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Energy for Rural Industrialisation **Productive Use of Energy 2.0**

NEW SCALING OPPORTUNITIES AND INNOVATIONS IN THE SECTOR

Ashley Wearne, Jeroen van der Linden, Zachary Bloomfield

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List of Abbreviations

A2EI	Access to Energy Institute
AECF	Africa Enterprise Challenge Fund
C&I	Commercial and Industrial
CaaS	Cooling as a Service
DC	Direct Current
DESCO	Distributed Energy Service Company
DFI	Development Finance Institution
EEP	Energy and Environment Partnership
EnDev	Energising Development
ESMAP	Energy Sector Management Assistance Program
FI	Financial Institution
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ICT	Information and Communications Technology
Intl.	International
kWh	Kilowatt hour
MDB	Multilateral Development Bank
NGO	Non-Government Organisation
PUE	Productive Use of Energy
RBF	Results-based Finance
SDG7	Sustainable Development Goal 7 (Affordable & Clean Energy)
SHS	Solar Home System
SIR	Solar Irrigation Rwanda
SME	Small and Medium Enterprises
TA	Technical Assistance
UNCDF	United Nations Capital Development Fund
USD	United States Dollars

Executive Summary

Rural electricity supply (grid extension, mini-grid, stand-alone) programmes and private sector-driven electricity access projects are beginning to scale up, approaching a point where electrification projects target hundreds of villages rather than, say, ten or twenty. Productive Use of Energy (PUE) promotion concepts must now be designed so they can be implemented at the same scale.

This study analyses the **changing nature of the PUE landscape.** It looks at the innovations and models emerging in the market and discusses the challenges hindering the deployment of large-scale PUE promotion, especially in off-grid areas. Formerly a topic dominated by technical assistance agencies and non-profit organisations, the improving pace of electrification positions us at the beginning of a new era. **Today, the private sector is defining innovative new approaches** and donors and governments are developing models to shift promotion from experimentation to scale – a kind of PUE 2.0.

With this study and future exchanges, **GET.transform hopes to inspire a new dialogue on *Energy for Rural Industrialisation,*** inviting practitioners to discuss opportunities and shape the sector to capitalise on emerging trends. We see this and other publications as documentation of an ongoing effort – one we are pleased to participate in. Only by bringing public and private stakeholders together can we accelerate the development of scalable approaches for renewable energy-enabled rural development.

Many actors in the sector have expressed the need to improve our understanding and approaches towards PUE. While promising trends are emerging in some countries, much funding for PUE is still flowing to project implementing agencies due to a lack of private actors, or a lack of understanding around commercial opportunities. This leaves **enormous sums of committed funding going unspent, or diverted away from the burgeoning commercial PUE sector, towards unscalable non-profit '1.0'-style measures.**

Furthermore, development banks and donors have little experience to draw upon when it comes to **designing support mechanisms.** This leads to the creation of support mechanisms that may distort the market, crowd out banks or simply fail to mobilise.

The purpose of launching this discussion targeted at government, development banks and donors, is to advance the understanding needed to support early-mover companies in the sector that are refining promising business models. Overall, we hope to foster convergence and partnerships amongst actors to minimise disruption to the already fragile rural electrification sector.

The topic of PUE does not fit eloquently or statically into any one particular sector. This explains why the discussion and understanding of issues involved has also been fragmented as the PUE market seeks to contribute to what is, above all, a rural economic development issue. Energy, agriculture, finance, rural commerce, industrial policy, trade, development cooperation, regulation and other fields will come into play. This variety of sectors presents as many challenges as opportunities. However, **the conditions for positive impact and innovation are steadily improving.** This needs to be capitalised on. How we do that is the topic of this paper and the dialogue we seek to inspire.

ASHLEY WEARNE
Off-grid Markets and Regulation Expert,
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1 Introduction

1.1 Background and Study Scope

Over the past decade, many pilot projects and village-level donor interventions have been conducted by development agencies, programmes and research institutes like GIZ, EnDev and A2EI, on the productive use of (renewable) energy (PUE) in rural off- and on-grid electrification. The objectives of these projects have centred around enhancing the financial feasibility and economic impact of energy access. The feasibility and impact of the PUE measures themselves have also been examined. It is well established that PUE initiatives increase the socio-economic impact of electrification. PUE reduces workload, increases income and generates employment opportunities, along with other positive outcomes pursued under the heading of *rural development*. Experience also shows that **the *omission* of a well-integrated PUE strategy can often minimise the intended impacts of rural electrification programmes in Africa.**

Currently, the sector is characterised by individual small-scale successes to deploy PUE in rural electrification projects. There are **no examples of projects or approaches which successfully scale PUE** and/or accelerate the market for PUE appliances. Government and donor electricity supply (grid extension, mini-grid, stand-alone) programmes and private sector engagement are beginning to scale up towards the potential of implementing 100-village projects. PUE promotion concepts must be designed for implementation at the same scale.

Fortunately, we are beginning to see **new trends in PUE activity between end-users and promoters.** With this, opportunities for scaling up are potentially available to us.

This study aims to identify the **changing nature of the PUE landscape.** It assesses the innovations and models manifesting in the market and discusses the main challenges hindering large-scale deployment of PUE support and promotion, especially in off-grid areas. The study also considers the effectiveness of several dissemination and disbursement mechanisms.

THE HIGHLIGHTS OF THIS PUBLICATION, IN ADDING VALUE TO THE UNDERSTANDING OF PUE SO FAR, ARE AS FOLLOWS:

1. **A new understanding and definition of PUE itself**
2. **An assessment of the key barriers the market faces**
3. **How the private sector is evolving in the PUE market – what a 'PUE company' looks like**
4. **How Technical Assistance (TA) instruments can complement PUE financing to scale PUE**
5. **What role governments can play to facilitate scaled PUE**

This should enable the development of approaches to effectively disseminate PUE technologies and solutions to potential customers (e.g. individual entrepreneurs, farmers, cooperatives, enterprises), using scalable deployment mechanisms and TA/finance cooperation models. Potential mechanisms to support PUE scaling and market acceleration are topics discussed in a separate paper which will be published at a later stage and looks at the financial challenges and opportunities to scale Productive Use.

1.2 Approach

This study is part of a wider series on *Energy for Rural Industrialisation* that looks at the synergies between electricity access and economic, commercial and industrial activity. Forthcoming publications in the series include GET.transform's case studies on various technologies that governments and donors need to be aware of in their efforts towards rural development and Sustainable Development Goal 7 (SDG7). Our sister programme, GET.invest, has developed upcoming **Market Insights** which help private companies understand the opportunities, challenges and approaches to realising projects in new renewable energy business models.

The present overarching study explores the status of PUE as a sub-sector or discipline and assesses the major developments underway. The approach taken was multi-dimensional. First, a literature analysis identified useful data from earlier studies and provided insights into past approaches used by policymakers, development partners and practitioners. This also uncovered gaps in the literature and set the scope for useful questions to address.

Second, at the core of this study is an analysis of current and emerging businesses and technologies for PUE. Focus group workshops were conducted with energy access and agriculture specialists. Furthermore, over 30 additional practitioners currently working on PUE-related topics were interviewed. This included a cohort of the latest players entering the market as part of the new trends in the PUE landscape – hardware suppliers, service providers, potential lenders and others entering the space due to the growing market of newly electrified villages.

Next, we collaborated with the team of experts from the **GET.invest Finance Catalyst** to obtain input based on the Finance Catalyst's experience in supporting decentralised renewable energy companies and project developers, many of which are active in the productive use space.

Finally, the series aims to open a dialogue on the topic of PUE, inviting practitioners to give feedback, discuss opportunities and shape the sector to capitalise on emerging trends. Our goal is to bring public and private actors together and accelerate the development of scalable approaches for renewable energy-enabled rural development.

2 Important Lessons from Previous Analyses

Improvements in numerous electrification initiatives in Africa, both in terms of strategies and implemented projects, have become tangible over the last decade. Governments and the private sector have joined forces in many markets to accelerate rural electrification. With the increased availability of electricity through stand-alone solar, mini-grids and grid extension, a better understanding of the way in which rural customers use electricity is also starting to emerge, bringing with it new opportunities for PUE approaches. Formerly a topic dominated by technical assistance (TA) and research organisations, the improving rate of electrification positions us in a new phase of the PUE discourse. Today, the private sector is defining innovative new approaches and support organisations are developing models to shift promotion from experimentation to scaling. As a result, this analysis focuses on updating our understanding of recent experiences and new opportunities, while building on the existing body of work for useful definitions and context.

A2EI PRODUCTIVE USE REPORT (2020)[1]

This Access to Energy Institute (A2EI) study explored the potential to scale up the dissemination of various solar-powered products in Tanzania. The goal was to find scalable PUE opportunities by using financial and economic business modelling on data collected through interviews with PUE equipment operators and end-users. The development of a robust technique for assessing PUE business models was also, however, a big part of the study's value for the general public. The value proposition derived from PUE, defined by income generated, was used to assess the impact and scalability of ten solar-powered applications. The authors estimated that two types of businesses – oil extraction and peanut shelling – have high potential and low barriers to scaling up. Under specific conditions, six more applications – spice grinding, rice hulling, fruit juicing, sugarcane juicing, fruit drying and flour milling – were also found to have potential. Maize shelling and coffee pulping, however, appeared to have limited potential for generating a stable income through solar power.

PRODUCTIVE USE OF ENERGY: MOVING TO SCALABLE BUSINESS CASES (2020)[2]

This recent knowledge product from Energising Development (EnDev), a global partnership programme for providing energy access, analysed the organisation's experiences in promoting PUE, with a focus on market profile, technologies, challenges and intervention success factors. EnDev has a large presence in Africa and other parts of the world. The paper therefore gives a good overview of how different PUE promotion programmes are set up. It includes several good suggestions on facilitating market expansion, stimulating demand and increasing supply. To highlight obstacles and potential, several PUE project case examples are given. The paper categorises the different approaches to PUE promotion identified: i) Targeting of specific groups (of PUE users), ii) Value chain approaches (covering a specific product), iii) PUE as one element in a broader approach (i.e. integrated in energy access projects), and iv) Focusing on supply side and technology.

1) Avila, E. et al. (2020) 'Productive Use Report - Evaluation of Solar Powered Agricultural Technologies for Productive-Use Applications: A Modelling Approach', Access to Energy Institute (A2EI), https://a2ei.org/resources/uploads/2020/09/A2EI_Productive_Use_Report_Agricultural_Technologies.pdf
2) Havinga, M., Teule, R. (2020) 'Productive Use of Energy: Moving to scalable business cases', Energising Development (EnDev), https://endev.info/wp-content/uploads/2021/03/EnDev_Learning_Innovation_PUE.pdf

PRODUSE Study and Manual (2013)[3] and PRODUSE II (2017)[4]

PRODUSE was a joint initiative implemented by the World Bank's ESMAP, the Africa Electrification Initiative, the European Union Energy Initiative Partnership Dialogue Facility (predecessor to GET.transform and GET.invest) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). The 2013 PRODUSE Study analysed the relationship between electricity access and productive processes, as well as economic development and poverty reduction. In 2013, although policymakers were interested in the link between electrification, productive electricity usage and development impacts, there was little solid evidence on the causal effects of electrification. The PRODUSE study analysed empirical data, concluding that small businesses do not automatically use available power and electricity use does not always result in profit growth. This challenged previous assumptions about electrification's natural impact on economic development, emphasising the necessity for cross-sectoral and holistic approaches to fully realise the impact potential of electricity access. The accompanying Manual provided a methodology and tools for conducting robust empirical studies on the impacts of electricity on small and medium sized enterprises (SMEs). These methodologies were then tested in three Sub-Saharan African countries, comparing businesses in electrified areas with businesses in unelectrified areas. PRODUSE II, a follow up research, built on the initial framework and adapted the methodology to an Asian setting, Nepal, to assess the impact of electrification. Here, the focus was on Nepal's bottom-up community-based approach to rural electrification.

INCREASING THE IMPACT OF ELECTRIFICATION THROUGH THE PROMOTION OF PRODUCTIVE USES (2015)[5]

This publication provides a useful overview of the majority of the promotion approaches still in use in Africa's off-grid market development. Stand-alone solar home system (SHS) companies improved their outreach at a time when rural electrification began to adopt new decentralised technologies and donors were playing a key role in advancing access into rural areas. Five approaches were identified from the perspective of a promoter seeking to stimulate PUE through project measures:

1) 'Electrification Plus' complementary activities such as awareness, training, business development, access to finance and appliances;
2) 'Call-for-Proposals' for existing businesses or start-ups to receive technical/financial support;
3) 'Application-Centred' approaches focused on specific technologies for dissemination via market creation, such as pilot installations, training and financing mechanisms;
4) 'PUE Financing' where a fund is set up to help users purchase certain hardware; and
5) 'Cross-Sectoral' approaches that draw on non-energy sector initiatives, viewing PUE as part of a larger integrated rural economic development approach and thus benefiting from overarching and accompanying initiatives from finance, agriculture, transport and other sectors.

In addition, an overview of the common stakeholders at the time provides a useful comparison in light of the situation as it is developing today. In 2015, ministries, government agencies and utilities were given significantly more weight in the PUE dialogue compared to private stakeholders.

3) Mayer-Tasch, L., Mukherjee, M., Reiche, K. (2013) 'Productive Use of Energy – PRODUSE: Measuring Impacts of Electrification on Small and Micro-Enterprises in Sub-Saharan Africa', ESMAP, Africa Electrification Initiative, GIZ, esmap_giz_bmz_aei_produse_study_fulltext_optimized_0-1_0.pdf
4) Brüderle, A., Tracy, J., Teplitz, W., Reiche, K., Rammelt, M. (2017) 'Productive Use of Energy – PRODUSE II: Measuring Impacts of Electrification on Small and Micro-Enterprises in Nepal', ESMAP, Africa Electrification Initiative, EUEI PDF, GIZ, https://energypedia.info/images/5/5d/PRODUSE_II_-_Measuring_Impact_of_Electrification_on_Micro_and_Small_Enterprises_in_Nepal.pdf
5) Attigah, B., Rammelt, M., Mayer-Tasch, L. (2015) 'Increasing the Impact of Electrification Through the Promotion of Productive Uses' in Sustainable Access to Energy in the Global South, p.33-47, https://www.researchgate.net/publication/300227067_Increasing_the_Impact_of_Electrification_Through_the_Promotion_of_Productive_Uses.

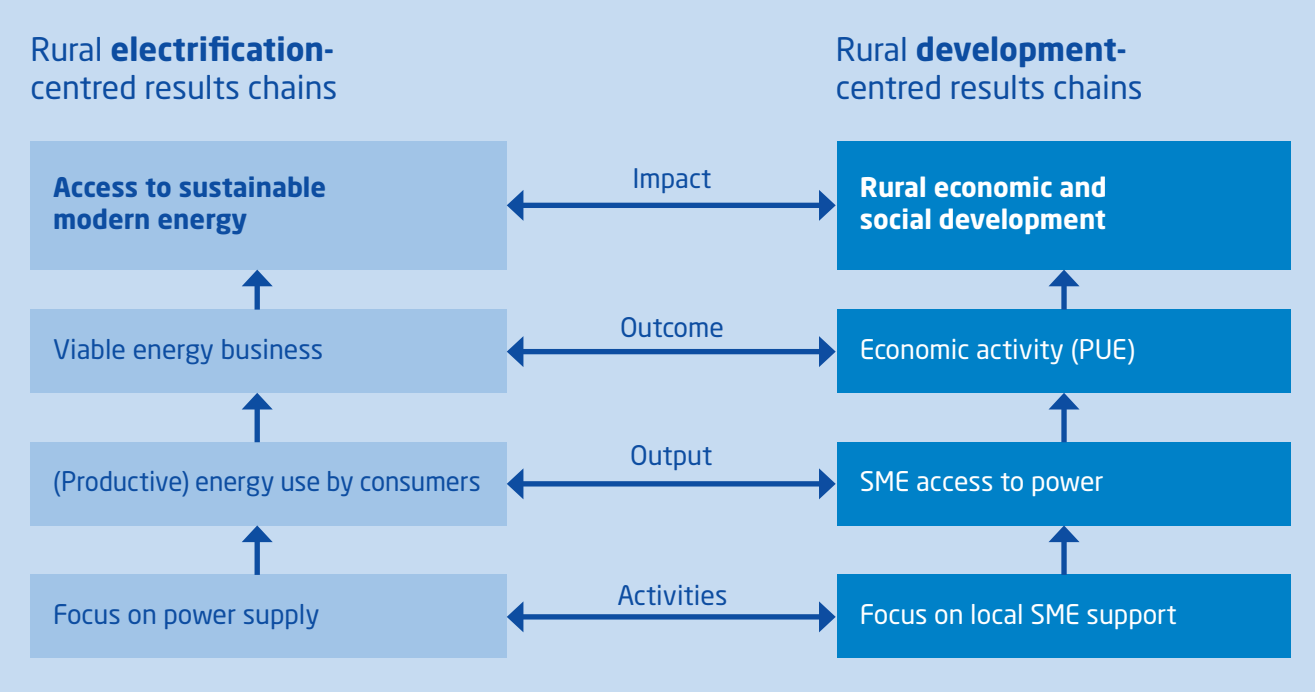
2.1 Updating Definitions and Understanding of PUE

As governments, donors and the private sector learned more about the challenges and opportunities, our understanding of PUE has naturally evolved. Perhaps most importantly, **energy practitioners have had to pivot from a position where the overarching goal was access to electricity supply to one where we think more seriously about what the consumers will do with the power.** As decentralised electrification moves from piloting to scale, we may even be lucky enough to witness a shift away from Productive Use of Energy as an enabler for electrification, and a move toward Energy-Enabled Business as an impact of electricity access.

PUE SHOULD BE VIEWED AS AN OBJECTIVE, NOT AN ACTIVITY OR INPUT TO ELECTRIFICATION

PUE has often been closely linked to the profitability of the electricity distribution business model by rural electrification practitioners: by 'growing the load' and encouraging economic activity with electricity, power supply is supported in its sustainable operations. To emphasise the skewed nature of the old understanding of PUE, energy access practitioners would estimate demand in African communities based on the number of houses and SMEs, choose between grid extension, mini-grid or stand-alone power supply, and then look for PUE equipment and promotion strategies that matched the pre-selected technology and electricity business model. **Strategically speaking, it was standard practice to view sustainable electrification as the objective of the PUE measure, whereas in reality, economic activity should be the objective of electrification.** If we look at PUE holistically, we should consider it as one measure amongst others, alongside electrification, which strengthens the local economy in the same way that electricity supply is envisaged to. Increasingly, companies now prefer to talk about energy-enabled business or similar terminology, instead of PUE technologies. **FIGURE 1**

FIGURE 1. Power supply and PUE in rural electrification vs rural development results chains



compares results chains from the perspective of standard rural electrification practice, as opposed to a new rural development framework for PUE conceptualisation. The point to be made here is that electricity supply should not be the overarching goal, as power alone may not achieve impact.

PUE NOT FAMILIAR OUTSIDE ELECTRIFICATION DIALOGUE

The term PUE is widely used among rural electrification practitioners. For agriculture practitioners or the finance industry, however, it is somewhat confusing or 'cross-cutting'. In Africa, **we observe strong interest from policymakers in the subjects of 'rural industrialisation' and 'industrial hubs' when discussing impact in the energy access dialogue.** The importance of using language that clearly explains what is meant should not be underestimated. The guiding principle of PUE is that electricity is used effectively or impactfully so that it contributes to the socio-economic development of the users and the electrified area. It is in this spirit that we chose to investigate the topic under the roof term of 'Energy for Rural Industrialisation.'

DEFINITIONS VARY BY INDUSTRY SUB-SECTOR

Many definitions of PUE have been used in the energy sector over the last decade and different actors have approached the topic in a variety of ways. PUE is typically thought of by **national grid operators** as a measure to ensure their distribution lines connect industrial and commercial customers. PUE approaches by **stand-alone solar companies** focus strongly on the tools and appliances that can be connected to their (typically DC) systems. **Mini-grid operators** may consider PUE promotion more in terms of stimulating commercial productivity amongst their customers. **Rural electrification agencies,** in general, look at the impact of all forms of electrification. They define PUE as the activities customers engage in with the power they are supplied, in the hope that electricity use improves the user's or community's standard of living or economic situation.

PRIVATE SECTOR'S DEFINITION OFTEN FOCUSES ON APPLIANCES

While PUE originated with actors who provide, plan, finance or support energy access, it is now gaining traction in the private sector, particularly by companies supplying concrete technical (and financial) PUE measures. As a result, **we are seeing more definitions of PUE centred on technologies, appliances and business models** like hardware suppliers that focus on water pumps and irrigation, or service providers that concentrate on cooling. We are also starting to see PUE used to refer to a certain segment of the energy access market, a little like the roof-top, mini-grid and solar home system segments, with some PUE companies joining forces with distribution companies for mutual benefit, like we see with EnerGrow and the Ugandan power utility UMEME.

PUE SEGMENTS ARE DISTINGUISHED IN FINANCE DISCOURSE

Our interviews with financiers revealed a distinction between project-level and product-level PUE. The two are treated differently depending on the type of financing required, the user and the type of activity that drives revenue from the investment. **Project-level PUE encompasses construction and commissioning of renewable energy specifically to power a commercial or industrial process** as a standalone project or bundle of projects such as solar irrigation, pumping and fixed refrigeration units. **PUE at the product-level refers to appliances that add value in some way and tools that "plug-and-play",** usually without project-specific energy generation. Examples include efficient cooking appliances and power tools.

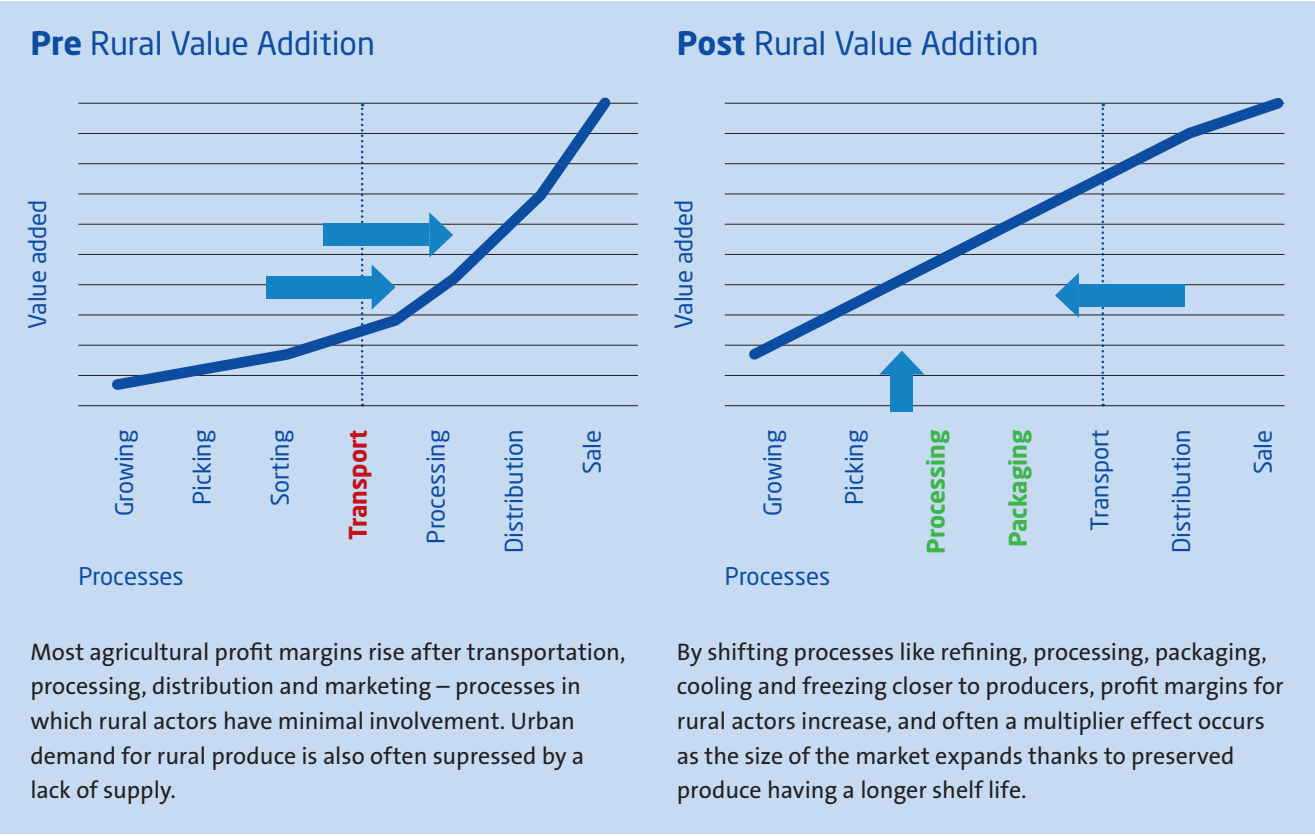
2.2 PUE Definitions Used in this Paper

DEFINITION BASED ON THE OBJECTIVE OF PUE

For the purpose of this paper, PUE refers to agricultural, commercial and industrial activities that use electricity generated where possible from renewable energy sources. There is an objective of boosting production or adding value to products or services from their raw form, thus increasing the returns from sales or extending the shelf life of goods, which in turn drives economic growth. As a result, **this paper focuses on enabling income generation and productivity in rural electrification programmes by integrating productive use into the design of the project or product.** While the emphasis is put on off-grid technologies and applications, captive power in the commercial and industrial (C&I) space is also considered in cases where the provision of renewable energy is directly linked to a specific process. Rural electrification measures that focus purely on power supply technologies may of course lead to incidental productive use applications, even if not explicitly included in the design, but it is important to note that power supply technologies alone have often failed to effect economic activity. As a result, a stand-alone SHS, solar lantern or rooftop panel that generates power is not considered in itself a PUE application. **We look at PUE as an energy-use application which helps alleviate rural poverty, adds value and increases access to business inputs in Africa's agricultural and natural resource-producing regions.**

FIGURE 2 below highlights the impact that rural PUE measures could achieve if we view electrification as a means of accelerating rural development. Measures must include some market linkage to ensure the improved quality and increased quantity of products can also be sold.

FIGURE 2. Shifting a portion of the value addition towards rural areas



Most agricultural profit margins rise after transportation, processing, distribution and marketing – processes in which rural actors have minimal involvement. Urban demand for rural produce is also often supressed by a lack of supply.

By shifting processes like refining, processing, packaging, cooling and freezing closer to producers, profit margins for rural actors increase, and often a multiplier effect occurs as the size of the market expands thanks to preserved produce having a longer shelf life.

DEFINITION FOR PROMOTION OF PUE

In the context of opening a broader dialogue through this study, **we see PUE promotion as measures that are implemented, alongside electricity access,** to support users to realise the benefits of electricity and the opportunities it brings. An important part of promoting PUE is to build the narrative around industrialisation, competitive trade opportunities and the links between rural electrification, commercial planning and national/regional economic strategies. While investigating examples of promising PUE promotion initiatives, we look at

1. **Rural businesses that offer added value and use decentralised renewables and other energy sources to power their plant and machinery;**
2. **PUE entrepreneurs who try to supply the tools and equipment/machinery for PUE to others.**

We also need to ensure that we are promoting both PUE activities initiated from within rural communities by farmers or SMEs, as well as PUE initiatives that stem from outside suppliers. Solutions can come from various angles and PUE definitions must be flexible enough to accommodate all possibilities. Definitions will most likely evolve further as the market matures.

3 Barriers to Scaling PUE

Interviewed stakeholders mentioned various specific challenges to scaling PUE measures. Below, we highlight the most cited barriers. These include the technical realities of reaching users, financial disbursement mechanisms, and capacity related aspects.

3.1 End-user Uptake Barriers

Before analysing obstacles to PUE promotion approaches, it is important to highlight the barriers experienced by rural end-users which continue to prevent uptake of PUE applications in Africa. These barriers have been analysed through different studies, though so far not listed methodically. A literature review and confirmation with practitioners enables a summary of key barriers as follows.

LIMITED DEMAND AND POOR MARKET LINKAGE

Rural producers in Africa often struggle to unlock demand for their produce due to their geographic location and market position. This is a key barrier to rural economic development. We have seen an over-supply of locally available resources, like fruit and vegetables, in several off-grid areas. If these producers cannot get their (enhanced) product to a larger market where it can be sold, then an investment in equipment and/or processes which add value is financially unviable. From a value chain perspective, it is critical to assess the level of demand and market linkage before, or in addition to, intervening with PUE promotion for value addition on a commodity. Interestingly, urban demand can also be suppressed by inadequate volumes of rural supply of raw material – a vicious circle – as the sourcing of small quantities is unviable for larger distributers.

POOR AVAILABILITY OF APPROPRIATE PUE EQUIPMENT IN THE AREAS THAT NEED IT

People and businesses in rural areas with poor electrification have frequently reported having limited access to machinery, tools and equipment. Retail stores often concentrate on necessities such as groceries, or at most, small household electronics. Hardware stores that sell power tools, kitchen appliances, and farming machines are generally only found in larger towns. Yet, even in these cases, the quality of the equipment is usually low and there is generally no after-sales support. PUE equipment found in agricultural regions is often provided by NGOs and donors. The range of available equipment is thus limited, with promoters focusing on particular technologies rather than allowing a natural market to develop. It is important to assess if inadequate availability is a cause of low uptake or an outcome of other barriers. PUE companies have also suggested **promoters should not make equipment available to end-users through direct subsidies, arguing this stifles development of a natural hardware market, and distorts healthy competition by giving new subsidised recipients an artificial advantage over pre-existing operators who may have invested their own money to buy their PUE equipment.**

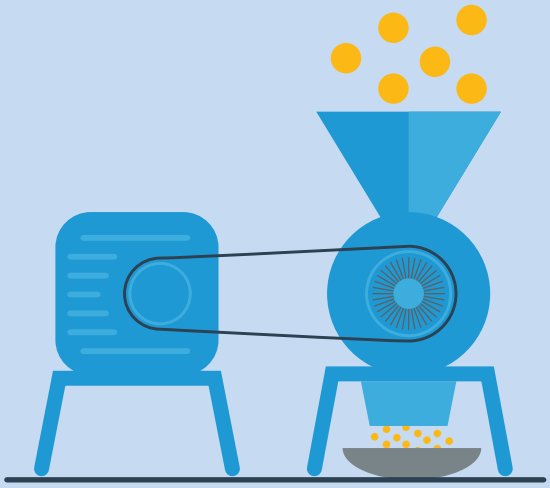
HIGH UPFRONT EQUIPMENT COSTS AND LOW AFFORDABILITY

Another barrier found in almost all the studies reviewed in the context of Africa is that **most PUE equipment that can lead to enhanced economic activity is relatively expensive for the targeted end-users.** Solar pumping and irrigation, mills, cooling equipment and even many of the power tools and appliances used in the services sector range from several hundred to several thousand USD. Farms in Sub-Saharan Africa tend to be too small to generate an income above the poverty line of USD 1.90 per day[6]. With average annual incomes in general ranging from around USD 400 to USD 900 in 2021[7], access to credit and affordable interest rates is another barrier (see below).

LOW ACCESS TO CONSUMER CREDIT AND HIGH INTEREST RATES

Without the financial means to invest upfront, a large proportion of the target group will require financial services to invest in PUE equipment. **The limited outreach of banks into rural areas, high interest rates and the terms/collateral requirements continue to suppress uptake.** Our interviews confirmed that high bank interest rates are a major barrier to purchasing equipment for both end-users and suppliers. We are observing numerous PUE companies developing product finance solutions for end-users, but it is still difficult for suppliers to secure capital at an affordable rate, given the business risks. When it comes to small stand-alone solar equipment, EnDev[8] has warned that Pay-As-You-Go sales mechanisms are unlikely to bear great success. Such equipment is often adapted for both power supply and payment modes, making it relatively expensive. Furthermore, a very large range of applications is required to cover a sufficient cross-section of rural economies. While mills, pumps, cooling and cooking are receiving a lot of attention, a full range of power tools, ICT, processing and packaging, beauty and textiles and so many others are just as important, and these cannot all be adapted for Pay-As-You-Go solar. A more flexible financing instrument to cover all this is necessary.

One hardware supplier said their milling equipment cost is low enough for an end-user to recoup their investment after 75 hours of use. However, farmers quickly recognised that the equipment would process their entire season's crop in just one hour – on their own, smallholder farms do not produce enough material to keep a machine running for 75 hours. Farmers are therefore not the right market for such hardware. Rather, the equipment should be targeted at service providers who can run the hardware for numerous farmers every day. So hardware suppliers of larger equipment need to market these products as a business opportunity to entrepreneurs.
[Source: Interview Elliot Avila (Lead author of 2020 A2EI PUE study and CEO of Imara Tech), 28/10/21]



6) Gassner, A. et al. (2019) 'Poverty eradication and food security through agriculture in Africa: Rethinking objectives and entry points', Outlook on Agriculture, 48(4), pp. 309–315.
7) https://worldpopulationreview.com/country-rankings/median-income-by-country
8) Gassner (2019).

3.2 Delivery and Disbursement Challenges

The challenges to scaling up PUE can vary significantly between project level activity and product level. Nonetheless, in both cases, successfully bringing PUE equipment to end-users demands effective delivery of hardware, related services and deployment of PUE finance. These must be tailored for geographical areas with large, dispersed and underserved populations. Various delivery and (financial) disbursement constraints impact the effectiveness of measures however and these are discussed below.

LIMITED NUMBER AND RANGE OF PLAYERS IN THE PUE MARKET

Governments, donors, financiers and even companies lament the lack of market players in the PUE sector. This is particularly true of private sector actors, such as hardware suppliers, due to the business ecosystem these companies require to establish a functional market. Similarly, while several donors are willing to commit quite substantial funding for PUE, there are limited options for absorption (i.e. limited user-level applicants and limited hardware suppliers). This means these funds are most likely to be used by actors whose primary business model is not related to user-level PUE and on-the-ground impact. For PUE funds to create a meaningful impact, the sector requires financial institutions with dedicated rural services and more specialised hardware wholesalers, retailers, distributors and system developers to deliver suitable equipment to rural businesses. By making funding available without promoting private actors, there is a tendency of attracting unsuitable actors – NGOs, government, utilities or community-based organisations – with non-commercial PUE models.

OVER-RELIANCE ON RESULTS-BASED DISBURSEMENT

Many existing funds in the off-grid energy sector deploy their grants as Results-based Financing (RBF). RBF is designed to reduce or mitigate commercial market failures by providing financial incentives to the private sector to overcome typical, but temporary, market development risks. This temporary type of finance can help various stakeholders (i.e. equipment suppliers, energy and finance providers, etc.) overcome financial risks typically associated with the beginning of the learning-experience curve and eventually reach economies of scale and viability of business models. However, **RBF does little to enable access to the up-front capital required to design and raise finance around a PUE investment.** Companies eligible for RBF would still face the challenge of acquiring working capital to pre-finance business revenues and RBF cashflows.

STANDARD OFF-GRID AND SME FINANCING INSTRUMENTS NOT WELL DESIGNED FOR RURAL BUSINESS

Funds and financing instruments seeking to scale PUE deployment must be designed with the context in mind. Existing finance models for rural SMEs in Africa, in general, are less than ideal. PUE business models are often akin to micro-scale projects; corporate/SME lending approaches are not well suited for such businesses given the proportional loan origination and management costs the lender will bear compared to the revenue (from interest income) paid, in absolute terms, for such small amounts of principal.

Some off-grid renewable energy financing instruments are trying to cater to the PUE market alongside power supply. The relatively large capital costs for PUE projects (number of transactions, diversity of recipients, complexity of investment decision etc.) compared with mature renewable energy investments can result in a slow uptake and limited deployment.[9] Moreover, dedicated funding (e.g. grants) has been concentrated in a limited number of financial institutions or development programmes. This makes it challenging to achieve broad outreach to potential recipients at village level. Grants of this nature can also destroy the market for hardware suppliers, service providers, and commercial lenders, as the donors or fund managers can easily overlook existing, invested market actors and subsidise PUE equipment for new entrants who appeared only after grants became available. The effort of identifying grant recipients for individual PUE appliances is also found to be unscalable.

9) It is also noted that some RBF grant funding opportunities have a limited view of PUE, excluding various types of PUE for financial support.

C&I PROJECT FINANCE NOT DOWN-SCALABLE

With project-level PUE (sometimes referred to as a PUE "pure play" by financiers, given the focus on electricity generation), the financing structure often echoes traditional C&I or captive power projects. Most commonly, this is through a senior loan (prioritised repayment) with a relatively long duration that finances construction of one or more power generation systems as well as PUE assets (e.g. water pumps for irrigation or agricultural processing and refrigeration). The loan is structured on terms that allow for revenues from the asset's use to cover repayment of the loan. However, **the relatively small size and scale of many PUE projects makes it hugely expensive to go through the project finance cycle** used for C&I, especially in the off-grid space.

NO SPECIALIST FUND, INVESTOR OR CHAMPION OF PUE

Among the financing instruments that do facilitate individual PUE investment projects as part of their overarching investment strategy, most active investors do not have a clear strategic orientation (or exclusion) towards PUE. Examples of funds that do include PUE to some extent include the Gaia Impact Fund, SunFunder, ElectriFI, the Africa Enterprise Challenge Fund (AECF), the United Nations Capital Development Fund (UNCDF) and the Energy and Environment Partnership (EEP) trust fund. However, **there are no funds that explicitly and/or exclusively support PUE;** those that are active make their investments in PUE alongside other opportunities and usually prefer other investments that are considered more scalable, lucrative or safe. **The absence of PUE as a core part of a rural electrification fund creates a situation where there is no clear champion for scaling PUE.**

Similarly, many debt providers struggle with project-level PUE as a nexus investment; **since PUE projects/businesses are (often) both renewable energy and agriculture/ industry projects, investment officers may not adequately understand both sectors.** Again, the often small size and relative technical complexity of PUE projects causes many to fall through the cracks, with investment teams typically organised by sectors. This impedes access to critical debt, especially blended/concessional finance which is principally controlled by Development Finance Institutions (DFIs) and Multilateral Development Banks (MDBs).

WORKING CAPITAL DOES NOT COVER ALL POTENTIAL PUE BUSINESS MODELS

Mini-grid operators sometimes act as PUE distributors and after sales service providers, whereas SHS companies typically rely on inventory-based financing, such as working capital facilities which finance everyday operations. However, mini-grid operators are less likely to organise their finances as the latter. Mini-grid developers tend to secure (concessional) loans to fund construction and initial operation of a mini-grid, but horizontal integration into the appliance market requires them to also take on working capital facilities to fund inventory. Furthermore, any actor selling appliances to rural customers will typically also have to extend credit themselves to their customers, who usually lack the cash on hand to pay for an appliance in full. This means **an otherwise well-positioned PUE disseminator may be forced to enter multiple complicated financing arrangements.**

Third-party distributors of appliances, similar to SHS companies, are used to operating with working capital facilities. With the concentration of grid-connected customers in urban areas who have greater ability to pay, it is highly unlikely such distributors would pursue business in more dispersed, rural areas. Undoubtedly some do, but the operational costs of such a sales approach (especially when providing after-sales support) are currently prohibitive compared to an urban-centred approach. Thus, to incentivise more existing appliance distributors to expand their sales focus into rural, 'last-mile' areas will likely require financing below commercial rates (for e.g. impact indexed financing).

FINANCIAL INSTRUMENTS NOT ADAPTED TO END-USER FINANCIAL NORMS

Instead of formal lending services, many potential customers in rural areas prefer to borrow money informally from family, friends or Village Savings and Loan Associations. Again here, it is important to make sure financial instruments (including disbursement mechanisms) are designed in such a way that they complement prevailing structures, increasing the chance of successful adoption. This requires close engagement with local banks, which needs to be supported with identifying viable PUE solutions and financial mechanisms which meet the needs of the potential end-user.

3.3 Technical and Capacity Challenges

One of the key constraints identified through the interviews is the immaturity of the market broadly. While financial instruments are a critical part of increasing supply of finance to PUE, this section discusses the important aspects (and related challenges) to be considered as a basis for growing the market before investment instruments will be able to yield a substantial impact.

USE DATA AND COMPANY PERFORMANCE BENCHMARKS ARE LACKING

One of the main underlying impediments is the lack of reliable data on PUE. Questions around how strong uptake by end-users may be, how stable loan repayments will be and what kind of equity returns can be expected are all key, unanswered questions. The absence of any benchmark data makes it challenging for even the best performing (relatively speaking) PUE players to access finance, since most lenders and investors lack enough usable data to make credit assessments.

END-USER BEHAVIOUR CHANGE AND OVERCOMING HESITANCY

Wider PUE adoption also requires substantial change in behaviour for end-users. Resistance to change, for instance towards prolonged food storage through refrigeration, can be strong in rural areas Rural villagers have seen many innovations introduced and then abandoned in their lifetimes — they also know and fear that utilisation of these new tools may require them to secure a substantial debt. Technical failure or low utilisation/slow payback of a PUE asset is therefore a very real threat to their livelihoods and the welfare of their families.

POOR SUITABILITY OF AVAILABLE TECHNOLOGIES

The type of hardware available to rural agricultural communities is often determined by low affordability, with limited interest from suppliers and diverse motives from governments and donors. As such, in rural areas there is a lot of hardware that is cheaply manufactured, over- or under-engineered for the needs of the end-user or geared towards renewable energy or efficiency above and beyond the purpose required by the user. Suppliers and donors need to improve their assessments of local markets, to ensure the range of available PUE equipment truly reflects local needs and context.

LIMITED CAPACITY FOR AFTER SALES SERVICES

The sale of appliances conceptually aligns with the business model of off-grid energy companies (SHS and mini-grids), as they could potentially increase demand for power and boost revenue for the SHS distributor/mini-grid operator (through sale of more units or increased consumption). However, these companies are usually quite stretched in terms of resources and distribution. They may not have additional human, financial or technical resources available to move into new product lines like sales, distribution and especially maintenance of efficient appliances.

3.4 Lack of Cross-Sectoral Approaches

CROSS-SECTOR COORDINATION AND HOLISTIC APPROACH REQUIRED

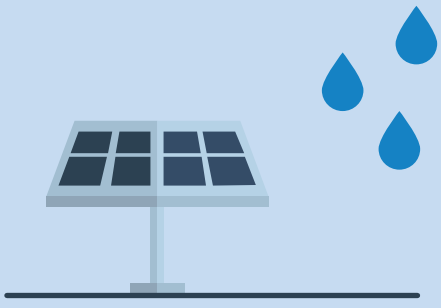
One of the most important conclusions from the research by A2EI on solar powered agricultural technologies for productive use applications is that PUE businesses need to be viewed with more than just a technology-focused lens.[10] PUE solutions, for the most part, do not consider productivity, market prices, access to markets, farmable land size, etc. This suggests that, depending on the applicable sector, nexus considerations (agriculture/health/finance/energy) should be considered in the design and implementation of PUE projects and programmes. This cross-sectoral lens implies a more holistic approach to PUE is required.

PUE project developers will have to interact with a constellation of stakeholders and operate in ecosystems of non-energy related fields such as health, agriculture, etc. Furthermore, there is potential to improve coordination and cooperation among and between sectors of government, development partners and (blended) financing institutions. In combination with offering the right set of technical assistance, this can contribute to financial deal flows. PUE finance instruments should be designed in complementarity with existing (government and development partners) financial schemes and supporting structures.

Drawbacks have, however, been identified with over-complicated integrated rural development programmes:[11] The management complexities and costs have often limited the success of such interventions. Rather than establishing integrated programmes that cover finance, transport, agriculture, energy and others, electrification programmes can be coordinated with other government and donor initiatives to amplify the productive use potential. Examples are numerous and can really differ depending on the creativity of the programme management, but there are excellent examples for the integration of energy supply with agricultural and other interventions.

In Sumbawa, Indonesia, a mini-grid project implemented by EnDev achieved excellent results due the government's broader agriculture and marketing support in the region.[12] In Nepal, the government's strategy required agro-processing mills to be installed in all micro hydro projects. In some cases, we see the private sector themselves apply partial cross-sector approaches (of sorts), linking agriculture, various renewables, other infrastructure like transport and water, social development and most importantly, market linkages. A Dutch flower farmer in Uganda provides various social support facilities for staff, such as housing and health, to improve local integration and productivity. A Swiss food production company similarly established a fruit drying plant with farmer supply networks in Ghana, to source high-quality processed ingredients for export to Europe. The key to the added value and sustainability of these businesses lies in the guaranteed linkage to an unsaturated market. This might also serve as an example for trade and industry policymakers.

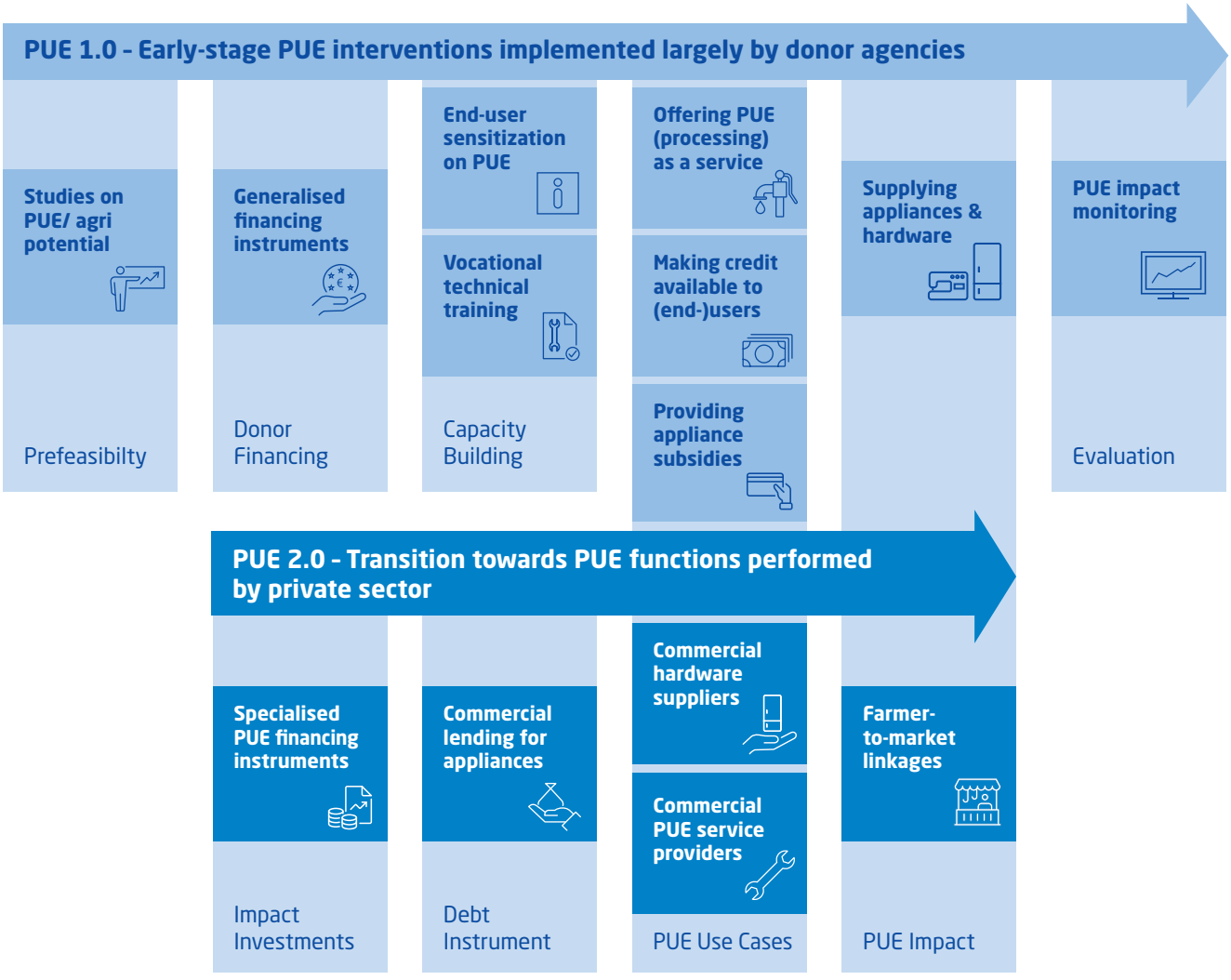
The **Solar Irrigation Rwanda** (SIR) programme has applied a three-pronged strategy to address low appetite from lenders in the market: (1) combining a high level of subsidies with agronomic advice to farmers, helping to reduce the financial risk for potential lenders; (2) supporting several banks to design new loan products, allowing repayments by farmers after the harvest; (3) convincing financial institutions to accept solar irrigation equipment as collateral for their loans. Clearly, this approach requires intensive TA support targeting farmers, processors, distributors and banks. [Source: https://energy4impact.org]



10) Avila et al (2020)
11) Attigah et al (2015)
12) Mahmoody, Farhad et al. (2021) 'A Brief Summary of Good Practices and Challenges on Renewable Energy', Indonesian Ministry of National Development Planning, https://www.esdm.go.id/assets/media/content/content-brief-summary-sstc-renewable-energy-1.pdf

4 Changing Landscape: Emerging Models for Scaling PUE

This section outlines opportunities to scale up technical assistance and catalytic sector financing to the different PUE segments with an eye towards achieving scale. While numerous project implementing agencies continue to conduct valuable piloting and refinement of PUE promotion approaches, a small but growing number of private operators are gradually offering various business models targeted toward the end-user. These developments can reduce the burden on government, development partners and non-profit organisations, by allowing the private sector to play a greater role and even mobilise private capital. These private sector models are still coming into their own, with actors potentially overlapping and alternating between the models identified, rather than following a distinct approach. However, it is clear **there are now new dynamics in the stakeholder landscape and a new set of models that offer the potential to scale up PUE promotion.** This is a welcome development and should be strongly supported (see section 4.2 for further details).



4.1 Stakeholders and Roles in the Modern PUE Landscape

With the PUE market in Africa starting to build momentum and private companies taking on more of the roles previously carried out by non-profit organisations, it is worth revisiting the stakeholder landscape. Most notably, in the zone between the end-user of a PUE appliance or measure and the promoter or TA provider, a number of promising facilitative functions have come into play. These reduce some of the complexities faced in the earlier approaches to PUE, where promotion was often more direct between development partners and end-users, and inherently less scalable.

TABLE 1. An updated PUE stakeholder landscape with new trends emerging

ACTOR	DEFINITION AND ROLE	EXAMPLES
End-user	An individual or enterprise that uses electricity to power an electrical appliance/application which adds value to a product or service in a way that improves their economic situation.	Farming, food processing, manufacturing, hair and beauty, retail, transport, construction, metalwork, health, education
Cooperative	A group of actors, largely from within the end-user category, typically in agriculture, who collectively engage in mutual objectives, such as the improvement of production, processing or market linkage for their product.	Farmers' cooperative, financial cooperative, mining cooperative, women's cooperatives
Hardware supplier *new trend emerging	An individual or enterprise that supplies end-users and service providers with tools, machines, appliances, equipment or any hardware that can be used for commercial, industrial, or even labour-saving purposes.	'Traditional' local shops, specialised PUE hardware suppliers, urban hardware stores, NGOs, some stand-alone solar companies
Service provider *new trend emerging	A contractor or operator that provides a service (such as electricity, farming services, transport etc.) which the end-user applies to add value to their product or service.	Energy service company, cold storage, milling
Commercial lender *new trend emerging	A bank or financial institution (FI) offering debt, usually either to end-users, cooperatives, hardware suppliers, service providers, for PUE activity.	Banks, (D)FIs, MFIs
Technical assistance provider	An actor promoting the uptake of PUE activity through measures such as analysis, sensitisation, training and coordination, or facilitating access to financial risk-mitigation instruments, generally financed by government or donors rather than end-users.	NGOs, government agencies, development agencies, (D)FIs, research institutes
Sponsor	A financier promoting the uptake of PUE activity through free or (blended) concessional financing, usually either to end-users, cooperatives, hardware suppliers, service providers, or through a technical assistance programme.	NGOs, impact investors, (D)FIs, donor agencies.

4.2 Two Promising Private Sector PUE Delivery Models

More and more private sector actors are moving into the PUE space. Their business models, progressively refined over recent years, are already showing compelling results in their ability to solve many of the challenges around PUE promotion and up-scaling. This is particularly so when it comes to end-users' ability to pay and the restricted capacity of lenders to extend their services into rural Africa. Following a review of today's stakeholder landscape, two private sector delivery models for PUE are particularly interesting for our approach to scaling up PUE promotion: the hardware supplier model and the service provider, as shown in Table 2.

These are not the only business models being used and they are not applied one-to-one in every market. We can also see actors sitting somewhere between the lines. However, there are enough examples falling within these two types, and some promising examples of financial viability and technical feasibility. We should also point out that the hardware supplier and service provider models can go hand-in-hand, with different actors working in the same market, or indeed one actor could function in both fields. We have distinctly highlighted the two models due to the prominence they are beginning to show in the PUE market.

TABLE 2. Promising PUE delivery models

HARDWARE SUPPLIER	SERVICE PROVIDER
DEFINITION	
A company which sells or leases PUE equipment to end-users at the cost of the equipment plus delivery and financing fees. This PUE requires power, which will either come with an integrated source (battery, solar etc) or require the end-user to plug in (main grid, mini-grid etc).	A company which sells a service or leases equipment to end-users, whereby either the end-user brings their produce to the service provider and receives it back in a value-added state, or the service is being used to facilitate productive use of energy at the end-user's site. Service providers may supply the power to run the equipment or lease equipment to use with an existing energy service, and can thus cater to off-grid end-users.
EXAMPLES OBSERVED IN THE AFRICAN MARKET	
Power tools, agricultural machinery, household appliances, solar-powered appliances.	(Distributed) energy services, cooling, freezing, drying, transport, milling, processing.
FINANCIAL STRUCTURES EMPLOYED	
Like solar home system companies, hardware suppliers tend to seek working capital in the form of grants and affordable credit in order to finance an inventory. Moreover, they tend to offer credit to their customers, and as such, need to be in a position to offer affordable interest rates for rural end-users.	Service providers may take out a loan or finance their own equipment through equity of grants to strengthen their business case. They tend to charge a fee for service or lease fee to their customers, prioritising immediate revenue with which to repay their investment. In some cases, they may actually buy the end-users' produce and sell it on in value-added form.
COMPANIES IDENTIFIED	
Agsol, Bonergie, EnerGrow, Futurepump, Imara Tech, InspiraFarms, Koolboks, RVE.Sol, Solarise Africa, Solar Village, SunCulture, VAC Solar, other mini-grid companies and (D)ESCOs	ColdHubs, Jumeme, SokoFresh, other mini-grid companies and (D)ESCOs

4.2.1 Hardware Supplier Model

Fourteen of the interviewees in this study reported that the supply of hardware to end-users is either a primary function or a secondary stream of their business. This PUE business model has emerged to fill the market gap that occurs in rural areas, when villages attain access to electricity, but not to the tools, appliances, machines and electronics urban electricity customers can obtain from hardware shops, electronics suppliers or larger supermarket and department store chains. As such, some mini-grid companies or distributed energy service companies (DESCOs) are now supplying hardware in their villages of operation, to stimulate demand for their power and encourage economic activity that creates impact from electrification.

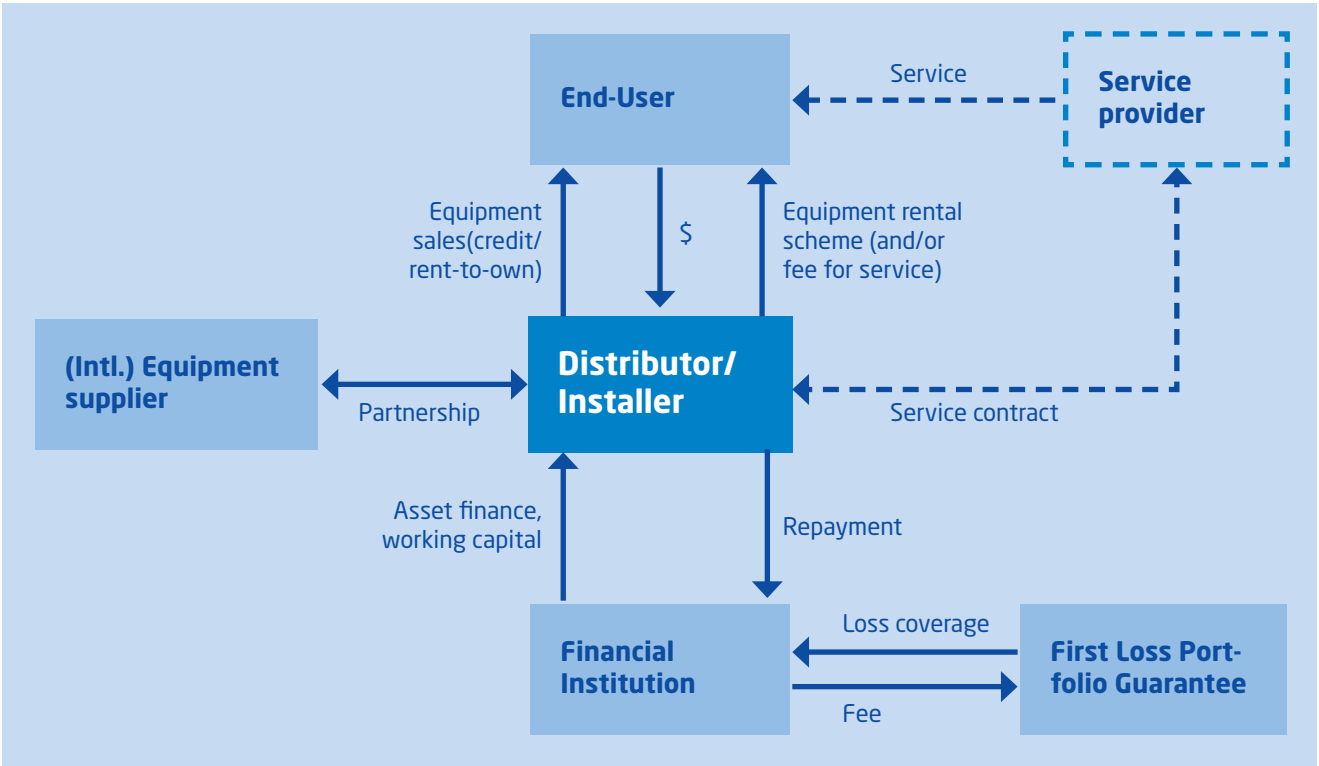
Hardware suppliers are also providing a smart and simple solution to many of the challenges around financing, promoting and disseminating PUE resources. The hardware supplier model builds on lessons from the SHS market, where generally the company seeks to build market share by providing reasonably priced, reliable equipment to end-users in a somewhat captive market. Customers have had little access to these kind of products, given they are often working in previously unelectrified communities. As such, building the customer base, collecting behavioural data, forecasting demand and attracting investment are key. While the ability to reach end-users at scale is a huge advantage, there is a significant risk in this model for companies in terms of the volume of transactions required for viable operations which necessitates large investments and most likely a significant proportion of debt (both borrowed and lent). The difference between the PUE hardware supplier model and the more familiar SHS business models, is that PUE equipment is highly likely to generate a profit for the end-user, which means better repayment rates and a stronger local economy than SHS, the bulk of which are used for lighting and phone-charging.

With private actors in the rural hardware supply business:

- a natural market for hardware can develop, whereby demand from end-users dictates the types of PUE products suppliers carry, rather than non-profit actors experimenting with hardware;
- the distributor (hardware supplier) can focus solely on this function and thus supply hardware to numerous villages, even beyond the scope of a rural electrification project or mini-grid;
- a lender, promoter or investor deals with one partner in the financial transaction, with this partner being far more credit-worthy than the hundreds or thousands of farmers, cooperatives or MFIs involved in previous PUE promotion models;
- the kind of scale, collateral and business model this kind of actor can demonstrate to financiers is more likely (than other models) to receive guarantees (e.g. First Loss Portfolio Guarantee, whereby a third party compensates lenders if the borrower defaults), grants, debt etc., especially as end-user credit ratings and off-take data can be collected by this actor.

EnerGrow in Uganda is acting as a commercial hardware supplier to newly electrified village communities, partnering with mini-grid operators and the national utility, to ensure that businesses are able to buy tools, appliances, refrigerators and other machinery.

FIGURE 3. Hardware supplier model[13]



Use of the hardware supplier model improves in situations where the distributor has a vast local presence (sales and/or service points) in the targeted client area. It can be applied to bespoke, larger scale PUE where specialised equipment is required. In light of the common scenario of African farming communities seeking reliable and affordable processing equipment, interviewees reported logistical challenges with local availability of different types of PUE equipment. As such, many of the hardware suppliers are trying to establish partnerships with larger equipment manufacturers/suppliers (possibly including supplier credit agreements) to mitigate these challenges.

13) The model assumes a financial risk mitigator in place at the financial institution.

TABLE 4. Opportunities and challenges of the hardware suppliers' model

OPPORTUNITIES	CHALLENGES
• The distributor's local presence enables the company to closely monitor PUE needs among its client network and identify the potential for equipment rental or lease mechanisms. • A fee-for-service model (convergence with service provider model) can be considered which may lower the threshold for agriculture producers and cooperatives to engage with the distributor. • Distributors have access to improved lending conditions. • By focusing on tools and machinery, rather than power supply, partnership opportunities with (international) hardware distributors or manufacturers are possible.	• Distributors need to have local presence (sales/after-sales) in areas it wants to service. • Some machines are too large for farmers to invest in and need to be marketed to more entrepreneurial actors. • Distributors would need to seek coverage for risk not covered by financiers (possibly by partnering with manufacturers). • A large number of distributors is required by providers of a First Loss Portfolio Guarantee to reduce transaction costs and spread risk.

4.2.2 Service Provider Model

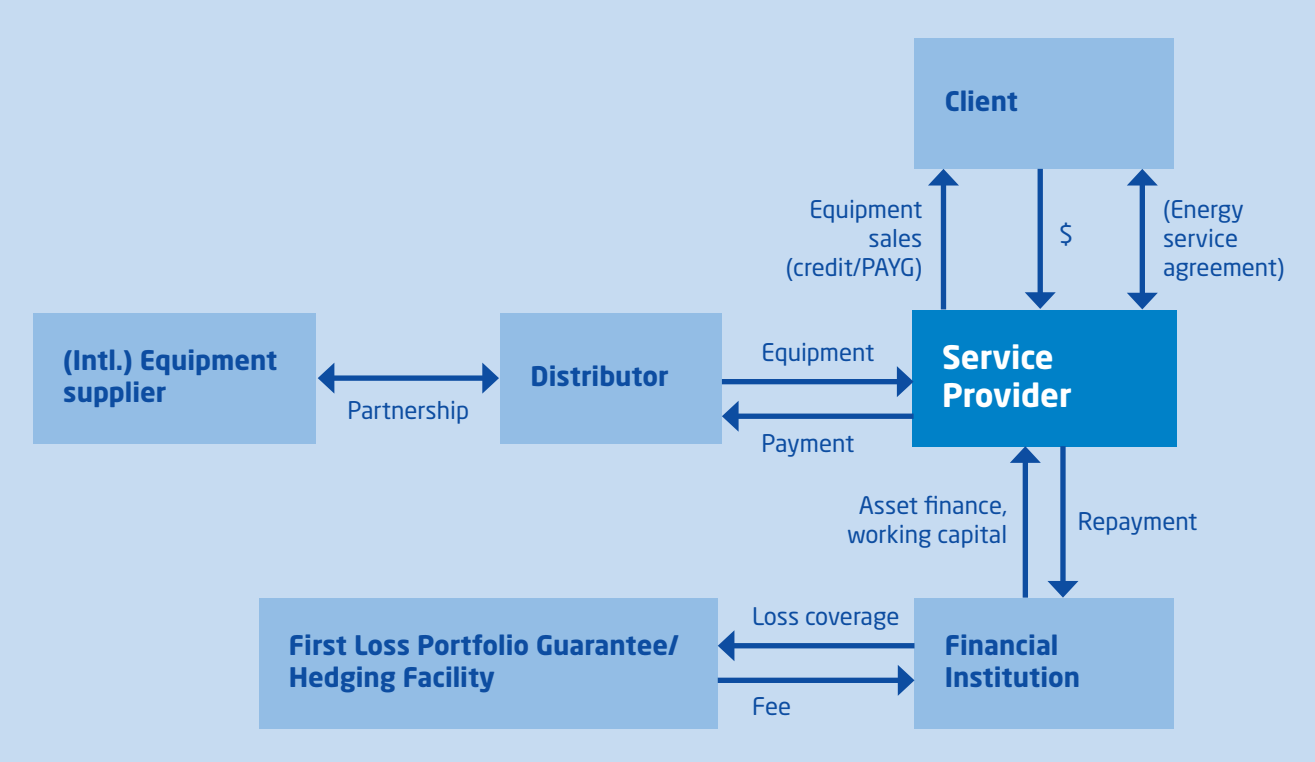
The service provider model is being adopted in many emerging economies with a prominent agriculture base. This goes hand-in-hand with a trend of farmers and end-users preferring to rent equipment than buy it themselves. Such service-based models can be implemented by various actors, including equipment suppliers, traders, entrepreneurs, NGOs, associations and cooperatives. Likewise, mini-grid companies or DESCOs are well placed to offer services under the energy-as-a-service model.

Cooling as a service (often abbreviated to CaaS[14]) is a model that has gained traction in several agricultural settings, with operators presenting a solid case to banks and investors. One such operator in Nigeria, ColdHubs[15], owns and operates walk-in solar-powered fridges and rents the space to traders who can extend the shelf life of their products by several days, easily covering the cost of the cooling service. This works well near markets, but can also be adapted for operation near production sites. Numerous examples of other services have been identified, such as dehusking, milling, grinding and dairy processing. These may be connected to a dedicated power source such as the ColdHubs, or operate alongside main/mini-grids.

ColdHubs in Nigeria operates solar-powered cool rooms where retailers can rent space to store their produce near markets. This allows retailers to extend the freshness of their goods from around 2 days to 21 days, with a post-harvest loss-reduction of 80%.

14) See Cooling as a Service | CaaS (caas-initiative.org)
15) Find more details in the upcoming GET.transform Stand-Alone PUE Case Study.

FIGURE 4. Service provider delivery model



In the case of mini-grid companies offering PUE (processing) services, the company invests in building end-to-end value chains. This feeds into a rural industrialisation concept which adds value to the local economy by processing local commodities close to farmer production sites. Doing this improves the quality and value of the local product and enables the farmer/supplier to tap in to urban or international demand for it. An example of this concept is provided by mini-grid developer JUMEME in Tanzania.[16] JUMEME buys fish from the local community and then freezes it, enabling the fish to be transported and sold to a city market with strong demand.

A mini-grid company or DESCO has the advantage of being able to offer PUE services to their customers under existing relationships. Several mini-grid companies are offering PUE equipment and services through existing energy agreements with households, businesses and/or institutions. Some even integrate PUE fees into the kWh electricity tariffs. This can be offered for a definite term (with PUE equipment ownership being transferred to the end-user after a set time) or an indefinite term (with the mini-grid company providing PUE services as needed by the customer).

The DESCO model is especially useful in situations where distributed energy suppliers, like mini-grid companies, establish energy infrastructure in remote regions where there are either no or limited equipment suppliers and/or MFI branches. The mini-grid company may be the first to establish an (energy) service agreement with a client, paving the way for other services to be offered. One of the downsides of this model is that the DESCO might need to engage directly in maintenance/after-sales services when it comes to supplying hardware. To accommodate this, partnerships with third parties (suppliers, agents) may need to be considered. But in many cases a PUE service provider model may be less complicated, as the DESCO can operate the PUE equipment under its own terms, with its own staff.

16) See the upcoming GET.transform Mini-Grid based PUE Case Study.

TABLE 5. Opportunities and challenges of the service provider model

OPPORTUNITIES	CHALLENGES
• Various actors can play the role of a PUE service provider. • Existing relationships between DESCOs and clients facilitate outreach to potential PUE clients and identification of PUE potential. • Existing customer bases facilitate access to the credit history of potential PUE clients and identification of credit risk (client due diligence), thus reducing transaction costs and risk of default payment. • Payment for PUE services provided by the DESCO can be realised through the energy service agreement (e.g. repayment through kWh tariff). • In case DESCOs offer Pay-As-You-Go modalities, there is need for local currency facilities which can be provided by an (M)FI (possibly in combination with a currency risk hedging instrument). • First Loss Portfolio Guarantees enable access to finance by DESCO with improved lending conditions.	• The stocking, distribution, potential buy-back, potential maintenance and after-sales is very hands-on. • Reputational risks in case of malfunctioning of the products. • Broadens role of the organisation or DESCO to hardware supplier. • Service provider needs to establish and maintain network with equipment suppliers/distributors.

Mini-grid operator JUMEME buys fish from the local fishermen which it refrigerates in order to deliver the local produce to bigger markets, significantly improving the viability of the village power supply and enhancing the impact on the local community.

5 Recommendations and Opportunities for Scaling PUE

5.1 Development Partners: A Different Approach to Promoting PUE

After many interviews, it is clear that investors, financiers, hardware suppliers and service-providing entrepreneurs are in need of support that addresses endogenous and exogenous risks to the nascent PUE space. The role of development partners in this field can be catalytic for accelerating PUE investments, provided they apply an approach which integrates PUE in their programming. Development partners are encouraged to apply the following approaches:

UNDERSTAND AND LEVERAGE PRIVATE SECTOR PUE MODELS

Some PUE interventions offered by government and development partners continue to occupy the space, although it is slowly being filled by the private sector. These actors have warned that continued use of end-user subsidies and grant-financed PUE equipment can crowd out private actors and financiers, who may be in a good position to develop a viable market. A multiplier effect can be achieved by working with hardware suppliers and service providers to help the market grow. These private sector actors can reach a larger number of end-users than a donor or government.

APPLY A CROSS-SECTORAL LENS WITH PARTICULAR ATTENTION TO MARKET LINKAGE

Many project teams within development organisations, as well as facilitators like NGOs and financial institutions, apply a traditional energy sector perspective when addressing PUE challenges. There is need for multi-disciplinary perspectives to ensure PUE integration into programme design. At the same time, the over-complicated nature of integrated donor-driven programmes is a common pitfall, and there has been a tendency for PUE funding to flow into the management of projects and activities, rather than value adding hardware and services. Cross-sectoral linkages need to be established between different development partners and programmes, making use of interconnections with transport, finance and agriculture. The market linkage element (i.e. trade facilitation) especially needs to be linked to a PUE equipment-based intervention, to ensure there is sufficient demand for the products and services enabled by PUE. It may be wiser to focus on connecting rural producers to a bigger market, rather than trying to add value to a product that may not be sold.

INCORPORATE A PUE MARKET ACCELERATION APPROACH INTO PROGRAMME DESIGN

Rather than deploying pilots, development programmes that address PUE should aim to include a set of instruments and activities that can lead to replicability/scale and sustained acceleration of the PUE market as a whole. This implies using different financing instruments to assist companies in different growth cycles. It also implies different types of TA to target different stakeholders (e.g. businesses, FIs, end-users, government).

ENHANCE COORDINATION WITH FINANCIAL INSTITUTIONS PROVIDING BLENDED FINANCE INSTRUMENTS

Several DFIs and MDBs are able to assist with providing various risk mitigation instruments. TA programmes should be designed hand-in-hand with financial products and instruments, including guarantees and insurances tailored to the needs of the market.

5.2 Technical and Financial Assistance

Different types of TA opportunities exist that respond to the PUE scaling challenges and opportunities identified in this paper.

MAINTENANCE AND LOCALISATION OF OPERATIONS FOR PUE PROJECT MANAGEMENT

Scaling PUE requires good availability of PUE assets and related services (e.g. training, repair, after-sales and customer support) close to the end-user. Moreover, PUE equipment or service providers need to familiarise themselves with existing and potential (energy, finance) demands and needs in order to best serve clients. In the absence of local availability of PUE equipment and appliance shops, partnerships between manufacturers/importers and local distributors need to be established. Forming partnerships between stakeholders with shared values can result in risk sharing and improvements in corporate risk profiles.

UPSKILLING END-USERS TO CAPTURE VALUE ADDED OPPORTUNITIES FROM NEW APPLIANCES & TOOLS

The specialised but narrow range of skillsets among farmers and farmer groups for the operation of equipment have been shown to contribute to low PUE utilisation rates. PUE equipment and appliance operators need to widen their skillset and knowledge to grasp the full productivity enhancement potential. Awareness raising is needed to help potential end-users of PUE appliances and tools fully understand how they can use electricity to take advantage of value added opportunities. This will require active demand stimulation to assess current consumer profiles, including energy demand and purchase priorities, to be able to market the right technologies and solutions that accelerate deployment of PUE products. Furthermore, capacity building and business development support is needed to ensure existing and potential clients effectively and efficiently run the equipment to fully benefit their business. Care should be taken in targeting the right users for PUE equipment, who in many cases will not be farmers themselves. Special attention should also be paid to youth and gender programmes in relation to upskilling activities. These kinds of interventions have been highly labour-intensive for donors and NGOs and the question remains whether they will remain part of a scalable system. Here, the cross-sectoral approach provides some hope. For example, we note some instances of electrification programmes joining forces with education strategies, supporting training institutions with course material that covers mechanisation.

PROJECT AND BUSINESS DEVELOPMENT SUPPORT TO MITIGATE ENDOGENOUS RISKS RATHER THAN VIA GUARANTEES

TA in the field of project and business development will assist both PUE proponents as well as financiers to review the technical, economic and financial viability of investments whilst identifying risks and mitigation measures. This enhances the chance of successful implementation and replication. Such TA should also assist the completion of the financiers' due diligence cycle. Capacity assessment and strengthening will also need to be conducted as needed.

EXPANDING AND CENTRALISING DATA CAPTURE

Better availability of reliable data around financial capacity, willingness-to-pay, credit history of potential PUE users, as well as data concerning PUE segmentations and market size, etc., will help PUE promoters and financiers make informed credit assessments and investment decisions. Expanding and centralising data capture on the sector would, over time, deeply enhance the understanding of the dynamics of PUE as a business for lenders and investors, thereby clarifying which risks are real and which may have been presumed but not materialised with frequency.

GUARANTEES AND PRICE HEDGING FOR COST REDUCTION

Certain risk mitigation instruments can be deployed to reduce risk exposure and associated costs for private actors. Guarantee instruments (e.g. a First Loss Portfolio Guarantee or other type of credit risk guarantee) can be instrumental in unlocking financing for development, by reducing credit/commercial, technical and finance related risks. Hedging instruments can be used as a means to minimise losses that could arise from certain price fluctuations on the asset.

REDUCE TECHNICAL AND OPERATIONAL COSTS OF HORIZONTAL INTEGRATION BY DESCOS

DESCOs that recognise the potential of integrating sales (and possibly after-sales) of PUE products into their business model need to be assisted with identifying the main managerial/logistical challenges and cost components associated with this. A structured and elaborate assessment of the economic potential is required. This includes a PUE demand assessment in combination with a landscape analysis and infrastructure assessment for identifying logistical and value chains that can be established or exploited. Equally important, to ensure the business thrives, it will be essential for DESCOs to create partnerships with other actors, such as agri-businesses, to capitalise on complementary skills. This can be useful where the DESCO lacks the necessary skills and/or time to meet certain market demands (e.g. maintenance).

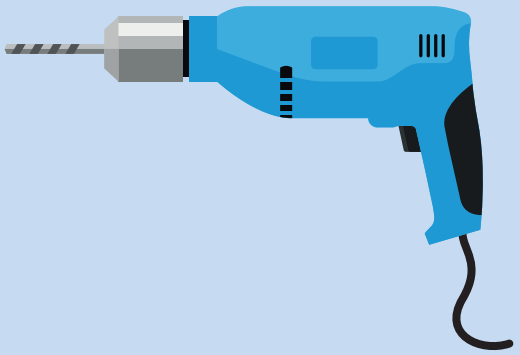
ADAPT LENDING APPROACHES TO MATCH END-USER NORMS

Local banks need to be closely engaged in order to leverage local financial markets. Raising awareness of the different PUE technologies in the financial sector is still necessary and seldom adequate. TA should be provided to help these banks offer financial instruments to farmers and entrepreneurs that better match their cashflow profile. Most individual farmers and cooperatives have poor solvency and few tangible securities that can be used as collateral. Therefore, pre-paid credit schemes like pay-as-you-harvest or a fee-for-service payment modality can help meet cashflow irregularities or upfront payment constraints. Specialised risk assessment and due diligence procedures are necessary for a bank to review credit applications for PUE.

FOSTER OFF-GRID PUE THROUGH CLOSER ENGAGEMENT WITH RURAL DESCOS ALREADY PROVIDING POWER

A DESCO can be well-positioned to further leverage on existing client contacts. This may be a mini-grid company providing energy services to clients, which would have an interest in those clients increasing their electricity use. Many mini-grid developers face the challenge of there being a lack of local hardware stores or equipment suppliers/distributors which can facilitate deployment of PUE equipment amongst mini-grid end-users[17]. As a result, these mini-grid developers directly engage with the suppliers and/or distributors available, whereby the DESCO takes on responsibility for logistics (getting PUE equipment to the client, possibly installation) and consumer financing. The latter can be in the form of a credit provided through the existing energy service agreement between the DESCO and the client. As an example, in addition to the down payment on the asset, the client may repay in instalments through an existing Pay-As-You-Go scheme.

EnerGrow in Uganda provides productive assets (e.g. drills, fridges, sewing machines), working capital and financial literacy and business training to small businesses and households. Appliances are valued between USD50 and USD5,000, while EnerGrow's sweet spot in loan size is USD 500-1,000. The company partners with utility UMEME, facilitating the use of data-driven credit profiling to assess the eligibility of loan requests. Having noticed increased energy demand and revenues from connections receiving asset finance from EnerGrow, UMEME is now considering establishing an off-balance sheet working capital facility.
[Source: Interview Aaron Leopold (CEO of EnerGrow), 28/05/21]



17) Stimulating companies to localise operations could be done by making available capital grants in combination with working capital. (Partial upfront) RBF that is channelled through and managed by a bank could possibly be assessed by the financing institutions as likely revenue. Provided local lending rates are not prohibitive, this could leverage local debt.

Conclusion

Development banks and other donors have only recently gained awareness of the need to tackle rural electrification not only from the electricity supply side, but also at the user-level. It has been challenging to identify financing and implementation models given the granularity of PUE promotion. As such, there has been a limit to the level of coverage that PUE promotion activities have achieved.

The PUE sector has now undergone somewhat of a transition from the '1.0' to the '2.0' era. Where governments, donors and non-profit organisations were previously performing a host of experimental and often one-off pilot interventions to support rural communities to conduct their business with electricity, the private sector is beginning to find commercial solutions to offer finance, PUE equipment and services to end-users.

With this transition, it is important for stakeholders to come together and take stock of the emerging market, understand its challenges and opportunities, and adjust their support to the new environment.

With new opportunities emerging in the market, we see some exciting options to jump forward in this area of the energy access agenda. GET.transform supports partner governments with policy, regulations and strategy, while GET.invest supports the private sector to advance viable business models and access finance. The aim behind the Energy for Rural Industrialisation series is to advance the debate, inspire strategies and build partnerships with like-minded organisations committed to an energy transition which simultaneously decarbonises the energy sector and provides access for all.

Alignment, innovation, awareness and strong partnerships will be the cornerstones of a new and indispensable piece of the energy transition.

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