Solar for Health (S4H) innovative financing feasibility study

in Liberia, Malawi, Namibia, Zambia and Zimbabwe

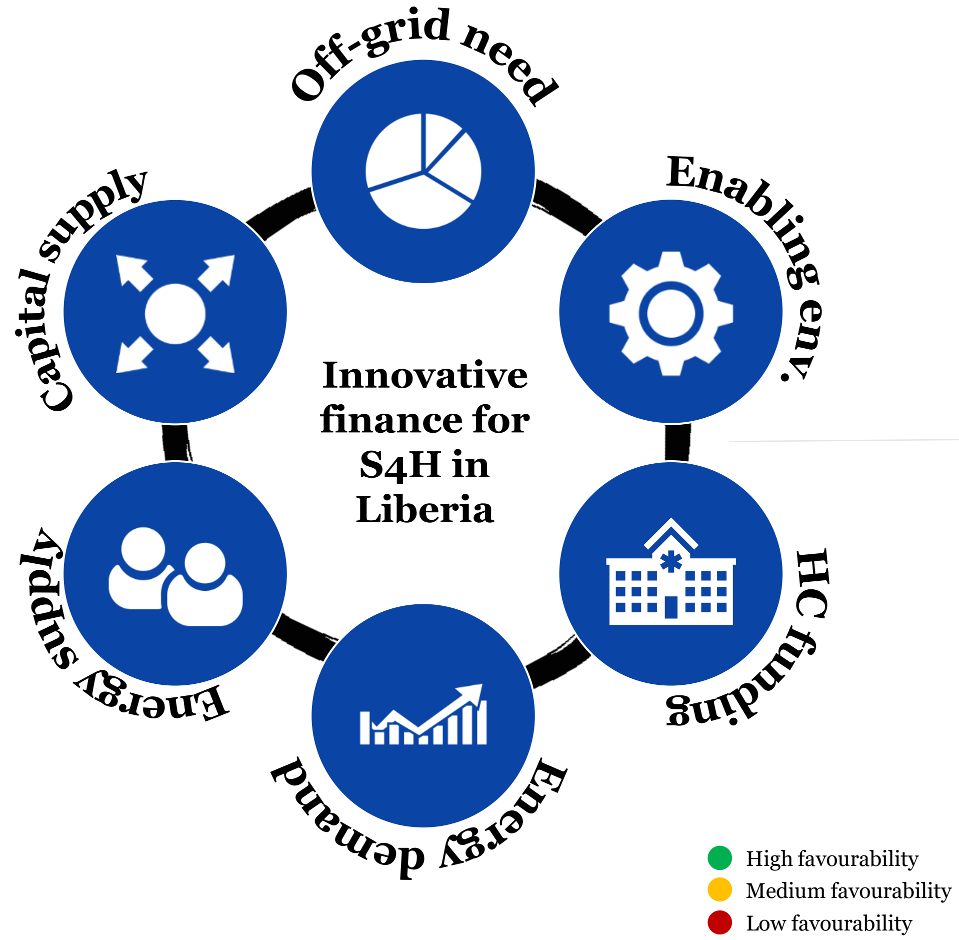
UNDP PRC/ZWE/RFP/0008/7/8/2019

Liberia – country report

September 2020

UNDP DIFFER KOIS CARING FINANCE

Improving healthcare quality via electrification will require better coordination and targeting of existing donor funding and strengthening of long-term accountability of MOH, as there is limited private capital available



Due to very limited availability and reliability of the national grid (12% access rate), and low inter-connection with neighbouring countries, off-grid energy might be a solution for the 3.8 million people living outside of the capital.

High macroeconomic risk (volatile currency, low economic growth and high inflation), opaque regulatory framework and a crumbling infrastructure, further aggravated by widespread corruption and a fragile post-conflict situation.

Due to lack of fiscal space and accountability, the Government is unable to secure funding to provide a free universal healthcare coverage, therefore most of CAPEX and a big part of OPEX are funded by bilateral/ multilateral donors.

464 public healthcare facilities rely predominantly on costly and polluting diesel generators for their energy needs of c.7.2 GWh/year. It is possible to close this gap by installing 6.7 MWp of solar capacity at a cost of up to US$23m.

LEC[1] is geographically limited to Monrovia and sells electricity at extremely high prices[2], effectively depriving rural users. Few competent off-grid solar companies are present in the market due to costly value chain and lack of human capital.

Private sector financing (i.e., FDIs and commercial banks) is limited to extractives and agriculture sector, and still very reluctant to renewables. Due to lack of fiscal space, most of infrastructure investments have to be funded by donors and DFIs.

[1] Liberia Electricity Corporation (LEC) is a national utility company in Liberia
[2] US$0.35/kWh, representing one of the highest tariffs in Sub-Saharan Africa

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With an extremely low starting position (particularly in rural areas), a rapid electrification will be required to reach the ambitious 2030 target access rate of 35%

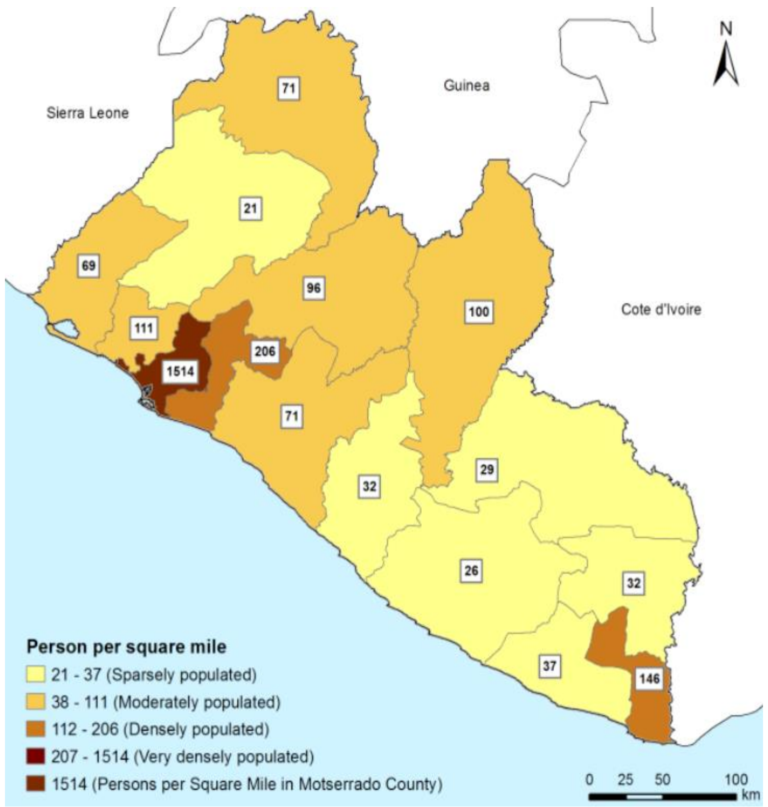
General figures

Population	4.8 million (49% rural)
Land size	111,369 km²
GDP/cap. (nom.) 2018	$703 (174/182)
Ease of doing business ranking	175/190

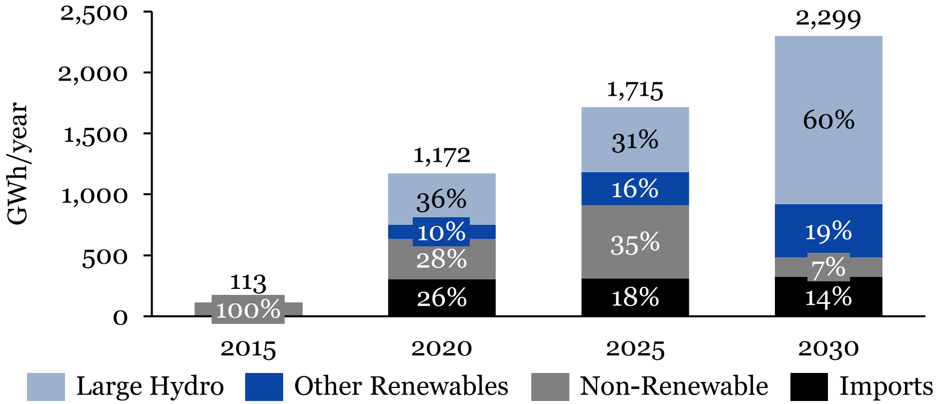
Electricity related figures[2]

Access to electricity	12% of total population
Rural grid electrification	3%
Electricity price	US$0.35/kWh
Installed capacity	126 MWp
Availability of fin. services index[5]	3.76

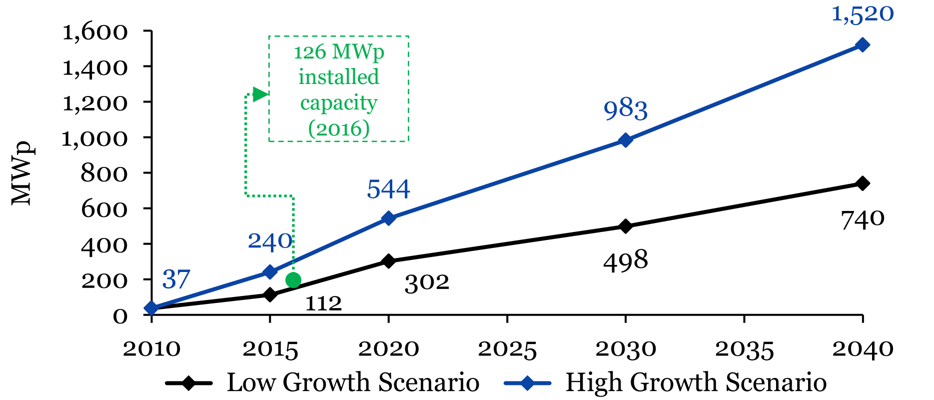
Population density by county[1]



Forecast of electricity consumption by source (2015-30)[3]



Forecast of electricity generation capacity (2010-40)[4]



[1] "Liberia National Population & Housing Census" 2008 | [2] "Power Africa – Liberia Fact Sheet" November 2018 https://www.usaid.gov/sites/default/files/documents/1860/Liberia_-_November_2018_Country_Fact_Sheet.pdf | [3] "Liberia Rural Energy Strategy and Master Plan" 2018 http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf | [4] "Sustainable Energy for All- Liberia: Rapid Assessment and Gap" 2013 https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_RAGAs/Liberia_RAGA_EN_Released.pdf | [5] The extent to which financial sector provides a range of financial products & services to businesses (1 = not at all; 7 = wide range); world median = 4.4

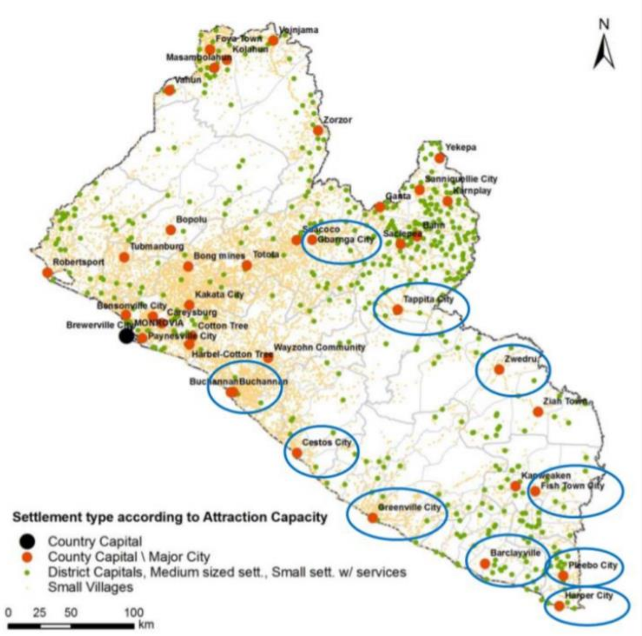
Several donor electrification programmes are currently underway – main efforts being on grid extension (transmission & distribution), mini-grid electrification of select towns and hydropower

Transmission efforts to connect to WAPP[1] and provide power to new areas

- The West Africa Power Transmission corridor aims to extend transmission lines though Liberia, Sierra Leone, Guinea and Cote d'Ivoire
  - funded by AfDB, WB, EIB, KfW, the phase currently under construction is to be finished in 2020
- Further Côte d'Ivoire - Liberia Interconnection
  - Reinforcement Project underway until 2024

Mini-grid and distribution and generation to add new connections

- In 2018, 10 mini-grids using renewable energy (hydro, wood, solar PV, palm oil, solar-diesel) are operational with capacities ranging 22.5-60 kW
- There is a new €42m EU project to electrify 10 towns in southeast Liberia (providing distribution and generation)



Several supply side and market kickstart efforts to increase power supply

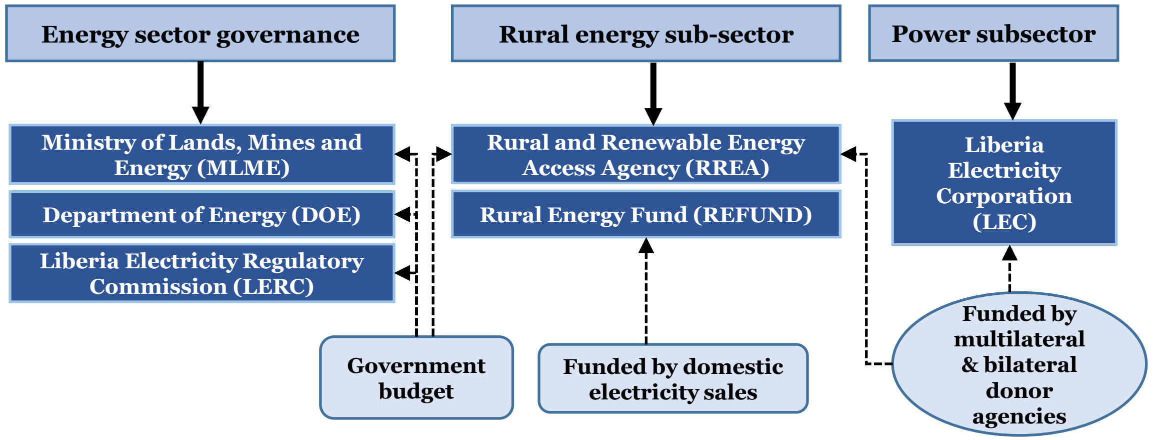
- Liberia Electricity System Enhancement Project (LESEP)
  - Further rehabilitation of the hydropower plants
- The Liberia Accelerated Expansion Project (LACEP)
  - Heavy fuel oil (HFO) infrastructure support to LEC
- Renewable Energy Access Project (REAP)
  - Promotion of to kickstart SHS market
- The Liberia Renewable Energy Access Project (LIRENAP)
  - Mini hydro projects (to be connected to grid) in Lofa County

- Over time, these projects will be important pieces also in grid-powering healthcare facilities
- The lack of infrastructure (even electrification of towns/cities) is so substantial that many parts of Liberia are unlikely to be electrified over the next 5-10 years
- Liberia's tropical climate makes for solid vegetation. This means that settlements are more concentrated along main roads than in many other African countries – providing distribution lines along main roads would likely reach a substantial part of the population

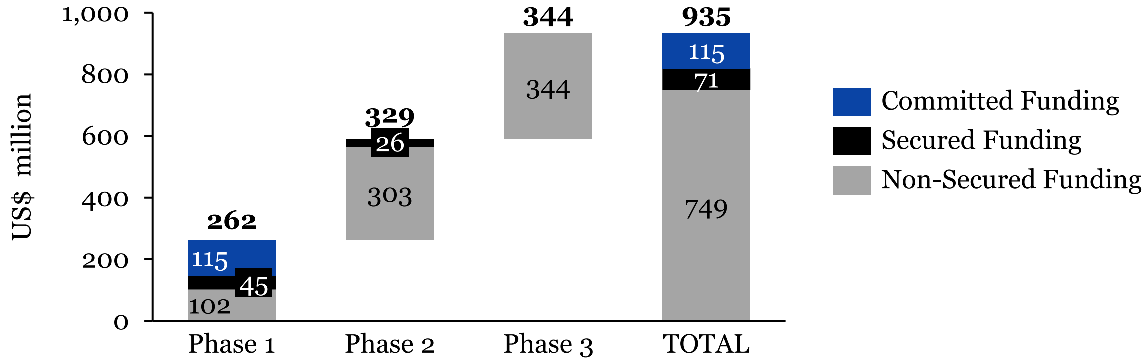
[1] West African Power Pool (WAPP) is a cooperation of the national electricity companies in Western Africa, looking for establishing a reliable power grid for the region and a common market for electricity
Source: Differ analysis

Despite post-war rebuilding efforts, energy infrastructure remains insufficient because of weak institutional framework and structural underfunding, likely constraining the ambitious 2030 electrification goals

Institutional framework of energy sector in Liberia[1]



$749mil of funding gap estimated to implement RESM by 2030[1]



- **MLME is committed to strategic planning and has created a general energy regulatory framework, though it has been little tested in practice:**
  - National Energy Policy (2009): Legal basis for public and private ESPs to offer commercial electric service in Liberia via grid expansion and/or off-grid (in remote communities)
  - Electricity Law of Liberia (2015): Legal and regulatory framework for the generation, transmission, distribution, sales and import/export of electricity to facilitate the implementation of the National Energy Policy
  - Creation of Rural and Renewable Energy Agency (2015): RREA's mandate includes integrating energy into rural development planning, promotion of RE technologies, facilitating delivery of energy products & services through rural energy service companies
  - Mount Coffee Hydropower Plant refurbishment (2020): After 6 years of refurbishment for US$230m, funded mostly by international donors (WB, AfDB, EIB and KfW), Mt Coffee is expected to resume operating at full capacity (88 MWp) in 03/2020

- **RREA prepared a strategic roadmap for providing access to improved rural energy services, though its implementation remains largely unfunded:**
  - Rural Energy Strategy and Master Plan (RESM), launched in 2016 and structured under 5 main programs, identifies 92 projects and investments to electrify 265,000 homes and 1.34 million people outside Monrovia until 2030
  - RREA relies on cross-border interconnection with Ivory Coast for electrification via energy imports in its 3 adjacent counties (Maryland, River Gee and Grand Gedeh) – while local interconnection points exist already, a high voltage interconnector aiming to interconnect the whole West African Power Pool (Ivory Coast, Liberia, Guinea and Sierra Leone) is still under construction[2]

[1] "Liberia Rural Energy Strategy and Master Plan" 2018 http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf
[2] https://www.transcoclsg.org/clsg-project-leaps-elecnor-eiffage-completes-tower-erection-in-liberia/

While some policies aiming to attract foreign capital have been adopted, these do not sufficiently target energy sector and the GoL will have to make further concessions and increase transparency in its regulations

GoL has launched efforts to implement a number of favourable policies for energy project development

Investment Incentive code: Incentives granted under this code include exemption from custom duties, income tax, stamp fees and other benefits to new and expanding businesses, and for approved investment projects in various sectors including but not limited to; mining, manufacturing, agriculture and transport. Approved investment projects may also be eligible for support in securing loans and guaranteeing credit by the Central Bank.

- Exceptions from trade taxes:
  - ✓ Machinery, equipment, raw materials, semi-finished products and other supplies to be used in a project are exempt from import duty up to 90% of their dutiable value
- Exemptions from income tax:
  - ✓ Reinvested profits are exempt from income tax
  - ✓ Profits not reinvested are exempt from 50% of the income tax otherwise payable

Though challenges in incentives for energy sector remain

Tax regime for energy: Current application of existing exemptions to energy is not clear. Applicable taxes can reach 25% (e.g., in the case of solar portable lamps). A tax regime for rural electrification and renewable energy investments will be developed to limit import duties and goods & services tax impact on the total investment and funding required. The future regime will also include tax exemptions for private sector investment on energy in order to incentive private and commercial funding. Tax/duty exemptions on imports are likely to only affect pico-solar equipment in first round.

Practical application of the policies: Current rules of duty waivers and sales tax on RE investments and products are applied non-systematically and on ad hoc basis.

Recommendations for long-term energy sector development

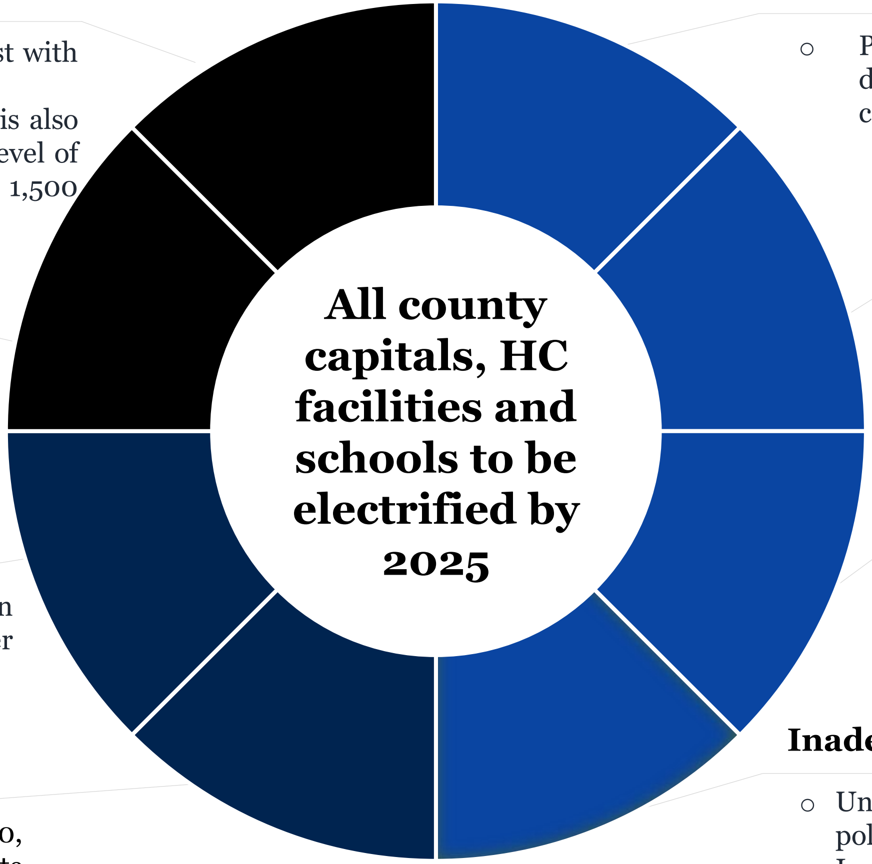
Findings of Off-Grid Solar Fiscal Impact Study: Supports strong case for introduction of sector-wide duty waiver (DW), estimating its revenue implications would range between US$106k and US$356k in total until 2025. Impact assessment recommended introduction of a full DW for an initial period of six years (2020-25). **RREA-led market assessment:**

- Promoting quality
  - ✓ Development of harmonised national quality standards
- Improving affordability and availability
  - ✓ Let companies set margins & prices
  - ✓ Accelerate transition from subsidising specific costs towards result-based financing based on milestones
- Coordinating stakeholders
  - ✓ RREA should delegate responsibilities to specialised organisations to free up time to provide leadership and oversight of energy sector
  - ✓ Set up Off-Grid Solar Sub-Committee

Predicted gains in energy access resulting from the DW on off-grid solar products over the 6-year period

Best case scenario	Medium case scenario	Worst case scenario
US$356k cost to GoL (with a full DW)	US$106k cost to GoL (with a partial DW)	Full duty applied; no revenue loss
88,834 households gain access to off-grid solar products	24,715 household gain access to off-grid solar products	Sales only marginally outpace 2012-2019

The poor starting position, further aggravated by a weak enabling environment, will likely impede achievement of the ambitious target of grid electrification of all healthcare facilities by 2025



Largely untapped potential for renewables

- Intense and long wet season together with a long seacoast with several river deltas represent high hydropower potential
- Solar radiance, while hardly justifying large solar farms, is also high and consistent across the country with an average level of 1,712 kWh/m²/year and generation potential of 1,400 to 1,500 kWh/kWp

Ongoing post-war reconstruction

- In spite of intense efforts (e.g., reconstruction of Mount Coffee Hydro), the reconstruction is lagging behind the plan and is heavily focused on Monrovia

Lack of human capital

- Lack of human capital and technical capacity present an obstacle towards rebuilding the country, further aggravated by widespread corruption

Very high macroeconomic risk

- Volatile currency, poor economic growth (est. 1.6% in 2020, prior to Covid-19) and high inflation (22.6% in 2018) create a very risky macroeconomic environment

Poor business environment

- Poor ease of doing business (175. out of 190 countries), notably due to existing trade barriers, cumbersome process of obtaining construction permits and poor contract enforcement

Ineffective public utility

- Public utility (LEC) is not commercially viable due to prohibitively high tariff and overstaffing (+50%)
- Good collection rate (94%), though power theft remains an important issue

Non-existent rural energy infrastructure

- Main grid only covering areas around Monrovia
- Rural population currently depends almost entirely on diesel generators (and energy imports to a lesser extent), unaffordable for a vast majority of population

Inadequate policy & regulatory framework in energy

- Unclear policy direction and poor implementation of existing policies and strategies
- Import duties on SE products and opaque application of waivers
- Lack of RE-focused incentives for potential providers/investors

http://gestoenergy.com/wp-content/uploads/2018/04/LIBERIA-RURAL-ENERGY-STRATEGY-AND-MASTER-PLAN.pdf
Trimble et al 2016 Financial viability of electricity sectors in SSA
Source: World Bank; Rural Energy Strategy and Master Plan Document; European Union; Power Africa; KOIS analysis

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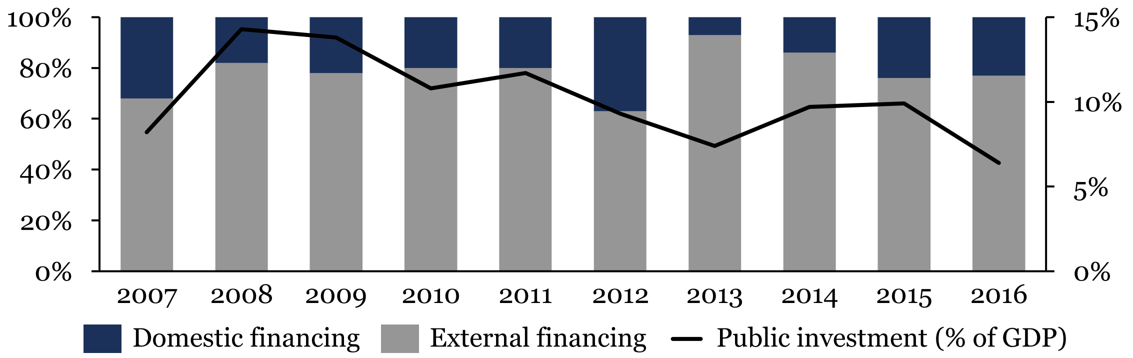
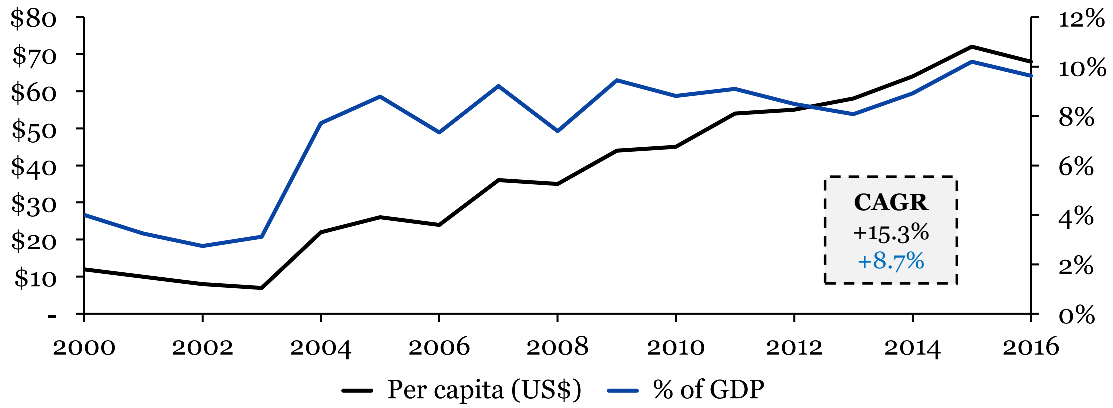
Essentially dependent on external funding – uncertain in the long run – the GoL has limited manoeuvring space in allocation of funds among its respective spending priorities

Public investments by funder (2007-2016)[1]
% of public CAPEX by funder (left axis); % of GDP (right axis)



Health sector spending (2002-2016)[2]
Per capita (US$); % of GDP

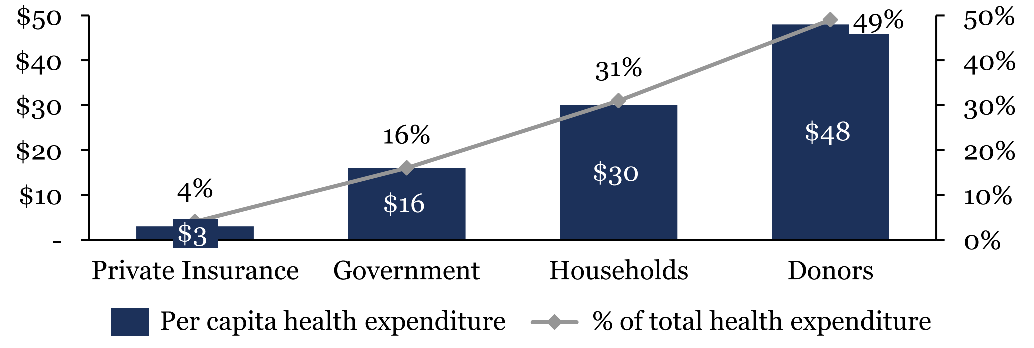


- **Liberia relies heavily on external country funding (such as ODA, concessional loans and grants) as a source of infrastructure investments**
  - Liberia receives 60% of its GDP from official development assistance (ODA) and allocates on average 10.5% on energy sector (ca. US$474m for rural energy)
  - Available amount of energy funding (determined by a country's level of income, capacity to repay debt and IMF policy on acceptable level of indebtedness), is currently estimated to US$75m in the form of concessional country loans (low interest rates and long maturities)
- **Severely constrained fiscal space leaves little room for increased budget allocation**
  - 9.6% of the GDP (~US$202m) was allocated to healthcare in 2016 – or US$5m less (-2.5%) than in 2015 in nominal terms
  - Tight fiscal space for health due to weak government revenues makes the country effectively dependent upon on-budget support from donors
- **Despite a steady growth in health sector spending, average per capita health spending in Liberia is one of the lowest in the world**
  - With US$69 per capita HC spending, Liberia ranked 153rd out of 189 countries in 2015[3]
- **Strong fiscal centralisation in the health sector is additionally leading to increasing regional differences**
  - Most of investments flow into Montserrado county, and Monrovia specifically, while only 21% of the country population lives in the capital
  - Budget execution challenges, including delays in disbursement of funds, leakages and weak financial reporting and accountability at county level

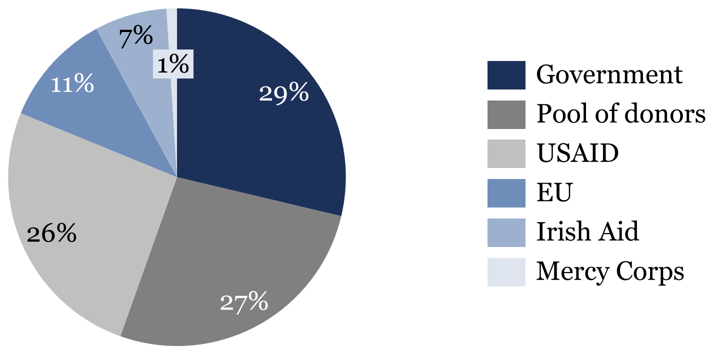
[1] International Monetary Fund, 2016 https://www.imf.org/external/pubs/ft/scr/2016/cr16352.pdf
[2] https://www.macrotrends.net/countries/LBR/liberia/healthcare-spending; https://data.worldbank.org/
[3] World Health Organization, 2015 https://apps.who.int/nha/database/Select/Indicators/en
Source: IMF, WHO, KOIS analysis

Investments into operating efficiency would yield savings in the future operating expenses of public healthcare facilities – cost savings that would benefit both government and donors

Total per capita health expenditure, by funder (2014/15) [1]
US$, %



Public healthcare facilities by financier (2012) [2]
%



- **Public healthcare facilities are largely funded, and often directly managed by international donors, further increasing the country's lack of ownership, accountability and effectiveness of public spending**
  - Healthcare sector is still largely underfunded due to limited GoL contribution to investments (i.e., hardly covering running costs) and lacking donors' coordination
  - Only 29% of the public healthcare facilities are also funded by the Government, being de facto dependent on ODA from foreign donors (i.e., funding channeled through MOH)
  - Due to this over-reliance on donors' funding, the Government is not incentivised to allocate capital expenditure to equip healthcare facilities with less costly electricity source (such as solar), therefore perceiving little value of potential cost savings
  - In some cases, donors frustrated by inertia of GoL are reconsidering their priority geographies (e.g., Norway has decided not to renew its funding past 2020 and channel their funds somewhere where it makes more sense; Germany is withdrawing due to corruption[3])

- **Hypothetical cost savings, resulting from installing a more cost-effective technology such as solar, would therefore benefit both local government and the donors**
- An average annual diesel consumption bill for a rural health clinic can reach up to US$2,000, amounting up to ~90% of the cash received from MOH (i.e., medicines are received in kind and salaries are paid directly via employees' bank accounts) → this amount represents potential cost savings for the healthcare funders (mostly donors and to a lesser extent he government through MOH)

[1] Public Financing for Health in Africa: from Abuja to the SDGs (WHO, 2016) https://apps.who.int/iris/bitstream/handle/10665/249527/WHO-HIS-HGF-Tech.Report-16.2-eng.pdf?sequence=1
[2] Liberia Institute of Statistics and Geo-informational Services, 2012 https://www.lisgis.net/pg_img/Health%20Facilities%20by%20County%20and%20District.pdf
[3] https://allafrica.com/stories/202005110400.html
Source: Liberia Institute of Statistics and Geo-Information Services, Ministry of Health and Social Welfare, KOIS analysis

88% of public healthcare facilities are clinics (both Level 1 and Level 2), providing primary healthcare services to the mostly rural population and having modest energy needs

	Health clinic (Level 1)	Health clinic (Level 2)	Health centre	Hospital
Healthcare facility characteristics				
General description	• Basic HC facility in remote setting for primary health needs (i.e., limited HC staff, basic storage of medication)	• Provides vital services (e.g., obstetric and surgical services), treatment of injuries & infections	• Provides vital services (e.g., obstetric and surgical services), treatment of injuries & infections and maternity services	• Largest infrastructures for patient capacity (over 120 beds) and wide range of services
# of public facilities	• 201	• 205	• 35	• 23
Local pop density	• Low	• Low/Medium	• Medium	• Medium/High
Patient type	• Rural and remote, low revenues	• Rural/semi-urban, low revenues	• Rural/semi-urban, low revenues	• Secondary cities, average to low revenues
Treatment capacity	• 0-20 beds	• 10-40 beds	• 40-80 beds	• 80 beds and more
Staff size & type	• No permanent doctor / full- or part-time primary HC provider	• One or more full-time nurses and potentially a part-time physician	• Several full-time nurses and 2-3 physicians	• Full-time doctors, nurses, and other technical and maintenance staff
Services provided	• Treatment of minor illnesses, prevalent diseases; basic immunisation services; first aid	• Wider array of services & equipment for basic diagnoses; treatment of injuries and infections; refrigerators for vaccine storage	• Wide array of services & equipment for sophisticated diagnoses; treatment of injuries and infections; maternity services	• First aid to surgery, non-communicable disease treatment and IC; medical analysis laboratories, diagnostic equipment and storage facilities for blood and vaccines
Healthcare facility energy needs				
Description of need	• Lighting for limited overnight procedures & maintaining the cold chain (vaccines & drugs)	• Lighting for basic overnight surgical procedures & maintaining cold chain; using lab, medical equipment and communication	• Lighting for complex overnight surgical procedures & maintaining cold chain; using lab, medical equipment and communication	• Similar to health centre plus communication with remote HC and hospitals, and using more sophisticated diagnostic devices
Energy need & equipment	• 10-20 kWh/day (e.g., microscope, lights & small refrigerator, hand-powered aspirator)	• 20-50 kWh/day (i.e., Level 1 clinic + basic diagnostic medical equipment)	• 50-100 kWh/day (i.e., Level 2 clinic + air conditioning for operating theatre)	• 100-250 kWh/day (i.e., HC + communication, more sophisticated diagnostic medical devices)

Source: World Bank; KOIS and Differ analysis

As of 2020, we estimate 464 public healthcare facilities need c.6.7 MWp in off-grid installed capacity, of which 23 hospitals account for 23% of energy demand, while clinics represent 88% of all healthcare facilities

Health facilities by ownership (2020)[1]
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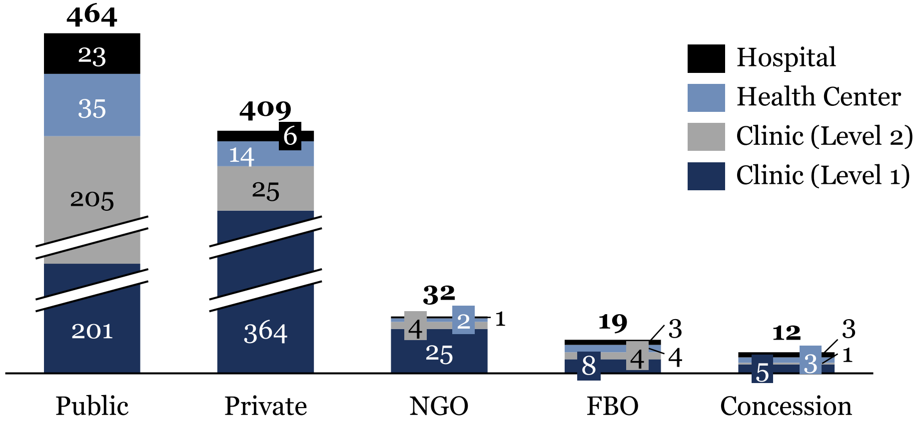
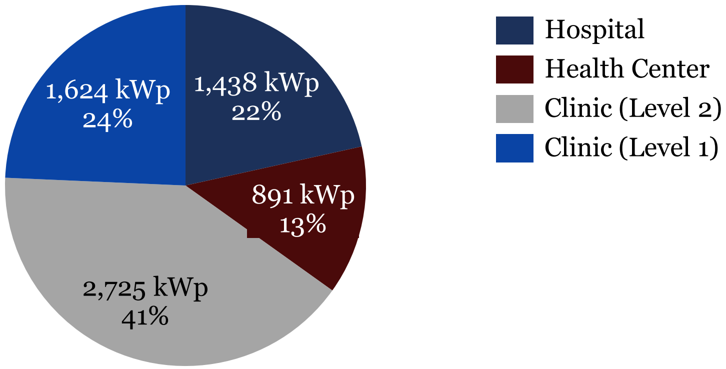


Installed capacity needed by facility type (public facilities)
kWp, % of total



Public healthcare facilities should be the main focus of S4H in Liberia

- Out of 936 identified HC facilities, 50% are owned by the Government, serving ca.63% of the population
- 89% of private HC facilities are very small individually-run Level 1 clinics → as these are hard to coordinate due to a high level of decentralisation, we recommend to focus on **public healthcare facilities only**
- Only 57 (12%) public facilities are located within the reach of the main grid (although few of them are actually connected due to high cost and low reliability of the grid); 407 are located in the counties without access to the grid[2]
- Public hospitals and health centers, as well as many clinics, have diesel generators at their disposal and are supposed to receive diesel or money to procure it on their own from MOH (though often delayed/not available, based on Government's current liquidity situation)

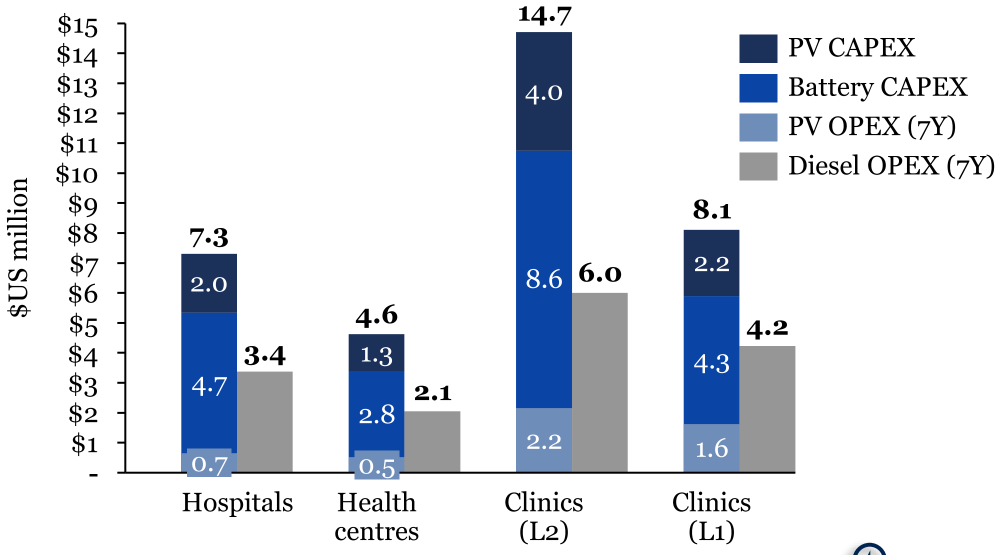
Their current energy need can be met via solar PV standalone systems

- Healthcare facilities have extremely limited access to the grid and mostly operate on costly and polluting diesel generators (even the fraction of healthcare facilities connected to the main grid often rely on diesel generators as a frequently used backup solution)
- Since the grid expansion to healthcare facilities will likely lag behind the 2025 plan, thus the immediate least-cost electrification option for the healthcare facilities, prior to their gradual connection to the national grid, is an off-grid electrification via solar PV standalone systems
- Assumptions on energy demand per facility type and corresponding installed capacity need:
  - Hospital: 200kWh/day
  - Health centre: 80kWh/day
  - Clinic (Level 2): 40kWh/day
  - Clinic (Level 1): 20kWh/day

[1] Ministry of Health of the Republic of Liberia
[2] With an exception of Maryland county, which is already partly connected cross-border to the grid in Ivory Coast
Source: KOIS analysis

The all-in cost of electrification of all public healthcare facilities via solar PV standalone systems amounts to US$34.7m over 7 years, partly offset by cost savings when compared to diesel generators (c.US$15.7m)

Solar PV investments vs. estimated diesel savings over 7 years
US$m



Transition from diesel to solar PV can yield important cost savings

- Electrification of all 464 public healthcare facilities using solar PV standalone solution would require an investment of US$34.7m (incl. pre-financing of 7 years of O&M)
- Assuming autonomy of 2 days – a central assumption as batteries are the single most expensive component of solar systems
- Estimated amount of initial investment necessary to electrify different-sized healthcare facilities via PV solar standalone systems is based on the following cost assumptions:
  - Hospital: 72 kWp installed capacity → US$289k turnkey cost + US$5.3k annual O&M cost
  - Health centre: 29 kWp installed capacity → US$117k turnkey cost + US$2.7k annual O&M cost
  - Clinic (Level 2): 16 kWp installed capacity → US$61k turnkey cost + US$2k annual O&M cost
  - Clinic (Level 1): 9 kWp installed capacity →US$32k turnkey cost + US$1.5k annual O&M cost
- Hypothetical savings of cost of diesel consumption amount up to US$15.7m, assuming:
  - Diesel consumption is based on all-in cost estimate of US$0.37/kWh
  - Diesel generators CAPEX is omitted – its addition would result in US$1.8m of extra savings
  - Negative externalities linked to diesel usage (e.g. carbon emissions) are not considered

Autonomy of the systems is a key question when calibrating size and assessing cost of PV systems
Size of batteries, representing a significant part of the initial investment, varies based on required autonomy of a system (i.e., currently estimated based on 2-day autonomy). 3-day autonomy would increase the cost by almost US$11m (i.e., total initial cost US$45.5m), whereas reducing it to 0.5 day would halve the total investment (i.e., US$17.7m). The decision about required autonomy should be made with regards to the investment available, access to grid (in Monrovia), as well as to meteorological conditions (i.e., average # of daily sun hours per month).

[1] Liberia Institute of Statistics and Geo-informational Services, 2012 https://www.lisgis.net/pg_img/Health%20Facilities%20by%20County%20and%20District.pdf
https://extranet.who.int/countryplanningcycles/sites/default/files/country_docs/Liberia/ndp_liberia.pdf
Source: Liberia Institute of Statistics and Geo-Information Services , Ministry of Health and Social Welfare, KOIS & Differ analysis

Solar PV standalone systems can be installed as a cost-effective solution to electrify 57% of facilities[1], serving nearly 2.5 million people (86% of catchment population of public facilities), at c.56% of total cost

	Relevant off-grid solution[2]	Rationale for healthcare facility	Market size			Energy solution cost	
			# facilities	*Catchment pop.*	*Capacity need*	*Total cost*	*Per patient avg.*
Hospitals	- Tailored PV standalone system (*i.e., we assume 72 kWp of installed capacity on average*)	- Flexibility to customise the size of the system based on the specific needs and equipment of a hospital	23	381,502	1.4 MWp	US$7.3m	US$19.1
Health centers	- Standard 29 kWp solar PV standalone system	- Economies of scale in procurement, installation and O&M thanks to standardisation	35	464,386	0.9 MWp	US$4.6m	US$9.9
Clinics (Level 2)	- Standard 16 kWp solar PV standalone system	- Economies of scale in procurement, installation and O&M thanks to standardisation	205	1,596,829	2.7 MWp	US$14.7m	US$9.2
Clinics (Level 1)	- Standard 9 kWp solar PV standalone system		201	407,975	1.6 MWp	US$8.1m	US$19.9

[1] Healthcare facilities considered include hospitals, health centres and Level 2 clinics due to their significantly better cost-effectiveness
[2] PV solar is selected as a base case because of its ability to focus specifically on healthcare facilities, though is some distinct cases, the mini-grid model might be more optimal
Source: Liberia Institute of Statistics and Geo-Information Services, KOIS analysis

Content

Liberian off-grid solar market is concentrated on small system providers (mostly SHS), with a limited number of ESPs able to provide larger off-grid systems, therefore an international ESP partner might be necessary

Larger systems[2]
(e.g., standardised/ tailored PV standalone, micro-/mini-grids)

Small systems
(e.g., SHS, solar lanterns & suitcases)

Local companies[1]

International companies with local presence

International company contractors

[1] The list of energy service providers (local and international) active on Liberian market is not comprehensive
[2] Larger installations often come from donations (particularly from the US)
Source: KOIS analysis

A mix of concessional country funding with other financing sources can respond to the US$33.5m financing need of S4H, though several risk mitigation instruments will be necessary to comfort the investors

- **The initial investment outlay can reasonably be provided by the existing energy-financing initiatives currently present in the country:**
  - We have identified 13 initiatives, which invested/committed a total of over US$200m from international donors/development agencies into the energy sector in Liberia (i.e., some of these requiring a public co-investment, to ensure their leverage effect)
    - The expected S4H initial investment of US$33.5m represents 17% of this amount
  - While commercial banks have been reluctant to investment into the renewable energy sector (i.e., notably due to a long time horizon), it might be possible to get a commercial loan from them too if the right securities are in place

- **Additionally, an integrated project finance approach or other national sources of funding can be used in combination with donor/investor financing to solidify the sustainability of future cash flows:**
  - Project-related funding: Repayment of initial investment coming from free cash flows generated from the investment (provided by DFIs, commercial and concessional investors – expecting their respective required rates of return); depending on capacity of consumers to pay, as well as on risk of the project (via debt interest rate)
  - REFUND: A dedicated Rural Electrification Fund (REFUND) to channel proceeds from LEC electricity sales into infrastructure investments *(Cf. Box on the righthand side)*

- **However, some risk mitigation instruments might be necessary to obtain this financing at more favorable terms**
  - A set of guarantees (credit, business risk), insurance (political risk) and hedging (foreign exchange risk) might facilitate the investment negotiations

REFUND

Objective: Provide capital for coordination and sustainable financing of projects and programs for the development of rural and/or RE projects.

Management: Managed by RREA, an independent public entity. and only funding publicly held assets from donors' contributions (subsequently leased to private distribution companies).

Fund revenues: Stable increasing revenues from the Power and Petrol Contribution (PPC) consisting of a small levy (i.e., initially 1%) charged to electricity generators and diesel/gasoline wholesalers. Additionally, REFUND will charge a lease fee to regional distribution companies operating its assets, depending on their electricity tariffs.

Transparency and use of funds: REFUND allows donors to direct their contributions to separate accounts directly linked and only used in specific projects. Operational costs are paid solely from sector generated revenues and not by donor contributions.

Risk mitigation for renewable off-taking: REFUND intends to either create escrow accounts to secure payments or be used as an interface for partial risk guarantee schemes with multilateral organisations.

Source: Rocky Mountain Institute; KOIS analysis

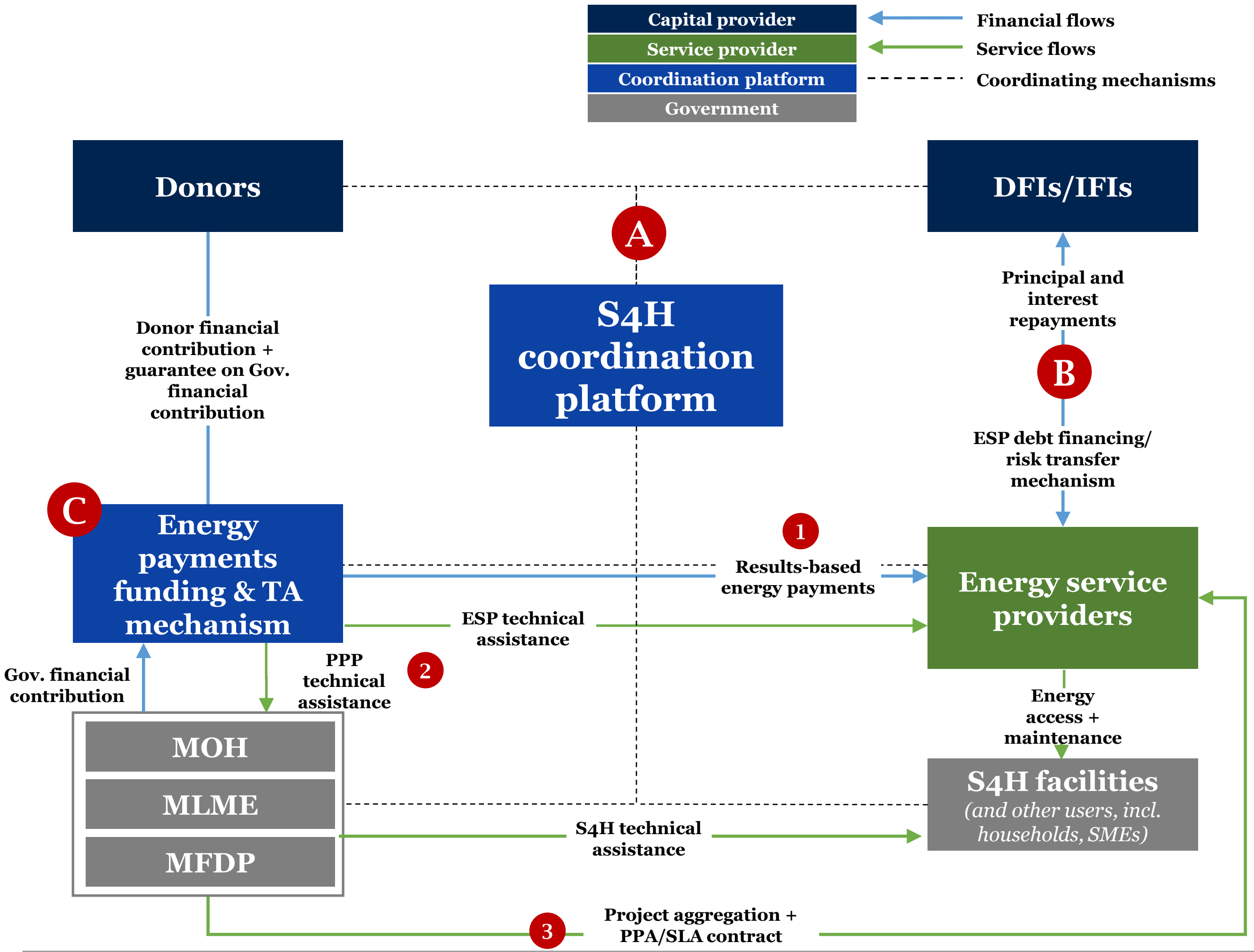
Climate finance facilities focusing on off-grid energy investment in Sub-Saharan Africa may also be relevant to tap into finance S4H in Liberia

Fund	Best fit	Who applies	Financing instruments	Application timeframe	Size of investment
Energy 4 Impact	Improving access to finance for early-stage ESPs	Private sector (ESPs)	Equity, debt, grants, TA, credit guarantees, crowdfunding, prizes, business incubators	Can only apply during rounds of call for proposals, currently closed	Up to US$2m
Nationally Appropriate Mitigation Actions (NAMA) Facility	Strengthening enabling environment and building institutional capacity	Public entity	Grants, concessional loans, guarantees	Call for submissions open from 1 April until 1 September	€5-20m
Sustainable Energy Fund for Africa (SEFA)	Improving access to finance for early-stage ESPs	Private sector	Grants, equity, TA	Rolling basis	US$1-3m
InsuResilience Investment Fund (IIF)	Reducing vulnerability of micro, small and medium enterprises and low-income households to extreme weather events via provision of affordable loans and insurance	Private sector (MFIs, insurance companies)	Equity, debt	Open	US$3-15m

Source: KOIS analysis

Content

A S4H coordination platform allows to take more calculated risks and deploy more capital in the target markets that would not normally be addressed, while dynamising local private sector and earning a return



KEY BUILDING BLOCKS

A S4H coordination platform

– A national coordination mechanism to harmonize stakeholders' interventions (e.g. UN agencies, donors, DFIs/IFIs, private sector and government entities) to electrify health facilities, and combine efforts to achieve efficiency and sustainability, as well as to link energy and health sectors.

B ESP access to finance

– DFIs/IFIs will provide access to affordable financing and risk transfer mechanism for ESPs.

C Energy payments funding & TA mechanism

1 Funding mechanism for PPA leasing payments

– Donor and Gov, financial contributions to support results-based energy payments to ESPs.

– Contingent grants/guarantees provided by donors can additionally transfer Gov. counterparty risk on its share of financial contributions towards energy payments.

2 Capacity-building of ESPs, government stakeholders, and S4H facilities

– Donor-funded technical assistance to strengthen (i) PPP procurement/ tendering, energy assessments, project development, and contractual/regulatory frameworks; and (ii) local ESP market development.

3 Project aggregation and PPA/leasing mechanism

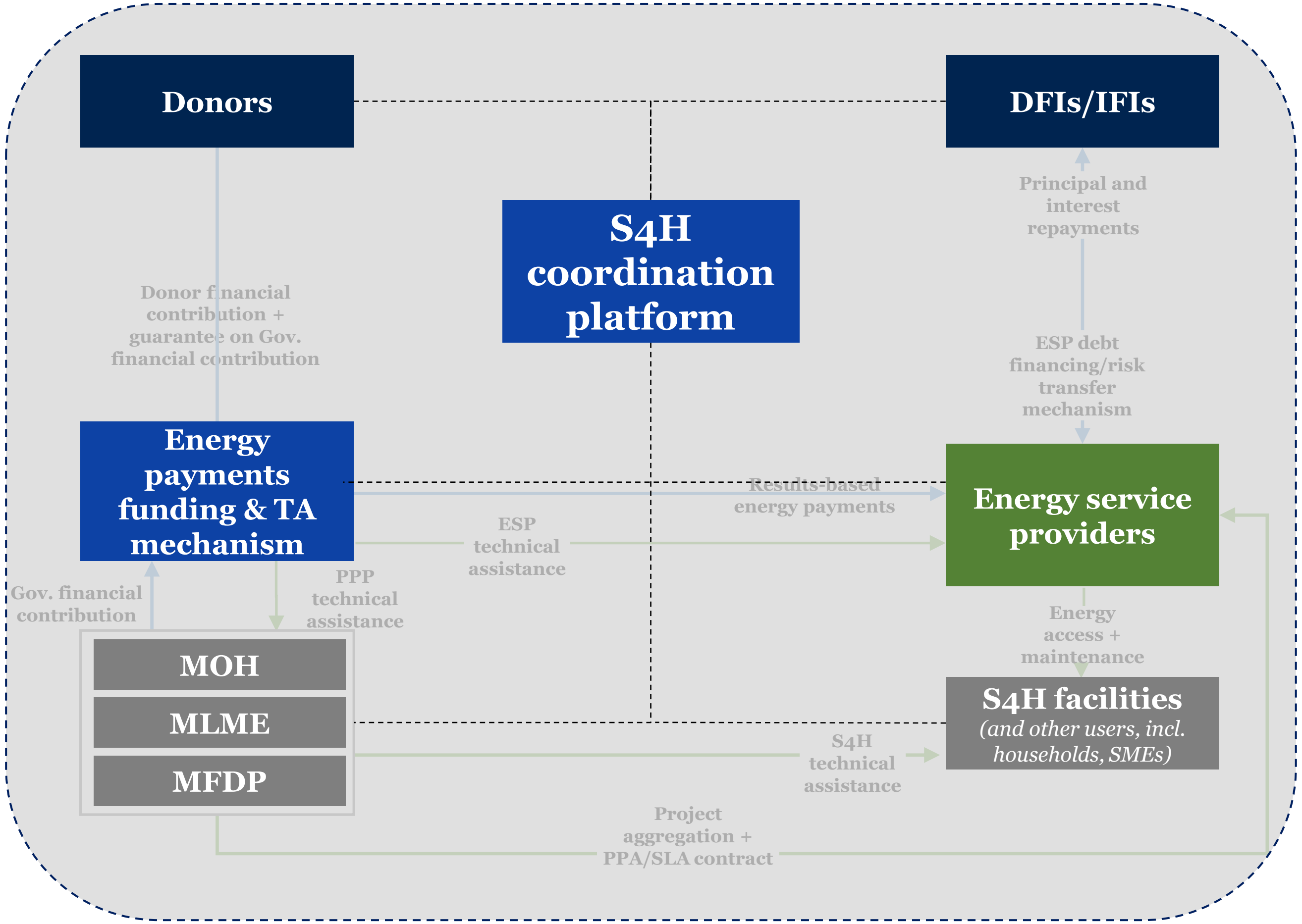
– Pooled procurement/tendering for demand aggregation to develop investable ticket sizes for ESPs and DFIs/IFIs.

– PPA/leasing framework between Gov and local ESPs to ensure: (i) long-term sustainability of energy service; (ii) stable revenue streams for ESPs and market development; and (iii) reduced upfront capital expenditure costs for Gov.

Source: KOIS analysis

The objective of the S4H coordination platform is to facilitate the interactions between the key stakeholders and oversee contractual relationships to align their incentives and activities

Zoom on S4H coordination platform



The S4H coordination platform plays a central role in bringing together all key stakeholders and coordinating their interactions and their contractual relationships.

- Facilitate access to capital for ESPs: the S4H coordination platform will ensure alignment of DFIs/IFIs, requirements with the terms of the PPP contract, facilitating access of ESPs to that capital. The S4H coordination platform also connects the ESPs with relevant DFIs/IFIs
- Support access to donor funding: the S4H coordination platform also mobilise donor funding to support the programme costs including energy payment, TA grants and guarantees
- Coordinate and align the objectives of the different stakeholders: different ministries, development partners and private sectors players need to be involved in the project implementations. The S4H coordination platform will ensure alignment between all the parties and coordinate their roles and responsibilities before and during the project implementation.

Specificities of the Liberian context

- Access to local finance is low, high interest rates
- Liberia is highly indebted to IFIs

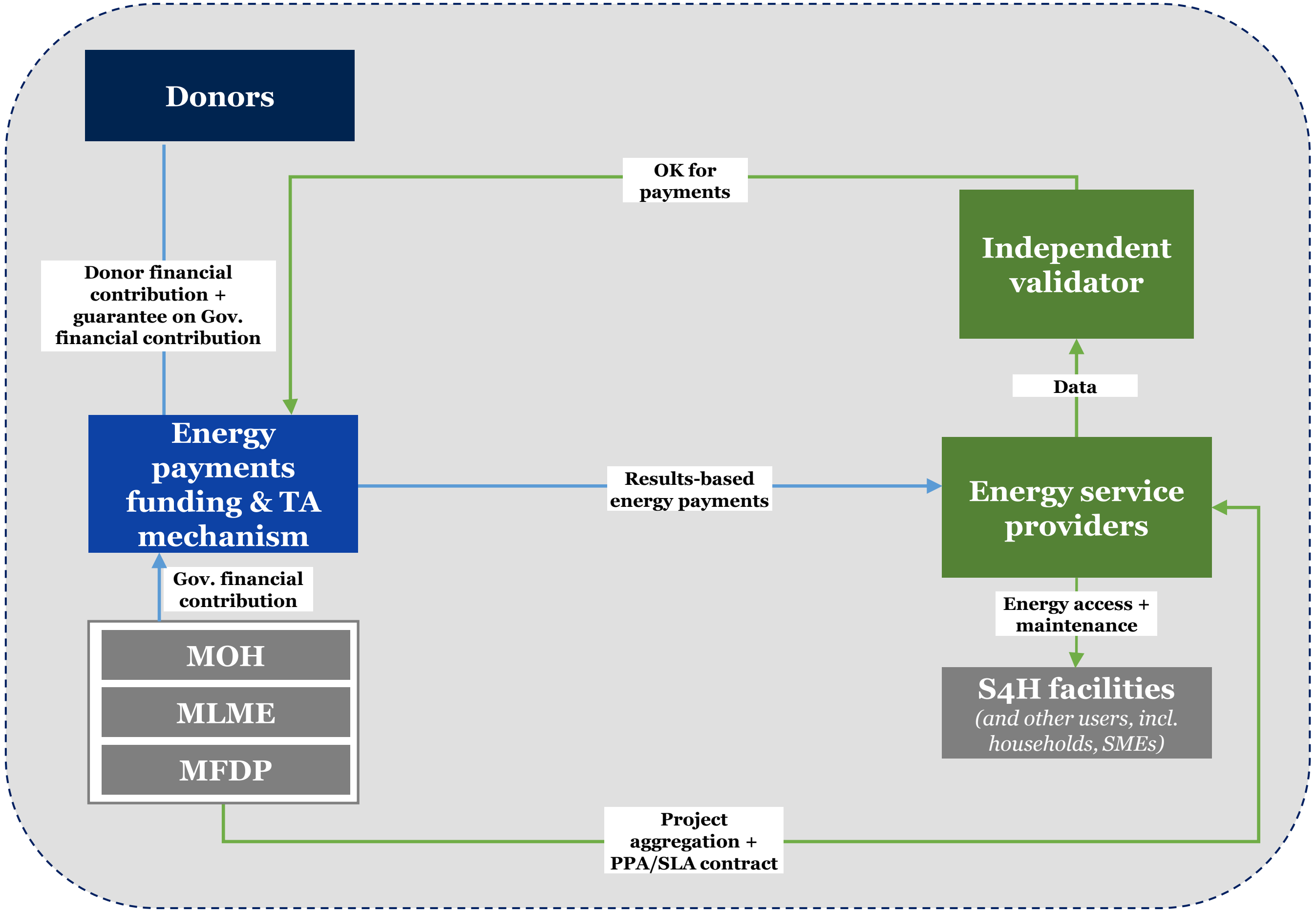
Recommendations for implementation

- Capital to be raised from international DFIs/IFIs
- First-loss/guarantees required might be challenging to obtain (i.e., remainder of the Global Fund grant for pilot round of S4H could be used for this purpose if available)

Source: KOIS analysis

Long term contract between the MOH and the ESP is a key element to ensure sustainability of the solar systems by aligning financial incentives for ongoing O&M

Zoom on PPA leasing payments



Long-term contractual agreements between the MOH and the ESP should contain features **supporting sustainability**:

- Payments spread over the contract duration give the ESP financial incentives to operate and maintain the solar systems
- SLA further sets contractual obligation for up to standard performance and incentivises the use of higher quality hardware
- Result-based payments ensure the ESP is providing an ongoing quality energy service over the full contract duration, an independent evaluator will be appointed to monitor the performance and authorise payments
- At the end of the contract asset ownership could be transferred to the MOH and a new O&M contract tendered out
- ESP is contractually liable for the proper disposal of the hardware

Specificities of the Liberian context

- Very limited number of competent ESPs
- ESPs concentrated in Monrovia

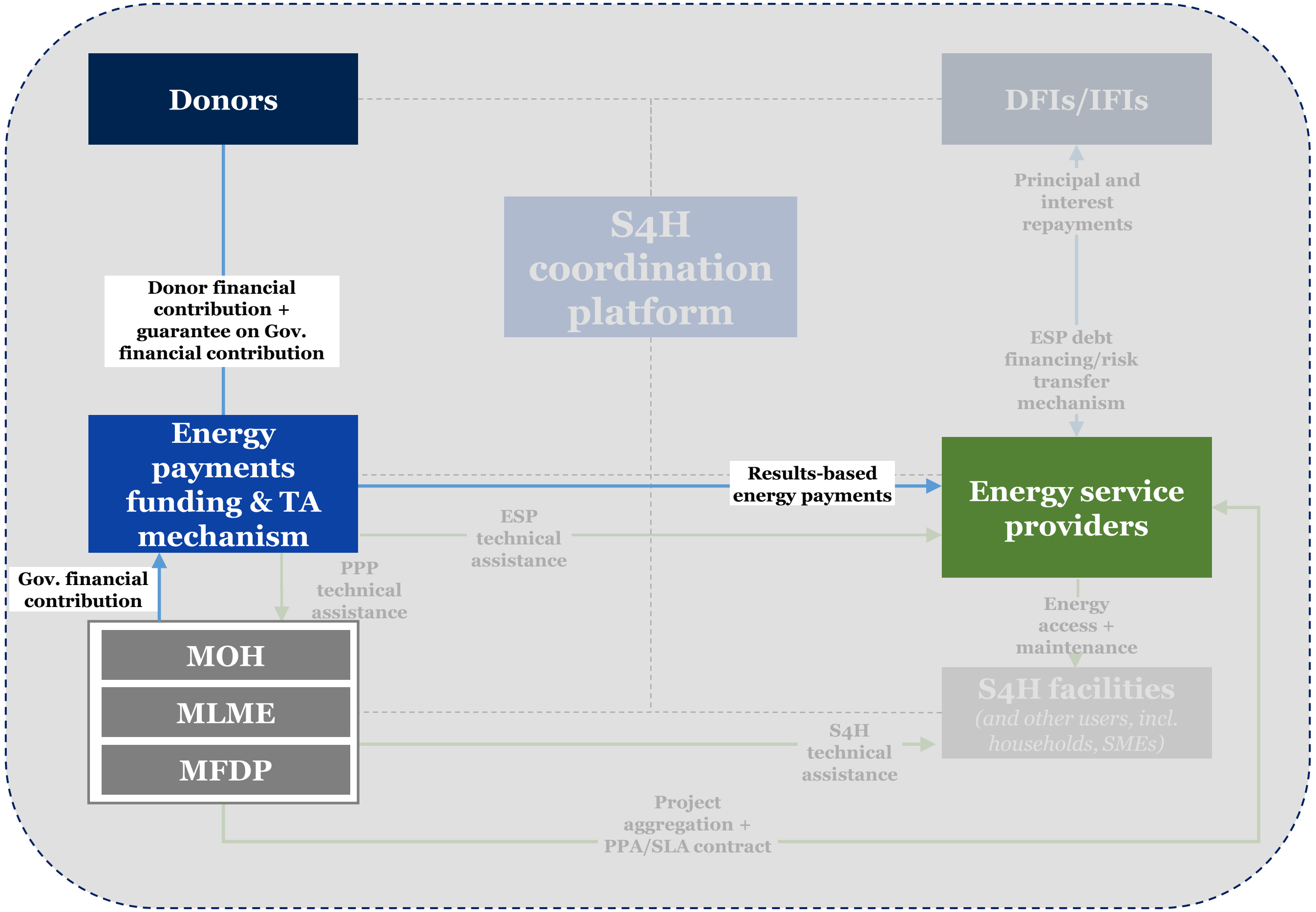
Recommendations for implementation

- MOH will be the off-taker responsible for energy payments under the PPA and shall be supported by donor funding
- Coordination with county representatives to ensure buy-in at local level, consolidation of energy payments at the centralised MOH level and contract management with local support to monitor SLA
- Several regional contracts will be necessary to address the entire market, given smaller size of local ESPs
- Potential need for a consortium with larger international ESP as a partner

Source: KOIS analysis

The energy payments funding addresses the limited ability to pay of the MOH and reduces the repayment risk for the investors

Zoom on energy payments funding



The energy payments funding & TA mechanisms is an **essential component** of the proposed model as it **manages grants for technical assistance** and **supports the low ability to pay of MOH** and largely **mitigates investors' risks** via:

- Transfer of the risk of MOH as a payer (both its credit and political risk components) are transferred to donors, to the extent of their respective contributions to the fund
- Partial FX risk mitigation thanks to the fact that donors' budgets are typically denominated in a hard currency (e.g., USD, EUR) and the investor payments can be matched to their revenue streams to the extent of donors' contribution to the fund
- Buy-in and long-term ownership of MOH is ensured via MOH's (limited) financial participation and the long-term commitments, leading to a better sustainability of the systems beyond the investment period

However, there are **several challenges** that are yet to be addressed

- Long-term donor commitments are complicated as donors typically work with shorter budget periods (i.e., 2-3 years, exceptionally up to 5 years)
- Increased coordination of donors effectively limiting suboptimal funding allocations too donors' priorities
- Capacity and proactivity of MOH is required as it is best positioned to coordinate the donors and align their funding with national health priorities (e.g., selection of health facilities to be electrified)

Specificities of the Liberian context

- Very low ability of MOH to pay
- Most of CAPEX and a majority of OPEX currently funded by bilateral/multilateral donors
- Past cases of misuse of donor funds further increasing the country risk

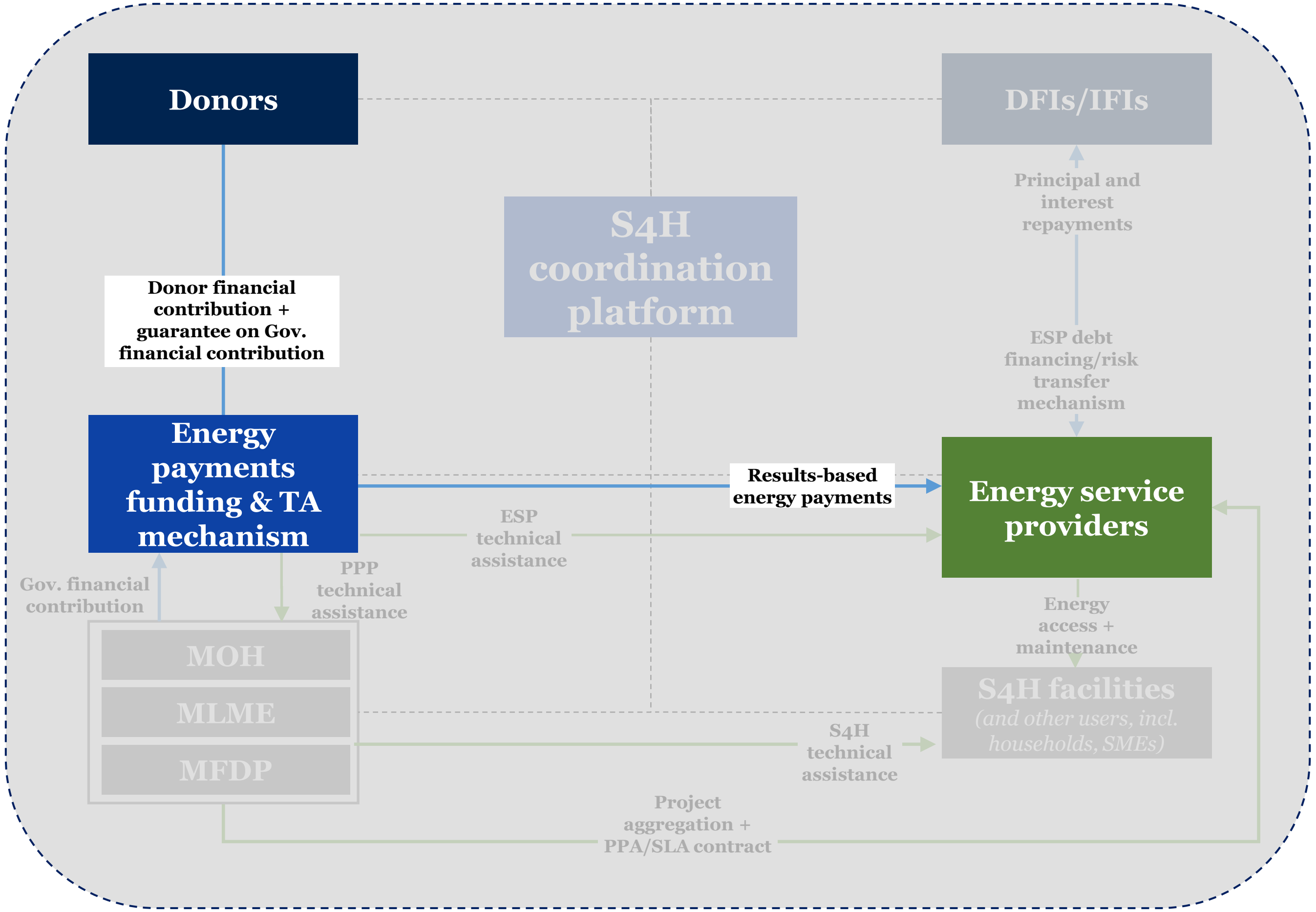
Recommendations for implementation

- Donor funding channeled to MOH should instead be channeled directly to the ESP(s)
- UNDP to support MOH in raising donor support for the programme

Source: KOIS analysis

The credit worthiness of the MOH and the difficulty to secure donor funding for the full length of the investment will make guarantees paramount to provide comfort to DFIs/IFIs in financing S4H contracts

Zoom on guarantees



Guarantees could **support the low credit worthiness** of the MOH and **help bridge the difficulty to secure donor funding** for the full length of the investment at two levels:

- Payment guarantee to backstop energy payment obligation of MOH to the ESPs under the PPA
- Partial loan guarantee to provide credit enhancement to facilitate financing of the ESP at more favourable terms

Specificities of the Liberian context

- Low credit-worthiness
- High level of debt
- No sovereign guarantees available

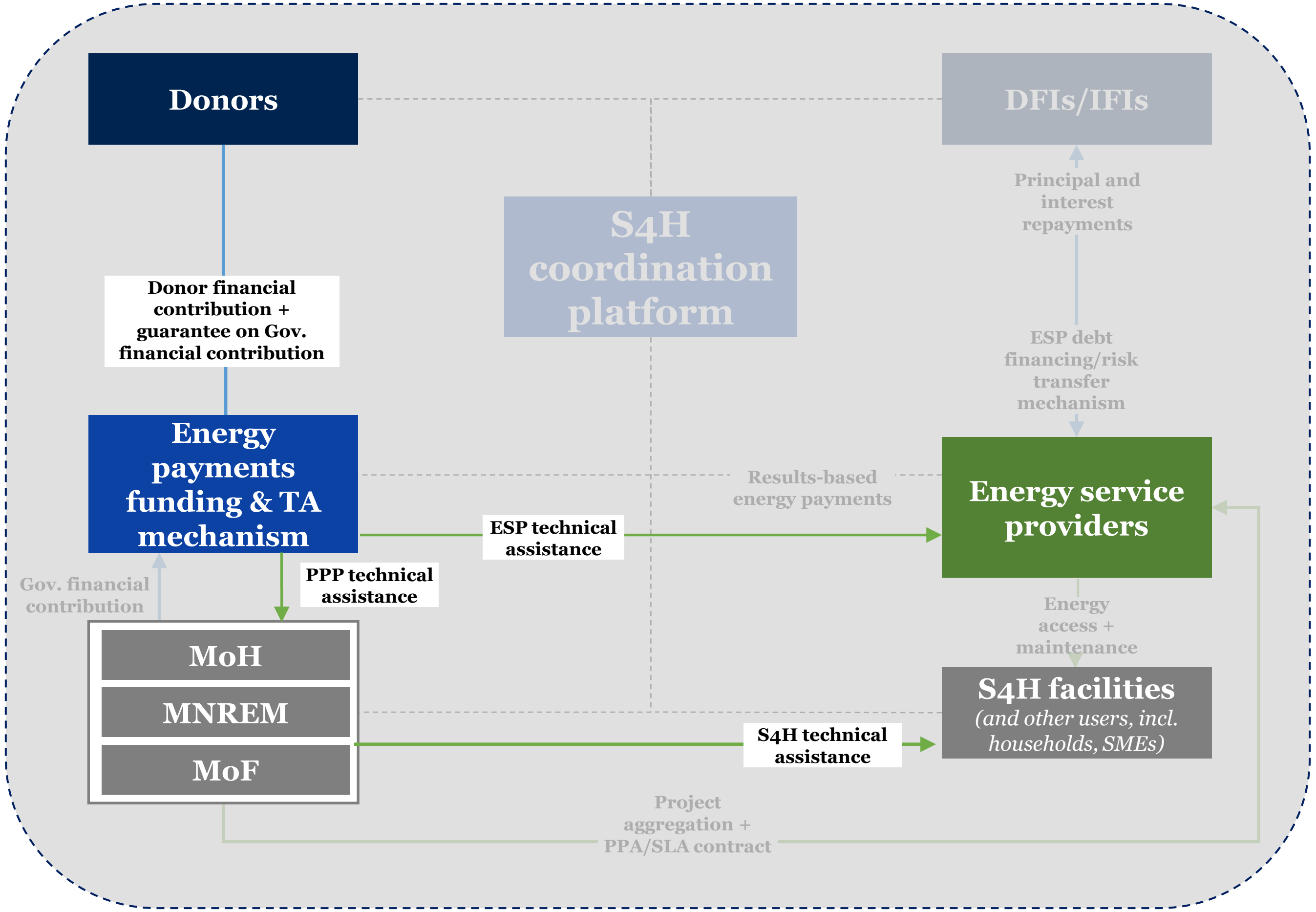
Recommendations for implementation

- Guarantees will be required and cover a high percentage of MOH obligation
- Appetite of guarantee providers will be limited and likely costly but will be necessary

Source: KOIS analysis

The S4H aims to develop local SE market and TA to local ESPs will be required to enable help provide a service up to the UNDP quality standards, as well as to the MOH for successful programme implementation

Zoom on technical assistance



TA will be required to **further enhance long-term sustainability** at two levels:

- TA to the ESPs
  - Project grants of 10% to 30% of investment cost to support project development costs and increases local ESPs competitiveness
  - Capacity building and training for sizing, installation and O&M
- TA to MOH
  - Tender preparatory phase including need assessment, definition of tender terms and quality standard
  - Tender process including drafting of the contractual agreement, evaluation of proposal, support with due diligence
  - Contract negotiation, management and evaluation post tender

Specificities of the Liberian context

- Limited number of competent local ESPs able to install larger PV systems
- Vague regulatory framework of PPP projects (i.e., currently implemented under concession agreement)

Recommendations for implementation

- Insufficient technical and human capacity of local ESPs to bid for large public contracts
- Needed TA to support the Government (i.e., MOH) in the procurement process and contract management

Source: KOIS analysis

Liberia represents a challenging context with respect to the model feasibility due to difficulty in mobilising guarantees and technical assistance that are instrumental for the S4H coordination platform

The S4H coordination platform coordinates contractual relationships to align incentives and activities of key stakeholders

S4H coordination platform brings together all stakeholders and defines their roles and responsibilities. Its role is also to facilitate local ESPs access to DFI/IFI capital

Medium feasibility

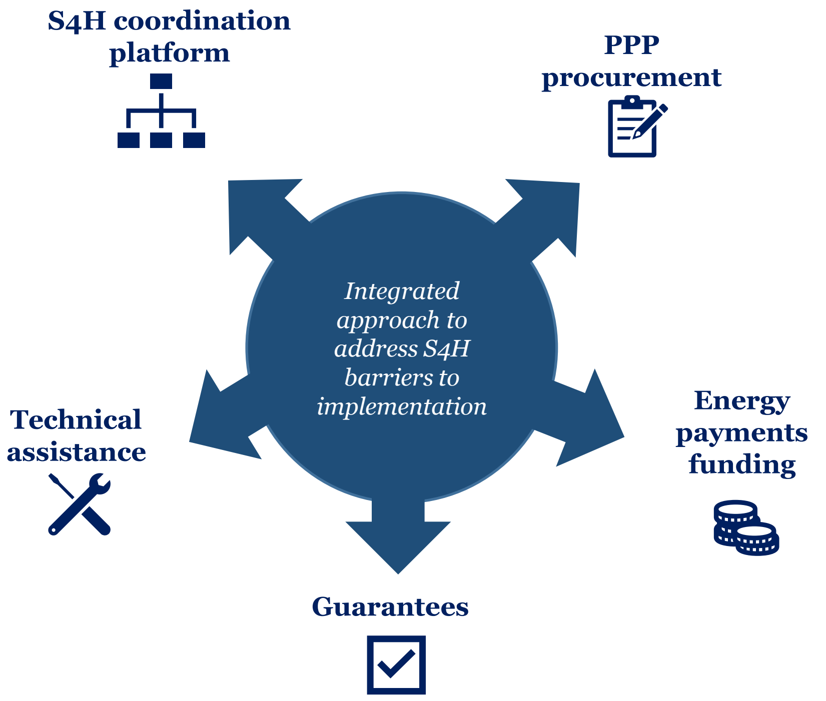
- 464 public healthcare facilities, geographically dispersed across the country and managed at county level, can be coordinated moderately well
- Few competent local ESPs able to absorb and repay capital

Technical assistance to MOH and to the ESP(s) in line with requirements of the platform to support sustainability

Support MOH in the procurement process and alignment with DFI requirements, as well as de-risking the investment by strengthening capacity of the ESP(s).

Low feasibility

- Limited presence of international ESPs able to act as a TA partner for local ESP(s), however, this role is partly ensured by international organisations (e.g., EnDev)
- RREA has good technical knowledge but critically lacks budget to be able to support players in the RE sector
- Bilateral donors are reluctant to work with the GoL (e.g., Norway withdrew funding after several years of disappointing results)



Guarantees over the MOH payment obligation under the PPP, or the loan repayment obligation of the ESP(s)

Mitigate investors' credit risk on public exposure to raise sufficient capital under the S4H coordination platform, provide risk coverage in case of default of the MOH or ESP(s)

Low feasibility

- GoL unable to issue sovereign guarantees due to high debt & low creditworthiness
- Limited interest of institutional donors to provide high amount guarantees

Tender process for S4H PPP contract conducted by the MOH to award it to ESP(s)

Long-term payment commitment of MOH, and ESP's commitment to deliver pre-defined services to a contractual remuneration (used to repay the investors).

Medium feasibility

- Some previous expertise with procurement process of energy PPP contracts (e.g., Mount Coffee Hydro)
- Lack of dedicated PPP regulation, although previously conducted under a concession framework (by MFDP)
- Appetite from local companies but tenders should be of limited size to be accessible to them and support market development

Donors support energy payments funding from MoH to the ESP

The energy payments funding of the facilities in scope shall be covered by both MOH and donors. Due to donors' constrained time horizons, guarantees supporting MOH payment obligation over time might be necessary

Medium feasibility

- GoL has extremely limited financial means to support the energy payments, nevertheless it has appetite to contribute in-kind (e.g., staffing)
- Limited number of donors with the sectorial focus in the country, however, they showed initial interest in S4H

Content

The S4H coordination platform might take approx. 1-1.5 years to launch, following the indicative structuring roadmap, the timeline could be further shortened by running some phases in parallel

1. ECOSYSTEM ANALYSIS
Engage with and interview relevant stakeholders on national level
2-3 months
Deliverable
- Comprehensive ecosystem analysis of S4H in Malawi

2. FUNDING MECHANISM
Obtain funding commitments from the Government of Liberia (i.e., MOH) and donors
2-3 months
Deliverable
- MoU between the MOH, donors and UNDP

3. OPERATIONAL DESIGN
Select specific HC facilities; reach out to potential ESPs
2 months
Deliverable
- Selected portfolio of healthcare facilities with defined energy requirements

4. FINANCIAL MODEL
Quantify the investment size; set initial hypotheses on investment terms
1 month
Deliverable
- Financial model with preliminary investment terms

5. PROCUREMENT
Pre-select and conduct due diligence on local energy service providers
3-6 months
Deliverable
- Formal evaluation of ESPs proposals
- Selection of ESPs for PPP contract

6. FUNDRAISING
Engage with potential investors (i.e., DFIs) and obtain their soft commitments
6-9 months
Deliverables
- Financial model with final investment terms
- Investment LoI signed

7. FIRST CLOSE AND LAUNCH
Finalise contracting and disburse funds for programme implementation
~1.5 years after the beginning of structuring[1]

[1] Timeline assuming sequencing of activities, activities 3 and 4 or 4-5 could partially run in parallel reducing the implementation timeline
Source: KOIS analysis

Procurement process under the S4H coordination platform will require TA to ensure all parties are aligned for a successful financing of the S4H programme

	1 Preparatory phase	2 Call for proposal	3 Proposal submission & evaluation	4 Award of contract and financing	5 Implementation
UNDP Coordination of key stakeholders In collaboration with TA advisors	- Supports national government in drafting the tender, need assessment and technical requirements setting - Aligns requirements of financiers with involved government entities' mandates and strategies - Sets contractual relationship between the different parties	- Supports national government in conducting tender process - Supports ESPs and national government in proposal preparation (Q&A,…)	- Supports national government in evaluation of proposal - Supports/conducts due diligence process - Submits pre-selected bids for financiers' approval	- Coordinates financing agreement between financiers and ESP(s) - Provide TA to ESP(s) in getting financing through the platform	- TA to the national government for legal and financial aspects - TA to ESP(s) throughout implementation
National government MOH/PPCC	- Defines need, quality standards and PPP terms in collaboration with UNDP	- Issues tender for a group of healthcare facilities	- Evaluates and select ESP in collaboration with UNDP/the platform manager	- Awards the contract to selected ESP - Validates internal budget lines for the PPP contract	- Contracts drafting with TA support
Energy service provider(s) Local ESP(s)/joint venture/…	n/a	- Interaction with UNDP/ national government to develop their proposal	- ESPs submit their technical and financial proposal - Provide additional information as needed	- Introduce financing request to financiers/the platform with the support of the facilitating platform/the platform manager	- PPP and financing contract negotiation
Financiers DFI/IFIs	- Provide input on financing terms and requirements (tenor, size, risk mitigants required, …) to UNDP	n/a	- In case of platform, evaluate proposals and conduct financial due diligence - Pre-approve financing of projects (fund, bilateral or club deal)	- Negotiate financing terms with all parties/the platform - Validate financing to selected ESP/the platform	- Financial contract negotiation with ESPs or the fund

Source: KOIS analysis

Operations at country level at inception and during implementation requires clear accountability and distribution of roles and responsibilities among stakeholders

At inception

Contractual

- Procurement process (supervised by UNDP) to select the ESP for a long-term PPA to procure, install and maintain solar systems for a group of healthcare facilities (regional/national)
- PPA contracts are drafted by legal advisors in collaboration with MOH and UNDP

Installation

- ESP is responsible for the procurement, the installation and precise need assessment
- MOH provides contractual guidelines for the quality requirements and standards as well as required service level

Financial

- ESP can get a loan from the DFIs/IFIs at an advantageous interest rate
- ESP is responsible for repayment of the loan
- Leasing payments from the MOH and donors to the ESP are defined in the PPA and paid directly to the ESP, to an escrow account pledged to the lender or go through UNDP

During implementation

Contractual

- PPA between MOH and ESP who shall ensure access to energy for healthcare facilities – an SLA defines the contractual level of service required from the ESP
- MOH is responsible for contract management and coordination through district/regional representatives to verify the systems are working and are operated properly
- Technical assistance can be foreseen to support the MOH in contract management

Operations and maintenance

- ESP is responsible for the sustainability of the systems including regular maintenance, repairs, replacement over the contract period
- ESP through their own teams or network or a subcontractor will be responsible for O&M under the PPA
- ESP is responsible and liable for proper disposal of the hardware
- An independent evaluator monitors the performance to authorise result-based energy payments

Financial

- UNDP supervises energy payments from MOH and manages donor contributions
- MOH and donors make result-based energy payments to the ESP as long as the SLA targets are met
- ESP repays its debt to the DFIs/IFIs (principal + interest)

Source: KOIS analysis

UNDP can leverage its in-house thematic expertise and broad network to play a strong coordinating role to support the launch and oversight of the recommended financing mechanisms[1]

Initial procurement of platform manager/ESP

- Leveraging UNDP's long experience with procurement processes, its geographical presence and ability to compare/assess proposals across countries to ensure a smooth and efficient procurement process as well as a good alignment with the S4H programme objectives

Coordination with donors and DFIs/IFIs

- UNDP coordinates with DFIs/IFIs to ensure alignment to successfully raise capital for S4H
- Building on UNDP's long-term established relationships with bilateral and multilateral donors present in Liberia, as well as MOH in order to set up and coordinate the S4H coordination platform and the energy payments funding throughout the programme lifetime

Advocating national policy change

- Using UNDP's broad thematic knowledge as well as a unique position of an international organisation to (i) aggregate best case practices from different countries, (ii) facilitate exchanges between governments and (iii) promote RE policy change at a national level

Providing technical assistance to local ESPs

- Depending on the technical area, TA can be provided directly by UNDP or outsourced to an external TA provider
- In case of an outsourced TA, UNDP can play a role of procurement manager
- UNDP can connect ESPs and DFIs/IFIs and support them in the funding application process

Programme oversight and impact evaluation

- Benefitting from its geographical presence, UNDP can play a central role in defining the quality standards and their monitoring throughout the financed programme
- UNDP has the flexibility to leverage its in-house expertise or hire an external firm for a broader programme's impact evaluation

Monetising reductions of GHG emissions

- Acting as an intermediary between national governments and emission markets would reduce overall transaction costs, ensure comprehensiveness of the emission reduction efforts and create a new source of funding to the programme and national governments

[1] UNDP activities related costs will most likely be covered by their standard [8%] fee
Source: KOIS analysis

MOH together with UNDP can investigate additional revenue streams to support S4H implementation cost

Potential revenue stream	Opportunities	Challenges	How to mobilise those revenues
Diesel/utility bills reallocation	• Currently the MOH/counties have a budget for energy expenditures that can be reallocated • Solar energy is cost effective compared to diesel in a long run, especially as diesel costs are likely to grow over time	• Long term sustainability is critical to ensure cost-effectiveness compared to diesel • Decentralised management requires alignment at all levels to facilitate reallocation of budgets	• Involvement and buy-in of at local levels
Connecting other users (public facilities, businesses, households)	• In off-grid areas, other users might benefit from a new energy access • Economies of scale can be reaped by connecting other public facilities • Dense areas with commercial clients are likely the best opportunity of business for ESPs	• If a mini-grid is set up with many connections, the complexity and the operational costs are likely to increase • Without substantial grant funding, mini-grid are not commercially viable • For public facilities only, greater coordination will be needed	• Moblise rural electrification grants (in collaboration with MLME) • Analyse potential for bankable anchor client • Mobilise other ministries (such as Ministry of Education or MLME) to support the cost of a network for public facilities
Feed-in tariff	• For grid-connected facilities net metering credit system can decrease the yearly utility bill	• There is currently no feed-in tariff policy	• Create and implement feed-in tariff policy for all grid-connected facilities/users
Carbon credit	• Article 6 of the Paris Agreement introduces a mechanism for transferable emissions reductions (“carbon credits”), so called Internationally Transferred Mitigation Outcomes (ITMOs) • ITMOs/climate finance could potentially cover a good share of the operational cost budget, and insure steady income over time	• Relatively complex procedure, MOH/MFDP might require TA to implement it • Probably non-cumulative with Green Climate Fund funding	• UNDP is in unique position to negotiate ITMO transfers with governments

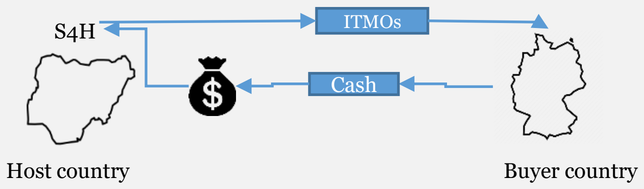
Carbon financing could be a clever way for national government to finance the S4H initiative and UNDP is well placed to support that process

- S4H can both reduce and avoid emissions and UNDP is in a very good position to monetise emission reductions under the Paris agreement, as it can bring a solid project portfolio to the table with S4H, with good environmental and social benefits
- ITMOs could be a "free" contribution to MoH payment obligation under the PPP
  - Host country (HC) government can commit with "funds they did not have"
  - S4H sells ITMOs from HC
  - HC government gets health services in return
  - UNDP manages the programme
- It is possible to get up-front financing for the project – we recommend UNDP to assess the potential for selling carbon and receiving up—front financing support from Korea, Sweden and Switzerland or even the Green Climate Fund could be a source of financing for the scheme
- UNDP portfolio with mix of least developed and low income countries health sector would be an interesting profile for buyers
- ITMOs/climate finance could potentially cover a good share of the operational cost budget, and insure steady income over time
- Assuming 42 ktoCO_2/year reduction could be achieved for the 5 countries, the total income from credits is est. to €1.1m over 7 years, discounted at 10%, using a scenario where 75% of the ITMOs go to UNDP for sale at €10

7 years, 1-year ramp-up, 3 issuances over period, 10% discount	EU/CDM	Article 6 - 75% ITMOs	Article 6 - All ITMOs to UNDP	Korea/CDM
	€0.20	€10	€10	€20
Admin cost	-350,000	-450,000	-450,000	-340,000
CDM std emission factor	-325,252	478,043	787,391	2,134,782
Main scenario	-308,840	1,093,497	1,607,996	3,775,991
Use pool EF	-296,942	1,539,658	2,202,878	4,965755

What is Article6/ITMOs?

- Article 6 of the Paris Agreement introduces a mechanism for transferable emissions reductions ("carbon credits"), so called Internationally Transferred Mitigation Outcomes (ITMOs)
- Article 6/ ITMOs (Paris Agreement) are still in negotiations
  - The new system will involve G2G deals. It is expected to be hard to get signatures from host countries (UNDP has advantage)
  - Still discussions on ambition, baseline approaches, etc.
  - Article 6 emissions reductions projects are in piloting stage (Sweden, Switzerland)
  - Expected deals to be done with governments in the beginning at prices a bit away from zero, with relatively round figures (€5, €10, €15?)



Source: Differ analysis

Following this feasibility study, a number of steps would facilitate the successful launch of the implementation phase

Regulatory framework

- **Introduction of feed-in tariffs**
  - A feed-in tariff would benefit the business case of the S4H programme for on-grid facilities and partly support the insufficient generation capacity in Liberia
- **Regulations and financial incentives for off-grid solutions**
  - Rural electrification is foreseen to be implemented through grid extension which is costly and takes time
  - A change of mentality to shift from a grid-only electrification perspective is needed
  - Grants for new connections created to support mini-grid is one example of potential regulatory and financial support

→ **UNDP CO can lobby feed-in tariffs or connection premiums for off-grid solution and mobilise technical assistance to support regulatory changes**

Government bodies buy-in

- **Preparation of UNDP concept note for GCF funding**
  - MOH to grant authorisation to proceed to the project preparation
  - GoM/MOH to approve the concept note requesting GCF funding for the programme implementation
- **Establish the priorities for the project**
  - Budget allocation of the MOH
  - Selection of facilities within that budget
- **Coordination and alignment of stakeholders**
  - MOH and counties to select the facilities
  - MLME and RREA to align with the electrification plan
  - MFDP/Treasury to ensure budget availability

→ **UNDP CO shall facilitate that process, bring all the parties around the table to ensure a timely decision making**

→ **UNDP to engage with GCF post validation by GoL**

Donors/DFIs mobilisation

- **Mobilisation of local sources of capital**
  - Preliminary discussions with identified potential local financiers (DFIs, banks, pensions funds, other private investors)
  - Identification of investment terms and conditions to align procurement terms
- **Mobilisation of climate finance and monetisation of carbon credit**
  - Investigate the potential for additional climate related revenues of grants
  - Development of procedures to ensure those can be mobilised at implementation

→ **UNDP has expertise in carbon credits and can facilitate that process**

→ **UNDP is well connected and can provide comfort to potential lenders by supporting the S4H programme implementation and fundraising**

Source: KOIS analysis

Indicative budget for implementation

Illustrative costs model
details of assumptions and cost estimates provided separately

Illustration of initial costs

	Indicative costs in US$
Set up costs	
S4H set-up costs	[US$700k]
- S4H platform structuring cost	*[US$500k]*
- Selection of the S4H platform manager	*[US$100k]*
- Energy payments funding mechanism set up cost	*[US$25k] per country*
Technical assistance	
Technical assistance to MOH	[US$3m]
- Procurement, quality standards, legal assistance	*[US$600k] per country*
Technical assistance to energy service providers	[US$500k-1m]
- Training and capacity building (disbursed over ~3 years)	*[US$100-200k] per country*
CAPEX lending portfolio	
Lending portfolio[1]	[US$100m]
- Liberia	*[US$23m]*
- Malawi	[US$21m]
- Namibia	[US$2m]
- Zambia	[US$30m]
- Zimbabwe	[US$24m]

Set up costs

- Costs of setting-up the S4H platform will depend on how UNDP will implement this platform and the potential outsourcing of structuring and fundraising activities
- We assume that the initial set up costs (i.e., structuring of the S4H platform and funding mechanism in different countries, platform manager procurement) and cost of technical assistance will be paid independently by donors, prior to the S4H platform launch

Technical assistance

- Technical assistance will be sized according to the need of each country
  - For the MOH consist of (i) tender preparatory phase including need assessment, definition of tender terms and quality standard and (ii) tender process including drafting of the contractual agreement, evaluation of proposal, support with due diligence, etc.
  - For the ESP contractor consist of (i) project grants of 10% to 30% of investment cost and (ii) capacity building and training for local operator
- Technical assistance will be financed by grants from donors or concessional investors and will likely be disbursed over the first years of the programme

CAPEX lending portfolio

- Lending book will be constituted as PPA contracts are awarded to ESPs. The loan shall cover the hardware cost to the ESP
- Financed by commercial and concessional investor over a period of min. 7 years
- Interest rate depending on the investor mix and portion of concessional capital

[1] Based on high level analysis of each country overall health care facilities energy need, actual numbers will be refined by UNDP in collaboration with the MOH
Source: KOIS analysis

Cash flows after implementation

Illustrative costs model details of assumptions and cost estimates provided separately

Illustration of cash flows after implementation

	Indicative annual cost in US$	
Operating cash flow		
S4H coordination platform administration fee *[0.5%] of assets under management*	[US$500k]	• S4H platform administration fee includes for instance coordination of the involved stakeholders, oversight of the payments, management of the technical assistance • S4H annual energy payments cover to the repayment of the CAPEX as well as operations and maintenance services provided by the ESP and the ESP margin, they are paid directly by the MOH/donors to the ESP on a monthly basis
S4H annual energy payments	[US$28m]	
- Liberia	*[US$6.2m]*	
- Malawi	[US$5.7m]	
- Namibia	[US$630k]	
- Zambia	[US$8.4m]	
- Zimbabwe	[US$6.7m]	
Financing cash flows[1]		
ESP repayment of debt + interest to the lenders	[US$20.5m]	• Annual repayment will depend on the tenor of the loan, interest rate and overall fund operating costs
- Liberia	*[US$4.8m]*	
- Malawi	[US$4.3m]	
- Namibia	[US$435k]	
- Zambia	[US$6.2m]	
- Zimbabwe	[US$4.9m]	
Disposal		
Disposal fee	[US$5.3m]	• Disposal cost is paid at the end of the hardware lifetime
- Liberia	*[US$1.2m]*	
- Malawi	[US$1.1m]	
- Namibia	[US$110k]	
- Zambia	[US$1.6m]	
- Zimbabwe	[US$1.2m]	

[1] Based on high level analysis of each country overall health care facilities energy need, actual numbers will be refined by UNDP in collaboration with the MOH
Source: KOIS analysis

Content

By promoting the use of renewable energy solutions, S4H not only improves healthcare quality via increased energy access, but also reaps other indirect benefits for Liberia

10 REDUCED INEQUALITIES | 5 GENDER EQUALITY | 3 GOOD HEALTH AND WELL-BEING

Improved healthcare quality

Severely affected by the civil wars and more recently by the Ebola crisis in 2014-15, Liberian health system is one of the worst in the world (e.g., maternal mortality ratio of estimated 1,072 per 100,000 live births, ranking 178/186 in the world).

This is to a large extent due to a critically low access to electricity (i.e., ranking 190/195 with ~12%), negatively affecting accessibility and quality of healthcare.

- **Ensuring quality:** S4H will provide health facilities with access to reliable energy, leading to strengthened resilience of the facilities as well as to improved health outcomes, such as reduced mortality and morbidity.

7 AFFORDABLE AND CLEAN ENERGY | 13 CLIMATE ACTION

Environmental benefits

Liberia produced 2.15 MtCO2e[1] in 2017. This contributed towards the increase of respiratory related deaths, which stood at 2,600 in 2016. Diesel generators produce vast amounts of CO_2, substantially reducing air quality, especially in urban areas.

With its low coastal belt and mostly equatorial climate, Liberia is particularly prone to climate change.

- **Reducing carbon emissions:** Adopting solar power reduces reliance on highly polluting diesel generators, improving local environment near health facilities.
- **Increasing resilience to climate change:** Renewable energy can increase resilience to climate change challenges, such as heavy rain and rising sea level.

8 DECENT WORK AND ECONOMIC GROWTH | 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

Development of local SE market

While FDI in Liberia has been relatively high in recent years, standing at US$122.2m or 3.96% of GDP (vs. 1.9% in Sub-Saharan Africa) in 2018, most of the investments flow in the traditional sectors, such as forestry or extractives.

Very few (~10-15) competent local private off-grid energy companies currently operate in the market

- **Stimulating local economy:** S4H can help catalyse FDI inflows, contributing towards development of energy sector, as well as create additional green jobs, especially for rural populations.
  - **SE sector capacity-building:** S4H can help increase technical capacity of local ESPs, contributing towards further market transformation and uptake of solar technologies.

[1] Metric ton of carbon dioxide equivalent is a measurement unit to compare the emissions from different greenhouse gases

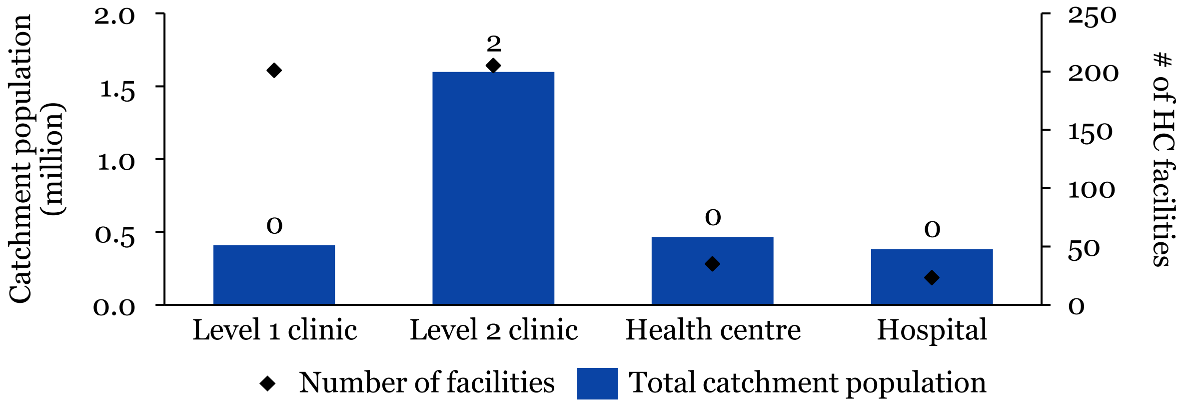
http://www.newnarratives.org/featured/liberians-health-generators-cars-posing-dangers-residents/ | https://apps.who.int/iris/bitstream/handle/10665/136911/ccsbrief_lbr_en.pdf;jsessionid=D5B37CDC448407715426BD45296E73B2?sequence=1 | http://liberianconsulatega.com/wp-content/uploads/2017/07/PAPD-Pro-Poor-Agenda-for-Prosperity-and-Development.pdf

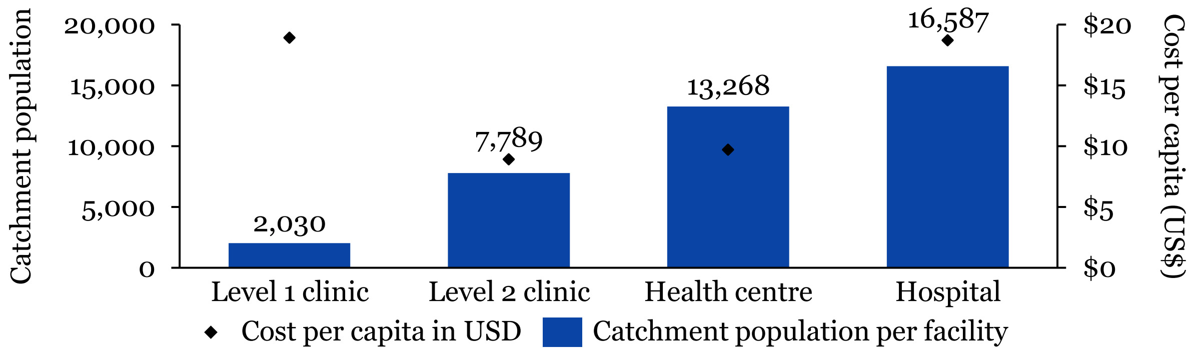
https://data.worldbank.org/indicator/SH.STA.MMRT?locations=FI-VE&year_high_desc=false

Source: New Narratives; WHO Liberia, Government of Liberia; UNDP Solar for Health Strategy Overview; KOIS analysis

S4H has the potential to increase the healthcare quality for more than 2.8 million people close to a facility not connected to the national grid

- By electrifying all public healthcare facilities (i.e., big majority off-grid), more than 2.8 million people will get access to better healthcare quality especially in poorest rural areas
- Prioritising off-grid clinics will reach the most people that today lack healthcare services with grid power
- Additionally, the bigger off-grid facilities (i.e., health centres and Level 2 clinics) exhibit the lowest cost per capita, therefore offering the best value-for-money
- It can be considered that electrifying remote rural clinics will have a stronger impact on the level of care than in larger on-grid facilities having alternative power supply
- There could be a trade-off between the number of patients that can benefit from the programme and the marginal difference of healthcare quality a patient can benefit from, depending on the budget and the type of facilities selected

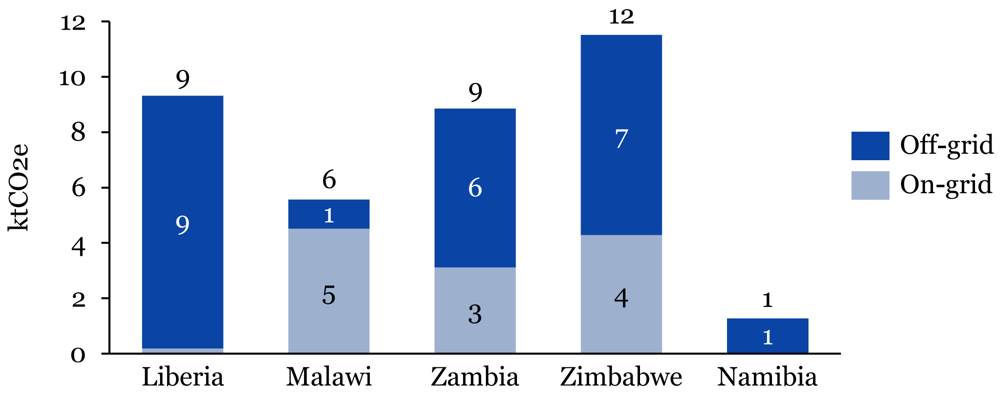




Source: KOIS analysis

Assuming solar solutions are installed at all facilities, S4H could achieve a reduction of 42 ktCO_2e/year for the five countries together and about 9.3 ktCO_2/year in Liberia

Annual emissions reductions per country

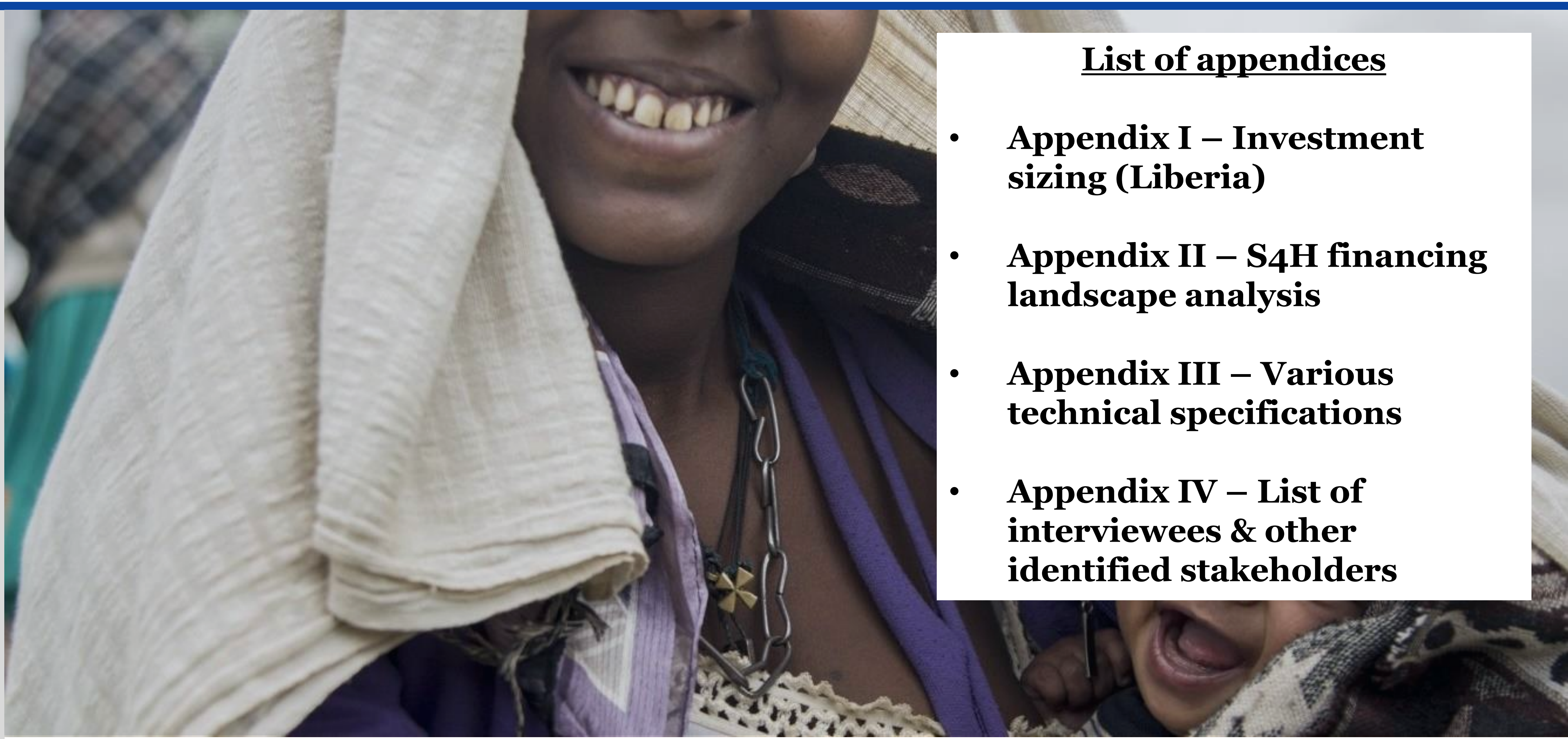


Annual emissions reductions in Liberia

Liberia	Total	Clinic (Level 1)	Clinic (Level 2)	Health centres	Hospital
Diesel efficiency	**21%**	15%	20%	20%	30%
Diesel MWh	**6,826**	1,467	2,993	1,022	1,343
Grid MWh	**336**				336
tCO_2/year	**9,321**	2,605	3,981	1,359	1,379

- Due to quasi-absence of grid, majority of CO_2 emissions of healthcare facilities in Liberia are coming from diesel power supply
  - CO_2 emissions reductions from diesel is found by the standard emission factor of 0.8kgCO_2e/kWh for small diesel networks
- Level 2 clinics, representing the highest number of healthcare facilities, have the highest potential for CO_2 reduction
- Solar PV is an environmentally friendly technology with zero emissions and as such, installation of solar PV completely removes CO_2 emissions from power production at the healthcare facilities

Source: Differ analysis



List of appendices

- Appendix I – Investment sizing (Liberia)
- Appendix II – S4H financing landscape analysis
- Appendix III – Various technical specifications
- Appendix IV – List of interviewees & other identified stakeholders

Appendix I – Investment sizing (Liberia)

Investment sizing (1/2)

Assumptions

0. Only **public** HC facilities are covered
1. Manual division of on and off-grid
2. All off-grid facilities (regardless of their current access) will pass to solar standalone as a main source, backed up by diesel generators.
3. Energy capacity needs as listed below.

Liberia settings			
Bad days/year	48	*Period (years)*	7
Built-in autonomy	25%	*Discount rate (% p.a.)*	10%
Diesel cost/kwh	0.33	*Diesel budget shortfall*	0%
Diesel cost/kwh incl. O&M	0.37	*Reserve for back-up*	0%
Grid cost	0.35	*Annualisation factor*	5.36
Sun hours per day	4.00	*Power source for autonomy*	PV

Number of healthcare facilities by type					
Size	1	2	3	4	Total
County	*Clinic (Level 1)*	*Clinic (Level 2)*	*HC*	*Hospital*	*Per county*
TOTAL	201	205	35	23	464
Programme coverage by facility type					
%	100%	100%	100%	100%	
# installations covered	**201**	**205**	**35**	**23**	**464**

Total power capacity necessary (kW)					
Size	1	2	3	4	Total
County	*Clinic (Level 1)*	*Clinic (Level 2)*	*HC*	*Hospital*	**need (kW)**
Total power capacity necessary (MWp)	1.62	2.73	0.89	1.44	**6.68**
Corresponding annual energy need (GWh)	1.47	2.99	1.02	1.68	**7.16**
Percentage	24.31%	40.81%	13.35%	21.53%	100.00%
Capacity covered by S4H (MWp)	1.6235	2.7251	0.8913	1.4375	**6.68**
Corresponding annual energy S4H (GWh)	1.4673	2.9930	1.0220	1.6790	**7.16**

	Total hardware (CAPEX) cost	23,192,768

Need by HC facility type	Liberia			
	1	2	3	4
	Clinic (Level 1)	Clinic (Level 2)	HC	Hospital
Required autonomy (days)	2.00	2.00	2.00	2.00
Days to fully charge	2.00	2.00	2.00	2.00
% of equipment included in autonomy	0.80	0.70	0.50	0.50
Daily consumption (kWh)	20.00	40.00	80.00	200.00
Installed capacity for daily load (kW)	5.0	10.0	20.0	50.0
Extra capacity for autonomy (kW)	3.5	6.1	8.8	21.9
Installed capacity need (kW)	8.5	16.1	28.8	71.9
Margin on equipment	20%	20%	20%	20%

Cost components				
Base kit	$4,550	$8,200	$15,500	$37,400
Battery	$18,000	$36,000	$72,000	$180,000
Extra panels	$1,943	$3,399	$4,856	$12,141
Total hardware cost	$24,493	$47,599	$92,356	$229,541
Margin on equipment	$4,899	$9,520	$18,471	$45,908
Design	$1,500	$2,000	$3,000	$6,000
Install	$1,000	$1,600	$2,800	$6,400
Ship	$375	$500	$750	$1,500

Cost budgeting				
Initial investment outlay ($)	$ **32,266**	$ **61,219**	$ **117,378**	$ **289,349**
Annual O&M cost ($)	$ 1,510	$ 1,968	$ 2,725	$ 5,313
Hypothetical initial cost of genset	$ 1,875	$ 3,750	$ 7,500	$ 18,750
Hypothetical annual diesel cost ($)	$ 3,932	$ 5,471	$ 10,942	$ 27,356
Hypothetical annual grid cost ($)	$ 2,555	$ 5,110	$ 10,220	$ 25,550

Cost splits (autonomy)				
PV cost	$ 11,035	$ 19,340	$ 35,950	$ 85,780
Extra autonomy cost	$ 21,231	$ 41,879	$ 81,428	$ 203,569
2 day battery autonomy system	$ 32,266	$ 61,219	$ 117,378	$ 289,349
0.25 day autonomy system + diesel	$ 15,788	$ 28,846	$ 54,962	$ 133,310
0.25 day autonomy system + grid	$ 11,035	$ 24,716	$ 46,702	$ 112,660

Source: Differ and KOIS analysis

Investment sizing (2/2)

TOTAL COST pure PV autonomy (not mixed with grid/diesel backup)					
	Clinic (Level 1)	Clinic (Level 2)	HC	Hospital	TOTAL
Initial inv.	$ 6,485,466	$ 12,549,946	$ 4,108,213	$ 6,655,021	$ 29,798,646
Annual O&M (pre-markup)	$ 202,340	$ 268,892	$ 63,583	$ 81,458	$ 616,273
Annual O&M	$ 303,510	$ 403,338	$ 95,375	$ 122,188	$ 924,410
PV	$ 2,218,035	$ 3,964,700	$ 1,258,250	$ 1,972,940	$ 9,413,925
Battery	$ 4,267,431	$ 8,585,246	$ 2,849,963	$ 4,682,081	$ 20,384,721
kW	1624	2725	891	1438	6677
%	20.49%	41.79%	14.27%	23.45%	100.00%

Chosen autonomy mix					
	Clinic (Level 1)	Clinic (Level 2)	HC	Hospital	TOTAL
PV	100%	100%	100%	100%	**100%**
Diesel	0%	0%	0%	0%	**0%**
Grid	0%	0%	0%	0%	**0%**

Total cost (present value of inv &					
	Clinic (Level 1)	Clinic (Level 2)	HC	Hospital	TOTAL
Catchment population	$ 407,975	$ 1,596,829	$ 464,386	$ 381,502	$ 2,850,692
Total hardware cost	$ 4,922,993	$ 9,757,872	$ 3,232,469	$ 5,279,434	$ 23,192,768
Turnkey cost	$ 6,485,466	$ 12,549,946	$ 4,108,213	$ 6,655,021	$ 29,798,646
O&M cost	$ 303,510	$ 403,338	$ 95,375	$ 122,188	$ 924,410
Total outflows	$ 6,788,976	$ 12,953,284	$ 4,203,588	$ 6,777,209	$ 30,723,056
PV of total commitment	$ 8,110,841	$ 14,709,924	$ 4,618,970	$ 7,309,367	**34,749,103**
Total commitment	$ 8,610,036	$ 15,373,309	$ 4,775,838	$ 7,510,334	36,269,516
%	23.34%	42.33%	13.29%	21.03%	
Cost/capita	$ 19.88	$ 9.21	$ 9.95	$ 19.16	

Savings of diesel/grid costs (est., ignoring autonomy)	Clinic (Level 1)	Clinic (Level 2)	HC	Hospital	TOTAL
Initial cost of gensets	$ 376,875	$ 768,750	$ 262,500	$ 431,250	$ 1,839,375
Annual diesel savings (est.)	$ 790,406	$ 1,121,580	$ 382,978	$ 629,179	$ 2,924,143
PV of Annual diesel savings	$ 4,232,830	$ 6,006,352	$ 2,050,950	$ 3,369,417	$ 15,659,549
Annual grid savings (est.)	$ -	$ -	$ 17,885	$ 117,530	$ 135,415
PV of Annual grid savings	$ -	$ -	$ 95,779	$ 629,404	$ 725,183

Initial cost of basic PV system	$ 2,218,035	$ 3,964,700	$ 1,258,250	$ 1,972,940	$ 9,413,925.00
Initial cost of autonomy	$ 4,267,431	$ 8,585,246	$ 2,849,963	$ 4,682,081	$ 20,384,721.00

Source: Differ and KOIS analysis

UN DP DIFFER KOIS CARING FINANCE

Appendix II – S4H financing landscape analysis

Lack of energy supply and access is a major issue for healthcare quality in Sub-Saharan Africa, solar energy could be a sustainable solution

Inadequate access to power is a major obstacle to quality healthcare in Sub-Saharan Africa (SSA)

Most health facilities in SSA have inadequate access to power

- 25% of health facilities in sub-Saharan Africa have no access to electricity
- Only 28% of health facilities and 34% of hospitals have "reliable" access to electricity
- Off-grid facilities often rely on stand-alone powered generators, most of which are not functional

This is a critical obstacle to the realisation of universal access to quality healthcare

- Unreliable power affects lighting for emergency night-time care (e.g. births), refrigeration (e.g. vaccines), use of medical technology (e.g. sterilisation) and communication (e.g. contacting emergency care personnel)
- Facilities that have access to electricity may be better positioned to attract and retain skilled health workers, especially in rural areas
- High cost of power (e.g. diesel for generators) weigh on constrained health budgets

Solar energy could be a solution, but barriers exist

Solar energy could provide a reliable power supply in remote areas or a backup for grid-connected facilities

- Price of solar panels have significantly decreased in the past decade
- SSA has ideal solar conditions
- Although a larger initial investment is necessary compared to other solutions (e.g. diesel generator), it is a cost effective

But there are several barriers to electrifying health facilities

- Weak enabling environments due to:
  - lack of policies, regulation and technical standards
  - lack of awareness and information
  - underestimation of the potential impact of electricity access on healthcare
  - underdeveloped local energy sector and infrastructure
- Premature fail of solar installation due to:
  - insufficient human capacity resulting in inadequate management and maintenance of the power system
  - lack of data resulting in poor system sizing and poor installation
- Insufficient investment capital and financial means due to:
  - lack of monetisation of environmental and healthcare benefits
  - high upfront capital needed

WHO, Modern Energy Access and Health, 2017
WHO, Access to Modern Energy Services for Health Facilities in Resource-Constrained Settings, 2015

UNDP Solar for Health (S4H) has been piloting a donor-funded initiative to install solar systems in health centres in rural areas to provide clean energy services and quality healthcare to underserved communities

Key features

Solar for Health programme was launched in 2016

- 7.7 MWp of installed capacity in Zimbabwe, Zambia, Libya, Namibia, Sudan and South Sudan
- Financed by donors including the Global Fund and Innovation Norway

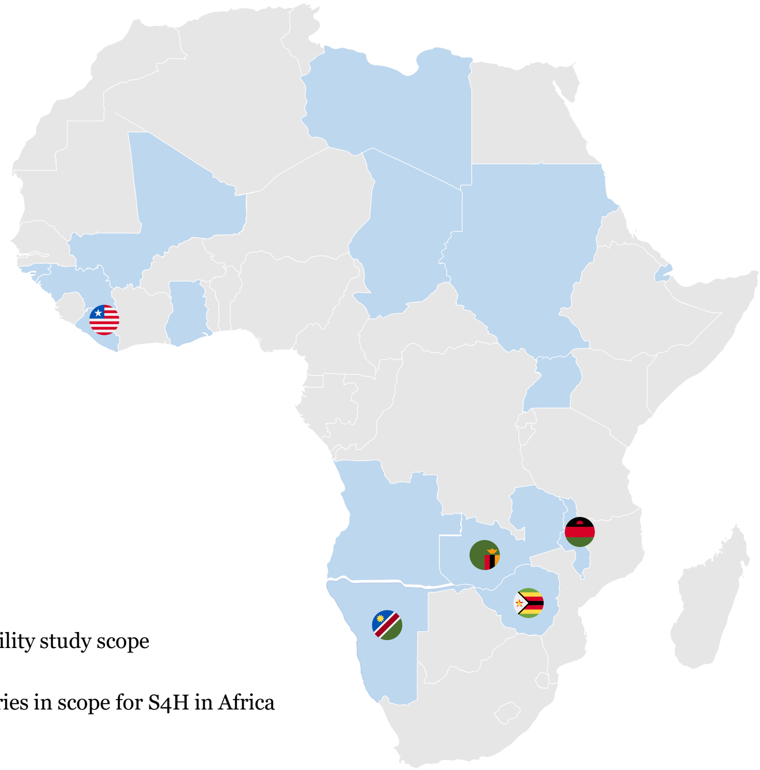
6 objectives contributing to multiple SDGs

1. Access to quality health services for all
2. Reduced environmental footprint of the healthcare sector
3. Cost savings on energy bills for health facilities and local government
4. Climate resilient health systems
5. Local green jobs, training of solar technicians and regulatory capacity development
6. Proof of concept for solar energy in healthcare and beyond

Facilities in scope

Rural health centre/clinic	Urban health centre/hospital	Warehouse
Problem: Off-grid centres using polluting and costly diesel generators or without any energy source **Solution:** complete power solution for lighting, medical equipment, drug preservation and electricity for staff housing. Energy need range from 10 kWh/day **Impact:** improved quality and access to health care for the most underserved communities	**Problem**: Non reliable energy supply due to frequent power cuts **Solution:** steady power supply reducing energy costs and securing key services such as surgery, maternal, ER, pharmacy and lab at all times in case of power cuts. Energy need range 50-500 kWh/day **Impact:** a greater healthcare quality for a large number of patient	**Problem**: Suboptimal drug preservation and stock management **Solution:** steady power supply for supply chain preservation (cold chain) and IT system for stock management **Impact:** better drug efficiency and better stock management

Solar for Health is targeting least developed countries



Feasibility study scope

Countries in scope for S4H in Africa

“Solar for Health Call for Private sector support,” UNDP (2017)
“Solar for Health 5 ways solar power can make universal healthcare a reality,” UNDP (2018)
Source: UNDP; KOIS analysis

S4H programme made substantial achievements, nevertheless challenges remain to reach its ambitions

Achievements and scale up

Achievements

- 7.7 MWp of installed capacity in 8+ countries
- Providing power to more than 650 health facilities and the biggest medical warehouse in Zambia (300 kWh/day)
- Plug and play, 5-15 kWp solar PV units installed, meeting all power needs of small healthcare facilities and approx. 30% for a hospital

Path to scale up

- UNDP creates the governance, harmonisation, capacity development and sustainability conditions necessary
- UNDP provides a standardised S4H equipment list and first health sector specific solar energy pre-qualified suppliers
- In collaboration with local ministries of health, UNDP identifies the health centres and facilities in scope
- UNDP builds local technical capacities and enables market transformation by partnering with local and national providers

Risks and challenges

Governance and regulation

- Insufficient regulatory framework prevents investments and long term contracts
- Political and economic stability is needed to secure long term funding for the solar installation
- High number of stakeholders involved with different objectives can block the expansion of the programme
- No clearly identified counterpart under a potential public-private agreement

Financial and economic

- UNDP estimates that US$690m is needed to equip the 18,000 healthcare facilities in scope of S4H
- Perceived risk and relatively high upfront costs hampers the scale-up of the programme
- Recurrent maintenance and replacement costs have to be born in the long term (e.g., by healthcare facilities or government or donors)

Operational

- Maintenance and monitoring of panel breakdowns and tampering is crucial as PV systems often become inoperative after 3–5 years without proper maintenance and repair.
  - Need for local buy in and long term commitment to maintain the installations
  - Need for human capital development and local technical knowledge
- Theft of solar panels requires security and surveillance of the solar installation
- Disposal of batteries (5- to 15-year lifetime) and panels (25- to 30-year lifetime) has to be addressed

UNDP, Solar for Health 5 ways solar power can make universal healthcare a reality, 2018

Scaling up off-grid solar energy solutions for healthcare will require both increasing demand-side potential and supply-side project bankability

Demand-side potential	Supply-side project bankability
Off-grid energy need (# facilities/total kWp)	**Policy and regulatory environment**
Affordability/ability to pay	**Market attractiveness:** - *Market size* - *Density of population/economic activity:* population demographics (i.e., population, poverty rates, mobile phone penetration, household incomes, etc.); social and productive uses (i.e., education, health, agriculture, mines, SMEs, public institutions, etc.) - *Distance from the national grid/infrastructure*
Availability of relevant options	
Acceptability of energy solution: adequate capacity and duration of energy; electricity quality; sustainability	**Access to capital**

https://www.energyaccessexplorer.org/methodology/
Source: KOIS analysis

A number of solar solutions can address the energy needs of a healthcare facility and their appropriateness shall be assessed in line with the specificities of each facility

	Solar lighting kits	Solar suitcase	Off-grid stand-alone or hybrid system	Mini-grid (stand-alone or hybrid)	On-grid
Description	• A solar lighting kit uses a solar panel to power a single or several bulbs.	• Portable and self-contained solar power generation and lighting system	• Off-grid electricity system providing power to one customer	• Off-grid electricity distribution network serving limited number of customers	• Solar installation connected in combination with power grid
Power capacity	• Max. 10 Wp	• Max. 80 Wp	• From 5 kWp to 1 MWp	• From 10 kWp to 10 MWp	• Above 1 MWp
Application in health facilities	• Provides lighting in the health centre	• Provides lighting in the health centre • Possibility to charge small devices (phone, tablet)	• All power uses if sized correctly • Possibility to charge devices • Emergency power	• All power uses if sized correctly • Possibility to charge devices • Emergency power	• All power uses • Reliable supply of energy with hybrid solutions • Emergency power
Advantages	• Portability • Easiness of installation • Low cost	• Portability • Easiness of installation • Low cost	• High energy levels provided • Good storage levels • Complete solution • Allows empowerment and self-sufficiency • Possibility of revenues from on-sell of power to local community	• High energy levels provided • Good storage levels • Complete solution • Allows empowerment and self-sufficiency • Possibility of revenues from on-sell of power to local community (anchor model)	• Very high energy levels provided • With or without storage • Possibility of revenues from feed-in tariffs
Disadvantages	• Extremely low energy levels provided • Low to zero storage levels • Very limited needs are met • Not a long-term sustainable solution	• Low energy levels provided • Low to storage levels • Limited needs are met • Not a long-term sustainable solution	• Requires professional installation • High investment costs (depending on size installed) • Higher need for local maintenance	• Requires professional installation • High investment costs (depending on size installed) • Higher need for local maintenance • Depends on the rest of the community • Needs high density of users • Increased complexity	• Requires professional installation • Technical integration required • Structured O&M required • Needs very high density of users

IRENA, Solar PV In Africa: Costs and Markets, IRENA Report, 2015

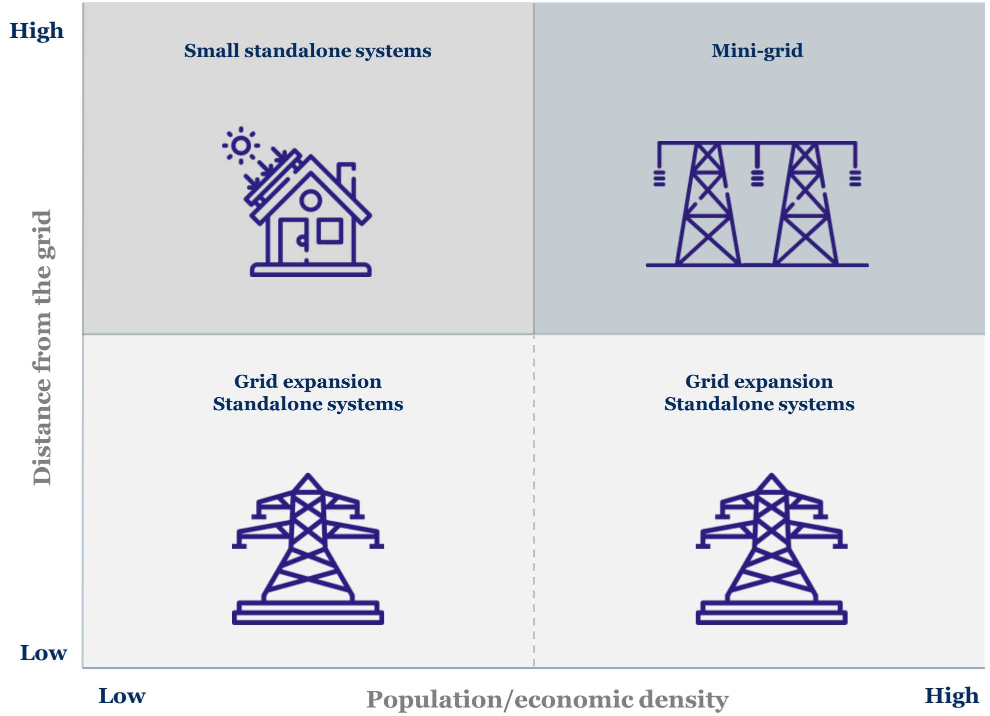
There are three main business models when it comes to solar energy service providers

	Purchase	Financial or operational lease	Fee-for-service
Adequate operational model	• Solar appliances	• Off-grid stand-alone • Solar appliances • Power plant	• Off-grid stand-alone • Mini/Micro-grid • On-grid
Adequate market	• Low energy needs • Very remote areas where providers have low incentive to invest	• Average to high energy needs • Low density settings where providers have no incentive to invest in the installation	• Higher energy need • Higher density of users
Advantages	For the user: • Ownership • Lower overall cost in the long term For the provider: • Risks and responsibilities are transferred to the user • No upfront investment required	For the user: • Low upfront cost • Ownership transferred at the end of the leasing period for financing leases • Maintenance and after sale is provided For the provider: • Contractual payback period for the user	For the user: • Lowest cost for users • Maintenance and after sale is provided For the provider: • Retains ownership of the installation • Can grow the capacity and connect new users (economies of scale)
Challenges	For the user: • Not affordable for larger installation • Provider has no incentive for proper maintenance/after-sale service • Potential poor quality or counterfeit products	For the provider: • Repayment risk although usually mitigated by contractual obligation for the user • For larger installation, local technicians must be deployed	For the provider • Need critical volume to generate sufficient revenues and make the investment sustainable • Revenue fluctuation and uncertainty on future usage • Local technicians need to be deployed • All risk and responsibilities lie with the provider
Potential for financial support	• Incentives to support and grow distribution networks • Identification, training, recruitment and support of rural based staff providing sales or after sales services	• Incentives to support and grow distribution networks • In new markets soft funding to establish an initial portfolio of customers • Soft funding for innovations delivery models and/or to reduce the repayment fees • Identification, training, recruitment and support of rural based staff providing sales or after sales services	• Subsidy for high investment requirements and to attract private capital • In new markets soft funding to establish an initial portfolio of customers • Concessional financing

EEP S&EA, Solar PV business models in East Africa: lessons learnt from EEP supported projects, 2016.

Large standalone/mini-grids can meet the energy demand for facilities near the grid/with high economic density; small solar standalone systems are more relevant for low economic density facilities far from the grid

A growing role for off-grid solar solutions[1]



Various factors influence the most cost-efficient SE technology[2]

High-density areas near the grid

- Relevant technology: larger (tailored) solar PV standalone systems
- Power generation capacity: 10 kWp – 100 kWp
- Cost range: US$2-17/Wp

High-density areas far from grid

- Relevant technology: mini-grids
- Power generation capacity: 10 kWp – 10 MWp
- Cost range: US$3-15/Wp with battery (US$3-7/Wp without battery)

Low-density areas far from grid

- Relevant technology: smaller standardised solar PV standalone systems
- Power generation capacity: 1-10 kWp
- Cost range: US$2-17/Wp

Cost-effectiveness is a key consideration when setting electrification targets
Achieving the highest energy access targets (Tier 5 – uninterrupted power access; >22h/day) can be 50-100x more costly than achieving entry level targets (Tier 1 – basic power appliances; >4h/day) on a per connected household basis.

[1] GOGLA study is on household energy needs. We make assumption that rural healthcare facility needs are comparable to those of off-grid households. https://www.gogla.org/sites/default/files/resource_docs/energy_access_through_off-grid_solar_-_guidance_for_govts.pdf; https://assets.publishing.service.gov.uk/media/5af96657ed915d0df4e8cdea/Costs_Benefits_Off-Grid_Electricity_Lighting_Systems.pdf
[2] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_Africa_2030_REmap_2015_low-res.pdf ; https://www.usaid.gov/energy/mini-grids/economics/cost-effectiveness/tiers-of-service/
Source: GOGLA; IRENA; USAID; KOIS & Differ analysis

On-grid/near-grid: reliance on overstretched government budgets can reduce ability to pay; though an economic case can be made for facilities with existing diesel generator budgets (as a primary or backup source)

Objective	Demand-side characteristics and challenges
Affordability/ ability to pay	- **User fees:** usually no fees charged to the patient in public facilities even if in urban settings some patients have an ability to contribute to the cost - **Government budgets:** depending on the level of dependence on public budget (revenue mix), and for public facilities on (i) specific government's solvency and (ii) other government's spending priorities - **Grant capital:** prioritise remote facilities with no access to energy serving vulnerable populations - **Public/private:** some privately-owned facilities in urban areas (targeting wealthier users) - **Other revenues:** regulation on resale of surpluses, provision of extra services (on the top of what is covered by government) should favorise renewable energies - **Alternative energy cost:** partial replacement of generators can free up some budget
Awareness/ knowledge among stakeholders	- **Awareness of solar and its benefits:** tendency to stick to status quo (even if it means no/expensive electricity), limited awareness of local population of solar energy and its benefits - **In-house solar know-how:** limited ability to maintain the installations on their own, facilities might have to pay for an external operator (→ risk of omission) - **Solar energy image:** previous negative experiences can result in mistrust and a bad image of solar energy sustainability
Acceptability of the solution	- **Quality of products:** low financial means result in selection of cheapest products - **Installation sizing:** sizing assessment has to be done properly and foresee change of behaviours - **Number of systems:** challenging O&M when several different systems installed in parallel - **Ownership:** without proper owners, users do not always feel responsible for the proper O&M of the system or can over/misuse the systems - **After-sale service:** contract do not sufficiently incentivise the providers to fulfill their after-sale responsibilities

Source: KOIS analysis

High-density areas far from grid: high density of economic activity can incentivise off-grid energy market-building and reduce overall costs to end-user; however, high service costs can still constrain ability to pay

Objective	Demand-side characteristics and challenges
Availability of product/ service	- **Hardware:** limited availability, potentially less choice of products or additional transportation costs - **Sales and installation:** potentially no local sales representatives increasing costs - **Financing:** local banks are reluctant to provide credit, interest rates are very high - **O&M:** lack of O&M service providers; the offer is more limited than in the capital and technicians might need to travel increasing costs or be less trained - **Disposal:** lack of disposal services - **Mini-grids:** viable option in high density area where grid extension are not planned
Affordability/ ability to pay	- **User fees:** usually low revenues and limited ability to pay - **Government:** in case of limited budget, main hospitals will be prioritised. If no grid extension, subsidise mini-grids - **Grant capital:** can be attracted especially if it helps the wider local communities and increase health quality - **Public/private:** usually mainly public facilities but some private healthcare facilities might be present in wealthiest areas. Private facilities can steer away wealthiest clients - **Other revenues:** on-sale of extra power to local community can generate revenues - **Alternative energy cost:** replacement of generators can free up some budget
Awareness/ knowledge among stakeholders	- **Awareness of solar and its benefits:** tendency to stick to status quo (even if it means no/expensive electricity), limited awareness of local population of solar energy and its benefits - **In-house solar know-how:** inability to maintain the installations on their own, facilities might have to pay for an external operator (→ risk of omission) - **Solar energy image**: previous negative experiences can result in mistrust and a bad image of solar energy sustainability
Acceptability of the solution	- **Quality of products:** low financial means result in selection of cheapest products - **Installation sizing:** sizing assessment has to be done properly and foresee change of behaviours - **Number of systems:** challenging O&M when several systems installed in parallel - **Ownership:** without proper owners, users do not always feel responsible for the proper O&M of the system or can over/misuse the systems - **After-sale service:** contract do not sufficiently incentivise the providers to fulfill their after-sale responsibilities

Source: KOIS analysis

Low-density areas far from grid: low ability to pay, low economic activity/small market size, and high service cost provide little incentive for private sector market-building and few energy access options

Objective	Demand-side characteristics and challenges
Availability of product/ service	- **Hardware:** barriers to procure required HW in the country (e.g., trade barriers); lack of technical options due to limited facility size - **Sales and installation:** complicated due to high cost and long time necessary to reach remote locations (often not justified by the low population in the catchment area) - **Financing:** inability to absorb upfront CAPEX; local FIs reluctant to lend - **O&M:** lack of O&M service providers; after-sales service limited in remote locations (i.e., low-quality network coverage, high cost of travel) - **Disposal:** lack of disposal services; high distance (i.e., cost) to disposal facilities (if any) • **Mini-grids:** low density not allowing to reach the critical size of perimeter for a mini-grid
Affordability/ ability to pay	• **User fees:** usually no fees charged to the patient in public facilities, low ability of rural population to contribute to the cost • **Government budgets**: depending on the level of dependence on public budget (revenue mix), and for public facilities on (i) specific government's solvency and (ii) other government's spending priorities • **Grant capital:** remote facilities with no access to energy serving vulnerable populations tend to get more attention from international donors • **Public/private:** limited/no private ownership (i.e., mostly public or NGO-run facilities) • **Other revenues:** very limited ability to generate extra revenues (i.e., no businesses and typically poorer population in sparsely populated rural areas) • **Alternative energy cost:** mostly unelectrified facilities, therefore no economies are generated (and the new PV installations can often be seen as an extra cost)
Awareness/ knowledge among stakeholders	• **Awareness of solar and its benefits:** tendency to stick to status quo (even if it means no/expensive electricity), limited awareness of local population of solar energy and its benefits • **In-house solar know-how:** inability to maintain the installations on their own, facilities might need an external operator (generating additional cost) • **Solar energy image**: little/no previous experience with SE
Acceptability of the solution	• **Quality of products:** low financial means or lack of quality standards result in selection of cheapest products • **Installation sizing:** sizing assessment has to be done properly and foresee change of behaviours • **Number of systems:** max. one/very few different systems per facility (i.e., low complexity) • **Ownership:** without proper owners, users do not always feel responsible for the proper O&M of the system or can over/misuse the systems • **After-sale service:** limited in remote locations (i.e., low-quality network coverage, high cost of travel)

Source: KOIS analysis

In sum, standalone systems for near-grid facilities and discrete high value opportunities are quick win, while medium-term plays and long-term challenges will require targeted support to become attractive opportunities

High density of energy demand

Medium-term plays

High-density far from grid (i.e., regional hospitals/clinics near dense populations)

- Mini-grid/large scale solar PV installations

Quick-wins

On-grid/near-grid facilities in areas of high density of economic activity (i.e., central hospitals/warehouses/urban clinics)

- Large standalone systems for primary reliable or backup solution

Long-term challenges

Low-density far from grid (i.e., rural health posts)

- Small solar PV standalone system with low expectation of grid extension

Discrete opportunities

Individual off-taker opportunities: high economic value far from grid in otherwise low-density area (i.e., humanitarian clinics)

- Large standalone systems for primary reliable or backup solution

High market attractiveness for energy companies

Source: KOIS analysis

Channelling financing to energy companies can tap into quick-wins and support the development of the local economy, though the financing shall be targeted to solar installation assets for healthcare facilities

	Systemic support to the solar energy sector[1]	Direct financing of energy service providers	Direct financing of solar installation assets
Relevant challenge addressed	- Support sector capacity building with market feasibility studies and project preparation	- Increase access to lower cost of capital - Increase access to long-term/patient capital - Reduce risk of asset-liability currency mismatch - Support capacity building with specific company/project technical assistance - Align financial incentive for on-going O&M/disposal service provision	- Increase health facility ability to pay - Mitigates energy service provider business risk - Direct and lowest cost S4H financing
Relevant market segment	- Provide sector capacity building support to strengthen renewable energy enabling environment	- Support energy value chain actors to strengthen business/investment case for energy provision across all market segments - Value chain actors targeting quick-win opportunities may still require innovative financing support, but likely significantly less than those targeting longer-term challenges	- Support less commercially viable investments and longer-term opportunities - Though equally applicable to any healthcare facility with low ability to pay across market segments

[1] Due to their broad character and need for systemic support of various public institutions, these investments are considered out of scope of this study.
Source: KOIS analysis

A number of innovative financing tools are available to support energy companies and reduce the various risks for financiers such as public sector off-taker risk and ESP business risk

	Systemic support[1]	Direct financing of energy service providers	Direct financing of solar installation assets
Investment instruments		Concessional financing; First-loss capital; Repayable grants	
De-risking instruments		Guarantee; Local currency hedging; Pooling projects; Advance market commitment	Guarantee; Advance market commitment
Result-based financing		Performance-based contracts	Performance-based contracts
Non-financing support mechanisms	Technical assistance; Project preparation facilities	Technical assistance; Project preparation facilities	

[1] Due to their broad character and need for systemic support of various public institutions, these investments are considered out of scope of this study

Source: KOIS analysis

Direct financing of solar installation assets: grants will be required to address low ability to pay and affordability challenge while RBF can incentivise O&M service provision for S4H healthcare facilities

Challenge	Specific issues	Relevant IF instruments
Affordability/ ability to pay	➢ **Domestic revenues:** high dependency of public facilities on government budget (i.e., solvability risk, non-systematic changes in spending priorities); limited social insurance deployment; limited/no ability of end users to contribute to HC cost ➢ **Foreign transfers:** inflow of private capital limited to larger facilities in higher-income areas; vulnerable & more remote areas tend to get more attention from foreign donors (i.e., grants and in-kind support) ➢ **Optimisation of operations**: some economies possible by replacement of costly generators (for facilities that were previously equipped by them)	• Grants, • Concessional financing, • Pooling of investments • Technical assistance
Accessibility	➢ **Availability of quality hardware:** limited choice of products; barriers to procure required HW in a specific country; low financial means and/or lack of quality standards resulting in selection of cheapest (low-quality) products ➢ **Distribution:** long time & high cost of transportation to remote locations ➢ **O&M:** lack of providers leading to limited after-sales service in remote locations ➢ **Disposal:** lack of disposal facilities	• Concessional financing to energy company • RBF • Grants • Technical Assistance
Awareness & acceptability among stakeholders[1]	➢ **Awareness of solar and its benefits:** tendency to stick to status quo; low awareness of economic benefits of solar energy ➢ **Solar energy image:** previous negative experience resulting in mistrust to SE ➢ **Solar know-how:** limited in-house ability to maintain the PV installations; lack of ownership among the users often leading to misuse of the systems	• Project-preparation facility • Technical Assistance

[1] Out of scope as these challenges are mostly linked to external factors and can only be addressed by innovative financing instruments to a limited extent
Source: KOIS analysis

Direct financing of energy service providers: concessional financing terms can address the limited access to capital locally but risk mitigating instruments will be paramount to guarantee repayment

Challenge	Specific issues	Relevant IF instruments
Market size & profitability	➢ **Economies of scale:** difficult to reach the critical size allowing the economies of scale in smaller economies and/or more geographically dispersed areas ➢ **Market power:** high market concentration impedes ECs from exercising power over their suppliers (i.e., push on lowering COGS); low price elasticity of demand in poor areas limits their pricing power; strong substitution effect for poorer end users (i.e., preference for cheaper and lower quality products) ➢ **Payment risk:** high risk of payment default in credit-based models	• Direct financing instruments • Technical assistance • RBF/advance market commitments • Guarantees
Access to finance	➢ **Insufficient amount:** ECs often deemed too risky for an amount allowing to finance CAPEX ➢ **Unfavourable terms:** high perceived risk leads to overly high interest rates/short maturities, further decreasing already strained margins ➢ **Local currency:** unavailability of funding in local currency (i.e., banks often offering loans in USD) results in an asset-liability mismatch, exposing the EC to a FX risk	• Concessional financing • First-loss capital • Guarantee • Local currency hedging • Matching of cash flows
Enabling environment[1]	➢ **Regulatory/policy issues:** SE legislative vacuum/too stringent regulation; high prevalence of trade barriers imposed on SE products ➢ **Infrastructure:** insufficient infrastructure increasing the cost & quality of marketing, service delivery and O&M in more remote areas ➢ **Human & social capital:** lack of qualified & motivated local workforce	• Project-preparation facility • Technical Assistance

[1] Out of scope as these challenges are mostly linked to external factors and can only be addressed by innovative financing instruments to a limited extent

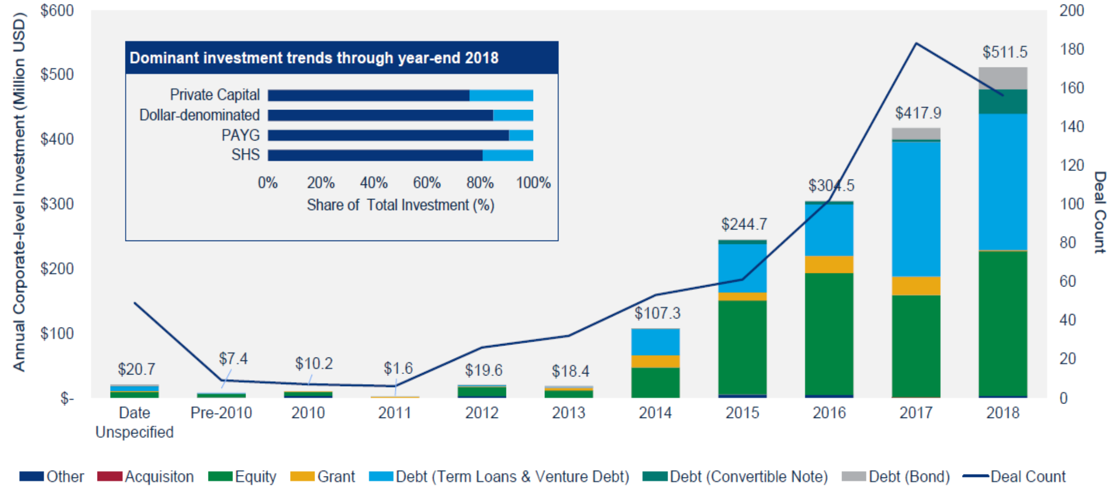
Source: KOIS analysis

There is significant pent-up private capital that can be unlocked for the proposed facilities, particularly for PAYG business models or large power plants where off-taker risk can be effectively mitigated

Growing investments

- >US$500m investments in 2018
- US$1.7b of cumulative investments in off-grid energy access compagnies (est. at US$2.3b in total with undisclosed investments)
- 50-50 debt-equity balance
- >20% YoY growth from 2017 to 2018
- 686 transactions, 426 investors, and 152 recipients in 2018
- 79% of investments go to Africa

Corporate-level investment into off-grid energy access companies by year and type of financing through year-end 2018

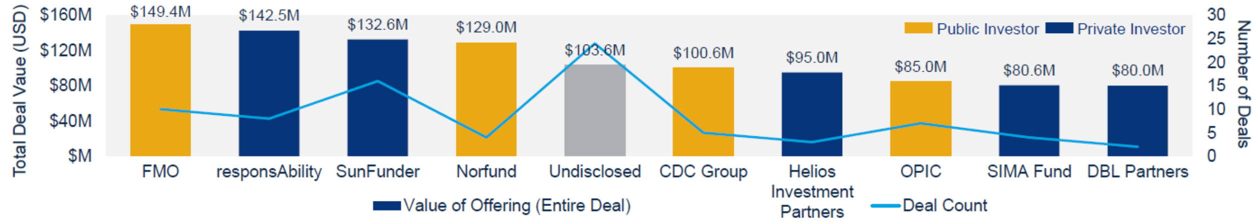


Source: Wood Mackenzie Power & Renewables, Energy 4 Impact

Specialised public and private funds dominate the investment scene

- Top 10 dealmakers are a mix of public and private investors, leveraging specialised energy access focused funds
- Most strategic investors are looking to buy small (~20%) equity stakes in players with growth potential and learning opportunities
- Many transactions have a blended finance component
- Strategic investments take 3 forms: direct investments and M&A, commercial partnerships and joint ventures, indirect investment through funds or financial intermediaries
- PAYG is the preferred business model (91% of investments)
- SHS the preferred product (81% of investments) with mini-grids coming as second (15% of investments)

Top 10 Investors by Total Deal Value (by sum of deal totals in which the investor participated), 2010-2018



Source: Wood Mackenzie Power & Renewables Global Off-Grid Renewables Investment Datahub

Source: Wood Mackenzie Power & Renewables Global Off-Grid Renewable Investment Datahub

Interviewed stakeholders recognise the need and importance of a sustainable energy access in healthcare, however some challenges to make such initiative investable remain

Donors

Development partners promoting economic development and welfare including official agencies (state and local governments, or their executive agencies) at concessional financial terms (if a loan, having a grant element of at least 25 per cent).

- **Health sector support:** In countries where donors are already heavily supporting healthcare expenditures, donors are interested in a more sustainable solution (solar) instead of financing diesel for instance.
- **Renewable energy support:** Support is provided to ESPs through concessional loans and grants.
- **Long term commitment:** Donors often have limited time engagement and often limit commitment to max. 5 years.
- **Coordinated action:** Donors run programmes in health and energy in parallel but effort to coordinate and join forces in conducting and funding common initiative is gaining ground. There is interest to contribute to an initiative managed by UNDP.
- **Risk mitigating instruments**: Donors can provide payment guarantees for the local government but that option is not always available or preferred in countries with high debt/low creditworthiness.

Concessional investors

Investors seeking impact first and offering below market interest rate or more concessional terms, includes DFIs, IFIs, foundations, impact investment funds. Investing in the form of debt or equity.

- **Support to local government:** Development finance institutions (DFI) have the mandate to support local government with concessional loans. Project financing of RE projects fall within their scope of action. Impact funds, even when providing more concessional financing, remain reluctant to take exposure on local governments.
- **Blended finance:** Objectives include catalysing additional financing and leverage the amount of concessional financial. Ready to take junior positions in similar funds.
- **Risk mitigation**: For this type of initiative, impact investment funds will require a very high level of security, indicative terms of 25% first loss tranche or minimum 50% guarantee on payments.
- **Covid-19 response:** Increased interest for investments that support the SSA healthcare system in view of the Covid-19 crisis.

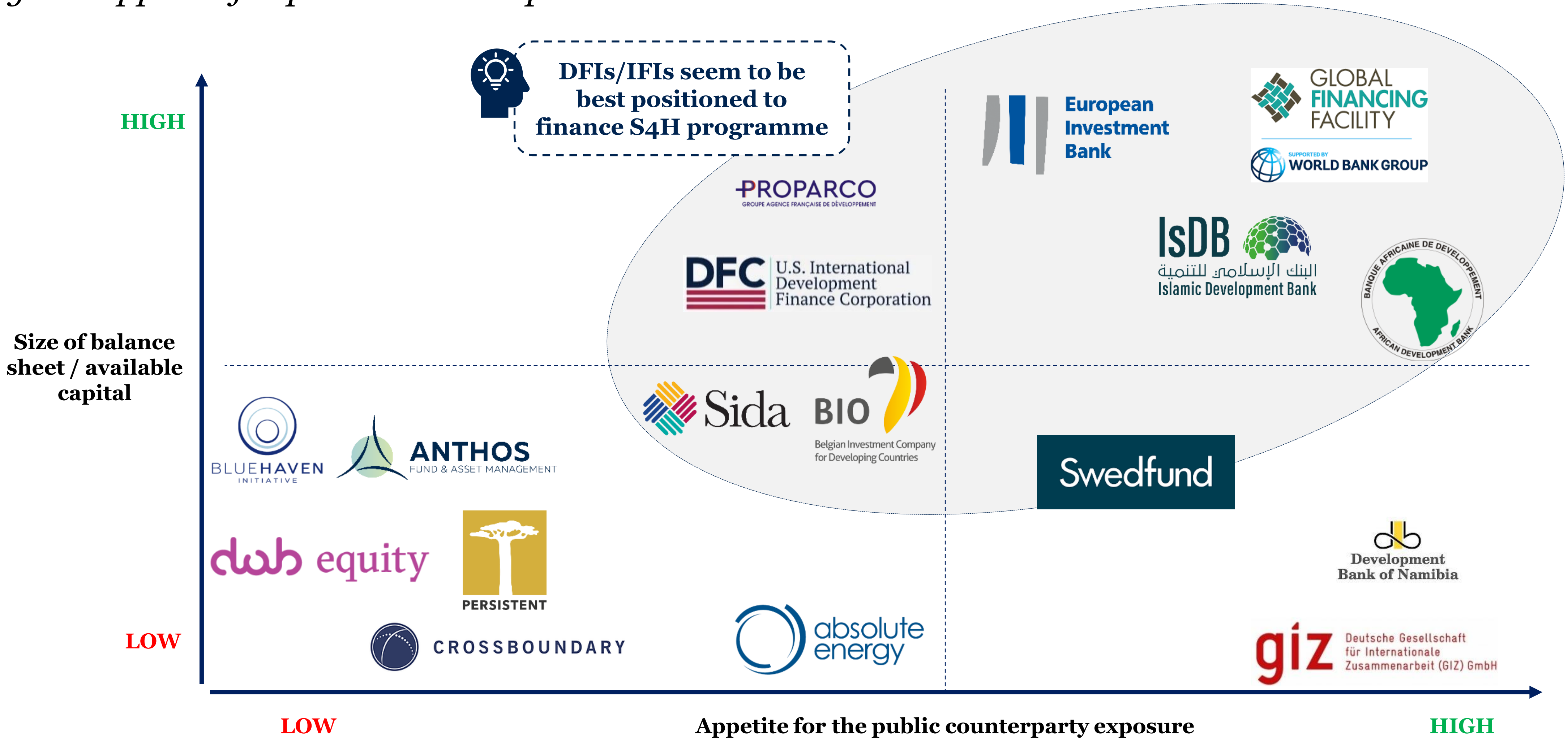
Commercial investors

Investors seeking a market return, includes impact investment funds, family offices, high-net-worth individuals, as well as commercial banks. Investing in the form of debt or equity.

- **Exposure on government entities:** Credit risk on the public sector is seen as high and payments difficult to enforce resulting in a reluctance to take any exposure on government entities.
- **Investments in renewable energy:** Investments typically target PAYG companies with strong track record and balance sheet or project finance vehicles with segregated cash flows to limit business risk on local ESPs.
- **Currency risk:** High volatility and inflation must be priced in or mitigated. Hedging is very costly and may not be available in the desired tenors or currencies. Some investors only take exposure in hard currency.
- **Expected return:** For long-term investments in SSA (i.e., 10 years and more), investors indicated an approximate required return of 30% for equity and 15% for debt (depending on the risk of a specific project).

Source: KOIS analysis

Indicative interest of potential financiers to participate in a S4H financing mechanism – DFIs/IFIs have the highest appetite for public sector exposure



Assessment based on interviews and desk research – further discussions and analysis required to confirm the interest and the investment terms of the listed organisations
Source: KOIS analysis

UNDP DIFFER KOIS CARING FINANCE

We have interviewed a number of DFIs during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (1/3)

Development Finance Institution	Investment initiative	Investment focus	Geographical focus	Financing instrument	Who applies/ Application timeline	Size of investment	Fit with model
World bank	**Green Climate Fund (GCF) - Readiness Programme**	Creating enabling environments and building institutional capacity	Developing countries	Grants, in-kind contributions	Public entity at national level, Private sector & NGOs at regional level / Proposals may be submitted at any time	Up to US$1m/country/year for capacity building Up to US$3m/country for formulation of national adaptation plans	TA provider, TA to MOH/ESPs
	The Carbon Fund- The Carbon Initiative for Development	Performance-based payments for the purchase of certified carbon emission	ODA eligible countries	Results-based financing	Public entity, Private sector / Application accepted on rolling basis	N/A	Energy payments to ESPs
	Clean Technology Fund of Climate Investment Funds	Financing for of low-carbon technologies for long-term greenhouse gas emission savings	Emerging countries	Grants, concessional loans, subordinated debt, market-rate loans, equity, guarantees	Public entity at national level, private sector & NGOs at regional level Approval may take up to 2 years	Cumulative pledges: US$5.5bn	S4H platform providing loans to ESPs TA provider, TA to MOH/ESPs
	Least Developed Countries Fund (LDCF)	Project and program implementation	Several LDCs incl. Malawi, Zambia and Liberia	Grants	Public entity	Full-sized projects: +US$2m Medium-sized projects: Less than or equivalent to US$2m	TA provider, TA to MOH
IFC	**International Finance Corporation (IFC) - Canada Climate Change Program**	Project and program implementation	Developing countries that are IFC members	Concessional loans and guarantees	Private sector	CA$286m for concessional investments CA$6m for advisory services and TA projects Applications accepted on rolling basis	S4H platform providing loans to ESPs

The Carbon Fund has an investment budget of US$267m

We have interviewed a number of DFIs during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (2/3)

Development Finance Institution	Investment initiative	Investment focus	Geographical focus	Financing instrument	Who applies/ Application timeline	Size of investment	Fit with model
AfDB	**Sustainable Energy Fund for Africa (SEFA)**	Project preparation, and enabling environment support	Developing counties in MENA/SSA	Grants, equity, in-kind contributions	Private sector Proposals are accepted on a rolling basis (turn around process approx. 5-9 months)	US$30-200m	TA provider, TA to MOH/ESPs
	NEPAD Climate Change Fund	Project and program implementation	AU member states	Grants	Public entity	N/A	TA provider, TA to MOH
	Green Bonds Program	Project and program implementation	Africa	Concessional loans	Project sponsors, governments, and government-guaranteed entities	N/A	MOH financial contribution to energy payments
	Africa Renewable Energy Initiative (AREI)	Project and program implementation	Africa	Grants, concessional loans, guarantees, in-kind contributions	Public entity at national level, Private sector & NGOs at regional level	US$10bn pledged during COP21 for phase 1, 2017-2020	S4H platform proving loans to ESPs/TA provider, TA to MOH/ESPs
	African Renewable Energy Fund (AREF)	Development stage renewable energy projects. Small to medium scale IPPs	SSA	Grants, concessional loans, guarantees, in-kind contributions	IPPs with size of 5-50 MWp	US$30-200m	TA provider, TA to IPPs S4H platform providing loans to IPPs

NEPAD Climate Change Fund has a fund size of EUR 3.6 million
AfDB is a repeat issuer of green bonds (USD2.6bn in total)

We have interviewed a number of DFIs during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (3/3)

Development Finance Institution	Investment initiative	Investment focus	Geographical focus	Financing instrument	Who applies/ Application timeline	Size of investment	Fit with model
FMO	**Access to Energy Fund**	Project and program implementation	SSA	Grants, concessional loans, equity	Private sector	Up to €7m	S4H platform proving loans to ESPs
AFD	**Le Fonds Français pour l'Environnement Mondial**	Project and program implementation	ODA eligible countries	Grants	Public entity at national level, Private sector & NGOs at regional level	€0.5-2m	TA provider, TA to MOH
European Investment Bank	**Climate Change Technical Assistance Facility**	Scoping and project preparation	Developing countries	Contingent grants	Public entity	N/A	TA provider, TA to MOH
	Interact Climate Change Facility (ICCF)	Project and program implementation	OECD DAC countries	Senior loans, mezzanine debt, equity, quasi-equity and guarantees	Private sector	€1-25m	S4H platform proving loans to ESPs
Nordic Development Fund	**Energy and Environment Partnership in Southern and East Africa**	Project and Program implementation	SSA	Grants, market-rate loans, guarantees	Private sector	Varies on financing window- up to US$2m	S4H platform proving loans to ESPs
	Nordic Climate Facility	Scoping and project preparation Project and program implementation	Several SSA countries incl Malawi & Zambia	Grants, Concessional loans, Equity	Public entity at national level, Private sector at regional level	€250-500k	TA provider, TA to MOH

Climate Change Technical Assistance Facility has a fund size of 10 million EURO

Two approaches can be followed to implement the S4H programme and mobilise financing for local ESPs – DFI/IFI preferences shall be considered when selecting the appropriate approach

Direct financing (platform)

Financiers provide capital to ESPs directly under a coordinated process

- A platform is set up to link DFIs/IFIs with ESPs awarded S4H contracts
- A coordinating unit ensures investors requirements are integrated in the procurement process to facilitate eligibility for financing
- Investors are presented S4H financing request and can finance directly alone or in a club deal

Advantages

- Each DFI/IFI can select investment opportunities, set its own investment terms and follow its standard procedure
- DFI/IFIs have specific mandates and less flexible processes making direct investments tailored to them more feasible

Disadvantages

- Each contract must reach a critical ticket size to justify the transaction costs
- Necessity to comply with specific terms for each project increases complexity
- No cross-subsidy between projects

Indicative DFIs/IFIs fit

IsDB, African Development Bank, BIO (Belgian Investment Company for Developing Countries), Development Bank of Namibia, PROPARCO (Groupe Agence Française de Développement)

- Mandate for specific countries only
- Financing provided to private sector directly for specific projects
- Investment in funds are not common practice

Fund structure

A fund is created to pool investments in S4H programme

- A dedicated S4H fund is created and managed by a fund manager (selected by UNDP through a procurement)
- The fund pools investments from different types of investors and conducts due diligence on their behalf before investing (i.e., providing financing) to ESPs awarded S4H contracts
- The fund centralises cash flows, repayments from ESPs and to investors

Advantages

- Investing in several projects/countries/ ESPs diversify the risks for DFI/IFIs
- Due diligence is partly outsourced to the fund manager
- Ensures flexibility in desired ticket size for investors
- Can be structured as a revolving fund

Disadvantages

- Requires a due diligence on the fund and potentially on the investments
- Limits the possibility for investors to select specific investments (according to their specific mandates)
- Fund manager charges a fee for its services increasing the costs

Indicative DFIs/IFIs fit

Swedfund, African Development Bank, The World Bank, DFC U.S. International Development Finance Corporation

- Preference for a simplified due diligence
- Requirement for minimum ticket size
- Cooperation with other large organisations such as UNDP

Source: KOIS analysis

According to the DFIs/IFIs we have spoken to, the large majority have the capacity to provide financing to the S4H coordination platform through providing loans to ESPs and technical assistance to MOH/ESPs

Energy payments

Green Bonds Program

Ci-Dev Carbon Initiative for Development

DFID Department for International Development

Norad

KFW

USAID From the American People

Guarantees

European Investment Bank

ICIEC

GuarantCo Guarantees for Development

Africa Greenco

ati | aca

MIGA

The World Bank

AFD Agence Française de Développement

Energise Africa

Munich RE

African Guarantee Fund

Technical assistance

To the MOH

AREF

European Investment Bank

FMO

BIO

To the ESPs

AFD Agence Française de Développement

USAID

The World Bank

IDB Lab

Sida

Least Developed Countries Fund (LDCF)

BMZ Federal Ministry for Economic Cooperation and Development

Green Climate Fund

AREI

Sustainable Energy Fund for Africa

NEPAD Climate Change Fund

NDF Nordic Development Fund

IFC International Finance Corporation World Bank Group

CTF Clean Technology Fund

PROPARCO Groupe Agence Française de Développement

Financing

IsDB البنك الإسلامي للتنمية Islamic Development Bank

NDF Nordic Development Fund

IFC International Finance Corporation World Bank Group

Swedfund

DFC U.S. International Development Finance Corporation

Sida

Banque Africaine de Développement / African Development Bank

AREF Africa Renewable Energy Fund

CTF Clean Technology Fund

European Investment Bank

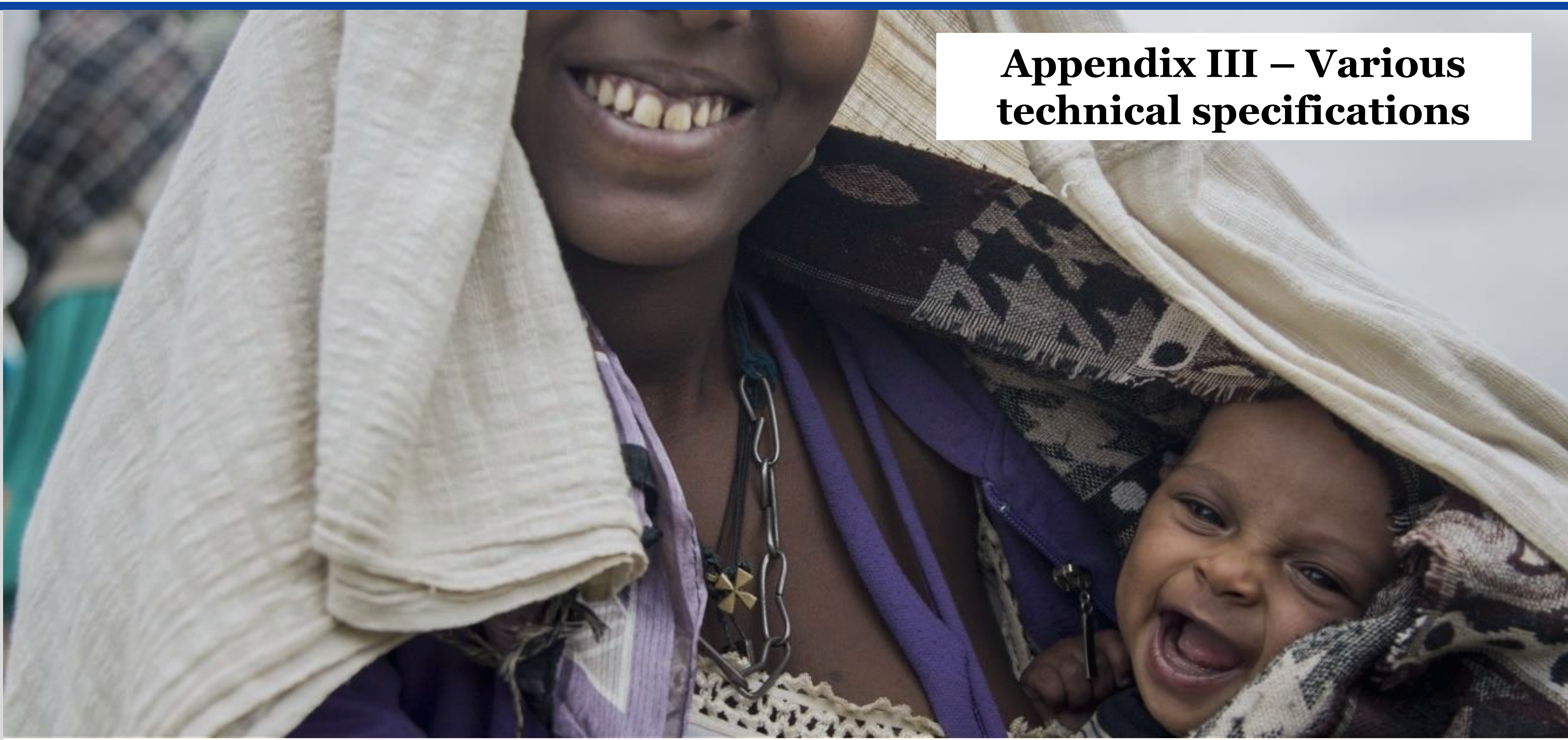
AREI

Development Bank of Namibia

FMO

PROPARCO Groupe Agence Française de Développement

This mapping is aligned with DFI's we have spoken to and their existing energy initiatives in SSA
The Carbon Fund- The Carbon Initiative for Development also provides financing for ESPs
Africa Renewable Energy Initiative (AREI) also provides financing for ESPs Climate Change Technical Assistance Facility- under the European Investment Bank also provides TA to MOH
Source: KOIS analysis

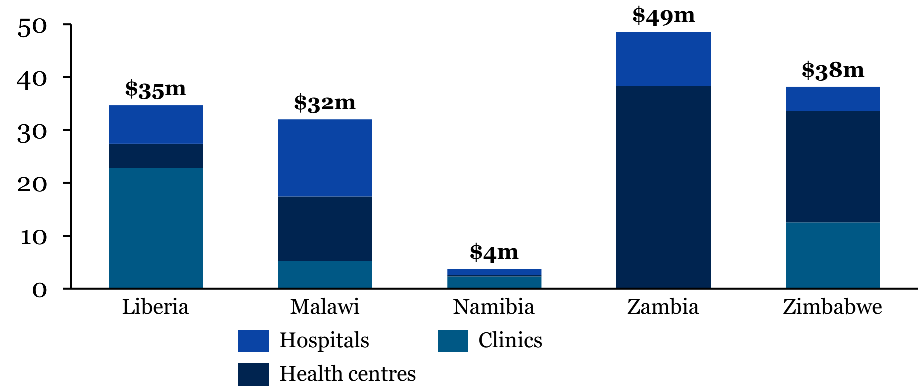


Appendix III – Various technical specifications

We estimate the total S4H programme initial investment in the 5 pilot countries to be approx. US$157m, depending on the MOH priorities and the technical requirements

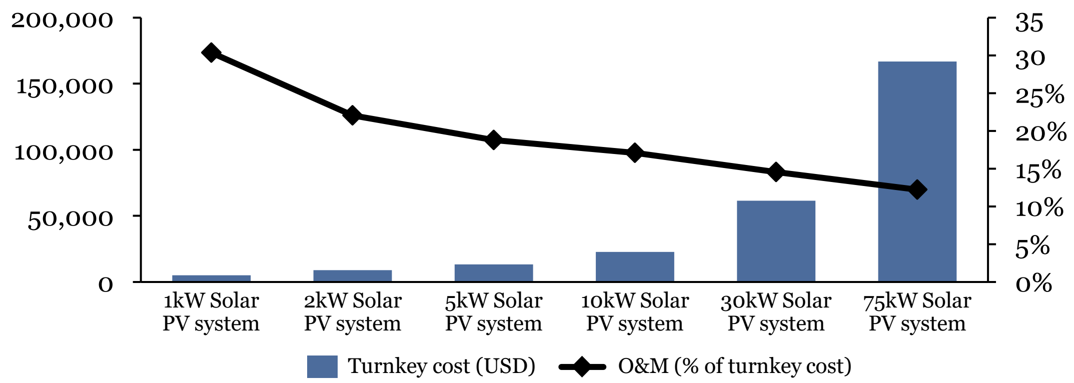
Market size: total energy solution cost[1]

US$m



Turnkey & O&M cost of standalone PV systems

US$



Market sizing assumptions

- For larger hospitals, a tailored PV system will be needed to respond to their specific needs and larger facility size
- For health centres and clinics, standardised systems are recommended to reduce the unit cost and allow for economies of scale
- Pre-financing of 7 years of O&M is included in the investment sizing

The impact of battery autonomy

- Battery autonomy represents a large portion of the installation cost, therefore the grid is used as a primary/back-up solution when available; diesel generators can be a cost-effective back-up solution for off-grid facilities
- Meteorological conditions also have a significant impact on the required autonomy (i.e., the more sunshine hours per day on average, the less autonomy needed)
- Additionally, prioritising critical load[2] is also a way to optimise battery size

Cost per patient versus need

- While the cost per patient depends on the exact catchment population of each healthcare facility, in general it is lower in larger facilities due to economies of scale (i.e., there is a certain amount of fixed costs that make larger installations more economical – typically hardware pieces but also service costs such as installation and periodic maintenance)
- The absolute need (i.e., in kWh) is larger in larger facilities, however, it is more urgent in rural facilities that often completely lack access to energy, therefore a prioritisation is necessary based on this trade-off

[1] The investment size includes the initial CAPEX, as well as present value of pre-financed 7 years of OPEX
[2] Critical loads are those loads to which power supply has to be maintained under any circumstances
Source: KOIS & Differ analysis

In dense off-grid areas, mini-grids could support a broader rural electrification objective and bring synergies compared to stand alone systems, however, the required investment would be much higher

Mini-grids are a sound path for rural electrification given the high costs of grid extension

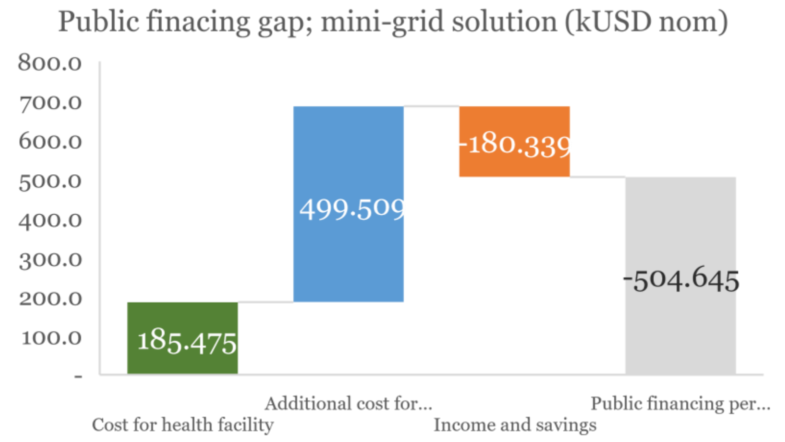
- When a country has a low population density and economic activities are concentrated in the urban areas, grid extension to bring electricity to the rural population is often not economical
- The electrification through grid extension is likely to take many years
- Setting up mini-grid would be a more cost effective path to rural electrification and require a lower investment cost

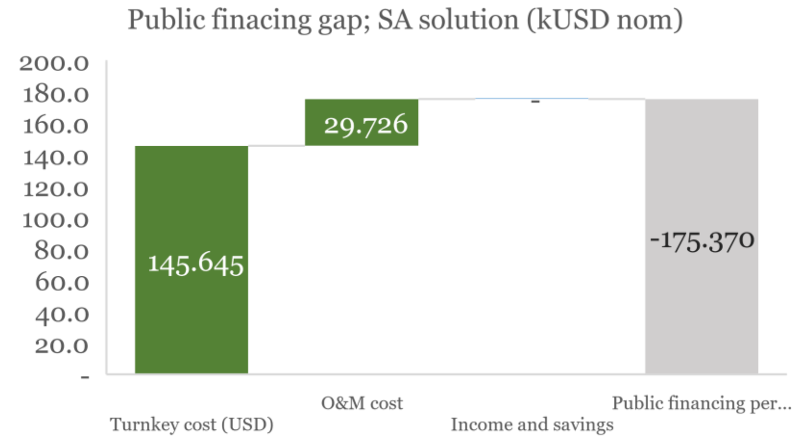
Rural electrification through mini-grids is however not economically viable to be implemented by the private sector, similar to the grid it requires public funding

- A mini-grid has high operational costs compared to a stand-alone system being a small network where the technical complexity is higher. Requiring:
    - A technician 24/7 on-site to ensure the proper operation of the system
    - A collection system to collect payments from all users and manage access
    - Security guards
- Public funding or grants are required to the investment cost and it is unlikely that that cost can be passed on to the customer especially given the low income level in rural areas

Given the need for grant funding, the higher costs and wider scope of a mini-grid solution, standalone systems are the least costly option for S4H

- For this study we have therefore limited the scope to stand-alone systems
- However, mini-grid can be considered in cooperation with the respective Ministry of Energy or rural electrification departments under a broader electrification strategy
- A hybrid mini-grid only for public buildings could however make sense and generate economies of scale in this project with the off-taker being the public sector



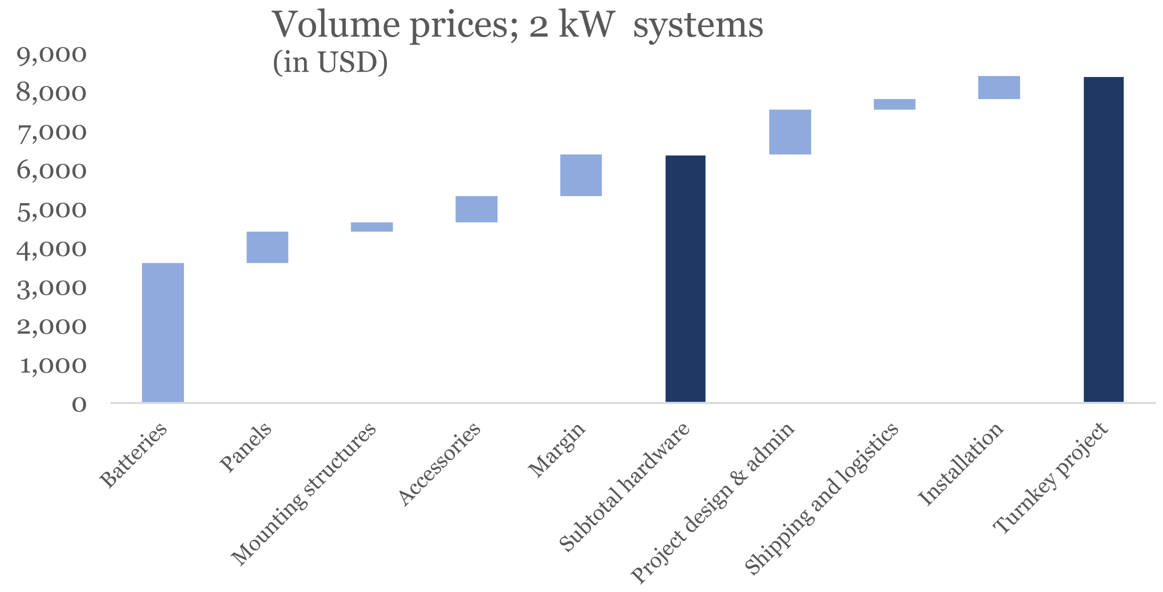


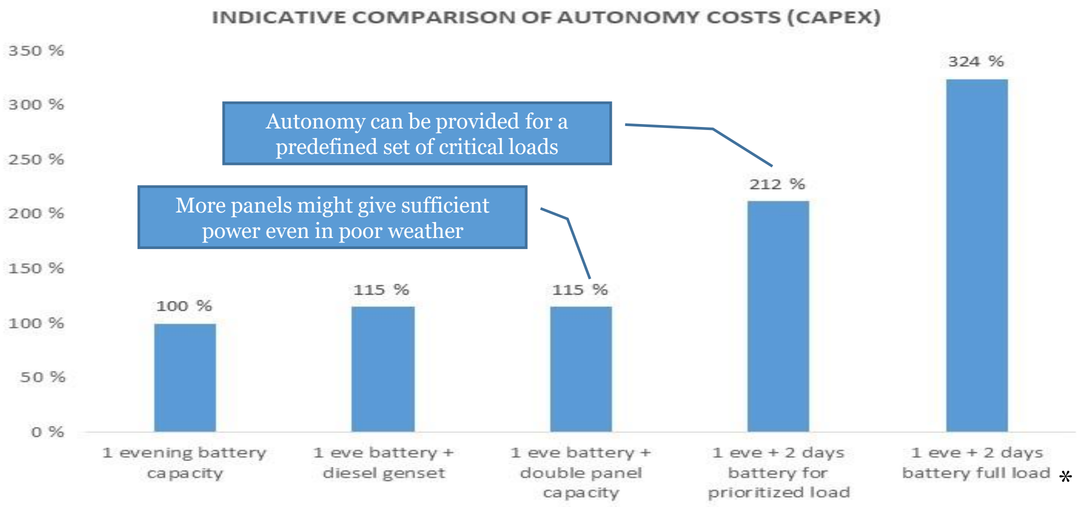
Source: Differ analysis

Autonomy can be obtained in different ways and to different degrees – costs of autonomy can be substantial

Battery prices vary significantly across manufacturers and specifications and they represent the largest portion of the investment cost

- We have used BYD's battery packs for the cost estimates, those are mid-range prices and cheaper or more expensive alternatives exist.
- We assumed that larger capacities approach US$450/kWh
- The BYD's batteries are Lithium LFP (LifePO4) that require limited maintenance and are recommended for back-up, solar storage and off-grid setting
- Those batteries have a 10 year warranty with a 60% EOL capacity





*** Assumptions on autonomy**

Day 1: Normal day with battery used for evening use (25% of total daily usage)

Day 2: Limited or no generation of solar energy. 100% of daily load on battery

Day 3: Limited or no generation of solar energy. 100% of daily load on battery

The total battery size for this autonomy will be nine times that of a battery to cover regular evening use

Source: Differ analysis

The CAPEX for one 30 kWp system with 2 days of additional autonomy equals that of 38 1-kWp systems with battery capacity for one evening only

ADDITIONAL NUMBER OF SMALLER FACILITIES ELECTRIFIED WITH LESS AUTONOMY, COMPARED TO ONE LARGE FACILITY WITH 1 EVE + 2 DAYS OF BATTERY AUTONOMY - WITH THE SAME BUDGET					
	Autonomy solution				
System Size (kWp)	**1 evening battery capacity**	**1 eve battery + diesel genset**	**1 eve battery + double panel capacity**	**1 eve + 2 days battery for prioritized load**	**1 eve + 2 days battery full load**
1	38,3	33,3	33,3	18,1	11,8
2	22,2	19,3	19,3	10,5	6,9
5	14,9	12,9	12,9	7,0	4,6
10	8,7	7,6	7,6	4,1	2,7
30	3,2	2,8	2,8	1,5	**1,0**

Source: Differ analysis

Achieving sustainability requires a payment structure providing incentives for proper O&M

Tender processes with donor financed CAPEX investments typically offer payments for O&M that are below the cost – leading to weak sustainability

- While experience indicates that sustainability requires an annual O&M cost of 5-10% (for systems of 2-30 kWp), traditional tenders often allocate only 10-20% of the total contract value for payment after commissioning.
- A leasing model can be mirrored to ensure that annual payments for O&M match the cost+margin of the the ESPs
- A leasing structure will allocate an even higher payment per year of operation, as a substantial share of the CAPEX will also be paid back over time.

The top graph illustrates how payments after commissioning compare with the cost of the O&M for a 2 kWp system over a 3-year period.

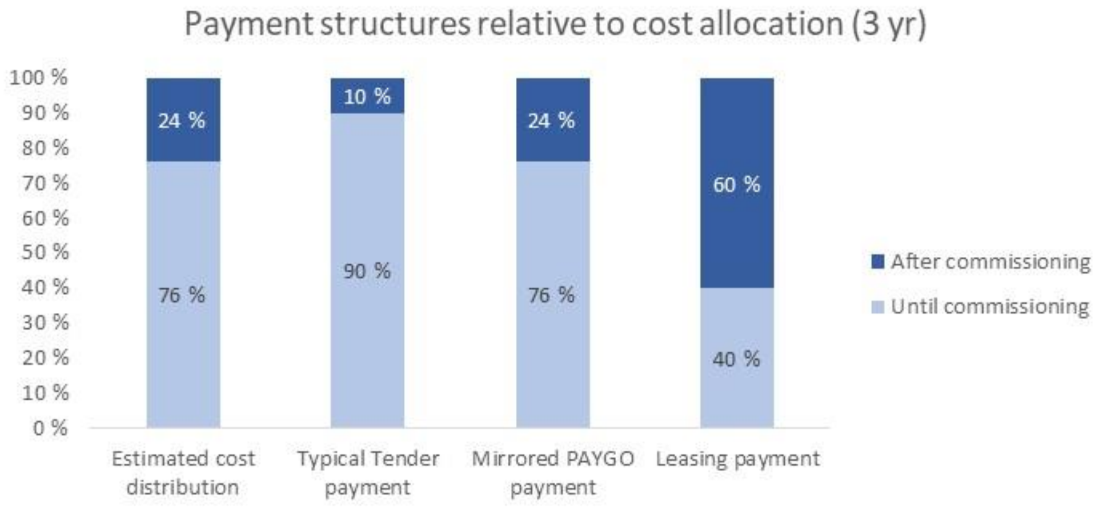
- There is an assumed down-payment of 40% of the total contract value in the leasing structure (i.e. more than 50% of the CAPEX)

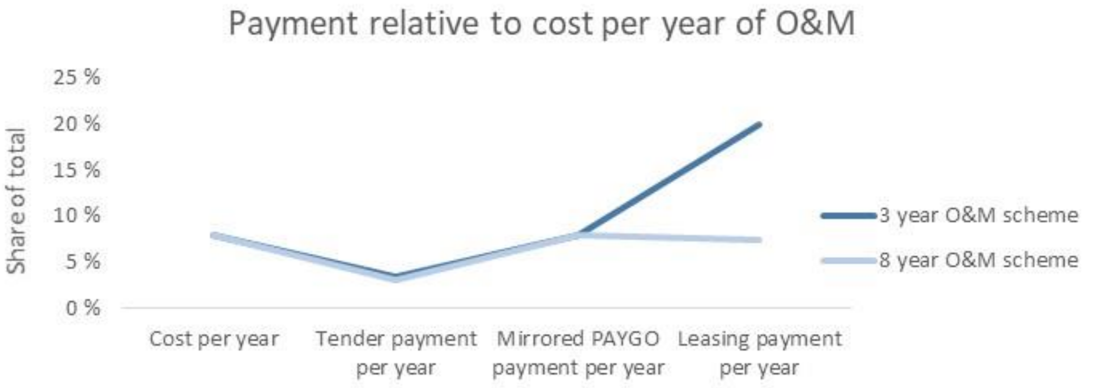
The bottom graph illustrates how the payment per year of operation compares with the annual cost of O&M (as a % of total contract value)

- We have not taken into account that leasing will have somewhat higher total cost, however, below is an assessment of the value of the additional costs.

As the share of the total payment is pushed out in time, the total cost per system also increases due to financing costs – but impact is expected to increase more

- There are two crucial impact gains that are expected to outweigh the additional cost
  1. Lower donor payment for each facility before commissioning means that more facilities can be electrified earlier - increasing the overall impact
  2. With many systems empirically failing and contractors abandoning O&M obligations after a few years with traditional tenders, a limited increase on total cost will ensure that more systems work for longer – increasing the overall impact.





Source: Differ analysis

Disposal shall be thought of in the S4H project design, there is potential for a recycling value chain that will limit the net replacement cost of components

There is still little practical experience with disposal and recycling of components from medium to large scale solar energy systems, but…
…there are **no hazardous materials** in silicon PV panels and Lithium batteries (as opposed to lead acid batteries)
…**life-time expectancies are generally very long** for quality components, and aging can normally be met with adding more capacity as opposed to replacing components (for both Li batteries and PV panels)
…**net cost of replacement likely limited** and it is even possible that the **economics of disposal/recycling will play in S4H's favor** (i.e. have a positive net value)

Key components	Contents	Aging/end-of-life outlook	Economics of disposal/upgrade
Batteries	• **No hazardous materials** • Valuable materials: Lithium, copper, nickel, magnesium, cobalt, aluminum • Recycling of these materials is still not profitable, but can become so as scale • Plants for recycling of lithium batteries are in progress in Europe	• Quality Li-batteries expected to age slowly and more linearly (likely in the range of 5-20% over 5 years) • Technical lifetime might be more than 10 years for most quality Li-battery solutions (i.e. not the same waste challenges as for Lead Acid batteries) • Some batteries will fail earlier or deteriorate faster	• For most sites, the likely scenario for well-managed systems is a need for adding extra capacity to meet the required service level • For batteries that will need replacement, there will be value in recycling • At scale, the value of the replaced battery might even bring down the cost of a replacement
PV Panels	• **No hazardous materials in Si panels** • Valuable materials: aluminum, copper and silver • Silicon can be recycled but unlikely to be profitable • Plants for recycling of PV panels are in progress in Europe	• Quality panels age slowly and have a very long technical lifetime	• For most sites, the likely scenario for well-managed systems is the need for adding extra capacity to meet the required service level • For broken panels, valuable components can quite easily be recycled - also locally
Inverters	• **No hazardous materials** • Contains electronics with fewer valuable materials	• Likely the component that will need replacement first • Technical life-time could still be more than 10 years	• Not likely to be commercially viable to recycle • However, total volume will be limited with only 1 to 3 units per site
Appliances	• LED products are not environmentally hazardous • Refrigerators, fans, laptops, air conditioners	• Quality LED products have long life-times • Disposal of other appliances likely to pose larger challenges than the solar systems	

There is still little practical experience with disposal and recycling of components from medium to large scale solar energy systems, but…

Components

Batteries

PV panels

Inverters

Appliances

Insights

*…there are **no hazardous materials** in silicon PV panels, inverters or Lithium batteries (as opposed to lead acid batteries)*

*…**life-time expectancies are generally very long** for quality components, and aging can normally be met with adding more capacity as opposed to replacing components (for both Lithium batteries and PV panels)*

*…**net cost of replacement likely limited** and it is even possible that the **economics of disposal/ recycling will play in S4H's favor** (i.e. have a positive net value)*

Implementation

- *Even if there are no hazardous materials in most components to be installed, the LTA/PPA contractor should be responsible for waste management according to [global/OECD/EU] EE-regulations*
- *A (small) refund for documented safe disposal will additionally incentivise the ESPs to ensure 'no waste'*
- *The inclusion of lead acid batteries or certain appliances might require additional measures (also in case of replacement of old PV-systems under the program)*

Source: Differ analysis

Appendix IV – List of interviewees & other identified stakeholders

We have interviewed over 100 relevant organisations during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (1/4)

Organisation	Role	Contact
Africa Mini-grid Developers Association	Expert	Daniel Kitwa
Beyond the Grid Fund for Africa	Donor	Esmeralda Sindou
CAA International	ESP	Nicole Plettenberg; Christopher Huys
CrossBoundary	Impact Investor	Gabriel Davis
Easy Solar	ESP	Nattie Davis
EnDev (GIZ)	Donor	Hans-Hartlieb Euler
European Commission	Donor	James Carey
Global Financing Facility (WB)	DFI	Sneha Kanneganti
Global Fund	Donor	Mehreen Khalid
Innosun	ESP	Tom Torne
inno: Africa	ESP	Genna Baron
Lib Solar	ESP	Nicholai Lidow
Norwegian Water Resources and Energy Directorate	Expert	Kirsten Westgaard

Organisation	Role	Contact
PEG Africa	ESP	Hugh Whalan
Pickering Energy Associates	ESP	Charles Pickering
Power Africa	Donor	Carolina Barreto
Rural Renewable Energy Alliance	Expert	Mary Jo Mettler; Muzalema Mwanza
Renewable Energy and Energy Efficiency Partnerships	DFI	Esmeralda Sindou
Rocky Mountains Institute	Expert	Edward Borgstein
Sustainable Energy for All	Donor	Jem Porcaro; Olivia Coldrey
Sida	DFI/Donor	Hanna Holmberg
SolarNow	ESP	Ronald Schuurhuizen
Tetra Tech	Expert	Ewan Bloomfield
USAID (Power Africa)	Donor	Katrina Pielli; Molly Dean
West Coast Energy Liberia	ESP	Samuel O. Simpson
World Bank	Donor	Rahul Srinivasan
independent consultant	Expert	Anil Cabraal

We have interviewed over 100 relevant organisations during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (2/4)

Organisation	Role	Contact
Absolute Energy Capital	Impact investor	Alberto Pisanti Jesus Fernandez
Anthos Fund & Asset Management	Impact investor	Dimple Sahni
Blue Haven Initiative	Impact investor	Lauren Cochran
Ceniarth	Impact investor	Vince Knowles
DOB Equity	Impact investor	Hayo Afman
Energy MRC	Expert	Douglas Caskie
Empower Energy	Impact investor	Alexander Pedersen
Islamic Development Bank	DFI	Bandar Alhoweish Hussain Mogaibel
Kube Energy	Investor/ESP	Mikael Clason Hook
Persistent	Impact investor	Christopher Aidun
Shell Foundation	Foundation	Ashish Kumar
Sustainable Energy Fund for Africa (AfDB)	DFI	Rahul Barua

Malawi field visit

Organisation	Role	Contact
Community Energy Malawi	ESP	Edgar Kapiza Bayani
Department of Energy Affairs	Government	Saidi Jabu Banda
DFID	Donor	Desmond Whyms
JCM Power Malawi	ESP	Jonas Sani
Malawi Energy Regulatory Authority	Regulator	Wilfred Kasakula
Department of Strategic Planning (MFDP)	Government	Chippo Masina
Department of Data & Aid (MFDP)	Government	Anwai Mussa
Ministry of Health	Government	Rumbani Sidira; Grycian Massa
Solar Africa	ESP	David Dean
UNDP Malawi	Client	Shamiso Kacelenga; Emmanuel Mjimapemba; Andrew Spezowka
UNICEF	Donor	Samuel Chirwa
USAID	Donor	Andrew Spahn
World Bank	DFI	Kagaba Paul Mukiibi

We have interviewed over 100 relevant organisations during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (3/4)

Liberia field visit

Organisation	Role	Contact
African Development Bank	DFI	Emmanuel Maniragaba
Ecobank	Commercial bank	Mohammed Dukuly
EcoPower	ESP	Vickson Korlewala
EnDev (GIZ)	Donor	Stephen Mulbah Freeman Godu
Environmental Protection Agency	Government	Nathaniel Blama
EU Delegation to Liberia	Expert	Stefania Marrone
Liberia Electricity Regulatory Commission	Regulator	Augustus Goanue
Ministry of Health	Government	Norwu Howard; Adrian Brown
Ministry of Mines and Energy	Government	Prince Nanlee Johnson
Rural & Renewable Energy Agency	Government	Stephen Potter
Sida	DFI/Donor	Jenkins Flahwor
UNDP Liberia	Client	Moses Massah
World Bank	DFI	Joseph Tawiah Quayson

Namibia field visit

Organisation	Role	Contact
Development Bank of Namibia	DFI	Hellen Amupolo
Electricity Control Board	Government	Foibe Namene
Environmental Fund	IFI	Pandeni Kapia
French Development Agency	DFI	Valentin Benoit
Hans Seidel Foundation	Foundation	Clemens von Doderer
Letshego	Expert	Jacques Bock
Ministry of Health and Social Services	Government	Thomas Mbeeli
Ministry of Mines and Energy	Government	Abraham Hangula
Namibia Energy Institute	Expert	Helvi Ileka
NamPower	Government	Fred Bailey
Private Financing Advisory Network	Expert	Harald Schütt
Soltech	ESP	Jason Sivertsen
Solsquare	ESP	Leonhard Eins
UNDP Namibia	Client	Alka Bhatia; Armstrong M Alexis
USAID	Donor	Randy Kolstad, David Jarrett
FNB	Commercial bank	Bolle Hans
University of Namibia	Expert	Prof. Chisale
SACREEE	Expert	Kudakwashe Ndhlukula
Ministry of Finance PPP Unit	Government	Rauna Mukumangeni
Namibia Biomass industry Group	ESP	Colin Lindeque
COMESA	Expert/Donor	Harrison Murabula, Samuel Mgweno
RERA	Regulator	Elijah C. Sichone

We have interviewed over 100 relevant organisations during the first phase of the study with whom we have touched upon the different aspects of off-grid energy financing in Sub-Saharan Africa (4/4)

Zimbabwe field visit

Organisation	Role	Contact
African Development Bank	DFI	Petronella Utete Laina Muguti
DPA Africa	ESP	Sindiso Ncube Taona Jakachira Edward Muchuchuti
Ministry of Health and Child Care	Government	Celestino Basera Clive Marimo
Stanbic Bank	Commercial bank	Lucia Siyavora Joshua Tapambgwa Blessing Manyeche
UNDP Zimbabwe	Client	Georges van Montfort Madelena Monoja Emmanuel Boadi Pfungwa Mukweza
UNICEF	Donor	Emelie Karre

Zambia field visit

Organisation	Role	Contact
Get Fit Zambia	Donor	Dailesi Njobvu
African Development Bank	DFI	Lewis Bangwe
USAID	Donor	David Mpundu
World Bank	DFI	Christopher Saunders
Delegation of the EU to the Republic of Zambia and COMESA	Expert/Donor	Davide Bixio
Buffalo Solar	ESP	Will Dryer
Embassy of Sweden	Donor	Magdalena Svensson
DFID	Donor	Magda Johansson
University of Zambia	Expert	Professor Prem Jain
Medical Stores Limited	S4H beneficiary	Timothy Sakala
Ministry of Health	Government	Jason Wamulume; Raphael L. Mwanaza
Vitalite	ESP	Russell Lyseight
Zambian Energy Corporation	ESP	Michael J. Tarney
UNDP Zambia	Client	Lionel Laurens; Winnie Musonda; Jan Willem van den Broek; Caoimhe Hughes

A number of stakeholders will intervene in the implementation of the S4H scale-up and shall have well defined roles and responsibilities

DFIs/IFIs

Financial role: provide upfront capital in exchange for financial returns
Operational role: conduct due diligence prior to and track its performance throughout the investment

MOH

Financial role: contributes to electricity payments
Operational role: PPP contract management, prepare O&M transition under MOH after the transfer of ownership

UNDP GO

Financial role: support the ESPs in raising capital for the project implementation
Operational role: coordinates the project implementation and the interactions among the different parties

International donors

Financial role: provide grants for energy payments, TA grants and/or guarantees to decrease the repayment risk; support the project feasibility by decreasing risks for other financing/supporting parties

MLME
DoE/RREA/LEC

Financial role: could provide subsidies within rural electrification plan; feed-in-tariff
Operational role: support the MOH in the selection of site, need assessment and technical specifications

UNDP CO

Financial role: receive TA fees, monetise reductions of carbon emissions
Operational role: provide TA, support procurement process, champion policy change at national level, assist in M&E

Energy service provider

Financial role: bear financing risk and obtain installation & O&M fees
Operational role: purchase, install and maintain the installations throughout the contracted period

MFDP

Financial role: guarantees the MOH obligation under the PPP
Operational role: support the MOH in the PPP process

TA provider

Financial role: receive TA fees, financed by donor grants
Operational role: provide TA to the local ESPs and to the MOH

Source: KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (1/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Committed/ invested amount	Instrument
Liberia National Adaption Plan	Green Climate Fund		Integrate climate change adaptation in agendas of key ministries and agencies	Strengthening enabling environment and building institutional capacity	US$2.2m	Grants
Rural Energy Strategy & Master plan	European Union		Develop Liberia's rural energy master plan	Enabling environments and building institutional capacity	US$2m	Grant
Liberia Renewable Energy Access Project (LIRENAP)	Strategic Climate Fund Grant & World Bank		Increase electricity access via decentralised electrification	Developing supply chain and addressing demand-side constraints	US$27m	Grants, loans
Beyond the Grid Fund for Africa (BFGA)	Government of Sweden		Build market for off-grid energy in rural & peri-urban areas	De-risk commercially viable projects	n/a	Grants
European Development Fund (EDF)	European Union		Increase rural electrification of south-east Liberia (mostly via grid and mini-grid)	Developing rural energy infrastructure (e.g., mini-grid)	€45m	Grants, sub-ordinate loans, (junior) equity
Light up Liberia (LUL) Program (*completed in 2019*)	European Union		Support local ESPs to deploy solar lamps and cook stoves, and later SHS and solar pico-grids in rural areas	Supporting local ESPs	US$2m	Grants
Renewable Energy for Electrification in Eastern Liberia (REEEL)	African Development Bank & Strategic Climate Fund		Develop hydropower power plant in Nimba County	Building energy infrastructure	US$34m	Grants, loans

BFGA Zambia program budget is US$20m, while Liberia's program budget is US$10m
Source: KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (2/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Committed/ invested amount	Instrument
Energising Development (EnDev) by GiZ	Germany, Netherlands, Norway, UK, Switzerland & Sweden		Strengthen SE sector and promote solar PV technologies	Developing local ESPs and increasing awareness of SE	n/a	Grants
AECF-REACT SSA Project	Government of Sweden		Incubate local ESPs via TA and seed funding	Early-stage ESPs	US$6.5m	Grants
Regional Off-Grid Electrification Project (ROGEP)	World Bank		Develop off-grid ESPs via TA and loans to support electrification of public institutions	Supporting local ESPs; focus on public institutions	n/a	Grants, loans, guarantees
Power Africa Beyond the Grid Initiative (BTG)	USAID		Increase electricity access via off-grid RE solutions	Increasing public awareness of benefits of solar energy	US$4.6m	Grants
Renewable Energy for Electrification in Liberia (REEL Project)	African Development Fund (ADF) , Scaling up Renewable Energy Program (SREP) & Transitional Support Facility (TSF)		Develop several hydro power plants in various locations across the country	n/a	US$25m	Grants
Liberia Energy Efficiency and Access Programme (LEEAP)	African Development Bank, European Union & Global Environmental Fund (GEF)		Extend the main grid and increase connections; strengthen project management capacity	Capacity building	€45m	Grants, concessional loans

EnDev total programme budget: €339m split across 21 countries; budget per country not available
ROGEP programme budget: US$200m for 15 ECOWAS countries
Source: World bank; KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (3/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Invested amount	Instrument
Southern Africa Energy Program (SAEP)	USAID		Increase the supply of and access to electricity in Southern Africa	Various	n/a	Grant
Climate Resilient Agriculture in three of the Vulnerable Extreme northern crop growing regions (CRAVE)	Green Climate Fund		Provide rural farmers with alternative sustainable access to off-grid solar energy technologies. promoting solar water pumping in the agricultural sector	Adapting off-grid solar energy technologies for agricultural sector	US$10m	Grant
SUNREF (Sustainable Use of Natural Resources and Energy Finance)	Agence Française de Développement (AFD)		Support financial institutions and their clients to boost financing for projects for sustainable natural resources management, focus on clean energy.	Enabling environments and building financial institutional capacity	n/a	Loan
Adaption Fund	Desert Research Foundation of Namibia		Pilot of poor quality local groundwater to a level that complies with the national standards for drinking water, using sun and wind energy	Improved resilience of vulnerable communities and groups to climate change impact	US$5m	Grant
Promoting Renewable Energy for Climate Change Mitigation Initiatives in Namibia	European Union & Spanish Red Cross		Mitigate the negative impacts of climate change in rural vulnerable communities	Distribution of solar products	€5m	Grant
Increased Access to Electricity and Renewable Energy Production (Project	European Union		Increase access to clean, reliable, more equitable and affordable energy and promote renewable energy production and energy efficiency across Zambia	Capacity building for renewable energy	€40m	Grant

Source: KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (4/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Invested amount	Instrument
Electricity Services Access Programme (ESAP)	World Bank		Increase electricity access in Zambia's targeted rural areas	Capacity building	US$26.5m	Loan
China- Zambia South-South Cooperation on Renewable Energy Technology Transfer Project	UNDP/ Government of Denmark		Strengthen the enabling environment for the transfer and use of priority renewable technologies in Zambia	Various	US$2.7m	Grant
Renewable Energy Resource Mapping Project	World Bank		Map solar and wind resource potential	Building energy infrastructure	US$3.6m	Grant
Africa Clean Energy (ACE) Business Programme	DFID		Catalyze market-based approach for private sector delivery of SHS products and services	Distribution of solar products Early stage investment and de-risking of commercially viable projects	n/a	Grant
Health Services Joint Fund	Royal Norwegian Embassy, DFID and KfW		Support of the government's priority budget lines, for the implementation of the Health Sector Strategic Plan	Capacity building	US$100m	Grant
Sustainable Energy for Rural Communities (SE4RC)	European Union		Enhance the socio-economic wellbeing of 30,000 rural men and women in Zimbabwe and Malawi through access to modern energy	Improved resilience of vulnerable communities	€7.3m	Grant

Africa Clean Energy (ACE) Business proramme has a total budget of £65m, of which £18.4m has been spent as of 2019 across 14 priority SSA countries
Sustainable Energy for Rural Communities (SE4RC) has a total budget of €7.3m split between Zimbabwe and Malawi
Source: KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (5/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Invested amount	Instrument
Solar Home System Kick-Starter Program for Malawi (under Power Africa initiative)	USAID		Catalyze increased investment and rapid growth in energy sector over a three-year period	Developing local ESPs	US$1.5m	Grant
Energy Sector Management Assistance Program (ESMAP)	Austria, DFID, Sida, SDC, World Bank et al		Mapping solar resource mapping	Capacity building	US$70m	Grant
Malawi Electricity Access Project	World Bank		Increase electricity access	TA and Capacity Building	US$150m	Grant, loan
Solar Energy for National Vaccine Store in Lilongwe	Gavi, the Vaccine Alliance		Electrify medical warehouses	Capacity building	US$1.2m	Grant
Standalone solar systems for rural health posts	Gavi, the Vaccine Alliance		Electrify 50 small rural facilities	Capacity building	US$935k	Grant
UNICEF Health section	UNICEF		Broad annual budget to implement various health projects	Capacity building	US$20m	Grant

Energy Sector Management Assistance Program has spent approx. US$70m in SSA countries
Source: KOIS analysis

Due to very high perceived country risk, private investors and commercial banks are reluctant to invest in the energy sector (RE in particular), therefore energy investments are done predominantly by donors (6/6)

Investment initiative	Funder	S4H Country	Objective	Fit with investment needs	Invested amount	Instrument
Zimbabwe Multi-Donor Trust Fund	Governments of Australia, Denmark, Germany, Norway, Switzerland, Sweden, and the United Kingdom		Water & sanitation and power projects	Infrastructure development	US$145m	Grant
Zimbabwe Reconstruction Fund (ZIMREF)	Governments of Germany, Norway, Sweden, Switzerland and the United Kingdom ; European Union, State and Peace Building Fund (World Bank)		Strengthening of Zimbabwe's systems for reconstruction and development	Infrastructure development	US$44.3m	Grant

Source: KOIS analysis

Case study: S4H grant-funded solar PV system improves the quality of healthcare services provided by a rural health centre at Sinje, while strengthening local capacities via international cooperation

Solar photovoltaic system

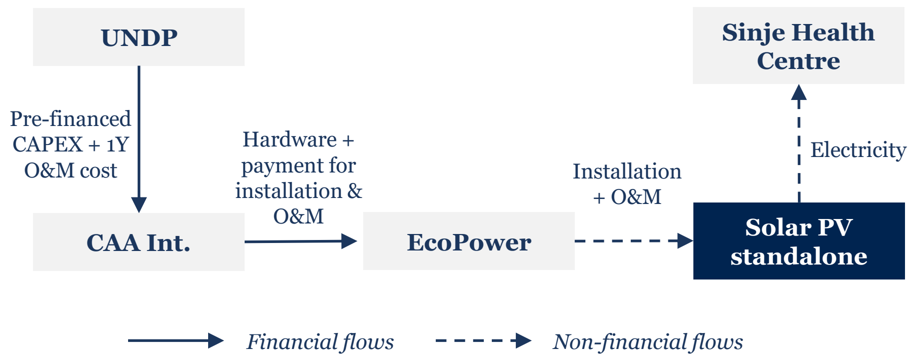
General context: solar PV system installed at Sinje Health Center in Grand Cape Mount County as a part of UNDP Liberia Solar for Health initiative; contracted with CAA International; installed and operated by their local subcontractor EcoPower

Technical specifications: 154 panels with total installed capacity of ~40 kWp; storage system consisting of 54 3-kWh batteries (162 kWh of total power storage, providing 1-2 days of autonomy); powering health center wards only

Commercial information: currently no regular income from the solar power (i.e., public HC services are provided free of charge; surplus power is not sold), though future objective is to extend the power to the village to earn money from community

Financials: funded by a grant of US$139k from UNDP, incl. initial cost (hardware, freight, local distribution, storage cost, installation) as well as upfront funding of 1-year O&M costs (commissioned to EcoPower); import duty waived as equipment was procured via UNDP (general exception to import duties applies to international organisations)

Mechanisms



Key takeaways

- Upfront funding of CAPEX by a donor is a key element for the mechanism
- International cooperation between an international contractor (CAA Int.) and a local subcontractor (EcoPower) allow to share expertise and develop local capacity
- Selection and training of relevant health center workers on solar energy to ensure optimal day-to-day use of the systems

Key challenges

- Ensuring sustainability beyond the current 1-year O&M contract
- Suboptimal use (e.g., overuse of AC) due to an insufficient initial load assessment
- Damage to, theft of, or failure of solar PV systems
- Unpredictable weather conditions represents a major challenge to the use of solar PV systems

Source: KOIS analysis