Renewable Energy for Smallholder Agriculture (RESA)

An Approach for Mainstreaming Renewable Energy in IFAD Operations

Abbreviations

ADB	Asian Development Bank
ADFD	Abu Dhabi Fund for Development
AECF	Africa Energy Challenge Fund
AEPC	Alternative Energy Promotion Centre
AFD	Agence Française de Développement
AfDB	African Development Bank
ARD	Agriculture and Rural Development
ASAP	Adaptation for Smallholder Agriculture Programme
ASHA	Adaptation for Smallholders in Hilly Areas Project
AVSF	Agronomes et Vétérinaires sans Frontières
BMGF	Bill & Melinda Gates Foundation
CAES	Centre for Agricultural and Environmental Studies, Cambodia
CIF	Climate Investment Fund
COSOP	Country Strategic Opportunities Programme
CPE	Country Programme Evaluation
CSN	Country Strategy Note
CTI	Climate Technology Initiative
DEG	German Investment and Development Company
DFID	Department for International Development
ECG	Environment, Climate, Gender and Social Inclusion Division
FAO	Food and Agriculture Organization
FMO	Netherlands Development Finance Company
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HLPF	High Level Political Forum
IAEA	International Atomic Energy Agency
ICAR	Indian Council of Agricultural Research
IEA	International Energy Agency
IIED	International Institute for Environment and Development
IIT	Indian Institute of Technology
IMI	Initiative for Mainstreaming Innovation
IFAD	International Fund for Agricultural Development
IPAF	Indigenous Peoples Assistance Facility
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
JREDA	Jharkhand Renewable Energy Development Agency
JTELP	Jharkhand Tribal Empowerment and Livelihood Programme
KfW	Kreditanstalt für Wiederaufbau
KIF	Danish Climate Investment Fund
KWAMP	Kirehe Community Based Watershed Management Project
LAPA	Local Adaptation Plan of Action
LDF	Louis Dreyfus Foundation
MICS	Middle Income Countries
MNRE	Minstry of New and Renewable Energy
NBP	National Biogas Programme
NCF	Nordic Climate Fund
NCSD	National Council for Sustainable Development
NDCs	Nationally Determined Contributions
NDF	Nordic Development Fund

NORAD	Norwegian Agency for Development Cooperation
PAU	Punjab Agricultural University
PBAS	Performance Based Allocation System
PMI	Production, Markets and Institutions Division
PRaREV	Programme to Reduce Vulnerability to Climate Change and Poverty of Coastal Rural Communities
REN21	Renewable Energy Policy Network for the 21st Century
RESA	Renewable Energy for Smallholder Agriculture
RET	Renewable Energy Technology
RMF	Results Management Framework
RUA	Royal University of Agriculture, Cambodia
SAIL	Sustainable Agriculture Investments and Livelihoods Programme
SCCF	Specail Climate Change Fund
SDGs	Sustainable Development Goals
SEAC	Solar Energy Association Cambodia
SECAP	Social Environmental and Climate Assessment Procedures
SHS	Solar Home Systems
SME	Small Medium Enterprise
SNV	Netherlands Development Organisation
SPIS	Solar Pumping Irrigation System
SPRERI	Sardar Patel Renewable Energy Research Institute
SREP	Scaling Up Renewable Energy Programme
SSTC	South South Triangular Cooperation
S-RET	Building Adaptive Capacity through the Scaling Up Renewable Energy Technologies Project
UMICs	Upper Middle Income Countries
UNDP	United Nations Development Programme
UNEP	United Nations Environemnt Programme
UNFCCC	United Nations Framework Convention on Climate Change
WASH	Water, Agriculture, Sanitation and Hygiene

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Introduction

1. This document presents an approach for mainstreaming renewable energy technologies (RETs) in the operations of the International Fund for Agricultural Development (IFAD), as a way for speeding up rural poverty alleviation efforts. The Renewable Energy for Smallholder Agriculture (RESA) approach enables IFAD to systematically invest in, and scale up, renewable energy for smallholder agriculture through the transfer of existing and emerging RETs, and by pursuing North-South, South-South, and Triangular Cooperation (SSTC). Through the RESA approach, IFAD will move towards achieving its vision of inclusive and sustainable rural transformation. The intended audience for this approach includes IFAD beneficiary countries, implementing agencies, technical partners, bilateral and multilateral donors, and specialized renewable energy (RE) funding agencies, as well as IFAD senior management, country programme managers, project design teams, and project staff.

2. The rural energy gap is a critical barrier to improving smallholder agricultural production and post-harvest value addition. Through a more targeted channelling of financial and technical resources, a technological leap can be stimulated in the agriculture and rural development (ARD) sector.

3. Renewable energy is energy derived from natural processes that are replenished at a faster rate than consumed (for example – solar, wind, hydro etc. see Annex I) (IEA 2018). Using renewable energy resources along agricultural value chains can help improve energy access and security, diversify farm and food processing revenues, avoid food waste, remove dependence on fossil fuels, and reduce greenhouse gas (GHG) emissions while at the same time building adaptive capacity of smallholder farmers to withstand climate shocks. Access to RETs thus offers an unprecedented opportunity to accelerate the transition to clean energy and to provide multiple benefits for smallholder households, rural communities, and the environment.

4. Approximately 1.06 billion people, about 14% of the global population, live without electricity (REN21 2018). If developing countries follow the same high carbon path to industrialization as developed countries, there will be a significant loading of GHGs in the atmosphere; thus accelerating climate change and its corollary effects of heat and water stress, salinity intrusion, spread of diseases, loss of biodiversity, and an increase in extreme events. Smallholder farmers, while only a limited contributor of GHGs globally, are highly affected by climate change given their livelihoods depend on climate-sensitive ecosystems and resources. As such, there is both an economic and environmental rationale for accelerating the transition to renewable energy and for reversing the constraints that low electrification and poor energy access have on agricultural production and post-harvest processing.

5. The RESA approach aligns with the 2030 Agenda for Sustainable Development[1], where powering smallholder agriculture with renewable energy directly relates to the following Sustainable Development Goals (SDGs): 1) *no poverty;* 2) *zero hunger;* and 7) *affordable and clean energy*, and indirectly relates to several others (SDGs 8, 9, 12, 13 and 17) (UNDP 2018). The RESA approach also supports countries to achieve their obligations under the Paris Agreement (UNFCCC 2018) by

[1] Transforming our world: the 2030 Agenda for Sustainable Development

contributing to their GHG reduction targets under the respective Nationally Determined Contributions (NDCs).

6. The current strategic framework of IFAD contains a vision of "inclusive and sustainable rural transformation" with an overall goal for "poor rural people to overcome poverty and achieve food security through remunerative, sustainable and resilient livelihoods". The framework involves three main strategic objectives and covers several areas of thematic focus, out of which the RESA approach will assist in the achievement of strategic objective (SO) 1, "increase poor people's productive capacities", and SO 3, "to strengthen the environmental sustainability and climate resilience of poor rural people's economic activities". The approach will also assist in meeting IFAD11 commitments, specifically relating to "strengthen[ing] IFAD's role as an assembler of development finance to expand the programme of work to US$8.4 billion" and for advancing cross-cutting themes of gender equality and empowerment, nutrition-sensitive agriculture, youth employment, and climate change. In addition, it will support the operationalisation of the IFAD environment and climate change strategy in which renewable energy is identified as an important theme. The niche in which IFAD operates, its experience with RE components in past projects, and the strong partnerships established, make IFAD a key player in the promotion of renewable energy for smallholder agriculture.

7. The RESA approach builds upon IFAD experiences in over 18 countries and from several projects/initiatives, especially from those funded by the Adaptation for Smallholder Agriculture Programme (ASAP), which was instrumental in advancing a more holistic approach to the integration of RETs into projects. There is a wealth of IFAD knowledge supporting the development of the RESA approach, which includes over two decades of lessons learned from initiatives promoting renewable energy solutions in smallholder agriculture (see Annex II and III). The approach is also informed by state-of-the-art knowledge from partner agencies' RE promotion efforts.

8. The **overall aim** of the RESA approach is to mainstream RETs into IFAD operations to power smallholder agriculture production and post-harvest processes. The approach contains the following **objectives**:

   i. Provide affordable and productive renewable energy solutions to smallholder farmers.
   ii. Establish functional linkages, partnerships and networks to enable scaling up of RET in the ARD sector.
   iii. Improve access to financing for RETs.
   iv. Training and capacity building for rural youth entrepreneurs and smallholder farmers.
   v. Disseminate lessons learned and best practices.

9. The RESA approach is divided into the following sections: Section 1 presents the overall context and discusses the energy needs of smallholder farmers, the uses and benefits of renewable energy and IFAD experiences with RE; Section 2 presents the objectives and main components of the approach; Section 3 describes potential challenges and ways for overcoming these for scaling up

of RE in IFAD operations; and Section 4 outlines the results monitoring and evaluation framework, followed by the conclusion.

Section 1: Overall Context

1.1 The Role of Renewable Energy in Smallholder Agriculture

10. As stated in IFAD's strategic framework, two things have become increasingly evident in the ARD sector: "the first is that farming at any scale is a business, and smallholders and producers must be treated as entrepreneurs. The second is that businesses need clear linkages along the value chain, from production to processing, post-harvest handling, marketing and, ultimately, to consumption" (IFAD, 2016). In this regard, it is clear that without affordable and readily available energy, transforming smallholders and producers into entrepreneurs will be an insurmountable challenge.

11. A steady source of energy for smallholder farmers can thus contribute to improving agricultural production through pumping water for irrigation, fish farming, livestock rearing, primary processing, or small-scale industries, to name a few[2]. Many of these activities require only small amounts of power (from 100W to 3kW) and yet it is scarce, and where available, it is expensive and highly polluting.

12. Similarly, the role of energy in value-addition processes such as grinding, rice hulling, drying, packaging, threshing, milking, lighting (to extend hours for small businesses) and storage (refrigeration, ice making) is vital. For example, the outcome of introducing motorized milling is significant - grinding a week's supply of maize meal can be reduced from anywhere between 8 - 15 hours to a mere 10 minutes (IIED, 2012). Table 1.1 below provides a brief overview of different RETs and their most common applications related to agricultural production and post-production processes.

Table 1.1: RETs and common applications for production and post-production processes

Energy source	Common technologies and applications
Solar energy	➢ Photovoltaic (PV) driven pumps for irrigation and potable water. ➢ Direct use (DC appliances) for milling, hulling etc. ➢ Drying, cooling and storage of produce (fish, meat, fruits and spices). ➢ Small-scale solar home systems (SHS) for charging mobile phones, running radios and TVs (for accessing weather information etc.) ➢ Livestock watering, solar aeration pumps for fish ponds and shrimp farms, solar lights for livestock security, poultry incubators. ➢ Mini-grids for village level electricity, electric fences to stop crop raiding.
Wind energy	➢ Direct use, grinders, mechanical / electrical water pumps.
Micro-hydro energy	➢ Direct use, grinders, mills, electrical motors for processing activities. ➢ Run-off-river household electricity generation.
Biomass energy	➢ Anaerobic digesters: biogas for cooking, lighting and for running engines including transportation. ➢ Briquettes from biomass residues (such as rice husk, coconut shells, olive seeds and pulp and by-products of oil extraction) for running steam engines.

Source: FAO, 2008

[2] Photovoltaics for productive use applications (GIZ 2016)

13. In addition to the practical uses of renewable energy in agriculture, the technology is also cost-effective in comparison to other energy sources. For example, Box 1.1 depicts the costs associated with investing in a solar pump system and a gasoline pump, and it can be seen that the solar pump is more cost-effective even from the first year.

Box 1.1: Cost comparison between diesel and solar pumping irrigation systems (SPIS)

The economics of solar pumping systems for irrigation is dependent on numerous factors. A SPIS System usually consists of the following elements:

- Solar components – PV modules, solar inverter, batteries (optional)
- Pump components – pump inverter, motor, pump
- Water storage or distribution system – tank, reservoir, pipeline distribution system.

Although diesel and electric pumps have low capital costs, their operation depends on the availability of diesel fuel or a reliable supply of electricity. The following are costs for solar pumps in Cambodia (taking into account a solar array power of 160W, and max flow $1m^3/hr$ at maximum head of 60m all year round).

		Solar Pump	Diesel Pump
Capital cost (USD)		600	160
Annual operational costs (USD)		50.26	493 (based on 2 hours per day, $1m^3/day$)
Total Cost (USD)	**First year**	**650.26**	**653**
	Second year	50.26	493
	Third year	300.26 (replacement of battery)	493
	Fourth year	50.26	493
	Fifth year	50.26	493
	Total cumulative cost after 5 years:	**1 101**	**2 625**

Cost wise, a solar pump has the advantage of minimal operating costs compared to diesel pumps – especially in view of volatile and rising fossil fuel prices. Other benefits include: (i) no specially trained personnel for the daily operation and maintenance of pumps; (ii) reduced transportation costs (time and money) for purchasing diesel fuel; (iii) reduced CO_2 emissions, noise pollution and the emission of particulate matter; and (iv) water systems (rivers, canals or aquifers) are less contaminated with oil pollution.

Solar PV systems could have a payback of two to four years. These estimates however, are strongly dependent on the farmer's annual irrigation requirement, solar radiation and on the price of diesel. An increase in the annual pumping hours makes solar energy more attractive than diesel (Raymond et al. 2018).

14. Given the above, it is clear there is a niche for stand-alone renewable energy systems in rural communities where electricity grid extension is too costly. The use of RE for smallholder agriculture will generate several agricultural, social, economic and environmental benefits and stimulate agricultural development. The following is a simplified version of the four-stage transition process of energy use:

   i. From utilising human muscle power for tilling, harvesting, and processing, together with rain-fed irrigation (none of which involve an input from external fuel sources);
   ii. To the use of draught animal power for ploughing, lifting water, grinding, and transportation;
   iii. Introducing fossil fuels for running diesel engines, chaff cutters, grinding and transportation;

iv. Utilising renewable energy technologies such as biogas for cooking (bioslurry for fertiliser), photovoltaic (PV) for charging phones, wind and solar pumps, passive solar heat for drying and hot water, and micro-hydro or solar mini-grids for electricity for household lighting, refrigeration, processing, and communications.

15. The challenge that the RESA approach seeks to address is to enable smallholder farmers to leapfrog to the fourth stage in the shortest possible time.

16. The use of fossil fuels in agriculture and the increasing demand and unsustainable harvesting of biomass for cooking and other domestic, agricultural, and industrial (e.g. brick-making) purposes, is leading to increased deforestation, land degradation, and the release of substantial GHG emissions. Increases in GHG emissions will affect smallholder farmers and livestock herders the most, even though their contribution to global anthropogenic GHG emissions is low. Within this scenario, the use of renewable energy for smallholder agriculture is able to catalyse a number of benefits and this has been demonstrated in IFAD projects that have included RET. The benefits of renewable energy occur at different levels, i.e. benefits to the smallholder farmer and family, benefits to the community and benefits at national level. Some examples of the various benefits are mentioned in Figure 1.1; however there are several other positive knock-on effects from utilising different types of renewable energy.

<table>
<tr><th></th><th>SOCIAL/HEALTH BENEFITS</th><th>ENVIRONMENTAL BENEFITS</th><th>ECONOMIC BENEFITS</th></tr>
<tr><td>FARMER/ HOUSEHOLD LEVEL</td><td>• Prevention of diseases related to indoor air pollution.
• Reduced time spent by women collecting firewood, carrying water (Gender empowerment).
• Improved quality of life.
• Improved education (e.g. increased time for studying).</td><td rowspan="3">• Improved waste management (e.g. manure for biogas and bioslurry).
• Reduced GHG emissions from lower consumption of fossil fuels.
• Reduced emissions from transport of fuels.
• Reduced deforestation.</td><td rowspan="2">• Increase in income due to increase in quantity and quality of products.
• Savings on fuel spending (for charcoal, kerosene, diesel etc.).</td></tr>
<tr><td>COMMUNITY / VILLAGE LEVEL</td><td>• Prevention of malnutrition and food contamination (e.g. better storage, transportation).</td></tr>
<tr><td>NATIONAL LEVEL</td><td>• Improve food security by increasing quantity of food produced (reduced food waste), frequency of yields and diversity of products.</td><td>• Reduce government spending on subsidies for fossil fuels.
• Newly created jobs (increase in rural youth employment).
• Reducing food imports by increasing local food production.</td></tr>
</table>

Figure 1.1: Broader benefits of renewable energy in agriculture (adapted from IRENA 2016)

1.2 Smallholder Farmers' Current State of Energy Access

17. Many countries have made significant progress in energy access, however a substantial number of people still work and live without electricity. In South America for instance, more than 30 million people (around 7% of the population) continue to live without electricity (IEA, 2013). These communities are typically based in remote locations, such as mountainous areas or Amazonian forests. The Middle East and North Africa region has about 57% of the world's proven oil reserves and 41% of proven natural gas reserves (World Bank, 2010), and the region is also endowed with abundant solar radiation. However, great gaps exist in the distribution of these resources amongst the population of the region - an estimated 28 million people lack access to electricity in rural areas, and about 8 million people rely on biomass for their energy needs (World Bank, 2010).

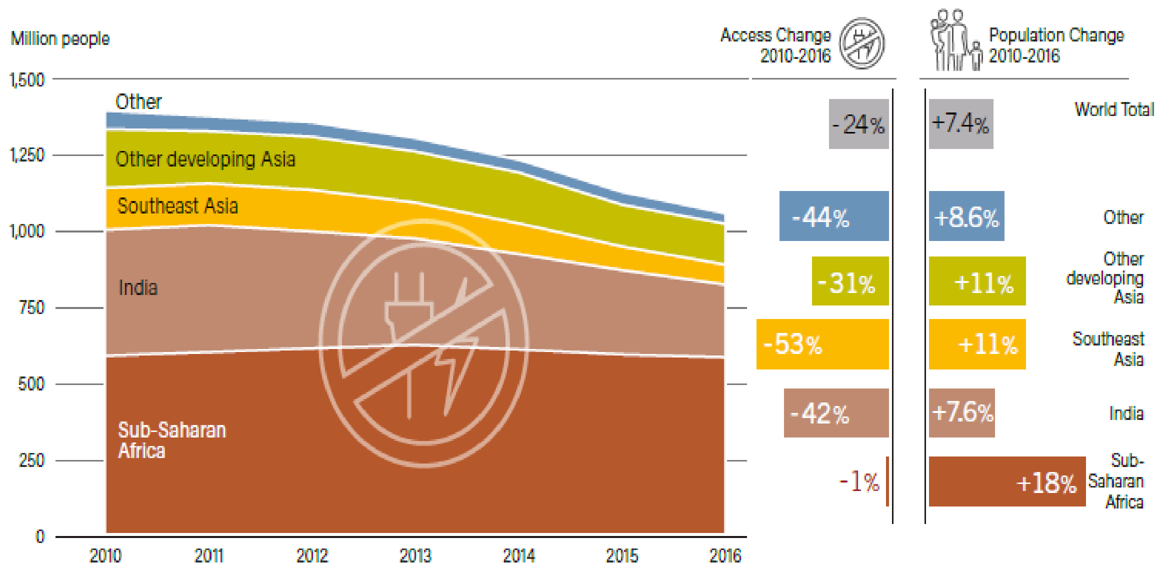

Figure 1.2: Population without access to electricity, by Region or Country 2010 – 2016 (Source: REN21, 2018)

18. Although population size has increased significantly in some regions like Sub-Saharan Africa and parts of Asia during the period 2010 - 2016, there has not been a significant change in access to electricity. The graph on the left in Figure 1.2 shows that the population without access to electricity in Sub Saharan Africa has decreased by only 1%, which means that there are still over 500 million people without access to electricity in the region.

19. Globally, more than 2.8 billion people – 38% of the world's population – lack access to clean cooking, typically using inefficient stoves or open fires in poorly ventilated spaces (IEA, 2017). Developing Asia and sub-Saharan Africa dominate the number of people relying on biomass for cooking. The consumption of fuelwood in these countries is high, where rural households typically consume between 1 to 2 tonnes of fuelwood per year (Bonjour, 2013). As Figure 1.3 shows, there is an inverse relationship between traditional energy use and GDP per capita; countries with lower GDP per capita have a higher dependency on solid fuels than developed countries.

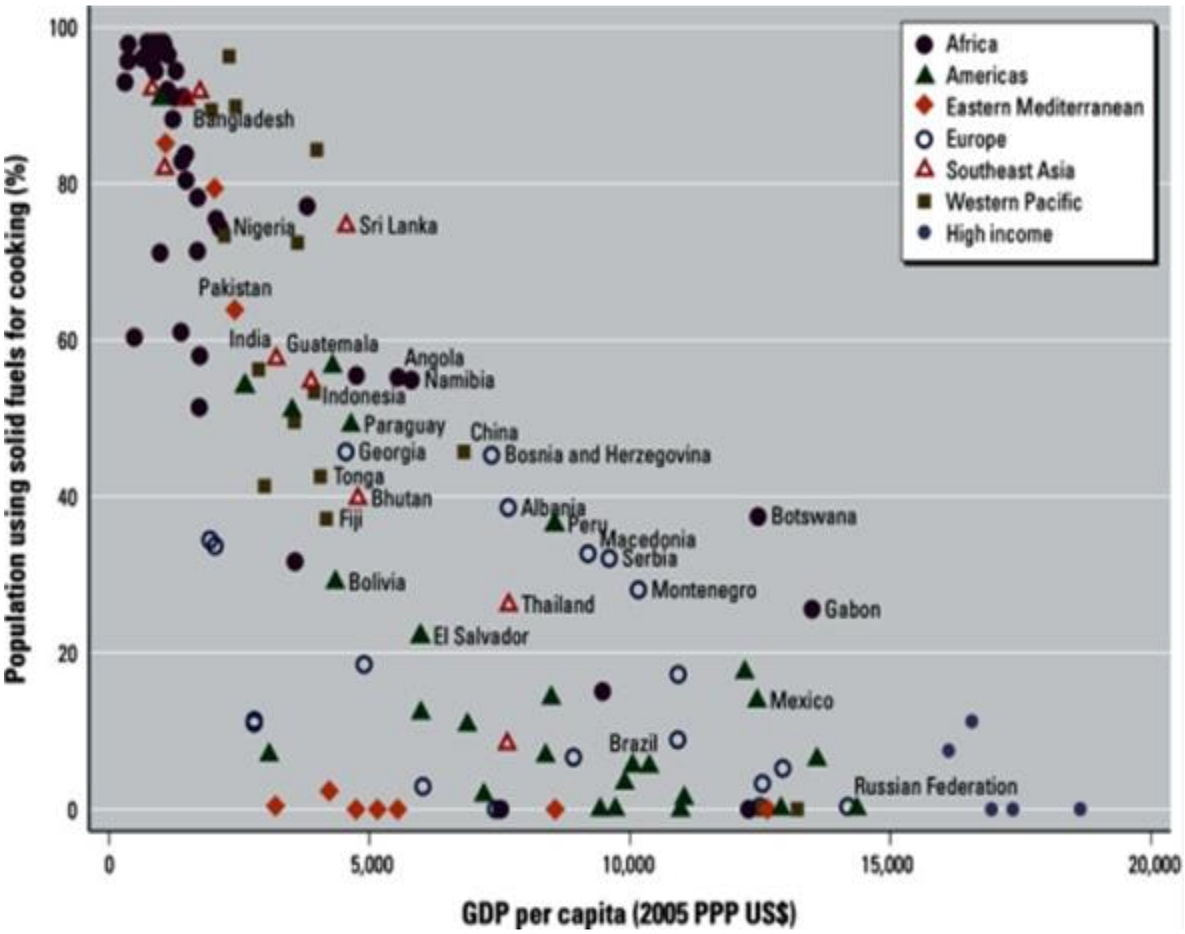

Figure 1.3: Percentage of population using solid fuels versus GDP per capita (Source: Bonjour et al, 2013)

20. In addition, rural areas in most of Sub Saharan Africa and South East Asia have the highest electricity costs per kilowatt hour per year (kWh/year) and not surprisingly, the lowest electricity consumption rates[3]. This deprives them of energy for cooking, lighting, heating, use of household or farm level appliances, and medical services that access to electricity could provide.

1.3 The Global Agenda on Renewable Energy in Agriculture

21. Renewable energy technologies for improving smallholder agriculture has been on the international agenda for quite some time. The Intergovernmental Panel on Climate Change (IPCC) and the United Nations Framework Convention on Climate Change (UNFCCC)[4] state that there is substantial technical and economic potential for the mitigation of global GHG emissions over the coming decade through the diffusion of environmentally-sound technologies. The NDCs under the Paris Agreement define countries' commitments to reduce national emissions as well as their adaptation needs, and a total of 164 countries have currently defined renewable energy targets within their NDCs.

[3] Mainly because of their low population density and remoteness (the seclusion of small villages from the electric grid)
[4] See here for more information on [the UNFCCC Technology Decisions Report 2016]

22. Countries such as Germany, Sweden, Denmark and Uruguay already meet their electricity needs largely from renewable energy sources, providing a sustainable green growth model for developing countries. EU countries have committed to reaching national renewable energy targets ranging from 10% in Malta to 49% in Sweden.

23. Developing countries such as Costa Rica, China, India and Albania are also embracing renewable energy sources, and are scheduled to achieve significant GHG emissions reductions. India in particular, with more than 300 million people living without access to clean energy, has emerged as a leader with ambitious targets to install 175 GW of renewable energy by 2022 (UNFCCC, 2016). India is also one of the few countries that has established a dedicated Ministry of New and Renewable Energy (MNRE). The following map (Figure 1.4) illustrates countries with renewable energy policies/targets and Table 1.2 depicts renewable energy targets of selected countries.

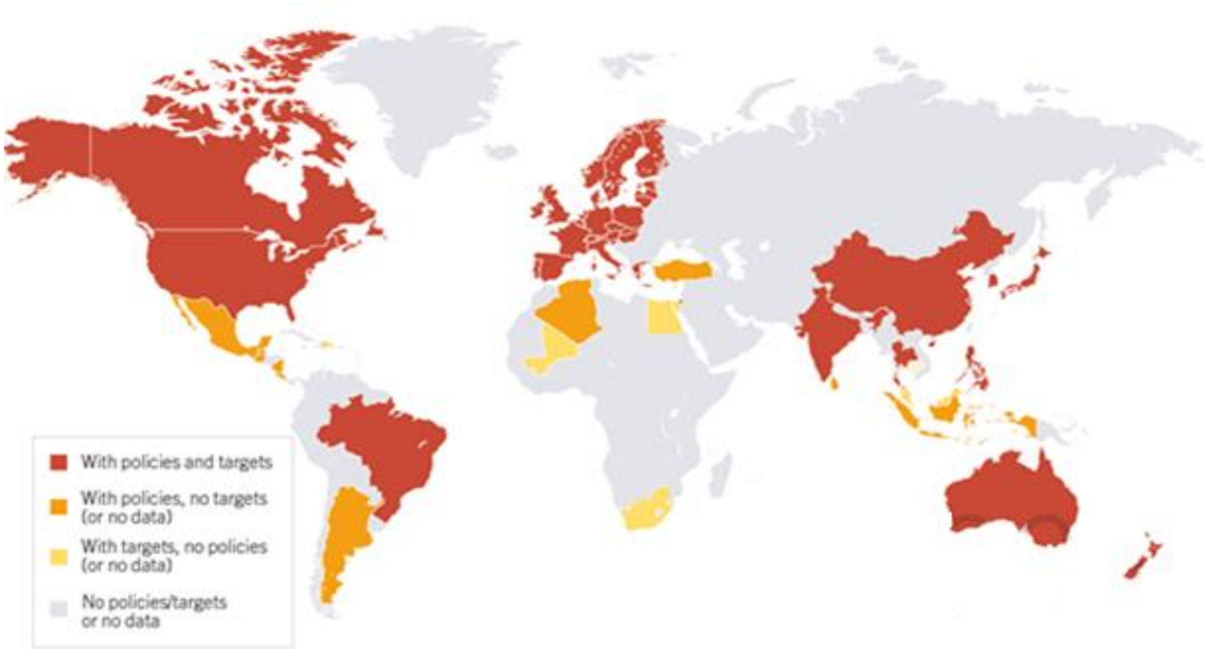

Figure 1.4: Countries with renewable energy policies and/or targets (Source: Renewables 2015 Global Status Report, REN21)

Table 1.2: Renewable energy targets for selected countries (Source: IRENA, 2014)

Country	Renewable Energy Targets
China	Aims to raise the share of renewable energy, from an initial 10% target by 2010 to 15% by 2020 (which it has already surpassed).
Indonesia	Aims to raise the share of renewable energy in its national energy mix from 4.79% in 2011 to 25% by 2025.
Vietnam	Vietnam is dominated by hydroelectricity, which supplied over 38% of the country's electricity in 2016. Other renewable sources such as wind, biomass, and solar are marginal, accounting for 0.4% of electricity generation. The country plans to increase the ratio of renewable energy sources to about 5% by 2020.
Nepal	Aims to provide electricity to 25% of the population through decentralized renewable energy solutions by 2030.
Mexico	The overall target is for 35% electricity generation from clean energy sources (defined as renewable energy, cogeneration, nuclear energy, and other low-carbon technologies) by 2024.

Colombia	The established target is 6.5% for on-grid and 30% for off-grid renewable energy sources (excluding large hydropower) by 2020.
Peru	Renewable energy targets were updated in the national energy plan 2014-2025, which aims for the goal of 60% electricity from renewables (including hydro) by 2025 from the current target of 6% renewable electricity generation by 2018.
Tanzania	The medium-term strategic plan (2012–16) includes a renewable energy target for electricity generation of 14% (complemented by 26% large hydro); Tanzania's Scaling-Up Renewable Energy (SREP) Investment Plan includes a total target of 47.5 MW of off-grid renewable energy for rural electrification by 2020.
Egypt	Targets of 20% of energy demand from renewable energy sources by 2020.

24. In the year 2014, more than USD270 billion was invested in green energy projects in developing countries, mainly in solar and wind technologies. Future projections forecast that USD2.5 trillion will be spent globally on RETs by 2030, a financing need that governments alone cannot fulfil. Africa is now the largest growing off-grid market projected to increase from 590 to more than 650 million people over the next two decades. In just 5 years (2009-2014), the sale of small-scale solar products in Africa grew from 40,000 to nearly 7.5 million (UNEP, 2014).

25. On a global scale some 130 million quality-assured off-grid solar systems had been sold cumulatively by the end of 2017, providing electricity access to about 360 million people (REN21 2018). Investing in RETs therefore aligns with global targets and future demand of developing countries, and would be a key area for the involvement of IFAD.

1.4 Renewable energy and the IFAD Mandate

IFAD vision and the importance of investing in RE

26. As mentioned in the introduction, the main vision of IFAD is to achieve inclusive and sustainable rural transformation. IFAD invests in increasing the productive capacity and the climate resilience of smallholder farmers. The sections above demonstrate the importance of renewable energy in agricultural production and post-production processes which enables rural development.

27. Renewable energy in smallholder agriculture will reduce drudgery associated with production, increase income, reduce GHG emissions, and increase the adaptive capacity of smallholder farmers, and provide different benefits across thematic areas such as, gender empowerment, nutrition and youth employment. Mainstreaming renewable energy into IFAD programmes is therefore essential to realising its vision, and this can be seen from IFAD's previous experience with renewable energy.

IFAD experience with RE

28. In the past, IFAD invested in renewable energy for smallholder agriculture at a small scale within broader programmes addressing rural poverty alleviation. Over the last decade IFAD has deployed renewable energy activities in over 18 countries. In Nigeria and Rwanda, IFAD has introduced energy-efficient processing and storage technologies such as solar heating, cooling, drying and energy-saving appliances, while in other countries like Mali, China, Mozambique and Rwanda, IFAD has enhanced and diversified access to clean and sustainable energy sources through the promotion of household biogas digesters, solar home systems and solar PV pumping systems. In India, IFAD has promoted hybrid solar/wind systems for village electrification and in Nepal, solar mini-grids and multi-purpose water mills for grinding, hulling, and pressing. More recently, in

Morocco, a project is promoting biomass-based energy systems for recovery of olive waste to use as heat and processing oil, and a 2.2 million grant was provided to SunDanzer to build small-scale solar based cooling systems for dairy, fish and vegetables in Sub-Saharan Africa.

29. Most of the examples cited above however have been promoted on an *ad hoc* basis without an approach for scaling up projects at a national level or across a region. Since 2011, with the advent of the Adaptation for Smallholder Agriculture Programme (ASAP)[5] however, a more strategic approach to integrating RETs into projects was pursued. The promotion of "multiple-benefit" approaches together with a scaling up strategy was piloted in a few countries leading to larger scale investment projects being developed subsequently. Furthermore, ASAP facilitated cooperation with local partners and research institutes in select countries, which led to the establishment of a growing network of RET service providers engaged in IFAD projects. Some ASAP projects have facilitated knowledge and technology transfer between different countries, increasing both South-South collaboration and capacity building of rural youth to become RET technical experts. In just the last 3 years (2014-2017), ASAP has integrated renewable energy activities into 15 projects at IFAD; a substantial increase compared to IFAD's 2006 – 2013 loan portfolio, which consisted of only 22 projects.[6]

30. In addition to ASAP, Global Environment Facility (GEF) grants have been leveraged for encouraging governments to invest in testing innovative RETs that they generally are averse to funding with loan financing. The ASAP and GEF funded projects have been designed with a more robust scaling up strategy, and Box 1.2 provides an example of this (see Annex II for a list of IFAD projects that have incorporated RET and click here for the Global Map on Renewable Energy Integration in IFAD's portfolio.

[5] ASAP is IFAD's flagship programme for channelling climate and environmental finance to smallholder farmers. The programme is incorporated into IFAD's regular investment processes.

[6] The review was conducted for the period 2006-2013 due to unavailability of reliable data before 2006.

Box 1.2: GEF-funded project: Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Cambodia (S-RET)

In Cambodia, through the Ministry of Agriculture, Forestry, and Fisheries (MAFF), IFAD is currently implementing a full-size GEF-funded (US$5 million) project entitled: *Building Adaptive Capacity through the Scaling-Up of Renewable Energy Technologies* (S-RET). The S-RET project builds on the RE piloting work done under the IFAD Project for Agricultural Development and Economic Empowerment (PADEE) and is linked to the IFAD project Agriculture Services Programme for Innovation, Resilience and Extension (ASPIRE).

Rice milling using biomass residues

Solar drying of fruits and spices

Fisherman using solar light

The objective of the Project is to promote the large-scale adoption of RETs in the agriculture sector of Cambodia. The project adopts a two-pronged approach: i) provision of matching grants for rolling out already proven RETs, for testing new high potential RETs, and for scaling up the National Biogas Programme (NBP); and ii) institutional capacity building and policy work for creating an enabling environment for promotion of RET in the ARD sector.

Matching grants are being provided to business oriented and development motivated firms and NGOs to scale up pre-identified priority technologies such as solar water pumps. Support also is being provided to the NBP to expand its outreach and to scale up the adoption of biodigesters by smallholder farmers. In addition, matching grants are being provided to companies and innovators for testing and demonstrating existing RETs linked to post-harvest processing, either successfully deployed outside Cambodia, or developed to readiness for field testing in Cambodia, and for developing supply chains and service capacity.

The first round of testing grantees have received a total of USD 486,086 in grants and have matched this with a contribution of USD 107,400. A total of 12 grants have been awarded including solar brooding/hatching units, mobile solar pumping irrigation systems, and clean charcoal-briquettes for warming chicks.

The policy work focuses on loosening regulatory barriers and creating positive incentives such as, tax holidays, net metering, feed in tariffs etc. for attracting private sector investments and making RET more affordable for smallholder farmers. It is anticipated that through these measures, investors would be more inclined to invest in supplying tried and tested RETs at national scale.

The S-RET project covers 10 provinces in support of RET for improving production and post-harvest processing. A reduction of GHG emissions equivalent to about 400,000 tonnes of CO_2e is expected.

More information can be found here

31. Table 1.3 summarizes IFAD's experience over the last 7 years and identifies areas of action that would enable a more systematic and holistic approach to scaling up RE adoption in beneficiary countries. These experiences inform the RESA approach and the opportunities outlined are potential areas for the involvement of IFAD.

Table 1.3: Country-level barriers and opportunities for scaling up RETs

	Barriers	Opportunities
Political	➢ Insufficient policy framework for promoting RETs to smallholders. ➢ High fossil fuels subsidies deter RET companies to enter rural markets. ➢ Lack of fiscal incentives for existing RET suppliers.	➢ Building knowledge and capacity of policy decision makers at national and sub-national levels. ➢ Supporting national policy planning processes to leverage changes in favour of RETs i.e. job creation in rural areas, waiver of import duties for RETs.
Economic	➢ Limited purchasing capacity of farmers and high costs of RETs. ➢ The payback period is often too long for an individual farmer. ➢ Limited presence of MFIs to provide loans for RETs.	➢ Building financial service models to promote outreach. ➢ Achieving significant cost reductions of RETs through pursuit of economies of scale. ➢ Increase productive and business capacity of rural youth for enterprise development (on and off-farm).
Social	➢ Traditional practices of using firewood and charcoal perceived as free or inexpensive. ➢ Limited knowledge on RET and their contribution to reducing energy expenditures. ➢ Increased rural youth migration (due to lack of employment opportunities beyond farming).	➢ Engaging women through informing them of the multiple benefits of RETs i.e. reduced drudgery, improved health and education outcomes. ➢ Youth empowerment through vocational training, coaching and demonstration activities on integrating RET into agriculture operations.
Technological	➢ Limited technical training programs in RET sector. ➢ Limited skilled expertise for installation, and operation and maintenance of RETs.	➢ Demonstration and support to adoption of RETs that are socially and culturally acceptable. ➢ Technical capacities of smallholder farmers strengthened. ➢ Development of renewable energy courses and curriculums in secondary/university level education, research and technical institutes.
Environmental	➢ Limited assessments of biomass use and environmental degradation. ➢ Lack of awareness of environmental costs from fossil fuel use.	➢ Promotion of multiple benefit RETs such as biogas i.e. manure management for improved health and methane capture, bioslurry for fertiliser. ➢ Quantification of GHG emission reductions and other environmental benefits.
Legal	➢ Lack of quality assurance processes, standards, and certification for RETs. ➢ Limited incentives and legal / regulatory support for pioneer firms.	➢ Establishing guidelines for RETs that are grid-compatible (net metering, feed-in-tariffs, buy-back agreements). ➢ Safeguarding Intellectual Property (IP) rights.

IFAD's comparative advantage

32. Given the experience IFAD has in the agriculture and rural development sector, strong partnerships with the countries it operates in, and on the ground expertise in country offices, IFAD has a clear comparative advantage for promoting renewable energy for smallholder agriculture.

33. The niche that IFAD has is its focus on smallholder farmers (especially in remote, isolated, off-grid areas where decentralized RE is economically and environmentally more viable) and this makes IFAD different from other renewable energy actors. Mainstreaming renewable energy in IFAD operations would therefore create financial opportunities for a beneficiary group that has limited exposure in the RE field.

34. As a result of IFAD's work it has been recognized in several international platforms, including the High Level Political Forum (HLPF) held in July 2018 in New York, on the "Right Energy Partnership with Indigenous Peoples". This initiative was launched with the goal to provide at least 50 million indigenous peoples access to renewable energy by 2030. IFAD has been identified as one of the lead partners given its track record on working with indigenous peoples through its Indigenous Peoples Assistance Facility (IPAF) and support to the Indigenous Peoples Forum.

Section 2: The RESA Approach

35. The Renewable Energy for Smallholder Agriculture (RESA) approach aims to mainstream renewable energy in IFAD operations over a five-year period. It is estimated that an annual outlay of USD 20 million will be required to operationalise the necessary actions. To achieve this level of financing, a resource mobilisation strategy targeting earmarked RE financing of bilateral, multilateral and philanthropic sources is needed (see section 2.3.3 for more detail). It is proposed that these funds can be housed within a dedicated RE financing window in the ASAP financing mechanism. This window will primarily fund the following five action areas illustrated in figure 2.1 below for meeting the key objectives that help power smallholder agriculture (more details on each action area can be found in the next section) .

36. The Renewable Energy for Smallholder Agriculture approach aims to mainstream renewable energy in IFAD operations over a five-year period. This will be achieved through the creation of a dedicated RE financing window within the existing ASAP financing mechanism. This window will primarily fund the following five action areas illustrated in figure 2.1 below for meeting the key objectives that help power smallholder agriculture (more details on each action area can be found in the next section).

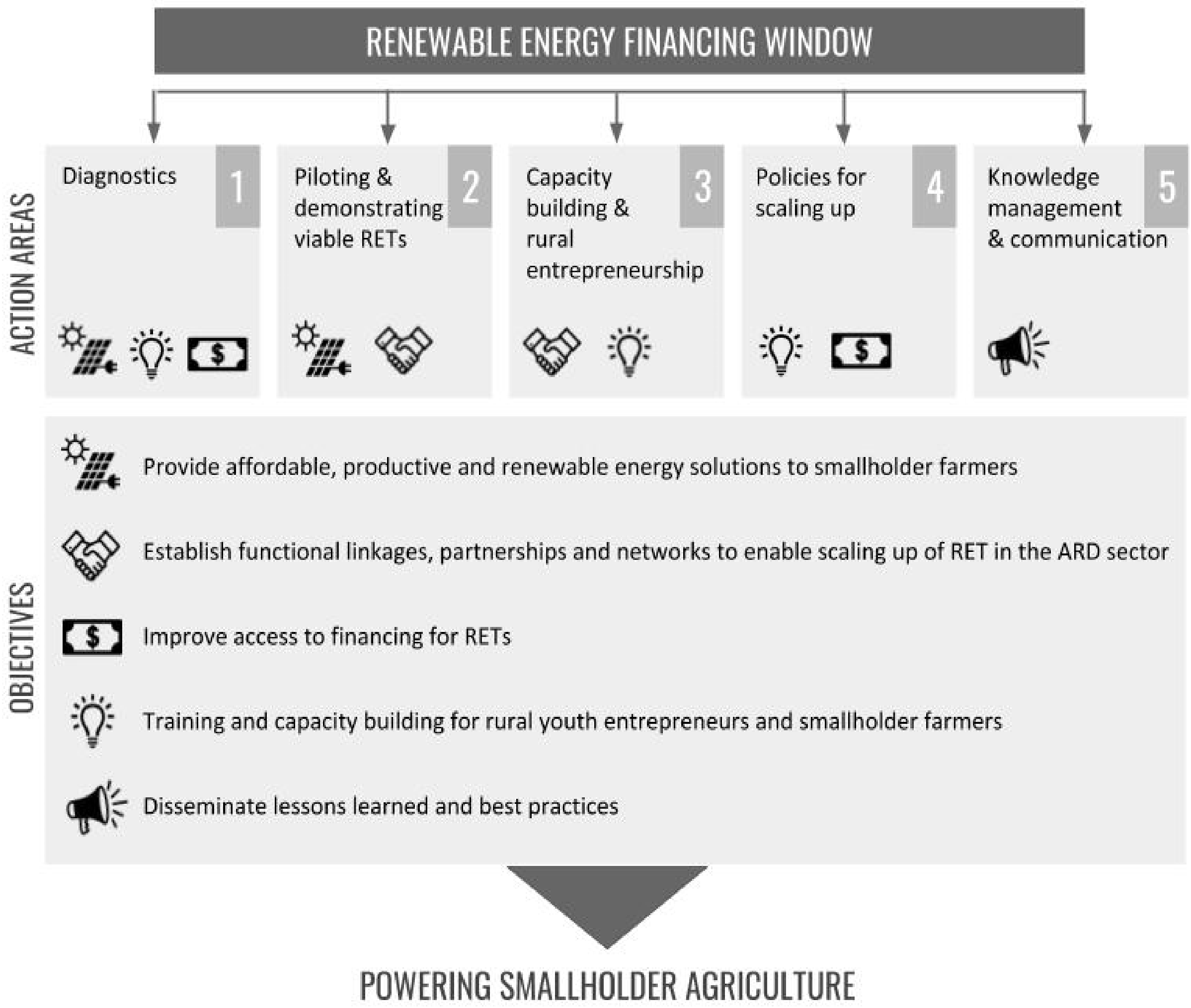

Figure 02.1: The renewable energy financing window enabling rural transformation

37. The work done with ASAP and GEF financing demonstrates that with dedicated finances, a more strategic approach can be adopted for promoting RE in the ARD sector. The analysis of the past 7 years indicates that mainstreaming RE into IFAD programmes and projects is difficult without additional dedicated resources. This is necessary because IFAD's Performance Based Allocation (PBA) per country is limited and has competing demands for different thematic priorities. As a result, the priority assigned to RE in the past has not been commensurate with its potential for achieving rural transformation and as such, has remained at the periphery of IFAD operations.

38. With the establishment of ASAP however, due to resource availability, 15 projects with RE components were developed in a span of 3 – 4 years and are currently under implementation (see next section for some examples). This is a clear indication that if IFAD is to move RE into the center of its operations, a dedicated RE financing window will need to be established. The most logical location for this window would be within the ASAP financing mechanism given RE's clear adaptation and mitigation benefits.

39. Considering there is increasing donor and private sector interest in RE, this would also allow IFAD to leverage substantial additional finance from a variety of new sources for capitalising the RE financing window, as well as, for mobilising supplementary financing for IFAD investments.

2.1 Action Areas

1. Diagnostics

40. The key activities that would be supported through technical assistance include, but are not limited to:

    i. Baseline studies, surveys and resource assessments for determining RET demand, and for informing Country Strategic Opportunity Programmes (COSOPs);
    ii. Assessing the energy needs of the farmer;
    iii. Site-specific analysis of consumer preferences for specific RETs;
    iv. Analysis of the social and environmental feasibility of switching to RE;
    v. Economic and financial analyses of RETs for smallholder agriculture (farmers, SMEs and Cooperatives); and
    vi. Articulating project interventions during project design

41. As illustrated by the ASAP-supported projects described below, the RE window will allow IFAD to better identify appropriate RETs to address specific needs, consistent with particular agro-ecological and sociocultural contexts[7]. For example, in Djibouti, the ASAP-supported *Programme to Reduce Vulnerability to Climate Change and Poverty of Coastal Rural Communities* (PRaREV) conducted a feasibility study for the utilization of solar energy in the fisheries sector. In particular, the project assessed the investment costs to install solar PV energy for cooling, storage and powering equipment on boats. In total, five sites were identified, each requiring an investment of about USD 16,000 to purchase all the components (solar panels, batteries, freezer, lighting and fans). In addition, the study concluded that with a total investment of about USD2,800 the current AC lamps used on artisanal boats for night visibility can be exchanged with LED lamps powered by a PV system thus reducing the consumption of 5 to 6 litres of diesel[8] per night. As a result, the project plans to install solar PV for refrigeration, fans and lighting for meeting the needs of artisanal fishermen in Arta, Sagallo and Kalaf areas.

42. In Morocco, under the *Rural Development Programme in the Mountain Zones Phase I,* a study was undertaken for the recovery of olive waste for heating and processing activities. This resulted in the project including a component on production of briquettes from olive oil press residues, as an alternative fuel for domestic heating, cooking and drying fruits (to reduce post-harvest losses). In Egypt, the *Sustainable Agriculture Investments and Livelihoods Programme* (SAIL) project conducted an assessment of solar pumping systems for the rehabilitation of 5 km of irrigation canals. The project now plans to incorporate the use of solar energy in pumping stations as an environmentally friendly technique and as an alternative to diesel fuel operated pumping stations.

43. A grant proposal for ASAP II has already been prepared in order to evaluate the economic and financial feasibility of RET in select countries in LAC, WCA and APR. These assessments will enable a process for IFAD to incorporate RET in agricultural production processes.

2. Piloting and demonstrating viable RETs

[7] See link here for the list of RETs for Rural Areas (IFAD 2017)
[8] According to information from the PRAREV team, 1 litre of diesel costs around 300 DJF (USD1.68) which means the cost for diesel per night is around USD 8.

44. A RE financing would facilitate the piloting of RET in different agro-ecological zones, and enable monitoring progress and adoption of these technologies by smallholders. Proven RETs will be demonstrated for attracting a critical mass of users and supported by national programmes and large investment projects for instituting commercially viable operations. For example, the DFID funded *Initiative for Mainstreaming Innovation* (IMI) grant led by the Livestock Desk in IFAD showed how an innovation can be taken from a testing stage to adoption into a national programme in a short time.

45. A new portable biogas unit, called FlexiBiogas (Box 2.1), was developed by a Kenyan inventor, Mr. Dominic Wanjihia, and piloted in Kenya and Rwanda. As an outcome of the pilot in Rwanda, the municipality of Kirehe district adopted this technology and has since deployed 450 units under the *Kirehe Community Based Watershed Management Project* (KWAMP) project. Subsequently, the technology was integrated into the Rwanda National Domestic Biogas Programme (NDBP) and the national 'Girinka' (one cow per family) programme under the Ministry of Agriculture and Animal Resources (MINAGRI). Piloting a RET would build on the baseline assessments (outlined in the previous action area), assess the RET's take up (local demand, specific agro-ecological and cultural constraints), comparative cost effectiveness with other technologies, and productivity and replicability considering positive and negative externalities that the RET may generate when deployed at larger scale.

The following points are lessons-learned from the IMI pilot, which are necessary to enable a smooth deployment of RET:

i. Assessment of energy costs and needs at the household and farm level;
ii. Selection of beneficiaries and assessment of willingness to participate;
iii. Facilitation of farmer-to-farmer exchange visits to successful RET adoption sites, participatory training, integration into farmer field schools, and using Learning Routes[9] for wider dissemination;
iv. Translation of knowledge products into local language;
v. Identification and training of cadre of technicians on specific RET;
vi. Engagement of local RET entrepreneurs for taking innovations to scale.

[9] A Learning Route (LR) is a planned educational journey with learning objectives designed to: (i) address the knowledge needs of development practitioners who are faced with problems associated with rural poverty; (ii) identify local stakeholders who have tackled similar challenges successfully and innovatively, recognizing that their accumulated knowledge and experience can be useful to others; and (iii) support local organizations in the systematization of these best practices in order for local stakeholders to proficiently share their knowledge with others.

Box 2.1: IMI Grant- Pilot Testing Portable Biogas

3. Capacity building and rural entrepreneurship

46. Capacity building of a number of actors such as agriculture extension agents, farmers, RE suppliers, technicians and investors, to name a few, are essential for effective introduction of RE into smallholder agriculture and guaranteeing its long-term sustainability. While targeted capacity building will need to be developed for each group of actors, the two main aspects at the local level that need to be kept sharply in focus are the following: i) building a skilled labour force that is able to install and provide after sales services; and ii) building the capacity of users of RETs for operation and basic maintenance for ensuring longevity of the RET. In this regard, the RE window would provide hands-on training on specific RET, for the development of skills of youth technicians, and also of smallholder farmers, especially women. The RESA approach would thus support setting up certification programs that could help create a cadre of qualified service providers. For example, in Cambodia under the S-RET project, IFAD regularly coordinates with the Solar Energy Association Cambodia (SEAC) and the *Good Solar* Initiative, which Cambodia's first certification and quality control system for solar companies and their products.

47. At national and provincial levels, training centres and technical hubs could be established to support innovation, construction, operation and maintenance of RETs, and to offer training on business management and microenterprise development. These centres/hubs could be modelled

on existing institutions such as the Songhai Centre in Benin[10] or the Barefoot College in India.[11] In addition, partnerships could be established with research/technical institutes to develop specific RE curriculums or programmes linked to agriculture, and with private sector RE businesses for training placements and/or internships.

4. Policies for scaling up renewable energy at country level

48. The above action areas will help with establishing the factual basis for informing the development of appropriate policies, programmes and projects for scaling up. Policy analyses, briefs and forums will be supported for facilitating the scale up of RET in the ARD sector. Specific policy studies that can be prepared using RE financing include:

   i. Analysis of energy use in agriculture value chains that smallholders have a comparative advantage in;
   ii. Overcoming fiscal, regulatory and legal barriers to the adoption and scaling up of RET in the ARD sector;
   iii. An analysis of compensation approaches for losers from RET adoption (such as charcoal producers).
   iv. Incentives for attracting the private sector through lower import duties, price rebates, favourable credit terms and payment for climate services;
   v. Designing strategies for the development of RE-based rural industries and agriculture modernization;
   vi. Transitioning to agricultural applications run on renewable energy.

49. Policy studies on renewable energy specific to smallholder agriculture can be a crucial tool for informing decision-makers on rural energy and energy access planning. For example, in Cambodia, IFAD and UNDP have established a donor platform to discuss policy options for mainstreaming RE in the smallholder agriculture sector, and the IFAD/GEF S-RET project is developing policy analyses to inform this platform. Given that electricity prices in Cambodia are one of the highest in the Southeast Asia region, the objective is to support the National Council for Sustainable Development (NCSD)[12] to facilitate an inter-ministerial dialogue for mainstreaming renewable energy into line department strategies and into the country's climate change policy frameworks.

50. The cost of renewable energy technology is one of the key issues hindering the scaling up of RETs with poor smallholder farmers. In this regard, various measures including subsidies need to be pursued for making RETs more affordable. Several of IFAD beneficiary countries have national biogas programmes that are subsidised for poor smallholder farmers, and this model could be further refined with innovative financing mechanisms for ensuring long-term sustainability. The International Energy Agency (IEA) estimated that global subsidies for fossil fuels were US$409 billion in 2010, while those for renewable energy amounted to US$66 billion (IEA, 2012).

[10] http://www.songhai.org/index.php/en/home-en

[11] https://www.barefootcollege.org

[12] The NCSD under the Ministry of Environment is the lead technical agency for climate change issues and mandated to formulate the country's Climate Change strategy.

Developing innovative ways for shifting the subsidies to RE would be one way of boosting efforts at scaling up RE in the ARD sector in developing countries.

51. Another barrier to scaling up RE is related to cumbersome and often opaque national procurement systems and procedures that require specialised expertise to navigate. In this regard, the RE financing window could provide operational flexibility for fast-tracking procurement by recruiting necessary specialised RE expertise to draft TORs, prepare calls for proposals, define technical specifications, develop qualification criteria, review proposals, engage in shortlisting etc. This would allow for an increased engagement of social and private enterprises that would otherwise shy away from government contracts due to lengthy bureaucratic processes.

5. Knowledge Management and Communication

52. Knowledge management and communication - targeted KM and communication will be undertaken for different target groups (i.e. policy makers, farmers, investors etc.) for informing, attracting and scaling up RET.

53. This action area will address at least three different levels of knowledge and communication gaps:

i. On the ground: awareness of the benefits of renewable energy for smallholder agriculture is limited among farmers. RE financing can thus generate knowledge products in local languages on the multiple benefits of RE, post-harvest processing options, farmer testimonials, trouble shooting guidelines etc.. Furthermore, farmer-to-farmer exposure visits, instructional videos and the use of social media can be financed.
ii. National level: initiatives that raise awareness of policy makers on the climate change adaptation and mitigation benefits of RE in different agricultural sub-sectors will be supported in order to advance policy dialogue for scaling up. Also, RE inventor, producer and investor forums can be supported to accelerate rapid roll out of good inventions.
iii. In house (IFAD): This component will support internal corporate commitments to better track and monitor climate change related investments in projects and demonstrate the value-for-money proposition of investments in RET (see IFAD 11 Business model[13]).

54. Through ASAP, IFAD created a strong, internationally-recognized brand on climate adaptation for rural smallholder farmers. The knowledge platform created under ASAP provides a solid foundation for supporting the RE scaling up agenda. A RE knowledge management strategy will assist with further refining the ASAP KM work for achieving greater RE uptake at local level, engagement of private sector, improvement of policy and regulatory frameworks, and mobilisation of resources for capitalising the RE financing window.

55. To date, the following communication and knowledge sharing work has been achieved: (i) a dedicated webpage on RE on the IFAD website[14]; (ii) a database of RETs relevant to smallholders; (iii) communication videos on pilot-tested RETs; (iv) "How to Do Notes" on mainstreaming portable

[13] Enhancing IFAD11 business model to deliver impact at scale
[14] https://www.ifad.org/en/renewable-energy

biogas systems[15]; accessing finance for renewable energy technologies[16] in IFAD funded projects; and (v) tools for project design (specifically on livestock and RE).

56. The initial work on RE is helping IFAD gain recognition as a player in the RE sector. This is reflected in IFAD's inclusion in a number of RE platforms, including the International Renewable Energy Agency (IRENA), the Renewable Energy Policy Network for the 21st Century (REN21) and the UN-Energy group[17]. IFAD has also contributed to the *Global Trends in Renewable Energy Investment,* an annual report published by REN 21. This foundation can be built upon to raise IFAD's profile as a key RE proponent for the ARD sector.

2.2 Moving Renewable Energy to the Centre of IFAD Operations

57. There are a number of entry points for mainstreaming RET into IFAD's programming cycle. The following describes how RE can be mainstreamed into the various programming processes using a combination of technical assistance, development of tools, and engagement with partners.

58. **Country Programme Evaluation (CPE):** Independent evaluation processes such as the CPE can help identify projects that have systematically integrated RETs and the benefits they have generated. The CPE therefore can become a tool for demonstrating to policy makers and interested financiers the added value of RET investments. This will assist with facilitating the dissemination of key insights and recommendations drawn from evaluation findings to a wider audience, and more importantly, will help with mainstreaming RE into COSOPs.

59. **Results Based-COSOP:** Country Strategic Opportunity Programme (COSOPs) and Country Strategy Notes (CSNs) need to systematically include an energy assessment for the ARD sector for defining RE strategic objectives at country programme level, and for informing specific project interventions. This would enable delineating financing gaps for RE related work that need to be mobilised from other sources. IFAD's Social, Environmental and Climate Assessment Procedures (SECAP) report now includes an Energy Guidance Statement to address energy-related aspects in project design. This is a good entry point and with robust analytics RE could be built into the country programme as a strategic objective. The technical assistance costs associated with undertaking the analyses could be funded from the RE window.

60. **Project Design**: The design and implementation of projects will require renewable energy experts to be part of the project design team. At present, since RET is rarely prioritised at COSOP level there is no systematic budget allocation for renewable energy-related activities. This results in RET being integrated on an *ad hoc* basis in some projects and usually without RE expertise on-board the design team. This could lead to insufficiently designed RE components that run into implementation challenges. Given the demand for IFAD services is shifting to more technical assistance based support, especially among Upper Middle Income Countries (UMICs) and MICS,

[15] How to do note: Mainstreaming portable biogas systems into IFAD-supported projects
[16] How To Do Note: Access to finance for renewable energy technologies
[17] Currently there are 21 UN agencies listed as members. The main goal of the UN-Energy group is to have a functional line of sight on each other's work and establishing the basis for more effective coordination, especially given the interrelationships of SDG7 with other SDGs.

the introduction of RE for smallholders as a central priority provides IFAD with a strategic niche. This could lead to borrowing for reimbursable technical assistance and supported through the RE window.

61. **Implementation Support and Supervision:** Currently, IFAD's in-house human resources for RET promotion is led by the Regional Lead Technical Specialists for the Environment, Climate, Gender and Social Inclusion (ECG/APR) division and a RE consultant with some support from other technical specialists who take a personal interest in RE. If RET is to become central to IFAD operations, then the current human resources will need to be augmented with dedicated in-house RET technical expertise complemented with external RE consultants who would be recruited to undertake project design, implementation support, and supervision.

62. An Action Plan is included in Annex IV prioritising projects for advancing RE activities. Selection criteria include: (i) an analysis of IFAD projects in the pipeline 2019-2020 focusing on agricultural productivity and mechanization with cross-cutting benefits (youth employment, gender empowerment, climate resilience); (ii) geographic location and natural endowments (sun, wind, water, biomass); (iii) potential activities where use of fossil fuels is foreseen.

2.3 Partnerships

63. Developing partnerships with relevant actors in the renewable energy sector will be important in taking the RESA approach forward. For instance, partnerships with RE technical institutions could be established for a more systematic support to country programmes. New partnerships can be developed with various institutions as described below, and existing partnerships can be strengthened for advancing RE in smallholder agriculture (Box 2.2 and 2.3).

2.3.1 Technical Partnerships

Development Cooperation Agencies and Non-Governmental Organizations (NGOs)

64. The *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) is active in over 130 countries and engaged in energy projects in half of them. Renewable Energy has been central to their energy projects in developing countries. The extensive experience garnered over several decades of work in the energy sector makes GIZ a strong technical partner to work with in advancing the RE agenda in the ARD sector. IFAD has engaged GIZ in various development related activities at country level however RE has been only a minor component, and in this regard, there is great potential for a strategic partnership with GIZ for facilitating the delivery of RE in IFAD investments.

65. The Netherlands Development Organisation (SNV), with over 50 years of experience, is active in 27 countries and known for its business inclusive and value chain approach. SNV focuses on the Water, Agriculture, Sanitation and Hygiene (WASH) sector placing an emphasis on RETs that support market creation, gender equality, health, education and climate change mitigation. Collaboration with SNV is being pursued for deploying 500 improved cookstoves in Lao PDR through the Global Alliance for Clean Cookstoves programme, which has a goal of 100 million households adopting clean and efficient Cookstoves by 2020. The Global Alliance has a network of suppliers but lacks the outreach and the implementation structures for achieving its targets.

66. IFAD, Enel Green Power (EGP) and RES4Africa are in an advanced stage for reaching an institutional collaboration on capacity building and training for the development of green mini-grids in Sub Saharan Africa. A number of avenues for partnering with EGP have been highlighted through i) Agri-Business Capital, that is aimed at supporting local farmers and agri-businesses through access to finance and; ii) IFC initiatives on mini-grids.

2.3.2 Research institutions and specialised RE agencies

67. The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity. Technical collaboration is envisaged through joint development of technical assistance activities (renewable energy cost studies, resource maps) and assessments conducted in partnership with governments and regional organisations, to help boost renewable energy development on a country by country basis. Discussions are ongoing between IRENA and IFAD on potential collaboration pertaining to off-grid renewable energy for smallholder agriculture. On the invitation of IRENA, IFAD participated in the 4th International Off-Grid Renewable Energy Conference & Exhibition (IOREC)[18] held in Singapore in October 2018.

68. Technical institutes and universities can also play a useful role in providing expertise and undertaking diagnostic work at country level. In many countries the lack of human resources to effectively collect and analyse data related to rural energy access and consumption can be offset with support from technical institutions. Operational partnerships with technical institutes would allow IFAD to obtain the technical services that is currently unavailable in-house. To date, IFAD has collaborated with a number of research institutes and universities through South-South and North-South collaboration, such as the Royal University of Agriculture (RUA) in Cambodia, Indian Institute of Technology (IIT), Polytechnic University of Milan, Vermont Law School, Danish Center for Energy Technology, and the University of Hohenheim in Stuttgart.
69. In Cambodia, IFAD has partnered with the Centre for Agricultural and Environmental Studies (CAES) at RUA to develop a Renewable Energy curriculum for BSc and MSc students. This is helping develop a cadre of university students knowledgeable in RET. This initiative is also closely aligned with an IFAD grant between IFAD and universities: *IFAD-Universities Win-Win Partnership Grant.* In addition to the technical institutes there are various specialised national agencies that are mandated to promote RE and Box 2.3 provides a few examples.

[18] Convened every two years by IRENA, the first IOREC was held in Accra, Ghana in 2012, followed by Manila, Philippines in 2014 and Nairobi, Kenya in 2016. The last IOREC brought together around 600 delegates from across the off-grid renewable energy value chain, with representatives from policy-makers, rural electrification agencies, private sector, NGOs, academia, financing institutions and international organisations.

Box 02.2: National implementing partners of RET activities within past IFAD projects

A number of partnerships have been developed under IFAD-supported projects. Sustaining these partnerships has proven vital for increasing the scale and impact of RET activities within IFAD projects. The following are some key implementing agencies driving renewable energy activities in IFAD projects.

- In India, under the IFAD-supported *Jharkhand Tribal Empowerment and Livelihood Programme* (JTELP), the project established a partnership with the state-run agency **Jharkhand Renewable Energy Development Agency (JREDA)** to deploy 3,000 solar lanterns and 650 solar home systems (SHS) in tribal communities. JREDA ensures that companies that have been selected are qualified by Ministry of New and Renewable Energy (MNRE) norms. It also ensures after sales services are provided by the selected private sector companies by retaining 10% of the payment, which is released by JREDA over 5 years (2% every year) until the RET is functioning optimally.

- JTELP has also established a partnership with the Punjab Agricultural University (PAU) to install 50 biogas digesters in piggery sheds as a waste management to energy model but also to provide support on technical assessments, training of local staff and rural communities on installation, operation and maintenance of biogas digesters. Similarly, collaboration with the Sardar Patel Renewable Energy Research Institute (SPRERI), part of the Indian Council of Agricultural Research (ICAR) consortium, has been established to install 1,000 improved cookstoves (ICS).

- In Nepal, under the ASAP-supported *Adaptation for Smallholders in Hilly Areas* (ASHA) project, a Memorandum of Understanding (MOU) was entered into with the **Alternative Energy Promotion Centre (AEPC)** under the Ministry of Population and Environment. Under this MoU, AEPC acts as an intermediary between private sector companies, farmers, and the project, and oversees the installation of RETs. They also monitor the provision of after-sales services by the company. This partnership is facilitating a demand-driven approach for responding to the energy needs identified in the Local Adaptation Plans of Action (LAPA). A total of 7,500 RET units are planned for deployment.

- In Cambodia, the **National Biogas Programme (NBP)** is a direct implementing agency under the IFAD GEF funded S-RET project to deploy 3,000 biogas digesters in rural areas by 2020.

2.3.3 Financial Partnerships (Capitalisation of the RE window)

70. It is estimated that for facilitating the systematic mainstreaming of RE into IFAD's operations an annual budget of about US$20 million will be required. These catalytic funds will support RE diagnostics for prioritizing RE in COSOPs, support project design, finance pilots and demonstrations, build capacity and launch policy dialogue processes for scaling up. These funds will not only help integrate RE activities into IFAD investments, but will also lay the foundation for developing strategic RE programmes that could draw upon financing from the GEF, GCF and other financing sources to supplement IFAD investments.

71. The dedicated RE financing window within the ASAP instrument will need to be capitalised with financing from specific RE and climate financing envelopes of bilateral and multilateral donors, and philanthropic institutions and foundations. Below are a few examples of potential financing sources for capitalising the RE financing window and for supplementing IFAD country investments. In addition, a preliminary database of potential financiers in the renewable energy sector can be found here.

Bilateral agencies

72. The Norwegian Agency for Development Cooperation (NORAD) has been a pioneer in the renewable energy sector and in 2007 launched the Clean Energy for Development Initiative to increase access to renewable energy in developing countries. Similarly, the French Development Agency (AFD), the Danish Climate Investment Fund (KIF), the German Federal Ministry for Economic Cooperation and Development (BMZ), the Swedish International Development Cooperation Agency (SIDA), along with a number of other bilateral agencies have also introduced programmes aimed at providing energy access to rural communities. Several of the bilaterals were contributors to the first phase of ASAP and mobilising them for capitalising the dedicated RE window under the second phase of ASAP will be a priority.
73. Some bilateral agencies have set-up private arms for advancing their respective renewable energy agendas, i.e. the Netherlands Development Finance Company (FMO), the German Investment and Development Company (DEG), which is part of KfW, and AFD's Proparco. This growing donor interest to support targeted investments in RETs offers an opportunity for IFAD to leverage additional funding. For instance, Finnfund has already provided funds to IFAD under the IMI grant for specific activities aimed at demonstrating the economic viability of biogas compression and bottling for use in vehicles, running farm machinery, and powering decentralized electricity mini-grids.

Philanthropic institutions and foundations

74. Philanthropic entities, such as the Louis Dreyfus Foundation (LDF), are involved in promoting sustainable agricultural projects. Created in 2013, LDF's current portfolio includes optimization processes for energy, water and waste management. LDF also supports the ''Energy Champions'' project reaching a total of approximately 70,000 farmers. IFAD and LDF have already collaborated to support portable biogas technologies in Rwanda and Kenya.

75. Global Good is a collaborative effort between the Bill and Melinda Gates Foundation (BMGF) and the Intellectual Ventures Lab. It focuses on inventing technology and supporting technology transfer. Some of their work focuses on renewable energy/biogas, milk cooling, thermal solutions for livestock vaccines storage, detection of spoilage of products and food, etc. Global Good has a multidisciplinary team of engineers and scientists who focus on making technology more efficient, better and cheaper and provide early-stage R&D expertise needed to translate ideas into viable technologies for commercialization in developing countries. IFAD and Global Good have been discussing several low-cost innovative technologies run on RE such as water purification, drying and storage technologies for vegetables, fruits and fish. Introducing these RE driven technologies into IFAD investments could have significant positive impact on agriculture value chains.
76. The Rockefeller Foundation in 2015 launched the Smart Power for Rural Development, a US$75 million initiative to address the “last-mile” energy gaps in the Indian states of Jharkhand, Bihar and Uttar Pradesh, where less than 10 percent of rural households are connected to the national grid.

77. The Skoll Foundation supports social entrepreneurs in several thematic areas including education, environmental sustainability, economic opportunities, health etc. and to date has invested approximately US$400 million worldwide to drive social entrepreneurship. The foundation has financed several actors in the renewable energy sector (B Lab, Health Care Without Harm, Barefoot

College, Proximity Designs) and since its inception in 1999, has provided a platform to educate adopters of clean energy with tools and research (ACORE, Bioregional Development Group, Ceres).

78. The above discussed institutions have expressed interest to collaborate with IFAD on the promotion of renewable energy. Some of the major reasons for interest in collaborating with IFAD, is IFAD's relationship with governments and the potential that this provides for scaling up through targeted policy work; IFAD's presence in remote rural areas and ensuring field level implementation; and the potential for stronger impact measurement.

Multilateral funding sources

79. The work financed by the RET window will allow IFAD country programmes to better articulate the demand for RET and improve scaling up strategies from pilot work. Initial work undertaken by some of the ASAP projects indicate that country demand for RET far exceeds IFAD's available Performance Based Allocation (PBA) financing. In this regard, the diagnostic work done with the support of the RET financing window will contribute to developing targeted proposals that enable the mobilisation of supplementary financing from environment and climate, and other multilateral sources.

80. The Global Environment Facility (GEF) has been supporting RET interventions for almost 2 decades. Furthermore, with the launch of the Special Climate Change Fund (SCCF), full-size RE projects have been funded such as, IFAD's US$5 million *Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies* (S-RET) project in Cambodia. The seventh GEF cycle started in July 2018 and this provides IFAD with opportunities for developing GEF financed RE components in its investment projects.

81. Consistent with the Paris Agreement, the Green Climate Fund (GCF) is promoting a low-carbon and climate-resilient development agenda. Renewable energy generation and access is a key vehicle for advancing this agenda. IFAD's focus on inclusive and sustainable rural transformation provides it with a strategic mandate to champion RE in the smallholder ARD sector. IFAD has received its accreditation to the GCF and can access grant and loan funds up to $250 million per project. This opens up an important entry point for IFAD to develop large scale RE interventions embedded within IFAD projects. Furthermore, the Private Sector Facility (PSF) under GCF provides a vehicle for engaging international businesses and local private sector companies in RE projects. Coupled with IFAD's Private Sector Strategy and the Small and Medium-Sized Enterprise Investment Finance Fund (SIF), working partnerships with the private sector can be operationalised.

82. The Asian Development Bank (ADB) has initiated a US$780 million project entitled *Scaling up Renewable Energy Programme (SREP)* under the Climate Investment Fund (CIF) window. The project covers 27 countries, and has two major components: (i) Investment in RET (with focus on solar mini-grids, solar rooftops, solar parks, and biomass – gasification and combustion); and (ii) technical assistance for capacity building and advisory services to implement favourable policies for RET uptake.

83. The Africa Development Bank (AfDB) is currently supporting and developing new programmes involving the renewable energy sector and IFAD is currently discussing co-financing opportunities

for the Western and Central Africa Division pipeline. These include the Green Mini-grid Development Programme (phase II) which has allocated USD 3 million to provide technical assistance for countries on energy efficiency and clean cooking and for developing policies to support the RE sector, the Off-grid Deployment Acceleration Program which looks at creating an enabling environment for private sector development programs such as tax incentives for SMEs, and the Desert to Power programme which aims to generate a total of 10 GW of solar PV by 2025 given the very high solar radiation in the area.

84. The Climate Technology Initiative (CTI) is a multilateral initiative[19] to foster the diffusion of climate-friendly and environmentally-sound technologies and practices. Through CTI's Private Financing Advisory Network (PFAN), a multilateral public-private partnership has raised over US$1.2 billion of investment for 87 clean energy projects.

85. The Nordic Climate Facility (NCF) is financed by the Nordic Development Fund (NDF) - a multilateral development financing institution of the Nordic countries. Since 2009, €30 million has been allocated to 72 projects in 21 countries. NCF phase 6 was launched in November 2015 with the theme Green Growth for Sustainable Livelihoods.

Other financing sources

86. IRENA and the Abu Dhabi Fund for Development (ADFD) have collaborated on a joint Project Facility to support transformative renewable energy projects in developing countries. ADFD committed US$ 350 million in concessional loans for financing renewable energy projects recommended by IRENA.

87. The Alternative Energy Challenge Fund (AECF) is a US$244 million fund capitalised by multilateral and bilateral donors to stimulate private sector entrepreneurs in Africa to support innovative business ideas in agriculture, agribusiness, renewable energy, adaptation to climate change and access to information and financial services. AECF has launched the DFID supported Renewable Energy and Adaptation to Climate Change Technologies (REACT) window, which supports innovative business models that improve access to electricity through off grid stand-alone renewable energy systems.

88. Acumen Fund, a non-profit global venture fund, supports innovations and business models ranging from off-grid solar solutions for homes and small businesses, to solar pumps powering irrigation solutions. In August 2016, Acumen and GCF signed a US$25 million agreement to implement household solar energy solutions in East Africa.

Section 3: Challenges and Opportunities

89. With the creation of a RE financing window comes certain challenges which need to be addressed in order to scale up RE within IFAD. The implementation of this approach however will also

[19] The CTI Member countries are: Australia, Austria, Canada, Finland, Germany, Japan, Norway, Republic of Korea, Sweden, UK and USA.

generate several positive outcomes and opportunities for further scaling up. These challenges and opportunities range across different areas and are key points for consideration in the mainstreaming of RE in IFAD operations (Table 3.1).

Table 03.1: Challenges and opportunities for scaling up RETs within IFAD

	Challenges	Opportunities
Policy	➢ No guidelines for country and project design teams, and implementing partners on how to integrate energy-related issues into IFAD's programming cycle (COSOP/SECAP), project design, and implementation stages ➢ During the COSOP and planning stage, limited discussions with government agencies mandated to oversee rural energy issues for systematically integrating RETs in IFAD country priorities.	➢ Providing advisory services to governments on rural energy and energy access planning. ➢ Linking projects with national rural energy subsidies, thus making RETs more affordable for smalholder farmers. ➢ Achieving a balance between mitigation and adaptation objectives while taking into account country-driven strategies i.e. NDCs and SDG targets. ➢ Reducing the level of risk to governments and the private sector in relation to RET projects in remote rural areas.
Economic	➢ Limited financing envelope per country for RE activities due to competing demands for other thematic investments. ➢ Limited concessionary financing options for RETs such as matching grants to companies and innovation grants to inventors. ➢ Limited financial and technical support for Small Medium Enterprise (SMEs) to integrate RETs in their business plans.	➢ Developing sound economic and financial analyses for investments in RETs. ➢ Mobilizing additional environment and climate change financing from bilateral and multilateral agencies . ➢ Facilitating a programmatic approach at regional level using sizeable GEF and GCF resources. ➢ Promoting innovative financing schemes to increase ownership and willingness to pay for RETs. ➢ Alignment with the IFAD SME Investment Finance-SIF.
Social	➢ Insufficient knowledge and exposure in-house to the multiple benefits of investments in RETs.	➢ Multiple benefits leveraged from investments in RETs on various thematic areas (agriculture, health, nutrition, environment, gender, youth employment, education etc.)
Technological	➢ Limited support for technical research and development of RETs adapted to specific sociocultural and agroecological systems.	➢ Testing cost-effective and relevant RETs in rural areas. ➢ Increasing South-South collaboration to test new innovations, piloting proof of concept RETs, and scaling up proven ones. ➢ Establishing demonstration and training centres to build capacity of rural youth to become technical experts in installation and after-sales services for specific RETs.
Environmental	➢ Limited renewable energy resource assessments with clearly articulated positive environmental impacts No standardized tool or methodology for measuring GHG emission	➢ Quantification of environmental benefits using geospatial tools to better inform projects, colleagues in-house and donors. ➢ GHG emission reduction potential (valued in CO_2e).

	reductions from the adoption of RETs.	
Legal	➢ Absence of financing products for bringing to scale technologies that are commonly associated with private sector profits or that have intellectual property rights (IPRs).	➢ Drafting collaboration agreements with private sector arms of bilateral agencies, which are tasked with channelling RE investments.
Institutional	➢ No technical unit or RE staff positions for mainstreaming RE in IFAD operations. ➢ No systematic knowledge management process to capture and disseminate lessons learned around RET (investment costs, social, environmental and economic benefits etc.). ➢ Limited efforts at positioning IFAD as a leader in renewable energy for smallholder agriculture.	➢ Establishing a RET unit with dedicated staff for advancing the mainstreaming of RE in IFAD operations. ➢ Improving the outreach strategy on RETs within the COM division through a more user-oriented approach. ➢ Developing partnerships with private sector companies, research institutes and NGOs. ➢ Emphasize the priority that IFAD11 places on its role as an assembler of development finance, and not just a direct lender

Section 4: Framework for Monitoring and Evaluation of the RESA Approach

90. In order to measure the progress and outcomes of the RESA approach, there are two levels of indicators that will be monitored: (1) Assessing the RET mainstreaming in IFAD; and (2) Assessing impact of RET in projects. Outcomes delivered by the Results Management Framework (RMF) of the RESA approach cover a five-year period.

91. Reporting of results will be aggregated across country portfolios on a yearly basis and monitored over the duration of project implementation. Reports to donors will include both quantitative data and a qualitative narrative describing what the resources were used for and the outputs and outcomes achieved. The reporting will be done through the ASAP 2 reporting mechanism.

Table 4.1: Results Management Framework for Five Years

Results hierarchy	Verifiable indicators	Sources of verification
Goal: Increase substantially the share of renewable energy in the smallholder agriculture and rural development sector (aligned with SDG7 target 7.2)	≤50% of IFAD investment projects include RE interventions	PDRs and COSTAB
Outcomes:		
Increased income at household, cooperative or enterprise level through adoption of RE at household and farm level	A total of ≤ 1 million RE applications installed in households, cooperatives or enterprises	ORMS
Increased capacity and rural entrepreneurship	≤ 10,000 trained cadre of technicians (≤ 50% women and youth)	ORMS
Increased environmental benefits	# of tons of greenhouse gas emissions (CO_2e) avoided and/or sequestered	ORMS
Knowledge on RE documented and disseminated	# of policy-relevant knowledge products completed	KM Products
	≤ 25 South-South exchanges on RE	SSTC reports
Improved policy, regulations and incentives in support of RE scaling up	# of existing new laws or regulations proposed for amendment/ratification to policy makers	ORMS

Conclusion

92. Access to energy is an indispensable element for sustainable agricultural and rural development. Renewable energy provides multiple benefits to improve rural livelihoods including increased income; reduced drudgery for women; increased health benefits; and improved education, to name a few. In this regard, IFAD needs to move renewable energy from the periphery to the centre of its operations and in order to do so, IFAD must mobilise resources and develop in-house knowledge and capacity. The RESA approach proposes a mechanism for achieving this mainstreaming objective.

Annexes

Annex I: Renewable Energy Technologies for Smallholder Agriculture

Renewable energy is any naturally occurring, theoretically inexhaustible source of energy, such as biomass, solar, wind, tidal, wave, geothermal and hydroelectric power that is not derived from fossil or nuclear fuel (REN21, 2010). The following provides further descriptions on different RETs and insights into the availability of energy sources for smallholder agriculture.

Solar energy – radiant light and heat – is harnessed using a range of evolving technologies such as solar heating, photovoltaic (PV), and concentrated solar power (CSP). The dramatic price reductions of the past decade have rendered solar PV more affordable, even for very small-scale applications. The demand for solar lanterns, Solar-Pico PV systems (SPS) (1–10 Watt capacity), and slightly larger Solar Home Systems (SHS) (10–200 Watt), continues to rise in rural areas. SPS are now commonly available that provide basic services such as lighting, communications, and battery or mobile phone charging.

Wind can be used to run a range of different-sized turbines. Modern utility-scale wind turbines produce in the range of 600 kW to 5 MW of rated power[20]. Areas where winds are stronger and more constant, such as offshore and high-altitude sites are preferred locations for wind farms. Small-scale wind turbines (up to 50 kW) are used in remote and rural areas for battery charging, telecommunications, and water pumping.

Since **water** is about 800 times denser than air, even a slow flowing stream of water can yield considerable amounts of energy. Therefore there are many methods of harnessing this energy, including:

- Hydroelectric energy (usually reserved for large-scale hydroelectric dams),
- Micro-hydro systems, which typically produce up to 100 kW of power. The main micro-hydro programmes in the developing world are in mountainous countries, particularly countries in the Himalayas. Installations in China, India, Nepal, and Sri Lanka have shown successful results with hydro-power based mini-grid systems that distribute power locally.
- Pico-hydro systems, which can be as small as 1kW, are common in many countries, where they provide local communities with affordable electricity. Such systems typically operate reliably and require minimal maintenance.
- Run-of-the-river (ROR) hydroelectricity systems derive kinetic energy from rivers without the creation of a large reservoir. ROR systems are ideal for streams or rivers that can sustain a minimum flow or those regulated by a lake or reservoir upstream.
- Wave power, which captures the energy of ocean surface waves, and tidal power, which converts the energy of tidal fluctuations. These two forms of hydropower have large untapped potential but are not yet widely employed.

Biomass is biological material derived from living, or recently living organisms (fossil fuels are thus excluded). Most often biomass is synonymous with vegetative matter. As an energy source, biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of fuel. Bioenergy can be classified into three different types:

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[20] From an engineering perspective, the rated power is the highest power input allowed to flow through particular equipment and be able to work at optimal levels.

- **Solid biomass**, such as wood and agricultural residues widely used for cooking and heating purposes and, more recently, to generate electricity using gasifiers produced from dry wood, rice husks, and other agricultural waste (e.g. corn cobs). Currently, this form of biomass is increasingly used to fuel generators that supply electricity to mini-grids and small factories.
- **Biogas** is produced with manure, crop residues, and other organic waste feedstock. Simple anaerobic digester technologies can produce clean biogas fuel for cooking. Biogas is best suited for households and small scale dairy cattle and pig farms, especially those located in warm climates. Biogas digesters integrated in a farming system can directly lower greenhouse gas (GHG) emissions by recovering the methane produced from manure. Methane is about 22 times more effective than carbon dioxide at trapping heat and is thus a more potent greenhouse gas).
- **Biofuels** in the form of ethanol and biodiesel are fuels produced from crops such as *jatropha*, corn, palm oil, etc. and also from used cooking oil. The resulting fuel can be used to power engines (for vehicles) and generators (for electricity), and its utilization is rising in numerous countries. However, the carbon footprint and displacement of food production makes biofuels a less attractive option.

Geothermal energy is derived from thermal energy generated and stored in the earth. It has the potential to provide reliable power with a small carbon footprint, and reduces vulnerability to extreme climates. Kenya's Vision 2030 has set out ambitious targets for geothermal energy and aims to have 5,530 MW of geothermal power or 26% of total capacity making geothermal the largest source of clean energy by 2030 (IAEA, 2012).

Annex II: Renewable Energy Activities in IFAD Portfolio through ASAP, GEF and Loan Funding (2013 – 2017).

COUNTRY -PROJECT NAME	RENEWABLE ENERGY ACTIVITIES IMPLEMENTED (UP TO END 2017)	RENEWABLE ENERGY ACTIVITIES PLANNED FOR 2018-2019	KEY CHALLENGES/ BOTTLENECKS EXPERIENCED

CAMBODIA –
 	
Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia (S-RET)
 	
** Total project cost: USD 4.6 million*
 	
** GEF Grant: USD 4.6 million*
 	
**** RET budget allocation: USD 4.6 million***
 	
** Duration: 2016 - 2020*
	- Call for proposals launched through the Ministry of Agriculture, Forestry and Fisheries (MAFF) for Testing and Roll-Out Grants to demonstrate RET in smallholder agriculture.
	- Royal University of Agriculture (RUA) with support from international NGO (GERES) developed Information, Education and Communication (IEC) material on RET options (costs, benefits, technical specifications).
	- Partnership with the National Biodigester Programme (NBP) to promote 3,000 biogas digesters (GHG emissions reduction of 5.6 tCO_2e per biodigester per year).
	- As of September 2018, NBP achieved the construction of 629 plants with 3,145 direct beneficiaries, covering 26 districts in 7 provinces.
	- Finalized policy study on ''*Energy use in agriculture for smallholder agriculture''*
	- Developed the 'Recipes for Climate Change' video in Kandal province highlighting aspects related to energy access (cooking fuels): https://www.youtube.com/watch?v=lJp78hzpmco
	- In collaboration with UNDP, established the informal working group platform on Sustainable Energy.
		- 12 'Testing grants' awarded to research institutes, NGOs etc. totalling USD800,000 for:
		  ○ Solar dyers (for spices, grains, fruits, vegetables, fish etc.)
		  ○ Solar chick hatching machine (brooding units) and solar ventilation and lighting for poultry sheds.
		  ○ Environmentally-friendly biomass briquettes for cooking and small-scale processing activities.
		  ○ Solar energy for powering small-scale machinery at farm level (water pumps, fodder chopping machine, hammer mills, grinding machines etc.)
		- 2 'Roll-out grants' awarded for establishing RET supply chains totalling USD320,000 for:
		  ○ Solar powered irrigation systems
		  ○ Improved cookstoves (for small-scale processing)
		- The project will provide results in a reduction of GHG emissions equivalent to at least 451,926 tonnes of CO_2.
		- Developing a Renewable energy curriculum led by the Centre for Agricultural and Environmental Studies (CAES) at RUA for MSc and BSc students.
			- Transition of S-RET from PADEE to ASPIRE requires sensitization of ASPIRE staff on S-RET activities.
			- Limited understanding of RET by government provincial staff who are expected to implement project activities (capacity building needed).
			- Need to establish mechanisms to ensure technologies are well installed so that farmers can receive RET subsidy (exists only for National Biogas Programme).
			- Delays in project start-up due to limited applications received for the national RET position under the project.

NEPAL –
 	
Adaptation for Smallholders in Hilly Areas (ASHA)
 	
** Total project cost: USD 37.6 million*
	- Memorandum of Understanding (MOU) signed with the Alternative Energy Promotion Centre (AEPC) under the Ministry of Population and Environment to oversee the installation of RETs. AEPC acts as an intermediary between the private sector, farmers and the project to ensure that RET units are properly installed and after-sales services provided, through their regional service centres.	- Based on the priorities of the Local Adaptation Plans of Action (LAPAs) 1,467 different types of RET installed (primarily in Kalikot and Rukum districts)
		- Plans under LAPAs to install:
		  ○ 45 improved water mills
		  ○ 10 Biogas digesters
		  ○ 210 solar home systems
		  ○ 5,530 improved cook stoves
			- Unclear customs rules for clearing imported RET (shipping docs, fees, documentation for tax exemption)
			- Lengthy bureaucratic procedures to obtain subsidies for biogas technologies under the national programme
			- Delays in ASHA project to transfer budget (more than 9 months)

** ASAP: USD 15 million* **** RET budget allocation: USD 300,000*** ** Duration: 2014 - 2020*	- Partnership with US based philanthropic institution Global Good - Intellectual Ventures for pilot testing 11 portable biogas digesters in hilly areas where fixed domes are logistically difficult to install. - Implementation of a 18kW solar plant under the UN ESCAP Grant: Leveraging Pro-Poor Public-Private-Partnerships (5Ps) for rural development - Widening access to energy services for rural poor.	- 7,500 planned RETs in all target districts - Scaling up of portable biogas in hilly areas through integration in Government programmes and SSTC with CARLEP Bhutan to field test portable biogas systems - Development of a KM video on the progress of the flexi biogas	from central to district to beneficiary groups - High staff turnover rate (including change of project director) affecting communication between AEPC and ASHA
BANGLADESH – Climate Adaptation and Livelihood Production (CALIP) ** Total project cost: USD 133.3 million* ** ASAP: USD 15 million* **** RET budget allocation: USD 195,986*** ** Duration: 2015 – 2019*	- Contracting service provider with the following profile to implement RET activities: o District/branch offices to provide cost-competitive and on-the-ground support in delivery, installation, operation, maintenance and post-sale services; and o Promotion of RET through associated microfinance services to improve uptake by poorer farmers.	- Project to support climate smart model villages with inclusion of solar home systems for household and community services (lighting, communication, education) as well as biogas digesters as a waste management tool for better sanitation, clean cooking fuel and organic fertilizer.	- Flash floods allow only 4/5 months per year for project implementation activities. - Complex project design deterred from prioritizing RET activities. - Delays in budget allocation for RET activities under the Development Project Proposal (DPP).
LAO PDR – Smallholder Adaptation for Climate Change Component (SACCC) ** Total project cost: USD 17.3 million* ** ASAP: USD 5 million* **** RET budget allocation: USD 325,000*** ** Duration: 2013 – 2019*	- Collaboration with SNV being discussed under the Global Alliance for Clean Cookstoves programme	- 30 micro-scale irrigation schemes (6 per district including solar powered drip irrigation) - 500 improved cookstoves to reduce consumption of firewood (and deforestation).	- Limited renewable energy companies present in the country. - Limited experience of project staff for contracting companies in the renewable energy sector. - No buy-in from farmers on value proposition for biogas due to abundancy of firewood, relatively short collection distances, and open grazing of livestock.

VIETNAM – Adaptation to the Mekong Delta (AMD) ** Total project cost: USD 49.3 million* ** ASAP: USD 12 million* **** RET allocation: USD 100,000*** ** Duration: 2013 – 2019*	- Renewable energy applications demonstrated include: ○ Solar power for fish sauce making ○ Solar power for water pumping in sugarcane production ○ Solar battery for road lighting ○ Efficient cooking stoves ○ Water misting irrigation	- Demonstration units planned for: ○ Solar-powered drip irrigation systems for horticulture production ○ Solar powered evaporative cooling storage system (SPECSS) to improve the shelf life of fruits and vegetables ○ Solar powered fans and lighting systems for poultry sheds ○ Solar aeration pumps for fish and shrimp farms	- Limited interest in small-scale RETs from the government due to the country's high electrification rate (98%). - Difficult for RET companies to enter markets due to high fossil-fuel subsidies.
RWANDA – Climate Resilient Post-Harvest and Agribusiness Support Project (PASP) ** Total project cost: USD 83.4 million*	- South-South collaboration with Kenyan private enterprise, Biogas International, led to the implementation of 401 portable biogas digesters (FlexiBiogas) under the 'Girinka' (One Cow for Every poor family) programme. - See flier and video of farmer interview - Partnership with Heifer International for the installation of a 24m^3 biogas system with hybrid 3kW solar panel in two communal cattle sheds for	- Large-scale (48m^3) biogas units for treatment of waste produced from 30 cows and milk handling and processing. - Establish 2 new milk chilling facilities by using solar energy. - Installation of solar energy systems to provide energy for lighting and powering different warehouse equipment as well as pilot testing of solar dryers manufactured by GrainPro.	- Lost opportunities for larger scaling up of FlexiBiogas due to technology innovators lack of business acumen

** ASAP: USD 6.9 million* **** RET allocation: USD 218,000*** ** Duration: 2013 – 2018*	running agricultural machinery (water pumps, milking machines and chaff cutters).	- Discussions with Heifer to expand the communal shed model for using biogas in integrated farming systems for chick & piglet brooding, post-harvest applications (drying, milk pasteurisation, yoghurt making).	
MALI – Fostering Agricultural Productivity Project (PAPAM) ** Total project cost: USD 173.4 million* ** ASAP: USD 9.9 million* **** RET allocation: USD 699,169*** ** Duration: 2010 – 2017*	- Installed 240 fixed-dome biogas digesters in partnership with *Agronome et Veterinaire Sans Frontieres* (AVSF) - 30 biogas digesters linked with toilets to improve human waste management and village sanitation - Pilot tested 48 FlexiBiogas digesters through South-South collaboration with Kenyan private enterprise, Biogas International. - 60 local masons trained on construction, operation and maintenance of biogas digesters	- Planned installation of 555 solar home systems and 500 fixed dome biogas digesters reaching 11,640 people and the conservation of 227 hectares of forest, the production of 1,858 tons of organic bioslurry and avoidance of 2,752 tonnes of CO_2eq. - Partnership with BioBolsa to test 500 portable biodigesters under the new project (MERIT) going to EB in September 2019.	- Political tension and civil conflict in target areas prevented implementing partners to provide on-the-ground support. - Delays in signing contract agreements and MoU between project and implementing partners.
EGYPT – Sustainable Agriculture Investments and Livelihoods Programme (SAIL) ** Total project cost: USD 86.9 million* ** ASAP: USD 5 million* ** Duration: 2014 -2022*	- Conducted a study on assessment of good examples of renewable energy. - Rehabilitation/upgrade of irrigation systems through use of solar pumping for improved water and energy efficiency	- Rehabilitation of 5 km of irrigation canals and use of solar energy for pumping - 11,067 households supported with increased water availability/efficiency (drip irrigation and solar energy)	- Limited capacity for drafting necessary documentation (costing/price details, technical information, agreements/MoU etc.)
MOROCCO – Rural Development Programme in the Mountain Zones Phase I	- Initial study to implement waste-to-energy systems from olive waste for heating and processing activities (briquetting)	- Plans to develop biomass-based energy systems for recovery of waste to use as heat and/or other processing activities	- Complex co-financing arrangements (GEF, loan, ASAP) have stalled project implementation for over 2 years.

** Total project cost: USD 49.4 million* ** ASAP: USD 2 million* ** Duration: 2014 – 2019*			
DJIBOUTI - Programme to reduce vulnerability to climate change and poverty of coastal rural communities (PRaREV) ** Total project cost: USD 13.3 million* ** ASAP: USD 6 million* ** Duration: 2013 - 2019*	- Feasibility study for the ''Utilization of Solar Energy in the Fisheries Sector of Djibouti''	- Plans to integrate renewable energy (mainly solar energy for storage, equipment, boats)	
PARAGUAY – Organizational Strengthening Project for Family and Indigenous Production (PROMAFI) ** Total project cost: USD 23.8 million* ** ASAP: USD 5.1 million* ** Duration: 2015 – 2019*		- South-South cooperation with Rwanda to implement biogas activities - Discussions with the International Centre for Numerical Methods in Engineering which have experience working with SNV on thermic model for enhancing biogas production in cold climatic areas	- The project still needs to be approved by Parliament after two years
BOLIVIA – Programme for Rural Families and Communities in the State of Bolivia		- 11,000 families receive technical support through concursos to adopt climate-resilient practices and technologies (including renewable energy sources)	-

(ACCESOS) ** Total project cost: USD 55.6 million* ** ASAP: USD 10 million* ** Duration: 2011 – 2016*			
GLOBAL	- Spearheaded IFAD's inclusion in a number of Renewable Energy platforms, including the International Renewable Energy Agency (IRENA), the Renewable Energy Policy Network for the 21st Century (REN21) and the UN-Energy group - Reviewed over 15 manuscripts for the Renewable Energy Journal - Contribution to the Global Trends in Renewable Energy Investment report published by REN 21 - Developed How to Do Note: Mainstreaming portable biogas systems in IFAD funded projects; - Developed a database of renewable energy technologies for rural communities (open access, online) - Published by IFAD "Tools for project design - Livestock and Renewable Energy"	- Discussions with Hivos to collaborate under the Africa Biogas Partnership Programme (ABPP) undertaken in Ethiopia, Kenya, Tanzania, Uganda, and Burkina Faso - Discussions ongoing with IRENA's Innovation and Technology Centre - Providing technical advice to the Core Advisory Group under the Council on Energy, Environment and Water (CEEW) for the "Development of a decision-support tool for solar-powered irrigation systems in India"	- Limited human resources to update the dedicated webpage on Renewable Energy on the IFAD website

Annex III: IFAD Investment Programmes with Renewable Energy (2006 – 2013)

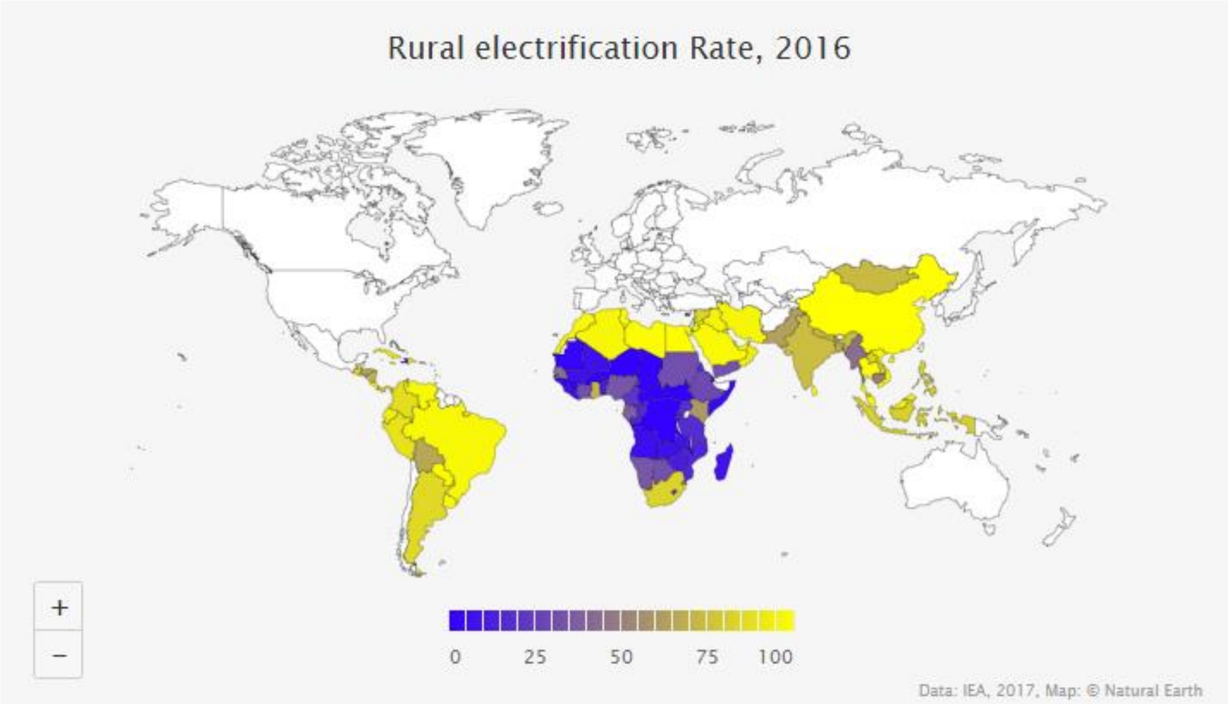
Country	Project	Renewable Energy Activities
Asia and the Pacific		
1. China	Guangxi Integrated Agricultural Development Project	569 household based biogas digesters constructed. Second phase, introduction of 2.73 million biogas digesters - 7.65 million tons of standard coal and 13.4 million tons of firewood saved annually equivalent to the recovery of 7,470 hectares of forest.
	The Wulin Mountains Minority Areas Development Project	Includes a credit component aimed directly at women's income-generating activities, which increases the chances that time released by biogas stoves will be used to earn extra cash
2. India	Orissa Tribal Empowerment and Livelihoods Programme (OTELP)	Solar lights & charging stations, solar water pumps, and in collaboration with Practical Action installation of hybrid wind/solar systems for village electrification (mobile charging, TV etc.)
	Jharkhand Tribal Empowerment and Livelihood Programme (JTELP)	Through the convergence programme under the state-run agency Jharkhand Renewable Energy Development Agency (JREDA) installation in tribal communities: ➢ 2,000 improved cookstoves ➢ 10,126 solar lanterns ➢ 2,000 solar home systems ➢ 150 biogas digesters ➢ 20 mobile solar pumps
3. Nepal	Western Uplands Poverty Alleviation Project (WUPAP)	Microhydro power and multi-purpose water mills, poultry lighting
	ESCAP Grant: Leveraging Pro-poor Public-Private Partnerships (5Ps) for Rural Development	Compiling the institutional linkages (including policy options, legal and regulatory conditions, and available financing mechanisms) and installed an 18kW solar plant for enterprise development.
4. Bangladesh	Promoting Agricultural Commercialization and Enterprises (PACE)	Introduction of technology, improved farm management practices targeted for small producers and microenterprises
5. Cambodia	Project for Agricultural and Economic Empowerment (PADEE)	Small-scale biogas digesters through the National Biodigester Programme (NBP) under the Ministry of Agriculture, Forestry and Fisheries (MAFF)
Eastern and Southern Africa		
6. Eritrea	Catchments and Landscape Management Project (CLMP)	Improved cookstoves, biogas digesters and solar panels
7. Rwanda	Kirehe Community Based Watershed Management (KWAMP)	Biogas initiative within the national Girinka programmes (One Cow Per Farmer Programme) which installed 3,000 portable biogas units for household energy (cooking fuel and organic fertilizer)
8. Uganda	Photovoltaic Pilot Project for Rural Electrification (PROFIRA)	Led to the installation of almost 600 solar home systems (SHS), refrigerators for vaccines and lights for maternity wards and education (e.g. lights for night studies at secondary schools). Women entrepreneurs were encouraged to buy solar systems to improve their businesses, but this proved to be unsuccessful because of inappropriate credit arrangements
9. Mozambique	Pro-poor Value Chain Development Project in the Maputo and Limpopo Corridors (PROSUL)	Supports the design and building of a slaughterhouse biogas plant. It will also provide an alternative energy source to help power the slaughterhouse meat processing equipment.

10. Kenya	Smallholder Dairy Commercialization Programme (SDCP) through an Initiative for Mainstreaming Innovation (IMI) grant	Pilot testing of portable biogas digesters in zero-grazing farming systems for dairy smallholder farmers. Use of biogas energy for reducing waste in slaughterhouses and also demonstrating a small-scale model of biogas compression and bottling
11. Mauritania and Burkina Faso	Initiative for Mainstreaming Innovation (IMI) Grant	In collaboration with the Italian Ministry of Education, ENEA organized a national competition on the theme of sustainable environment for Italian students. Students presenting the best projects won, amongst other things, a photovoltaic kit which they donated to 10 Mauritanian rural schools and 10 Burkina Faso rural schools (all schools financed by IFAD ongoing projects)
12. Swaziland	Lower Usuthu Sustainable Land Management Project	Biogas digesters for household energy consumption and use of organic fertilizer in home gardens
Western and Central Africa		
13. Benin	Market Gardening Development Support Project	Pilot tested solar powered drip irrigation systems for horticulture production
14. Mali	The Mali Multifunctional Platform (MFP) project in collaboration with UNIDO and UNDP	Multifunctional platforms for 700 communities which have installed biodiesel generators, powered by oil from the jatropha provide electricity for lighting homes, running water pumps and grain mills as well as other post-harvest handling activities.
Near East and North Africa		
15. Egypt	Promotion of Rural Incomes through Market Enhancement (PRIME)	Solar water pumping systems for desalinization integrated to provide a reliable source of water (also for potable drinking)
16. Djibouti	Programme to support the reduction of vulnerability in coastal fishing areas (PRAREV)	Investments in renewable energy equipment, ice plants and coolers / insulated containers to improve the conservation of fish products.
17. Turkey	Murat river watershed rehabilitation project (MRWRP)	Promoting energy saving technologies to reduce pressure on the forests for fuel wood
18. Yemen	Rural Growth Programme (RGP)	Renewable energy grants will support the development of small businesses and microenterprises in villages that are not connected to the national grid. This will not only reduce dependency on fossil fuel sources, but also contribute to a reduction of greenhouse gas emissions.

Annex IV: Action Plan

The following action plan seeks to provide a preliminary classification or clustering of countries that would allow IFAD to prioritize its engagement in this specific agenda. The major criteria that have been chosen are as follows:

1. Based on rural electrification rates:



Source: IEA, 2017

2. Discussions with Regional Climate and Environment Specialists in IFAD
3. Analysis of IFAD projects in the pipeline 2019-2020 focusing on agricultural productivity and mechanization with cross-cutting benefits (youth employment, gender empowerment, climate resilience)
4. Geographic location and natural endowments (sun, wind, water, biomass)
5. For specific technologies based on analysis of potential energy interventions where use of fossil fuels is foreseen. For example:
   - Solar energy in projects featuring rehabilitation/upgrade of irrigation systems for improved water and energy efficiency
   - Improved cookstoves / Biogas for projects that have primary focus on women empowerment, labour saving technologies and community-based forest management

1. Western and Central Africa (WCA)

2019:

Country	Project name	Total Project Financing (USD)
Cote d'Ivoire	Agricultural Value Chain Development Support Programme (PADFA)	69 448 939
Mali	Multi-Energy for Resilience and Integrated Territorial Management (MERIT)	39 670 974
Burkina Faso	Agricultural Value Chain Promotion Project (PAPFA)	71 700 656
Senegal	Support to Agricultural Development and Rural Entrepreneurship Programme Phase II (PADAER-II)	72 435 352
Liberia	Tree Crops Extension Project Phase II (TCEP-II)	55 831 000

Guinea	Family Farming, Resilience and Markets Project in Upper and Middle Guinea (AgriFARM)	97 090 000
Benin	Agricultural Value Chain Development Project (PADAAM)	104 370 999
Central African Republic	Project for Reviving Crop and Livestock Production in the Savannah (PREPAS)	29 443 400

2020:

Sierra Leone	Agriculture Value Chain Development Project (AVDP)	11 789 380
Niger	Family Farming Development Programme - Diffa Expansion (ProDAF-Diffa)	18 525 900

2. Eastern and Southern Africa (ESA)

2019:

Country	Project name	Total Project Financing (USD)
Rwanda	Kayonza Irrigation and Integrated Watershed Management Project-I (KIIWP I)	7 000 000
Malawi	Value Chain Project (tbd)	56 919 775
Eritrea	Integrated Agriculture Development Project (IADP)	47 175 287

2020:

Rwanda	Kayonza Irrigation and Integrated Watershed Management Project-II (KIIWP II)	50 360 000
Tanzania	Southern Highlands Milkshed Development Project	32 120 000

3. Asia and the Pacific (APR)

2019:

Country	Project name	Total Project Financing (USD)
Bhutan	Commercial Agriculture and Resilient Livelihoods Enhancement Programme (CARLEP)	9 000 000
Cambodia	Sustainable Assets for Agricultural Markets, Business and Trade (SAAMBAT)	53 000 000
India	Scaling up Agricultural Technologies for Smallholder Farmers (SCATE)	146 000 000
Lao PDR	Partnership for Irrigation and Commercial Smallholder Agriculture (PICSA)	21 000 000
Kiribati	Outer Islands Food and Water Project	4 500 000

2020:

Tonga	Tonga Rural Innovation Project - Phase II (TRIP2)	4 500 000

4. Near East and North Africa (NEN)

2019:

Country	Project name	Total Project Financing (USD)
Syria	Reconstruction of Agricultural Production Facilities Project	28 524 000
Kyrgyzstan	Resilient Pastoral Livelihoods Project	32 440 000
Morocco	Agricultural Value chain development programme	37 245 000
Sudan	Inclusive Agribusiness Development Program	67 736 000

2020:

Uzbekistan	Agricultural Modernization and Diversification	45 277 000
Moldova	Development of Small and Micro Agricultural Enterprises	19 995 000
Tajikistan	Agricultural Modernization and Mechanization	38 780 000

5. Latin America and the Caribbean

2019:

Country	Project name	Total Project Financing (USD)
Bolivia	Economic Inclusion Programme for Families and Rural Communities in the Territory of the Plurinational State of Bolivia (ACCESSOS II)	23 591 221
Cuba	Livestock Cooperatives Development Project in the Central-Eastern Region (PRODEGAN)	50 000 000
Haiti	Agricultural and Agroforestry Technological Innovation Program (PITAG)	76 860 000

References

Ahuja, D., Tatsutani, M. (2009) Sustainable energy for developing countries: *SAPIENS*, Vol.2. Retrieved from: https://sapiens.revues.org/823

Bloomberg (2016) Off-Grid Solar Market Trends Report 2016; Bloomberg New Energy Finance and Lighting Global, 2016: 78. Retrieved from: file:///C:/Users/k.sehgal/Downloads/20160301_OffGridSolarTrendsReport.pdf

Bonjour, S. (2013) Solid Fuel Use for Household Cooking: Country and Regional Estimates for 1980–2010

Buchner B. et al. (2015) The Landscape of Climate Finance 2015, Climate Policy Initiative. Retrieved from: http://climatepolicyinitiative.org/wp-content/uploads/2015/11/Global-Landscape-of-Climate-Finance-2015.pdf

Ceres and the Pacific Institute (2009) Water scarcity and climate change: growing risks for businesses and investors

Chua, J. (2015) Why the smart money is looking at clean energy in Asia. Retrieved from: http://www.eco-business.com/news/why-smart-money-looking-clean-energy-asia/

Chua, J. (2015) The emerging renewable financing landscape. Retrieved from: http://www.eco-business.com/news/the-emerging-renewable-financing-landscape/

Climate Policy Initiative (2014) The Global Landscape of Climate Finance. Retrieved from: http://www.climatefinancelandscape.org/#/

Dobias, R.J. (2010) Financing for Climate Change Adaptation; Asian Development Bank (ADB)

FAO (2009) Food security and Agricultural Mitigation in Developing Countries

Goldemberg, J. (2000) Rural energy in developing countries; Full Report UNDP

Hartmann, A., Linn, J. (2008) Scaling Up Through Aid: The Real Challenge; Brookings Institution

Hartl, M. (2011) Lightening the Load Labour-saving technologies and practices for rural women; IFAD

Institute for Policy Studies (2015) Climate Finance and Markets. Retrieved from: http://climatemarkets.org/course

International Energy Agency and the World Bank (2015) Sustainable Energy for All 2015 - Progress Toward Sustainable Energy

International Renewable Energy Agency (IRENA) (2016) Renewable energy benefits: Decentralised solutions in the Agri-food chain. IRENA, Abu Dhabi.

ITDG (2000) Best practices for sustainable development of Micro-Hydro power in developing countries. Full Report

IUCN (2009) Training Manual on Gender and Climate Change. Working paper: *Climate change and gender: economic empowerment of women through climate mitigation and adaptation*

Kieffer, G., Couture, T.D. (2015) Renewable Energy Target setting. IRENA Publication. Retrieved from: http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Target_Setting_2015.pdf
Nakhooda, S., Marigold, N. (2014) Climate Finance: Is it making a difference? Overseas Development Institute (ODI). Retrieved from: https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9359.pdf

OECD (2015) Climate finance in 2013-14 and the USD 100 billion goal. Retrieved from: http://www.oecd.org/environment/cc/OECD-CPI-Climate-Finance-Report.htm

Power for All (2016) Decentralized Renewables: The Fast Track to Universal Energy Access. Retrieved from:
http://static1.squarespace.com/static/532f79fae4b07e365baf1c64/t/5743c79b37013bd05153c7a6/1464059812855/Power_for_All_POV_May2016.pdf

Practical Action Consulting (2009) Small-scale bioenergy initiatives; Pisces and FAO

Raymond, A. and Jain, A. (2018) Solar for Irrigation: A Comparative Assessment of Deployment Strategies. Council on Energy, Environment and Water (CEEW) Full Report 2018.

Shah, V., Cheam, J. (2015) Meeting Southeast Asia's ambitious clean energy targets. Retrieved from: http://www.eco-business.com/news/meeting-southeast-asias-ambitious-clean-energy-targets/

REN21 (2016) Renewable 2016 Global Status Report. Retrieved from: http://www.ren21.net/wp-content/uploads/2016/06/GSR_2016_Full_Report_REN21.pdf

REN21 (2018) Renewables 2018 Global Status Report. Paris, REN21 Secretariat.

Simon, C. (2007) Is Energy a Public Good? Retrieved from: https://www.renewableenergyworld.com/articles/2007/07/is-energy-a-public-good-49201.html

Smart Villages (2016) Smart Villages in South America: Lima Workshop Report. Retrieved from: http://e4sv.org/wp-content/uploads/2016/05/WR16-Smart-Villages-in-South-America-Lima-Workshop-Report.pdf

Sovacool, B. (2013) The energy-enterprise-gender nexus: Lessons from the Multifunctional Platform (MFP) in Mali; *Renewable Energy Vol. 50*: 115–125

Sovacool, B. (2014) Scaling and commercializing mobile biogas systems in Kenya: A qualitative pilot study; Renewable Energy Vol. 76

Tice, D., Skierka K. (2014) Power for All: The Energy Access Imperative. Retrieved from: www.powerforall.org/resources

Tweed, K (2015) Private and Public Funds Continue Flowing Into Off-Grid Power Projects. Retrieved from: http://www.greentechmedia.com/articles/read/private-public-funds-flow-to-off-grid-power-projects

UK Aid (2015) Energy Access Campaign. Retrieved from: https://www.gov.uk/government/news/energy-africa-campaign

UNCTAD (2009) Trade and Development Report, Responding to the Global Crisis, Climate Change Mitigation and Development

UNDP (2004) Reducing rural poverty through increased access to energy services. Full Report

UNDP (2009) Bringing small-scale finance to the poor for modern energy service: What is the role of Governments. Full Report

UNDP (2009) Expanding Energy Access in Developing countries: the role of mechanical power

UNDP (2018) Sustainable Development Goals. [Online] Available at: http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-17-partnerships-for-the-goals.html

UNEP (2011) Global Trends in Renewable Energy Investment. Retrieved from: http://www.unep.org/pdf/BNEF_global_trends_in_renewable_energy_investment_2011_report.pdf

UNFCC (2018) The Paris Agreement [Online] Available at: https://unfccc.int/process/the-paris-agreement/the-paris-agreement

UNISDR (2015) Sendai Framework for Disaster Risk Reduction 2015 – 2030. United Nations Office for Disaster Risk Reduction

Van Campen, B. (2000) Solar Photovoltaics for sustainable agriculture and rural development; FAO

Van-Dijk, A.K. (2005) Energy choices in SME's in rural areas; Technology and Sustainable Development, University of Twente

Women's Environment & Development Organization (2007) Changing the Climate: Why Gender perspectives matter

World Bank (2010) Development and Climate Change. World Development Report

World Bank (2010) The Economics of Renewable Energy Expansion in Rural Sub-Saharan Africa

World Bank (2015) Electricity Access, FY 2000–2014: An Independent Evaluation

World Bank (2016) Africa Far from Sustainable Energy for All, But Showing Signs of Progress. Retrieved from: http://www.worldbank.org/en/news/feature/2016/02/17/africa-far-from-sustainable-energy-for-all-but-showing-signs-of-progress

World Energy Outlook (2015) Biomass databases, electricity access and reliance on traditional biomass for cooking since 2002