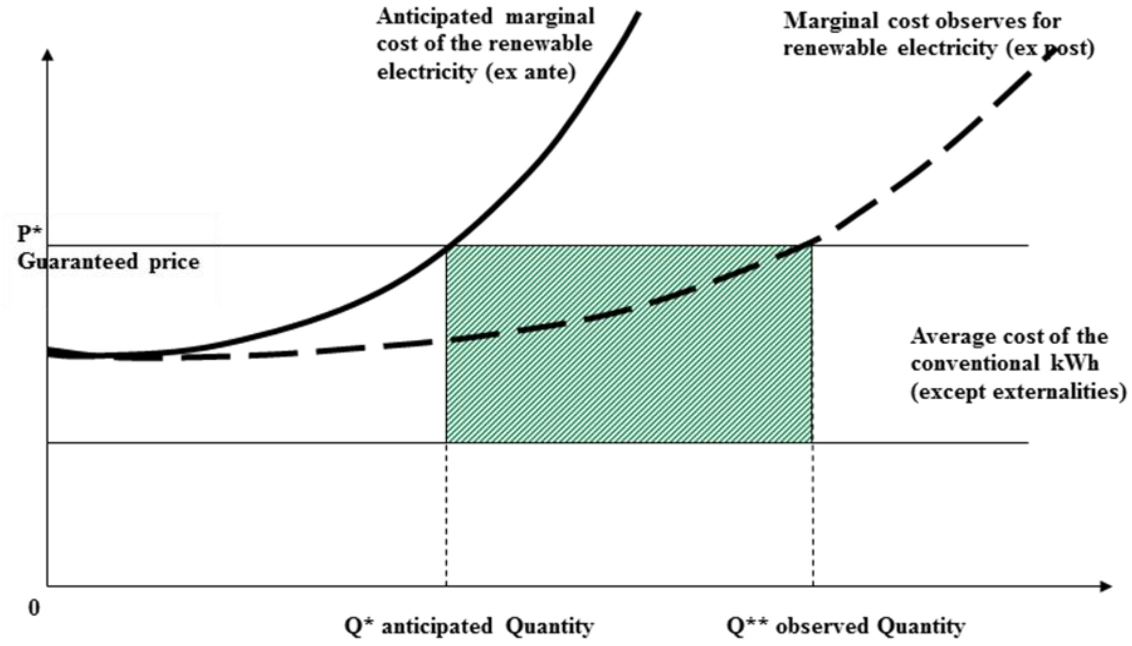
2.4.3 SWOT Analysis

Table 6 : Strengths and Weaknesses of Feed-in-Tariffs

Strenghts	Weaknesses
For producers: **Stable and secure income independently from fluctuations in the conventional electricity price**	For public authorities: no guarantee on the quantities produced by renewable energies (risks of assessment/assumptions errors on calculation ofmarginal cost curves leading to unexpected impacts in terms of quantity and overall cost for the utility/consumers
Existence of a differential rent incites the producers to invest in the R&D (research) for innovative technologies to reduce generation costs	Guaranteed income in the form of "Windfall Profits" or 'Free Rides' for the producers whose marginal cost is low: can require to programme a FIT's diminution over time or a price cap principle and a differentied FIT by technology
No transaction costs **(due to a Stable and transparent regulatory framework)**	For consumers: expensive system (if the electricity from conventional source is more competitive). The additional cost will be reduce over time if the price of conventional electricity increases.
	The guaranteed price does not take into account the default cost resulting from the irregularity of certain renewable energies (wind energy)

The FIT system is at present the system dominating in Europe but it is expensive for the consumer. The total cost increases with the increase of the renewable energy share in the energy mix unless the price of conventional electricity increases strongly, as during the sharp rise of oil prices.

Figure 5 : Guaranteed price and error of anticipation on the slope of the marginal cost



▨ **Additional cost with regard to the anticipations of public authorities**

2.5 Quota system with competitive bidding

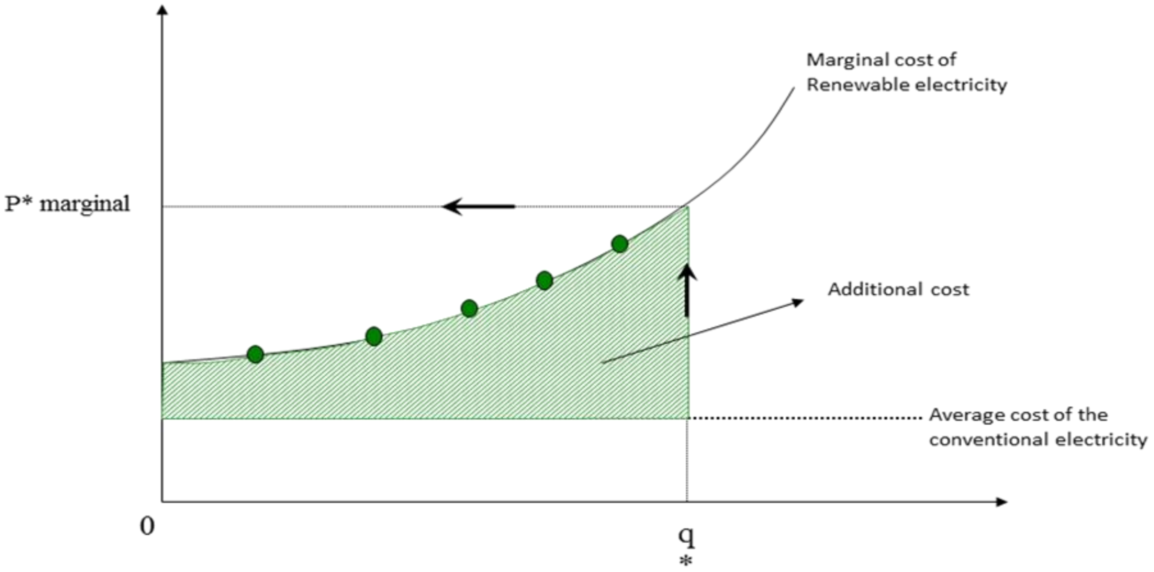
2.5.1 Definition of the theoretical approach

In order to generate a given quantum of green electricity the public authority sets a quantified target for green electricity bulk production to be injected into the grid and proceeds through competitive biddings.

Producers that are successful in the tender (merit order) get through their contract with the utility the guarantee to sale their green energy production to a given price. The contract price for green electricity for each awarded producer is:

- Either the same price-limit fixed on the basis on the last successful offer (the price proposed by the last awarded bidders) if the bidding system is "at the marginal price bid" or "French auctions" (In that case the price is uniform)
- Or the price charged by each awarded producer if within the system "pay as bid" or "Dutch auction" (in that case there is a price discrimination)

Figure 6 : Quota system with « *paid as bid* » auctions *(Dutch auction)*



The regulator sets a quota (q*) and proceeds through competitive biddings to the selection of projects. The bids are ranked in order of increasing price (merit order) and each bid receives the demanded price (Price ●) if the rule is 'paid as a bid' or the same price corresponding to the highest awarded bids if the rule is 'paid as marginal price'.

2.5.2 Examples of implementation

This system was used in England from 1991 to 2001 (Non Fossil Fuel Obligation) and in France between 1996 and 2000 (program "Eole 2005"), but both abandoned in favor of guaranteed prices in France and green certificates in England. This system remained in force in Ireland.

Quotas with competitive bidding are nevertheless still used case by case in France for offshore wind (see Agde and Fos-sur-Mer).

2.5.3 SWOT Analysis

Table 7 : Strengths and Weaknesses of the quota system with competitive bidding

Strenghts	Weaknesses
The government keeps control of the volume of green electricity fed into the grid (but not of the cost)	Responses to tenders are uncertain and the price of each bidder is not known ex ante
Governments can choose in the tender documents the areas where the facilities will be implemented (Land-use policy planning)	Transaction costs (related to the organization of the auction)
Differential income observed with the system of guaranteed prices disappears. Bids prices follow the marginal costs (with a "reasonable" rate of profit)	A priori system that is less remunerative to producers and thus less incentive for RE clusters development
	The cost of failure remains for wind projects
	The "Dutch auctions" bring perverse effects: - The producers have an incentive to overstate their offer price as they anticipate the

	"winner's curse", whoses price is below the marginal cost. [5] - Producers are seeking to acquire information about competing bids (expensive) - The producers have an incentive to agree (collusion)

2.6 Decentralized quota system backed by a green certificate market

2.6.1 Definition of the theoretical approach

An alternative to the previous quotas system with competitive bidding is the fixation of mandatory production quotas for green electricity supply. These quotas are imposed on power generating utilities and / or electricty distribution utilities (calculated as a percentage of production/sales). Operators can meet these obligations in three ways:

- by producing their own green electricity,
- by buying the electricity under long term contracts,
- by acquiring on the financial market the "Green Certificates" corresponding to the amount of electricity required.

The green electricity producers receive for each green MWh produced a green certificate and they sell the two separate commodities (electricity on one hand and certificate on the other hand) in two markets:

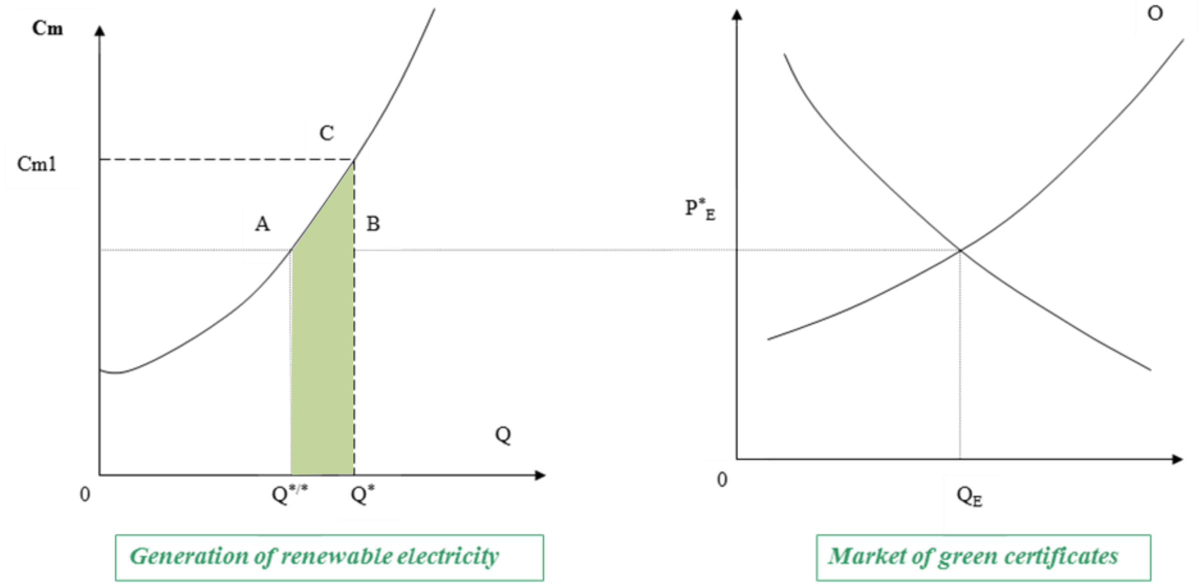
- green electricity is sold on the wholesale electricity market, at the price of conventional electricity,
- the green certificate, which represents the " added value" of this electricity, is traded in the market for green certificates.

The certificate price is equal to the difference between the marginal cost of green electricity and the price of conventional electricity. This system allows an optimal allocation of effort (equalization of marginal costs).

Figures 7 : Decentralized quota system backed by a green certificate market

---

[5] Cf Chari et Weber (1992)



Generation of renewable electricity

Market of green certificates

Q^*	**Imposed Quantity**
Q^{**}	**Produced Quantity**
$Q^* - Q^{**} =$	**Quantity bought on the market of certificates**
P_E	**Price of the green certificate**

Both graphs show the dynamics of the green certificates and mandatory quotas. Imposing a quotas for green electricity will increase the demand of green certificate on the financial market and lead to readjustment of the value of the green certificates. At the same time, producers or developers in the real world will build new capacity as the market is giving a clear signal.

The new additional capacity will lead to an increase of the production marginal cost (from A→B on the left inside graph. The product of the green certificates on the financial market has to cover the extra costs for RE generation (the top of the romble ACQ*Q**) and a reasonable profit for the producer. The market regulates the quantities of RE electricity produced.

2.6.2 Examples of implementation

There are currently more than 6 million green power consumers in Europe, the United States, Australia, Japan, and Canada. Green power purchasing and utility green pricing programs are growing, aided by a combination of supporting policies, private initiatives, utility programs, and government purchases. The three main vehicles for green power purchases are:

- utility green pricing programs,
- competitive retail sales by third-party producers enabled through electricity deregulation/liberalization (also called “green marketing”),
- and voluntary trading of renewable energy certificates.

Germany has become the world’s green power leader, with a market that grew from 0.8 million residential customers in 2006 to 2.6 million in 2009. These consumers purchased 7 TWh of green electricity in 2009 (6% of the nation’s total electricity consumption). In addition to residential consumers, 150,000 business and other customers purchased over 10 TWh in 2009 (9.5% of total electricity consumption). Other major European green power markets are Austria, Finland, Italy, Sweden, Switzerland, and the United Kingdom, although the market share of green power in these countries is less than 5%.

Australia’s 900,000 residential and 34,000 business consumers collectively purchased 1.8 TWh of green power in 2008.

In Japan, the green power certificate market grew to 227 GWh in 2009 with more than 50 sellers. The Green Heat Certificate Program began in 2010 for solar thermal, with biomass joining in 2011.

In South Africa, at least one company offers green power to retail customers using renewable electricity produced from bagasse combustion in sugar mills.

Some governments require that utilities offer green energy options to their consumers. In the United States, where green pricing programs are offered by more than 850 utilities, regulations in several states require utilities or electricity suppliers to offer green power products. More than 1.4 million U.S. consumers purchased 30 TWh of green power in 2009, up from 18 TWh in 2007.

The U.S. Environmental Protection Agency’s Green Power Partnership grew to more than 1,300 corporate and institutional partners that purchased more than 19 TWh of electricity by the end of 2010. The largest consumer, Intel, nearly doubled its purchases in 2010, to 2.5 TWh. Other innovative green power purchasing models are emerging in the United States. For example, some utilities enable customers to purchase shares in a community solar project and then obtain a credit on their utility bill equivalent to their share of the project output.

The European Energy Certificate System (EECS) framework has 18 member countries and allows the issue, transfer, and redemption of voluntary renewable energy certificates (RECs). It also provides “guarantee-of-origin” certificates in combination with RECs to enable renewable electricity generators to confirm origin. During 2009, 209 TWh of certificates were issued, more than triple the number in 2006.

Norway, a major hydropower producer, issued 62% of all certificates under the EECS, virtually all of which were hydropower. In other European countries, green power labels such as “Grüner strom” and “Ok-power” in Germany and “Naturemade star” in Switzerland have been introduced to strengthen consumer confidence.[6]

2.6.3 SWOT Analyses

Figure 8 : Strengths and Weaknesses of a decentralized quota system backed by a green certificate market

Strenghts	Weaknesses
Optimal allocation of efforts encourages the most efficient producers to expand its production; flexible and scalable system	High transaction costs
Incentive to locate production in most appropriated areas and allow a regional market for certificates	Market sometimes narrow, with low degree of liquidity and high price volatility of the certificates

---

[6] Renewables 2011 Global Status Report (REN21)

Inexpensive system for the consumer; the overhead is proportional to electricity consumption, whereas with the guaranteed prices the extra cost is fixed **$S = \alpha.C$ with green certificates** **$S= pV$ (V amount injected independent of C) with guaranteed prices** **Incentive Certificate system to reduce electricity consumption C**	Conceivable market in the EU but need to standardize the certificates and to improve the convergence of wholesale prices of conventional electricity
	Risk of assigning green certificates to depreciated facilities ("windfall profits"); difficult to control in practice

Later, the settlement of a green certificates market backed by a system of compulsory quota could become the standard. The green certificates system can be coupled with that of the CO^2 certificates ("black certificate") and that of the "white" certificates (energy savings).

This approach which gives the confidence into the liberalized market mechanisms to reach the optimal allocation of the resources was chosen by the EU. Moreover, it allows trade and crossed investment of industrialized countries towards developing countries.

2.7 Worldwide review of the policy landscape

Policies to support renewable energy investments continued to increase in number during 2010 and early 2011. Only a few countries had renewable energy support policies in the 1980s and early 1990s, but many more countries, states, provinces, and cities began to adopt such policies during the period 1998–2005, and especially during the period 2005–2011. The number of countries with some type of policy target and/or support policy related to renewable energy more than doubled during this latter period, from an estimated 55 in early 2005 to 118 by early 2011.

2.7.1 Summary of UE member states' progress

The following table provides an overview of the renewable electricity support instruments that are in place in the EU Member States. We differentiate six categories of support instruments:

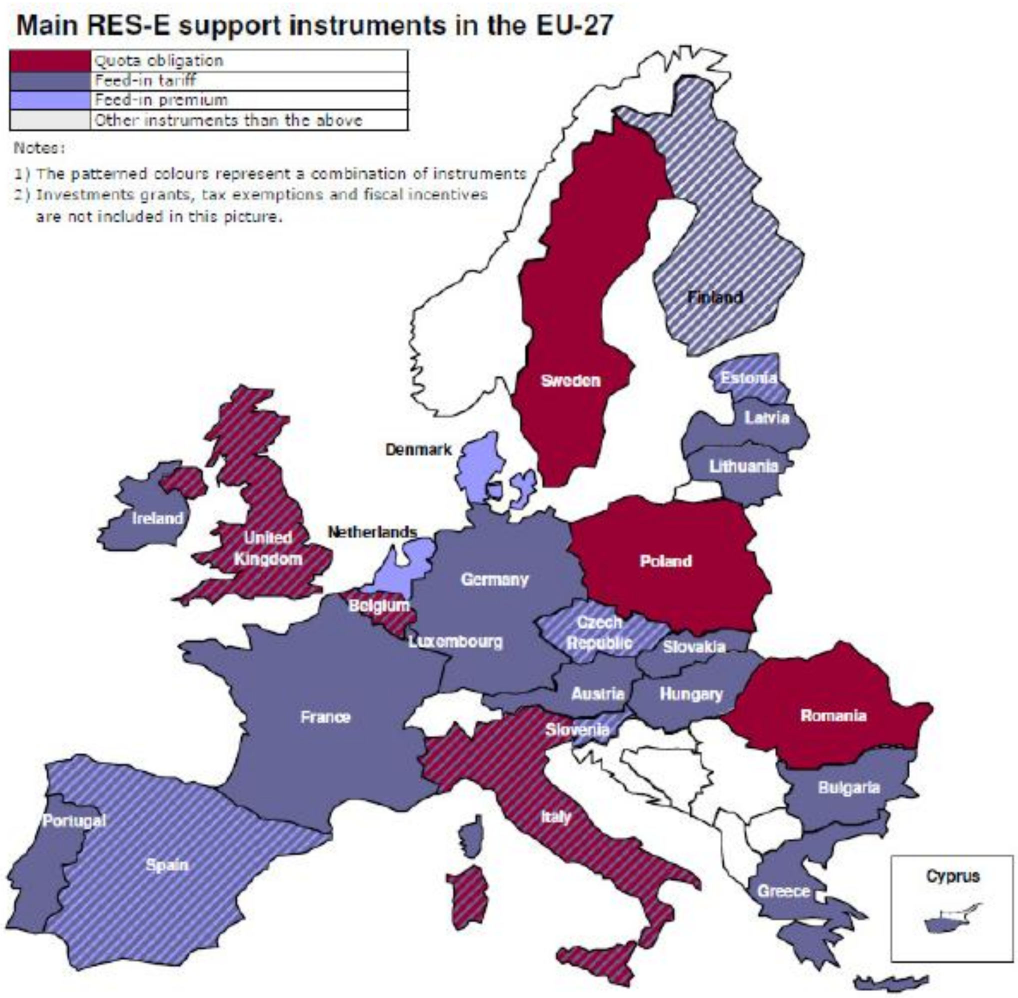
- feed-in tariff,
- premium,
- quota obligation,
- investment grants,
- tax exemptions, and
- fiscal incentives.

Table 9 : Incentive Instruments used in EU member countries

	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE
FIT	X	X	X	x	x	X		X	x		X	x	x	x
Premium					x		x	X	x					
Quota obligation		X												
Investment grants		X		x	x					x		x	x	
Tax exemptions		X							x	x		x		
Fiscal incentives			X			X		X						

	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
FIT	x	x	X	x	X			x			X	x	x
Premium						x					X		
Quota obligation	x						X		x	x			x
Investment grants		X	X	x	X								
Tax exemptions				x		x	X			x		x	x
Fiscal incentives					X	x	X				X		

Source : Ecofys for the DG Energy of the European Commission[7]



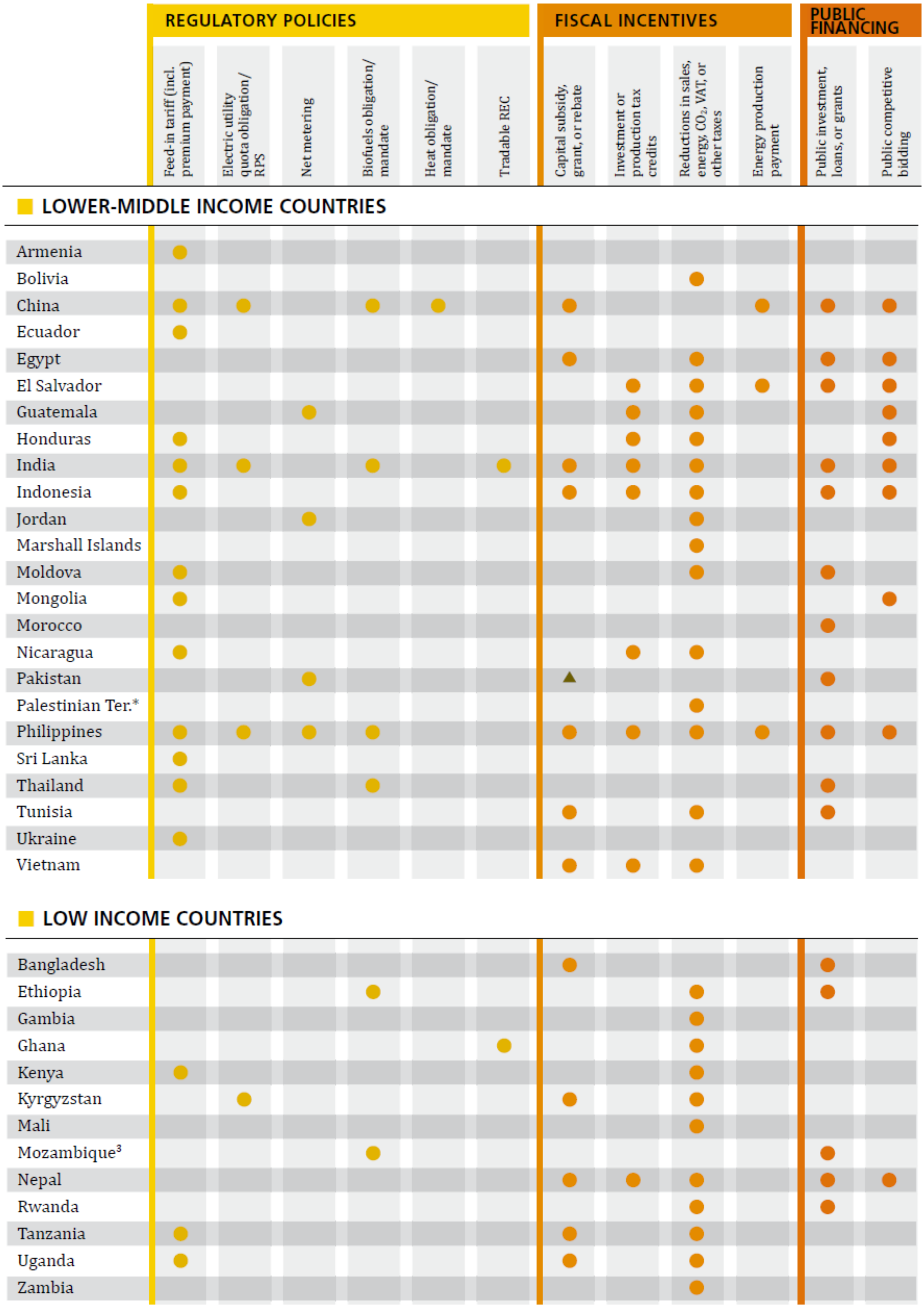
Source : Ecofys for the DG Energy of the European Commission

---

[7] European Commission DG Energy : "Financing Renewable Energy in the European Energy Market" (2011)

2.7.2 Summary of developing countries progress

Table 10 : Incentive Instruments used by developing countries

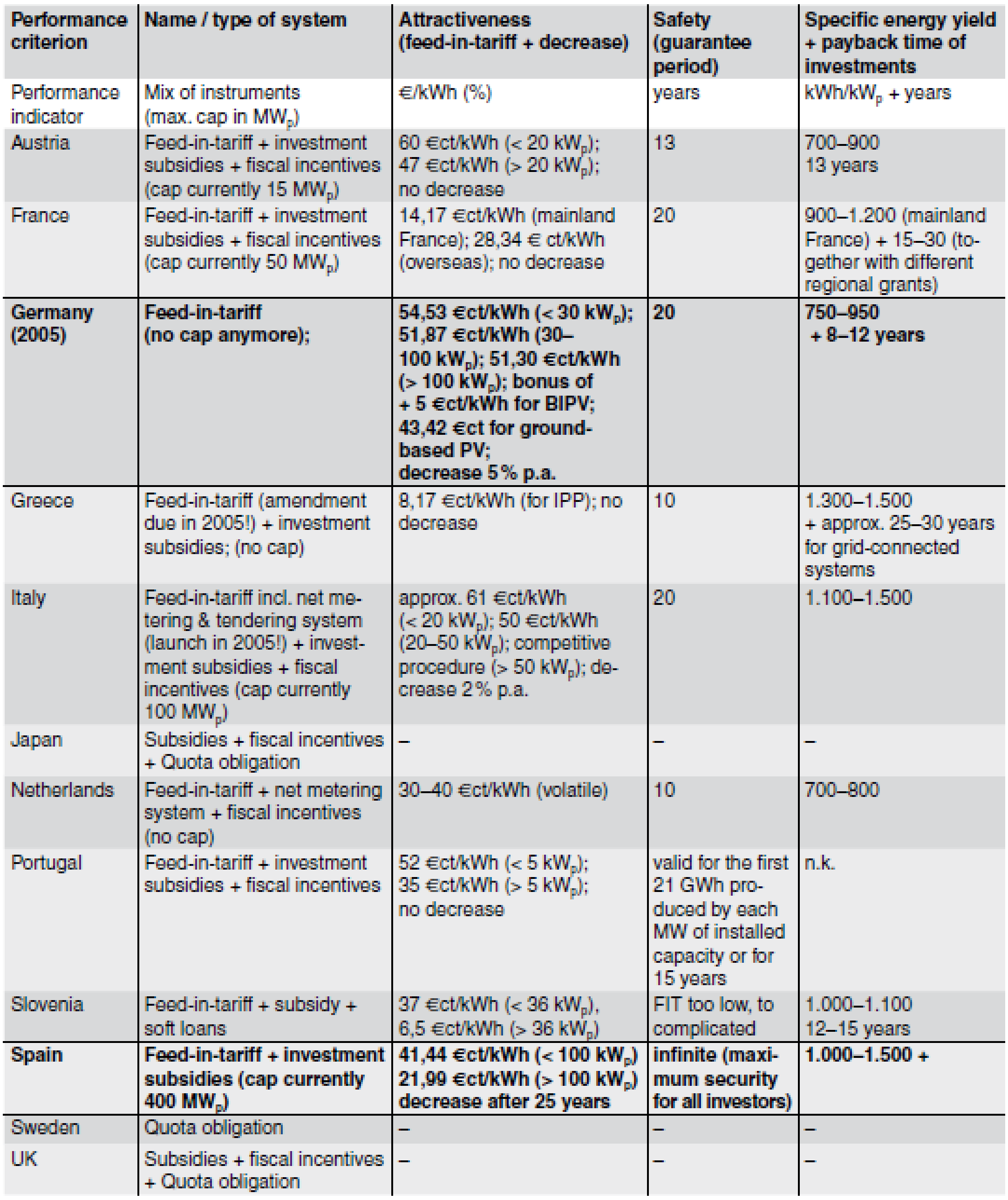


	REGULATORY POLICIES						FISCAL INCENTIVES				PUBLIC FINANCING	
	Feed-in tariff (incl. premium payment)	Electric utility quota obligation/ RPS	Net metering	Biofuels obligation/ mandate	Heat obligation/ mandate	Tradable REC	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO_2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding
LOWER-MIDDLE INCOME COUNTRIES												
Armenia	●											
Bolivia									●			
China	●	●		●	●		●			●	●	●
Ecuador	●											
Egypt							●		●		●	●
El Salvador								●	●	●	●	●
Guatemala			●					●	●			●
Honduras	●							●	●			●
India	●	●		●		●	●	●	●		●	●
Indonesia	●						●	●	●		●	●
Jordan			●						●			
Marshall Islands									●			
Moldova	●								●		●	
Mongolia	●											●
Morocco											●	
Nicaragua	●							●	●			
Pakistan			●				▲				●	
Palestinian Ter.*									●			
Philippines	●	●	●	●			●	●	●	●	●	●
Sri Lanka	●											
Thailand	●			●							●	
Tunisia							●		●		●	
Ukraine	●											
Vietnam							●	●	●			
LOW INCOME COUNTRIES												
Bangladesh							●				●	
Ethiopia				●					●		●	
Gambia									●			
Ghana						●			●			
Kenya	●								●			
Kyrgyzstan		●					●		●			
Mali									●			
Mozambique[3]				●							●	
Nepal							●	●	●		●	●
Rwanda									●		●	
Tanzania	●						●		●			
Uganda	●						●		●			
Zambia									●			

Source : Renewables 2011 Global Status Report (REN21)

2.7.3 Comparison of diverse incentives dedicated to the PV sector

Table 11 : Performance criteria for PV incentives



Performance criterion	**Name / type of system**	**Attractiveness (feed-in-tariff + decrease)**	**Safety (guarantee period)**	**Specific energy yield + payback time of investments**
Performance indicator	Mix of instruments (max. cap in MW_p)	€/kWh (%)	years	kWh/kW_p + years
Austria	Feed-in-tariff + investment subsidies + fiscal incentives (cap currently 15 MW_p)	60 €ct/kWh (< 20 kW_p); 47 €ct/kWh (> 20 kW_p); no decrease	13	700–900 13 years
France	Feed-in-tariff + investment subsidies + fiscal incentives (cap currently 50 MW_p)	14,17 €ct/kWh (mainland France); 28,34 € ct/kWh (overseas); no decrease	20	900–1.200 (mainland France) + 15–30 (together with different regional grants)
Germany (2005)	**Feed-in-tariff (no cap anymore);**	**54,53 €ct/kWh (< 30 kW_p); 51,87 €ct/kWh (30–100 kW_p); 51,30 €ct/kWh (> 100 kW_p); bonus of + 5 €ct/kWh for BIPV; 43,42 €ct for ground-based PV; decrease 5 % p.a.**	**20**	**750–950 + 8–12 years**
Greece	Feed-in-tariff (amendment due in 2005!) + investment subsidies; (no cap)	8,17 €ct/kWh (for IPP); no decrease	10	1.300–1.500 + approx. 25–30 years for grid-connected systems
Italy	Feed-in-tariff incl. net metering & tendering system (launch in 2005!) + investment subsidies + fiscal incentives (cap currently 100 MW_p)	approx. 61 €ct/kWh (< 20 kW_p); 50 €ct/kWh (20–50 kW_p); competitive procedure (> 50 kW_p); decrease 2 % p.a.	20	1.100–1.500
Japan	Subsidies + fiscal incentives + Quota obligation	–	–	–
Netherlands	Feed-in-tariff + net metering system + fiscal incentives (no cap)	30–40 €ct/kWh (volatile)	10	700–800
Portugal	Feed-in-tariff + investment subsidies + fiscal incentives	52 €ct/kWh (< 5 kW_p); 35 €ct/kWh (> 5 kW_p); no decrease	valid for the first 21 GWh produced by each MW of installed capacity or for 15 years	n.k.
Slovenia	Feed-in-tariff + subsidy + soft loans	37 €ct/kWh (< 36 kW_p), 6,5 €ct/kWh (> 36 kW_p)	FIT too low, to complicated	1.000–1.100 12–15 years
Spain	**Feed-in-tariff + investment subsidies (cap currently 400 MW_p)**	**41,44 €ct/kWh (< 100 kW_p) 21,99 €ct/kWh (> 100 kW_p) decrease after 25 years**	**infinite (maximum security for all investors)**	**1.000–1.500 +**
Sweden	Quota obligation	–	–	–
UK	Subsidies + fiscal incentives + Quota obligation	–	–	–

Source : PV Policy Group – European Best practice report (2006)

2.8 Power Purchase Agreements (PPA)

Among the major tools at the disposal of the regulator and the public authorities, a standardized contract type of Power Purchase Agreement must be available in the country to facilitate involvement of private bodies. PPAs are helpful for projects dealing with national grid as well as mini-grids.

2.8.1 Definition of the theoretical approach

Power Purchase Agreements are contracts between two parties, one who generates electricity for the purpose of sale (**the seller**) and one who is looking to purchase electricity (**the buyer**). There are various forms of Power Purchase Agreements; these are differentiated by the source of energy harnessed (solar, wind, etc.). Financing for the project is delineated in the contract, which also specifies relevant dates of the project coming into effect, when the project will begin commercial operation, and a termination date for which the contract may be renewed or abandoned. All sales of electricity are metered to provide both seller and buyer with the most accurate information about the amount of electricity generated and bought. Rates for electricity are agreed upon in the contract between both parties to provide an economic incentive to being a Power Purchase Agreement.

Under a PPA, the buyer is often a utility company that purchases the electricity generated from the seller. In some circumstances, a company may be trying to meet renewable-energy portfolio standards and would be considered a retail purchaser. Under this condition, the retail purchaser may resell the electricity to another entity under a new PPA. Typically, a PPA is established between the primary seller and a utility company who is regulated to buy the electricity.

The PPA is often regarded as the central document in the development of independent electricity generating assets (power plants), and is a key to obtaining project financing for the project. Under the PPA model, the PPA provider would secure funding for the project, maintain and monitor the energy production, and sell the electricity to the host at a contractual price for the term of the contract. The term of a PPA generally lasts between 5 and 25 years. In some renewable energy contracts, the host has the option to purchase the generating equipment from the PPA provider at the end of the term, may renew the contract with different terms, or can request that the equipment be removed. One of the key benefits of the PPA is that by clearly defining the output of the generating assets (such as a solar electric system) and the credit of its associated revenue streams, a PPA can be used by the PPA provider to raise non-recourse financing from a bank or other financing counterparty.

2.8.2 Examples of implementation [8]

Five innovative nations in Asia have been among the first in developing ECOWAS (SPP) programs to promote renewable energy development in-country (Thailand, Indonesia, India, Sri Lanka and Viet Nam). These programs have been very successful in some of these nations in promoting during just a

---

[8] cf Ferrey S. : Small Power Purchase Agreement Application for Renewable Energy Development: Lessons from Five Asian Countries (2004)

few years a substantial contribution of renewable small power projects to the national energy supply. Some of the most successful program features, innovative elements, and PPA design that have achieved notable success and could be the basis of programs in other nations. Each of these programs involves standardized PPAs or standardized tariffs, or both, which are a material element of program design. Most of these countries advanced their programs with technical and/or financial assistance from international donors and agencies, although the Thailand program proceeded without such assistance.

The Thai program operates in tranches of formal solicitation by the state utility. Eligible projects mirror the requirements of those of the "PURPA program" in the United States, with size limitations up to 60 MW, and in some cases, 90 MW. State subsidies are provided for some renewable SPPs competitively selected. As in the U.S. experience, the majority of projects are natural gas-fired cogeneration projects.

Both firm and non-firm PPAs are available. The contract was designed to be indexed, but instead is adjusted periodically for foreign exchange risk for capacity and energy payments. For intermittent renewable projects, the capacity factor[9] must be greater than 0.5, without a reduction in capacity payments. Thailand was the first of the Asian SPP programs, and it set a standard for successful program development. A noteworthy feature is its competitively determined renewable SPP subsidy program.

The Indonesian began to develop a program in 1993. It came to involve a standardized PPA and tariff. The SPP program was designed to supply up to one-third of national new power supply from small, renewable sources, organized into four tiers of priority for projects of up to 30 MW in size on the primary island, and half of that size on smaller island grids. Since Indonesia comprises several separate and not interconnected island grid systems and isolated diesel systems, this program design was nuanced and disaggregated to address avoided cost and power requirements on a regional basis.

The standardized PPA in its original design contemplated either a firm[10] or non-firm power sale. The incentives for firm power delivery were embodied in the tariff, with indexation of capacity payments for foreign exchange risk, on the theory that most of the value added of generating capacity would be foreign production (this program included cogeneration utilizing fossil fuels as a lower-priority generation source). This provided an innovative approach to structuring the performance obligation, whereby no legal sanctions were imposed for performance failure of the SPP, but rather a substantial economic disincentive for the SPP from such nonperformance was in place. Some innovative fuel price hedging was provided for renewable power projects.

In India, each state makes its own determinations about SPP programs. Two representative Indian states are described below. Although some Indian states provided formal SPP solicitations or allowed direct retail third-party sales, or both, neither of the two states evaluated here now allow direct third-party sales or conduct a formal project solicitation.

In the **state of Andhra Pradesh**, no formally standardized contract is in place, although de facto a set contract form is used by the utility, leaving some case-by-case discretion with the utility. The tariff is escalated at 5 percent annually from a base year. Moreover, the tariff can be reset mid-contract after

---

[9] Total production/installedcapacity/8760 h. A capacity factor >0.5 only for biomass and mini-hydro

[10] Firm power sale as defined in the contract (when and how many MW fully available)

three years by the government. This undercuts long-term certainty. Energy wheeling is allowed, but discouraged economically by a high wheeling charge. No third-party retail sales are allowed.

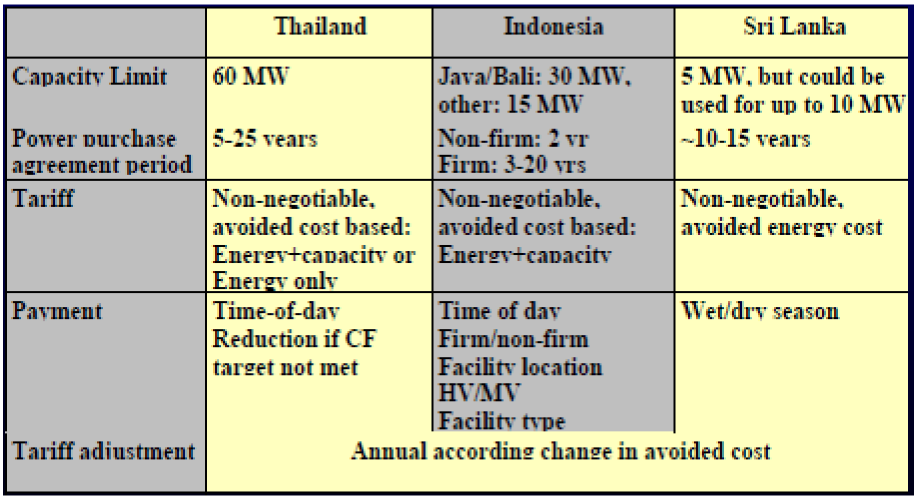
In **Tamil Nadu state**, a similar de facto set PPA is employed. An SPP is defined as any project up to 25 MW. Many wind power projects have been developed and grid connected. Wheeling of power to an affiliated location—not to a third-party—is permitted with a 2 percent charge. No third-party retail sales are allowed.

The Sri Lankan program does not utilize a simultaneous solicitation for SPP bids as was deployed in Indonesia and Thailand. Ad hoc offers are entertained by the state utility. Fifteen-year PPAs are available for projects up to 10 MW in size. All but one of the successful SPPs to date are small hydroelectric projects. The PPA is standardized, as it is the tariff. The tariff development was assisted by consultants provided by the World Bank. The tariff is revised annually based on a three-year fuel average, with a tariff floor of 90 percent of the original tariff underneath renewable projects.

These Asian nations offer different forms of government and have different predominant fuel sources in their generation base (hydro, coal, gas, oil). Some of the national electric systems have an integrated high-voltage transmission system, whereas others have a disintegrated or island system, but there are key similarities:

- All are in need of long-term increases in power generation capacity (although Thailand has a short term current surplus).
- All have the potential of small-scale renewable energy options which is quite relevant for the WA region.
- Each country is being approached by private developers who seek to develop renewable SPP projects.
- Each system employs either deliberately or de facto a standardized PPA, although it is not necessarily a neutral or consensual document in all cases.
- Although **avoided cost** concepts for establishing the SPP tariff are recognized in each nation, avoided cost concepts are applied differently in these nations' SPP programs.

Table 12 : Examples of Small Power Purchase Agreements



	Thailand	Indonesia	Sri Lanka
Capacity Limit	60 MW	Java/Bali: 30 MW, other: 15 MW	5 MW, but could be used for up to 10 MW
Power purchase agreement period	5-25 years	Non-firm: 2 yr Firm: 3-20 yrs	~10-15 years
Tariff	Non-negotiable, avoided cost based: Energy+capacity or Energy only	Non-negotiable, avoided cost based: Energy+capacity	Non-negotiable, avoided energy cost
Payment	Time-of-day Reduction if CF target not met	Time of day Firm/non-firm Facility location HV/MV Facility type	Wet/dry season
Tariff adjustment	Annual according change in avoided cost		

2.8.3 SWOT Analysis

Table 13 : Strengths and Weaknesses of PPA

Strengths	Weaknesses
Renewable developer (or partner) eligible for tax incentives, accelerated depreciation	Some utilities may find that the PPA option does not provide them with sufficient control over or certainty with regard to the operation and management of renewable resources
Minimal risk to public authorities : minimizes the capital demands on traditional utilities	Many renewable developers are having difficulty attracting the necessary capital to complete their projects (especially individuals or SME involved in small mini-grid projects)
No up-front capital from public required	
Renewable developer provides O&M	
Known long term electricity price for portion of site load	

Buying renewable energy through a PPA also minimizes development and construction risk for the utility. This may be particularly appealing to those utilities that divested their generation fleet in response to restructuring mandates, many of whom lack direct experience with renewable energy development and consider this function to be outside of their core business of energy delivery.

Accordingly, pursuit of and diligence regarding renewable PPAs may provide valuable experience for traditional utilities in renewable development, particularly if utility personnel work closely with renewable energy developers in developing the PPA and operational/ dispatch protocols for the facility.

The PPA option also leaves technology risk with the renewable developer. Given the speed of technological change in the renewable sector, utilities and their state commissions may be reluctant to take on actual or perceived technology risk.

2.9 Mini-grid concessions

2.9.1 Definition of the theoretical approach

Mini-grids involve a centrally located generating system that serves generally tens or hundreds of users. A mini-grid is an attractive option when customers are concentrated enough to be economically interconnected but the connection to the main grid is not feasible. It is typically the case of many isolated communities in African countries.

The outputs on which subsidies are disbursed in mini-grid systems are diverse and can range from construction milestone to installed capacity to connection of new customers. Most projects identified include a mix of these outputs, but most of the subsidies target the access to energy for rural population. In terms of market model, public-private partnerships in the form of concession contracts are the most common. Under concession, the service provider has exclusive rights to generate, distribute, and sell electricity in the concession area.

The concept of a "**concession**" was first developed in France. As with leasing, the framework for the concession is set out in the country law and the contract contains specific provisions to the project. Emphasis is placed in the law on the public nature of the agreement (because the operator has a direct relationship with the consumer) and safeguards are enshrined in the law to protect the consumer. Similar legal frameworks have been incorporated into civil law systems elsewhere.

Within the context of common law systems, the closest comparable legal structure is the BOT (Build-Operate-Transfer), which is typically for the purpose of constructing a facility or system.

The "**Concession**" and "**BOT**” contracts are almost similar: The main difference between concession and BOT contracts is that investment charges, operation and maintenance, commercial risk, and asset ownership for the duration of the contract are fully born by the private contractor in the case of the concession, while they can be shared between public and private entities as part of a mixed enterprise corporation for the BOT. Both systems were developed to attract private investments to the new infrastructure construction phase. Concession or BOT contracts allow the private sector to build a new infrastructure in compliance with standards established by the State, and to own exclusive operation rights for the concession area and for a sufficient period (generally ten to twenty years) to earn back the initial investment, plus a profit. The State becomes owner of the infrastructures at the contract expiration and then has the option to place them on a long-term lease contract, for example, with a private operator. The concession contract differs from other contracts, such as construction or public service contracts as follows:

- The assumption of the total or partial investment by the contractor as part of a long term contract, (duration of contract must be longer than the expected delay of return on investment);
- The transfer from the conceding entity to the contractor of public service obligations corresponding to a public responsibility and the sharing of the various risks between both parties;

Concession is defined by multiple criteria. Consequently, the national law must offer a distinct legal framework to concessions, different from that of public markets, and with assignment and execution rules specific to these contracts, in particular for those operating on mini-grid systems.

2.9.2 Examples of implementation

In most African countries, local communities do not (yet) have the technical and organizational capacities required to directly manage their rural electrification program: Therefore, the most common public service execution mode is public service management delegation. It is also the best system to financially involve the private sector in the investment phase.

The Madagascar implementation of concession model for mini-grid systems

In Madagascar, mini-grids are operated by private bodies under concession contract or authorization depending on the size of the generation and/or distribution system.

Table 14 : Differences between concession and authorization

Concession	Authorization
Generation : **> Thermal power plant / Genset : > 500 kW** **> Hydro power plant : > 150 kW**	**Generation :** > Thermal power plant / Genset : < = 500 kW > Hydro power plant : < = 150 kW
Distribution : **Peak load exceeding 500 kW**	**Distribution :** Peak load under 500 kW

The process to award concession and authorization is basically based on **call for tenders**. However, authorization can also be awarded after **unsolicited application.**

After technical acceptance by the National Agency for the Rural Electrification (ADER), tariff is negotiated between the contractor and the local community, and submitted for control and validation to the Regulator.

The ESCO model in Mali

Koraye Kurumba and Yeelen Kura are two Rural Energy Services Companies (RESCOs) created in 1999 and 2001 in two areas of rural Mali (Kayes and Koutiala). The companies were created by France's electricity company EDF, in partnership with the Dutch energy company NUON, the French TOTAL and with the support of the French Agency for the Environment and Energy Efficiency. The provision of low-cost electricity, based on solar home systems or small low-voltage village micro-networks supplied by diesel generators, resulted in undeniable development impacts, such as enhancing standards of living, favouring the development of income-generating activities, and improving quality of healthcare and education. Backed by a new institutional framework and international donors, the model– designed to ensure profitability, sustainability, reproducibility and local ownership– is to be expanded beyond the 24 villages and 2176 households/43,520 people were served at the end of 2006. The initial targets were 10,000 clients for a total population of 200,000 inhabitants.

Senegal: the concept of technological neutrality

In Senegal, the concept of technological neutrality is applied. For every concession, a Local Plan of Electrification is firstly drawn up, defining the appropriate technologies of electrification, the required investments, and the potential market. Actually, the technico-economic optimization favors the use of Renewable energies on mini-grids systems. As a result, from 2000 till 2007, looking at the solar energy only, the capacity installed in Senegal increased from 850kWc to about 2 000 kWc.

The system of attribution of the concessions is based on selection or call for tenders. Regarding the choice of the concession's operator, the determining criterion is the number of users to be supplied with a subsidy at the investment fixed by the ASER (Senegalese Agency of the Rural Electrification) in the call for tenders. The candidate who proposes the largest number of users' supplied with the granted level of subsidy is the winner.

To increase the chances of success, the choice of the most adapted technology and efforts in sizing are essential. The concession contract is obtained for a duration of 25 years. The selected candidate to operate the concession proceeds to the realization of the works of electrification, the maintenance and the renewal of the installations present in its area during the duration of its contract. Within this framework, the integration of the local private sector in the creation of the project's company, which will have to operate the concession, is fundamental.

A particular but replicable electrification model in South Africa

The South African Energy Policy White Paper of 1998 required the integration of grid and non-grid technologies in a single National Electrification Programme. The South African Government encouraged private-sector participation in rural energy service provision. The approach being pursued, as in a number of other countries, was the award of geographical concessions to provide non-grid electricity supplies (primarily solar home systems) in remote areas.

The work conducted was particularly focused on the potential for isolated communities to benefit from emerging renewable technologies in the form of a renewable mini-grid. The interest in this particular form of rural electrification comes from the demographic profile of many sub-Saharan African countries, which have a high proportion of isolated communities. The development of an appropriate economic solution for isolated communities is a challenging aim. Yet, with rising in fuel prices and the mitigate success of a number of diesel based isolated systems throughout the region, there is an emerging interest in the use of renewable energy.

In 2003, the Global Sustainable Electricity Partnership (e7) began the development of a demonstration project in South Africa targeting off-grid mini-hybrid systems, with an emphasis on wind and solar power. The project objectives included: eligibility for CDM status, replicability, financial sustainability, and the practical principles associated with economic sustainability.

After identifying the sites, the e7 undertook a pre-feasibility study that yielded positive conclusions, leading to a decision to pursue the project at the feasibility stage. However, due to a faster growth in electrification plans in South Africa, the sites chosen for the feasibility study were no longer eligible for further implementation. Their conclusion not to proceed in South Africa was driven by the failure to identify a suitably remote site of reasonable density that was unlikely to be grid connected within the next five years. In discussions with government it also became obvious that providing rural communities with renewable energy solutions was likely to conflict with developing electrification policy in South Africa.

Nevertheless, the information and lessons learned from this study can greatly benefit similar electrification projects and programmes in other Sub-Saharan African countries. Among the main lessons learned from this South African experience we note the importance of a good coordination with government and electrification authorities, to avoid any conflict between mini-grids development and main grid deployment in the country that would result in a waste of financial resources.

2.9.3 SWOT analysis

The private company is responsible for infrastructure and daily operation financing. Pricing rules are discussed in the concession contract.

Table 15 : Strengths and Weaknesses of of mini-grid concession

Strenghts	Weaknesses
Substantial contribution of private capital	Implies a regulation capacity by the government
Combining private sector responsibilities in infrastructure development and daily management: Greater opportunities for innovation	Contract complexity : need to combine foresight and flexibility
Public sector get back the infrastructures and equipment upon expiration of the concession contract	Process not very competitive

2.10 Netmetering

2.10.1 Definition of the theoretical approach

Netmetering is a power supply arrangement that allows a two-way flow of electricity between the electricity distribution grid and customers that have their own generation system. The customer pays only for the net electricity delivered from the utility (total consumption minus self-production). A variation that employs two meters with differing tariffs for purchasing electricity or exporting excess electricity off-site is called “net billing.”

2.10.2 Examples of implementation

Net metering is an important policy for rooftop solar PV (as well as other renewables) that allows self-generated power to offset electricity purchases. Net metering laws now exist in at least 14 countries including Italy, Japan, Jordan, and Mexico, and almost all U.S. states. And finally, new forms of electric utility regulation and planning are emerging that target the integration of renewables into power grids at increasing levels of penetration.

Bibliography

Rapports

- **Arthur W.B. :** Competing technologies: increasing returns and lock-in by historical events - *Economic Journal*, 99 (1989)
- **Boubou P., Watchueng S. and Massé R. : Public-Private Partnership in rural electrification programs in Africa – Club-ER (2010)**
- **Chari V.V. et Weber R.J.** « How the U.S. Treasury should auction its debt » in Federal Bank of Minneapolis Quarterly Review , autumn (1992)
- **Communication de la Commission Européenne** : Aide en faveur de l'électricité produite à partir de sources d'énergie renouvelables (2005)
- **Ferrey S.** (AAEP – World Bank) : Small Power Purchase Agreement Application for Renewable Energy Development: Lessons from Five Asian Countries (2004)
- **Foray D. :** Diversité, sélection et standardisation : les nouveaux modes de gestion du changement technique - *Revue d'Economie Industrielle* (pp.257-274), (1996)
- **Global Sustainable Electricity Partnership : Community Electricity in Rural South Africa: Renewable mini-grid assessment Renewable mini-grid assessment (2003)**
- **Menanteau P., Finon D., Lamy M.L.** (IEPE) : Prix versus quantités : Les politiques environnementales d'incitation au développement des énergies renouvelables - CAHIER DE RECHERCHE N° 25 (Mai 2001)
- **Mumssen Y., Johannes L., Kumar G. : Output-Based Aid, Lessons learned and best practices - The World Bank - (2010)**
- **Reiche, Covarrubias, and Martinot : The world Bank (2008)**
- **Weitzman M.L.** « Prices versus Quantities » in The Review of Economic Studies vol 41, issue 4, p 477-491 (1974)

Articles

- **Ben Jannet Allal H., de Perthuis C., Pouffary S.** « Le Mécanisme de Développement Propre dans les pays méditerranéens ; comment accélérer la mise en œuvre ? » Liaison Energie-Francophonie n°71 (2006)
- **Pouffary S.** « Le financement des énergies renouvelables et de la maîtrise de la demande en Méditerranée : Réalités, perspectives et opportunités » Medénergie n°23/24 (2007)

- **Chabot B.** « Du coût global à la rentabilité différentielle : une nécessité pour le développement durable, une opportunité pour les économistes du bâtiment » E&C n°142 (2007)

Presentations

- **Viard E.** (AFD) « Plan Solaire Méditerranéen : Le financement de projets novateurs » Conférence sur le PSM, Paris (22 Novembre 2008)
- **Cornut B.** (ADEME) "Escaping from the trap of social tariffs: Integrating the reforms as an energy policy : The case of Lebanon" Séminaire Maîtrise de l'énergie (15 mars 2004)
- **Mostert W.** "Financing grid-connected renewable energy systems in developing countries", Danish Conference on Renewable Energy Sønderborg, (September 17-19, 2003)

Laws:

- FEED-IN-TARIFFS POLICY ON WIND, BIOMASS AND SMALL-HYDRO RESOURCE GENERATED ELECTRICITY March 2008, MINISTRY OF ENERGY, KENYA
- FEED-IN-TARIFFS POLICY ON WIND, BIOMASS SMALL-HYDRO, GEOTHERMAL, BIOGAS AND SOLAR RESOURCE GENERATED ELECTRICITY revised January 2010, MINISTRY OF ENERGY, KENYA

ECREEE Secretariat

Achada Santo Antonio

C.P. 288, Praia, Cape Verde
Tel: +238 2604630

E-mail: info@ecreee.org

Web: http://www.ecreee.org

ECREEE is supported by:

UNIDO

MINISTERIO DE ASUNTOS EXTERIORES Y DE COOPERACIÓN

aecid

Austrian Development Cooperation