

GOGLA Technology Working Group

Open solar: options to enhance interoperability

2.30 – 4pm (CET), 30th January, 2020



Aim of Webinar

To review the tangible options for standardisation and interoperability, and determine if there is interest amongst members to collaborate.

Agenda

- Welcome & introductions.
- Graham Pugh, EforA Interoperability Technology Roadmap.
- Drew Corbyn, GOGLA. Overview, benefits & risks.
- Group discussion.
- Garick Lee, GOGLA. Options for a universal connector.
- Claudio Shawawreh, Solaris Offgrid. OpenPAYGO Token and OpenPAYGO Link
- Group discussion.
- Announce EforA R&D Grant + Wrap-up

Graham Pugh

Chair, EforA LEIA Technical Working Group on Interoperability
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Low Energy Inclusive Appliances (LEIA)

See Annex 1 for more info about EforA & LEIA.

LEIA's Relevance to this Webinar

Interventions

Activity



R&D Partnerships &
Co-Investment

EforA research grant for Solaris Offgrid to develop an open source standardized PAYGO appliance communication protocol



Market Intelligence &
Technology Roadmapping

Technology roadmaps completed for solar water pumps, offgrid refrigerators, and compatibility and interoperability

<https://efficiencyforaccess.org/publications/compatibility-and-interoperability-technology-roadmap>

Compatibility and Interoperability Technology Working Group

- A group of 15 – 20 participants from a handful of interested companies, EforA secretariat and GOGLA staff/consultants, and representatives from IEEE and IEC
- Meetings from Sept 2018 to July 2019, with roadmap published in Sept 2019
- Roadmap makes recommendations for Industry Actions and R&D Priorities



Recommended Industry Action 1

The off-grid industry should identify companies willing to lead and/or participate in a working group focused on defining uniform requirements for electrical connectivity

Background and Rationale

- Electrical connectivity for AC appliances missed the standardization opportunity
 - TC23 established in 1934; 85 years on: 14 main plug/socket types, 8 voltages, 2 frequencies, governed at national levels
 - 11 pairs of appliance inlets and connectors for globally traded devices
- Electrical connectivity for DC appliances should not do the same
 - DC chaos is worse – chaos by manufacturer's choice, not national standards
- Electrical connectivity for off-grid systems is at a critical point now
 - Not only lack of standardization, but lack of knowledge
 - Lighting Global Quality Certification and other testing programs don't record data on appliance connector types
 - No comprehensive survey data to identify how many of what type of connectors are used where

Recommended Industry Action 1

Most relevant industry example

USB Implementers Forum

- Formed by seven companies in 1995
 - Now features more than 1000 members
- Goal was to develop and maintain USB as a universal interface to replace numerous different PC connectors
- USB-C now advancing universal DC power connectivity
- Proliferation of AC adapters with non-standard DC connectors contributes significantly to electronic waste
 - Discarded mobile phone chargers have been estimated to account for 51,000 tons of e-waste annually in the EU alone, and the IEC estimates that e-waste from chargers of all types is half a million tons annually

Recommended Industry Action 2

The off-grid industry should identify companies willing to lead and/or participate in a working group focused on connectivity and communication for load management

Background and Rationale

- Ensuring electrical compatibility for off-grid appliances and systems is difficult for consumers
 - Voltage compatibility and current carrying capacity of plugs and cables is not apparent; solving connectivity issue helps going forward, but cables still a concern
 - Consumers need information on sufficiency of supply to meet their needs
- Passive approaches to electrical compatibility
 - Labels to enable an application to read/calculate compatibility
 - Labels to inform consumers of system capacity and demand from each load
- Active approaches to electrical compatibility
 - Communication of power status and active load management
 - This could also be an area for R&D

Recommended R&D Activities

Listed here but not the focus of today's discussion; see roadmap for more information

Development of Interfaces and Protocols

- For power distribution to support load management, depending on industry consensus on whether R&D is necessary
- To support the ability of SHS controllers to interface with other SHS systems, DC minigrids, or AC minigrids
- For remote monitoring of systems and appliances
- For an interoperable PAYG solution for controllers and appliances

Off-grid solar sales. January – June 2019.



Global Sales Highlights

4,11 million

off-grid solar lighting products sold globally

3,10 million

have been sold as cash products for a value of **\$85,34 million**

1,00 million

sold via Pay-As-You-Go (PAYGo) for a value of **\$216,85 million**



2,83 million

solar lanterns sold globally



600,000

multi-light systems sold globally



680,000

SHS sold globally

40,88 MW

newly installed capacity globally through the off-grid solar lighting products



Appliance sales. January – June 2019.



Global Sales Highlights

730,000

off-grid solar appliances sold

535,000

units have been sold as cash products

195,000

units sold via Pay-As-You-Go (PAYGo)



Companies reporting sales data:

- 58 off-grid solar product manufacturers
- 44 off-grid solar appliance manufacturers

Each manufacturer has a different connector and electrical standards.



190,000

TVs sold



530,000

fans sold



3,000

refrigeration units sold



3,000

solar water pumps sold

The interoperability conundrum

Electronics and consumer goods markets show that the “open system” model – with greater interoperability and compatibility enabled by standardisation – is a strategy for market growth.

It enables products, services, and information systems to work well together and cost less to build and operate, while enabling specialisation and greater competitiveness.

It offers consumers enhanced choice, experience and value for money.

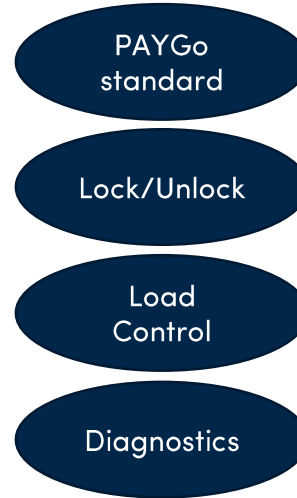
The off-grid solar sector is a unique beast – with businesses combining hardware, software, finance and distribution, and serving low-income consumers in complex and volatile economies.

An “open ecosystem” market presents risks to consumers and companies alike, with challenges to ensure a quality service for consumers that drives brand reputation and avoid increasing payment risk.

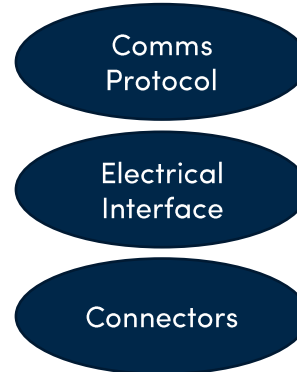
Standardization and Interoperability

- Standardization provides the building blocks for interoperability
- Generally requires major investment from a “heavyweight” player
- Needs a compelling “raison d’être” to be successful

Main benefits to Consumers and Distributors



Main benefits to OEMs and Suppliers



Standardization

Interoperability

Use case specificity

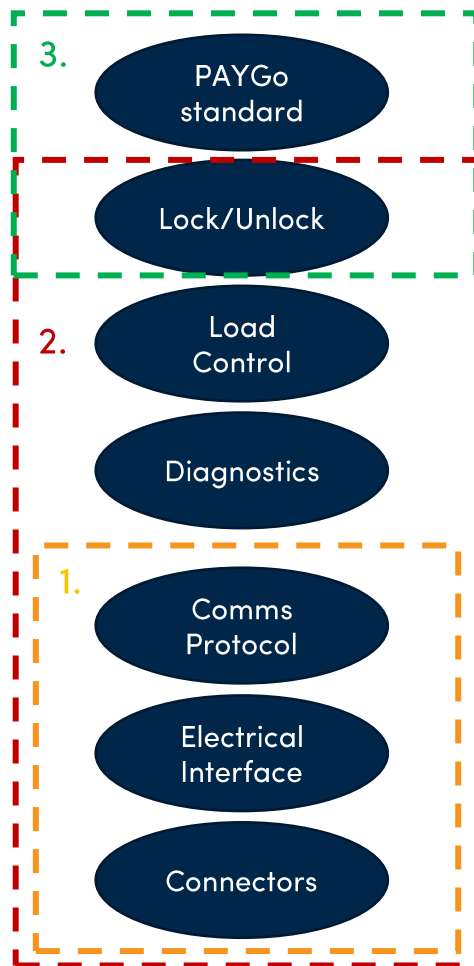


Technical options / opportunities for standardisation



2. Standardized messaging to support diagnostics, load management, verify elec. compatibility, PAYGo activation, and power management .

1. The foundation layer: a universal (family of) connectors, electrical compatibility and communications protocol.



3. A PAYGo standard with protocols (token generation, etc.), software compatibility standards, and PAYGo-enabling hardware.

Initial sale

Combined package:

- SHS kit (core system)
- Appliance

PAYGo

PAYGo company has wider appliance choice and flexibility, and control of service quality.

Consumer choice limited to provider's product range, and appliance only works with the coupled SHS kit (during payment period).

Post payment

- SHS kit (core system)

Appliance unlocked

- Appliance

PAYGo company can offer follow-on products/services (and maintain lock), or unlock.

Consumer has choice and flexibility to upgrade/change either SHS kit or appliance (with original provider or different).

Initial sale

- | | |
|---|--------------------------|
| <ul style="list-style-type: none">• SHS kit
(core system) | Cash
sale or
PAYGo |
|---|--------------------------|

No appliance lock

- | | |
|---|--------------------------|
| <ul style="list-style-type: none">• Appliance | Cash
sale or
PAYGo |
|---|--------------------------|

Distributor offers SHS kit and appliance together AND/OR separate.

Consumer has wider choice of appliances (can select from market), though has to buy cash sale (or from other asset finance provider).
The appliance works with other power sources.

Product Interoperability

Strengths & Opportunities

- **Consumers** would have a wider choice of appliances and increased options for upgrades / second-hand markets (to buy, sell and gift).
- A standard could attract big **appliance manufacturers** (e.g. LG or Samsung) and connector suppliers to the off-grid market – to increase quality and reducing costs.
- **Distributors** would have a wider choice of appliances, would have lower costs of developing a combined hardware, software offering, and the potential to improve supply chain efficiency, e.g. by sourcing locally.
- **Distributors** would be able to switch more easily between hardware and software providers.
- **Environmental** benefits (reduced e-waste) by reducing appliance obsolescence and enhancing repairability.
- It may help mitigate risk of non-harmonised national plug standards, as with the on-grid market.
- It would offer good PR for companies and the sector (e.g. “off-grid solar market demonstrates good coordination and coherence for consumers around the world”).

Issues & Risks

- **Consumers** may purchase appliances that are not well matched with their SHS, resulting in reduced running times (or even faults) and dissatisfaction. For **PAYGo companies**, this creates a brand reputation risk and increases payment risk.
- It is harder to “lock-in” consumers (say, if they can use their TV on a neighbour’s system), which increases payment risks.
- **Companies** would struggle to offer warranty and after-sales to products using off-brand appliances.
- Increased consumer choice adds **complexity to marketing and sales**.
- Upgrades and add-ons are an important revenue stream for PAYGo companies.
- It would likely require a **certification framework** (standard, testing and certification, e.g. USB) and consumer-facing label.
- The transition to new connectors would bring operational challenges, particularly for companies with large product fleets already in the field.

Risk

- Energy service quality

How to ensure that the core system and appliance are well matched (and the appliance does not diminish system performance and damage consumer satisfaction or be cause to raise a warranty claim).

Mitigation options

- Active power management

Standardised diagnostics and load control.

- Passive power management

Battery state of charge display.

Appliance and SHS energy rating labels.

Considerations:

- It would require an appliance certification framework (standard, testing and certification).

Risk

- Payment security

How to ensure consumers that buy an appliance on PAYGo don't use it with another power source (and then cease payments).

Mitigation options

- A 'digital handshake' between control unit and appliance

Function to be deactivated upon payment completion.

Considerations:

- Follow-on sales after payment of initial product (requiring re-activation of handshake?)
- Digital third-party verification of handshake to increase security.

Risk

- Provision of warranty and after-sales

Use of off-brand appliances may void the warranty and make it difficult to provide after-sales services. This would increase payment risk.

Mitigation options

- The 'foundation layer' standard would limit the damage an off-brand appliance could cause¹.
- A quality certification for appliances to ensure compatibility and minimise faults.
- Increased technical training for agents and call centre staff.
- Limited warranties and after-sales service contracts.

Considerations:

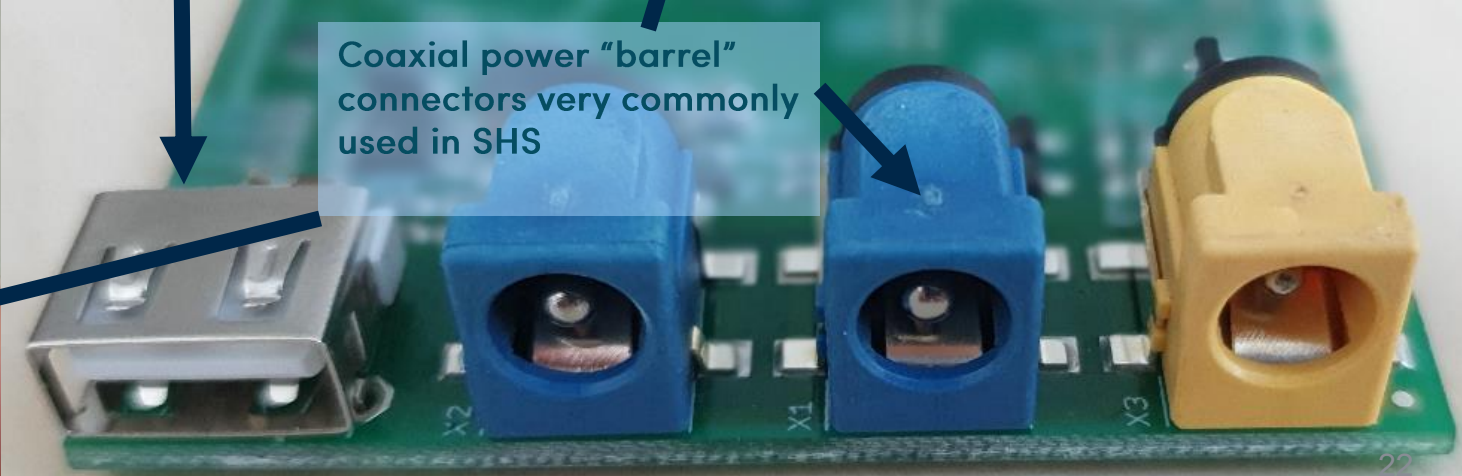
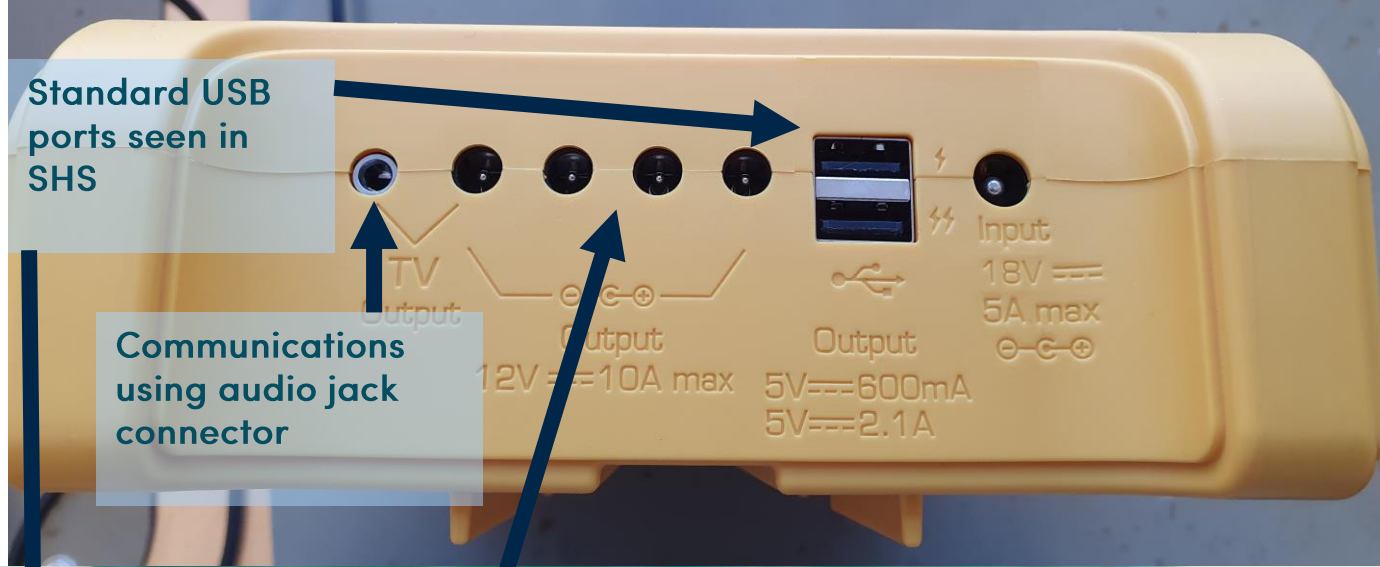
- The warranty risk would only be present if the SHS distributor enabled off-brand appliances during the payment period.
- ¹ The risk of damage occurring is considered relatively low since SHS kits are necessarily robust.

Discussion questions



1. Do you agree that there is a benefit to and/or need for standardization?
2. Which, if any, should be the priority for the industry?
3. Are the benefits of interoperability tangible? Can the risks be mitigated?
4. Is now the right time?

Examples of connectors in use



A universal family of connectors

An industry standard for a family of connectors could look like this (this is for illustrative purposes only).



Connector type	Purpose	Max. current	Specifications	Approx. cost per connector
12V low power	Lights, radios, etc.	3A	Coaxial power ("barrel") connector. 5.5mm outer diameter, 2.5mm inner diameter. Defined polarity. Appropriate labelling	\$0.05
12V high power	TVs, fans, refrigerators, etc.	10A	"Barrel" connector. 6.3mm OD, 3.0mm ID. Defined polarity. Appropriate labelling	\$0.35
PV (36 cell modules, 18V)	All 36 cell modules (18V)	10A	"Barrel" connector. 5.5mm OD, 2.0mm ID. Defined polarity. Appropriate labelling	\$0.35
Communications	For PAYGo comms / load shedding		2.5mm mono audio jack. Appropriate labelling	

Other options for consideration –

- A very high power connector
- Different system voltages (e.g. 12, 24, 48)
- USB-C Power Delivery
- 3-pole "barrel" connectors for combining power and data
- power-line communications

OpenPAYGO Suite

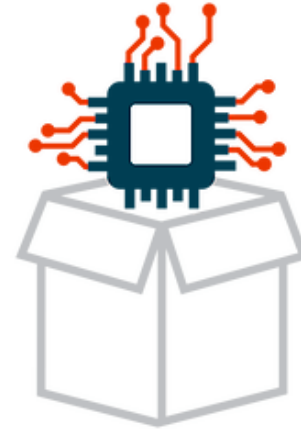
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OpenPAYGO Token:

Hardware and software agnostic appliances.

Technology to make your products PAYGO enabled.



OpenPAYGO Link:

The open source PAYGO communication protocol to make your products interoperable.

OpenPAYGO Link: Problem to tackle

- Appliances and SHS do not share a common protocol for communication
- Each appliance manufacturer has to adapt its own firmware in order to communicate with other PAYGO hardware
- Lack of interoperability between different systems leading to high R&D expenses and high costs for distributors and end-users



OpenPAYGO Link: Solution (1)

- This open-source and free technology ensures interoperability between appliances and SHS from different brand and distributors
- It will rely on a standardized communication protocol shared among the appliances and the SHS for locking and secure activation/deactivation of PAYGO devices
- Custom commands can be built on top of the communication protocol (usage data, load shedding, electrical compatibility)



OpenPAYGO Link: Solution (3)

- Hardware:

- 1-wire communication protocol (Data + GND) or RS485 + UART (pair of twisted cables)
- Level shifter for immunity against noise
- Single data connector (mono jack 2.5mm) separated from power connector (DC barrel 5.5mm).
- The data connector can also be combined with the power one into a 3-pole coaxial cable

- Firmware:

- Custom open source protocol built on top of the standard communication protocol
- Possibility to have load shedding features implemented (8 levels of granularity)
- Data feedback from the appliance at regular intervals to show data usage, potential issues and electrical compatibility of the appliance



A vision for the “open solar” market

We envisage a market in which both “closed system” (proprietary plugs and protocols) and “open system” (standard plugs and protocols) co-exist and compete as part of the commercial landscape¹.

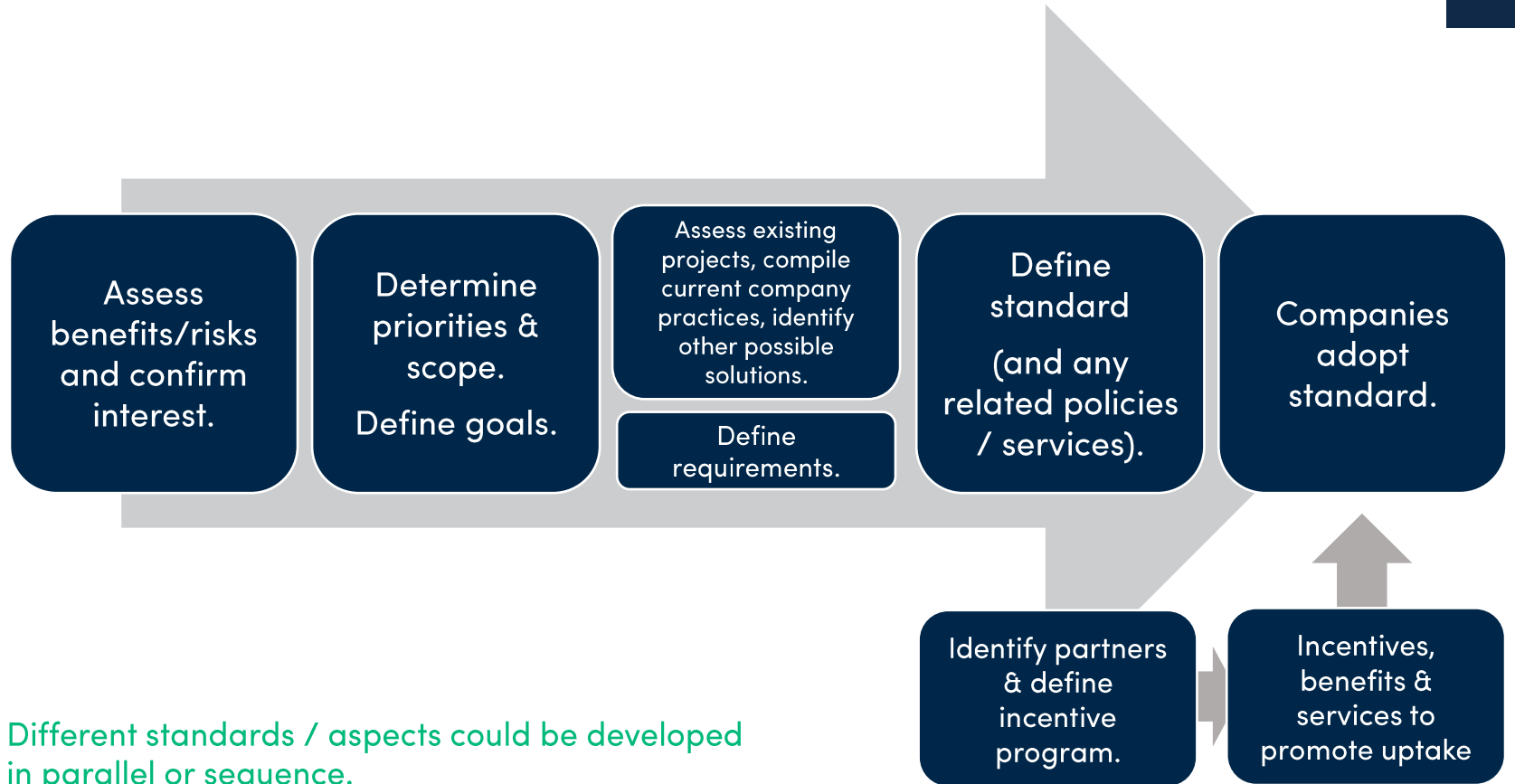
The “open solar” alliance would entail a group of off-grid solar companies and service providers that see value in collaboration, working together to select a connector family, establish the necessary standards and protocols, and implement on their products and systems. It would be entirely voluntary, and (hopefully) financially supported by donors.

GOGLA’s Technology Working Group and the EforA Interoperability Working Group offer platforms to convene the requisite industry players and expertise².

1. This has analogies in other industries – e.g. Mac vs PC, iPhone vs Android, or Apple Lightning connector vs USB for phone charging.

2. Notable other such industry groups include the EMergy Alliance, SunSpec and USB-Implementers Forum.

A possible process to define and adopt standards



Different standards / aspects could be developed in parallel or sequence.

Discussion questions

1. Are you interested to collaborate on this agenda?
2. Which of the specific options are most interesting?
3. Is the GOGLA Technology Working Group the right forum to collaborate on this? What other partners/initiatives could add value?
4. Do you have any feedback on the proposed process?

Open solar: a new paradigm to enhance consumer value and drive appliance market growth



Global Off-Grid Solar FORUM & EXPO

18-20 February, Nairobi

offgridsolarforum.org



Mr. Thibault Lesueur
Co-founder and Chief Marketing O...
Solaris Offgrid



Ms. Makena Ileri
Manager (Research)
CLASP



Mr. Drew Corbyn
Program Manager Consumer Prot...
GOGLA



Mr. Hugh Whalan
CEO
PEG Africa Ltd



Dr. Nigel Preston
Co-founder and VP of Product Dev...
Azuri

EforA Research and Development Fund : Enabling Tech call

Scope

To be in scope for this call, R&D projects must meet the following two criteria:

- 1) Focus on the development of an innovative electrical appliance technology or product for delivery via inclusive business models in off- and weak-grid settings in developing countries
- 2) Focus on at least one of the thematic areas of Inclusivity or Interoperability.

Funding

- Grants are available from £50,000 to £300,000
- Up to £2million in funding is available
- Applicants are required to provide matched funding

Timelines

- 15 March 2020, at 1800 GMT Submissions of applications closes
- May 2020 Successful applicants that pass due diligence are notified
- 1 June 2020 Projects must start by this date

Focus Areas**Priority Areas****Inclusivity**

R&D projects that focus on inclusivity must be targeted towards one or more of the following vulnerable and disadvantaged groups –

- Gender (women and girls)
- Persons with physical or mental disabilities
- Other vulnerable and disadvantaged groups

Gender focused projects should involve either –

- Developing innovative appliance technologies and business models that promote gender inclusion or equality;
- Economically empowering women, at the household level but also women-led enterprises;
- Improving accessibility of appliances for women and girls,

Disability and other inclusivity R&D projects should involved either the development or improvement of an appliance technology or product that assists a vulnerable or disadvantaged group in off- and weak-grid areas.

Interoperability

- Development of interoperable power distribution connectivity interfaces and protocols for SHS load management
- Development of power distribution connectivity interfaces and protocols to support the ability of SHS controllers to interface with other SHS, DC mini-grids, or AC mini-grids
- Development of general data connectivity and communications interfaces and protocols for remote monitoring of SHS and appliances
- Low cost embedded controllers and other components that enable the implementation of the communication protocols above
- Development of technology to enable appliances that require high in-rush currents or have low tolerance for poor power quality to be interoperable with off- and weak-grid power systems, e.g. Embedded or pre-packaged controllers that enable soft-start of motor driven appliances, allowing the appliances to run on power systems with low surge power capabilities

Thank you.

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Annex 1 – Efficiency for Access Coalition & LEIA Program

About the Coalition

Donor Coalition



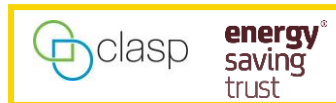
Investor Network



Programme Partners



Co-Secretariat





Low Energy Inclusive Appliances (LEIA)

A research & innovation programme that aims to accelerate the availability, affordability, efficiency, and performance of a range of low energy inclusive appliances particularly suited to developing country contexts.

<https://efficiencyforaccess.org/leia>

Technology Focus Areas

LEIA will help **halve the cost** and **double the efficiency** of a range of off- and weak-grid appliances in least developed countries.

Driving scale in **near-to-market** technologies:



Televisions



Fans



Solar Water Pumps



Refrigerators

Enabling innovation in **horizon and enabling** technologies



Brushless DC Motors



Connectivity/Internet of Things



Advanced Electric Cooking



Agricultural Processing



Interoperability



Advanced Cooling

LEIA Program Overview

Interventions



Example of Programmatic Activities

Run Solar Water Pump and Refrigerator Competitions to identify and reward market leaders

Test over 250 off-grid appliances procured directly from the market in over ten countries and publish the results online

Coordinate a coalition of donors investing in the off-grid appliance sector

Publish appliance market trends reports in collaboration with GOGLA, Lighting Global and others

Provide grants to fund joint R&D efforts to address technology barriers

Annex 2 – Open PAYGo Token

OpenPAYGO Token: Our technology

- Developed thanks to the funding provided by Enaccess
- Free and secure Open Source Token System to make any product PAYGO compatible
- This token system can be integrated with any PAYG software platform
- Possibility to generate token offline
- Multi-purpose transmitted token



OpenPAYGO Token: Security

- The security of the algorithm and the implementation has been reviewed by several industry specialist
- The security of the open token generation algorithm resides in the secret key used for encryption known only to distributors and manufacturers



OpenPAYGO Token: Download package

- The free download package includes the open-source and well documented PAYGO technology suite:
 - Guide to understand the different cost and compromises in the choice of code-based PAYGO systems
 - Source code for implementation in servers and devices
 - Examples
 - Hardware schematic and layouts
- Through merge requests in the github repo everybody can contribute to the project:

<https://github.com/EnAccess/OpenPAYGO>

<https://github.com/EnAccess/OpenPAYGO-HW>

