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UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

UNIDO's SMALL HYDROPOWER STRATEGY

Building sustainable industries on renewable energy

Energy and Climate Change Branch
Renewable Energy Unit

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1 INTRODUCTION

UNIDO's goal for the development of small hydropower (SHP) is to provide energy access for productive uses and industrial applications that will trigger sustainable economic and social growth of the community. The use of SHP can contribute to poverty alleviation through sustainable socio-economic development, increasing employment opportunities for local people, improving living standards, and promoting environmentally friendly development. SHP has a substantial global potential for electricity generation in rural and remote areas that is still underexploited today, especially in Asia, Latin America and Africa (IEA, 2010). Therefore, SHP technology needs to be optimized and promoted to increase its efficiency and viability as a renewable energy source.

UNIDO has developed this strategy to facilitate the development and the promotion of SHP technology among energy producers and users. This development should be coherent, cost-effective and add value. At the same time, it should be in line with the priorities of the Member States and with UNIDO's recently adopted Renewable Energy Strategy which has been developed to prioritise activities in promoting renewable energy.

The Renewable Energy Strategy aims to put in place long-term objectives and promote areas of strategic outcomes, as follows:

1. Create business development opportunities through increasing access to energy through minigrids
2. Mainstream the use of renewable energy in industrial applications, in particular Small and Medium-sized Enterprises (SMEs)
3. Support innovative business models promoting renewable energy as a business sector

At the same time, the Renewable Energy Strategy has set specific quantitative targets based on successful implementation of ongoing projects in the next 5-years. The SHP strategy should contribute to help reach these targets by pursuing a three-fold strategy:

- Ensure lessons learned from past SHP projects are reflected in the design and implementation of new projects. In particular, by paying attention to the design and supply of key components such as intakes, control systems, distribution lines and transformers, to ensure strong and steady supplies of electric power.

- Support the use of SHP for industrial applications in SMEs, identifying productive uses at an early stage of project development.

- Develop business models and entrepreneurship for SHP, ensuring that ownership structures are acceptable for all main stakeholders, including beneficiaries. These objectives will be achieved by engaging with a full range of stakeholders, partnering with other UNIDO Branches and/or UN Organizations as well as fostering South-South partnerships. The focus during the next five years will be on dissemination and replication of successful projects, besides building technical and institutional capacity and implementing demonstration projects. Thus, a further boost in the path of sustainable industrial development, poverty reduction, energy security and a reduction in GHG emissions will represent the expected outcomes.

2 STUATION ANALYSIS

Hydropower plants of 0.1 to 10 MW in capacity[1] are considered to be SHP projects and work on a run-of-river (RoR) scheme powering the base load. Small scale hydropower plants have the same components as large ones and require less construction time and resources. SHP plants can be installed on small rivers or streams, with varying impacts on ecosystems depending on the site's geographical, hydrological and biotic characteristics. It is more fruitful to evaluate hydropower based on its sustainability performance and type of service provided as opposed to a classification based on technical units with little or no relevance to nature or society. All SHP plants like any hydropower plant are site specific and their output depends on the hydraulic head, flow rate during the year, geological and geographical features, equipment (turbines and generators) and civil engineering works. Making use of existing weirs, barrages, navigation locks and dams for small hydro plants can significantly reduce environmental impacts, costs and implementation time.

2.1 Energy Access and Role of SHP

Today, significant parts of the global population, especially in Asia, Africa and Latin America, have no (or limited) access to modern and clean energy services. Table 1 provides an estimate of 1.3 billion people without access to electricity in 2009 along with the projections by region for 2030 (IEA, 2011). The regional distribution indicates that a lack of access to electricity is entirely a developing country issue, particularly in sub-Saharan Africa and South Asia. The IPCC suggests in its Special Report on Renewable Energy Sources and Climate Change Mitigation (IPCC, 2012) that SHP can often be an economically viable option for providing electricity supply source through decentralized generation in areas with the hydropower potential. An example of this is China, where by the end of 2010, 45 thousand small hydropower plants totalling over 59 GW installed capacity produce 200 TWh per year providing services to more than 300 million people (Heng and Xiaobo, 2011). SHP plants can also be installed by using existing water resources infrastructure such as dams, barrages, navigation locks or irrigation channels, which are mostly located close to villages and towns with short high-voltage transmission and distribution lines and connected losses.

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[1] For the purpose of this strategy SHP will be considered ranging from 0.1 to 10 MW. Though many countries define the upper range of SHP up to 50 MW.

Table 1: People without access to electricity in 2009 by region and future projections in 2030 (IEA, 2011)

Region	2009			2030		
	Population (million)		Share of population	Population (million)		Share of population
	Rural	Urban		Rural	Urban	
Africa	466	121	58%	539	107	42%
Sub-Saharan Africa	465	121	69%	538	107	49%
Developing Asia	595	81	19%	327	49	9%
China	8	0	1%	0	0	0%
India	268	21	25%	145	9	10%
Rest of developing Asia	319	60	36%	181	40	16%
Latin America	26	4	7%	8	2	2%
Middle East	19	2	11%	5	0	2%
Developing Countries	**1,106**	**208**	**25%**	**879**	**157**	**16%**
World*	**1,109**	**208**	**19%**	**879**	**157**	**12%**

* World total includes OECD and Eastern Europe/Eurasia

As pointed out by Platt et al. (2011), developing countries need to develop power systems with low GHG emissions. Mini-grids represent a way of meeting such a challenge, as they facilitate large numbers of distributed generators and provide strong integration between supply and demand. A mini-grid is a group of controllable and physically proximate distributed generators and load resources that may or may not be connected to the large electricity grid. Mini-grids are better suited to power load variations when compared to the main grid because they are adaptable dynamic power systems and even though they manage a diversity of generation and complex power demand, they use relatively traditional control methods. For these reasons, developing mini-grids, in conjunction with SHP and other renewable energy technologies, could provide first time access to electricity for a large number of people throughout the world in a sustainable way.

2.2 SHP for Productive Use

SHP can bring substantial improvements to the quality of life for people living in areas with little or no electrification. However, pure electrification projects are expensive in rural or isolated areas, as these areas normally have very low load factor (utilization) in the absence of productive daytime activities and only peak consumption in the evening for domestic purpose. In 1995, the World Bank reported that rural electrification alone does not directly influence the reduction of poverty. Most of the poor cannot afford electricity mainly because of the high entry costs (grid connection and house wiring), as it has happened in Kenya, Tanzania and Rwanda. Nevertheless, if the electrification program is designed in conjunction with related productive activities, then the probability of the project's success increases because the local economy will start developing. For these reasons, UNIDO has decided to support SHP projects for productive uses that can bring integral benefits to the local community.

2.3 SHP Electricity Generation Costs

The cost of electricity generation from SHP depends considerably on economics of scale. REN21 published in its 2012 Renewable Global Status Report (REN21, 2012) a comparison of the electricity generation costs for various hydropower technologies, as seen in Table 2. Other renewable energy sources for rural and semi-urban applications are included for comparison.

Table 2: Generation cost comparison of different renewable energy technologies (REN21, 2012)

Technology	Power Generation Capacity	Generation Costs (US cents/kWh)
Hydropower (grid-based)	1 MW–18,000+ MW	5–10
Hydropower (off-grid/rural)*	0.1–1,000 kW	5–40
Biomass gasifier	20–5000 kW	8–12
Small wind turbine	3–100 kW	15–25
Solar home system	20–100 W	40–60

* Small capacity plants in some areas may exceed these costs.

Compared to other renewable energy technologies, SHP competes well against biomass, small wind turbines and solar systems.

The IPCC (2012) indicates that 75% of the costs for SHP projects are site specific and vary depending on the site selection. The investment costs have two major components: (i) civil construction costs are always site specific and follow the price trend of the country where the project is to be developed; and (ii) costs related to electromechanical equipment, which follow the world market prices. SHP plants usually require low maintenance and therefore the operating and maintenance (O&M) costs are low. The O&M costs are most of the times expressed as a percentage of investment cost per kW (IPCC, 2012). The O&M costs of small scale hydropower may be 3 – 8% of the investment cost depending upon the plant size and specific site conditions.

Even though SHP technology competes well against other technologies with similar generation capacity, its development has been hindered because in many situations SHP plants are required to be combined with other generation sources to ensure continuous supply during dry periods and natural seasonal flow variations (World Bank, 2008). Additionally, SHP projects take long for planning, permitting and construction. Investments from the private sector can help in speeding up the SHP development. On the other hand investors are faced to uncertainty and risks because of long planning, permitting and regulatory processes which needed to be reduced by appropriate policy and financing models.

2.4 Barriers for SHP Development

SHP projects generally face similar barriers to other renewable energy technologies, such as the absence of suitable policies, institutional and technical capacities, implementation and financing. These barriers can be broadly grouped into four categories, as follows.

2.4.1 Lack of suitable policy, legal and regulatory frameworks

Policy barriers include lack of information, awareness and understanding of renewable energy sources, technologies and designing policy options or how to implement the energy transitions. Conflicts with existing regulations, use of conventional approaches and lack of skilled workers can also undermine the development of projects from a political and administrative point of view. The lack of support from the local government heavily influences the development of SHP projects, as well.

2.4.2 Inadequate access to finance

The capital costs of SHP plant installations are high, but the operating and maintenance costs are low. This means that a large part of the project's overall cost is spent at the development stage. Problems to access adequate financing rely on the fact that during the planning stage, there is no proper project cost estimation to evaluate the balance of the capital costs against the magnitude and speed of energy output (revenue of the project) whether the project is worth pursuing, and if so, to plan the subsequent budget (Aggidis et al., 2010). The life cycle cost of electricity for SHP is low and requires long term financing for meeting initial high capital. The risks imposed by the long-term planning and regulatory processes may also slow down the access to an appropriate financial mechanism. Finally, the environmental externalities may be difficult to evaluate in comparison to conventional energy sources, so the reduced environmental costs from SHP might not become evident.

2.4.3 Lack of relevant SHP knowledge

The lack of basic knowledge with respect to selection of an appropriate site, associated civil works, equipment for SHP technology can hinder the output, performance and benefits of a project. An established flow rate and head are necessary for a RoR scheme to deliver a required power output that could be used by the local industry. Furthermore, the chosen technology used in the project must be designed to withstand the variations of climatic and physical conditions in a specific region.

2.4.4 Lack of technical capacity

The absence of technical capacity may obstruct the continuous operation of SHP plants in a situation of faults/damage to the equipment caused by the lack of operating and maintenance facilities and personnel. The site's climate and operating conditions must be taken into account, when choosing the best equipment that can withstand such conditions. Additionally, the cost of long transmission and distribution lines to transmit the electricity from power plants to the users may reduce the profitability of the project, together with the amortization time and the project cycle. Lack of technical capacity also obstructs the replication process.

2.5 Environmental and Social Considerations

SHP projects can have negative impacts to the environment and society if they are poorly planned. The environmental impacts are mainly related to the transformation of rivers and ecosystems due to the construction of channels and the alteration of river flows (Abbasi and Abbasi, 2011). The alteration of water flows, such as the broadening of stream bed and the reduction of discharge and velocity may cause shrinking or replacement of indigenous aquatic species. Additionally, SHP projects may change the level of suspended solids in the water to some extent and have negative consequences for flooding and water supply at any abstraction point downstream of the scheme. Land acquisition, physical resettlement as well as the loss of lands with agricultural and historic values can be considered as examples with negative social impacts.

In order to estimate and mitigate these risks UNIDO has adapted the Guidelines for SHP Systems, developed by UNEP and BASE[2] (see UNEP and BASE (n.d.)). These Guidelines comprise various kinds of environmental and social risks, as well as environmental opportunities that SHP projects face. In line with this guideline, UNIDO will assess its SHP projects.

The checklist given in Annex 2 comprises the environmental and social risks during the constructional and operation activities may arise, under the following categories:

- Effluent emissions onsite contamination hazardous materials issues;
- Biodiversity protection issues;
- Environmental issues sensitive to public opinion and;
- Worker health and safety issues.

Furthermore, the checklist also comprises the environmental opportunities to present more balanced view of positive and negative impacts of a particular project.

2.6 UNIDO's Interventions in SHP Projects

UNIDO has implemented several SHP projects in the past, as shown in Box 1.

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[2] Basel Agency for Sustainable Energy

Box 1: Development and installation of SHP plants

India:
- 110 kW plant in Mankulam Kerala. Status: in operation

Zambia:
- 1 MW plant. Status: in operation

Indonesia:
- 30 kW plant in Nias Island. Status: in operation

Kenya:
- Implementation of 10 model pico hydro systems donated by the International Center for Small Hydro Power, Hnagzhou, China.

Rwanda:
- Two 100 kW plants. Status: in operation
- Two 200 kW plants. Status: in operation

Nigeria:
- 30 kW plant in Enugu. Status: in operation
- 150 kW plant in Bauchi. Status: in operation
- 400 kW plant in Taraba. Status: under construction
- 1.2 MW plant in Akoke. Status: under construction
- 90 kW plant in Akure using locally manufacture turbines. Status: under construction

Tanzania:
- 10 kW plant in Kinko. Status: in operation

India:
- Demonstration of ultra low-head SHP plant technology from Japan in the State of Uttarakhand. Status: under planning

Projects related to capacity building activities, feasibility studies and investment promotion have also been developed, as seen in Box 2.

Box 2: Projects on capacity building, feasibility studies, technology transfer and investment promotion

- Technology transfer for local manufacture of cross flow turbines of up to 100 kW in Nigeria.
- Training courses for water-turbine design in Sri Lanka.
- Know-how transfer from Sri Lanka to Rwanda for the construction of four micro-hydro power projects.
- Development of a national master plan for SHP exploitation in Madagascar, Zimbabwe and Mozambique.
- Training at the International Center on SHP, Hangzhou, China, of selected experts from Latin America and Asian countries for SHP application, development of feasibility studies, technology adoption, assessment of social impacts, technical competencies, design and implementation of SHP projects.
- Seminars in Hangzhou, China on SHP development and policy with participants from UNIDO Member Countries, with a special priority for African countries having abundant hydropower resources.
- Development of feasibility studies, including the technical design and full implementation of 30 kW demonstration plants in Madagascar, Zimbabwe and Mozambique, with the involvement of local authorities in cost sharing for the civil works.

Research and development activities are important for the proper development of an SHP project. However, the sharing of information among Member States is also important to increase the value, enhance the efficiency, achieve economy of scale and promote networking and joint activities. With this regard, UNIDO organizes Expert Group Meetings (EGMs) to share information about the best practices related to the design, production and application of SHP technologies, as presented in Box 3.

Box 3: Research & development and networking activities
Project outcomes: • Expert Group Meeting (EGM) in Central American countries to discuss regional needs for the establishment of a regional SHP technology center. • EGM in China to discuss the need for the expansion of a dedicated SHP technology base dealing with SHP technology adoption, training, management, maintenance and refurbishment. • EGM in Argentina to discuss national needs for the establishment of an SHP Technology Center dedicated to research and development and financing mechanisms to support renewable energy.

3 UNIDO STRATEGIC APPROACH

Greater deployment of SHP worldwide can only be achieved if the necessary level of investment is available. An enabling environment needs to be created in order to attract investors, develop market incentives, remove barriers, reduce the risks, foster technology transfer and sharing of the best practices. To achieve this objective, UNIDO works on creating an enabling environment for promoting SHP with productive uses by following guiding principles:

3.1 Respond to Priorities and Needs of Member States

Due to the fact that SHP projects are site specific, depending on the region's hydrology and topography, UNIDO will develop projects that are needs driven and will seek to apply proper SHP technology given the region's physical and economic conditions to provide energy solutions that maximize local resources.

3.2 Engage at Multiple Levels with a Full Range of Stakeholders

For the development of SHP projects, UNIDO not only makes use of its expertise in headquarters, country, field and regional offices, but consults with key stakeholders at various levels, such as:

- Local communities: they play a large role in the development of SHP projects as they can be organized in a cooperative for electricity that could help in building stronger project ownership, reduce costs, have productive end use, and build local capacity;

- Private investors: they can help to boost the investments in SHP projects because Governments alone might not be able to manage power generation due to difficulty in obtaining and mobilizing funding;
- Donor organizations: to whom SHP projects, can be offered/persuaded as an appropriate opportunity of people's development and poverty reduction;
- Existing or budding independent power producers;
- National and regional governments;
- Local suppliers and manufacturers: establishing a network of local SHP equipment suppliers and manufactures could boost the community's economic growth and create expertise that could serve as a basis for the development of new projects.

Finally, the stakeholders will benefit from UNIDO's technical assistance in creating an enabling policy environment and establishing mechanism for technology transfer, institutional and technical capacity building, South-South cooperation and investments in demonstration projects.

3.3 Partnership with Other Branches and/or UN Organizations

The Renewable Energy Unit, as part of the ECC Branch, aims to make the best use of synergies with other branches within UNIDO and other UN and international organizations to maximize the end-user impact of SHP projects.

UNIDO's projects are often funded by the GEF (Global Environment Facility), but also by its own resources and bilateral cooperation. However, for the period from 2012 to 2018 the development of SHP projects under the Renewable Energy Program will consolidate existing projects and their funding streams; develop a new portfolio of GEF projects that will focus on promotion of private sector participation; and diversify the funding sources, including Public Private Partnerships (PPPs), Energy Services Companies (ESCOs) and Special Purpose Vehicle companies (SPVs).

3.4 Build Technical Capacity

The development of SHP plants requires specialized skills. A common deficiency observed in the project development stage is that owners and project managers lack necessary knowledge or experience in project execution. SHP projects installed as off-grid technology often do not adequately take into account the capacity development activities required for adoption. UNIDO considers the cost of capacity development as part of the program's budget per beneficiary because it constitutes a significant portion of the overall SHP development costs especially during the initial stages. According to the report from Clemens et al. (2010), which represents an analysis of two scaled up national programmes in Nepal[3], the whole capacity building cost represented 56 % of a total budget of 14.3 USD Million from 1996 to 2006.

In general, capacity development efforts should cover the following areas:

- Planning, oversight, and monitoring;
- Site sensitivity analysis;
- Standard equipment adoption;
- Stakeholder dialogues, communication and community mobilization;
- Setting up and enhancing institutions and their capacity;
- Training programs for project developers, facilitators, financial institutions and community members;
- Implementation and management;
- Preparation of manuals and handbooks;
- Setting up facilities for the local manufacture of different parts for SHP.

UNIDO has established a Regional Centre for SHP in Africa located in Abuja, Nigeria and another in Thiruanathapuram (Kerala), India. Additionally, the International Center on Small Hydropower (IC-SHP) was established in Hangzhou, China, co-sponsored by UNDP, UNIDO, the Ministry of Water Resources and the Ministry of Foreign Trade and Economic Cooperation of the People's Republic of China. Regional Centers and the IC-SHP, promote regional networks and partnerships to contribute to the wide spread adoption of SHP projects for productive uses.

3.5 Demonstrate Technology Use

The build up of SHP demonstration plants and electricity distribution systems aims to show the state of the art in planning, designing and constructing of SHP projects. Demonstration projects shall show the sustainable delivery of electricity for productive uses and/or trigger new productive activities, and simultaneously reduce poverty.

These projects should also encourage capacity building with the government for the promotion of SHP, including the development and replication of successful business models to strengthen the South-South cooperation. Thus, the project formulation will focus on technology transfer, replication and scale-up and integrated activities aimed at addressing barriers as well as reducing the risks to private sector investment in SHP projects.

Finally, UNIDO supports demonstration projects only after careful investigations and planning have been done, and only if the needed conditions are satisfied. UNIDO requests monitoring, evaluation and reporting of each project for suggesting preventive and corrective measures.

[3] National Micro-Hydropower Programme and the National Improved Cooking Stoves Programme

3.6 Policy Development

The development of adequate enabling policies is a key element to boost the development of SHP projects. UNIDO assists Member States in policy formulation for the development of SHP projects through its Regional Center for SHP in Nigeria, and the IC-SHP in China. Additionally, these Centers assist Member States in the following activities:

- Advice in the formulation of appropriate legislative frameworks to encourage private investment in the development of SHP;
- Promote SHP development through technical cooperation among the countries of the region;
- Exchange information on SHP development and management through workshops, seminars, publications etc;
- Assist in the development of a regional market for SHP technologies and expertise;
- Elaboration of adequate policy frameworks to avoid conflicts on a national and international level.

3.7 Leverage External Financing

The upfront costs for SHP projects are high and long-term financing is often not available for renewable energy projects in developing countries. Therefore, UNIDO together with the host country, seek to develop appropriate financing models that include the inherent risks of long-term planning and regulatory processes, and try to find the optimum roles for the involvement of public and private sectors.

For projects supported by UNIDO, it may neither be feasible, nor desirable in the interest of development, to provide financial assistance for all the components/activities of a project. The country are supported and encouraged to create mechanisms for funding through loans, technical expertise, capacity building and, if necessary, subsidies. Such windows of financial support should be incorporated as a contribution of the host government through its own funds or other sources to the project and ensure the program's continuity, after it has been completed. Similarly there may be other donor agencies working in the country with which UNIDO could coordinate their program in mutual consultation.

4 STRATEGIC OBJECTIVES 2013-2018

UNIDO has set up a strategy to clearly define its goal for SHP projects. A set of objectives have been established to reach this goal, together with various activities that facilitate reaching each objective.

4.1 Goal

UNIDO's goal for the development of small hydropower (SHP) is to provide energy access for productive uses and industrial applications that will sustainably trigger economic and social growth for the benefit of the community. The SHP projects targets have been defined in accordance with the key targets of the Renewable Energy Strategy (RES). Accordingly the SHP projects will contribute to the overall RES targets through reaching the following expected results by 2018:

Indicators based on successful implementation of SHP projects by the end of 2018	
Number of people gaining access to energy:	70,550[4]
New SHP capacity installed:	~8- 10 MW
Total SHP energy generated:	>45 GWh/year
Million tons of CO2eq avoided:	>1 million tons direct[5]
Number of SMEs benefiting from projects:	~115

4.2 Strategic Objectives

In following the defined strategic objectives will be explained in more detail.

4.2.1 Ensure lessons learned from previous projects are reflected in the design of new SHP projects

UNIDO will help countries identify target areas of SHP electrification programs, implementing the following work-flow:

1. Development of a work plan, together with the host country, including collecting and creating reliable technical data about the region's hydrology, topography and climate; information about the region's renewable energy sources to determine an optimal energy mix; and data of natural and agricultural resources that could provide raw material for regional industries and SMEs.
2. Pre-feasibility studies.
3. Collecting socio-economic information necessary to (i) identify target beneficiaries and determine their needs, (ii) define the kind of assistance to be provided, and (iii) identify the local organizations able to participate in the project.

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[4] Calculated on the basis of MWh/year generated as a result of projects divided by average electricity consumption per capita in a given country (based on 4 projects), using World Bank Statistics 2009

[5] Based on emissions over the lifetime of projects (typically between 10-20 years, depending on technology and size of project)

4. Feasibility studies reflecting country and site specific needs on the design and supply of key components such as intakes, control systems, distribution lines and transformers, to ensure strong and steady supplies of electric power. Annex 1 contains a checklist to support project managers to develop projects with maximized impact and to support UNIDO to review the pending SHP projects. The checklist comprises minimum requirements for the design, development and implementation of small hydropower projects.
5. Development of demonstration projects.
6. Manuals and hand books

4.3 Support the use of SHP for industrial applications in SMEs

UNIDO will seek to strengthen the capacity of support institutions in the public and private sectors to assist small and medium enterprises meeting their energy demands from SHP projects. Actions to achieve this objective will focus on:

7. Promotion of appropriate technology transfer to be used by SMEs.
8. Identify productive uses at an early stage of project development.
9. Provide training to members of public institutions and private companies.
10. Capacity strengthening of local enterprises to undertake the manufacture, assembly, repair and maintenance of SHP equipments and works.

4.3.1 Development of business models and entrepreneurship for SHP

UNIDO will support local entrepreneurs to create sustainable enterprises that can deliver reliable energy services based on SHP. Actions to achieve this objective will focus on:

1. Assistance to counterparts in the host country to carry out market surveys for identifying the potential energy users and income-generating productive activities, ensuring that ownership structures are acceptable for all main stakeholders, including beneficiaries.
2. Targeting capacity development for SHP as a business opportunity.
3. Fostering up-scaling and replication of appropriate SHP business models.

4.4 Tools for Implementation

Based on the strategy and the activities discussed above the following tools for implementation are proposed.

1. Create awareness and build capacity, in order to enable governments in member countries to support the development of SHP.
2. Reduce the gap between experts and policy makers for harnessing SHP through the creation of policy frameworks.

3. Demonstrate the technical, environmental, economic and social feasibility of SHP for energy access and industrial applications.
4. Develop bankable projects based on sound feasibility studies of potential SHP sites that can attract international funding or investment in order to boost industrial growth and productive activities in the region.
5. Promote partnerships between public and private organizations to increase the sources of funding and human and technical resources.
6. Promote long term local capacity not only to operate and maintain SHP plants but also to design and manufacture them locally for wide spread replication.
7. Contribute to policy and regulatory frameworks for SHP development.
8. Remove the barriers that hamper the full development of SHP markets.
9. Promote successful SHP programs to attract local and international entrepreneurs to increase the development of SHP.
10. Promote networks, partnerships, synergies and knowledge management on SHP including dissemination of lessons learned and sharing of best practices among all stakeholders.
11. Enhance and timely deliver SHP solutions by working with UNIDO's accredited strategic partners, the existing network of UNIDO international, regional and national centers, as well as its ITPOs[6] network and regional offices.

4.5 Monitoring and Evaluation of Results and Impacts

The SHP projects developed under the assistance of UNIDO will be measured by mechanisms for capturing and communicating the success, results and impacts in their respective community. The monitoring and evaluation of SHP projects will be carried out in accordance with the Monitoring and Evaluation Framework for UNIDO's renewable energy projects, measured against the key targets contained in section 4.1.

The strategy will be evaluated and reviewed after the end of the implementation period, i.e. after 2018, to ensure that the global context and realities of the renewable energy market are reflected in future actions.

[6] UNIDO-Investment and Technology Promotion Office

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ANNEX 1. SMALL HYDROPOWER CHECKLIST

The purpose of this checklist is to support project managers to develop projects with maximized impact and to support UNIDO to review the future small hydropower projects. The checklist comprises minimum requirements for the design, development and implementation of small hydropower projects.

1. Programmatic basis	
Pilot projects are based on systematic programmatic planning, which includes systematic review of literature and resource assessments, and notes UNIDO's role in providing strategic support to governments, rather than implementing pilot projects as an end in itself.	☐ Yes ☐ No
2. Feasibility Studies	
Feasibility studies are carried out for individual project sites. The studies are based on at least monthly discharge data based on measurements, address silt load management, include cost-benefit analyses, and take regional and national electrification plans and policies, and environmental risks into account.	☐ Yes ☐ No
3. Reporting, accounting and learning mechanism	
Clear reporting mechanisms are foreseen in the project document, including regular project progress reports and evaluations of the outputs and outcomes as well as lessons learnt. Findings of previous related evaluations are taken into account.	☐ Yes ☐ No
4. Reasons for Intervention	
The project document clearly describes the reasons for the intervention and ensures the projects are in line with regional and national development strategies.	☐ Yes ☐ No
5. Productive Uses	
In line with UNIDO's mandate to foster electricity for productive uses, the project document showcases the package of dedicated activities to ensure the promotion of such productive uses.	☐ Yes ☐ No
6. Tariff Structures and Economic Sustainability	
Expected tariff structures are explained as part of the project document and ensure the economic and financial viability of the project. The electricity tariffs don't undermine private sector based user models and are based on a careful assessment of complementary electrification projects and plans.	☐ Yes ☐ No
7. User Models	
Sustainable operation and maintenance of the projects is ensured through community based or private sector based user models (recognising that cooperative management structure require hands-on assistance over a long period time).	☐ Yes ☐ No
8. South-South Cooperation	
The potential for South-South technology transfer with a focus on know-how transfer (as opposed to sole technology donations) has been investigated and is incorporated into the project appropriately.	☐ Yes ☐ No

ANNEX 2. ENVIRONMENTAL RISKS AND OPPORTUNITIES GUIDE FOR SHP SYSTEMS (SOURCE: UNEP AND BASE (N.D.))

Activity		**Environmental and Social Risks**				**Env. opportunities**
		Effluent emission onsite contamination hazardous materials issues	***Biodiversity protection issues***	***Environmental issues sensitive to public opinion***	***Worker health and safety issues***	
Construction	***Earthworks***	Contamination of surface water with dust, construction materials, oil, grease, hydraulic fluids, etc.	Eutrophication of water ways downstream from construction site	Visual impact	Social consequences of increased migration to plant site: Insufficient and/or inadequate housing, public health problems, etc.	Developmental opportunities: creation of infrastructure, employment opportunities, etc
			Loss of fauna and flora	Disruption of sites with historic/cultural/religious significance		
				Noise		
	In stream barriers (dams and diversion work)		Creation of fish migration barriers	Threat to human life and property in case of dam failure	Occupational Accidents	
			Alteration (change, degradation, loss) of aquatic habitats	Visual Impact		
	Transmission lines and access roads		Impact on fauna and flora	Land use		
				Visual impact		
Operation	***Reservoir impoundment***		Loss of aquatic, wetland and/or terrestrial habitat due to flooding	Increased concentrations of methyl-mercury in fish species	Public health risks (e.g. risk of dengue or malaria epidemics) due to increase of disease vectors, such as flies, mosquitoes and other pests, due to reservoir	Avoided CO2 and other air pollutant emissions from deployment
			Changes in fish communities	Loss of land with agricultural/historic/cultural/ scenic value		
			Detrimental effects on downstream aquatic ecosystems due to the release of anoxic water and/or increase in suspended solids	Changes in water quality due to changes in natural sediment loads		Recreational opportunities
				Visual impact		
				Public health risks (e.g. risk of dengue, malaria epidemics) due to increase of disease vectors such as flies, mosquitoes and other pests, due to reservoir		
	Regulated (altered) flow		Changes to aquatic habitats or ecosystems, particularly habitat and species loss or depletion	Insufficient flow for downstream and instream users (farming, fishing, irrigation, and other economic uses of water, and recreation uses such as canoeing and rafting)		Beneficial effects on ecology: e.g. reduced erosion of the river bank due to slower water flows; improved micro-climate from the additional moisture, raised water table
				Changes in water quality (higher pollutant concentrations, increase in suspended solids due to erosion of river banks and beds)		
			Changes in terrestrial habitats due to increased erosion of river banks	Threat to human life and property during sudden releases		
	Maintenance	Emissions of pollutants due to O&M practices onsite		Changes in water quality (higher pollutant concentrations)		

Note: The appropriate risk rating letter, L (Low/No risk), L-M (Low to moderate), M (Moderate), M-H (moderate to high) and H (High), can be entered in this matrix.