Potential of off- and mini-grid application in remote regions

Content

Introduction

In remote areas, technologies for off-grid rural electrification in combination with proper financial engineering promise environmentally friendly access to electricity at a lower cost than conventional technologies. Carpathians and Caucasus mountains regions have a number of remote areas and using of off-grid applications open an access to the secure electricity supply of regions. Securing rural provides social benefits including improved living standards, reduced negative impact of energy use on health and local environment.

Most of energy users (households, productive and public uses) have a possibility to be served by grid connections. However, in spite of high level of electrification, old technical solutions and equipment from the middle of last century is out of date and highly insecure. Settlements are oft disconnected from the grid because of the high costs of grid extension when serving new loads.

Off-grid electrification can provide an alternative solution for many low-demand users - at lower cost than grid extension - and a growing market niche for small types of rural energy service companies. Costs of off-grid technologies have decreased significantly over the last years.

There are number of technologies providing energy for domestic, productive and public needs using diesel-, biomass-, wind-, PV-, or small hydro-generators, or hybrid combinations of these.

Here, we analyse possibility of exploitation of micro- and mini hydro plants for creation of off- grid applications in remote regions of Armenia, Azerbaijan, Georgia and Ukraine.

Electricity supply options

Power may be supplied through two basic distribution options: village ***mini-grids*** (serving tens or hundreds of users) or ***isolated systems*** (serving just one or two users). These options are fits very good capacities providing by small hydropower technologies. Isolated applications are most favourable for Caucasus and Carpathians region because of simpler and prompt accession to the generating energy. Creation of mini – grids linked with number of system troubles expressed in the lobbying of major ESCOs and energy policy.

Village mini-grid

Consumers far from existing utility grids may be served by isolated mini-grids. Because the distribution system *is similar* whether served by a central grid, a local renewable energy source, or hybrid systems these mini-grids may be upgraded through grid connection. The capital costs for a low-voltage distribution line are typically around $5-7 per meter and the costs of an electricity meter may be around $120. The resource that are using for generating electricity will vary according to village load profile, availability of renewable resources, and energy transportation costs.

In most cases, *a small hydropower plant* as well as *diesel generator, a wind-diesel-hybrid* will be least cost, depending on local conditions (Fig.1).

Energy demand, costs, and user satisfaction are particularly interwoven in the case of mini-grids, *making technology assessment difficult*. Mini-grids are sized according to estimated consumption and then can be extended or revaluated as sub grids of national providers. This problem can be solved at the planning phase by oversizing systems or restriction of consumption per user.

Energy generation prices for mini-grid application are in range 8-14 cents / kWh.

Average village mini-grids demand can be covered by lower power range of mini SHP (upto 1 MW) using good elaborated and tested technologies.

Except general market and monetary problem there is also the big question – How to check energy quality and control energy supply in remote areas ?

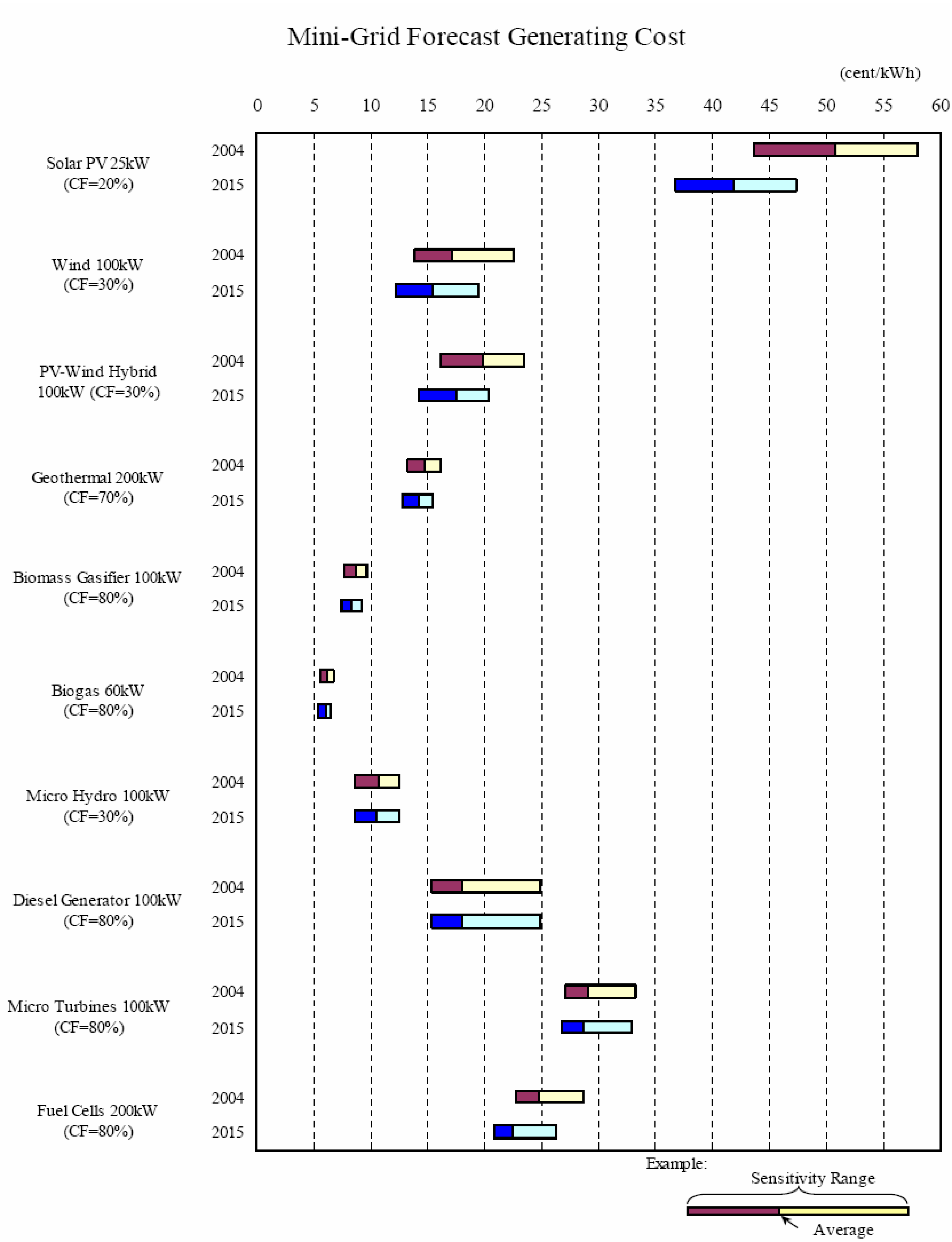

Figure 1 Mini – grid generation technologies (2004 – 2015). Ref. Technical and economic assessment: Off-grid, Mini-grid and Grid electrification. Discussion report. The World bank 2005

Isolated (off-grid) applications

Organisations or SMEs located in the remote region may exploit benefits of small hydropower as isolated power generation systems. Use of such installation refers to the lower limit of mini or micro applications. Insignificant loads can be covered by using lower limit of micro station, having a modern technical portable assessment. The power output of such device is sufficient for a single house or small business. Energy generation prices for off-grid application are in range 10 -18 cents / kWh.

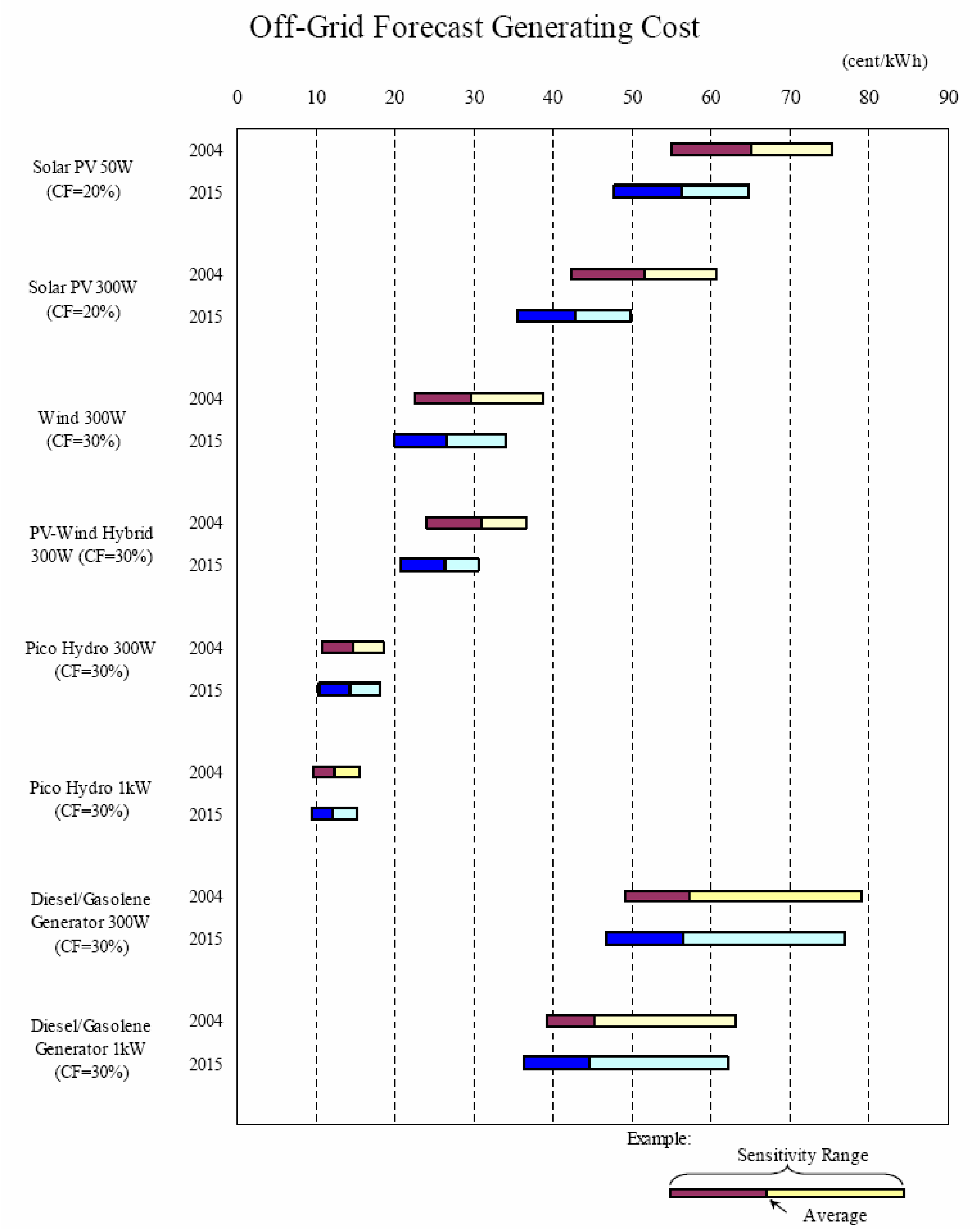

Figure 2 Off-grid generation technologies (2004-2015) Ref. Technical and economic assessment: Off-grid, Mini-grid and Grid electrification. Discussion report. The World bank 2005

Example of isolated application in Georgia

In 2003 micro hydro power plant was built in Bolnisi. The construction was ordered by *the boarder defence department*. Electrical capacity of the HPS is 50 kilowatt; average annual production – 349 500 kWh per year. Total costs of construction equal to: 112456 GEL ~ 47 000 €. Price of electricity produced in a year – 28000 GEL ~ 11 500 € (price of 1 kWh – 0.08 GEL). The HPS will produce the amount of electricity value of which will cover the construction costs in 47 000 : 11 500 ~ 4.1 years

The main reason why this project is so economically feasible is that in this case the department fully consumes whole electricity produced by Bolnisi HPS and there are no intermediaries between the energy production and energy consume.

Bolnisi SHP plants

General information

Name of the HPS	Bolnisi SHP
River	Poladauri
Region (exact location)	Bolnisi region, village Poladauri
Implementer/ers	"Energyprovide" Ltd.
Orderer / ers	Commendatory "Bolnisi" of the Boarder defence department
Actual owner/ers of the HPS	Boarder defence department
Operator	The station is being operated by the employees of the "Bolnisi" commendatory, trained by the "Energyprovide" Ltd. specialists

Technical Information

Max. electrical capacity	42 kW
Annual electricity production	0,35 mln. kWh
Water pressure	19 meters
Construction date and period	February 2003
Used water flow	0.3 m³ / sec
Specific technology used	Frensis Type turbine, produced by "Tbilaviamsheni" Ltd. Georgia

Financial information

Total investment	State Financing	Commercial loan	Equity	Public Funding
		-	-	-

Calculated payback Time	4 years

History of the project

The Commendatory “Bolnisi” of the Boarder defence department was using a micro HPS with a capacity of 1.5 kW, which was not enough to satisfy its electricity needs. There was an alternative to by the electricity from the central grid, but the central grid could not guarantee a non-stop supply which is vital for the Commendatory, so the idea of building a bigger HPS on the nearby river came up. The project was developed and implemented by the “Energyprovide” Ltd. with the support of the “Tbilaviamsheni” Ltd. It was financed by the Boarder defence department.

Specific advantages of the project

The main advantage of the project was the ideal situation in financing and electricity selling. There was no need to look for the credits (what is in deed very complicated in Georgia), because the project was financed by the State. But even more important is the fact that the “Bolnisi” commendatory consumes the whole electricity produced by the SHP. If there was no SHP the commendatory would have to by the electricity from the grid and pay 0.084 GEL (0.04 EURO) for the kW\h. If we calculate how big a payback time of the station is evaluating one kWh of electricity for 0.04 EURO, it is less than 4 years. This specific situation makes the project exceptionally advantageous.

There are many other places in Georgia with similar circumstances. The autonomous energy supply is very convenient especially for the mountain regions, both technically and financially, especially regarding the energy crisis and the central grid instability.

Environmental aspects of the project

Due to the very little used water flow and absence of the dam the ecological situation was practically not affected.

Technical assessment for Mini and Micro SHPs

Small hydro technologies are mostly quite old, basic elements of a small hydro power station have not experienced any dramatic changes in recent decades.

Mini-hydro technology is well established around the world, and is in generally accepted by private investors. The systems are simple enough to be built or refurbish locally at relatively low cost and have simple requirements, which gives rise to better long-term reliability including environmentally friendly aspects.

Larger mini hydro projects are envisaged for grid-connected applications, while smaller mini hydro projects are suitable for mini-grids. Micro projects are suitable for mini-grid application in upper limit and for isolated applications in lower limit.

A mini and micro- hydroelectric power project comprises two principle components – hydrotechnical and civil works (weir, dam, penstock etc.) and electro-mechanical works (turbines, generators, and controller). There is also hydropower plants, which are very small (e.g., 1 kW or 300W), and incorporates all of the electro-mechanical elements into one portable device, which is easy to install. For example, a 300W-class hydropower station can be installed by even by purchaser because of low (1-2 meters) waterhead, whereas, a 1kW requires a small amount of construction work because of the higher (5-6 meters) required waterhead but provides a longer and sturdier product life-span. They are typically installed on the river or stream embankment and can be removed during flood or low flow periods.

Current small hydropower equipment market provides us automated control systems to regulate voltage and balance loads that prevent lighting flicker and extend appliance life. It is to note, that during last five years the prices and technology for electro-mechanical equipment for small- and micro small hydropower projects is not changed dramatically.

Market assessment

Strength of the new off- and minigrid tendencies in the countries can assist to the restructuring and improvement of the market situation. It is clear that existing market barriers includes both the *demand side* (e.g., awareness, training, local ownership) and the *supply side* (e.g., business development services, market surveys, databases on renewable energy resource availability). To overcome such barriers and improve structure of energy supply in remote regions new *financing* schemes (e.g., small finance, consumer credit, and revolving funds) and *institution* building (e.g., government, regulators, quality assurance and certification institutions) are required.

Wide market entrance only is possible if it will be allowed private firms to make profit beyond the short term. As the ability to pay of public consumers in Caucasus and Carpathians is still low and long-term off-grid service costs are depend on individual case, market entry in rural off-grid markets is considered high risk. This requires identifying well balanced public private partnership mechanisms that will allow private-sector service delivery companies to build their business to the specific requirements of each local market.
Service delivery mechanisms may involve ESCOs (proposing concessions or contracting), equipment dealers (selling or leasing systems), or cooperatives – there are a number of financing models are available. Successful rural electrification projects will have to develop viable business plans and financial engineering sfor both sides.

Conclusions

The target of SHYCA project is to develop sustainable local markets for mini small hydro power service provision. The creation of off- grid applications requires innovative solutions for demand side; supply side, financing and institutional strengthening. Because of the high up-front costs of most rural electrification options and the low cash capacity of rural households, innovative *small scale financing* must be provided. Small credit, leasing and prepaid meters for fee-for-service provision seem to be the most promising options. The third party financing is to be considered. Projects may have to include the use of subsidies if the project should reach the poorest segments of population. How to design well balanced public private partnerships with maximum private sector participation and minimum subsidies is a crucial question for rural electrification.

Possibility of off-grid applications depends on socio-political frameworks of countries. So, in Armenia currently it is only possible to build mini-grids, because of prohibition on the governmental level and lobbying of national grid operator. Isolated applications and possible schemes of supporting are very new in the country and there is only one USAid programme, which issues the grants to build off-grid SHP applications.

Strong monopoly tendencies of main ESCOs block the creation of independent mini – grids. So, several firms having energy generation license in Azerbaijan and operating SHPs have a troubles to create own mini-net for villages. So, nowadays isolated “off-grid” applications are mostly feasible in the region and generally supply with electricity remote SMEs.

Utilising of power generation facilities in the Ukraine allow to create as well as mini grids and isolated applications. West Ukrainian territories have a dense power line network and it will be tried to improve it due to EU harmonisation trends. However, there are remote settlements that do not have enough sufficient energy supply. Current energy policy isolated applications are mostly useful for SMEs also. Mini – grids examples are not known.

In Georgia energy policy is allowing to create both mini-grids and isolated applications. But till now no single of mini-grid was constructed. Development of the “off-grid” facilities namely in Georgia can be very good options comparable with conventional energy supply because of geographical and climatic conditions.

Isolated applications are most favourable for Caucasus and Carpathians region because of simpler and prompt accession to the generated energy. However, the installation of mini-grids is hindered by general administrative constraint which results from lobby with national energy utilities. Future trends towards adding electricity and possible liberalisation of the market will lead to the market restructuring. The economical feasibility of off-grid applications in Caucasus countries and Carpathians can be achieved through different financial and structure schemes, including Joint Implementation or CDM mechanisms, and of course who have understood the economic and social benefits of decentralised electricity producers through proper understanding of relevant-makers.