INTERNATIONAL SOLAR ALLIANCE

Funded by the European Union

BUSINESS MODELS AND FINANCING INSTRUMENTS IN THE SOLAR ENERGY SECTOR

2023

Business Models and Financing Instruments for Solar

This document presents the compilation and analysis of solar business models and financing instruments based on the review of volume of documents and practical experience of the finance expert in the subject area as part of an activity under "EU Co-operation with the International Solar Alliance" project. The results and synthesis of such compilation and analysis enables logical grouping of business models and financing instruments which will be a useful guide to achieve adoption of solar energy across the world particularly in SIDS and LDCs. The document also presents interesting readings related to the topic of business models and financing instruments in various countries wherever possible.

Disclaimer

This compilation of business models and financing instruments was prepared with the financial assistance of the European Commission. The listing of business models and financing instruments is the work of the consultants and not the work of the European Commission. This compilation is "work-in-progress" and is therefore not exhaustive and is verified as of 31 July 2023. To offer suggestions or to raise queries relating to the content, please write to us at info@isolaralliance.org.

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Abbreviations

EPC	Engineering, Procurement and Construction
EMI	Equated Monthly Installment
EV	Electric Vehicle
ESCO	Energy Service Company
FiT	Feed-in-Tariff
IPP	Independent Power Producer
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
P2P	Peer to Peer
PPA	Power Purchase Agreement
PV	Photovoltaic
RESCO	Renewable Energy Service Company
SHS	Solar Home System
TRA	Trust and Retention Account

Terms and Meanings

The following are the terms and their definitions that are used in business model frameworks in Appendix 1. Some of the terms and their meanings seem to be obvious and redundant but the context requires them to clarify and hence enable us to understand the models better.

Term	Definition
Consulting Services	Consulting services means the provision of expertise or strategic advice that is presented for consideration and decision-making.
Electric Vehicle (EV)	An EV is defined as a vehicle that can be powered by an electric motor that draws electricity from a battery and is capable of being charged from an external source.
Engineering, Procurement and Construction (EPC)	Engineering, Procurement and Construction (EPC) firms deliver a complete package of resources to complete infrastructure projects. EPC services typically provide a single responsible source for executing a project, thus alleviating risk for the owner
Energy Service Company (ESCO)	An Energy Service Company (ESCO) is a company that provides a broad range of energy solutions including design and implementation of energy savings projects, retrofitting, energy conservation, energy infrastructure outsourcing, power generation, energy supply, and risk management
Equated Monthly Installment (EMI)	It is the monthly amount one must pay his or her lender to repay a loan or debt
ESCROW	In financial transactions, the term “in escrow” indicates a temporary condition of an item, such as money or property, that has been transferred to a third party. This transfer is usually done on behalf of a buyer and seller.
Feed-in-Tariff (FiT)	A payment made to households or businesses generating their own electricity through the use of methods that do not contribute to the depletion of natural resources, proportional to the amount of power generated.
Funds	Sum of money either as equity or debt that is expected to be paid back with a return or interest
Facilitation Fee	A fee paid for the action of facilitating something
Independent Power Producer (IPP)	An Independent Power Producer (IPP) or non-utility generator (NUG) is an entity that is not a public utility but owns and facilities to generate electric power for sale to utilities and end users.
Operation and Maintenance (O&M)	O&M refers to the functions, duties and labour associated with daily operations. The ultimate goal is to preserve an asset so that it continues to provide reliable services throughout its expected useful life
Payments	The action or process of paying someone in return for service rendered
Peer to Peer (P2P) Electricity Trading	P2P electricity trading is a platform that allows local distributed energy generators to sell their electricity at the desired price to consumers willing to pay that price

Term	Definition
Power Purchase Agreement (PPA)	A power purchase agreement (PPA), or electricity power agreement, is a long-term contract between an electricity generator and a customer, usually a utility, government or company. Ppas may last anywhere between 5 and 20 years, during which time the power purchaser buys energy at a pre-negotiated price
Power Purchase Agreement (PPA) Payments	Payments for supply of electricity as per power purchase agreement
Renewable Energy Service Company (RESCO)	A Renewable Energy Service Company (Resco) is an ESCO (Energy Service Company) that offers consumers access to energy derived from renewable sources such as solar photovoltaics,wind power etc.
Roof Rental Fee	A rental payment made to the rooftop owner
Services	An action of helping or doing work for someone
Solar Home System (SHS)	A Solar Home System (SHS) is a small-scale, autonomous electricity supply for households that are off-grid or have unreliable access to energy. It generates electricity from sunshine and stores the electricity in a battery for consumption during the night or cloudy days.
Super RESCO	Super RESCO refers to an entity which aggregates RESCOs.
Trust and Retention Account (TRA)	TRA mechanism has been a common feature in financing of infrastructure projects. It seeks to protect the project lenders against the credit risk (the risk of debt service default) by insulating the cash flows of the project company. This is done through shifting the control over future cash flows from the hands of the borrowers (project company) to an independent agent, called tra agent, duly mandated by the lenders.
Turnkey Services	Turnkey is basically a service that is installed or supplied completely and is ready to operate as intended

1

Preface

In a time when sustainable energy solutions take centre stage, the solar sector is emerging as a leader in progress. This report on Solar Business Models and Financing Instruments, delves into the complex landscape of strategies, risks, and benefits that define this ever-evolving industry. Explore how 42 unique business models, categorized into 11 overarching themes, are shaping the trajectory of solar energy business and financing. As we dissect these models and introduce 12 new additions, we invite you to use this compilation as a handy guide to understand the different ways in which solar energy is being disseminated, financed and utilised by different stakeholders. Especially beneficial here is the section on the utility of these models in Least Developing Countries (LDCs) and Small Island Developing States (SIDS).

The business models in solar can be clustered depending upon the overarching themes of value proposition, value creation and value delivery among the stakeholders. In this report, we bring to you 12 new business models which are presented in each of the 11 overarching themes as below.

i. Solar Rooftop Business Models
    a. Solar Co-operative Business Model

ii. Large Scale Solar(Solar Park) Business Models

iii. Utility Focused Solar Business Models

iv. Off-Grid Solar Business Models

v. Solar Mini-grids Business Models
    a. Peer to Peer (P2P) electricity trading model
    b. Hybrid model (a mix of community, utility and private sector run mini-grid systems)

vi. Business Models for Multipurpose Use of Land for Renewable Energy Projects
    a. Solar developer leases land from small farmers and construct the solar plant (Farmer- Land owner, Solar developer- Tenant)
    b. Land as well as the solar plant is owned by the farmer (Farmer- Landowner as well as solar plant owner)
    c. Solar developer- Land and solar plant owner, subsidiary of developer- Farming agency

vii. Solar Business Models for Agriculture

viii. Solar Business Models for Floating Solar
    a. RESCO model (Pond owner leases pond to a project developer who finances, builds, owns, operates and sells the electricity to the grid (<= 5MW)
    b. IPP ownership with PPA through project financing route (>5MW)

ix. Solar based E-Mobility and Storage
    a. Battery swapping with battery charged through PV systems owned, operated or banked by utility, private sector, OEM
    b. Captive PV charging through PV systems owned, operated or banked by utility, private sector, OEM
    c. Solar carports (can be portable, grid connected or battery stored)
    d. Solar PV, battery energy storage, electric vehicles in virtual power plant model in a grid/mini-grid/ microgrid application owned and operated by utility, private sector,
    e. Solarizing Heating and Cooling Systems

x. Carbon Finance Models

Meanwhile, financing instruments are utilized to displace, share or cover risks of technical, financial, policy, regulatory and political nature. There are various types of financing instruments depending upon the nature of risk that is mitigated or covered through them. In total, 43 financing instruments are compiled, analyzed and clustered in 11 themes in Chapter 4 of this document. This also includes 16 new financing instruments which are presented in each of the overarching themes as below:

i. Grants

ii. Results/Outcome based

iii. Tax Rebates

iv. Debt Instruments
    a. Project Financing

v. Equity and Quasi Equity Instruments
    a. Crowd funding

vi. Blended Finance
    a. Blending of investment grant with debt

vii. Funds and Structured Products
    a. Structured/Securitized products (such as Synthetic Risk Transfer for Mezzanine tranche of loans)
    b. Green Bonds
    c. Blue Bonds
    d. Transition Bonds
    e. Sustainability Bonds

viii. De-risking Instruments
    a. Insurance (against weather, solar/ wind resources, climate risk, force majeure events, unforeseen events, political risk etc.)
    b. Risk guarantees (partial risk, partial credit)
    c. First loss facilities
    d. Local currency loans and facilities
    e. Swaps/Derivative (Credit, Weather indexed, interest rate, currency, commodity)
    f. Export credit guarantees

ix. Small Scale Project Financing
    a. Microfinance
    b. Portfolio guarantees/loss reserves

x. Off-grid Finance

xi. Carbon Finance

The compilation of business models and financing instruments are not exhaustive. However, efforts have been made to include as many of them as possible. Furthermore, in the business models presented, it may be possible that additional stakeholders, who share a particular risk and value, can be added to the business model depending upon the requirement. For example, Government or Development institutions can be represented as a stakeholder who can share or cover financial, policy, regulatory and political risks and in return get the value of development, job creation and economic growth.

2

Methodology

This section describes the methodology adopted for compiling and analyzing existing financing instruments, regulations and business models supporting the program areas that the International Solar Alliance (ISA) focuses on. These also involve European IFIs and donors, implemented in LDCs and SIDS countries (in total 85 business models and financing instruments, of which 28 new are identified).

For this report, the following methodology was adopted:

- The list of LDCs (46 countries) and SIDS (38 countries) as per the definition of UN is noted. These are presented in Appendix 3 and 4.
- A scientific literature search was undertaken on this topic through organic search of keywords related to business models and financing instruments.
- The results were noted as it is and then analyzed for the content. The clustering was done based on the ISA's nine program areas. A few business models were not able to fit the nine program areas and were hence clustered under different titles based on the experience of the finance expert. These business model frameworks are presented in Appendix 1.
- The financing instruments are clustered based on the scientific literature and practical experience of the finance expert working in different projects.
- When the secondary research for a country was done, interesting case studies, press articles, press/media releases were noted down. Interesting articles with respective to countries on solar business models and financing instruments were noted and presented as short case studies in Appendix 2.
- The research articles, documents, press releases, short cases and reports that were studied to compile the business models and financing instruments in the solar energy sector is listed in the 'References and Further Readings' at the end of the document
- The analysis of the business models enabled us to compile 42 business models clustered under 11 overarching themes in the solar program areas.
- The analysis of the financing instruments enabled us to compile 43 financing instruments clustered under 11 overarching themes in the financing instruments subject.
- Such a compilation and analysis was peer reviewed by experts in the area. Based on their comments and inputs, the compilation and analysis is finalized and presented in the chapters 3 and 4.

3

Compilation and Analysis of Solar Business Models

Solar Rooftop Business Models

1. Roof Rental Model
2. Solar PPA Model
3. Solar Leasing Model
4. Solar Co-operative Business Model (NEW)

Large Scale (Solar Park) Solar Business Models

5. Consulting Business Model
6. Technology Provision Business Model
7. Turnkey Business Model
8. Large solar leasing model
9. Engineering Procurement Construction (EPC) model by public sector
10. Large solar PPA by IPP (Independent Power Producer) model

Utility focused solar business model

11. Utility owned, on customer or utility premises
12. Community owned and utility facilitated
13. Utility financed customer owned
14. Grid Connected, Consumer Owned, (Utility as Super RESCO) Model
15. Grid connected, utility owned (Utility, as super RESCO, owned systems)
16. Facilitated Procurement Model
17. EPC contractor model
18. On-bill Financing
19. Payment assurance model

Off-Grid solar business models

20. Lease to own model (PAYGO Model)
21. Usage-based payment model (PAYGO model)
22. Dealer credit Business Model

Solar Minigrids business models

23. Peer to Peer (P2P) electicity trading model (NEW)
24. Utility owned and operated
25. Private sector owned and operated (Franchise approach, Anchor, businesses and consumers (ABC model), Clustering approach)
26. Community owned and operated
27. Hybrid model (a mix of above three) (NEW)

Business Models for multipurpose use of land for renewable energy projects

28. Solar Developer leases land from small farmers and construct the solar plant (Farmer- Land owner, solar developer- Tenent) (NEW)
29. Land as well as the solar plant is owned by the farmer (Farmer- Landowner as well as solar plant owner) (NEW)
30. Solar developer- Land and solar plant owner, subsidiary of developer- Farming agency (NEW)

Solar Business models for Agriculture

31. Utility as aggregator and owner for installation of solar pumps in agricultural lands, Farmers are given free power and land rental, extra electricity is fed into the grid
32. Utility as facilitator and the farmer as the owner of solar pumps. Farmers invest in the solar pumps, he is paid FIT for feeding the grid
33. Utility as facilitator and the RESCO as the owner for installation and operation of solar pumps on Build, own, operate (BOO) basis

Solar Business models for floating solar

34. RESCO model (Pond owner leases it to a project developer who finances, builds, owns, operates and sells the electricity to the grid for <= 5MW (NEW)
35. IPP ownership with PPA through project financing route (>5MW) (NEW)

Solar based E-Mobility and Storage

36. Battery Swaping with battery charged through PV systems owned, operated or banked by utility, private sector, OEM (NEW)
37. Captive PV charging through PV systems owned, operated or banked by utility, private sector, OEM, (NEW)
38. Solar Carports (can be Portable, grid connected or battery stored) (NEW)
39. Solar PV, Battery energy storage, electric vehicles in virtual power plant model in a grid/minigrid/microgrid application owned and operated by utility, private sector, OEM (NEW)

Solarizing Heating and Cooling Systems

40. ESCO Business models (Shared Saving, Guaranteed saving, Performance contracting, Deemed savings, outsourced energy model)

Carbon Finance Models

41. Developer is the owner and gets funding from a funder/agency based on the estimated reduction in GHG emissions arising out of the solar project and signs a forward deal for fixing prices for carbon credits. (Carbon credit prices are high for minigrid, offgrid and cook stove projects. For mega scale projects the prices are lesser. Social motive related projects, the prices are higher in general)
42. Developer is the owner and funder as well for the solar project. He registers the project for carbon credit. He then sells them to others who are in need of carbon credits at the existing spot prices.

The business model frameworks are represented in Appendix 3.

4

Compilation And Analysis Of Financing Instruments

Grants

1. Investment grant
2. Interest grant
3. Technical assistance
4. Research Grants
5. Subsidies (capital, interest, tax etc.)
6. Convertible grants

Results/outcome based

7. Results based financing (output based aid, conditional cash transfers etc)
8. Generation based incentives

Tax Rebates

9. Tax credits
10. Tax holidays
11. Duty exemption
12. Accelarated Depriciation

Debt Instruments

13. Concessional/Flexible Loans (Direct)
14. Concessional/Flexible Loans with financial intermediaries
15. Project Financing (NEW)

Equity and Quasi Equity Investments

16. Direct equity investment
17. Quasi equity (Convertible bonds, subordinated debt)
18. Convertible bonds
19. Venture capital
20. Crowdfunding (NEW)

Blended Finance

21. Blending of investment grant with debt (NEW)

Funds and Structured Products

22. Debt and Equity funds
23. Structured/Securitized products (such as Synthetic Risk Transfer for Mezzanine tranche of loans) (NEW)
24. Pledge Funds
25. Green Bonds (NEW)
26. Blue Bonds (NEW)
27. Transition Bonds (NEW)
28. Sustainability bonds (NEW)
29. Financial lease

De-Risking Instruments

30. Insurance (against weather, solar/wind resources, climate risk, force majure events, unforeseen events, political risk etc.) (NEW)
31. Risk guarantees (Partial risk, Partial credit) NEW
32. First loss facilities (NEW)
33. Local Currency Loans and facilities (NEW)
34. Liquidity facilities
35. Swaps/Derivative (Credit, Weather indexed, interest rate, currency, commodity) (NEW)
36. Export credit guanrantees (NEW)

Small scale project financing

37. Microfinance (NEW)
38. Aggregation
39. Portfolio gurantees/loss reserves (NEW)

Off-Grid Finance

40. Entreprenuers' Equity
41. Suppliers credit program
42. End-consumer finance

Carbon Finance

43. Carbon Finance (CDM projects, Carbon Emission Reduction (CER) certificates related loans, carbon credits)

Appendix 1

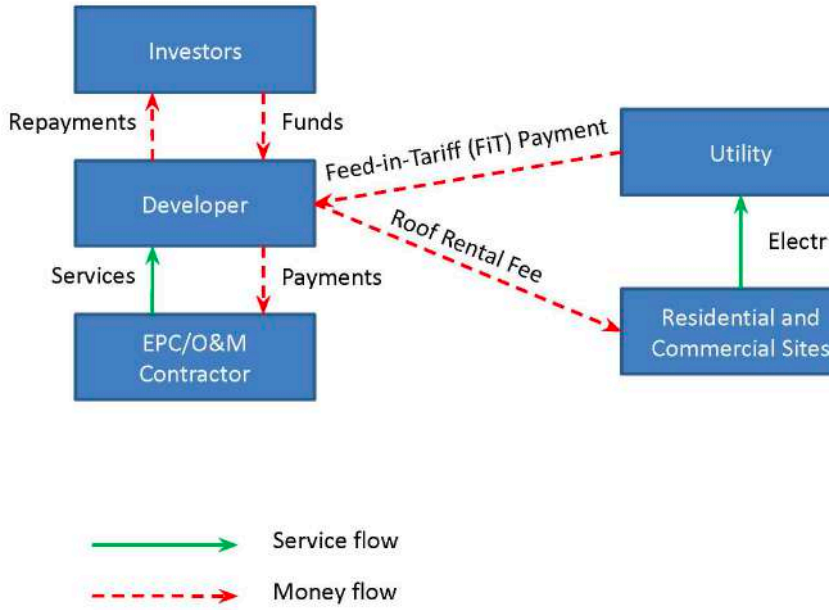
Business Model Frameworks

This section describes the business model frameworks that are clustered based on the key program areas of the International Solar Alliance (ISA). They contain the nature of value proposition, value creation and value delivery in the process of solar businesses.

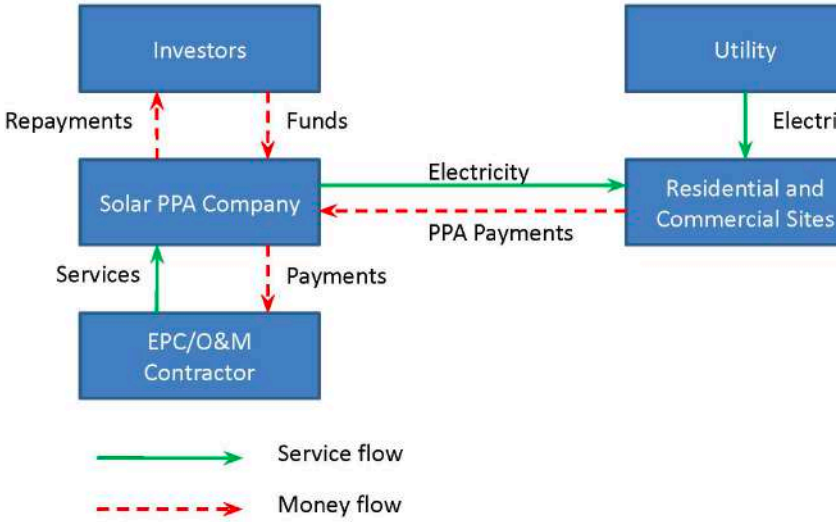
A1.1 Solar Rooftop Business Models

The business models are concentrated around the way rooftops are being utilized for solar PV installation. Accordingly four business models could be discovered in the markets which are explained through the following diagrams.

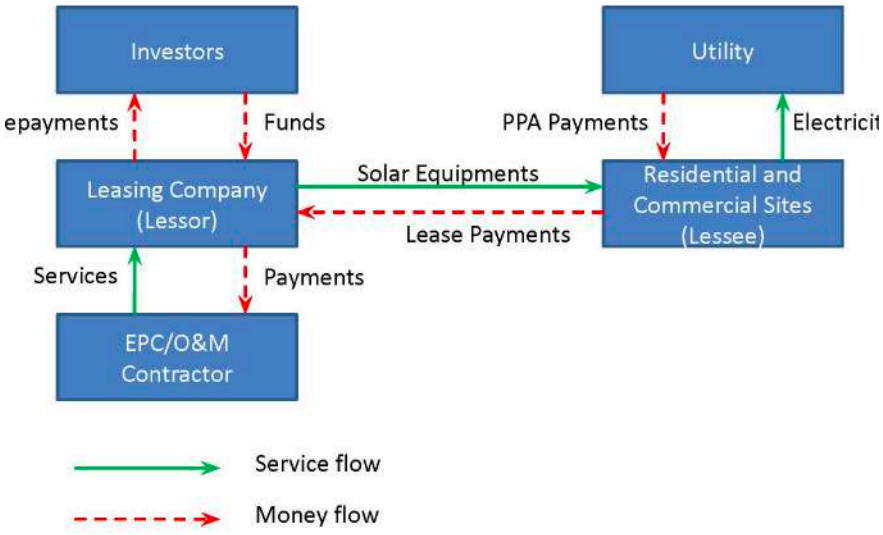
1.1.1. Solar Roof Rental Model



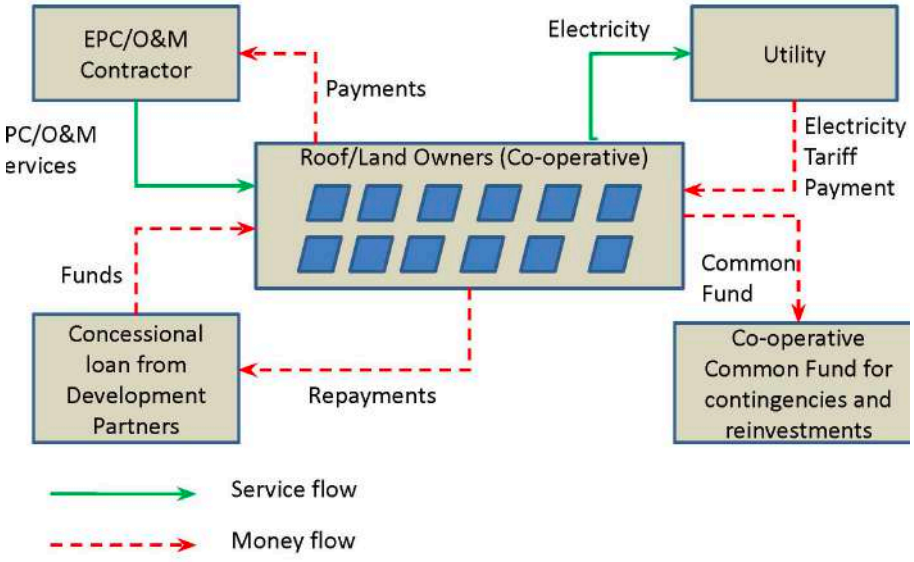
1.1.2. Solar PPA Model



1.1.3. *Solar Leasing Model*



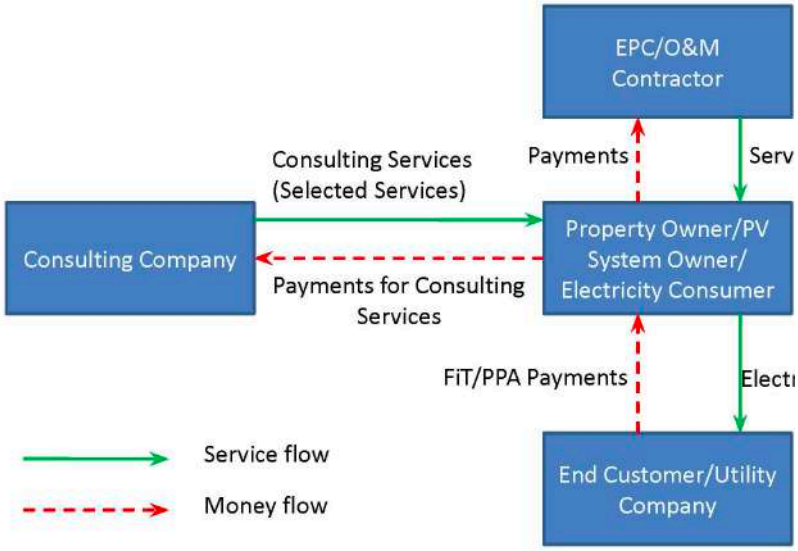
1.1.4. *Solar Co-operatives Model*



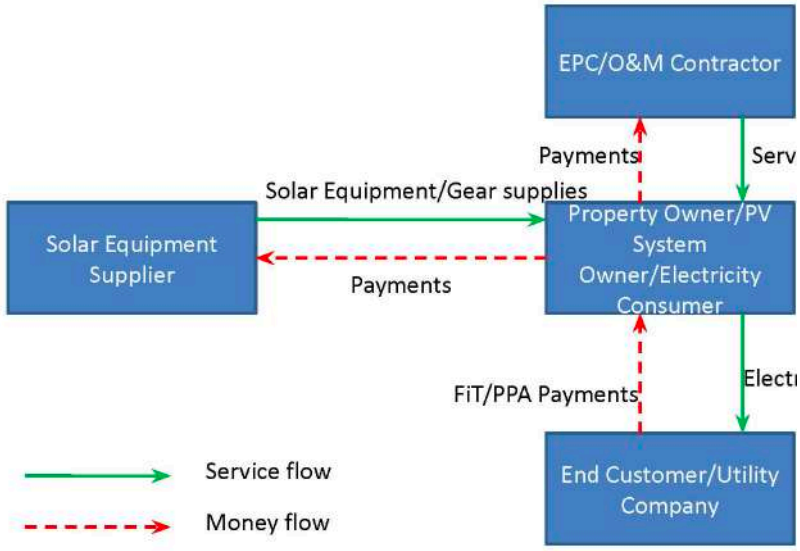
A1.2 Large Scale solar business models (as given by Bankel and Mignon, 2022)

These business models are designed for MW scale business models where value is created during the design, engineering, procurement & contracts, installation, commissioning and operation and maintenance of solar plants. There are about 6 business models that can be found in the market that are described below.

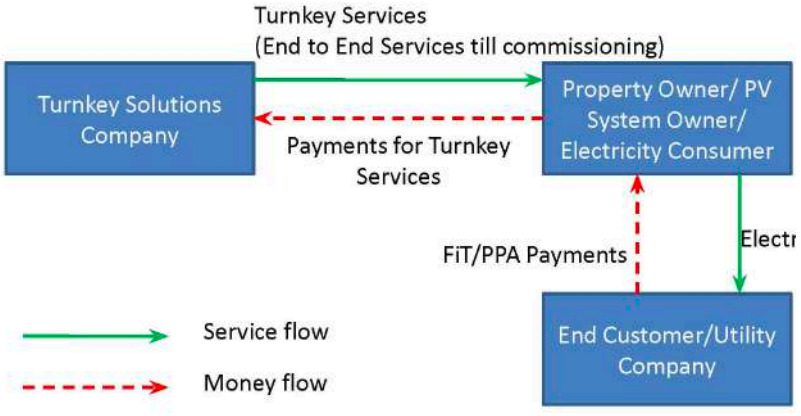
1.2.1. Consulting Business Model



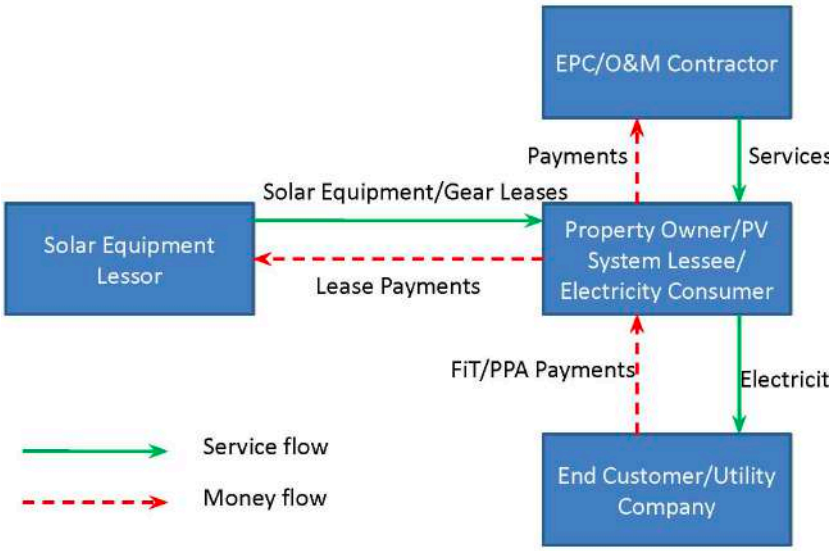
1.2.2. Technology Provision Business Model



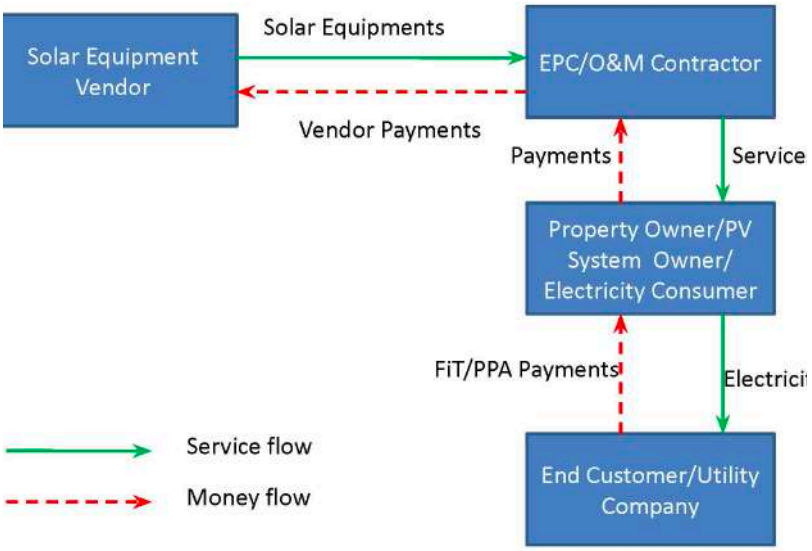
1.2.3. Turnkey Business Model



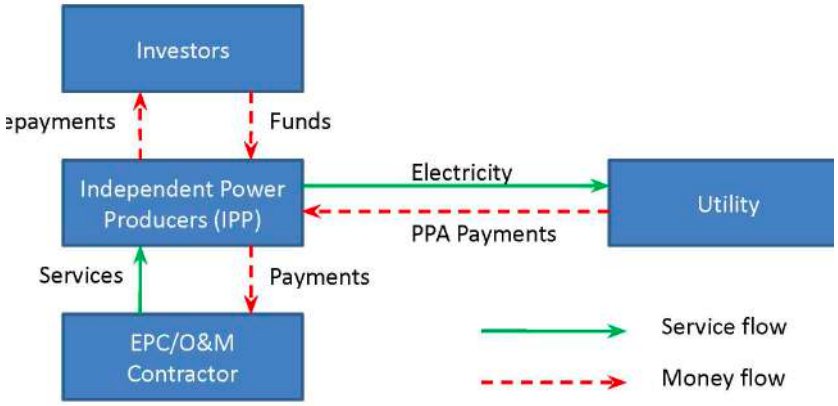
1.2.4. *Large Solar Leasing Business Model*



1.2.5. *Engineering Procurement Construction (EPC) model*



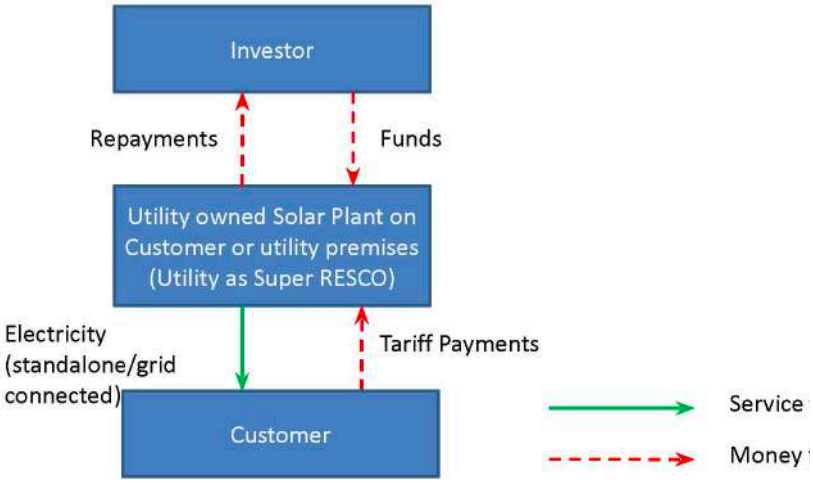
1.2.6. *Large Solar Power Purchase Agreement (PPA) by IPP model*



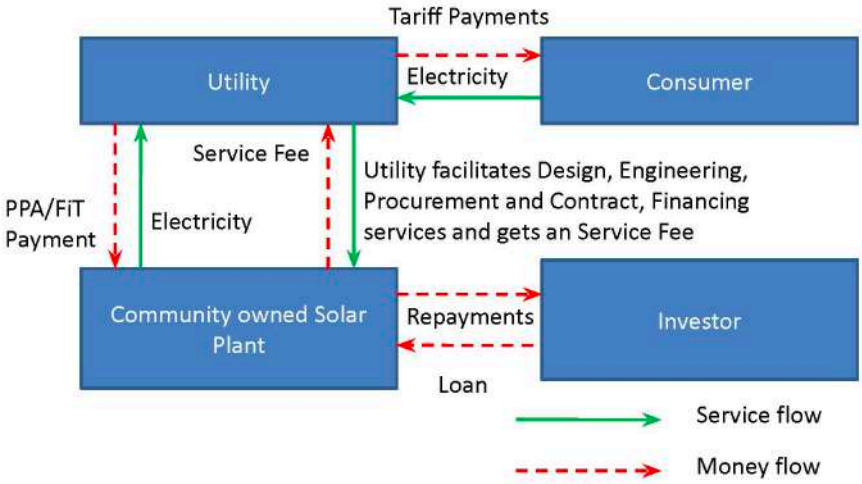
A1.3 Utility focused solar business models

These business models are designed to keep utility at the forefront in value chain process. Being the grid operator and dealing with the end-customer, the utility understands the issues and concerns in the implementation of solar projects. These solar projects will help utilities to decarbonize the grid and bring the cost of power down considering the reduction in current solar PV prices.

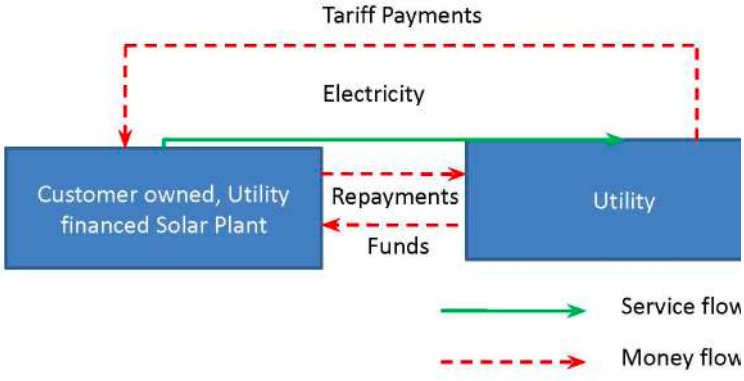
1.3.1. Utility Owned, on Customer or Utility Premises



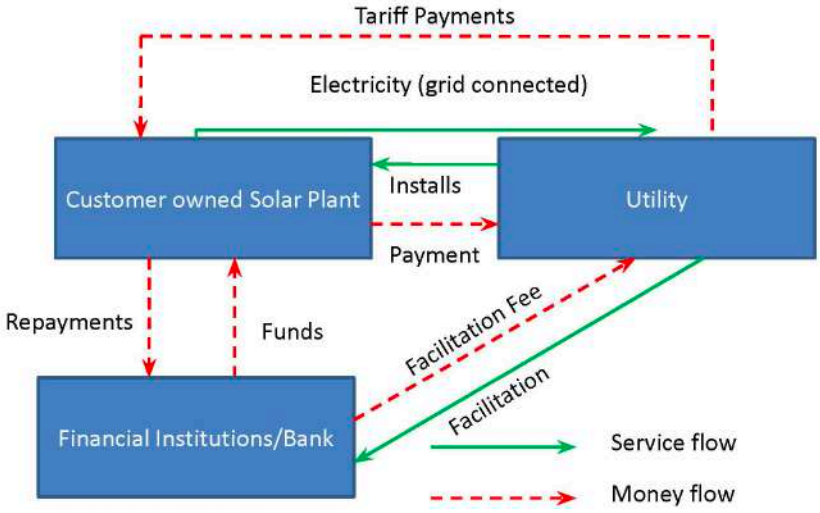
1.3.2. Community Owned and Utility Facilitated



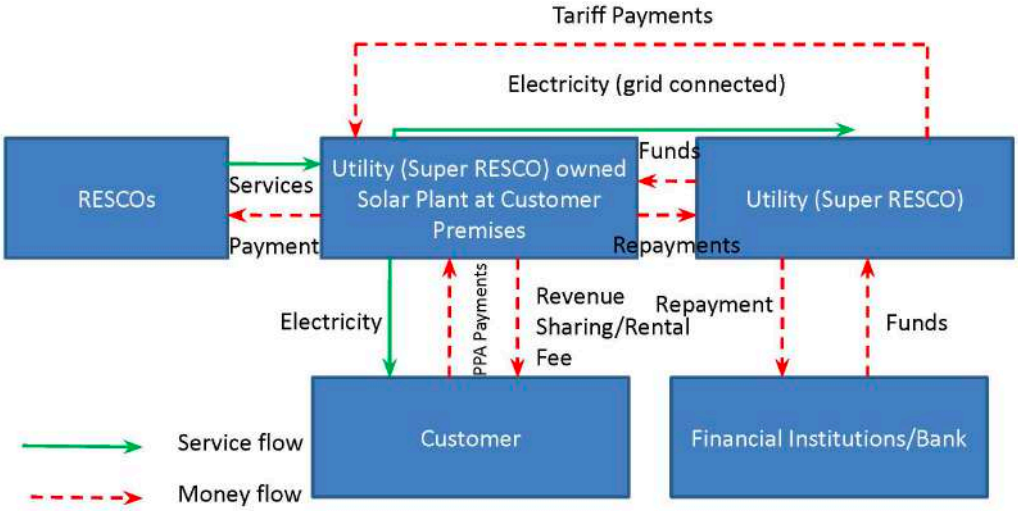
1.3.3. Utility Financed and Consumer Owned



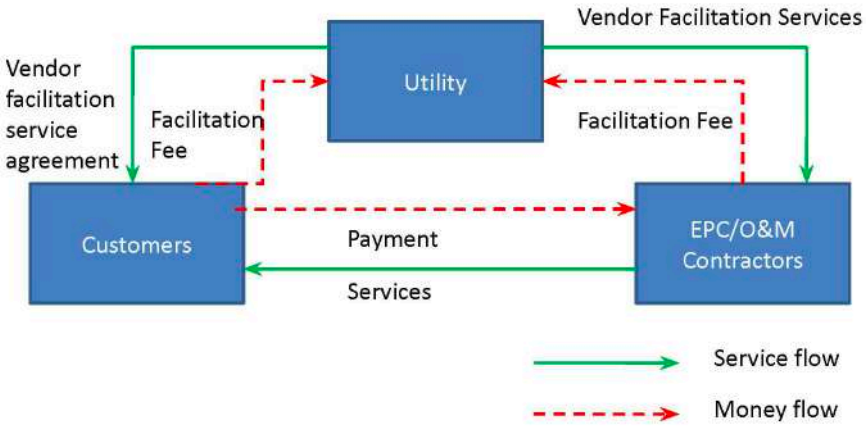
1.3.4. *Grid connected, Customer owned- CAPEX model*



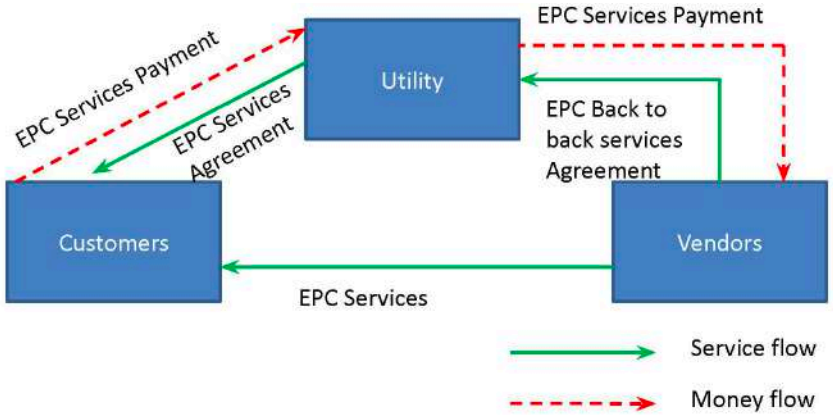
1.3.5. *Grid Connected, Utility owned (Utility, as super RESCO, owned systems)*



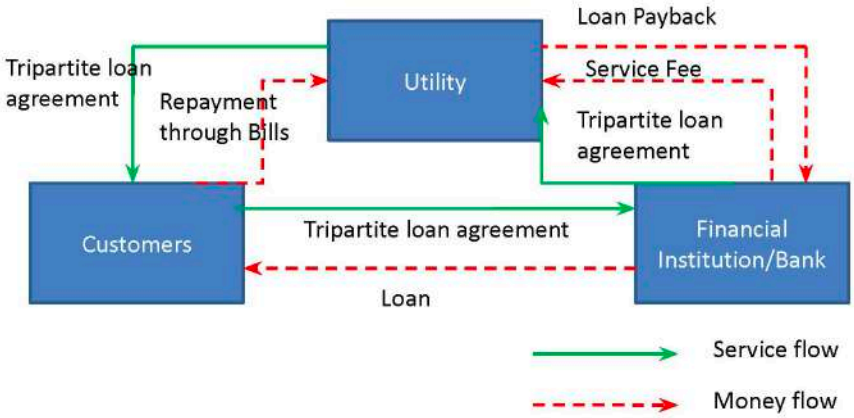
1.3.6. *Facilitated Procurement Model*



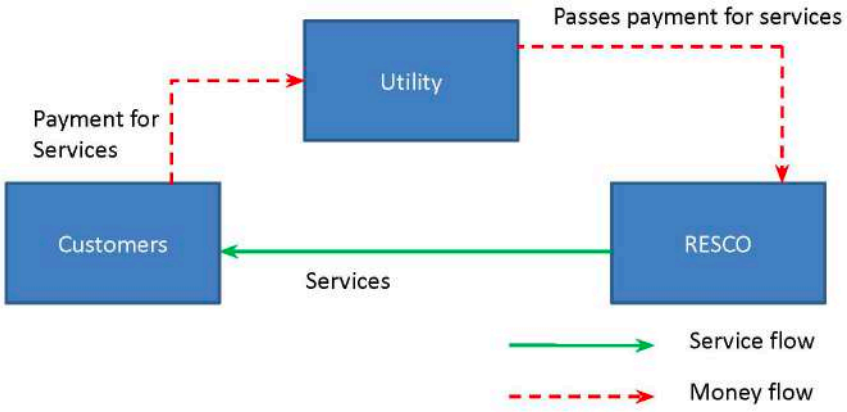
1.3.7. *Engineering Procurement Construction (EPC) Contractor Model*



1.3.8. *On Bill Financing*



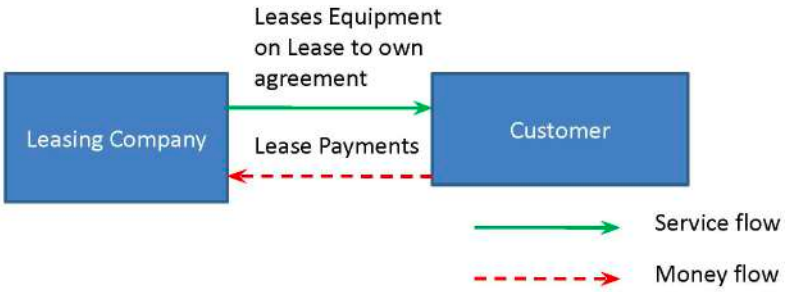
1.3.9. *Payment Assurance Model*



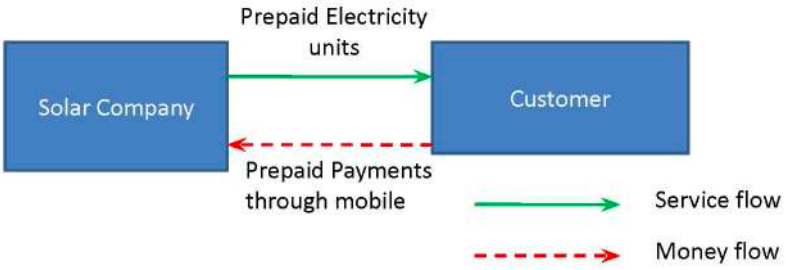
A1.4 Off-grid Solar Models

Off-grid solar models are popular in Africa, in places with difficult terrains and in rural areas of developing countries where grid extension is complex and costly to implement.

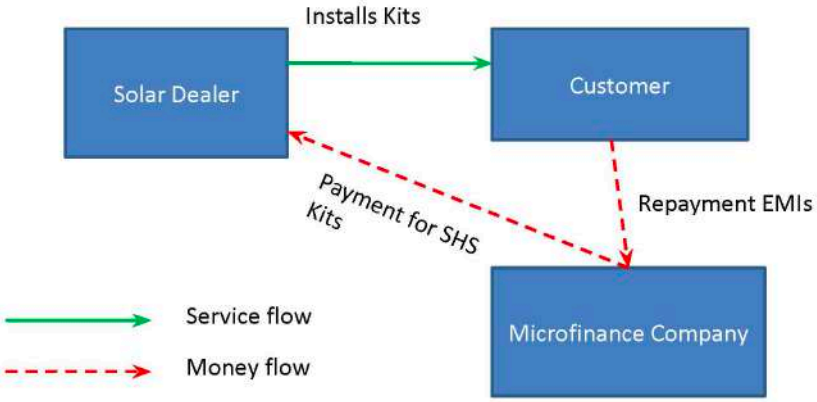
1.4.1. Lease to Own Model (PAYGO Model)



1.4.2. Usage Based Payment Model (PAYGO Model)



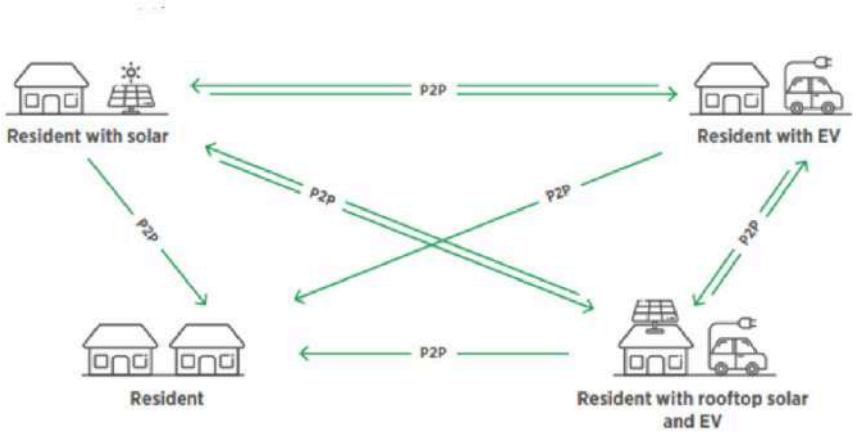
1.4.3. Dealer Credit Business Model



A1.5 Solar Mini-grid Business Models

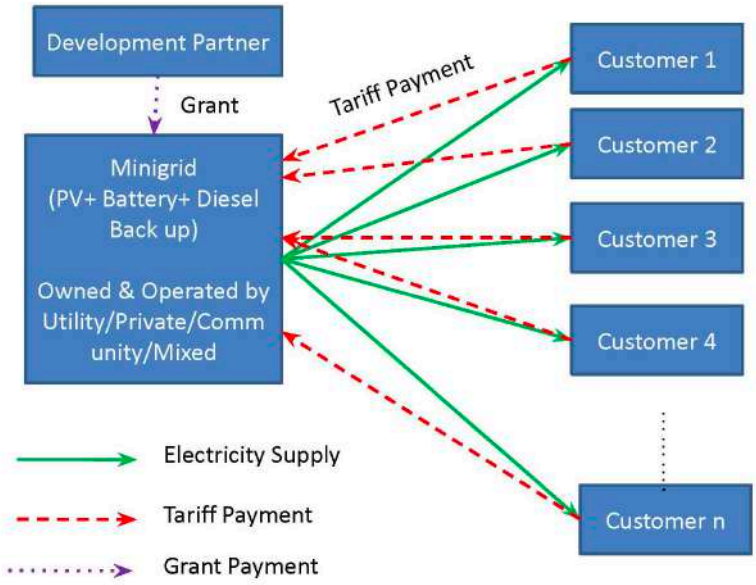
Solar Mini-grid Business Models are popular in island countries and rural areas where the population density is relatively high and the energy demand is largely from residential and small commercial services. New business models such as the peer-to-peer electricity trading model with block chain technology is being tested in certain countries.

1.5.1. Peer to Peer (P2P) Electricity Trading Model



Source: Liu *et al.*, 2019

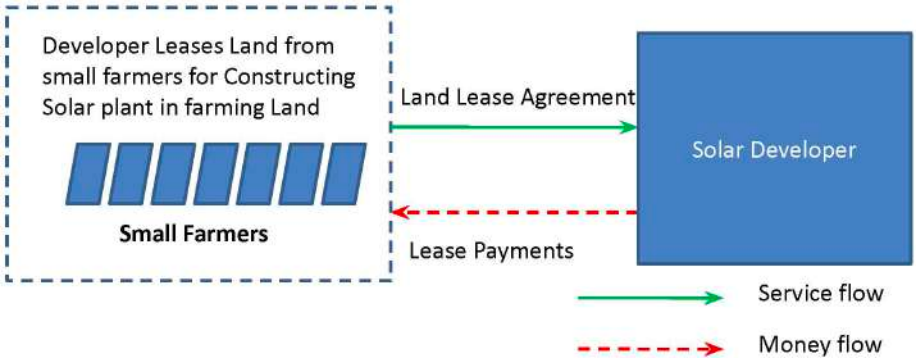
1.5.2. Utility/Private Sector/Community/Hybrid Owned and Operated Business Model



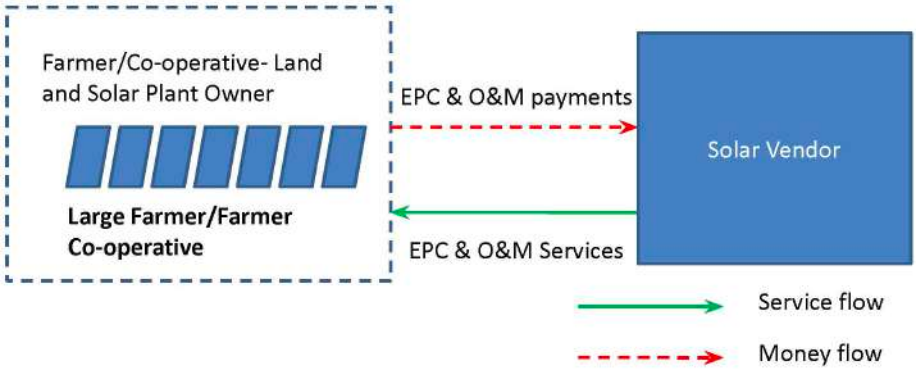
A1.6 Business Models For Multipurpose Use Of Land For Renewable Energy Projects

Countries with high population densities are considering multipurpose uses of land that can include multiple activities along with farming. In such cases, farmers are compensated for the yield loss and are also provided with free power for their agricultural needs. This is usually implemented by an external agency that has the expertise of implementing solar projects and has the knowledge for localized solutions of multipurpose use of land in the area.

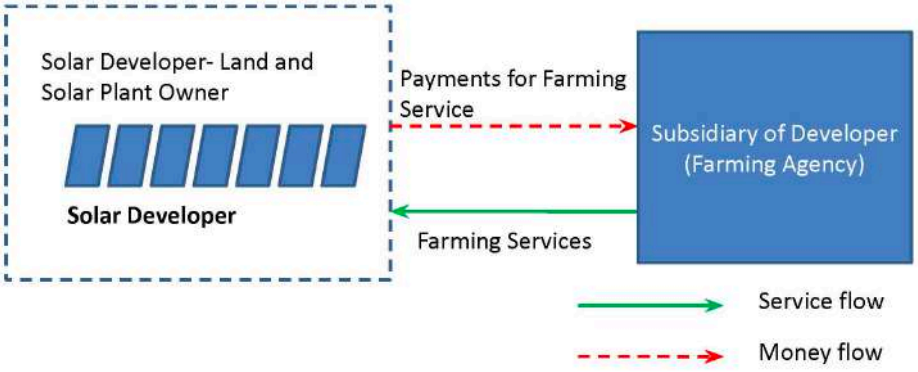
1.6.1. Solar Developer Leases Land From Small Farmers And Construct The Solar Plant (Farmer - Land Owner, Solar Developer - Tenent)



1.6.2. Land as well as the solar plant is owned by the farmer (Farmer - Landowner as well as solar plant owner)



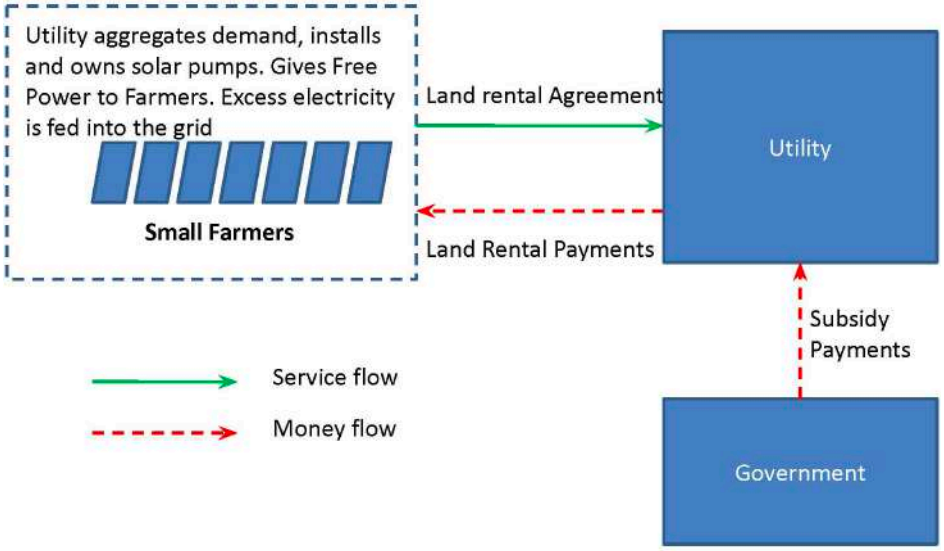
1.6.3. Solar developer - Land and solar plant owner, subsidiary of developer - Farming agency



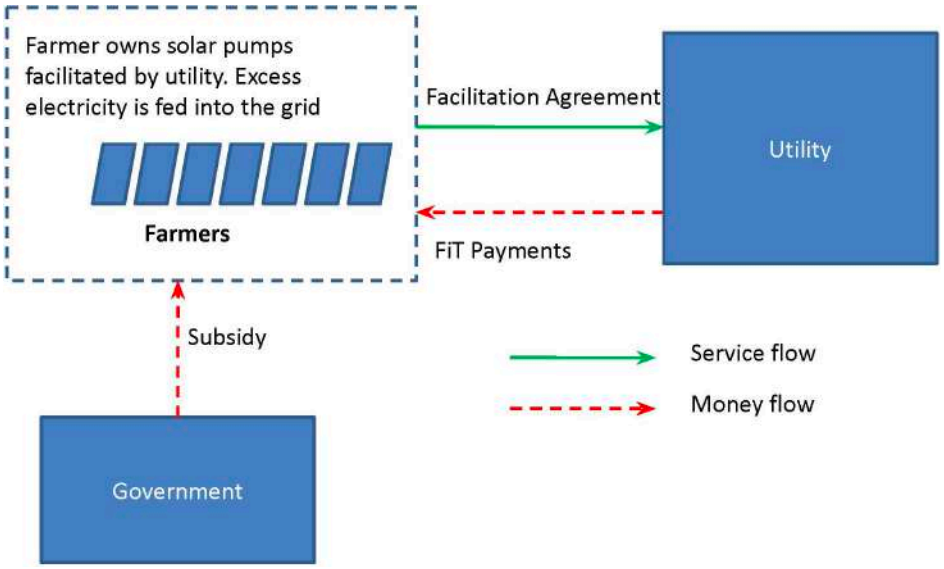
A1.7 Solar Business Models for Agriculture

The highest energy need in agriculture is for water pumping requirements. Governments provide power subsidies in various countries. In the emerging models related to agriculture, the subsidies are used to construct solar pumps and farmers are provided with free power.

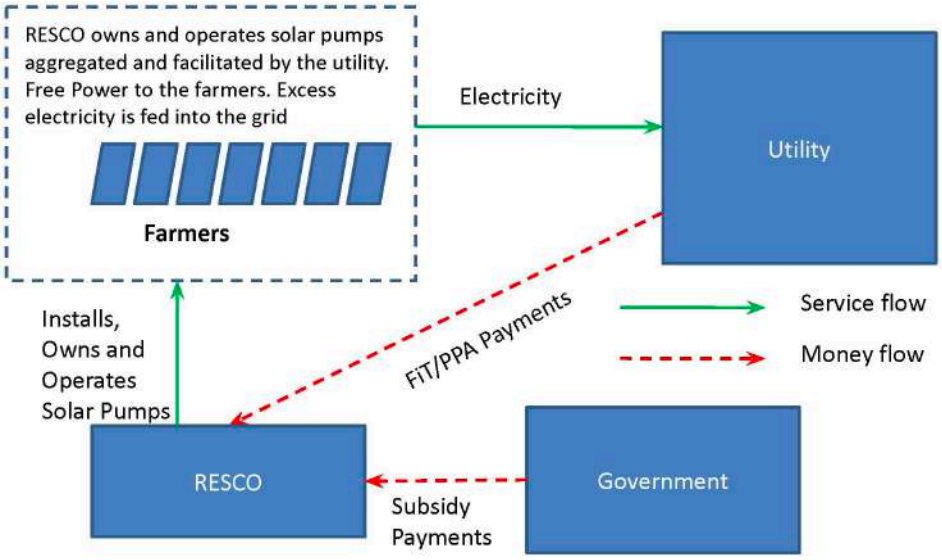
1.7.1. Utility as aggregator and owner for installation of solar pumps in agricultural lands, Farmers are given free power and land rental, extra electricity is fed into the grid



1.7.2. Utility as facilitator and the farmer as the owner of solar pumps. Farmers invest in the solar pumps, and they are paid FIT for feeding the grid



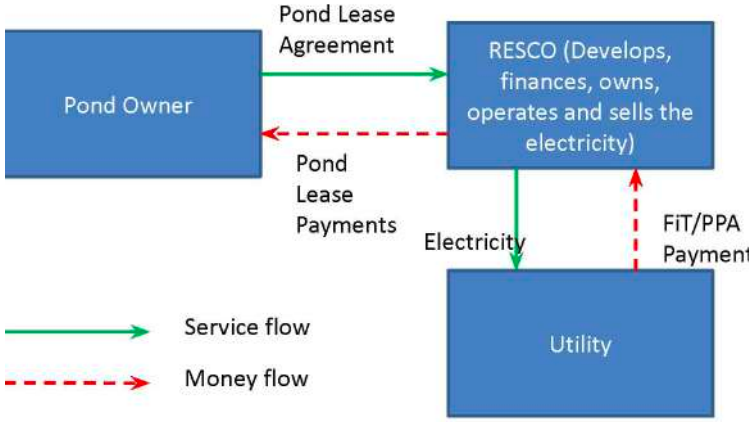
1.7.3. Utility as facilitator and the RESCO as the owner for installation and operation of solar pumps on Build, own, operate (BOO) basis



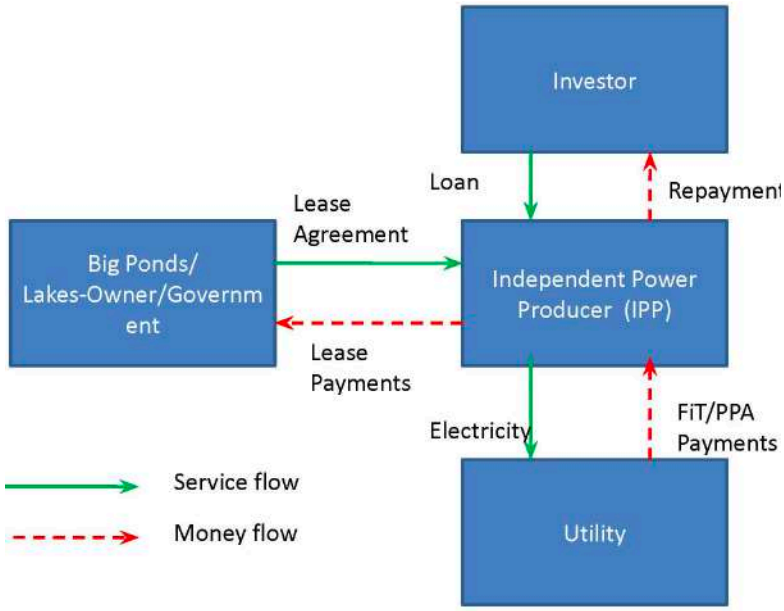
A1.8 Solar Business Models for Floating Solar

With the establishment of floating solar technologies, pilot projects with different business models are tried for small (<5MW) and big projects (>5MW).

1.8.1. RESCO model (Pond owner leases it to a project developer who finances, builds, owns, operates and sells the electricity to the grid for <= 5MW)



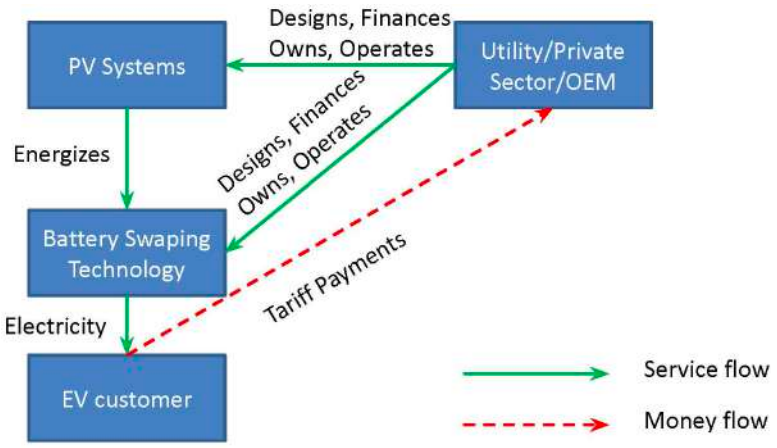
1.8.2. IPP ownership with PPA through project financing route (>5MW)



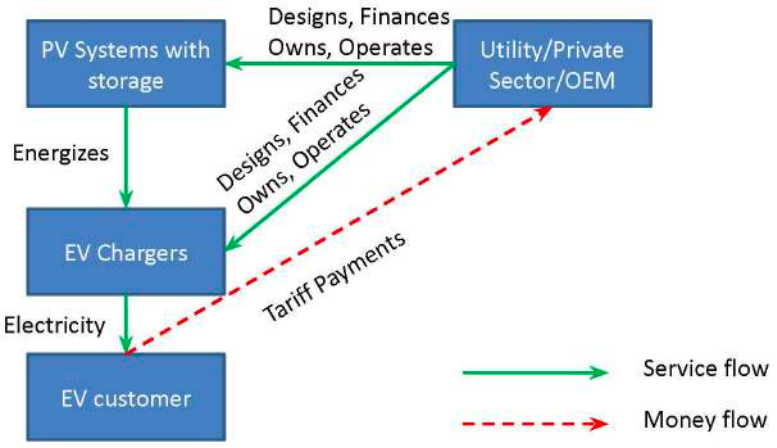
A1.9 Solar Based E-Mobility and Storage

Governments are promoting e-vehicles due to their cleanliness and possible integration with renewable energy systems.

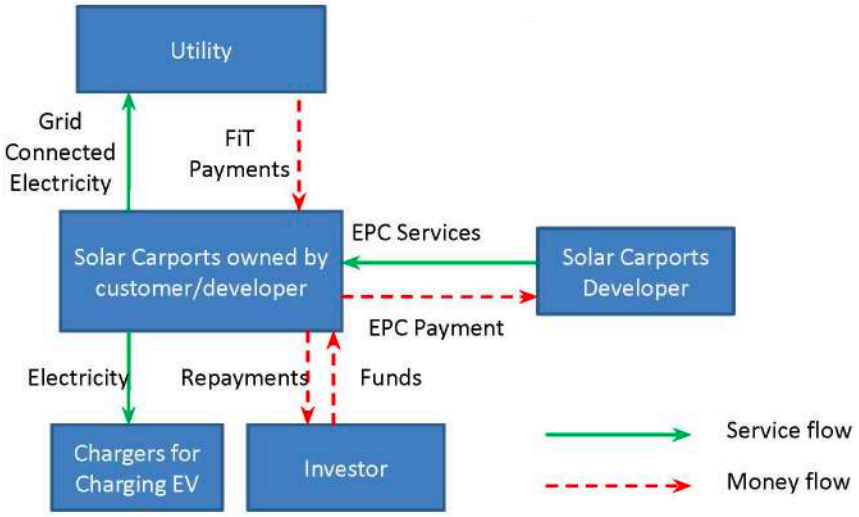
1.9.1. Battery Swapping with battery charged through PV systems owned, operated or banked by utility, private sector, OEM



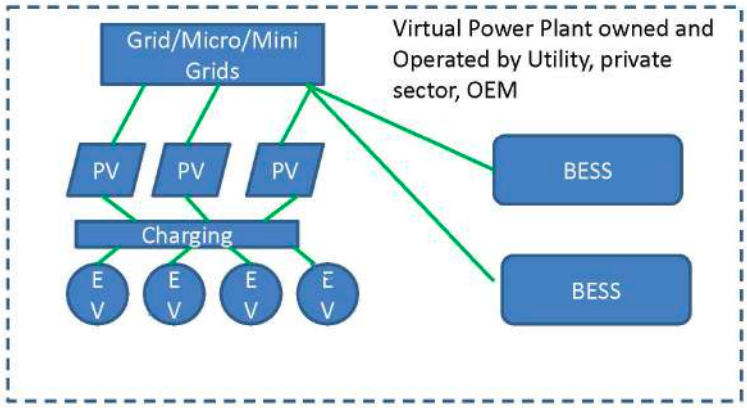
1.9.2. Captive PV charging through PV systems owned, operated or banked by utility, private sector, OEM



1.9.3. Solar Carports (can be Portable, grid connected or battery stored)



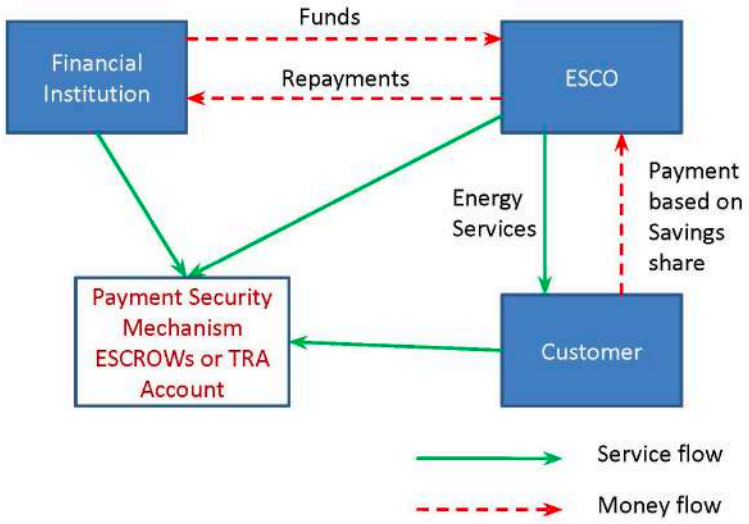
1.9.4. Solar PV, Battery energy storage, electric vehicles in virtual power plant model in a grid/minigrid/microgrid application owned and operated by utility, private sector, OEM



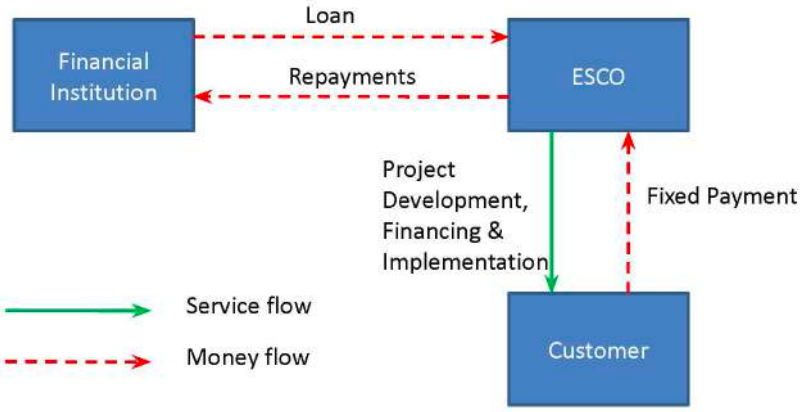
A1.10 Solarizing Heating and Cooling Systems

Heating and cooling are two of the main energy needs in industries and commercial entities. With the advancement of solar systems, it is possible that solar energy can be harnessed for this purpose. In this context, the traditional Energy Saving Company (ESCO) business models can be looked into.

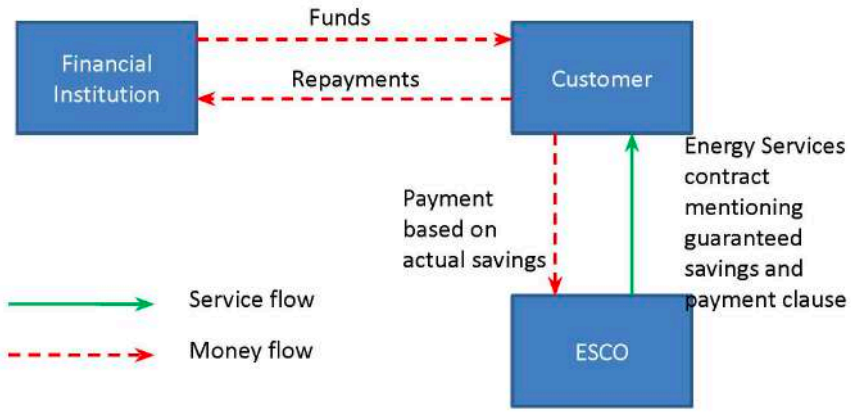
1.10.1. ESCO Business Models (Shared Savings Model)



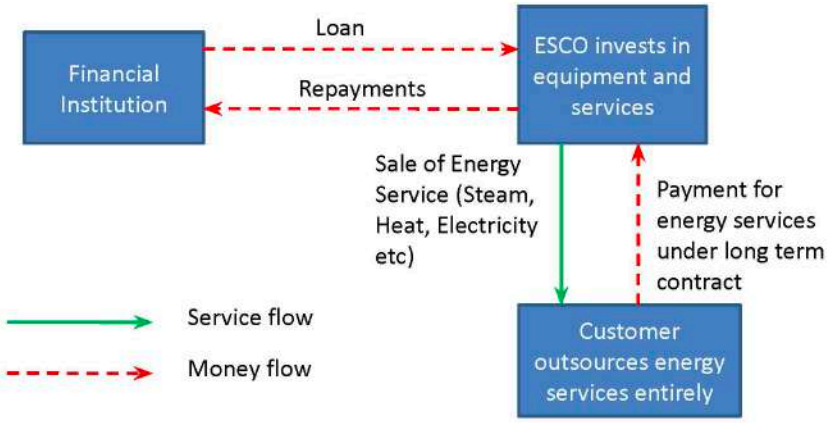
1.10.2. ESCO Business Models (Deemed Savings Model)



1.10.3. ESCO Business Models (Guaranteed Savings Model)



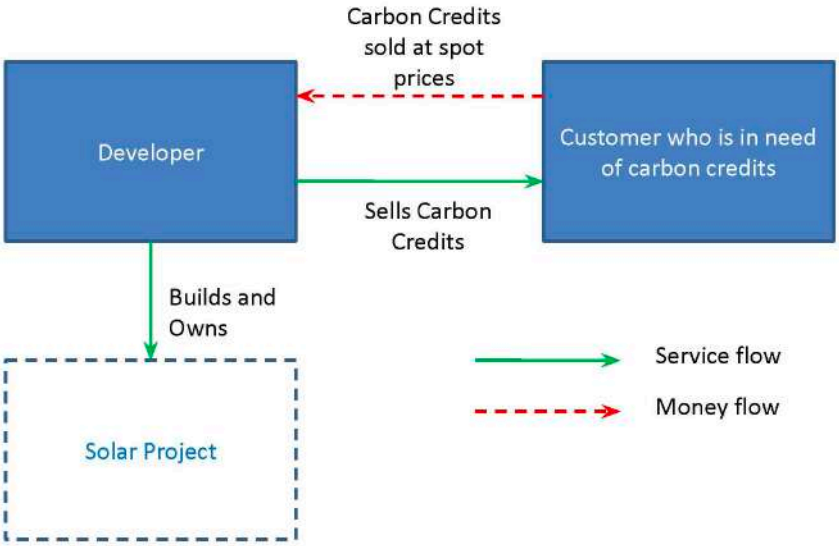
1.10.4. *ESCO Business Models (Outsourced Energy Model)*



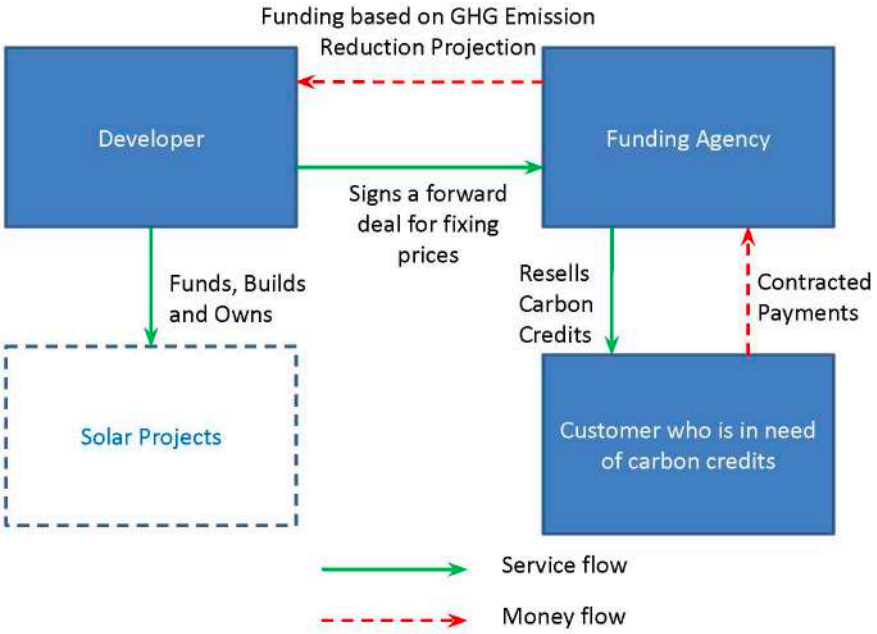
A1.11 Carbon Finance Business Models

With countries voluntarily declaring their NDC commitments as part of the 2015 Paris agreement and net-zero carbon targets at COP 26 and 27, the carbon finance business models are looked into with renewed interest. Carbon credit prices are high for mini-grid, off-grid and cook stove projects. For mega scale projects, the prices are even lesser. Whereas the prices are higher for projects with a social motive.

1.11.1. Developer is the owner and gets funding from a funder/agency based on the estimated reduction in GHG emissions arising out of the solar project and signs a forward deal for fixing prices for carbon credits.



1.11.2. Developer is the owner and funder as well for the solar project. He registers the project for carbon credit. He then sells them to others who are in need of carbon credits at the existing spot prices.



Appendix 2

Case studies related to Business Models and Financing Instruments in selected SIDS and LDC Countries

2.1 Antigua and Barbuda

In Antigua and Barbuda, the government is establishing a trust fund for biodiversity and climate change projects and programs. The funds and its provisions were embedded within an overall Environmental Management Bill responsible for the setting of climate change targets. The fund was designed to purchase assets and sell services such as energy generated from renewable energy technology. It was empowered to own and sell ecosystem services generated within protected areas. These services included energy, water and carbon sequestration. Microlending was part of the business model of the fund, which were developed over the next two years. Assistance to design and build the fund was provided by the Global Environment Facility and other donors. At its onset, the trust fund was expected to provide funding for projects generating upto 1MW of electricity. The microlending window of the national fund faced several barriers to technology uptake including the low cost of conventional technologies, the high cost of green technology, and high interest rates. The Green Climate Fund considered entering into arrangements with the national fund or national entities to assist in providing necessary incentives required to change technology choices, such as low interest rates. In Antigua and Barbuda, an interest rate of 3-5 percent is considered low enough to encourage the uptake of adaptation and mitigation technologies. This fund was legally established by the end of 2013 and implementation began once the Business Plan was completed by the end of 2014.

Reference: Government of Antigua and Barbuda, Environment Management Bill 2013

2.2 Bangladesh

The Rural Electrification and Renewable Energy Development (RERED) solar home system experience highlights the central role partner organizations played in accessing an existing customer base. For instance, the program benefitted considerably from the extended network and reputation of Grameen Shakti. Infrastructure Development Company Limited (IDCOL) also played an important part as a financial intermediary, addressing barriers and challenges with partner organizations, particularly as the sector had previously been unwilling to finance “non-productive loans” such as those for solar home systems.

RERED partner organizations were responsible for all technical, commercial and financial aspects of the solar home system business, including procurement and pre-financing of the systems. They also installed the systems using their own network of technicians and looked after maintenance as well as after-sales service, including any related training or capacity building for customers.

Prospective consumers were screened using pre-defined eligibility criteria. Group lending and social collateral models were also employed. Once approved, consumers placed a down payment equivalent to 10-15% of the system cost, with the remainder typically repaid over 2-3 years on microcredit terms spelled out in the purchase contracts, generally at prevailing market interest rates (typically 12-15%).

To help bring down the cost of credit, refinancing through IDCOL acted as an incentive for partner organizations. Between 70-80% of credit to customers was eligible for refinancing at market rates of 6-9%, with a 5-7-year repayment period and a 1-1.5-year grace period. The refinancing also helped to ensure quality, as IDCOL carried out technical verifications of installed systems within 21 days of the refinancing claim before providing the improved credit, along with any applicable subsidy (World Bank, 2014).

In case of default, partner organizations could reclaim a solar home system. Conversely, customers had a buy-back guarantee at depreciated price if they obtained a grid connection within a year of purchasing the system. Once the loan was repaid, partner organizations offered an optional service contract for an annual fee.

Flexible project design using a range of subsidies and system sizes allowed for adaptation with evolving technology and market conditions along with consumer feedback. The combination of consumer credit and subsidies particularly helped to make the system affordable for early market adoption. As competition in the local supplier market increased and local technical competencies improved (e.g. through training), system costs came down, allowing the subsidies to be reduced. Economies of scale through the partnerships also helped to bring down the cost of technology. Notably, the success of the partnerships in achieving sizable demand (through existing customers) and in working with supply chains helped to achieve attractive costs early in the program.

The success of this initiative in Bangladesh led to a number of private competitors outside of the RERED program entering the solar home system market. Adapting to this evolving context, the RERED II program in 2014 expanded to clean cook stoves, solar irrigation pumps, biogas digesters and solar mini-grids. While solar home systems continued to be a component of the program, these were mostly targeted to small systems designed for the poorest households.

The RERED program design also had a number of potential elements that could be used to deploy local, small-scale solar solutions for homes and businesses in other countries such as India. For instance, India already has strong experience with MFIs applying a diverse range of business. This includes a number of existing microfinance initiatives that support distributed renewable energy access.

Like partner organizations in the RERED example, Micro Finance Institutions (MFIs) in India can perceive risks with supplying energy products. A flexible partnership program through a financial intermediary like IDCOL (e.g. via Indian Renewable Energy Development Agency (IREDA) or REC in India) could help build lender confidence and capacity, while supporting escalated deployment of small-scale solar solutions. Development of technical expertise, particularly at the branch level, would also facilitate the processing of distributed renewable energy loans by financial institutions in India.

Program design could also consider additional or alternative elements beyond concessional credit, such as credit guarantees or partial risk-sharing agreements, depending on the needs of eventual partner organizations. A buy-back guarantee could equally be a valuable mechanism in the Indian context, given irregular supply in many states, where rooftop solar solutions can act as a valuable complement to grid electricity as grid electricity continues to expand and supply stability improves.

Reference:https://www.oecd.org/cefim/india/SHS/

2.3 Barbados

For the Small Island Developing States (SIDS) of the Caribbean, Renewable Energy Technologies (RETs) will become increasingly important in the face of high fossil fuel costs. Many countries now recognize the need to move towards low-carbon, climate resilient economies, as set out in the Caribbean Community (CARICOM) implementation plan for climate change-resilient development. Barbados has been extremely successful in its embrace of solar water heating (SWH) saving millions of dollars in imported fossil fuel costs and millions of tons of carbon dioxide every year, thanks to the expansion of this climate compatible technology.

The SWH industry in Barbados emerged in the early 1970s in response to the major oil shock, where prices increased threefold in the space of one year. Like many SIDS in the Caribbean, Barbados relied heavily on imported fossil fuels providing 95% of the country's energy needs.

A few important findings include:

- The Solar Water Heater (SWH) industry in Barbados has been very successful. It boasts over 50,000 installations that have saved consumers as much as US$137 million since the early 1970s.
- Governments must create a framework to support the development of SWHs and ensure long-term fiscal and regulatory certainty for manufacturers and customers.
- Government incentives brought competition in the business of manufacturing and supplying SWHs, with SunPower and AquaSol setting up shop. The market grew, with solar installations peaking in 1989 at over 2800 units. By 2009 there were around 45,000 installed SWH systems, representing two in five households.
- Giving sufficient regulatory certainty and financial support in key areas was crucial for investor confidence. Starting in the 1970s, the Barbados government introduced a series of measures to support the fledgling SWH industry. The Fiscal Incentives Act of 1974 was perfectly timed to coincide with the first oil crisis, and was a clear signal of the government's intentions to move away from fossil fuels. As part of this act, the government

introduced a tax exemption for the materials used to produce SWHs, saving 20% of their cost. Importantly they also levied a 30% tax on electric water heaters, significantly increasing their price. In 1977, the government supported the industry through government purchase for state housing. Further government incentives in the 1980s, in the form of the Homeowner Tax Benefit (see Box 1), also had a major impact on SWH installations, which rose from around 900 per year in 1980 to peak at over 2800 per year in 1989. Although the benefit was stopped in 1993 following an economic recession in the early 1990s and the restructuring that followed, it was reinstated just 3 years later – a testament to its efficacy.

- Fiscal incentives are good value; government support for the Barbados SWH industry was approximately US$550,000 in 2002. Estimates suggest SWHs save consumers between US$11.5 and 16 million per year.
- Governments can play a major role in establishing a commercial market by installing SWHs on public buildings and social housing.
- Persuasive champions who are able to speak to communities, together with effective marketing strategies, are vital for consumer acceptance of the technology.
- Public recognition of the personal, financial and quality of life benefits of SWHs provides a springboard to acceptance of other renewable energy technology programs.
- One of the consumer barriers is the temperature of water. Companies removed this consumer risk by offering a guarantee on temperature. Another barrier for consumers was the high up-front cost of the unit itself. To counter this, credit unions and distributors offered financial support, allowing consumers to spread the cost of the units over 3 years. Matching the credit term to the 3-year payback time of the SWH units meant that some consumers spent less than if they had continued heating their water with gas.
- The Barbados experience could be easily replicated in other countries with high fossil fuel imports and abundant sunshine.

Reference: https://cdkn.org/resource/cdkn-inside-story-seizing-the-sunshine-barbados-thriving-solar-water-heater-industry#:~:text=Box%201%3A%20Fiscal%20Incentives%20to,saving%2020%25%20of%20their%20cost.

2.4 Fiji

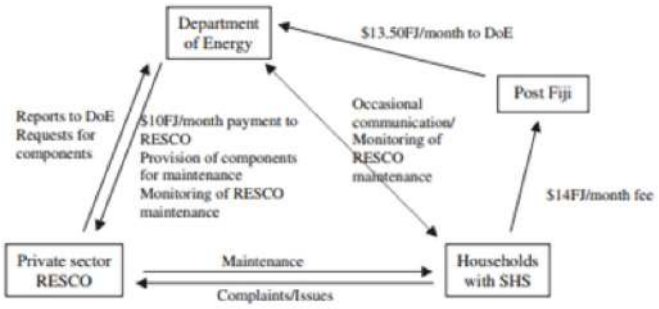
In the following section, two case studies are presented.The first study is of the innovative, “Fee for Service” RESCO model implemented in Fiji, Kiribati and Dominican Republic. In the second study, a solar PPA model case is discussed from Fiji.

2.4.1 RESCO’s “Fee for Service” model

Under the Renewable Energy Service Company (RESCO) program, Solar Home System (SHS) is the property of the Department of Energy, which pays a contractor (a RESCO) from the private sector to provide maintenance. SHS installed under the RESCO scheme provide lighting and one DC power point for powering a small radio. They consist of 2 panels of 50 W each, a 12 V Battery and a prepayment meter/controller.

The upfront cost of each system amounts to 4065FJ (about $2073) and is paid by the Department of Energy. Households pay an initial deposit of $50FJ, thereafter ‘renting’ the SHS for a monthly fee of $14FJ, which is paid at the local post office in return for a token that must be entered into the SHS prepayment meter. This amount is supposed to cover all maintenance costs and 5 per cent of the capital cost of SHS, consistent with Fiji’s Rural Electrification Policy. The Department then pays the RESCO approximately $10FJ per month for each household under its maintenance contract.

Payments to the RESCO are made every two months, during which time the RESCO is expected to visit every household with an SHS once. During these visits, technicians check the water levels of batteries and test the output of the batteries and panels. Where batteries or lights have failed, RESCO technicians make a note and report this to the Department of Energy. The Department uses the remaining money to purchase replacement parts, such as batteries and light bulbs, and sends these to the RESCO for installation in their next round of maintenance visits. These arrangements are illustrated in the following Figure.



2.4.2 Solar PPA model case example in Fiji

"Sunergize", a private sector company focuses on blue chip corporate clients to own and operate the infrastructure that they put on their roof. The clients don't pay anything upfront for the solar infrastructure. Sunergize sells contracts for 10 or more years, with the client enjoying an initial saving of about 10 per cent and certainty on their power costs for the full term of the contract. One of Fiji's top hotels, the Tokoriki Island resort, uses Sunergise's solar power technology and has cut its power bill by 50 per cent and silenced its expensive diesel generators. The World Bank's International Finance Corporation (IFC), its private sector arm, made its decision to take a 20 per cent stake in Sunergise based on the skills of its people.

Reference: https://www.abc.net.au/news/2016-06-30/innovative-start-up-puts-fiji-ahead-on-renewable-energy/7557594

2.5 Guinea- Bissau

The following section presents two case studies from Guinea-Bissau.

2.5.1 Solar Home Systems for Rural development of Guinea-Bissau

Foundation Rural Energy Services (FRES) provides electricity through Solar Home Systems (SHS) with a fee-for-service model using a Pay as you-Go system, meaning customers pay a monthly fee through a mobile payment system and can upgrade their systems when needed. A standard SHS consists of a battery, a charge controller, solar photovoltaic (PV) modules and a mobile payment system. SHS customers can choose between pre-set service levels – from 80 Wp up to 320 Wp – based on their needs and budget. This model entails the installation of a SHS in which the customer pays a fixed tariff according to the delivered service, which covers installation, maintenance, and utilization costs. In addition, FRES takes responsibility for collecting and recycling old systems, which reduces waste and promotes a circular economy. FRES Guinea-Bissau channeled more than 3 M€ to this project, funded by the European Commission, and by 2020 had a total of 3,248 solar home system customers and 13 energy shops. Currently, 609 villages in the regions of Bafatá, Quinara, Tombali and Gabú, including households, businesses and public services or entities, now have secure and reliable access to electricity.

Reference: https://www.africanpowerplatform.org/resources/reports/west-africa/guinea-bissau.html

2.5.2 Community Energy Service – a mini-grid in Bambadinca

The Bambadinca Community Renewable Energy Access Program - "BambadincaSta Claro" promoted the construction of a mini-grid in the village of Bambadinca, supplying electricity from a hybrid photovoltaic power plant. This power plant has a peak power of 312 kWp, a battery bank of 1.1 MWh and diesel generators as backup. A three-party management model was developed and implemented to ensure an efficient and sustainable operation of the mini-grid through a Public-Community Partnership between Bambadica Community Development Association and the Bafatá Regional Directorate of Energy. The project was developed between 2011 and 2015, with funding from the European Union, Camões - InstitutodaCooperação e da Língua, the Global Environment Facility, the United Nations Industrial Development Organization and the ECOWAS Centre for Renewable Energy and Energy Efficiency. The mini-grid began operating in 2015, and currently the Bambadinca Community Energy Service has over 650 customers, including residential, commercial, and institutional customers, demonstrating the viability of this type of solution for the electrification of rural areas or territories without access to electricity in Guinea-Bissau.

Reference: https://www.africanpowerplatform.org/resources/reports/west-africa/guinea-bissau.html

2.6 Guyana

With a view to reducing its dependence on fossil fuels to generate electricity, minimizing its carbon footprint and guaranteeing access to energy, the government of Guyana launched a solar power generation project. Implemented through the Ministry of Agriculture, the Ministry of Public Works and the Guyana Power and Light (GPL) company, the initiative involves the installation of a network of solar panels at the facilities shared by the Inter-American Institute for Cooperation on Agriculture (IICA) and the Organization of American States (OAS). The project, which receives financial and technical support from the Organization of American States (OAS), the Inter-American Institute for Cooperation on Agriculture (IICA) and the German Cooperation Agency (GIZ), also serves as a pilot plan for expanding the use of renewable energy in the Caribbean region and Latin America.

Reference: https://iica.int/en/press/news/guyana-accelerates-transition-towards-renewable-energy-matrix-through-solar-panel

2.7 Haiti

Haiti is the poorest country in the Western Hemisphere with an electricity infrastructure that reaches only 12.5 per cent of all Haitians. Access to sustainable energy in Haiti is crucial to fostering improvements in the living conditions of the poor, to provide economic opportunities, to improve health and to support educational goals. Here we present two case studies.

2.7.1 Remittances for sustainable energy solutions

Tapping into the USD 1.5 billion of remittances sent to Haiti each year from migrant workers residing in the US can offer a sustainable and empowering way to overcome the challenge of energy poverty. The Haitian economy relies heavily on remittances, which constitute about 26 per cent of the country's GDP. The project was implemented with the support of the Multilateral Investment Fund of the Inter-American Development Bank (IDB), and the Clinton Bush Haiti Fund, and in partnership with Arc Finance. The project developed a locally relevant and self-sustaining business model that enables migrant workers from Haiti, who live and work in Miami (US), to direct part of their remittance payments towards sustainable energy solutions for their communities and families at home.

This business model pilot enables Haitian emigrants residing in Miami to purchase solar energy products at a remittance agent affiliated with FoodExpress, a Haitian-owned remittance company with an extensive network. The products are then sent directly to the receiver through the vast network of SogeXpress – a major Haitian Make to Order (MTO) with 56 flagship stores across Haiti – who obtains the products at the wholesale price from a local distribution partner. The distributor also provides warranty fulfilment, which is critical to consumer satisfaction and market sustainability.

The project in Haiti was launched in April 2012, and by the end of the two-year project implementation period, over 5,000 lanterns, lanterns with mobile charging and mini solar home system had been sold. By 2016, the model was already self-sustaining on the local market, and over 82,000 clean energy products were sold, benefiting 410,000 household members with a 30 percent reduction of their energy cost. 165 kilowatts of clean energy were installed and reduced 7,000 tons of greenhouse gas emissions.

Through the project, 136 staff have been hired at Sogexpress and 601 consignment agents have been recruited. Sogexpress staff has been trained on solar products, 59 percent of which were women, through 11 training courses. Moreover, 6 million people were reached in Haiti through awareness-building campaigns. With this, the pilot successfully presented remittances as a viable means to finance clean energy.

Reference: https://energy-base.org/projects/remitenergy-in-haiti/

2.7.2 Solar Powered Smart Grids in Haiti

OPEC FUND provided grant to EarthSpark International to develop and launch a town-sized, solar-powered smart grid in Tiburon, Haiti, with a view to validate a business model and investment plan for the construction of another 40 town-sized solar powered smart micro-grids across the country. The town-sized, solar-powered smart-grid inaugurated in December 2019 benefited over 200 households directly impacting 1,000 individuals. Current configuration of town-sized, solar-powered smart-grid inaugurated in December 2019, includes: - Nameplate Microgrid Capacity (Multicluster limit): 138 kVA - Installed PV kWp generation capacity: 95.04 kWpeak - Installed Diesel Generator: 55 kW (prime) - Nominal solar daily power generation: ~485 kWh (peak) - Voltage of the medium-voltage distribution system: 13.2/22.86 kV - Voltage of the low-voltage distribution system: 120/240V (split phase) - Kilometers of distribution line: ~1.6 KM medium voltage, ~3.7 KM low voltage. With an ambitious but achievable plan for blended finance for the next 22 grids, EarthSpark is now well-positioned to finally build upon its extensive experience in Haiti to meaningfully scale micro-grid electricity service and the attendant opportunities for growth and resilience to dozens of towns in the next several years.

Reference:

https://opecfund.org/operations/list/solar-powered-smart-grids-in-haiti-brownfield-launch-and-model-development

https://www.developmentaid.org/organizations/view/192971/earthspark-international

2.8 Papua Guinea

In Papua New Guinea, a Business Partnership Platform (BPP) involved partnership among solar energy company Sola PayGo, payment services provider Bmobile, product manufacturer d.light, and the Australian Department of Foreign Affairs and Trade (DFAT) provided affordable and reliable solar power units to remote rural households

using a pay-as-you-go business model. The partnership scaled up Sola PayGo's existing business model, providing high-quality solar power units to rural and remote households on a pay-as-you-go basis. For households, access to affordable energy leads to improved security and health outcomes and opens up further income generation opportunities. During the partnership period, over 1,400 families gained access to free power, impacting more than 18,000 people. 100% of customers indicated that their quality of life had significantly improved and 33% of respondents indicated extra earning potential from access to the solar unit.

Reference: https://thebpp.com.au/partnership/affordable-solar-solutions-in-papua-new-guinea/#:~:text=The%20partnership%20scaled%20up%20Sola,up%20further%20income%20generation%20opportunities.

2.9 Samoa

Energy Storage is a major challenge for the renewable-energy industry. With sufficient storage, when the sun isn't shining or wind isn't blowing, intermittent power generation wouldn't be such an issue. Ta'u, a small island in American Samoa, now gathers enough solar energy for 24/7 power, thanks to a microgrid project completed in November with solar provider SolarCity and Tesla.

The system, operated by American Samoa Power Authority, comprises 5,000 SolarCity solar panels and 60 Tesla Powerpack battery-storage systems. It has 6 megawatt-hours of battery storage and can fully recharge in seven hours of sunlight. SolarCity implemented the microgrid in one year, according to the company blog. Ta'u switched from diesel generators to 100 percent renewable energy with the microgrid, according to an article in the Pittsburgh Post-Gazette. The microgrid has 1.4 megawatts of solar generation capacity and can power the entire 17-square-mile island for a full day and night.

Providing power to a remote island can be difficult. Ta'u, with a population of 1,000, has been relying on diesel generators. Fuel for the generators had to be shipped in by boat, a very expensive endeavor. The island often ran low on fuel before the next shipment arrived and had to ration power or face outages.

Now with the microgrid, the island can stay powered for three full days without the sun. Ta'u hospitals, schools, fire and police stations and local businesses no longer need to worry about outages or rationing. Power outages are now unlikely, and intermittent electricity will not be as much of an issue.

With the SolarCity-Tesla battery-coupled system, energy can be stored and dispatched even if the sun isn't out. So far, the microgrid has met 99 percent of Ta'u's power needs.

The switch to solar energy limits costs and greenhouse gas emissions. The microgrid system could save the island almost 110,000 gallons of diesel fuel annually, or about 2.5 million pounds of carbon dioxide emissions per year, according to the Post-Gazette article.

Reference: https://www.ecmag.com/magazine/articles/article-detail/green-building-island-american-samoa-fully-powered-solar

2.10 São Tomé and Príncipe

The island country located off the equatorial coast of Central Africa has a population of more than 219,000, with a total installed capacity of 35.8 MW. Renewable energy represents only 5% of the country's electricity mix. According to data from the International Renewably Energy Agency(IRENA), Sao Tome and Principe did not have any grid-connected solar generation capacity installed at the end of 2021. The World Bank says Sao Tome and Principe has an electricity access rate of around 76%, with 92% of the total coming from imported diesel. The government has vowed to increase the proportion of renewable energy from 5% of the energy mix to 50% by 2030.

In this direction, the governments of São Tomé and Príncipe and Portugal-based Cleanwatts have signed a contract to develop 1.7 MW of solar in the West African island nation. The project will include three solar installations. Cleanwatts started developing 1.1 MW at Sao Tome airport and 300 kWp at Principe airport. The first phase of the 2 MW installation was built at a diesel power station in the city of Santo Amaro, with a capacity of 540 kWp. The project was backed by an investment of $690,000, funded by the United Nations Development Program and the Global Environment Fund.

Reference: https://www.pv-magazine.com/2022/11/10/solar-gaining-traction-in-sao-tome-and-principe/

2.11 Saint Kitts and Nevis

The Government of St. Kitts and Nevis, the state-owned St. Kitts Electric Company (SKELEC) and Leclanché SA broke ground on a landmark solar generation and storage project that will provide between 30-35% of St. Kitts baseload

energy needs for the next 20-25 years while reducing carbon dioxide emissions by more than 740,000 metric tons. The project is being built in St. Kitts' Basseterre Valley on a 102-acre plot of government-owned land adjacent to the current SKELEC power station and next to the thriving capital city of Basseterre, the heart of the country's economic region. The land, which was once used for sugar cane production but has been idle for years, was leased to Leclanché by the Government of St. Kitts and Nevis under a 20-year agreement with an automatic five-year renewal. Environmental Impact Assessment and geotechnical analysis were successfully completed in 2019, demonstrating the renewable energy project will bring a positive impact to the Basseterre Valley.

The $70 million microgrid project is being built by Leclanché, one of the world's leading energy storage companies, which will serve as the prime engineering, procurement and construction (EPC) contractor. Leclanché will provide a turnkey solar plus storage solution together with its main subcontractor Grupotec, headquartered in Valencia, Spain, an experienced engineering and construction firm and leader in the photovoltaic energy sector. Leclanché will own and operate the facility under its strategic build, own and operate model through its SOLEC Power Ltd subsidiary with partner Solrid Ltd.

Construction and start-up will take approximately 18 months. The project consists of a fully integrated 35.7 MW solar photovoltaic system (solar field) and a 14.8 MW / 45.7 MWh lithium-ion battery energy storage system (BESS) utilizing Leclanché's proprietary energy management system software. Upon completion, the St. Kitts project will be the largest solar generation and energy storage system in the Caribbean and a model for other island nations worldwide. In its first year of operation, the system will generate approximately 61,300 MWh of electricity with a 41,500 metric ton reduction of CO2 emissions. Clean, renewable energy produced from the solar + storage project will be sold to SKELEC under a 20-year power purchase agreement at flat rate over that entire period which is designed to provide a significant long-term savings to the projected diesel generation costs.

Reference: https://www.leclanche.com/government-of-st-kitts-and-nevis-skelec-and-leclanche-commence-construction-of-caribbeans-largest-solar-generation-and-storage-system/

2.12 *Vanatu*

Many villages in Vanuatu lack access to electricity, relying on expensive and unreliable fossil fuels to support basic household needs. If electricity is not available, villagers, particularly women, spend up to an hour a day manually processing food crops, such as grating cassava and coconut, shelling corn, grinding flour and hulling rice.

Since 2017, the Australian Government has partnered with Village Infrastructure Angels Australia through its Business Partnerships Platform to provide solar energy solutions to 3,000 poor and remote off-grid households in 60 villages in Vanuatu. Australia's contribution of A$500,000 over two years towards the initiative has helped supply solar agricultural mills to 30 of the country's 60 inhabited islands, reducing reliance on fossil fuels and boosting rural incomes.

The use of solar mills means villagers are spending more time on income-producing activities like weaving baskets, and some villagers have even started making new products like vacuum-packed cassava flour and coconut oil, which have a higher profit margin compared to raw crops. Plus, the more reliable power source provides better lighting for children to study by at night and will help communities recover faster after disasters, such as 2015's devastating Tropical Cyclone Pam.

The initiative is structured as a shared value business model with the private sector, so the communities will eventually own the solar mills and lights once they have been paid off, encouraging remote villages in Vanuatu to pursue sustainable development pathways that are more disaster and climate resilient.

Reference: https://www.dfat.gov.au/about-us/publications/Pages/solar-mills-increase-rural-resilience-in-vanuatu

2.13 *Gambia*

Energy demand in Gambia has grown by 5.5% a year in recent years and the new 20 MW solar power plant to the national energy grid will both significantly increase Gambia's current generation capacity of 98MW and enable electrification of rural areas. At present less than half the population of Gambia have access to electivity and in rural areas only 15% of people are connected to the energy network. Electricity costs in the country are far higher than neighboring countries and fluctuate due to reliance on imported diesel.

Access to clean energy in the Gambia is set to be transformed under a new EUR 142 million initiative to harness solar power and supply clean energy

across the country, backed by the European Investment Bank, World Bank and European Union.

Once operational, the scheme will increase energy supply in the Gambia by one fifth and transform electricity access in rural communities through construction of a new photovoltaic plant at Jambur near Banjul, new power transmission and distribution infrastructure. The project will increase access to energy, ensure that education and health services benefit from reliable power and help to address current power shortages in the country. The Project is designed to assure the sustainable provision of electricity powered by the solar systems for at least 20 years and to lay the groundwork for a national solar energy industry to provide additional services in the future.

The European Union will provide EUR 106 million for the clean energy programto be implemented by national electricity utility NAWEC. This includes EUR 65 million under a 25-year long-term concessional loan from the European Investment Bank and a EUR 41 million grant from the European Union budget. The project will also be supported by EUR 35.7 million financing from the World Bank.

Under the scheme all 1,000 schools and 100 health centers in rural parts of the Gambia that currently have limited electricity access are expected to benefit from reliable energy supply through new connections to the national energy network and provision of off-grid solar and battery systems.

A dedicated part of the European funding will support feasibility and environmental studies, technical training, new infrastructure to connect social services and regulatory assistance to allow renewable energy to be supplied to the NAWEC.

Reference: http://www.ecowrex.org/news/solar-energy-power-1100-schools-and-health-centers-gambia

2.14 Madagascar

Two case studies from Madagascar are discussed below.

2.14.1 Solar Mini-grids

Madagascar offers the prospect of rapid growth in electricity consumption, as about 85% of the population has no access to electricity. The country has no national grid, yet it enjoys about 2,800 hours of sunshine per year. That means solar mini-grids may be a viable way forward.

The European Investment Bank (EIB), Tridos Investment Management and EDFI ElectriFI announced their new collective investment of $20.5 million to support WeLight Madagascar's $30.5 mn project. The investment will enable WeLight to build and develop solar mini-grids to supply electricity to over 120 villages in Madagascar which currently have no access to the national electricity grid. The new Mini-grids will provide residents in off-grid rural villages access to clean and affordable energy. Alongside homes and businesses, the project will benefit schools, health centers and public places, strengthening the local economy and improving health, security and education.

Reference:

1. https://www.eqmagpro.com/solar-energy-is-madagascars-key-to-boosting-electricity-in-rural-areas/

2. https://www.esi-africa.com/renewable-energy/solar/120-villages-in-madagascar-to-benefit-from-off-grid-solar-project/

2.14.2 Solar Energy Kiosks

In Madagascar, rural populations have very limited incomes which are mainly from agriculture and are on the lowest level of the power consumption pyramid. The communities must cope with seasonal revenues and also lack awareness on modern, affordable energy solutions. Hence, they always turn to traditional energy solutions for basic services (such as lighting). In these circumstances, how canone reach the most vulnerable rural populations with modern, reliable and affordable energy services, while prioritizing socio-economic development and minimizing impacts on health and the environment?

This is the challenge that HERi Madagascar, a social enterprise created in 2011, is addressing through the development of a "pre-electrification"model based on the implementation of solar energy kiosks (SEKs). These SEKs offer energy solutions with an emphasis on social considerations in the heart of off-grid rural villages in Madagascar. The kiosks are franchised, managed by local businesswomen, and offer sustainable solutions and modern energy services, based on the sale/rental of solar equipment for individuals (rechargeable lamps, telephone charging) or the community (refrigeration, printing). The combined actions of sale/rental, rural marketing and local services have allowed the company to expand its network, in January 2016, to 44 SEKs across the country and to strengthen the technology and impacts model prior to a commercial upscaling phase. While the financial profitability of the business

model has not yet been achieved, each kiosk is financially autonomous within a period of two years. Based on this initial success, the company plans to extend its network to 150 SEKs by 2018 and use economies of scale to move toward a financially sustainable model, while maintaining wider socio-economic benefits.

Its inclusive business model has been recognized by the German government and by the ACP-EU facility, which has given its support to the PowerKiosk project (HERi Madagascar, ICCO, Solar Kiosk), which benefits from being able to compare lessons learned from the implementation of the kiosk model in three different countries - Ethiopia, Kenya and Madagascar. In particular, this feedback from the commercial exercises will allow HERi to extend its network to 150 kiosks in Madagascar by the end of 2018.

The solar photovoltaic (PV) technology perfectly fits with the SEKs' needs: it allows the system to become quickly operational, allows for modular production, requires little maintenance and is easy to use. Each SEK has six solar PV panels installed on the roof. The installed power is modular and can be increased or reduced according to changing demand. The electrical system is intuitive and based on "plug-and-play" models.It allows the system to adapt to rural needs, facilitates its use by the manager, and can power a wide range of electrical devices. The system includes two 180 Ah GEL batteriesto store the energy, a load regulator (to ensure safety and optimize battery life by regulating charging and discharging) and a 450 W converter (which converts direct current into alternating current and limits the appliance use to a 450 W threshold). Exceptionally, 1,000 W converters were installed in two kiosks in order to increase the entrepreneurs' ability to use multiple devices simultaneously. The available connections are direct current/DC10(mainly used to charge lamps, mobile phones and radios) and alternating current/AC (to power other electrical devices). Both solar and electrical equipment are imported from Germany. Since the launch of the first kiosk in December 2012, HERi has experienced no technical problems. The only incidents usually occur a few days after the opening of each kiosk, when the entrepreneurs (despite the operating recommendations and warning) overload the system by plugging in too many appliances, thus exceeding converter capacity. This is not an alarming issue, since the system shuts down for safety reasons and automatically restarts within a few minutes.

Reference: https://journals.openedition.org/factsreports/4168

2.15 Senegal

Nearly 540,000 people in Senegal will get access to clean and affordable power following the launch of two solar photovoltaic (PV) plants, financed by IFC, the European Investment Bank and Proparco, under the World Bank Group's Scaling Solar program.

The two plants that launched operations last month are located in Kael and Kahone in Western Senegal and have a total capacity of 60MWac. They will provide energy at tariffs of 3.98- and 3.80-Euro cents per kilowatt hour, respectively – one of the lowest prices for electricity in Sub-Saharan Africa – and will help avoid 89,000 tons of CO2 emissions per year.

The two plants are sponsored by Engie, Meridiam, and the Senegalese Sovereign Wealth Fund for Strategic Investments (FONSIS). The competitive tendering was led by Senegal's Energy Regulatory Commission (CRSE).

Although the proportion of Senegalese people with access to electricity has increased sharply over the past 30 years, nearly a quarter of the population still lacks access. Senegal´s power sector has been historically reliant on costly fuel imports, with about 80 percent of its energy mix being oil-based.

"The Kael and Kahone solar power plants exemplify our commitment to supporting Senegal's transition to cleaner, more affordable energy, while creating business opportunities for local communities. These two projects are expected to provide the equivalent of 540,000 people with cheap, renewable electricity. This is a record in sub-Saharan Africa, which will support more than 400 direct and indirect local jobs", said Mathieu Peller, COO of MéridiamAfrique.

The financing package of the plants includes senior loans worth €38 million from IFC, the Finland-IFC Blended Finance for Climate Program, the European Investment Bank, and French development finance institution Proparco. The Multilateral Investment Guarantee Agency (MIGA), a member of the World Bank Group, issued €6.9 million in guarantees to support the plants, providing protection against non-commercial risks for duration of up to 15 years.

The Kahone and Kael projects were implemented in partnership with the United States Agency for International Development (USAID)'s Power Africa, the Government of the Netherlands, the Rockefeller Foundation, and the Infrastructure Development Collaboration Partnership Fund (DevCo).

Senegal is the second country to bring Scaling Solar-backed PV projects to the operational stage. In March 2019, the first solar plant financed and tendered under the Scaling Solar program was inaugurated in Zambia. The Scaling Solar program continues to grow as it supports projects in Afghanistan, Côte d'Ivoire, Madagascar, Togo, and Uzbekistan currently at various stages of development.

Reference: https://pressroom.ifc.org/all/pages/PressDetail.aspx?ID=26382

2.16 *Zambia*

The Bangweulu Scaling Solar Plant 54MW plant is expected to supply as many as 30,000 households and several businesses with electricity. This is particularly important in Zambia, where one-fifth of the population has access to electricity and drought has taxed hydropower facilities. For a 54-MW project over a 25-year concession period, it equates to a saving of almost $140 million."

The first projects at Bangweulu, sponsored by French company NEOEN, is now commissioned with IFC financing and letters of credit backed by International Development Association (IDA) partial risk guarantees. Zambia has entered a second round with Scaling Solar to develop additional solar plants, which also envision IDA18 payment and loan guarantees to back-stop the plants coupled with IFC financing.

Based on initial assumptions, Zambia's savings over the first 25 years would be about $163 million per 50 MW power plant. The first two plants will increase the country's available generating capacity by 5% and will help restore water levels in its hydropower dams.

Constructed with support from the World Bank Group through the International Finance Corporation (IFC), Zambia is the first country in Sub-Saharan Africa to implement the Scaling Solar program. The program brings together Bank Group services and instruments under a single engagement aimed at creating viable markets for grid-connected solar energy.

Scaling Solar is an open and competitive approach that facilitates the rapid development of privately-owned, utility-scale solar PV projects in Sub-Saharan Africa. It enables governments and utilities to procure solar power transparently and at the lowest possible cost. Through competitive auctions organized by the program, Zambia was able to attract world class developers to its first two projects and obtain some of the lowest tariffs in Africa at that time; $0.06 cents and $0.078 cents per kilowatt hour fixed for 25 years.

In recent years, droughts in southern Africa have significantly reduced the electrical output of Zambia's hydropower plants, leaving many Zambians in the dark. Power shortages and forced rationing have impacted the national economy and pushed the government to mandate the procurement of 600 megawatts (MW) of solar photovoltaic (PV) power and to target an overall increase in electricity generation to 6,000 MW by 2030.

With its year-round sunshine and geographical location, Zambia is well positioned to integrate solar power into its energy mix dominated by climate-vulnerable hydropower. Scaling Solar is also quick. Zambia has been able to assess projects and manage competitive tenders in short order. The first plants are now being built with commissioning set to occur within a fraction of the time it would have taken Zambia to do so independently.

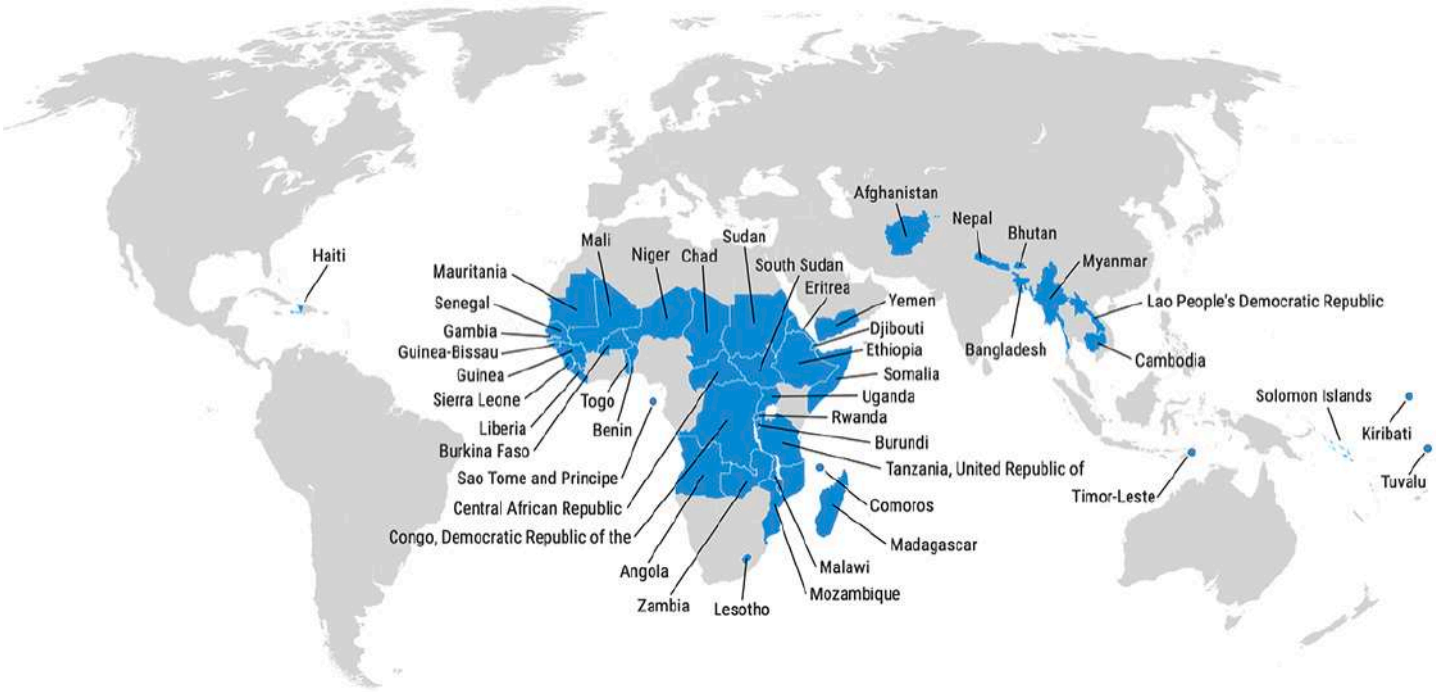
Reference: https://www.worldbank.org/en/news/feature/2019/05/14/unlocking-low-cost-large-scale-solar-power-in-zambia

Appendix 3

Least Developed Countries (LDCs)

(46 countries)

Africa 33, Asia 9, Caribbean 1, Pacific 3



Note: The boundaries and names shown, and the designations used on this map do not imply official endorsement or acceptance by the United Nations

Date: October 2022

These 46 LDCs are distributed among the following regions:

1. **Africa (33):** Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Democratic Republic of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Togo, Uganda, United Republic of Tanzania and Zambia
2. **Asia (9):** Afghanistan, Bangladesh, Bhutan, Cambodia, Lao People's Democratic Republic, Myanmar, Nepal, Timor-Leste and Yemen
3. **Caribbean (1)**: Haiti
4. **Pacific (3):** Kiribati, Solomon Islands and Tuvalu

Appendix 4

Small Island Developing States (UN Members)

1. Antigua and Barbuda
2. Bahamas
3. Bahrain
4. Barbados
5. Belize
6. Cabo Verde
7. Comoros*
8. Cuba
9. Dominica
10. Dominican Republic
11. Fiji
12. Grenada
13. Guinea-Bissau*
14. Guyana
15. Haiti*
16. Jamaica
17. Kiribati*
18. Maldives
19. Marshall Islands
20. Federated States of Micronesia
21. Mauritius
22. Nauru
23. Palau
24. Papua New Guinea
25. Samoa
26. São Tomé and Príncipe*
27. Singapore
28. St. Kitts and Nevis
29. St. Lucia
30. St. Vincent and the Grenadines
31. Seychelles
32. Solomon Islands*
33. Suriname
34. Timor-Leste*
35. Tonga
36. Trinidad and Tobago
37. Tuvalu*
38 Vanuatu

** Also Least Developed Country*

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