SOCIAL IMPACT

ADVANCING DEVELOPMENT EFFECTIVENESS

EVALUATION DESIGN

FOR EVALUATION SERVICES IN SUPPORT OF THE BENIN II OFF-GRID ENERGY ACCESS PROJECT

Submitted: **February 27, 2019**

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Submitted: February 27, 2019

Submitted to:

Millennium Challenge Corporation

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ACRONYMS

ABERME	Agence Béninoise d'Electrification Rurale et de Maîtrise d'Energie
ADB	Asian Development Bank
ANADER	Agence Nationale des Energies Renouvelables
AWR	Arab Water Report
CBA	Cost Benefit Analysis
CBNRM	Community Based Natural Resource Management
CEB	Communauté Electrique du Benin
CHNP	Community-Based Health and Nutrition to Reduce Stunting Project
DID	Difference-in-Differences
DQA	Data Quality Assurance
ECOWAS	Economic Community of West African States
EDR	Evaluation Design Report
EIF	Entered into Force
EMICOV	Enquête Modulaire Intégrée sur les Conditions de Vie
EREF	Renewable Energy Facility
ERR	Economic Rates of Return
ET	Evaluation Team
FAO	Food and Agriculture Organization
FDG	Focus Group Discussion
FSRU	Floating Storage Regasification Unit
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GOB	Government of Benin
GOGLA	Global Off-Grid Lighting Association
HOMER	Hybrid Optimization of Multiple Energy Resources
ICCTF	Indonesia Climate Change Trust Fund
IED	Innovation Énergie Developpement

IEG	Independent Evaluation Group
IE	Impact Evaluation
IRB	Institutional Review Board
ITT	Intent to Treat
KII	Key Informant Interview
LED	Light Emitting Diode
MCA	Millennium Challenge Account
MCC	Millennium Challenge Corporation
NGO	Non-Governmental Organization
NPV	Net Present Value
OCEF	Off-Grid Clean Energy Facility
OECD	Organization for Economic Co-operation and Development
OGEAP	Off-grid Energy Access Project
PAYGO	Pay as You GO
PDER	Politique de Développement des Énergies Renouvelables
PDEHR	Plan Directeur d'Energie Hors Réseau
PE	Performance Evaluation
PSRA	Private Sector Response Sub-Activity
PVDI	Photovoltaic Drip Irrigation
QCBS	Quality and Cost Based Selection
RCT	Randomized Controlled Trial
RE	Renewable Energy
REDS	Rural Economic and Demographic Survey
SBEE	Société Béninoise d'Énergie Électrique
SHS	Solar Home Systems
SI	Social Impact
USD	United States Dollar
WAGP	West Africa Gas Pipeline

WWF World Wildlife Fund

1.0 INTRODUCTION & BACKGROUND

1.1 COUNTRY CONTEXT

Benin, a politically stable democracy, has experienced steady economic expansion in recent years (averaging around 4-5% growth each year in the last decade). However, per capita growth has remained low, with macro stability translating to little growth benefit for most citizens. One example of this is the fact that roughly half of Benin's citizens are engaged in subsistence agriculture, productive activity that falls outside the formal economy. One of the factors constraining growth is electricity supply and distribution. Only about 41% of the population had access to electricity as of 2016.[1] In rural areas, where just over half of Benin's population live, access was only about 18%. In addition, "access" (having any electricity or not) belies a spectrum of reliability, quality, and affordability for consumers.[2]

Benin suffers from almost total dependence on regional partners for energy generation, insufficient supply, and inadequate infrastructure. The vast majority of Benin's electricity consumption is fed by imports from Ghana and Nigeria to the Communauté Electrique du Benin (CEB), of which the Government of Benin has been a joint owner with the Government of Togo since 1968. The CEB then supplies electricity to the Société Béninoise d'Energie Electrique (SBEE) for distribution. This imported power meets only 50-75% of Benin's estimated needs. Installed generation capacity has not kept up with demand in either Nigeria or Ghana, and therefore this bottleneck is passed on to Benin. Existing domestic generation capacity is low, erratic, and suffers from sporadic supply of fuel, again from an external source: natural gas from Nigeria transported via the West Africa Gas Pipeline (WAGP).

Even if generation were to increase, and/or become less dependent on external suppliers, access cannot improve without upgrades to and expansion of the existing distribution infrastructure. The current SBEE grid is near capacity, unstable voltage is a problem, and technical losses in the system are high. These conditions are paired with high commercial losses, an issue which has conspired with a weak regulatory framework to deter otherwise interested investors and independent power producers (IPPs).

SBEE is also constricted by the political economy of electricity tariffs, which constrains these to USD 0.20/kWh for typical household consumers. While these tariffs are relatively high compared with those in many countries (Kojima & Trimble 2016),[3] they do not cover the costs of capital investment and the revenue base in Benin is low due to its relatively low per capita consumption (about 110 kWh/capita per year). In the off-grid sector, the new regulatory framework allows for tariffs to be set on a project by project basis ostensibly to allow for cost-recovery plus a profit, yet it is unclear whether such tariffs will be attractive or affordable to

[1] World Development Indicators database accessed via the World Bank Databank: databank.worldbank.org

[2] World Bank Energy Sector Management Assistance Program (ESMAP), Multi-Tier Framework for Measuring Energy Access page: https://www.esmap.org/node/55526 (accessed 12/22/2018).

[3] Kojima, M. & Trimble, C. "Making Power Affordable for Africa and Viable for Its Utilities." World Bank, AFREA & ESMAP: Washington DC, 2016. http://documents.worldbank.org/curated/en/293531475067040608/pdf/108555-Revised-PUBLIC-Making-power-affordable-for-Africa-and-viable-for-its-utilities-Oct-2016.pdf

consumers. Financing capital expansion to increase access is therefore extremely difficult and requires significant public subsidies. In addition, the minimum cost of a residential connection begins at US$150 and rises with distance from the grid. Wiring, and voltage regulation equipment to manage poor voltage stability, add to the cost of a connection that is likely to be intermittent at best. With an average GDP per capita of US$2266 per year (PPP, 2017 current international dollars), connections are prohibitively expensive for most households. These issues are compounded in rural areas, resulting in substantial unmet latent demand, which in turn makes grid extension cost-ineffective. However, off-grid energy solutions have the potential to meet, and drive, demand at a lower-per customer cost.

In recent years, the Government of Benin has been working toward expanding its renewable and off-grid electrification efforts, as well as tackling policy and regulatory issues. In 2014, the Ministry of Energy formed the Renewable Energy Agency (Agence Nationale des Energies Renouvelables, or ANADER), with jurisdiction over all renewable energy and off-grid electrification projects. However, in 2017, three years after its formation, ANADER was disbanded and its role taken over by the Renewable Energy Development Policy Unit (Unité chargée de la Politique de développement des énergies renouvelables, or UC/PDER) as part of the reform process. According to Decree No 2018-050 establishing UC/PDER,[4] the unit is mandated with giving technical assistance on defining renewable energy policy and supervising its implementation.

Additional policy shifts include the Rural Electrification Agency (Agence Béninoise d'Electrification Rurale et de Maîtrise d'Energie, or ABERME). ABERME had been established in 2005 and had focused on projects related to energy efficiency and clean energy in the past; going forward its rubric will be rural electrification via extension of the existing grid.

The 2015 establishment of the National Regulatory Authority (Autorité National de Regulation d'Electricité or ARE) was a major step forward. ARE was the inaugural regulatory authority for Benin's electric power sector and was supported by the already-existing legal framework for regulation. Nevertheless, it remains to be seen whether the GoB will allow ARE the authority and autonomy to enact critical regulatory mandates, such as tariff-setting.

In Benin's 2015 SEF or All Action Agenda, the Ministry of Energy, Petroleum and Mines Research, Water, and Renewable Energy Development stated a goal of 25% renewables in the national energy mix by 2025, up from around 8% in 2010;[5] this is, however, not stated explicitly in any other policy document.

In December 2016, the GoB launched its "Revealing Benin" Government Action Plan.[6] With a budget of US$ 15.24 billion for 2016-2021, this national development and investment plan

[4] Décret No. 2018 – 050 15 février 2018 portant création et mise en place d'Unité chargée de la Politique de développement des énergies renouvelables (UC/PDER), https://sgg.gouv.bj/doc/decret-2018-050/

[5] "Agendas De L'initiative De L'energie Durable Pour Tous (SE4ALL), Benin, Période [2015-2020/2030]." 10 July 2015, Ministère de L'énergie, des Recherches Pétrolières et Minières, de L'eau et du Développement Des Energies Renouvelables. https://www.se4all-africa.org/fileadmin/uploads/se4all/Documents/Country_AAs/Benin_Agenda_d%E2%80%99Action_de_L%E2%80%99initiative_Energie_Durable_Pour_Tous__SE4ALL_AA_.pdf

[6] "Un Nouveau Départ Pour Le Bénin", Benin Révélé, http://revealingbenin.com/

includes electricity as one of its nine key sectors, and renewables as the focus of three of the four projects within this sector:

FIGURE 1: GOVERNMENT ACTION PROGRAM: FLAGSHIP PROJECTS RELATED TO RENEWABLE ENERGY

Project	Aim	Description	Renewables Focus?	Total Capacity Increase (if applicable)
Modernize and Extend the Thermal Sector to Ensure Affordable Access to Electricity	Achieve greater energy independence in the short term through a competitive thermal energy sector operating within an integrated vertical market	Rehabilitate SBEE's power generation fleet Rehabilitate the Maria-Gléta thermal power plant: increase operating capacity to 120 MW – dual-fuel installation Construct a new, 120-MW dual-fuel plant Construct a floating storage regasification unit (FSRU) in the Port of Cotonou: supply gas-powered plants with a total output of 500 MW Rent a stand-by generator set from 2016-2018	No	740 MW
Develop Renewable Energies	Reduce generation costs through the use of hydropower Increase the proportion of renewables in the energy mix by providing rural communities with a modern energy supply	Construct two hydro-electric power plants (Adjarala and Dogo Bis): restore the balance in the thermal power generation fleet through the generation of low-cost hydro-electric energy for rural and urban populations	Yes	Up to 110 MW

		Install solar farms with a total capacity of 95 MW Develop the biomass sector (potential output of 15 MW): improve usage of agricultural by-products (cotton stems, oil palm)		
Restructure the National Operator and its Network	Restructure the national operator and the national grid: new management system and investment in infrastructure	Construct a dispatching centre for the SBEE (Benin's national power grid operator), and modernise the SBEE's operating methods (improvement of grid management capabilities) Strengthen the distribution network Reform of the SBEE's customer management system: invoicing, procurements, skills building for institutional stakeholders	No	
Better Manage Energy Use	Develop a national energy efficiency programme encompassing all sectors: industrial, tertiary (government buildings), households Reduce peak power requirements by 80 MW	Introduce binding norms to reduce energy consumption Install rooftop solar panels with storage batteries on the main government buildings; replace air-conditioning systems and install solar water heaters Replace public lighting bulbs with low-energy	Yes	

		LED lights; solar energy Improve efficiency of domestic energy consumption		

Source: Project Summaries of the Revealing Benin program, http://revealingbenin.com/wp-content/uploads/2017/03/The-project-sheets.pdf

Faced with such significant supply constraints and a highly rural population, but enjoying strong political will for transformation, Benin's nascent off-grid energy sector is poised to emerge as an important part of the energy access solution in Benin. The sector, however faces important challenges, related to unclear government regulation capacity and responsibilities and a lack of clarity about which implementation modalities would be most effective. Multiple donors, including the European Union, GIZ, the World Bank, and the Millennium Challenge Corporation (MCC), are working together with Benin to address these challenges. Specifically, through the Benin II Compact, MCC seeks to address generation, distribution, access, and policy and institutional reform.

1.2 OBJECTIVES OF THE REPORT

This design report presents Social Impact's (SI's) approach to evaluating the design and implementation of the core components of the MCC Benin Off-grid Energy Access Project (OGEAP)—which includes the Off-Grid Clean Energy Facility (OCEF) and the Enabling Environment for Off-Grid Electricity activities—as well as generating lessons learned from the OCEF grant portfolios. This design report is informed by a desk review and a November 2018 scoping trip to Benin by three core team members, and two representatives from MCC. The design report outlines the design for the evaluation and SI's approach to answering each of the evaluation questions.

The report is organized as follows: Section 2 presents an overview of the Compact and the OGEAP interventions, including brief summaries of intended beneficiaries and geographic reach, and introduces the MCC/MCA-Benin theory of change. Section 3 then discusses prior literature relevant to thinking about the impacts of the Compact and discusses the aforementioned theory of change in light of that prior work. Section 4 then presents the evaluation design, including SI's proposed methods and data collection strategies for assessing implementation fidelity and the other questions related to effectiveness, sustainability, successes, and lessons learned. Section 5 summarizes the administrative steps that SI will take to ensure that the evaluation meets ethical and quality standards and describes the evaluation team and the timeline for the evaluation.

2.0 PRESENTATION OF THE BENIN COMPACT AND INTERVENTIONS TO BE EVALUATED

2.1 SUMMARY OVERVIEW OF THE COMPACT AND THE INTERVENTIONS EVALUATED

The Benin II Compact between the MCC and the Government of Benin (GoB) was signed on September 9, 2015 and entered into force (EIF) on June 22, 2017. The Compact targets poor electricity infrastructure, noting that insufficient quantity and quality of electricity results in reduced productivity, output, and investment for businesses, less effective delivery of public and social services and diminished well-being and economic opportunity for households. The causes underlying these problems are lack of resources, and public policies and institutions that have been unable to deliver sufficient power to meet growing national demand.[7]

The Compact will approach these fundamental problems through policy reforms and institutional strengthening, large-scale investments in energy generation and distribution infrastructure and off-grid electrification to expand access in a country where only one-third of the population has access to electricity.[8] The Compact includes four Projects, each with a related project objective[9]: (i) the Policy Reform and Institutional Strengthening Project, (ii) the Electricity Generation Project, (iii) the Electricity Distribution Project, and the (iv) Off-Grid Electricity Access Project.

The focus of this evaluation is the fourth, namely: The Off-Grid Electricity Access Project ($46 million). The OGEAP has the objective of increasing access to electricity and thereby (i) increasing the hours of operation for businesses and public and social services, (ii) reducing reliance on costlier sources of energy, (iii) reducing losses of products and perishable goods, and (iv) improving productivity for users of electricity.

The OGEAP is comprised of the Enabling Environment for Off-Grid Electricity and Off-Grid Clean Energy Facility activities.

2.1.1 ENABLING ENVIRONMENT FOR OFF-GRID ELECTRICITY

Under the Enabling Environment for Off-Grid Electricity Activity ($5.7 million), MCC is supporting:

- Design and implementation of a national off-grid electrification framework in form and substance satisfactory to MCC ("National Framework"). The National Framework will articulate a model for off-grid electrification to include regulatory and institutional framework, licensing, tariff evaluations, regulations and technical standards. The model will be designed to ensure minimum technical specifications, quality of service

[7] Summary Paper Regarding Benin's Off-Grid Energy Access Project. Provided to SI by MCC Benin II team.

[8] Ibid.

[9] All four Compact Projects are described in full at: https://www.mcc.gov/where-we-work/program/benin-power-compact

standards, licensing, pricing and contracting arrangements, and consideration of gender and social inclusion needs and concerns; and

- Development of market information, market characterization, outreach to the private sector and sector donors, and community-led engagement on the OCEF.

The National Framework consists of the an Off-Grid Electrification Policy, the Off-Grid Electrification Master Plan, and the Off-Grid Regulatory Framework, which was approved by the Government of Benin and signed by President Patrice Talon in September 2018.

2.1.2 OFF-GRID CLEAN ENERGY FACILITY

The OCEF Activity ($40.3 million) aims to increase access to electricity for the currently unconnected majority of the population in rural and peri-urban areas, by reducing or removing initial cost and investment barriers for off-grid electricity service providers. MCC funding will support the establishment of OCEF and grants issued there under in four primary windows (summarized in Table 1):

- Essential public infrastructure;
- Mini-grids providing electricity generation and distribution for various uses;
- Household generation, storage, and productive uses; and
- Energy efficiency measures (via independent interventions, or together with windows 1-3)

The facility manager for OCEF selects the most promising partners (those selected for awards are hereafter referred to as “grantees”) across the four windows based on a strict set of criteria, including cost-sharing requirements. This granting process effectively serves as a pilot project of the off-grid regulatory framework. Proposals will be selected through two rounds of calls for proposals and are expected to grant awards ranging between $100,000 and $5,000,000 per proposal. The OCEF is expected to award no more than 20 grants between the two calls for proposals. The first round closed in early 2018, and then in August 2018 short listed 10 proposals for further elaboration (two of which were selected as "reserve” projects that might go forward with some improvement). The second call has been issued and proposals must be submitted by early March 2019. In the second call, proposals that include multiple windows may be submitted, and were in fact encouraged.

Following evaluation, pre-selected organizations, which are eligible to become grantees contingent on meeting certain requirements, begin a technical assistance program during which they are provided with expertise related to environmental and social performance, gender and social inclusion, monitoring and evaluation, and economic analysis. As a part of this process, they also submit more detailed design proposals and discuss implementation prior to signing their funding agreements (expected in February/March 2019 for the first round). Grant activities, which can be implemented throughout Benin, are expected to start immediately after the final grant agreements are signed and to then provide support over a 24-month period. We refer to “beneficiaries” in this report as the end users (individuals, households, small firms, or communities) who adopt and use connections or technology promoted by the grantees. During

the first call for proposals, which was open to proposals under windows 1, 3 and 4 (window 2 requires satisfaction of policy compliance requirements that had not been satisfied at the time of the first call), requirements were placed on the minimum distance from the electricity grid, to avoid conflicts with grid extension; these requirements were however relaxed in the second call for proposals, which is open to proposals under any of the four windows. That second call was announced in December 2018 and pre-selection under call 2 is expected in June 2019 (with implementation agreements in place around December 2019).

TABLE 1: SUMMARY OF GRANT WINDOW PROJECT TYPES AND STATUS

Window 1
Description: Critical public infrastructure with stand-alone electricity generation capability This window, open in calls 1 and 2, covers interventions that would help improve public services, such as water pumping and treatment, street lighting, hospitals and health centers, and educational or government facilities. The focus of the window is installation of off-grid power generation equipment and accompanying electrical systems along with an administrative framework for operations and maintenance to ensure continuous delivery of the targeted services. Only 3 applications under window 1 were submitted in the first call; two of these were selected, and the third is being held in "reserve". The projects that were pre-selected are largely focused on providing pumping services to access safer drinking water from deep groundwater (all 3 projects), electricity for health centers (1 project), and public lighting (all 3 projects).
Window 2
Description: Decentralized community-level generation and distribution (e.g., minigrids) This window, open only in call 2, covers interventions that would target household, commercial, agricultural and small industry uses of electricity. The OCEF encourages generation for productive use, particularly models that involve an anchor tenant that produces/consumes power for production while also supplying power to the community. OCEF grants will not fund agricultural equipment directly (e.g., food processing equipment), though such equipment could count towards the grantee contribution requirement. Funding for window 2 projects was contingent on the signing of the regulatory framework law for off-grid interventions in Benin, which was achieved in November 2018.
Window 3
Description: Household energy systems and products (e.g., solar home kits) This window, open in calls 1 and 2, covers interventions that provide decentralized renewable energy services to households, through combined generation and storage kits, pico solar, or specific renewable energy products. Companies under this window are encouraged to provide affordable financing terms and convenient payment systems that fit client needs. Applicants are also encouraged to provide solar-powered technologies that may improve livelihoods or generate time savings for households, and particularly women (e.g., solar drip irrigation or mini solar-powered appliances). Seventeen applications under window 3 were submitted in the first call; 6 were selected, and 1 is being held in "reserve". The projects that were pre-selected all aim to promote home solar kits, that would generally allow the following types of uses: lighting, charging of small devices like phones, use of relatively low power appliances.

Window 4
Description: Energy efficiency measures This window, open in calls 1 and 2, covers interventions aiming to improve energy efficiency for buildings, facilities, and other installations, which can be combined with windows 1-3 as appropriate. Energy-efficient appliances and equipment not only reduce overall costs for electricity consumers, but also reduce demand for electricity from the grid. Only 1 application under window 4 was submitted in the first call; it was not selected.

2.2 OVERVIEW OF COMPACT THEORY OF CHANGE

The Benin II Compact seeks to stimulate economic growth and reduce poverty via stimulation of a) expanded business production and productivity; b) greater economic opportunities for households; and c) improved capacity to provide public and social services. Each of the four projects in the Compact feed into these goals, with improved SBEE capacity as a catalyst.

Through the Policy Reform and Electricity Distribution, this is theorized to result first in reduced losses (both technical and commercial), better distribution, and greater efficiency in meeting demand (Figure 2). Avoided generation of electricity (due to excess generation to cover technical losses and provide energy to inefficient uses), and its associated costs, and lower commercial losses, will create a virtuous cycle of better financing of new investments, and improved management at SBEE.

Meanwhile the Electricity Generation Project aims to invest in new generation capacity. Finally, the OGEAP will provide the legal and institutional frameworks and support necessary for enhancing the market for decentralized energy solutions and will there by increase employment opportunities in the sector and extend electricity access (Figure 3).

These investments will in turn allow for improved productivity, while also reducing fuel costs (because of decreased reliance on alternatives such as diesel, generators, and kerosene), and outage-related losses of products and perishable goods.

FIGURE 2: COMPACT LOGICAL FRAMEWORK

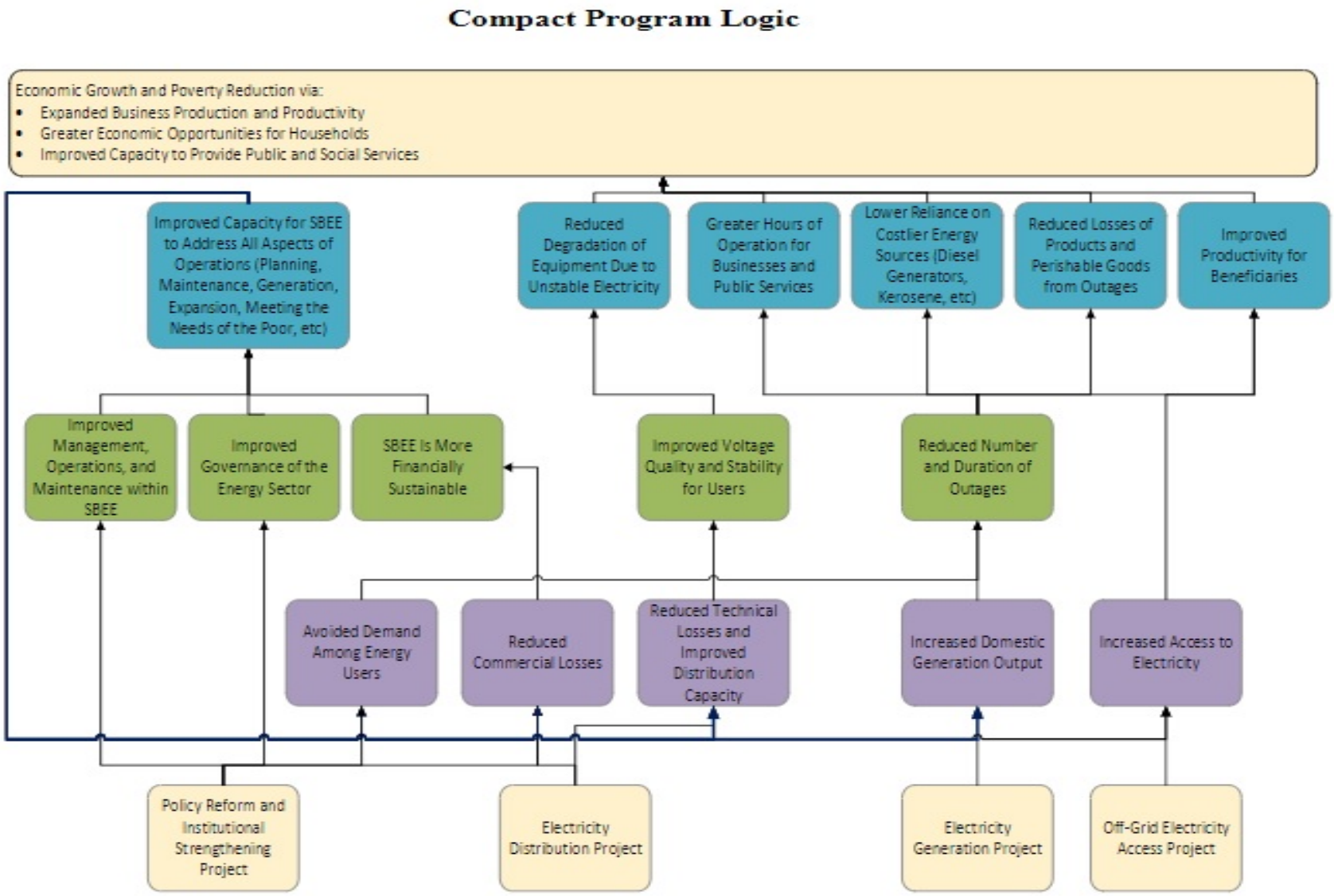
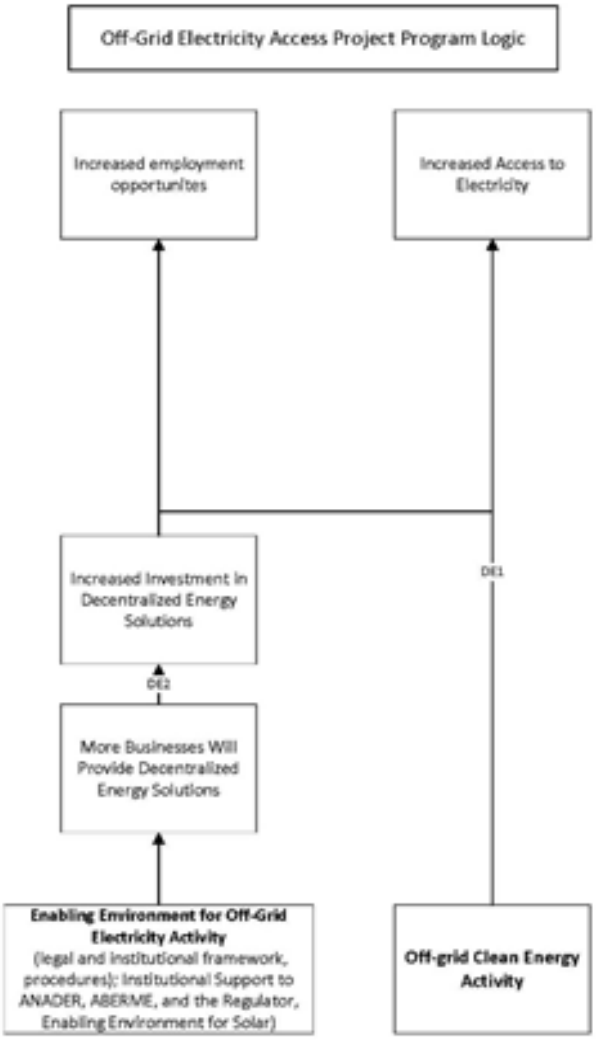


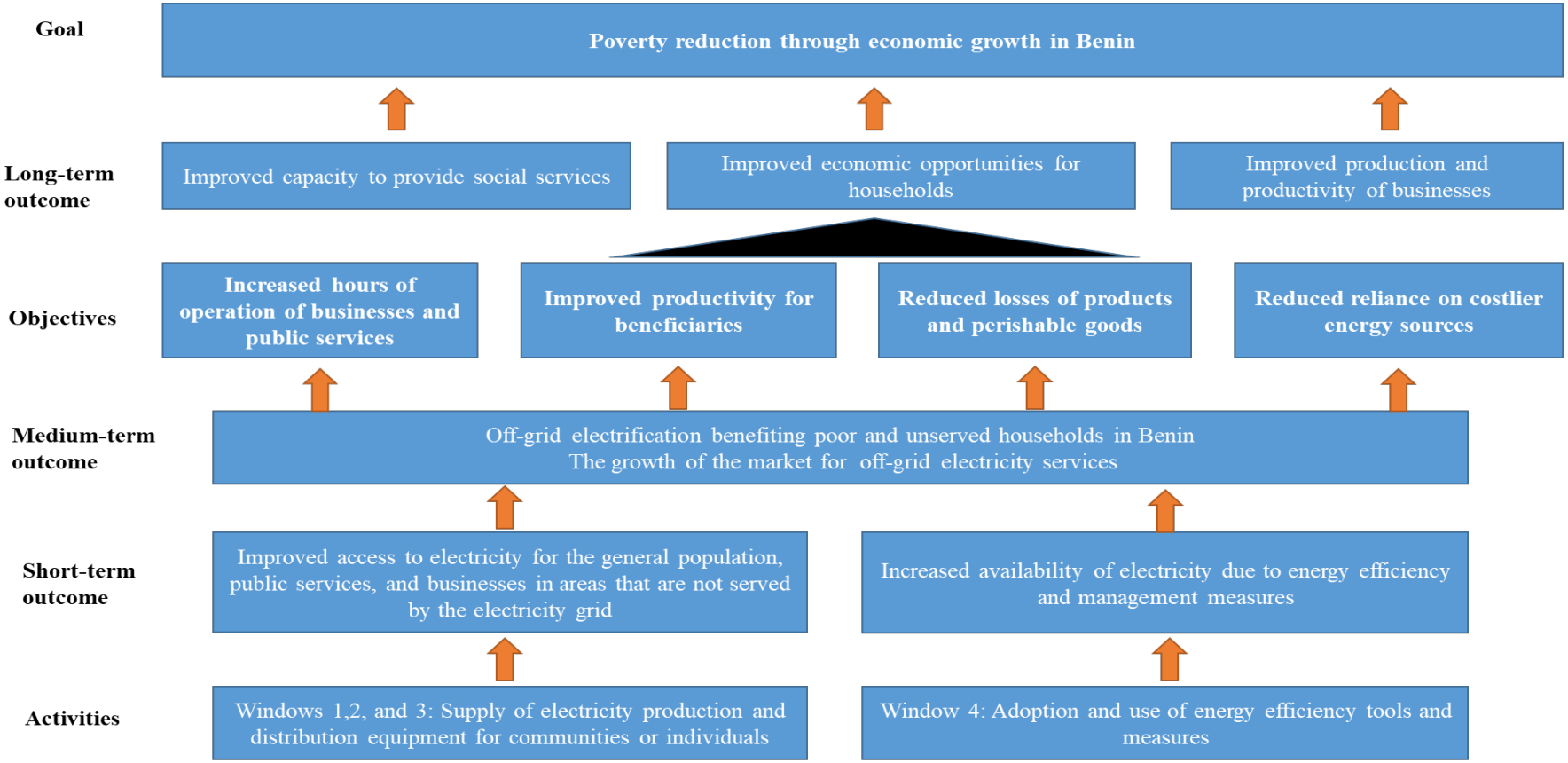
FIGURE 3: OGEAP THEORY OF CHANGE



Focusing more specifically on the mechanics of the OCEF elements of OGEAP, these are theorized to increase the supply of electricity generation and distribution equipment available to individuals and communities (through Windows 1, 2, and 3 - described above), and promote energy efficiency via technology and behavior change (Window 4). Figure 4 displays the logic behind the OCEF. The collective package of investments under these windows would lead to the growth of the market for off-grid electrification, which specifically targets poor and unserved households and communities in rural Benin. That new electricity market will then generate a set of benefits flowing to households, businesses and the public service sector, especially those delineated above (i.e., increased hours of operation and productivity, and reduced reliance on costly alternatives and losses). Key assumptions that have been highlighted in this logic are:

1. The idea that potential users currently without access to electricity will be able to afford the new off-grid solutions being offered, despite their likely higher current cost relative to grid-based energy (DE1 in Figure 3 above),
2. The assumption that improved regulatory and institutional frameworks will not only be necessary, but sufficient for energy entrepreneurs and companies to make concrete investments in Benin's off-grid sector (DE2 in Figure 3 above), and
3. The assumption that a focus on off-grid energy access alone will be sufficient to engender "productive" uses that lead to increased income.

FIGURE 4: OCEF THEORY OF CHANGE



We return to a more thorough discussion of the Compact logic as described above in Section 3, after reviewing relevant literature on the economic benefits of off-grid investments. There we also discuss how economic analysis of these investments could proceed.

2.3 STATUS OF IMPLEMENTATION TO DATE

OCEF launched the first Request for Applications ("Call 1") in February 2018 for $12 million of grant funding. At the time of generation of the draft of this EDR (in early January 2019), of 39 complete applications received, 10 were short-listed: three under Window 1 and seven under Window 3. Final awards of Call 1 projects will be announced in March 2019, and implementation will begin shortly thereafter (upon signature of grant agreements). In addition, MCA-Benin II signed an agreement with the African Development Bank in June 2018 to increase access to debt financing for companies looking to invest in Benin's off-grid market through the OCEF.

In conjunction with these efforts, the Government of Benin and the Compact have been working together on the Enabling Environment for Off-Grid Electricity Activity. In September 2018, the Government of Benin approved the off-grid policy, strategy, regulatory framework and master plan, formalized by the signing of the off-grid regulatory decree (Décret N° 2018-415 du 12 septembre 2018 portant réglementation de l'électrification hors-réseau en République du Bénin).

Signature of this decree satisfied the conditions precedent related to the release of the $20 Million off-grid tranche for the Off-Grid Clean Energy Facility (OCEF). A second round Request for Applications ("Call 2") opened in December 2018 and will remain open until March 2019. The grant agreements for the second call for proposals are expected to be signed in December 2019.

3.0 LITERATURE REVIEW IN RELATION TO THEORY OF CHANGE

As discussed above, less than 20% of the rural population of Benin had access to electricity in 2016. This population's current electricity and energy demand is very low and grid extension to reach these primarily low-density locations would be extremely costly, challenging the financial viability of a conventional energy access investment strategy. Off-grid energy solutions have been proposed as a more viable and lower cost alternative for meeting rural communities' needs for access to modern energy services. In this section, we review relevant literature from similar settings and populations' needs for energy, and on the impacts of access on productivity and well-being. We also discuss how these relate to the investment in off-grid energy in Benin.

3.1 EXISTING LITERATURE

3.1.1. THE UPTAKE AND EFFECTS OF ENERGY ACCESS INTERVENTIONS

Academic literature suggests that rural electrification can meet the kinds of objectives targeted by OGEAP in Benin, although this evidence predominantly investigates the effect of grid extension rather than off-grid technology, as might be expected. For example, in India, Bangladesh, and Vietnam, respectively, van de Walle et al. (2017),[10] Khandker et al. (2012),[11] and Khandker et al. (2013)[12] found that grid extension delivers improvements in employment status, household income, and educational performance. To draw these conclusions, van de Walle et al. (2017) exploited the India Rural Economic and Demographic Survey (REDS) data collected from 1981-1982 and again from 1998-1999, Khandker et al. (2012) used regression analysis to analyze cross-sectional data from 2005, and Khandker et al. (2013) conducted a regression analysis of panel data collected from surveys administered in 2002 and 2005. A number of studies use instrumental variables approaches to identify the impacts of electricity access. For example, in South Africa, Dinkelman (2011)[13] exploit variation in topography (which, as the paper argues, leads to large differences in the costs of extending the grid to different locations) to identify positive effects of enhanced access on female labor force participation. Similar to Dinkelman, Lipscomb et al. (2013)[14] use variation in topography and water flows to examine the impacts of electrification in Brazil between 1960 and 2000 due to the placement of

[10] Van de Walle, D., Ravallion, M., Mendiratta, V., & Koolwal, G. (2017). Long-term gains from electrification in rural India. *The World Bank Economic Review*, *31*(2), 385-411.

[11] Khandker, S. R., Barnes, D. F., & Samad, H. A. (2012). The welfare impacts of rural electrification in Bangladesh. *The Energy Journal*, 187-206.

[12] Khandker, S. R., Barnes, D. F., & Samad, H. A. (2013). Welfare impacts of rural electrification: A panel data analysis from Vietnam. *Economic Development and Cultural Change*, *61*(3), 659-692.

[13] Dinkelman, T. (2011). The effects of rural electrification on employment: New evidence from South Africa. *American Economic Review*, *101*(7), 3078-3108.

[14] Lipscomb, Molly, A. Mushfiq Mobarak, and Tania Barham. "Development effects of electrification: Evidence from the topographic placement of hydropower plants in Brazil." *American Economic Journal: Applied Economics* 5.2 (2013): 200-231.

hydropower plants, finding that access to electricity has large positive effects on development outcomes, as measured by the human development index and housing values. Finally, Rud (2012)[15] uses groundwater availability in India as an instrument for investment in electricity infrastructure (which is required for pumping) and argue that moving a state from the twenty-fifth to the seventy-fifth percentile of the distribution of electrification would increase manufacturing output by nearly 25 percent.

The benefits of increased energy access for communities or households seem clear: Modern electricity should provide an "energy access dividend" that includes improved productivity and income, increased business opportunities and investment, more effective public and social services, and positive changes to population well-being (through enhanced consumption opportunities and time savings) and health (Pakhtigian et al. 2018).[16] Yet, some recent literature raises questions about the extent of these benefits. We highlight several influential studies in this vein, all of which focus on grid extension.[17] Peters and Sievert (2016) analyze the impacts of rural electrification in the African context, based on data from ten studies conducted between 2009 and 2013.[18] In all the reviewed studies, including – notably – one from Benin, rural households or small enterprises obtaining new electricity connections hardly used electricity for income generating activities. Regarding increases in the number of productive hours by households, they further observe that "changes in the daily routines mostly relate to how people spend their leisure time and... studying."[19] In an evaluation of the MCC rural electrification program in Tanzania, Chaplin et al. (2017)[20] found no impacts on non-agricultural employment or firm creation, though they did note some positive impacts. Finally, Lee, Miguel and Wolfram (2018)[21] identify little effect on economic, health, and educational outcomes from electrifying rural Kenyan households who live "under the grid." Reviewing rigorous studies in the electrification literature, Bos et al. (2018)[22] suggest that potential benefits of grid electrification are large and spread across both economic and noneconomic domains, but that the cost-effectiveness of such interventions remains questionable and a major challenge.

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[15] Rud, Juan Pablo. "Electricity provision and industrial development: Evidence from India." *Journal of development Economics* 97.2 (2012): 352-367.

[16] Pakhtigian, E.; Burton, E.; Jeuland, M.; Pattanayak, S.K.; Phillips, J. (2018). "The Energy Access Dividend in Latin America." Duke University Energy Access Project Report.

[17] Lenz, L., Munyehirwe, A., Peters, J., & Sievert, M. (2017). Does large-scale infrastructure investment alleviate poverty? Impacts of Rwanda's electricity access roll-out program. *World Development*, *89*, 88-110.

[18] Peters, J., & Sievert, M. (2016). Impacts of rural electrification revisited–the African context. *Journal of Development Effectiveness*, *8*(3), 327-345.

[19] Peters, J., Vance, C., & Harsdorff, M. (2011). Grid extension in rural Benin: Micro-manufacturers and the electrification trap. *World Development*, *39*(5), 773-783.

[20] Chaplin, Duncan, et al. "Grid Electricity Expansion in Tanzania by MCC: Findings from a Rigorous Impact Evaluation." *Report Submitted to the Millennium Challenge Corporation. Washington, DC: Mathematica Policy Research* (2017).

[21] Lee, Kenneth, Edward Miguel, and Catherine Wolfram. "Experimental evidence on the economics of rural electrification." *University of California, Berkeley, NBER, and Energy Institute at the University of Chicago, http://www.catherine-wolfram.com/uploads/8/2/2/7/82274768/repp-jpe_2018-01-31-final.pdf* (2018).

[22] Bos, K., Chaplin, D., & Mamun, A. (2018). Benefits and challenges of expanding grid electricity in Africa: A review of rigorous evidence on household impacts in developing countries. *Energy for Sustainable Development*, *44*, 64-77.

Both Peters and Sievert and Chaplin et al. posit that lack of access to electricity is far from the only constraint handicapping economic growth in rural parts of Sub-Saharan Africa. They speculate that poor market access, and the lack of roads, create bottlenecks that prevent income-related outcomes from materializing. Another perspective considers that there is difficulty in establishing a linkage between electrification of a rural community and positive welfare outcomes. Ellis (2005), in particular, noted that conventional methods of wealth assessment are unhelpfully broad in their generalizations when applied to rural livelihoods, which he characterized as more heterogenous and dynamic.[23] Thus, access to modern energy may be a necessary but not sufficient condition for rural economic development, and overinvestment in energy infrastructure alone may lead to an infrastructure quality trap (McRae 2015).[24]

Electricity access investments also have important distributional implications: In the Bangladesh study cited above (Khandker et al. 2012), impacts on household income and expenditures were greater among better-off households, while in Vietnam (Khandker et al. 2013), educational benefits were higher for better off households. In India, rural electrification "increases labor supply of men and women, schooling of boys and girls, household per capita income and expenditure … [b]ut the larger share of benefits accrue to the wealthier households" (Khandker et al. 2014).[25] Similar distributional differences have also been noted for off-grid solutions; for example, Samad et al. (2013)[26] found that Solar Home Systems (SHS) used to provide off-grid electrification in Bangladesh were more likely to benefit households with higher levels of education or physical assets (wealth), because these households were more likely to gain access. Such findings mirror the more general development literature which finds that higher income, socio-economic status and education are common determinants of increased technology adoption (Brooks et al. 2016[27]; Graham et al. 2018).[28]

If we narrow our focus to off-grid energy access interventions, the literature becomes much sparser. Samad et al. (2013) found in their research that off-grid solutions have lower impacts on those connected, relative to grid-extension. Logically and empirically, the capacity of energy generation matters a great deal in the types of benefits that can be expected. In a household-level randomized controlled trial in Rwanda, for example, Grimm et al. (2016)[29] found that pico-

[23] Ellis, F. (2005). Small farms, livelihood diversification, and rural-urban transitions: Strategic issues in Sub-Saharan Africa.The future of small farms,135

[24] McRae, Shaun. "Infrastructure quality and the subsidy trap." *American Economic Review* 105.1 (2015): 35-66.

[25] Khandker, S. R., Samad, H. A., Ali, R., & Barnes, D. F. (2014). Who benefits most from rural electrification? Evidence in India. *The Energy Journal*, 75-96.

[26] Samad, Hussain A.; Khandker, Shahidur R.; Asaduzzaman, M.; Yunus, Mohammad. 2013. The Benefits of Solar Home Systems: An Analysis from Bangladesh. Policy Research Working Paper;No. 6724. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/16939 License: CC BY 3.0 IGO.

[27] Brooks, N.; V. Bhojvaid; M. Jeuland; J. Lewis; O. Patange; S. Pattanayak (2016). "How much do clean cookstoves reduce biomass fuel consumption? Evidence from North India" Resource and Energy Economics 43:153-171.

[28] Graham, J.; M. Kaur and M. Jeuland (2018). "Access to Environmental Health Assets across Wealth Strata: Evidence from 41 Low- and Middle-Income Countries."PLoS One13(11): e0207339.

[29] Grimm, Michael; Munyehirwe, Anicet; Peters, Jorg; Sievert, Maximiliane. 2016. *A first step up the energy ladder? Low cost solar kits and household's welfare in Rural Rwanda (English)*. Policy Research working paper; no. WPS 7859. Washington, D.C.: World

PV kits that could be used for lighting and charging a radio or cell phone were mainly used for lighting because it was technically difficult to charge a cell phone or radio. Households effectively had to choose between lighting or charging (and almost always chose lighting) given the small capacity of the device and the energy requirements of multiple services.[30] Treated households nonetheless experienced considerable reductions in total energy expenditures and expenditures for dry-cell batteries and kerosene, the latter of which also provided health benefits. The kits would thus pay for themselves within 18 months, which is less than their 2-3 year expected life-span. Further, although the results could not be fully quantified, Grimm et al. speculated that these pico-PV systems would enable households to more flexibly allocate domestic production tasks to available time, especially after sunset, but that household adoption would likely be severely constrained by cash and credit constraints, lack of information about the devices, and high individual discount rates. Furukawa (2014) completed a related RCT study that concentrated solely on educational outcomes of 155 primary school students in Uganda from use of pico-PV lamps.[31] These students would normally have used kerosene for illumination, and the research found that children's study hours increased by 30 minutes per day on average. Oddly, this increased study time results in lower test scores (especially among students in the top quintile). Unable to provide a suitable explanation, Furukawa conjectures that these lower power lamps, coupled with inadequate charging, may have led to flickering light and reduced effectiveness of studying.

Larger capacity interventions have focused on home energy production systems and community-based mini-grids, using power produced with solar technology, diesel generators, or other technologies. In a purely observational study in Kenya with what would now be considered very primitive solar technology, Jacobson (2007)[32] found that children in households with larger systems (>25 W) were more likely to benefit from better lighting for evening study compared to children in households with smaller systems (<25 W). Jacobson opined that this was because most of the energy (~54%) from smaller systems was allocated to television viewing, in contrast to larger systems where more energy could be directed to lighting. This reasoning fits a theory that argues that better illumination improves evening study conditions, which in turn might lead to better school performance. Yet an alternative explanation could be that households with access to larger systems are positively selected (i.e., wealthier or more educated) and therefore place more emphasis on their children studying.

Another type of decentralized household-level (or more accurately, farm-level) system that has been investigated is for stand-alone solar pumping for irrigated agriculture. In a study in the rural Sudanian zone of northern Benin, Burney et al. (2009)[33] used a matched-pair comparison of

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Bank Group. http://documents.worldbank.org/curated/en/966011476292381076/A-first-step-up-the-energy-ladder-low-cost-solar-kits-and-households-welfare-in-Rural-Rwanda.

[30] The pico-solar deployed was so small in energy generation that it barely exceeded the modern energy benchmark defined by the United Nations as Tier 1, the lowest level of modern electricity access under the 5-tier UN Sustainable Energy for All multi-tier framework. Tier 1 is defined as having enough electricity for “task lighting and phone (or radio) charging” (UN SE4ALL, 2013).

[31] Furukawa, C. (2014). Do solar lamps help children study? Contrary evidence from a pilot study in Uganda. *Journal of Development Studies*, *50*(2), 319-341.

[32] Jacobson, Arne. "Connective power: solar electrification and social change in Kenya." *World Development* 35.1 (2007): 144-162.

[33] Burney, Jennifer, et al. "Solar-powered drip irrigation enhances food security in the Sudano–Sahel." *Proceedings of the National Academy of Sciences* 107.5 (2010): 1848-1853.

four villages (two treatment and two for comparison) and household survey and field-level data to consider the impacts of such investments. That research found that implementing solar-powered drip irrigation can "provide substantial economic, nutritional, and environmental benefits." Since the photovoltaic drip irrigation (PVDI) systems installed were used to pump ground water during periods of high solar insolation (when photosynthesis is greatest), the PVDI does not require energy storage. Most off-grid solutions instead require energy deployment during dark periods, which necessitates more equipment and interfaces between components, raising costs and other concerns (e.g., battery disposal). The largest improvements to net welfare and productivity may therefore stem from solutions that provide electricity when it is most needed.

Turning to mini-grids, Aklin et al. (2017) assessed the effects of a field experiment that deployed solar installations randomly across 1,281 rural households in India.[34] The study found that treated households (those who received energy access) lowered their expenditures on kerosene by about 50 rupees per month, or slightly less than $1. Despite this strong expenditure effect, the study found "no systemic evidence for changes in savings, spending, business creation, time spent working or studying, or other broader indicators of socioeconomic development," however. On the other hand, a village-level case study – that did not include a comparison group but based on simple before and after comparisons – in Kenya found that access to electricity enabled use of electric equipment and tools by small and medium enterprises, resulting in improvements to productivity (Kirubi et al. 2009).[35] This benefit translated into income growth, from 20-70% depending on the product manufactured. Kirubi et al. also found that access to electricity appeared related to greater agricultural production and enabled or improved the delivery of social and business services (e.g. schools, markets, and water pumps). Meeks and Thompson (2019), through an instrumental variable analysis of microhydro mini-grids in Nepal, find that off-grid electrification can lead to increases in the number of household enterprises, the number of people employed by such enterprises, and the enterprises' net revenue.[36]

Though the Kenya studies described above pertain to larger systems than the evaluations of pico-PV that show more mixed results, differences in outcomes may arise for a range of reasons: Differences in energy generation capacity, local context, implementation quality and management, complementary investments, or study designs, to name just a few. As a reminder, the Kirubi et al. and Jacobsen papers studied the effects of village-level micro-grid and solar kits using pre-post and observational comparisons, respectively, while Grimm et al. used a better identified RCT design. Importantly, Aklin et al. also found only limited evidence of impacts, and none on productivity or income, in their solar mini-grid RCT. Such study design effects have led some scholars to question the underlying justification for energy access interventions. Bhattacharyya (2012) for instance claims that "energy access should not be the focus" without a

[34] Aklin, M., Bayer, P., Harish, S. P., & Urpelainen, J. (2017). Does basic energy access generate socioeconomic benefits? A field experiment with off-grid solar power in India. *Science advances*, *3*(5), e1602153.

[35] Kirubi, C., Jacobson, A., Kammen, D. M., & Mills, A. (2009). Community-based electric micro-grids can contribute to rural development: evidence from Kenya. *World development*, *37*(7), 1208-1221.

[36] Meeks, R. & H. Thompson. (2019). "The Economic Impacts of Grid versus Off-grid Electrification: Evidence from Nepal". Working Paper.

comprehensive understanding of long terms impacts on sustainability, which is consistent with some of the concerns about grid extension discussed previously[37] More specifically, he opines that "there has been a disproportionate emphasis on electrification in the past" and that these efforts have not effectively improved outcomes due to poor sustainability.[38]

These caveats notwithstanding, it seems plausible that small-scale energy access projects lead to relatively muted improvements – modest money savings, slightly improved health, and additional flexibility in time allocation. Larger interventions at village scale, meanwhile, may be needed to raise the productivity of more energy-intensive tasks including business and agricultural activities, and to deliver income benefits. At the same time, such larger interventions face a different set of challenges the solutions to which are unclear at this time.[39] It is worth noting that we are unaware of quasi-experimental studies from a single setting that speak directly to the question of impact heterogeneity as a function of the capacity of technology delivered. We note that this is likely an issue worth exploring given the radically different resource and financing needs of pico vs. solar kit vs. mini-grid interventions.[40]

At the end of the day, electricity access is highly correlated with a wide variety of development indicators, a fact well-documented in many cross-country regression-based analyses in the literature (e.g. Barnes, Peskin and Fitzgerald 2003; Khandker 1996;[41] Martins 2005;[42] World Bank 2008).[43] And yet, it is often not the only factor at play (Alstone et al. 2015).[44] Returning to one of the points made previously, there is a strong case for the argument that electricity access is a necessary, but not sufficient, condition for improving human development. Importantly, "expanding access through decentralized power systems could have radically different climate and equity impacts from the incumbent system, challenging the conventional knowledge held by some that one must choose between progress on energy access or climate" (Alstone et al. 2015). What Alstone et al. are trying to say is that a decentralized renewable solution (such as solar-based off-grid electrification) will perhaps be the best, most sustainable chance, of bringing electricity to the projected 900 million rural people that will remain without electricity in

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[37] Bhattacharyya, S. C. (2012). Energy access programmes and sustainable development: A critical review and analysis. *Energy for sustainable development*, *16*(3), 260-271.

[38] As an extension to these assertions, Bhattacharyya paired with Sen (2014) to propose such a "sustainable" solution for energy access in poor and underdeveloped regions. That solution required a hybrid design of small hydro-power, solar PV, biodiesel, and batteries; a set-up that seems, on its face, to be extremely complicated, raising questions about its scalability. [Sen, Rohit & Bhattacharyya, Subhes. (2014). Off-grid electricity generation with renewable energy technologies in India: An application of HOMER. Renewable Energy. 62. 388-398. 10.1016/j.renene.2013.07.028.]

[39] Fowlie, M., Y. Khaitan, C. Wolfram, and D. Wolfson (2018). Solar Microgrids and Remote Energy Access: How Weak Incentives Can Undermine Smart Technology. International Growth Center. Final Report. E-89226-INC-1.

[40] Peters, J.; Sievert, M. & Toman, M. (2018). Rural electrification through mini-grids: Challenges ahead. Ruhr Economic Papers #781: Essen.

[41] Pitt, M. M., & Khandker, S. R. (1996). *Household and intrahousehold impact of the Grameen Bank and similar targeted credit programs in Bangladesh*. The World Bank.

[42] Martins, J. (2005). The state of skills training in very small and microenterprises in the South African environment. *South African Journal of Labour Relations*, *29*(Issue-2-3-4), 33-58.

[43] World Bank, 2008. The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits, an IEG Impact Evaluation. World Bank.

[44] Alstone, Peter & Gershenson, Dimitry & Kammen, Daniel. (2015). Decentralized energy systems for clean electricity access. Nature Climate Change. 5. 305-314. 10.1038/nclimate2512.

2030, the vast majority of whom will live in sub-Saharan Africa (UN SE4ALL, 2013).[45] Such a claim is not inconsistent with the broad evidence for both positive (on increased income and education, and reduced poverty) and negative (on environmental quality and sometimes health) impacts of conventional energy solutions, as documented in Usmani et al.'s broad-spanning review (2019) of the impacts of energy interventions in the developing world.[46]

3.1.2. FACILITY-BASED DEVELOPMENT INTERVENTIONS

What we discuss above all relates to evaluations or research on individual projects (or meta-reviews of unconnected projects). However, OCEF is fairly unique in that it provides a facility for multiple off-grid projects alongside the Enabling Environment Activity, which together are hypothesized to generate development of the off-grid sector in Benin. There is very little research on the effects of this type of mechanism, which is broadly aimed at generating development of the off-grid energy sector and not just delivering energy-related outcomes to beneficiaries. There are also few examples of similar grant facilities in other sectors.

One notable exception to this dearth of research relates to the ECOWAS Renewable Energy Facility (EREF), which "provides grant co-funding for small to medium sized renewable energy and energy efficiency (RE&EE) projects and businesses in rural and peri-urban areas".[47] Among its "objectively verifiable indicators," EREF lists "volume of investment in start-up businesses leveraged through grant support," and in the longer term, "sales of supported companies" and "number of businesses replicated in the region";[48] however the long-term impacts of the facility have not been examined.

Reports on financing mechanisms also tend to focus on large-scale, national-level grants, non-profit intervention, or private equity or venture capital. However, if a joint report of A.T. Kearney-GOGLA that examined the global solar off-grid lighting sector can be used as a proxy,[49] the following conclusions about financial barriers might be expected to hold in the off-grid and renewable energy industry as whole, and to sub-Saharan Africa, which is home to about 43% of the world's off-grid population, in particular:

- Inadequate financial risk-sharing between firms, investors, and government;
- A mismatch between traditional deal/funding structures, and the characteristics of operating in an unproven industry in small and shallow markets;

[45] SUSTAINABLE ENERGY FOR ALL (SE4All) (2013), "Sustainable Energy for All Global Trecking Framework Consultation Document", http://www.se4all.org/tracking-progress/

[46] Usmani et al. (2019). "When is energy a golden thread? Characterizing the impacts of modern and traditional energy use in low- and middle- income countries." Duke University Working Paper.

[47] "Renewable Energy Facility for peri-urban and rural areas (EREF)" http://www.ecreee.org/page/renewable-energy-facility-peri-urban-and-rural-areas-eref ECREEE, 2013

[48] "Project Document for the establishment and first operational phase of the ECOWAS Renewable energy Facility (EREF) for peri-urban and rural areas (2011 to 2016)." ECREEE EREF II page, update May 29, 2014. http://www.ecreee.org/sites/default/files/documents/basic_page/i._ecowas_renewable_energy_facility_project_document_0.pdf

[49] "Investment and Finance Study for Off-Grid Lighting: An A.T. Kearney report in collaboration with GOGLA." A.T. Kearney, Global Off-Grid Lighting Association (GOGLA), June 2014.

https://www.gogla.org/sites/default/files/recource_docs/investment-study-vol-2.pdf

- Deal sizes that are too small to meet financiers' requirements; and
- An absence of domestic/local banks as providers of working capital, either by self-exclusion, or effective exclusion by way of prohibitively high interest rates.

Given the concerns delineated above, the semi-competitive mechanism for stimulating off-grid investment and development espoused by OGEAP through the OCEF is an innovative, and perhaps timely, approach. This evaluation will thus present a valuable opportunity to both contribute to the nascent discussion about off-grid rural electrification as a poverty reduction strategy and to study this innovative investment mechanism. It could be that this mechanism's grant making process, combined with the creation of an enabling environment in Benin, can avoid pitfalls that have led to sub-par economic outcomes in past rural electrification strategies.

3.2 GAPS IN LITERATURE

As discussed above, there is some evidence of improved outcomes stemming from off-grid electrification interventions, but that evidence base is thin and typically pertains to single technologies or comes from small samples or observational study designs. There is certainly no clear consensus on impacts in this literature, whether at the household or business level. Evidence on firms and productive uses, as well as on public service provision, is especially limited. We note here a set of critical gaps in the literature that pertain also to the investment in Benin:

1. There is hardly any evidence concerning the factors affecting development of the off-grid energy sector, and especially on how the establishment of a regulatory framework coupled with subsidies and financing encourage investment and development. While it seems logical that the presence and effective implementation of a regulatory framework and policy would encourage investment, there is scant research on whether this will be sufficient for additional investment in the sector, either in Benin or globally, and whether supply-side policies or demand-side stimulation is most important to achieving success. Off-grid solutions platforms have achieved wide penetration in concentrated locations (namely East Africa), suggesting a potential for rapid scaling. Importantly, there is also already a robust market in Benin for small, household solar systems, though financing programs for quality systems remains limited. On the other hand, there is very little evaluation of mini-grid projects in the literature; this is relevant to Benin because the only experience there has largely been negative. It is unclear whether that absence or lack of functioning of mini-grids is due to a deficient policy framework or because of broader market constraints such as low demand or high cost of the energy.
2. At a basic impact level, there is a surprising lack of consensus on why household effects of off-grid electrification are positive in some locations, and nonexistent in other, and whether electrification is indeed a binding constraint to growth and development. While some studies have shown positive benefits, others have found little, none, or even negative effects on development indicators. It is also worth noting that there is little positive evidence in the literature concerning effects of off-grid investments on productive uses.

3. There is some, though not convincing, evidence of differential effects across socio-economic groups (with better off households generally experiencing more positive outcomes), yet the mechanisms behind these differential impacts are unknown. It may be that this is largely due to a screening effect: Given its costs, households with higher socio-economic status (SES) are more able to connect or take up energy access technology. Alternatively, it may be that higher SES households are better able to leverage other assets or opportunities they have once electrification occurs. If the latter is the case, the relevant assets and opportunities have not been clearly identified. It could be, too, that both explanations apply. Sorting this out is important if policy-makers want to induce broad-based development, because strategies to increase connections and use once connected will be substantially different.
4. Building on the point above, we can also theorize about different mechanisms of change (and different binding constraints) behind different off-grid electrification approaches or technologies, but there is little evidence to support an interpretation that such differences exist. On the surface, this is strange, but too little attention has been focused historically on the quality and reliability aspects of energy access. For example, we would expect a community-level solar mini-grid to have very distinct effects from those of a household-level system, and particularly a pico-PV system, yet these differences have again not been clearly explored. Comparisons using the innovative multi-tier framework concept (Bhatia and Angelou, 2015) are currently confounded by differences in study methods, contexts, and implementation.[50] This lack of evidence prevents sound cost-benefit analysis of solutions that have widely divergent costs and likely widely divergent benefits.
5. At an operational level, and particularly in Benin, there is little clarity on how to make systems sustainable, and no clear evidence that cost-covering tariffs for off-grid systems are viable. Such questions relate to both the development of the off-grid sector from a business point of view and to the optimal deployment of modern energy given the externalities and large economies of scale associated with electrification.

3.3 POLICY RELEVANCE OF THIS EVALUATION

Given Benin's low levels of electrification, highly rural population, constrained electrical supply, and significant costs to grid expansion in rural areas, off-grid solutions to electrification are of high policy importance. Combining this with the lack of consensus in the literature on the effects of off-grid electrification, the most effective ways of providing off-grid electricity, and on sector development, we would argue that this evaluation has very high policy relevance, both for Benin and globally. While the evaluation will not be able to conclusively address all of the gaps noted above, we do expect to be able to contribute to the literature on each, providing evidence that can be used to guide policy on the relative benefits (and hence importance) of off-grid

[50] Bhatia, M. and Angelou, N. (2015). Beyond Connections: Energy Access Redefined. ESMAP Technical Report 008/15. World Bank, Washington, DC.

electrification, the most effective approaches to off-grid electrification, and the factors contributing to sector development.

3.4 DISCUSSION OF THEORY OF CHANGE

Before delving into the specifics of our evaluation design, we return to a discussion of the OGEAP and OCEF theories of change. We begin by highlighting two important observations that we believe to be germane to this discussion:

1. The logics depicted in Figure 2 (overall Compact) and Figure 4 (OCEF) include only a subset of the impacts of off-grid electricity access that are hypothesized in the literature (Table 2 attempts to provide a concise description of these impacts, based on prior work on the "Energy Access Dividend" (SEForAll 2017; Pakhtigian et al. 2019), noting that the overlap in concepts is not perfect);[51] and
2. The Economic Rate of Return analysis for the Compact, as a whole, utilized the economic concept of **consumer surplus** to value the benefits of improved energy supply and demand management in Benin.[52] Meanwhile, the economic benefits of the OGEAP have been highlighted as a key uncertainty that may decrease the economic viability of the Compact, considering its more certain costs.[53]

There is not much precision on the anticipated outcomes and impacts within the theory of change for the OGEAP, which is perhaps unsurprising given the nascent status of the off-grid sector in many countries and especially in Benin. Nonetheless, it is somewhat odd that the primary benefit valuation approach in the economic analysis of the Compact – based on additional consumer surplus generated – is so disconnected from the theory of change for this project.[54] The advantage of this consumer surplus measure is obvious; it is theoretically rather complete, encompassing the difference between willingness to pay and the marginal cost of energy to consumers of various types (households, businesses, etc.). This is only an appropriate and complete measure of benefits if two conditions hold, however: a) The actual tariffs paid reflect the full cost of energy provision to consumers (i.e., prices are cost-reflective); and b) There are no unpriced externalities, positive or negative, that would create a wedge between the marginal social and private benefits on the demand side, and/or the marginal social and private costs, on the supply side. Neither of these conditions are likely to fully hold in the case of the electricity market in Benin, and it is unclear how the economic analysis intends to handle these issues.

Unpacking the categories of expected benefits highlighted in the theory of change a bit, we first begin with potential benefits to businesses supplying and utilizing energy. The Evaluation Team

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[51] SEForAll (2017). "Why Wait: Seizing the Energy Access Dividend." Sustainable

Energy for All, Power for All and Overseas Development Institute, Washington, DC. License: NonCommercial—NoDerivatives 4.0 International (CC BY-NC-ND 4.0).

[52] The consumer surplus refers to the difference between what consumers are willing to pay for electricity and the actual tariffs that they pay.

[53] Summary Paper Regarding Benin's Off-Grid Energy Access Project. Provided to SI by MCC Benin II team.

[54] For an interesting application of this concept, the reader can refer to: ESMAP (2010). A New Slant on Slopes Measuring the Benefits of Increased Electricity Access in Developing Countries. World Bank: Washington, DC.

(ET) noted during its scoping mission considerable speculation among stakeholders regarding the types of productive uses that might follow from expanding off-grid energy access, which is consistent with the lack of evidence in the literature. Tools have been developed (notably by Innovation Énergie Developpement (IED)) that demonstrate the feasibility of business models for different activities (e.g., milling, carpentry) given different energy costs, but there is little empirical evidence to confirm that feasibility at this time. It seems important to track what types of businesses will become more viable in communities benefitting from OCEF grantee activity, and whether there will be growth and expansion in the type of business offerings available at the community level. On the energy supply side, an important feature of the performance evaluation will be to study the costs and cost-sharing situation of each grantee, to understand whether their business models are replicable and sustainable.

Moving next to public services – we find this is a major gap in the general energy access literature that has previously been noted by Usmani et al. (2018). Deriving the economic benefits of improved public services, should they follow from the grantee investments, requires careful valuation work that needs to be tailored to the service in question. Many of these services provide nonmarket benefits: for example, the security benefits that come with public lighting are not priced in a market; others deliver primarily public benefits (for example many water supply, sanitation, and health improvements do not restrict access). Approaches exist to conduct such valuation, using both stated preferences, revealed preferences, and benefit transfer methods (Boardman et al. 2017), but they must be context- and service-specific.[55] It is unclear whether such valuation will prove feasible within the context of the OGEAP evaluation; absent full valuation, however, we will endeavor to obtain measures of impacts that provide qualitative and quantitative insights on them. Specifically, we will use community surveys to understand the availability of public services and household surveys to consider subjective perceptions of the quality of these services.

Cost savings, reduced losses, and improved productivity all comprise a broader category of reduced coping costs from provision of higher quality energy. There is a vast literature on use of such methods particularly in the water and sanitation sector (see for example Orgill-Meyer 2018 or Pattanayak et al. 2005), that can be leveraged to develop a comprehensive understanding of energy-related coping costs due to lack of access to electricity.[56] Indeed, some have already begun to apply these concepts in the energy domain as well. This coping cost literature highlights the following types of impacts (Meles 2017), which we will aim to track to understand these aspects comprehensively;[57]

- Spending on costly alternatives (e.g., fuels, batteries, charging services)

[55] Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2017). Cost-benefit analysis: concepts and practice. Cambridge University Press.

[56] Orgill-Meyer, J., Jeuland, M., Albert, J., & Cutler, N. (2018). Comparing Contingent Valuation and Averting Expenditure Estimates of the Costs of Irregular Water Supply.Ecological Economics,146, 250-264.

Pattanayak, S. K., Yang, J. C., Whittington, D., & Bal Kumar, K. C. (2005). Coping with unreliable public water supplies: averting expenditures by households in Kathmandu, Nepal.Water Resources Research,41(2).

[57] Meles, T. H. (2017). Preferences for Improved Electricity Services in Developing Countries: Households' Defensive Behavior and Willingness to Pay.Power Outages, Increasing Block Tariffs and Billing Knowledge, 1.

- Losses of produced goods (spoilage) or reduced production during interruptions in energy access
- Time lost on drudgery to cope with poor energy access (e.g., collection of solid fuels, time spent on tasks that could be made more efficient)
- Loss of productive hours due to darkness (that could be used for domestic tasks, studying, and/or income generation)
- Exposure to health harming-pollutants from use of dirty fuels (e.g., fine particulate matter or $PM_{2.5}$, carbon monoxide or CO).

The last category of private benefits is in the form of pure consumption benefits – as opposed to those related to productivity and human capital development – that are newly obtained from energy access (categorized as those derived from appliances that deliver primarily taste, leisure or other aesthetic benefits). These are not highlighted in the theory of change despite their implicit inclusion (alongside the other aforementioned private benefits) in the consumer surplus measure of economic benefits from the Benin Compact investment overall. Measuring consumer surplus on its own requires understanding the shape of the demand curve as was done in the pre-Compact ERR template (Note however that this ERR did not include OGEAP due to insufficient information); separating out these purely consumption benefits from the rest of the benefits just discussed would then require estimation of those other benefits such that they could be netted out. Alternatively, one could look to the related market for consumer appliances as a proxy for these benefits and derive demand relationships for those products, based on either stated or revealed preference data. There are thus several potential approaches to inclusion of consumption value that should be considered in a full economic analysis.

Finally, we return to the second problem associated with a measure of benefits based only on consumer surplus and one that is only implicitly included in the OGEAP theory of change: its lack of inclusion of externalities from energy generation and use. The marginal social costs of off-grid solutions should, of course, include the costs of disposal of batteries and other spent equipment, whether those costs are borne by suppliers and users, or not (in Benin, they seem likely not to be). They should also adjust for the climate mitigation and local air quality benefits that come from using renewable energy rather than polluting fuels like kerosene, solid fuels, diesel, or in some cases where grid electricity is displaced, conventional energy sources. Similarly, the marginal social benefits of energy use should include any spillovers that come in the form of benefits to those who do not obtain energy access. For example, unconnected households may still benefit from neighbors use of lighting or some types of appliances, without paying for these benefits.

Again, Table 2 attempts to provide a concise summary of these various impacts and aims to elucidate the overlap between a general typology and the characterizations of benefit in the OGEAP Theory of Change and Energy Access Dividend approaches, respectively. We return to these aspects in our discussion of the cost benefit analysis further below.

TABLE 2: TYPOLOGY OF BENEFITS ASSOCIATED WITH OFF-GRID ENERGY INVESTMENTS

Type of benefit (and examples)	Overlap with OGEAP and Benin Compact concepts	SEForAll (2017) "Energy Access Dividend" concepts
Supplier benefits		
• Net income for off-grid businesses and their workers [a]	• Increased investment and employment in the off-grid energy sector	• Not mentioned
End-user benefits		

• Net income for electricity-using businesses and their workers
  ○ Irrigated agriculture
  ○ Agro-processing & storage
  ○ Small artisanry (Tailoring/ironing; hair dressing; metalwork; carpentry)
  ○ Restaurants/bars
  ○ Telecom/IT/office services
  ○ Difference between the shadow cost of labor and worker salary[a]
• Value of enhanced public service provision
  ○ Public lighting
  ○ Improved health and education facilities
  ○ Water supply and sanitation
	• Greater hours of operation of businesses and public services (including employment benefits)	• Not mentioned (but likely overlap with access to refrigerators and mobile phones)

• Cost savings
  ○ Reduced spending on energy alternatives for various purposes – kerosene, diesel, outside charging, batteries
  ○ Reduced prices of locally produced goods)
	• Lower reliance on costly energy alternatives	• Value of savings on household lighting expenditure & use of savings
		• Value of savings on costs of phone charging

Type of benefit (and examples)	Overlap with OGEAP and Benin Compact concepts	SEForAll (2017) "Energy Access Dividend" concepts
• Reduced losses (losses of products and perishables) [b]	• Reduced losses of products and perishables	• Not mentioned (but likely overlap with access to refrigerators)

• Household productivity
  ○ Time use and re-allocation
  ○ Health improvement
  ○ Educational improvement
	• Improved productivity for beneficiaries	• Health status (from reduced household air pollution)
		• Hours spent studying at home
		• Hours spent to earn income
		• Hours spent on domestic / care work
		• Time required for essential communications

• Pure consumption benefits from new appliance use	• Not included	• Access to, and use of, TV/radio • Access to, and use of, mobile phone [c] • Access to, and use of, refrigerator
External benefits		
• Spillovers to unconnected households	• Not included	• Not included
• Reduced climate-altering emissions	• Not Included	• Reduced climate-altering emissions
• Reduced local air pollution	• Not Included	• Not included
• Battery and equipment disposal costs	• Not Included	• Not included

Notes:

[a] There will be net benefits to workers if there is a wedge between their willingness to accept a wage (the shadow cost of labor) and the salary they are paid. This is likely to be the case in rural Benin, where unemployment is very high.

[b] This category of benefits may overlap with businesses' net income and should be considered carefully.

[c] The report does not specify that these are consumption benefits (in contrast to radio and television, which are considered to increase the value of leisure time); in reality some of their benefits may overlap with improved productivity, reduced losses, and/or income generation.

4.0 EVALUATION DESIGN

4.1 EVALUABILITY AND BRIEF OVERVIEW OF APPROACH

4.1.1 EVALUABILITY ASSESSMENT

Prior to developing the evaluation design, the ET conducted an evaluability assessment organized around the following primary questions to assess the potential risks and benefits associated with an evaluation of OGEAP.

1. Is the problem clearly defined and is there sufficient evidence to support the problem diagnostic?
2. Are the project objectives and theory of change/logic clearly defined?
3. Are the risks and assumptions clearly defined with potential risk mitigation strategies?
4. Are project participants clearly defined and justified in terms of geographic scope and eligibility criteria?
5. Are the metrics for measuring results for both accountability and learning clearly defined?

The ET conducted interviews with key stakeholders during the inception visit and reviewed documents to conduct the evaluability assessment that is included in Annex 7.1. Based on this assessment, the ET found:

- There is ample evidence supporting the claim that lack of reliable, affordable, and high-quality energy acts as a binding constraint for many households and businesses in Benin. Our inception visit confirmed that a range of stakeholders (households, businesses, NGOs, researchers, and government) agree with this supposition, and also confirmed that a key goal of the OGEAP, improving electricity access, is a national priority for the Government of Benin.
- The overarching theory of change developed for the compact is clear, as is that for the OGEAP project. However, final theories of change have not been developed for each window or type of grant activity that is expected under OCEF, and there is some disconnect between the project theory of change and that which would stem from specific types of activities (especially public service-related investments in window 1). Moreover, the existing project logic seems to place heavier emphasis on increased productivity as a result of increased access to electricity, where the evidence from the literature (reviewed in Section 3) is weakest and suggests a need for larger capacity than that which will be provided in window 3, for example. The ERR analysis for the Benin Compact (which does not include OGEAP) meanwhile focuses much more on consumer surplus. Finally, the assumptions and risks in the logic models are not comprehensive, nor are they assessed for likelihood or mitigation plans. To address these issues, and with an interest in maintaining an analytical structure that usefully provides comparisons across grants, the evaluation will need to work to construct logic

models for each of the grants that are to be evaluated and will need to discuss how those grants are or are not representative of the overall portfolio supported by OCEF.

- For OCEF, the targeting of participants will be conducted by individual grantees. This presents potential challenges for the evaluation, particularly if take-up rates are low. This issue is discussed in detail in the evaluation methodology below. For the Enabling Environment Activity, the expected participants are much clearer; sampling for that evaluation component will thus be relatively straightforward.
- The indicators for OGEAP developed in the MCA M&E Plan are relatively few, and at least in the case of OCEF, do not cover higher-level outcomes related to how increased access might lead to increased productive activities or reduced household energy expenditures. The NIRAS M&E Plan includes a more comprehensive set of indicators, particularly at the process and implementation levels, but similarly does not cover higher-level outcomes.
- There is significant interest among a range of stakeholders in an evaluation of both the Enabling Environment and OCEF activities, particularly one that focuses on higher-level outcomes.

4.1.2. OVERVIEW OF EVALUATION DESIGN

This evaluation of OGEAP will have two main components. The first of these is a more qualitative performance evaluation of the Enabling Environment Activity and the OCEF grant facility functioning (as a facility or mechanism, rather than looking at results of individual grants). Indeed, the second component will be a more quantitative impact evaluation centered on a collection of grants. The questions guiding both of these evaluations were revised during the inception phase though discussions with MCC, MCA, and other stakeholders.

Below, we present the questions and design of the performance evaluation, followed by the questions and design of the impact evaluation. We follow that with a discussion of our data collection approach, including both quantitative and qualitative elements, which will be coordinated across both evaluation components.

4.2. EVALUATION OF THE OFF-GRID ENABLING ENVIRONMENT AND FACILITY

4.2.1. MAJOR EVALUATION QUESTIONS

The performance evaluation of the facility and Enabling Environment Activity is focused on a qualitative analysis of the implementation and contribution of both activities to higher level changes in the sector. Specifically, the evaluation is guided by the following 3 primary questions and supplementary sub-questions:

1. Was the OCEF grant facility designed and implemented in a way that encouraged high-quality proposals and projects?

This question looks at both the design and the implementation of OCEF, from the proposal to technical assistance to project implementation stages. The evaluation will address the differences between the design and implementation of the two calls for proposals. The intent is not to assess individual projects, but whether the facility itself was well designed and implemented. An important topic under this question will also look at whether the process encouraged serious consideration of gender and social inclusion issues in project design and application development. Question one will be assessed through the following sub-questions:

- Design:
    - Were the selection criteria and procedures defined in the manual well aligned to the objectives of selecting and scaling effective, sustainable models of off-grid energy services and expanding access to energy to underserved communities?
    - To what extent did the grant facility's evaluation criteria incentivize the proposal and acceptance of grants that best advanced its intended outcomes as defined in the theory of change?
    - Was OCEF and the application process and requirements designed in a way that effectively led to applications and projects that addressed relevant gender and social inclusions issues?
    - To what extent did the evaluation criteria incentivize all applicants to reveal the minimum subsidy required for their investment to move forward?
    - Was the cost sharing amount sufficient to allocate the risks appropriately to the grantee?
- Implementation
    - To what extent was the technical assistance provided to grantees relevant to the gaps identified in the grantee proposals and to the grantee's objectives?
    - Did grantees perceive the technical assistance and more general communications and support they received from OCEF as hindering or enabling their ability to meet the grant's objectives?
    - To what extent were OCEF grants implemented in accordance to the grantees' implementation plans?
    - To what extent did OCEF support projects that are financial sustainable and scalable?

2. To what extent has the regulatory framework for off-grid energy been implemented?

Whereas the first question looks at implementation of OCEF, this question focuses on implementation of the Enabling Environment Activity, with a specific emphasis on implementation of the regulatory framework. Now that the regulatory framework has been approved by the Government of Benin, implementation remains a significant challenge with lack of clarity on roles, process, and capacity. The question will also investigate implementation from the perspective of use. That is, one way to assess whether the framework has been

implemented is to look at whether it is currently being used by organizations entering the market in Benin. Specific topics to be considered under this question include:

- Are relevant Government entities, specifically ARE and ABERME, fulfilling the functions required for implementation of the framework?
- How do organizations interested in the off-grid electricity market in Benin perceive the framework?
- How do relevant Government entities, specifically ARE and ABERME, perceive the framework and the progress in its implementation?
- What are private sector actors' experiences in attempting to enter or grow in the off-grid clean energy market?
- Did the presence of an off-grid regulatory framework make private sector actors more or less likely to enter the off-grid clean energy market in Benin?

3. To what extent did OGEAP encourage additional investment in the sector in Benin?

The final question under the performance evaluation looks at a key outcome area of OGEAP related to the development of the off-grid sector in Benin. It will investigate whether the two activities have generated additional investment in the sector, both in terms of attracting new entrants and technologies to the market and in terms of attracting additional investment. The project logic is based on the assumption that by generating (and implementing) a regulatory framework and demonstrating that viable investments in off-grid projects can be made in Benin, private sector actors will gain the confidence to invest further in the sector. Specific topics of interest include:

- To what extent did the grant facility generate information externalities that encouraged subsequent investment in the off-grid clean energy sector?
- Did the grant facility catalyze additional commercial financing of the off-grid energy sector in Benin?
- To what extent did the grant facility resolve discovery and/or coordination market failures limiting investment in Benin's off-grid clean energy sector?
- Did the grant facility demonstrate scalable business models that would be sustainable in the absence of subsidies?
- To what extent did the facility encourage coordinated, complementary investments that increased the viability/sustainability of facility investments?

4.2.2. PROCESS/PERFORMANCE EVALUATION DESIGN

To answer these questions, we will conduct a mixed-methods Performance Evaluation (PE) with three data collection periods, drawing principally on qualitative data from key informant interviews (KIIs), conducted in the initial and final periods only, supplemented with quantitative data from a three-wave survey of private sector stakeholders who have applied to OCEF (“Applicant Survey”). The first round of data collection in April 2019 and will serve as both a

baseline and follow-up measurement, depending on the question. The second round of data collection (only the Applicant Survey) will occur in early 2021, and the third in early 2022, allowing sufficient time to measure longer term outcomes, particularly related to market development. In this section we summarize our approach to answering each question, and then below in Section 4.4 and 4.5 we discuss the quantitative and qualitative approaches in more detail followed by the sampling.

For the first PE question, related to design and implementation of OCEF, we will rely on three main data sources. First, we will conduct a thorough desk review of key documents related to the design and implementation of OCEF. This will build on the extensive document review for the evaluability assessment and will be more directly focused on the design and implementation of OCEF relative to its objectives. The second data source will be KIIs with key stakeholders involved in or knowledgeable about OCEF, including the following:

- MCC: Resident Country Director and Deputy, Washington-based staff involved in Compact and OCEF development (including Director, Finance, Investment, and Trade)
- MCA Benin: National Coordinator, OGEAP Coordinator, M&E Director
- NIRAS: Chief of Party, M&E Director
- Private Sector: a convenience sample of organizations that registered interest in OCEF, including at least two firms that were shortlisted and received TA, at least two firms that submitted an application but were not shortlisted, and at least two firms that registered interest but did not submit an application (as available)

These interviews will seek detailed answers to each of the sub-questions related to the design and implementation of OCEF. The final data source will be the Applicant Survey. This is a primarily quantitative, 3-wave and close-ended survey of all firms that registered interest in OCEF, regardless of whether they submitted an application or the final status of that application. Other relevant private sector organizations may be included in the sample as well. While this survey will also be an important part of the IE, it will serve to gather a more comprehensive set of findings, relative to the KIIs, related to perceptions on the design and implementation of OCEF from the private sector.

The first round of data collection is planned to occur after firms have been shortlisted and received TA in the first call for proposals, but prior to shortlisting for the second call. This will allow us to collect data related to design of OCEF as close as possible to the actual point of design, which is helpful to understanding the actual thought-process driving design, relatively unbiased from hindsight which may revise perceptions over time. This timing will allow us to gather data on changes made from the first call to the second call, understand the rationale for those changes, and assess applicant perception of those changes. This timing also allows us to collect data from firms who applied for the second call prior to their knowledge of the result of their application, which, again, may bias their perspective. Since the first question is focused on design and implementation more so than outcomes, the initial data collection will serve as a first measurement of results, rather than as a baseline. The second data collection – only with applicant and other relevant private firms – will serve to assess whether these companies' perceptions of implementation and design have changed over time once the results of projects

and the facility are better known (and perhaps other models are tested), and the final wave will allow a richer understanding of these aspects from the variety of perspectives listed above.

For the second question, which looks at the implementation of the regulatory framework, we will rely principally on the same three data sources, and also including NIRAS. The desk review will focus on the enabling environment documents, including the regulatory framework. KIIs will include the following stakeholders:

- MCC: Resident Country Director and Deputy, Washington-based staff involved in Compact and OCEF development (including Director, Finance, Investment, and Trade)
- MCA Benin: National Coordinator, OGEAP Coordinator, M&E Director
- NIRAS
- IED: Chief of Party
- Private Sector: a convenience sample of organizations, including at least two firms that were shortlisted and received TA (and are expected to complete projects)
- Government of Benin: ARE, ABERME
- Other stakeholders: EU, World Bank, GIZ

The third data source, the Applicant Survey, will include questions on their perception of the regulatory framework and how it might affect their operations. Since the regulatory framework has only recently been approved, and at present, we do not believe it has been 'tested' or implemented with any new projects yet, the data collection in April 2019 will serve as a baseline assessment of the suitability of the framework and its prospects and challenges for implementation. Follow-up data collection in early 2021 (Applicant Survey only) and 2022 (with all parties) will serve to assess progress on implementation, as well as experiences of firms with the framework and the government entities responsible for its implementation.

For the third question, on the market and sectoral effects of OCEF and the Enabling Environment activities, we will also use the same three primary data sources. First, the document review will seek to incorporate data from ABERME and ARE on applications for licenses or concessions over time, supplemented by media reports or other research documenting investments in the sector. For KIIs, we will target many of the same stakeholders, asking them about their awareness of additional investments, and for those who have invested, the decision making behind their investment and the timing of it. Specific respondents will include:

- MCC: Resident Country Director and Deputy, Washington-based staff involved in Compact and OCEF development (including Director, Finance, Investment, and Trade)
- MCA Benin: National Coordinator, OGEAP Coordinator, M&E Director
- Private Sector: a convenience sample of organizations, including at least two firms that were shortlisted and received TA (and are expected to complete projects) and at least two firms that submitted applications but were not accepted.

- Government of Benin: ARE, ABERME
- Other stakeholders:
    i. Donors: EU, World Bank, GIZ
    ii. Investors in the off-grid sector in Benin, as identified

Finally, we will also use the Applicant Survey to assess their perceptions of how the regulatory framework and OCEF have changed the market. For the first round of data collection, this will serve principally as a baseline, documenting the challenges and constraints to investments and project development in the sector in Benin, as well as views on how the regulatory framework and OCEF are expected to affect this context (if at all). The follow up data collection in early 2021 (Applicant Survey only) and 2022 (with all parties) will allow us to investigate whether the investment context and market for off-grid, particularly mini-grids, has developed since passing of the regulatory framework and implementation of OCEF. The midline and endline Applicant Survey rounds are especially key to include for answering question 3, given that they will provide understanding on the evolution of the sector over time and once the granting period is finished.

TABLE 3: SUMMARY OF EVALUATION APPROACH

Evaluation Question	Key Outcomes	Data Source	Data Type
1. Was the OCEF grant facility designed and implemented in a way that encouraged high-quality proposals and projects?	Implementation fidelity Design relevance	Desk Review KIIs Applicant Survey	Primarily Qualitative
2. To what extent has the regulatory framework for off-grid energy been implemented?	Implementation fidelity Capacity of key stakeholders relevant to implementation roles Perception of level of implementation of framework among private sector firms	Desk Review KIIs Applicant Survey	Primarily Qualitative
3. To what extent did OGEAP encourage additional investment in the sector in Benin?	Level of investment in the off-grid sector Perception of the role of OGEAP in encouraging that investment	Desk Review KIIs Applicant survey	Primarily Qualitative

4.3. IMPACT EVALUATION OF THE OFF-GRID INVESTMENTS

4.3.1. MAJOR EVALUATION QUESTIONS

An impact evaluation will be conducted to understand the impacts of the projects selected for co-financing support from the OCEF, and to inform the cost-benefit analysis discussed further below in Section 5. This evaluation will focus on the questions detailed in Table 4, which are consistent with the priorities expressed in Compact documents and are justified by their importance in assessing the program's success relative to the anticipated theory of change.

TABLE 4: GRANT-LEVEL EVALUATION QUESTIONS

Grant Outcomes (aligned with the Project Objective)	
Evaluation Question	**Justification**
1. What were the impacts of the investments on beneficiaries? Specifically, did the grants: a. Increase access to and consumption of energy? Was connection status and consumption sustained over time? b. Affect expenditures on energy? c. Increase appliance ownership? d. Increase the hours of operation and coverage of businesses and public services? e. Increase revenue generation, net income, consumption of perishables, and/or productivity?	This question corresponds directly to the various impacts hypothesized in the Compact Theory of Change, but adds impacts not considered there. Specifically, increased energy access and consumption (a) are key hypothesized outcomes of the investments, which in turn are expected to improve productivity (e), reduce losses (b, e), decrease dependence on costly alternatives (b), and increase coverage by businesses and public services (d). Consumption benefits may also stem from appliances (c), however.
2. **What was the distribution of those impacts?** Were the above impacts distributed differently across key population sub-groups, namely gender, age, or income groups?	This question relates to the distribution of benefits assessed in question 1 and focuses attention on 3 particular sub-groups of interest: Lower-income households, women, youth, and possibly education and/or occupation sub-groups.
3. How did impacts vary according to the exposure period?	This question relates to the benefits assessed in question 1. The amount of time beneficiaries will have received the treatment is expected to vary considerably given the staggered implementation inherent to the facility. Therefore, it is important to analyse and report outcomes according to this variation.

Grant Outcomes (aligned with the Project Objective)	
Evaluation Question	**Justification**
4. What factors – contextual, household-specific, targeting or business models, other – drive or constrain adoption of new connections, appliances, and energy services related to off-grid energy?	This question draws attention to socio-economic, intervention-specific, and geographic or other factors that may influence access to the energy technologies supported by OCEF, which also help determine the distribution of its impacts.
5. **Via what mechanisms did revenue generation or productivity increase?** (i.e., for what types of activities/businesses did energy stimulate investment and growth?)	This question considers more carefully the mechanisms through which energy delivers productivity enhancements. It covers the types of activities (e.g., home production, or specific business types) for which such benefits occur, as well as the type of productivity enhancement (e.g., time savings, increased output, or lower cost of production).
6. Can the OCEF-supported investments be considered cost-beneficial or cost-effective, relative to alternatives?	This question seeks to clarify the policy case for the co-financing of grantee investments through OCEF, and to shed light on differences across business models and different windows of OCEF grants.

4.3.2 GRANT-LEVEL IMPACT EVALUATION

This evaluation combines a rigorous quasi-experimental methodology with innovative data collection to answer the evaluation questions. The basic evaluation objective in all cases is to determine how outcomes experienced by a unit *i* (where *i* is a household, business, or community) experiencing an energy improvement ($Y_{i,1}$), most typically a new connection to a solar home system or minigrid (but possibly an energy efficiency improvement or access to public services that benefit from an energy improvement), differ from the outcomes ($Y_{i,0}$) that unit would have experienced without the improvement. This latter counterfactual obviously cannot be observed, and we require other methods for measuring it with a minimum of bias. The approaches we have proposed for evaluation of these changes hinge around exploiting variation in "exposure to treatment" to these improvements across space (Approaches 1 and 2), given an exogenously determined encouragement (Approach 3), or using some combination of these strategies. Our preferred approach is to combine approaches 2 and 3, given the internal validity and statistical threats in approaches 1 and 2 (most severe for the former), and the practical and generalizability challenges stemming from approach 3. We note here that phase 1 grants will be evaluated using approach 2, per our discussions with MCC and stakeholders during the design phase.

Before discussing these approaches and describing their strengths, weaknesses, and operationalization in more detail, we provide a summary (as of information available at the time of the drafting of this EDR in early January 2019) of the shortlisted applications from the OCEF's first call for proposals and assess the implications of these application-level details for planning

the grant-level impact evaluation. Considering the details of these shortlisted applications, and the likely differences with proposals that will follow under call 2 (especially in prioritizing larger mini-grid investments), we review options for impact evaluation methodologies. We note here that while our approach anticipates inclusion of investments to be made in the second round of awards (hopefully spanning across all windows but especially windows 2 and 4, which are missing from the first call), we lack some key information on those investments and are therefore unable to fully describe a sampling approach for those grants. As such, an annex to this EDR will follow once grantees are short-listed under call 2; that annex will detail the specific evaluation design adjustments needed to include the additional grants.

4.3.2.1. SUMMARY OF SHORTLISTED APPLICATIONS FROM THE FIRST OCEF CALL FOR PROPOSALS

At the time of generation of the draft of this EDR (in early January 2019), of the applications that were reviewed and scored for the first call, 10 applications had been shortlisted (two of which were classified as "reserve" grants). There were 10 shortlisted applications; seven shortlisted applications under Window 3 (Household energy systems and products) and three shortlisted applications under Window 1 (Critical public infrastructure with stand-alone electricity generation capability). Our review of the application materials submitted by the shortlisted projects provide insights that are important to keep in mind for the design of the grant-level impact evaluation. Insights specific to Windows 1 and 3 are listed below.

Window 3 shortlisted applications

- **Technology:** Amongst the seven shortlisted applications, there are similarities in the solar technologies offered and in terms of the potential spatial targeting of the proposed interventions. All applicants will offer a solar kit with PV panels of varying capacities. Some applications, but not all, explicitly mention that the PV panels will be sold with batteries having specific capacity. Only a few applications describe selling the home solar kits with capability to support services that extend beyond lighting and phone charging, such as TVs, fans, and radios. *Implication for evaluation: The expected impacts, as detailed by the evaluation questions in Table 4, will vary depending on the set of technologies offered by the applicant organizations included in the impact evaluation. It seems important to measure not just productive uses, which are likely be limited under these investments, but also consumer cost savings and consumer surplus associated with the targeted energy services.*

- **Spatial units:** Four of the seven shortlisted applications mention identifying target locations based on the Plan Directeur d'Énergie Hors Réseau (PDEHR) documentation (www.benin-energie.org), which specifies priority areas for the country. Another applicant mentioned an NGO partner assisting in site identification. There is heterogeneity across applications in the level of the geographical unit to be targeted, with some applicants listing specific villages and others mentioning communes or regions. Applications differ in the number of sites identified and there is also some overlap in the sites identified across applications. *Implication for evaluation: The commune-level is a relatively coarse level at which to consider "treatment"; there will likely be significant heterogeneity in uptake within a commune. Applicant expectations*

regarding the proportion of villages to be covered within a commune are not obvious. In addition, the potential overlap in coverage by multiple applicant organizations will likely make the timing of treatment imprecise and may create challenges for selection of suitable control locations. It is not obvious whether the applicant organizations expect or will be encouraged to also cover communes beyond those they have listed in their applications, and on what time frame.

- **Customer payment structure:** All applications list the proposed payment by consumers for purchasing the solar kits to be via mobile money. Nearly all shortlisted applicants propose pay-as-you-go models for customer repayment. The frequency of repayment varies across applicants from daily to weekly or monthly. *Implication for evaluation: Differences in the frequency of repayment must be anticipated when constructing measures of impacts and considering the power of the evaluation; these could also affect use patterns, non-payment rates, and therefore outcomes.*

- **Applicant-proposed data collection:** Four of the Window 3 applicants mention a parallel deployment of surveys, implemented either face-to-face or by phone at some interval of time within the project. Notably three of the shortlisted applicants (two of the four planning to survey plus one additional entity) mention automated collection and transmission of data on electricity consumption. *Implication for evaluation: The automatic data collection could be extremely beneficial for the evaluation, and the final award contracts should mandate that these organizations share both draft data collection instruments and protocols, and data collected using them. Data collection plans of the other grantees (those not mentioning surveys, and those not mentioning automated collection of consumption data) should be further assessed since focusing on those (potentially higher capacity or higher cost) grantees with more advanced data collection plans may introduce bias into estimates of impact of the grants overall.*

- **Cost-sharing:** There is heterogeneity in the cost-share required by the shortlisted applicants. For example, amongst those in Window 3, the cost shares range between 50% and 75% and averages 64%. *Implication for evaluation: The different cost-share requirements may partly reflect differences in costs, but it is also likely that they will influence the cost faced by households, with implications for take-up, energy use, sustainability and growth of the grantees' business, and final outcomes (as well as the statistical power of the evaluation). Thoroughly understanding these two aspects (differences in costs and benefits) is critical to careful assessment of the "minimum subsidy" needed for investments of this type, and sampling and data collection across grants with different cost-sharing requirements could provide valuable insights on cost and demand differences. Final award contracts should mandate that grantees share cost data to more fully unpack these issues.*

<u>Window 1 shortlisted applications</u>

- **Technology:** These are solar PV systems that provide electricity for important community services. All applications mention the use of solar pumping to deliver clean water (specifically, electricity for water pumping from deep groundwater), and all three suggest some investment in public lighting (either street-level or at water points). In

addition, one applicant also mentions sanitary facilities, whereas another mentions electricity for health centers (and the potential to refrigerate vaccines). *Implication for evaluation: Each of these projects is unique, idiosyncratic, and all are quite different from those of Window 3. A window 1-specific theory of change would need to focus on mechanisms related to changes in time allocation and health (from changes in water sourcing, sanitation, and public health services provision), safety (from public lighting), and possibly gardening (though this is not mentioned by grantees) rather than household consumption and other productive uses.*

- **Spatial units:** The applicants mention identifying locations based on priorities listed in the PDEHR; one also works with a Benin-based NGO that will assist in identifying specific locations. The spatial units identified by the Window 1 applications are fewer in number (12 communes total listed across the 3 applicants) than those mentioned in Window 3. *Implication for evaluation: If the treatment assignment is at the community level, then number of treated units will be limited. Both aspects increase the challenge of achieving statistical power needed to quantitatively identify impacts. On the other hand, it may be easier to find suitable untreated controls that approximate the counterfactual given the limited coverage of these grants.*

- **Customer payment structure:** All three applicants state that customers will pay for use of the wells; however, only one of these mentions a specific rate (e.g. cost per liter of water) at which the customers will be charged.

- **Applicant-proposed data collection:** Two of the three shortlisted applicants in this Window report data collection via survey or collection of comments. *Implication for evaluation: The proposed data collection by these applicants is relatively limited in nature and seems unlikely to be very useful for the purposes of the evaluation. Given the different theory of change operating in each of these investments, MCC, MCA and NIRAS should consider requiring reporting (in the award contracts) that is aligned with the expected effects of these interventions.*

- **Cost-sharing:** Cost-sharing rates are lower amongst the Window 1 shortlisted applicants, ranging between 26% and 61% and averaging 49%. *Implication for evaluation: The reasons for these very different cost-share amounts are unclear, but they may reflect differences in the interventions' varying cost recovery potential.*

4.3.2.2. OPTIONS FOR THE GRANT-LEVEL EVALUATION

Given the details listed above and the overall objective of identifying impacts based on differential exposure to treatment with energy access interventions, we identify three potential approaches to the impact evaluation, and discuss each of their strengths and weaknesses in what follows (these aspects are also summarized in Table 4). At the outset it is important to highlight several challenges that are specific to this case:

a. The "treatment" varies, especially across windows, but also across grantees. That is, each grantee will use different promotion, cost recovery, technology and servicing models, and each window supports activities that lead to different changes and favor distinct energy uses;

b. The geographic target zones identified by applicants to the OCEF at this stage are coarse identifiers at the village-, commune-, or region-level. These contain significant heterogeneity themselves, which is likely to influence grantees within-Commune targeting and prioritization;

c. Those pre-selected zones were likely at least partially selected to be responsive to national priorities for rural energy access and particularly the prioritization schemes discussed in the Off-Grid Master Plan (which favor more rural and distant sites), such that sampling from other non-selected zones may result in confounding by other differences;

d. Similar to call 1, targeting under call 2 is unspecified, and there is a high risk that these plans will impinge on the areas selected as controls to the investments under call 1 (introducing a major contamination threat);

e. The grantee activities will likely have (mostly positive) spillovers on untreated locations, either because increased business activity lead to new products going to market or because of an imitation effect whereby other off-grid energy entrepreneurs expand into non-OCEF supported areas; and

f. The timeframe over which different types of impacts are likely to manifest will vary considerably, with energy connections responding quickly, energy uses changing gradually as new adopters also acquire new appliances, and income generation and productivity lagging more due to their greater investment needs.

Each of these concerns influences our assessment of the strengths and weaknesses of our three proposed evaluation approaches and informs the data collection plan that we describe further below. At the outset, we wish to clarify that our aim is to evaluate grants of each window type, as far as possible, though practical challenges may get in the way of this aim.

Approach 1 (not preferred): Difference-in-differences (DiD) design with ex-ante matching at the commune level, followed by repeated cross-sectional surveys from a representative sample of households

Under this approach, the evaluation would start by creating two lists of communes (or smaller units such as arrondissement or villages) that include rural and off-grid communities in Benin. The first list would include all the communes or other zones identified by the shortlisted applicants (this would comprise the list of intended *treatment* areas), and the second list would include all other communes or zones (the list of potential *control* areas to be used for comparison). We would then use a matching method (likely propensity score matching or some variant of it) to pair potential treatment zones with similar control zones, using the most recent Census and/or EMICOV data. We would further assess similarity in important zone-level pre-trends for a range of variables (a key identifying assumption in DiD designs), using prior rounds of EMICOV data. Here we note that most (6) grantees have specified commune-level targeting, three have specified a lower level, which is typically a village, and one has only specified regions.

Random sampling of households and businesses within treated zones is likely to be problematic, however. This is because we expect uptake of technologies within a commune to

be low, possibly for two reasons: a) Potentially low treatment intensity within a commune; we do not currently have enough information to determine how much of a commune many applicants aim to cover; and b) Potentially low take-up rates among those within *exposed* locations, where grantees promote their off-grid technologies. As such, a random sample would need to be extremely large to allow detection of relatively small average differences across treated and control communes. Instead, under approach 1, we would need to collect data from villages (for window 1) or households (for window 3) who are actually treated, rather than those simply living in communes being targeted for treatment. Those actually treated units cannot be known *ex ante,* so approach 1 would require sampling of different households and villages at baseline and after the intervention, and then construction of a commune- or other zone-level panel for analysis, from those data. Close cooperation with the grantees may allow definition of more spatially refined targeting criteria prior to intervention roll-out (e.g., villages rather than communes) and thus a more finely-tailored matching approach.

There are notable strengths in this type of design. First, it would start from the full (or near full) universe of grantees, and thus be relevant to the performance of the OCEF portfolio rather than one or a few specific grantees working in specific areas. While the matching approach might limit representativeness, such concerns could be properly contextualized since the first stage would clearly identify what types of communes have been targeted. Second, the samples constructed at baseline and following intervention would largely be representative of rural off-grid households living in the sample communes, rather than being particular “types” of households. Logistically, the design would not require much additional agreement or interaction with the shortlisted applicants, beyond perhaps acquiring more details on their targeting strategy. The fieldwork is also logistically simple, with the main requirement being that the evaluation construct valid baseline and follow-up survey samples and manage those data collection efforts. Finally, for the purposes of analysis, a commune-level unit of analysis would allow full use of M&E data collected by grantees alongside the survey data analysis; for example, allowing parallel analysis of the number of new connections or electricity consumption across treated communes.

Unfortunately, there are also severe and major difficulties in such a design. For one, statistical power challenges would be significant with a commune-level panel (since the number of treated and control units would be small – preliminary assessments suggest there will not be sufficient units unless targeting by grantees can be much more finely specified). Indeed, more refined village-level panels, the variant discussed immediately above, would be better, but it is possible that grantees will develop their specific targeting strategies in dynamic fashion, challenging such a refinement. In any case, power calculations are discussed in additional detail in the Sampling section (4.6); these reveal that approach 1 has a high risk of being underpowered for even the most basic outcomes, unless the grant facility has a very large impact on adoption of new energy connections in targeted communes of rural Benin. This leads to an additional problem; if the treatment is so powerful, it is likely that it would spread quickly into control areas as well.

Second, though we could ensure that the baseline samples within sampled areas are representative of rural populations within those areas using random sampling, we would similarly need to ensure that the follow-up cross-section is also representative. A random sample of those taking up the new technologies is unlikely to be so, as the vast literature on the

determinants of technology adoption in a wide variety of domains makes abundantly clear. To maintain representativeness, we would need to have the grantees collect basic data on those taking up the technology, such that we could further compare sub-samples of those households with households in our baseline sample to construct the follow-up sample. This procedure would at best remove observable differences across households but would also possibly require inclusion of control variables to account for differences in the characteristics of the follow-up sample. It would also create possibilities for confounding by unobservables, a threat that would be untestable given this design.

Third, all communes have some baseline electrification rate prior to the intervention, although villages may not. Employing a method in which the treatment unit is at the commune-level, the evaluation would be measuring the impact of an increase in electrification on the intensive margin and not the extensive margin. In other words, it is measuring the impacts of some small increase in the proportion of the commune that is electrified. A village-level panel could more accurately assess the effect of providing electricity for the first time.

Finally, contamination could occur in both control and treatment areas, if other actors are intervening on energy access in the sample areas independently of the OCEF-sponsored grantee. Given the considerable growth in off-grid energy sector over time, particularly in the household solar kit business, and given the comments about statistical power discussed above, this threat is significant.

Based on these various considerations, we feel that the success of approach 1 is unlikely.

Approach 2: DiD design with ex-post matching of targeted households in treatment communes with controls in non-treated communes

The second approach is similar to approach 1 in using a DiD design, with the key differences lying in the sample construction. We would once again use a matching method (likely propensity score matching or some variant of it) to pair potential treatment zones with similar control zones, using the most recent Census and/or EMICOV data. We would again assess similarity in important pre-trends for a range of variables (a key identifying assumption in DiD designs), using prior rounds of EMICOV data.

For specific sample construction within communes, however, we would modify the procedure in approach #1 as follows. We would sample households or businesses randomly from the lists of only those signing up for new connections from the grantees and collect baseline and follow-up data from these individuals. Such lists would need to be obtained promptly from grantees once new customers are identified, and surveys would need to be deployed rapidly to collect baseline data, prior to connections being installed (and likely, this baseline surveying would need to occur on a rolling basis). In control zones, we would oversample at baseline, to allow *ex post* matching from a representative sample of households or businesses in control communes to those actually signing up to receive connections in treatment zones. This approach would thus require a larger sample of controls at baseline (with cost implications) but would allow a full panel analysis of households and businesses for the matched sample of observations. Importantly, treatment is defined at the household or business level in this approach for windows 2 and 3, and probably at the community level (given that the investments there are for

public services) for window 1 (the appropriate level of assignment for window 4 is currently unclear).

In terms of strengths, this approach would again start from the full (or near full) universe of grantees, and thus be relevant to the performance of the OCEF portfolio rather than one or a few specific grantees working in specific areas. The initial zonal selection again might limit representativeness, but such concerns could again be properly contextualized. As discussed in additional detail in Section 4.6, statistical power would be much improved over approach 1 given the construction of a household- or business-level panel, though we would still need to cluster at the community level to account for correlation in the patterns of targeting and technology uptake. Logistically, the design would require considerably more interaction with shortlisted applicants and timely access to clients as they would sign up. Once the sample was established, the fieldwork would proceed normally, with the main requirement again being that the evaluation construct valid baseline and follow-up survey samples and manage those data collection efforts. We would require grantees to honor a waiting period prior to connections or investments being deployed, to allow time for baseline surveying.

This approach would thus reduce some of the difficulties inherent in the first approach but introduce new ones. A key challenge would be to obtain information to sample and then conduct baseline surveys in a timely fashion, at the appropriate pre-intervention moment. Such reporting and the existence of a waiting period prior to connections could be perceived by grantees as burdensome, given the likely dynamic process by which potential customers indicate interest and the desire for grantees to provide connections and services to them promptly. In particular, it is unlikely that grantees would want to wait long between sign-up of new customers and installation, and behaviors and responses to many questions related to energy access might change even in anticipation of new connections. Pending further discussion with grantees, the baseline survey may need to be tailored or transformed into a rapid survey measuring a select number of key variables most critical for impact analysis and/or matching.

Second, the final sample would no longer be representative of rural populations within targeted areas, challenging generalizability to other parts of Benin. While we would certainly learn something about the determinants of adoption (from the *ex post* matching step), it would be difficult to assess the implications of this selection for generalizability of impacts, which are likely to differ according to many of the same characteristics. A random sample of those taking up the new technologies is unlikely to be so, as the vast literature on the determinants of technology adoption in a wide variety of domains makes abundantly clear.

The possibility of confounding by unobservables would also remain, given that the *ex post* matching would be limited to observed variables. The panel analysis would allow inclusion of household fixed effects for key outcome measures, however, reducing somewhat these unobservable threats. The remaining threats would be in time-varying unobservables, or threats related to contamination, which could still occur in both control and treatment areas, if other actors are intervening on energy access in the sample areas independently of the OCEF-sponsored grantee. Given the considerable growth in off-grid energy sector over time, particularly in the household solar kit business, this threat is significant.

Based on these various considerations, we feel that approach 2 has important merits and shortcomings and should be considered seriously as part of the evaluation strategy. We also note that this was the approach that stakeholders including MCC have suggested implementing for grantees supported under the first call, due to the short time frame before the start of implementation of those agreements, and the challenge of crafting an encouragement approach that would be acceptable to all relevant parties in such a short time frame.

Approach 3: Randomized encouragement design

The third potential evaluation approach is substantively different from the prior two methods. Rather than relying on spatial variation in exposure to treatment as the means to identify the impacts of OCEF grants, the logic of this strategy would be to employ a randomized encouragement to induce exogenous variation in the probability of take-up of off-grid energy technology. Such an approach would allow identification of the impacts of new connections on a range of outcomes, among the population subjected to these inducements. In principle, an encouragement approach could be combined with one of the other two variants; such a hybrid evaluation strategy might be particularly valuable in offering comprehensive insights both on who adopts these new technologies (and conversely, who does not), and on how those taking up energy access may benefit. Though somewhat costlier and more ambitious, a hybrid strategy would also allow balancing of some of the strengths and weaknesses inherent in each approach.

To operationalize an encouragement strategy, which would require the cooperation of grantees to be fully successful, we propose to offer grantees (in windows 2 and 3) the choice of opting into participation in the encouragement experiment, the specific details of which would then be discussed with (and perhaps tailored specifically to the concerns of) interested grantees. Though inducements could in theory be seen to interfere with grantees' business models, we believe that many would be interested in participating under certain conditions, specifically: a) that they would not necessarily bear the additional costs of providing incentives (which could come from MCC's evaluation budget) or that they might already be experimenting with inclusion of such features as part of their business model development; b) that the encouragement design would affect a small portion of their project, and thereby qualify more as a sort of focused evaluation study rather than a re-engineering of a business model; and c) that this activity could generate valuable data on market demand particularly among segments of the population that might ordinarily not choose to take up products. This latter aspect would be of particular interest to the grantees as they seek to develop and improve on their business strategy, but it would also be extremely valuable for OCEF more generally, as the facility aims to learn about the implications of different subsidies (and their relation to the so-called "minimum subsidy") for energy-related outcomes.

Among the organizations choosing to opt-in, a subset of potential customers (both households and businesses) could be randomly assigned to receive a modest financial subsidy that would lower either i) the cost of connection; ii) the tariff rate being paid; or iii) the financing cost associated with acquisition of the system. Alternatively, encouragement could be offered for specific types of uses (e.g., adoption of appliances or machines). This discount would provide an additional inducement to take-up the product, and we would utilize the exogenous variation in the strength of the inducements to identify specific impacts of energy access. The amount of

the subsidy and the products for which the subsidy would be eligible are points to be negotiated with interested grantees. All households or businesses enrolled in the experiment would be interviewed at baseline, prior to the intervention and announcement of inducements, and then after the intervention, again facilitating a panel-level analysis. We note that the baseline data is not strictly needed under this type of design; however, it would be preferable to check that the randomized treatment is balanced on key baseline household and enterprise characteristics, and to understand the nature of the sample to which the experiment applies (relative to other locations in Benin and targeted by OCEF).

There are a number of important advantages to deployment of an encouragement design. A first advantage is that the treatment and control groups are easily identified in an encouragement design. The second and arguably most obvious advantage is the value that such a strategy offers in terms of measuring impacts. Because the strength of the encouragement (or alternatively, the size of the discount) is randomly assigned across the population, we can be confident that it is unrelated to both observable and unobservable characteristics that could otherwise confound measures of impacts. Any differences in outcomes across low and high encouragement groups can therefore be ascribed to the differences in the levels of access, which will be greater among the highly encouraged. A third advantage is that the evaluation sample in such a design is stable and allows analysis to occur at the individual household, enterprise, or other institutional level, subject of course to potential concerns about spillovers biasing impact measures (if some lower-encouraged units benefit from the higher access among more highly-encouraged units) and differential attrition (if, for example, more of the sample in one of the arms of the experiment is lost by the time of follow-up).[58] This stable sample offers advantages for adequately projecting the statistical power of the evaluation, relative to the matching designs where it is unclear how much sample will ultimately be retained. Finally, an encouragement design would enable a more well-constructed demand study that would not only consider who is likely to adopt, but also how the likelihood of adoption responds to changes in the private costs of off-grid energy. Adoption in this case could refer to more than just connections as it could be broadly construed to also cover complementary investments in appliances that deliver specific electricity services (e.g. fans, energy efficient TVs), and for which encouragement could be provided.[59] This responsiveness of take-up to price is intimately related to the viability of a privately driven off-grid sector, the long-term sustainability of this strategy, and to issues of proper regulation and the minimum subsidies required to reach different segments of the population.

Alongside these advantages, an encouragement design also has some important limitations. Perhaps the most significant of these is logistical. Implementation would be challenging; the ET would be responsible for specifying who within a target zone is to be targeted with different inducements, but the delivery of these would certainly have to be managed by a local

[58] Of course, though positive spillovers might challenge measurement of impacts, studying these carefully might also be of interest for learning about the effects of off-grid investments, and an encouragement design could be structured to shed light on such a mechanism.

[59] In this context we will also considering stratifying the encouragement according to policy-relevant characteristics that might be of particular interest to both OCEF and to the grantees, such as poverty status of a household, in line with an attempt to better understand answers to distributional questions, although statistical power to detect differences across groups may not be sufficient, depending on the nature of the outcome.

institutional partner. To avoid tampering by the grantees and recipients, institutional oversight would likely need to be provided by the OCEF implementer, working with the evaluator and the MCA. This of course poses some challenges related to the independence of the evaluation, since there would need to be close communication and coordination between the ET (primarily through its in-country representative) and the MCA and MCC. A second concern might be that an encouragement approach would alter the business models of the grantees in a way that would compromise its policy relevance. Clearly, this concern would be greater the larger the scope or scale of the encouragement strategy, but we believe that in this case, this threat is relatively small because the encouragement will comprise a focused evaluation study. A third concern, also related to the scope of the encouragement design, would be the cost of the incentives provided to households and businesses. Fourth, it is possible that no grantees would want to participate in this activity, or that the encouragement would be too weak to alter uptake. Finally, the sample constructed for the encouragement design would likely not be representative of areas targeted with OCEF support, given that grantees would be opting in (and there may be important differences across those participating and those not interested in participating), and given that the scope and target area for the encouragement would be constructed based part on input from the grantee on the location most appropriate and interesting for deployment of a marketing study.

Based on these various considerations, we feel that similarly to approach 2, approach 3 has important merits and shortcomings, and should be considered seriously as part of the evaluation strategy. We note that exploration of the feasibility of this approach will continue in the lead up to the selection of grantees funded under the second call for proposals.

TABLE 5: SUMMARY OF EVALUATIONS OPTIONS; PRINCIPAL THREATS TO VALIDITY; AND POTENTIAL MITIGATION STRATEGIES

Approach 1	Approach 2	Approach 3
Summary of approach		
Ex ante matching to select treatment and control zones for surveys; DiD w/repeated cross-sectional samples to remain responsive to intervention micro-targeting	Ex ante matching to select treatment and control zones for surveys; DiD based on panel sample of enrollees for connections matched to observationally similar households from control zones. Oversampling from control zones at baseline.	Deployment of randomized encouragement strategy to exogenously create variation in exposure to energy access. Use that random variation to identify impacts.

Approach 1	Approach 2	Approach 3
<u>Internal validity considerations</u>		
Potential for bias from selection		
Moderate to high risk. Potential problem because *ex ante matching* uses a statistical approach to accounts for selection on observables. Factors omitted from the matching may contribute to selection bias being maintained. In particular, it is well-known that grantees are targeting "higher priority" areas, per the off-grid master plan work.	**Low to moderate risk**. Potential problem in initial sample construction for similar reasons as in approach 1. Selection threats are somewhat reduced overall, however, by the second stage of *ex post* matching, which allows use of a richer set of baseline characteristics that predict adoption of energy connections. This allows better control for household, if not zone-related, selection.	**Low risk**. Use of randomization to encourage uptake and comparison across corresponding set of low and high adopters renders systematic differences in groups unlikely.
Mitigation strategy: Use lower-level administrative definitions; leverage both Census and EMICOV data.	**Mitigation strategy**: Use lower-level administrative definitions; leverage baseline data.	**Mitigation strategy**: Control for any imbalances remaining after randomization statistically.
Potential for bias from confounding		
Moderate to high risk. Possibility for confounding from unobserved factors or inadequate control for differences between treated and untreated areas. DID strategy only controls for zone-level time-invariant unobservables.	**Moderate risk**. Possibility for confounding from unobserved factors or inadequate control for differences between treated and untreated households. Household fixed effects control for time-invariant unobservables, but threats remain in time-varying factors. Changes made in anticipation of new connections could confound baseline assessments.	**Low risk**. Confounding is unlikely to be correlated with treatment status, due to use of randomization, unless other off-grid actors specifically target lesser-treated populations. Risk of such a compensatory response increases over time.
Mitigation strategy: Use zone-level and time fixed effects; monitor and control for time-varying changes as far as possible. Apply robustness checks; sensitivity analysis.	**Mitigation strategy**: Use household-level and time fixed effects; monitor and control for time-varying changes as far as possible. Apply robustness checks; sensitivity analysis.	**Mitigation strategy**: Test robustness of results to inclusion of household fixed effects; monitor and control for compensatory targeting as far as possible.

Approach 1	Approach 2	Approach 3
Risk of contamination		
Moderate to high risk. Contamination could occur in both control and treatment areas, if other actors are intervening on energy access in the sample areas independently of the OCEF-sponsored grantees. Risk increases in the coarseness of the zonal matching method and increases once call 2 grantees begin implementation.	**Moderate risk.** Contamination could occur in both control and treatment areas, if other actors are intervening on energy access in the sample areas independently of the OCEF-sponsored grantee. Risk is somewhat lower than in approach 1, due to sampling of panel from more highly treated areas, in which duplication risk is likely to be lower (though increasing with call 2).	**Moderate risk**. Contamination could occur in the locations enrolled in the encouragement experiment, if other actors intervene there as well. Duplication risk is likely to be lower (even when call 2 launches). Contamination could also occur if participating grantee(s) decide(s) to scale up incentives based on observations of the success of the experiment.
Mitigation strategy: Monitor situation on the ground carefully; work with OCEF to avoid duplication of grantee actions in evaluation sample areas. Consider that contamination may be the counterfactual.	**Mitigation strategy**: Monitor situation on the ground carefully; work with OCEF to avoid duplication of grantee actions in evaluation sample areas. Consider that contamination may be the counterfactual.	**Mitigation strategy**: Monitor situation on the ground carefully; work with OCEF to avoid duplication of grantee actions in evaluation sample areas; work with participating grantees to prevent contamination.
Risk of bias from attrition or spillovers		
Low risk. Attrition is not relevant in the context of repeated cross-sections. Spillovers are unlikely to be large due to low intensity of treatment	**Low to moderate risk.** Attrition in panel is likely to be limited due to targeting in rural areas, where migration is relatively limited. Spillovers are likely to be modest due to low to medium intensity of treatment.	**Moderate risk**. Attrition in panel is likely to be limited due to targeting in rural areas, but fairness concerns may lead to non-response. Spillovers are likely to be greater due to increased intensity of treatment (with encouragement).
Mitigation strategy: No major needs anticipated. To reduce non-response, work to make surveying as easy for respondents as possible.	**Mitigation strategy**: Record address/contact information carefully; use community surveys and qualitative data collection for assessing, if not estimating, spillovers.	**Mitigation strategy**: Record address/contact information carefully; consider stratifying the intensity of the experiment to specifically measure spillovers.
Lack of statistical power		
High risk. Statistical power is very difficult to assess, given that uptake levels are unknown *ex ante*. Sample size (number of treated and control units) is small.	**Moderate risk**. Much improved compared to Approach 1	**Moderate risk**. Easy to calculate and control based on sample size, though adoption response is difficult to predict.

Approach 1	Approach 2	Approach 3
Mitigation strategy: Use conservative assumptions in power calculations; use replacement in the case of non-consent	**Mitigation strategy**: Use conservative assumptions in power calculations; use replacement in the case of non-consent; oversample by 10% to buffer for attrition	**Mitigation strategy**: Use conservative assumptions in power calculations; use replacement in the case of non-consent; oversample by 10% to buffer for attrition
External validity (representativeness)		
Moderate to high. The evaluation considers a real program as implemented on the ground. Baseline samples are likely to be highly representative of off-grid areas in Benin. Unclear if window I and IV grants can be studied adequately; however, given their small numbers and different logic. Follow-up sample may not be fully representative given grantee micro-targeting to "easier" locations.	**Moderate**. The evaluation considers a real program as implemented on the ground. The final sample will be unrepresentative (a random sample of clients adopting new technology is unrepresentative as it ignores those unconnected). We would learn about the determinants of adoption, however; by considering the characteristics of this population relative to the representative baseline sample of control households.	**Moderate**. The evaluation would modify the real program being implemented with unclear implications for external validity. The final sample would be representative in the areas where the design is implemented, however. External validity would also vary depending on how many grantees participate, since grantee selection into the experiment may create concerns for generalizability.
Mitigation strategy: Use the full set of off-grid zones in Benin for sampling; construct sample from information from all grantees for Windows II and III, and I and IV if possible.	**Mitigation strategy**: Use the full set of grantees for Windows II and III for sample construction, and I and IV if possible.	**Mitigation strategy**: Use the grantees surveys that make up the performance evaluation to help understand differences in participating and non-participating grantees. Use experimental games in those surveys to obtain additional insights on grantee behavior.
Cost		
Highest. Large sample engenders high cost, though the repeated cross section design is somewhat cheaper than a panel design, given a fixed sample size.	**Likely lowest (?)**. Relatively large sample will be needed in baseline control areas, so surveying is costlier than approach 3. Additional subsidies and management of encouragement program are not needed, so this is likely to be the cheapest design.	**Likely middle (?)**. Smaller sample is needed to achieve sufficient statistical power, since adoption is highest, but the encouragement subsidies must be paid.

Approach 1	Approach 2	Approach 3
Logistics		
Least intensive. With OCEF/grantees: Some initial coordination with grantees to better map their targeting strategy With fieldwork: Standard survey methods for representative sampling within survey zones, and for management of data collection efforts	**Moderate intensiveness**. With OCEF/grantees: More interaction with shortlisted applicants and timely access to newly signed-up clients. With fieldwork: Baseline survey would need to be conducted between new customer sign-up and technology installation, which could be challenging, especially if sign-up is on a rolling basis. For follow-up, management is standard but harder than in approach 1, given panel nature of survey.	**Most intensive.** With OCEF/grantees: Most complicated, requiring full cooperation and engagement by all parties and delivery of incentives by local institution separate from SI and from grantees. With fieldwork: Standard survey methods for representative sampling within experimental zones, and for management of data collection efforts. Somewhat harder than approach 1, given panel nature of survey.
Other considerations		
Overall risk of null results is likely to be high. In such a case, it would be unclear if impacts are really null or if statistical power was insufficient.	Grantees and clients will be unlikely to want to wait long between sign-up and installation. Client behavior might change in anticipation of new technology. Baseline survey might need to be tailored into a rapid survey measuring only key variables most critical to our impact analysis.	It is possible no grantees would want to participate in this approach. The encouragement design might alter the business model of the grantees, detracting from our ability to produce a relevant evaluation of the grant facility. Encouragement could be seen as unfair, though such aspects can be mitigated with other compensation.

4.3.2.3. MEASURES OF OUTCOMES AND IMPACTS, AND RELATION TO EVALUATION QUESTIONS

The principal outcome and impact measures that will be collected in the grant-level evaluation are presented in Table 6, where they are additionally mapped to the evaluation questions elaborated previously. This list of measures was developed to be responsive to three different dimensions of the OGEAP:

- The outcomes expected in the project theory of change (presented in Section 2);
- The outcomes discussed in the literature on energy access and off-grid energy interventions in particular (as summarized in Section 3); and

- The outcomes that might be anticipated based upon the nature of the grantee applications submitted under the first call (this is most different from the project theory of change when considering the window 1 grants).

Table 6 also indicates the anticipated source for each of these measures. Many of the measures are expected to come from the grantee-level data; **reporting on these should be mandated in the implementation contracts with the final awardees**. The beneficiaries to which the measures pertain include all energy end users, that is, households, enterprises, and public institutions gaining access to electricity, as well as the communities in which electricity arrives. The latter is especially relevant when considering services such as public lighting or access to new water sources, and when considering that new businesses and income generation activities may emerge in communities following grantee interventions. Such new activities would not be picked up in a panel sample that only considers units that existed prior to the intervention.

TABLE 6: SUMMARY OF OCEF GRANT EVALUATION OUTCOMES AND MEASURES

Grant Outcomes (aligned with the Project Objective)			
Evaluation Question	**Key Outcomes**	**Data Source**	**Data type**
1. What were the impacts of the investments on end users?			
a. Did they increase access to and consumption of energy? Was connection status and consumption sustained over time?	# New connections, by technology (including generation and storage capacity); working connections	Grantee data (and Applicant Survey); field audits by engineer	Quant
	Electricity consumption (kW-hour/connection-month) over time, if metered	Grantee data; *household* & *firm surveys*	Quant
b. Did they affect expenditures on energy?	Connection costs (CFA/connection); expenditure (CFA/connection-month); default rates on contracts over time (%)	Grantee data (and Applicant Survey); *household* & *firm surveys*	Quant
	Other fuel and energy-related (equipment, battery, collection time) costs (CFA/month)	Household & firm surveys	Quant
c. Did they increase appliance ownership?	Purchase (0/1) and spending (CFA) for promotional appliances	Grantee data, if applicable	Quant
	Ownership and use (frequency/duration) of appliances and machines, timing of purchases	Household & firm surveys	Quant
	Access to different modern energy services (e.g., lighting, refrigeration)	Household & firm surveys	Quant

	Consumer surplus from appliance ownership (CFA)	Household surveys	Quant
d. Did they increase the hours of operation and coverage of businesses and public services?	Hours of operation of public services / businesses (hours/week)	Community & firm surveys	Quant
	Household use of public services (0/1), and frequency of use	Household surveys	Quant
	Perceptions of quality of local public services and business offerings (Likert-scale)	Community & household surveys	Quant/Qual
e. Did they increase revenue generation, net income, consumption of perishables, and/or productivity?	Time savings (hours/week) and changes in time allocation and timing across activities, especially for productive use (e.g., study, paid work, domestic work)	Household surveys	Quant
	Incidence of air pollution-related illness (cases/household; 7-day recall); and expenditures (CFA/household-month)	Household surveys	Quant
	Revenue and/or net income (CFA/month)	Household & firm surveys	Quant
	Non-fuel cost savings (CFA/month)	Household & firm surveys	Quant
	Value of lost perishables (CFA/month)	Household & firm surveys	Quant
	# and types of firms	Grantee data; Community surveys	Quant/Qual
2. **What was the distribution of those impacts?** Were the above impacts distributed differently across key population sub-groups, namely gender, age, or income groups?	All above measures, disaggregated by sex (male/female), age group (<18 years; 18-30; >30 years), level of education (none, primary only, secondary or greater), and income (poverty status) or occupation (unemployed, agriculture, or non-agriculture)	Sources listed above for all outcomes	Quant
3. How did impacts vary according to the exposure period?	All above measures, analyzed using an econometric model that accounts for the duration of exposure	Sources listed above for all outcomes	Quant

4. What factors drive or constrain adoption of new technologies related to off-grid energy (both connections and equipment, appliances or energy services)?	All outcomes under evaluation questions 1a-c, but particularly adoption of connections and of appliances/energy services	Sources listed above for all outcomes 1a-c	Quant
5. **Via what mechanisms did revenue generation or productivity increase?** (i.e., for what types of activities/ businesses did energy stimulate investment and growth?)	All outcomes under 1d-e, disaggregated by business/service type	Sources listed above for outcomes under 1d-e	Quant
6. Can the OCEF-supported investments be considered cost-beneficial or cost-effective, relative to alternatives?	Valuation of impact measures (demand; valuation of public services)	Household & firm surveys	Quant
	Cost of interventions	Grantee data (and Applicant Survey)	Quant

The anticipated calendar of data collection under the grant evaluation is shown in Table 7 below. We anticipate that baseline data collection for the grants funded under the first OCEF call will take place beginning in April 2019, prior to the start of installations supported by those awards. Under approaches 1 and 3, the timing will be optimized in relation to the start of the planned activities; with approach 2, in contrast, we will implement a rolling baseline that tracks the on-the-ground activities of grantees. Baseline data collection for the grants funded under the second call will follow prior to their implementation (likely in early 2020, assuming the pre-selection and technical assistance goes as planned), as soon as sufficient information is available to: a) Develop a detailed sampling strategy given the grantees' targeting plans; and b) Be certain about which grants will be awarded support.

For follow-up endline surveys, we propose to conduct surveying during the same season around the close of the Compact, during the year 2022 or later, if appropriate based on completion of projects funded under the second OCEF call, at least 5 years after the Compact entry into force (the follow-up would therefore likely begin in April 2022). In planning the timing of endline, we did consider the need for allowing a sufficient duration of exposure to the interventions to allow measurement of the impacts of interest, within the constraints of the evaluation contract. We note that there is no consensus on this in the literature, although studies with exposure periods of less than 18 months have generally found very limited impacts on economic development (whereas others with periods ranging from 2-6 years have found supportive evidence). Bos et al. (2018) observe that "the literature seems to show that it may take several years for electricity

to have an impact on household-level outcomes".[60] Inclusion of a midline data collection event focused on the grantees and other applicants and relevant private sector firms (the "Applicant Survey") in late 2020 would allow better understand of the evolution of changes over the short and long term, and of the development of the off-grid market. This is particularly important for understanding the dynamics of the market, and the use of energy for productive uses and income generation, which the literature suggests do not materialize immediately. While we had originally thought that an interim wave of data collection conducted between call 1 and call 2 might be worthwhile among beneficiaries, we no longer see as much value in that since productive uses are less likely under call 1 with its major focus on SHS.

Under Impact Evaluation (IE) approaches 1 and 3, each data collection event would be expected to take between about 6-8 weeks in the field and would focus primarily on quantitative data collection. In approach 2, as discussed above, the baseline surveys will require a rolling deployment, however, that is responsive to a changing rate of customers signing up for new connections. Each data collection event will survey households, enterprises, and community key informants (the latter will include questions targeted at informants knowledgeable about specific public institutions such as schools, health centers, religious institutions, etc.). The instruments, which are currently under development and for which drafts will be shared with MCC and other stakeholders, will cover a range of topics that are critical to understanding both outcomes and potential determinants of those outcomes (the latter are specifically important for addressing OCEF grant evaluation questions 2-4). These are described in additional detail in Section 4.4 below, along with the analysis plan for using those data.

TABLE 7: TIMING OF DATA COLLECTION EVENTS

Window[α]	Baseline	End of Compact Follow-up	Midline Follow-up
Applicant survey	April 2019/ January 2020	April 2022/ December 2022	Early 2021
1: Public infrastructure	April 2019 and possibly January 2020	April 2022	n.a.
2: Mini-grids	January 2020	December 2022	n.a.
3: Household systems	April 2019 and possibly January 2020	April 2022	n.a.
4: Energy efficiency	If applicable, January 2020	If applicable, December 2022	n.a.

Notes:

[60] Bos, K., Chaplin, D., & Mamun, A. (2018). Benefits and challenges of expanding grid electricity in Africa: A review of rigorous evidence on household impacts in developing countries. *Energy for Sustainable Development*, *44*, 64-77.

[α] Data collection related to grants funded under the second OCEF call may include projects that combine interventions across more than one window. All projects selected under the first call are specific to either window 1 or window 3.

[¥] The specific timing of endline is subject to adjustment, based on the implementation progress particularly for grants funded under the second OCEF call, which may require additional time to generate impacts.

4.4 QUANTITATIVE DATA COLLECTION AND ANALYSIS

The quantitative data collected as part of this evaluation will consist of:

1. Three types of surveys collected within communities sampled for the evaluation of the OCEF grants;
2. The mixed methods three-wave Applicant Survey of all organizations who at least initiated an application for OCEF funding in calls 1 and 2; and
3. Data collected through routine M&E reporting by grantees implementing their projects, for which we intend to coordinate with NIRAS, MCC, and MCA.

In developing the instruments for each of these data collection activities, a desk review of relevant project documents and of similar surveys deployed in other contexts will be conducted to both tailor data collection to the local context and structure of the Compact and take advantage of best practices and learning from prior off-grid energy sector evaluations. Each of these procedures and instruments is discussed in additional detail below (in sub-sections 4.4.1-4.4.7), and a preliminary data analysis plan for analysis of key outcomes and evaluation questions follows in Section 4.4.7.

4.4.1 DESK REVIEW

In order to prepare instruments that are maximally relevant to the evaluation context at hand, in addition to reviews of documents already conducted in the preparation of this EDR, the ET will also conduct:

- A thorough review of all pre-selected grantee applications (this has largely been achieved already for the grants per-selected under call 1, and provides information on the grantee organization, technology specifications, targeting approach, sales model; and project objectives and expected outcomes);
- A more rudimentary analysis of both incomplete applications and complete but non-selected grants. These two types of applications will be particularly useful for development of the Applicant Survey described in Section 4.4.5;
- A thorough review of the evolving M&E plan being instituted by the grant facility manager (NIRAS), as well as any additional theory of change documents elaborated and discussed by the facility manager's M&E specialist; and
- Other M&E documents or revisions elaborated by MCC and MCA.

The team will also review existing survey prototypes to inform development of state-of-the-art energy access surveys. To do so, examples will be harvested from researchers affiliated with Duke University's Energy Access Project, from the World Bank's Multi-Tier Framework surveys, which have been made public for Ethiopia, Cambodia and Bangladesh, and from contacting other researchers active in the sector, including those serving the ET in an advisory capacity.

4.4.2 HOUSEHOLD SURVEYS

Household surveys conducted in communities sampled for the OCEF grant evaluation will cover the following major topics:

- Administration and consent;
- Contact details and basic household and respondent information;
- Household roster, including basic demographics, education status, and livelihoods activities;
- Perceptions of the household energy and electricity situation;
- Electricity connection status uses of electricity, reliability and quality, and coping behaviors;
- Other energy sources and uses;
- Individuals' time use and health;
- Availability and quality of public services and access to privately-produced energy-intensive goods and services;
- Income and socio-economic status; and
- Enumerator observations.

At follow-up only, selected surveys will be accompanied by field audits from the ET's engineer, in order to assess the quality of the connection and the functioning of the technology from a technical perspective.

Importantly, the household rosters and elicitation of time use and health responses specific to individuals within households will allow analysis of the distribution of impacts by gender and age characteristics. We will additionally explore the feasibility of conducting basic cognitive testing for school-aged children (6-15) in sample households, using standard non-language-based methods that have been applied widely across the world, such as Raven's progressive matrices tests (Raven & Court 1998).[61] Such tests have been found to be correlated with school performance and future earnings (Ceci et al. 1997; Glewwe & Jacoby 1994).[62]

[61] Raven, J. C., & John Hugh Court. (1998). Raven's progressive matrices and vocabulary scales. Oxford Psychologists' Press.

[62] Ceci, S. J., & Williams, W. M. (1997). Schooling, intelligence, and income. American Psychologist,52(10), 1051.

Glewwe, P., & Jacoby, H. (1994). Student achievement and schooling choice in low-income countries: Evidence from Ghana.Journal of Human Resources, 843-864.

TABLE 8: QUANTITATIVE DATA COLLECTION

Data collection	Timing MM/YYYY (include multiple rounds)	Sample Unit/ Respondent	Sample Size	Relevant instruments/ modules	Exposure Period (months)
Applicant surveys	Round 1: April 2019 (Call 1); December 2019 (Call 2) Round 2: Early 2021 Round 3: April 2022 (Call 1); December 2022 (Call 2)	Private sector off-grid energy firms	60?	Applicant survey	Round 1: Baseline Round 2: 1-1.5 years; Round 3: 3 years
Grantee reporting data	Throughout evaluation	Grantee	20?	Routing M&E reporting	From baseline to 3 years
Beneficiary surveys	Round 1: Rolling baseline, beginning in April 2019 (call 1)/ December 2019 (call 2) Round 2: Equivalent month to baseline, in 2022	Households	4224 at baseline; 2112 at follow-up	Household survey	Round 1: Baseline Round 2: Approximately 3 years
		Village enterprises	600-1200 (~10 per community)	Enterprise survey	
		Communities	60-120?	Community Survey	

4.4.3 ENTERPRISE SURVEYS

Similarly, enterprise surveys, also conducted in communities sampled for the OCEF grant evaluation, will cover the following:

- Administration and consent;
- Contact details and basic enterprise and respondent information;
- Perceptions of the enterprise's energy and electricity situation;
- Electricity connection status uses of electricity, reliability and quality, and coping & losses;
- Other energy sources and uses;
- Enterprise inputs and costs;
- Enterprise outputs and revenues; and
- Enumerator observations.

As in the household survey, at follow-up only, selected surveys will be accompanied by field audits from the ET's engineer, in order to assess the quality of the connection and the functioning of the technology from a technical perspective.

4.4.4 COMMUNITY SURVEYS

Community surveys conducted in communities sampled for the OCEF grant evaluation will meanwhile cover:

- Administration and consent;
- Contact details of key informants and respondent characteristics;
- Basic community information (size, ethnicity/language of households, etc.);
- Village-level infrastructure, market access and availability of public services, especially those dependent on electricity (e.g., electric water supply, public lighting);
- A basic Census of energy-using enterprises and types;
- Village electricity and energy situation; and
- Questions specifically about schools, health centers, and other public institutions and services provided by these.

At follow-up only, the community survey will be accompanied by a field audit from the ET's engineer, in order to assess the quality of connections to public institutions, the functioning of the technology from a technical perspective, and the availability of public lighting and/or any other services provided to affected communities.

4.4.5 APPLICANT SURVEY

In addition to these various end user surveys, the other major data collection activity, run to inform both the OCEF grant evaluation and the performance evaluation, will be an Applicant Survey. In this survey, we will collect quantitative information on:

- Applicant characteristics and structure;
- Core business model or approach;
- Prior experience and interventions; especially in the off-grid energy sector and including in utilizing the regulatory framework;
- Perception of key constraints limiting effectiveness and profitability, and perceptions of the OCEF application and selection process;
- Perception of the regulatory framework and the status of and challenges to its implementation;
- Experience with or awareness of other investments or activities in the off-grid sector after OCEF;

- Expectations about future intervention in the off-grid energy space; and
- If possible, completion of a hypothetical exercise in with the viability of different cost-sharing and financing models are assessed.

4.4.6 DATA COLLECTED FROM THE ROUTINE GRANTEE REPORTING

As highlighted in Table 5 above, we expect to work closely with the OCEF manager and MCA to require reporting of key information by all grantees obtaining financial support (as part of their contractual arrangements). This would include the following specific metrics:

- Information on new connections. For each connection: Location (e.g., village and commune), type of connection (household, business, public institution), technology used, capacity of the system, inclusion and capacity of batteries, inclusion of basic appliances or energy-using equipment (e.g., light bulbs);
- Payment information. For each connection, upfront payment for connection, payment system type (One-time purchase cost; Regular financing; PAYGO), detailed payment history, default and connection status (e.g., disconnection of original customers);
- Energy consumption, if possible. For each connection having such information recorded (we are aware that this is not possible for pico solar or for some solar home systems), high frequency consumption of energy over time (kW-hr per month);
- Maintenance events/calls. For each connection, a record of any maintenance event requiring intervention by the grantee, what the problem was, and whether and how it was resolved;
- Information on any complementary products or appliances sold to customers, if applicable, as well as the timing of these sales; and
- Firm-level costs for the implementation of the program, by category (labor/salaries, office/overheads, equipment, taxes/licensing, transportation, marketing, other), reported monthly.

The above information will be collected and analyzed over time to provide a rich perspective on the nature and extent of connections under each of the grantee contracts. To implement it, close contact and discussion between the OCEF manager and the ET is essential. The ET will initiate this discuss with NIRAS in February 2019, aiming to participate fully in the contract reviews under call 1 alongside the MCC and MCA M&E teams in March 2019.

Indeed, the grantee data will enable the IE to both a) put results from the beneficiary surveys into the broader context of the OCEF-supported projects (by assessing the relevance of those areas targeted for the beneficiary IE, to the success of the program as a whole); and b) conduct comparisons of the success of the different grants according to design features including business models, technologies, geography, targeting strategies, and other aspects. While identification of causal relationships related to the latter will be extremely difficult, such comparisons would be impossible without access to detailed grantee data.

4.4.7 ANALYSIS PLAN

4.4.7.1. Main empirical analyses (OCEF grant evaluation question 1).

The analysis will quantify the impacts of the grantee interventions on a number of outcome measures, as previously detailed in Table 5. The regression analysis for these outcomes will depend on which of the three evaluation methods is employed. We describe the expected analyses for each methodological approach below, including discussing how the "treatment" status is specified in each case.

1. Difference-in-differences (DiD) design with *ex-ante* matching at the commune level, followed by repeated cross-sectional surveys from a representative sample of households

   The DiD estimation of the impacts of off-grid electrification will be calculated using the sample matched *at the commune level*, through the following equation:

   $$Y_{hct} = \beta_0 + \beta_1 S_{ct} + \Gamma' X_{hct} + \theta_{ct} + \delta_t + \varepsilon_{hct} \quad (1)$$

   where Y_{hct} is a household/enterprise level outcome, such as the number of electricity-using appliances owned, for household/enterprise *h* within commune *c* at time *t*; S_{ct} is an indicator equal to 1 if commune *c* at time *t* is "treated" and equal to 0 otherwise; X_{hct} is a vector of household/enterprise-level controls (which could include factors such as household composition, and demographic or socio-economic characteristics that are unlikely to themselves be affected by energy access); θ_{ct} are commune-level fixed effects; δ_t are time fixed effects; and ε_{hct} is the error term. Standard errors would be clustered at the commune-level. The impact measure of interest is the estimate of β_1, which indicates how much outcome Y_{hct} changes as a consequence of treatment with grantee targeting of the commune in which the household resides.

   As noted above, the analysis would ideally be at a geographical scale that is below the commune-level (i.e. the village level, in which case clustering would also occur at that level); however, analysis at such a level would require more detailed information than that which has been provided by most applicants to date. With this additional information, we could specify a finer level of treatment, that would better correspond to the areas being targeted by the grantees. In either case, the treatment variable used in Equation 1 is really an intent to treat (ITT) variable, based on the intention of the grantee to target the location in question. ITT estimators perform best when adherence to the treatment is high, which we believe will be unlikely in this case.

2. DID with *ex-post* matching of targeted households in treatment communes with controls in non-treated communes

   The second approach employs regressions similar to those illustrated in equation 1 above, but "treatment" is now defined at the household/enterprise level. Identification in this approach comes from the change in household/enterprise exposure to treatment over time. This DiD estimation of the impacts of off-grid electrification will be calculated using the sub-sample of control households/enterprises who are specifically matched to

those taking up connections in targeted areas. The estimation employs the following equation:

$$Y_{hct} = \beta_0 + \beta_1 S_{hct} + \gamma' K_{ct} + \alpha_{hct} + \delta_t + \varepsilon_{hct} \quad (2)$$

where S_{hct} is an indicator equal to 1 if household/enterprise *h* in commune *c* at time *t* is "treated" and equal to 0 otherwise. Rather than commune fixed effects, this approach includes household/enterprise fixed effects (α_{hct}) and controls for a vector of commune or other zonal-level characteristics (K_{ct}) and time fixed effects (δ_t). Standard errors would likely be clustered at the household/enterprise level in this model, although there might still be a need for clustering at a higher level depending on the specific sampling approach that is utilized within grantee-targeted areas. The impact measure of interest in this case is still the estimate of β_1, which now indicates how much outcome Y_{hct} changes because of a household/enterprise connection to off-grid energy.

3. Randomized encouragement design

Like the previously described approach, identification in the randomized encouragement design comes from the change in household/enterprise treatment over time. However, in this approach exposure to the treatment is induced by the random encouragement. As such, the empirical analysis for the randomized encouragement design diverges from the DiD approaches above. Analysis of the data generated via the randomized encouragement design occurs through a two-stage least squares regression analysis.

In the first stage regression, we predict household/enterprise electrification, E_{hct} for household/enterprise *h* in commune *c* at time *t* using an instrumental variable, Z_{hct}, which is an indicator equal to 1 if the household/enterprise is randomly assigned to the treatment (the randomized encouragement) and 0 otherwise. As discussed previously, the actual encouragement (and therefore treatment) implemented within the randomized encouragement design would depend on the agreement with the participating grantee(s).

The following equation is illustrative of the first stage:

$$E_{hct} = \alpha + \lambda Z_{hct} + \gamma' K_{ct} + \theta' X_{hct} + \alpha_{hct} + \delta_t + \varepsilon_{hct} \quad (3)$$

where X_{hct} is a vector of household/enterprise controls for time *t*; K_{ct} is a vector of commune-level controls; α_{hct} are household/enterprise fixed effects; and δ_t are time fixed effects. This first stage could be modified if the encouragement has multiple groups of varying intensity *j* to include additional indicator variables Z_{hjct}, although this is not anticipated at this time.

The second stage regressions utilize the predicted electrification from the first stage equation, $\hat{E}_{hct}$, to estimate the impact of off-grid electrification on the abovementioned outcomes. The following equation, in which the household/enterprise-level outcome measures are represented by Y_{hct}, is illustrative of such a second stage regression:

$$Y_{hct} = \eta + \beta \hat{E}_{hct} + \gamma' K_{ct} + \theta' X_{hct} + \alpha_{hct} + \delta_t + \varepsilon_{hct} \quad (4)$$

Standard errors in both the first and second stage regressions are clustered at the household/enterprise level for this approach, assuming that the random encouragement is assigned at the household/enterprise level. The impact measure of interest in this case is the estimate of β.

4.4.7.2. Empirical analyses of distribution of impacts (OCEF grant evaluation questions 2 and 4).

These questions focus on the issue of which segments of the population (households and enterprises) benefit the most from gains in energy access and would be analyzed in a "triple difference" framework. In each version of this analysis, the term including treatment status would be replaced by two terms, one of which includes an interaction with the characteristic of interest (e.g., female, or poor), and the other of which would represent the effect of treatment among the remainder of the population (in the example here, this would be male, or non-poor). The regression would also include an additional term for the non-interacted characteristic of interest, to accurately control for the difference between, say male and female outcomes, among the control households. Taking approach 1 as an example, the expanded triple difference model would be written as follows:

$$Y_{ict} = \beta_0 + \beta_1 S_{ct} + \beta_2 S_{ct} C_{ict} + \beta_3 C_{ict} + \Gamma' X_{hct} + \theta_{ct} + \delta_t + \varepsilon_{hct} \quad (5)$$

where all variables are defined as before, except that Y_{ict} is now an individual outcome (such as time spent studying by individual *i*), and C_{ict} is an indicator equal to 1 if individual *i* in commune *c* at time *t* is female and equal to 0 otherwise. The estimate of β_2 now indicates the difference in the effect of treatment among women, compared to men, for outcome Y_{ict}. In the case of enterprises (OCEF grant evaluation question 4), the unit of analysis would still remain the enterprise (indicated by *h* as indicated previously), but this would be interacted with the type of enterprise of interest, which could be some category like agricultural processing.

Finally, note that an additional "triple difference" that appears interesting to study judging from the gaps highlighted in Section 3.2 is the difference according to system type or capacity (or other dimensions of interest such as technology, grantee business model, etc.). In the context of window 2 and window 3 evaluation, we anticipate estimating equation 5 where C_{ict} would represent the capacity of a connection, rather than some characteristic of the enterprise or household being treated. This variable could be expressed as a continuous variable, or as an indicator for mini-grid connection, or as an indicator for an above median capacity connection.

4.4.7.3. Empirical analyses of determinants of adoption (OCEF grant evaluation question 3).

This question focuses on the factors that drive (or conversely constrain) adoption of off-grid energy technology. The econometric framework for this analysis is distinct from that presented above. Rather than focusing on the whole suite of outcomes presented in Table 6, the question 3 analysis is primarily concerned with assessing what characteristics of household, enterprises, and communities are correlated with (or "determinants" of) adoption. We will estimate models of the form:

$$A_{ict} = \beta_0 + \gamma' K_{ct} + \theta' X_{hct} + \varepsilon_{hct} \quad (6)$$

where A_{ict} is equal to one if a unit *i* in commune *c* and at time *t has* taken up a connection, energy-using appliance, or energy service (and 0 otherwise). As before, X_{hct} is a vector of household/enterprise controls for time *t*; K_{ct} is a vector of commune-level controls; and ε_{hct} is the error term. Standard errors would likely be clustered at the zone-level in these regressions.

Importantly, analysis of question 3 using DiD approach 2 would be conducted differently. In that case, "treated" households are only sampled in target areas if they are adopters, so the determinants of adoption would have to be obtained by looking at how those households are systematically different from the oversampled representative sample of potential controls interviewed at baseline. This would be achieved by again estimating a model of the form shown in equation 6 but including all control households alongside the adopters selected from targeted communities. This is exactly the same as the regression model that would be used in the first stage to conduct matching of controls to treatment households, which is concerned with identifying what types of households or units are more likely to adopt.

4.4.7.4. Empirical analyses of OCEF grant evaluation question 5.

This question is discussed below in Section 4.7. It will be informed by the analyses specified above, but then uses those results (and information collected on grantee costs) as inputs for the calculations of costs and benefits.

4.5 QUALITATIVE DATA COLLECTION AND ANALYSIS

Below we summarize our approach to qualitative data, which will serve as the principal source for the PE and a supplementary source for the IE. As noted above, document review will be an important source for each of the three PE questions and will include review of OCEF manuals, grantee reports, the regulatory framework and any associated policies, and administrative data from ABERME and ARE, as available. We also plan to use the quantitative survey for the PE. However, the primary data source for the PE (and for the supplementary qualitative data for the IE) will come from KIIs. Below we describe our approach to KIIs along with sampling and a summary of the instruments to be used. We also describe briefly the qualitative data collection that is planned as part of the IE.

4.5.1 KEY INFORMANT INTERVIEWS

KIIs will be a key source of documentation on design, implementation and perception of results for OCEF and the Enabling Environment Activities. They will be planned for roughly one hour and, whenever possible, will be conducted by two team members. The first will lead the interview, with the second supporting and taking detailed notes. All interviews will be conducted following a KII protocol specific to the respondent group, though each protocol leaves room for probing to get detailed information, including on unexpected outcomes. We anticipate the majority of interviews will be conducted in French. We plan to collect data from the following respondents, though we will also be open to identifying additional respondents during field work through suggestions from other interviewees.

TABLE 9: KEY INFORMANTS

Data collection	Timing MM/YYYY (include multiple rounds)	Sample Unit/ Respondent	Sample Size	Relevant instruments/ modules	Exposure Period (months)
KII	Round 1: May 2019 Round 2*: Early 2021 Round 3: May 2022	MCC Staff: - Benin Resident Country Director - Benin Deputy Country Director - Washington-based staff involved in Compact and OCEF development (including Director, Finance, Investment, and Trade)	5	KII Guide	Round 1: Baseline or immediate outcomes for some questions Round 2: Approximately 3 years
		MCA Benin Staff: - National Coordinator - OGEAP Coordinator - M&E Director	3		
		Implementer: - NIRAS: Chief of Party, M&E Director - IED: Chief of Party	3		
		Private Sector - at least two firms that were shortlisted and received TA - at least two firms that submitted an application but were not shortlisted - at least two firms that registered interest but did not submit an application (as available) - Firms or organizations that have invested in the off-grid sector in Benin or offered financing opportunities	10		
		Government of Benin - ARE - ABERME	6		
		Other Donors: - GIZ - EU - World Bank	5		

*Contingent on a budget/contract modification reflecting this additional round of data collection and reporting.

4.5.2 COMPLEMENTARY QUALITATIVE DATA COLLECTION FOR THE IE

We will complement the quantitative data collection used in communities sampled for the OCEF grant evaluation surveys with some focused qualitative data collection for the purpose of:

- Better understanding field conditions and finalize survey instruments;
- Diagnosing more effectively the key issues constraining adoption of the new technology;
- Obtaining a nuanced understanding of the interventions' effectiveness and sustainability from the beneficiary perspective; and
- Probing issues related to perceptions of the systems and their management.

4.5.3 ANALYSIS PLAN

Detailed notes will be collected by both team members during each interview. Following each interview, ideally the same day, though within the same week if field work does not permit daily, both team members will clean and organize their notes in electronic format. During this process they will also take note of emergent themes that will be used for coding. At the conclusion of fieldwork, the qualitative researcher will review all notes and emergent themes to develop a preliminary codebook. The codebook will contain a set of themes for each question. The qualitative researcher will then go through each set of interview notes a code each interview according to the codebook. The result will be one document which notes important meta-data for each interview (such as respondent type, sex, and organization of respondent) along with the relevant codes discussed by that interviewee. This allows for a systematic analysis of responses, including facilitating understanding of the relative prevalence of responses. The results from the coded interviews will be analyzed alongside the desk review and survey data by the qualitative researcher and program manager to draw findings and conclusions for each question and the associated topics of inquiry.

4.6 SAMPLING APPROACH

The main sampling considerations pertain to the quantitative surveys that are planned for the grant-level IE. Table 9 summarizes the results from power calculations that help to inform our final design recommendations.

In these power calculations, which are based on household-level impacts (we did not have access to enterprise data that could be used for this purpose), it is important to bear in mind that approaches 1 and 2 rely on a cluster-based sampling approach. We are therefore constrained by the number of potential sample clusters. We assume that 60 clusters could be sampled, and the number of units within each cluster is therefore equal to the total sample size divided by 60. Other assumptions are detailed in the notes below the table.

For approach 1, these calculations reveal that a 6.8-8.2% increase in energy access would be needed within "treated" clusters. While this may be possible for villages specifically targeted by grantees, such a large increase in energy access seems unlikely at the commune level or at the

level that could be identified prior to grantees intervening in their targeted communes. Since measuring changes in all other impacts is highly dependent on these uptake levels being achieved, we believe that approach 1 is a high-risk evaluation strategy.

In approach 2, concerns about uptake are alleviated by a strategy that samples from households who sign up for new connections, prior to installation. In these calculations, we assume that 80% of those signing up would follow-through and ultimately adopt the energy access intervention, but minimum detectable differences remain reasonable even if final adoption proves to be much lower (results not shown, but these would scale in proportion with the adoption level achieved, relative to 80%). This is true for all of the major outcomes that we are able to analyze using available data, except for ownership of generators, for which we would be unlikely to observe changes.

Finally, approach 3 is similarly well-powered to detect differences in all outcomes except generator ownership, assuming that the encouragement design results in 30 percentage points greater uptake than the baseline sales offer from grantees. Results are somewhat sensitive to the strength of this encouragement effect.

Given the value of learning about demand response to price and about impacts, we propose to combine this encouragement strategy (for grantees who are amenable to is) with the more general strategy described in approach 2, which suffers from potential concerns about sample representativeness and contamination of impact measures by the endogeneity of take-up.

We were unable to conduct power calculations for enterprises due to lack of data, but our sampling strategy would be to enroll all small and medium enterprises within our approach 2 sample clusters (probably approximately 5-10 enterprises per cluster, or 300-600 enterprises overall), and to similarly conduct the community-level survey (including public services) in all 60 sampled clusters. For the encouragement design, sampling of these types of units would be subject to negotiation and coordination with the grantees.

TABLE 10: MINIMUM DETECTABLE (Δ) DIFFERENCES IN THE IMPACTS OF THE OFF-GRID ENERGY GRANTS, GIVEN TWO (MINIMUM AND RECOMMENDED) SAMPLE SIZE ALTERNATIVES FOR APPROACHES 1-3

	Baseline value (s.dev.)	Approach 1 Minimum Sample Size (n=3,000 per group)	Approach 1 Recommended Sample Size (n=4,800 per group)	Approach 2 Minimum Sample Size (n_b=3,168 total; n_f=792 per group)	Approach 2 Recommended Sample Size (n_b=4,212 total; n_f=1,056 per group)	Approach 3 Minimum Sample Size (n=700 overall)	Approach 3 Recommended Sample Size (n=1,000 overall)
α = 0.05; β = 0.8							
1-Electricity Connection rate (%)	20.8% (n.a.)	8.2%	7.7%				
2-Electricity consumption (kW-hr/mo)	5 (16)	3.02; 37	2.86; 37	5.2	4.8	3.39	2.84
3-Expenditure on electricity (CFA/hh-mo)	867 (2775)	524; 6427	496; 6447	896	824	589	492
4a-# non-lighting appliances owned	1.0 (1.2)	0.23; 2.78	0.22; 2.79	0.39	0.36	0.25	0.21
4b-# lights owned	0.1 (1.1)	0.21; 2.55	0.20; 2.56	0.36	0.33	0.23	0.20
5-Generator ownership (%)	6.3% (n.a.)	-0.039; -0.47	-0.037; -0.48	-0.062	-0.058	-0.11	-0.089
α = 0.1; β = 0.8							
1-Electricity Connection rate (%)	20.8% (n.a.)	7.2%	6.8%				
2-Electricity consumption (kW-hr/mo)	5 (16)	2.69; 37	2.54; 37	4.6	4.2	3.01	2.52
3-Expenditure on electricity (CFA/hh-mo)	867 (2775)	466; 6469	441; 6487	796	733	522	437
4a-# non-lighting appliances owned	1.0 (1.2)	0.20; 2.80	0.19; 2.81	0.34	0.32	0.23	0.19
4b-# lights owned	0.1 (1.1)	0.19; 2.56	0.18; 2.57	0.32	0.29	0.21	0.17
5-Generator ownership (%)	6.3% (n.a.)	-0.035; -0.49	-0.033; -0.49	-0.056	-0.053	-0.09	-0.079

Notes:
1) Calculations were conducted using available data as documented in footnotes to this table. We assume a power of 80% and α=0.05 (top panel) or α=0.1 (bottom panel).
2) **Attrition**: Calculations for approaches 2 and 3 assume 10% sample attrition from baseline to follow-up; attrition is not relevant for repeated cross-sectional sampling approach 1.

3) **Assumed takeup rates**: In approach 1, the take-up rates needed to detect impacts are shown as the detectable effect for outcome 1 (electricity connection rate). The first number (before the semi-colon) is the impact across an entire zone, whereas the second (after the semi-colon) is for the impact among those taking up a grant-supported improvement. In approach 2, it is assumed that 80% of households identified as wanting a connection would follow through and take up a connection (i.e., 20% would renege). In approach 3, it is assumed that take up under the encouragement would be 30%.
4) **Clusters**: Calculations for approaches 1 and 2 also assume that 60 clusters would be sampled (30 treatment, 30 control); and an intra-cluster correlation of 0.05 for all outcomes; approach 3 assumes treatment randomized at the household, rather than cluster, level. For approaches 1 and 2, this is a likely upper bound for the number of possible clusters and explains the lack of substantial power improvements when moving to larger samples (since adding clusters is what delivers more substantive power improvements). Cluster sizes would thus be determined by the total sample size divided by 60.
5) **Oversampling at baseline (approach 2)**: Finally, approach 2 assumes that there would be oversampling of controls at baseline and that only one third of sampled households would match well to treatment sample; hence the two sample sizes correspond to baseline and follow up samples under those approaches, respectively.

4.7 COST BENEFIT ANALYSIS AND BENEFICIARY ANALYSIS

As part of this evaluation, we intend to collect data that can be used to conduct cost-benefit analysis of grants in windows 2 and 3 (which we believe – based on our review of round 1 pre-selected grantees – will have a similar and consistent structure), and, sampling and design considerations permitting, at least one of those in windows 1 and 4 as well (which pose more significant challenges). This will allow us to address evaluation question 5 for the OCEF grants and, ideally, for the OCEF as a whole.

If we are able to implement the hybrid design discussed above, we would be able to do this; if not, additional assumptions will be required, concerning either a) the shape of the private benefits curve (and the resulting consumer surplus), and b) the nature of the impacts resulting from the investments. More specifically, a key advantage of the encouragement design approach would be to provide information on demand at several price points within a similar population, and a clearer identification of the impacts resulting from different uptake levels. On the other hand, to better assess whether results from the encouragement design are generalizable across grants, we would need to have information from one of the other quasi-experimental methods to be able to put the uptake levels into the broader context of OCEF-supported projects. Thus, our goal will be to use a design that balances internal and external validity concerns, and that samples beneficiaries from as many grants as possible.

In our discussion of potential designs, we noted that the precise number of grants evaluated will depend on feasibility considerations, and more specifically the extent to which the spatial targeting can be refined, and the extent to which grantees opt into the encouragement design. These aspects are hazy for the moment and require additional work with the grantees prior to development of a final sampling frame.

Following the survey-based measurement of impacts, we will work to estimate the economic net present value (NPV) and economic rate of return (ERR) of the grants evaluated under each of the windows, the set within each specific window, and, if possible, of the program as a whole. If necessary and appropriate and based on the final evaluation design that is selected, we will work with stakeholders to identify and select “representative” grants for this analysis. This selection would be based on considerations such as number of target beneficiaries, cost-sharing arrangement and total cost, type of investment; and would be conducted around the time of the evaluation design, based on an MCC and stakeholder agreed-upon method for allocation of joint costs and settling of other issues (e.g., administration of grants). This will ensure that results are more general and will allay critiques that analyses are influenced by the selection of high- or low-performers. We offer additional thoughts on costs and benefits and key assumptions below, building on the prior discussion of the program logic from Section 3.4.

Costs. Data required to calculate the costs of individual grants will come from the data acquired from:

1. Awards from the OCEF;

2. In-kind and cash cost-sharing contributions from grantees, as described in the proposals;
3. M&E reporting requested of the grantees, as discussed above (see table 6, under evaluation question 5); and
4. The endline surveys of awardees, insofar as other nonpecuniary costs are incurred, and insofar as *ex post* costs deviate from original proposed and budgeted amounts.

Here, we emphasize again that it will be especially important to get implementation cost (both in-kind and cash) data from the grantees regularly, as they will likely have been different from their own *ex ante* expectations of costs.

Benefits. Data used to calculate the benefits will come from data collected in baseline and endline surveys of both suppliers of off-grid energy services, and the impact evaluation of OCEF grantees that will yield information on demand-side benefits of various types. These survey respondents will include households, enterprises, public service providers, and key community informants. The most straightforward approach to benefits estimation is to estimate producer and consumer surplus econometrically, by deriving supply and demand curves based on price and quantity variation in the realized grants (some of which will be from the natural experiment across sites and grants, and some of which will hopefully be experimentally induced using the encouragement design). Without the experimental data, this may not be possible, because variation in the price per kW-hr in different grants may be perfectly correlated with unobserved market-specific factors affecting those grants.

In addition, as noted in Section 3 and also by the discussion of the enabling environment in the performance evaluation, there are likely to be significant positive externalities from off-grid energy investments, especially those using renewable energy technology. Nonetheless, we will estimate energy demand and supply curves, controlling for a set of likely determinants, including beneficiary income and socio-economic status, household composition, community density and characteristics, relative prices of alternative fuel sources, quality of electricity supplied, factors related to connectivity to other critical infrastructure and remoteness, etc. In addition to this, we will conduct a bottom-up analysis that aims to add mutually exclusive categories of benefits based on the list provided in Section 2.1.2 Table 1.

Key assumptions. Prior to implementation of the CBA, we will discuss with MCC and other stakeholders several key additional assumptions important for the analysis, including those related to:

- The **time horizon** over which to extrapolate the benefits, which depends both on the lifespan of the technologies and the time profile of benefits. There will be heterogeneity across windows, given the different types of technologies they are likely to be supporting. Also, as most measured impacts will pertain to the short or medium term, we will need to make assumptions about the longer-term trajectory of these benefits. We will exploit the differences in grant timing to the extent possible to inform these assumptions (see prior table referring to shorter-run versus longer-run evaluation windows).
- **Valuation** and **inclusion** of nonmarket benefits such as time or emissions savings.

- **Discount** rates and appropriate accounting for the cost of capital. We anticipate performing the CBA using several different discount rates (including the 10% rate conventionally used by MCC), to illustrate the sensitivity of results to assumptions regarding the same and will additionally report the ERR of the investments.
- The **opportunity cost of the different sources of capital** being allocated to the project, which will include tax revenue in the US (the source for MCC grants), private capital (insofar as this is the source of grantees cost-sharing), and any other relevant sources.
- Inclusion of shadow prices rather than market prices (if market values of benefits are distorted, or to appropriately account for the costs of unskilled labor).

5.0 ADMINISTRATIVE

In this section we summarize our plans for carrying out required administrative tasks to implement the evaluation.

5.1 SUMMARY OF IRB REQUIREMENTS AND CLEARANCES

SI has an in-house Institutional Review Board (IRB) that can review applications for human subject research. One particular question that will be discussed during IRB review relates to MCC's stated objective[63] to obtain from evaluators, where possible, raw qualitative data for the purposes of potentially posting this information publicly or with restricted-access at some future date for use by other researchers. We note that providing the raw qualitative data to MCC would pose plausible risks of re-identification by both MCC and/or other users of the data. In many cases, even if names, titles, and contact information were scrubbed from the qualitative data, the questions asked in the interview and the content of the responses could serve to re-identify a respondent. If data were to be provided to MCC with the potential for use by other researchers, the informed consent forms would also be required to state this to respondents. SI believes that this could negatively affect the quality of data received and/or respondent trust in SI's independence, especially given the potential for some of the KIIs to touch upon topics related to institutional arrangements, and roles, responsibilities, and performance of various stakeholders involved in funding, overseeing, and monitoring these interventions, including the role of MCC and MCA-Benin II.

Therefore, SI will submit the evaluation for SI IRB review, with an explicit request for comment by the IRB on SI's intention to refrain from sharing raw qualitative notes or transcripts with MCC, given the concerns described above. In this case, only the analysis would be shared with MCC, and informed consent forms would not include language related to future use of the data by other researchers or by MCC (as is included in MCC's informed consent template). We expect to undergo expedited (as opposed to full-board) review by the IRB.

5.2 DATA PROTECTION

To protect the privacy and confidentiality of key informant interviews, the SI team will ensure that interviews and surveys take place in a reasonably private location where respondents are comfortable responding openly. An informed consent form will be administered to all respondents prior to the start of the interview, to ensure respondents understand SI's independent role in the evaluation, the voluntary nature of the interview, and their right to refuse to answer specific questions and/or to stop the interview early. For qualitative data, respondents will also be informed in this consent form that their names and job titles will not be referenced in any reporting, and quotes that would serve to re-identify them will not be used in reporting. Further, to ensure respondent comfort during interviews, interviews will not be audio recorded. SI will take detailed notes and will transcribe these notes in full, electronically, following the interviews. After reporting and dissemination is complete, SI will dispose of hand-written notes

[63] MCC Evaluation Microdata Documentation and De-Identification Guidelines January 2017 p. 9.

which include any names, job titles, or contact information. Transcribed interview notes will be saved in project folders which are accessible only by project team members. For surveys, all data will be de-identified, and no identifying information will be reported.

5.3 PREPARING DATA FILES FOR ACCESS, PRIVACY, AND DOCUMENTATION

While SI is committed to the principals of transparency and open data, we believe that balanced against the risks to privacy, data quality, and re-identification described above, the case for making the qualitative data from this evaluation public (openly or through restricted access) is weak from a technical point of view. The purpose of the KIIs described in this design report and methodology is different than, for example, qualitative research done using a series of focus groups with a single guide or questionnaire repeated among a large group of beneficiaries meant to capture representative perspectives of a broader group. In this process evaluation, only a limited number of individuals can be expected to comment substantively on a specific topic or on specific evaluation questions. As such, interview guides will necessarily differ by respondent. This limits the team's ability to protect anonymity of respondents due to the low number of respondents per portfolio. Similarly, anonymizing qualitative transcripts would likely require the team to remove a large portion of portfolio-specific and historical information in order to truly protect the respondent's anonymity. That would limit the utility of that data for MCC or other stakeholders. As such, we do not expect that there is a strong case for secondary analyses that could be done using such interview data.

Following approval of the final report, SI will prepare and submit any quantitative data collected as part of this evaluation to MCC, and SI will upload all data to produce a Nesstar Metadata file.

SI will also adhere to MCC's open data policy with regard to preparing data for publication. All primary quantitative data collected by the evaluation will be prepared and submitted to MCC according to the most updated version of the Disclosure Review Board (DRB) guidelines available at the time of data collection

5.4 DISSEMINATION PLAN

Upon completion of each[64] stage of data collection and analysis, SI will develop a draft evaluation report that synthesizes all qualitative and quantitative findings from the evaluation. The report will follow MCC's template for final evaluation reports and will serve as an easily digestible resource for dissemination among stakeholders and to further inform MCC's design of future grant facilities. SI will share the initial evaluation draft report with local stakeholders and MCC for review. SI will also present draft findings to MCC and local stakeholders, in a workshop/presentation for each audience. Upon receipt of feedback from circulation of the report, and these workshops, SI will prepare a 'comments matrix' that systematically tracks SI's

[64] Interim data collection (to include another round of the Applicant survey, ongoing grantee data collection, document review, and interim KIIs), an interim evaluation report describing all qualitative and quantitative findings from the midline phase, and interim dissemination will be conducted/provided by SI, contingent on a budget/contract modification reflecting this additional round of data collection, reporting, and dissemination.

response and edits, if any, to all comments received. This matrix will be submitted along with the final evaluation report.

SI will also prepare a four-page evaluation brief, comprised of a project overview, evaluator description, key findings, detailed findings, MCC learning, economic rate of return, evaluation questions, and evaluation methods.

This evaluation brief will be submitted after local stakeholders have reviewed the draft report, and following discussion with key stakeholders at MCC and MCA-Benin II regarding what will be included in the evaluation brief and how it should be presented to optimize use. The evaluation brief will be shared with MCC and MCA-Benin II for feedback, and a final version will be submitted approximately one week after receipt of feedback.

These are 4-page documents containing an image, project overview, evaluator description, key findings, detailed findings, mcc learning, and economic rate of return, evaluation questions, and evaluation methods.

SI will disseminate the final results through presentations at MCC headquarters in Washington, DC, and MCA-Benin II headquarters in Cotonou. These presentations will be delivered with an accompanying facilitated discussion to (1) validate the findings and recommendations presented and (2) discuss action planning around the recommendations to facilitate use and uptake. If requested by MCC, we can also facilitate a presentation of the findings to external stakeholders, including GPF grantees and/or other donors, in Cotonou.

At SI's own cost, we will follow up with MCC stakeholders at 6 months and 1 year after the completion of the evaluation to understand how the evaluation was used.

5.5 EVALUATION TEAM ROLES AND RESPONSIBILITIES

SI will distribute responsibilities among the team as follows:

TABLE 11: TEAM ROLES AND RESPONSIBILITIES

Role/Name	Responsibilities
Key Personnel	
Program Manager for Grant-level Evaluation Dr. Marc Jeuland	• Technical Lead on all aspects of the grant-level evaluation and CBA. • Supports facility-level evaluation
Program Manager for Facility-level Evaluation Mr. Mike Duthie	• Technical lead on all aspects of the facility-level evaluation, primary point of contact for MCC, overall responsibility for technical quality of deliverables, as well as financial and contractual management. Supports grant-level evaluation.

Non-Key Personnel	
Senior Technical Advisor Robyn Meeks	• Technical advisor on energy efficiency, off-grid electrification, and measuring gendered aspects of electrification. • Supports evaluation design, instrumentation, analysis, and reporting
Senior Technical Advisor Jorg Peters	• Technical advisor on off-grid electrification in Benin. • Supports evaluation design, instrumentation, analysis, and reporting
Electrical Engineer TBD	• Conduct site inspections, support development of measurement approaches • support the review and assessment of grantee technical support
Qualitative Researcher Amy Porter	• Lead the design and conduct fieldwork for qualitative study component
Research Expert/Field Coordinator Olou Koucoi	• Oversee all contracted data collection efforts (including implementing SI DQA processes after HQ staff leave the field), support other members of the team in conducting qualitative interviews, support in-country stakeholder communication, support in-country logistics.
Quantitative Program Manager Corinna Bordewieck	• Contract/financial management, support all quantitative aspects of evaluation design, including background research, instrumentation, data collection partner procurement, field work preparations, DQA implementation, data collection partner management, cleaning, analysis, reporting
Program Assistant Euphonise Loiseau	• Provide administrative and logistical support—arrange travel and lodging, process expense reports • Copyedit and format deliverables

5.6 EVALUATION TIMELINE AND REPORTING SCHEDULE

The evaluation will undergo a maximum of three rounds of data collection to accommodate the varying schedules of MCA-Benin II staff and the grantees[65]. All rounds of data collection will be followed by a data collection report, with the full draft evaluation report to follow the final round of data collection.

[65] Interim data collection, to include another round of the Applicant survey, ongoing grantee data collection, document review, and interim KIIs, and an interim evaluation report describing all qualitative and quantitative findings from the midline phase will be provided by SI, contingent on a budget/contract modification reflecting this additional round of data collection and reporting.

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7.0 ANNEXES

7.1 PROJECT EVALUABILITY ASSESSMENT

Background

As a results-based institution, MCC is dedicated to using rigorous methods to identify the core constraints to growth and design and implement evidence-based Projects in every Compact and Threshold country to address those core constraints.

For this reason, the concept of evaluability is central to MCC's results agenda, as it is impossible to determine the results achieved by MCC projects unless they are designed up-front to be evaluable downstream. MCC defines evaluability as *the ability of an intervention to demonstrate in measurable terms the results it intends to deliver*. An evaluable intervention uses data to identify and verify the problem(s) it intends to address and underlying causes, has an evidence-based design to address the problem(s) identified, clearly identifies assumptions and risks associated with the intervention to address the problem(s), including identifying means for verifying and mitigating risks, and has clear and time-bound metrics for the results of the intervention in terms of outputs and outcomes.

Objective

The objective of an evaluability assessment is to use specific, transparent standards and best practices for assessing the following five dimensions of a project: (i) Problem Diagnostic, (ii) Project Objectives and Logic, (ii) Risks and Assumptions, (iii) Project Participants/Beneficiaries, and (v) Accountability and Learning Metrics.

Evaluability in Practice

A tool has been developed to help guide the iterative process of evaluability assessment.[66] The Project Evaluability Assessment tool draws on and expands on the standards and best practices identified in the MCC Due Diligence Book in order to assess the five dimensions of a project through Compact development and into Compact implementation. The tool is intended to help guide teams to answer five big questions:

1. Is the problem clearly defined and is there sufficient evidence to support the problem diagnostic?
2. Are the project objectives and theory of change/logic clearly defined?
3. Are the risks and assumptions clearly defined with potential risk mitigation strategies?
4. Are project participants clearly defined and justified in terms of geographic scope and eligibility criteria?

[66] The evaluability assessment tool was developed through a yearlong pilot from 2012-2013, tested by the MCC M&E Team on the following 7 Compact and Threshold programs: Threshold (Honduras); Implementation (Cape Verde II and Lesotho); Compact Development (El Salvador II, Georgia II, Ghana II, Benin II).

5. Are the metrics for measuring results for both accountability and learning clearly defined?

Within each of these five areas, SI has drawn on secondary document and interviews to provide an assessment of strengths, weaknesses, and next steps, particularly as they relate to the ability to conduct a rigorous, useful evaluation.

Project[67] – Evaluability Assessment	
Assessment Categories	**Strengths, Weaknesses, and Next Steps**
Dimension 1: Is the problem clearly defined and is there sufficient evidence to support the problem diagnostic?	
1. Is there quantitative evidence regarding constraints to and sources of economic growth?	The compact references a constraints analysis conducted in 2012 that found, "poor electricity infrastructure and an inadequate business environment are binding constraints to growth in Benin." Moreover, the compact states, "after a year and a half of project development and due diligence, it was evident that insufficient electric power, both in terms of quality and quantity, was a key concern for all agribusinesses, and that electric power was a strategic national priority of the Government." The constraints analysis references World Bank enterprises study that notes that electricity was among the top three constraints (at 15% of respondents) to investment noted by business managers (along with Access to Finance at 18.2% and Practices of the Informal Sector at 14.6%). The constraints analysis also notes that Benin had the worst performance in the same World Bank study on the time and cost to get an electrical connection. The report does not, however, conclusively show that access to reliable electricity is a binding constraint to growth, particularly in rural areas that are not likely to be connected to the grid in the foreseeable future. Nevertheless, our scoping interviews have confirmed qualitatively that access to reliable, affordable electricity is a national priority for the government of Benin and is seen as a constraint to households and businesses in the areas visited. In summary, the Investment Memo provide strong quantitative evidence, including through a willingness to pay study conducted by MCC, the lack of affordable,

[67] It is anticipated that an evaluability assessment will be conducted for each Project; however, this may vary depending on Compact composition. For example, the country team may prefer to conduct the evaluability assessment for individual Activities rather than Projects.

6. Is the institutional context understood, the political economy understood, and does the team clearly understand how the proposed intervention(s) link to other initiatives by the gov't and/or other partners?	The Investment Memo discusses at length the institutional and political context that has contributed to low levels of access to affordable, reliable electricity. Moreover, from interviews during scoping, it is clear that MCC and MCA have worked closely with other donors, with high levels of awareness of each other's activities, including through an energy sector donor working group.
2. Is the problem(s) clearly defined and understood with sufficient evidence/quantitative (baseline) data available to support claims?	The Investment Memo clearly outlines the problem of lack of affordable, reliable electricity citing three primary causes (with justification for each): 1. an insufficient supply of energy (kWh) in the system to meet demand, 2. unsustainable utility finances and operations, and 3. weak governance of the overall power sector
7. Is there a clear understanding on how different social and cultural dynamics (gender, poverty, race, ethnicity, etc.) may be influenced by or influence the problem identified?	The Investment Memo does not provide detailed analysis of the social and cultural dynamics that might mediate program effects. These is discussion of how off grid access could reduce time and work burden for women, but there is little to no discussion of how different cultural groups or social groups (for example, households with varying degrees of poverty) would be affected by the interventions.
3. Is there evidence to support root causes identified?	The Investment Memo provides detailed evidence of each of the three root causes identified above, drawing on both quantitative and qualitative data, though in most cases, the sources of data are not specified.
	Each of the root causes is planned to be addressed by one or more activities/projects, as follows: i. an insufficient supply of energy (kWh) in the system to meet demand, a. Electricity Distribution Project b. Electricity Generation Project c. Off Grid Access Project ii. unsustainable utility finances and operations, a. Policy Reform and Institutional Strengthening Project iii. weak governance of the overall power sector a. Policy Reform and Institutional Strengthening Project
4. Will all root causes be addressed by the proposed intervention or other, complementary intervention(s)?	
5. Is there a public good rationale and/or market failure that necessitates government intervention and funding? This is linked to sustainability – how will recurrent costs be covered in the future, how will private sector investment be triggered, etc?	There is a strong element of market generation in the intervention, particularly through the regulatory strengthening, policy reform and off-grid pieces. The lack of a regulatory framework has significantly hindered development in the sector (based on interviews with stakeholders during the scoping). Moreover, the OCEF grant facility is expected to demonstrate the viability of sustainable off-grid projects, which is expected to encourage additional private sector investment and projects.

Project – Evaluability Assessment	
Assessment Categories	**Strengths, Weaknesses, and Next Steps**
Dimension 2: Are the project objectives and theory of change/logic clearly defined?	
1. Is the objective of the Project clearly stated with a link from the problem diagnostic? 2. Is the project logic and economic model clear, plausible and based on existing evidence and literature? If there is limited evidence, is there commitment to generating evidence via an impact evaluation (linked to Section 5)? 3. Is there a clear logic that links different projects within the Compact program that is then linked to accelerating economic growth? 4. Is it clear which component(s) of the problem diagnostic will be addressed by the proposed intervention, which will be addressed by complementary activities and which will remain risks for the MCC intervention to achieve proposed results? 5. Are the inputs, outputs, outcomes clearly defined and linked to the economic analysis (ERRs)? 6. Is the timeline for expected results clear and based on evidence? 7. Is it clear whether or not benefits are expected to be sustained beyond the life of the compact?	The objective is clearly stated and supported by a problem statement. This problem statement is well developed in the Investment Memo, but it is not tied to an overall constraints analysis that is available to SI. While the ERR for the Compact as a whole expects benefits to be derived mostly from consumer surplus related to unmet demand and willingness to pay for electricity access, the results in the project logic focus more on increased productivity as a result of electricity access (and indeed the ERR did not included OGEAP). **Currently, the evidence for this set of results for rural electrification is limited. This is an important set of results/assumptions that need to be assess in the evaluation.** While there is a clear logic that links each of the projects within the compact to the overall goal of accelerating economic growth, there are not fully developed logic models for each of the specific types of grant activities that are expected within the OCEF grant facility. The links between each of these activities and the common objectives of OCEF are not immediately clear. **The evaluation will need to develop project logic (building on the draft versions available from MCC/NIRAS) for each of the grant activities it evaluates.** The overall projects and activities are clearly linked to the root causes as identified in the problem assessment of the Investment Memo, and these are clearly linked within the project logic. It is clear that OCEF grant activities are expected to yield benefits sustained well after compact closure. **The evaluation will need to assess whether these results are indeed sustained (for example, whether infrastructure is likely to be maintained and used post-compact) and whether the compact generated additional market activity.**

Project – Evaluability Assessment	
Assessment Categories	**Strengths, Weaknesses, and Next Steps**
Dimension 3: Are the risks and assumptions clearly defined with potential risk mitigation strategies?	
1. Are the risks to achieving expected results clear, with clearly defined risk mitigation strategies? 2. Does the ERR reflect these assumptions and risks? Has sensitivity analysis been used to select key risks and assumptions? 3. Is it clear how risks will be monitored? 4. Is it clear how design and implementation may be altered as information on new risks/realization of risks occurs? 5. Does the project team make a critical assessment of the degree to which there may be blind spots or unknown unknowns in a project of this nature (e.g. how foreseeable are the potential risks that may arise in new sectors)?	The Investment Memo addresses key risks and assumptions in the project logic, but the listed assumptions are not well founded or comprehensive. For example, there is no discussion of the assumption that indeed electricity access is a binding constraint to growth or productivity improvements for many businesses. Additionally, the Investment Memo cites the following assumption, "Assumes that users currently without access to electricity (who are disproportionately poor), will be able to afford the new off-grid solutions, despite the reality that off-grid solutions are often more expensive than grid-based energy." This assumption itself seems to recognize that it may not be met. **For the evaluation, the assumptions behind each of the activity logics will need to be elucidated and clearly assessed, as some assumptions (both stated and unstated in the Investment Memo) could significantly diminish the likelihood of achieving the project results related to increased productivity.** In neither the Investment Memo nor the ME Plan do we find evidence of a plan for monitoring risks nor for how monitoring of risks would feed into decision making and activity management.

Project – Evaluability Assessment	
Assessment Categories	**Strengths, Weaknesses, and Next Steps**
Dimension 4: Are project participants clearly defined and justified in terms of geographic scope and eligibility criteria?	
1. Is the selection criteria for project participants clearly defined and based on the problem and evidence in the program logic? 2. Is program participants' selection based on credible, quantifiable selection criteria? 3. Are specific demographics (age, gender, poverty status) defined where necessary? 4. Are the geographic location(s) for the Project defined and based on the problem listed above and evidence in the program logic? 5. Will the Project design and implementation plan vary by different sub-groups and/or geographic locations based on the problem listed above and evidence in the program logic? 6. Can the selection be replicated for the purposes of an impact evaluation (linked with Section 5)?	The selection of participants in individual grant activities under OCEF is not clearly discussed and is not currently known given that grants are still being finalized. Activities under the first call for proposals were expected to target communities at least 7km from where the grid was planned to be extended by 2025, yet that restriction has been removed for the second call for proposals. For individual grants, it is expected that the targeting process may differ across grants and according to the business models for each grant. **The lack of clear targeting represents a risk for the evaluation in terms of sampling and ensuring data is collected from grant participants, as well as using participant profiles to identify a suitable comparison group. This challenge is discussed in greater detail in the evaluation design report.**

Project – Evaluability Assessment	
Assessment Categories	**Strengths, Weaknesses, and Next Steps**
Dimension 5: Are the metrics for measuring results for both accountability and learning clearly defined?	
Are there clearly defined indicators and data sources identified for monitoring <u>project implementation</u>? 1. Are there clearly defined indicators for measuring expected performance (processes, outputs)? 2. Are the indicators linked to the ERR? 3. Is it clear which indicators will be disaggregated by gender, age, income as appropriate? 4. Is there a clear understanding of the time frame for expected results of each indicator (if varies)? 5. Is there sufficient information to set appropriate and feasible baseline and annual/quarterly targets? 6. Are there sufficient human and financial resources in the MCA and IEs to conduct the necessary data collection/reporting during the life of the intervention? Are data collection costs known and budgeted for? 7. Is it clear who will use the data and for what purpose(s)?	There are currently few indicators in the MCA M&E Plan developed for OGEAP, though these are expected to be revised in June 2019. i. For the Enabling Environment Activity, these are focused on high level outcomes related to jobs created and investments made in decentralized energy solutions, as a result of the development and implementation of the Off-Grid regulatory framework. While these indicators track the high level outcomes expected, the indicator on number of jobs created needs more clarity, as many jobs would likely be created indirectly as a results of increased investment in off grid energy (including, proximally, service sectors related to installation and maintenance of infrastructure at the household level and more distally, sales and maintenance of appliances), yet it is unclear if they are captured (and if so, how) under this indicator. Moreover, there are no indicators of intermediate results, including for example, number of applications to ABERME/ARE. ii. For OCEF, there are 5 indicators, 2 outcome and 3 output. The outcome indicators capture capacity and access to off grid electricity, but they do not capture (or it is not clear how they would) results from grant projects other than mini-grids. Moreover, the indicators stop at the level of access and do not capture whether and how this access is used (e.g. whether this increases productive activities or whether it reduces electricity costs). In addition to the MCA indicators, the implementer, NIRAS, has developed 29 indicators that span process indicators related to implementation of OCEF and grants, output indicators for each window (or project type), outcome indicators related to shifts in the market (though some of these are less clear on how they will be

	implemented- for example, one indicator tracks additional investments directly related to OCEF, yet does not state what types of investments would be included or how these would be measured), and outcome indicators related to energy access. While these indicators are more comprehensive, they still lack clarity in some important areas and do not cover results related to the effects of increased access. At the grantee level, during discussions with the implementers of OCEF during the evaluation scoping, they noted that their focus has been on setting up the grant facility and managing the first call for proposals. They stated that they had not worked concretely on monitoring plans for grantees yet. **Given the gaps noted above, the evaluation will need to document clear indicators tied to the project logics it develops for each of the grants being evaluated.**

Dimension 5: Are the metrics for measuring results for both accountability and learning clearly defined?	
Are there clearly defined indicators and data sources identified for monitoring <u>project results</u>? 1. Are there clearly defined indicators for measuring expected performance (processes, outputs)? 2. Are the indicators linked to the ERR? 3. Is it clear which indicators will be disaggregated by gender, age, income as appropriate? 4. Is there a clear understanding of the time frame for expected results of each indicator (if varies)? 5. Is there sufficient information to set appropriate and feasible baseline and annual/quarterly targets? 6. Are there sufficient human and financial resources in the MCA and IEs to conduct necessary data collection/reporting during the life of the intervention? Are data collection costs known and budgeted for? 7. Is it clear who will use the data and for what purpose(s)?	See above.

Dimension 5: Are the metrics for measuring results for both accountability and learning clearly defined?	
Is the evaluation clearly defined for maximizing learning and accountability? 1. Is there commitment by all key stakeholders to implement the independent evaluation? 2. Are evaluation questions and outcomes clearly defined and prioritized? 3. Is it clear which outcomes will be disaggregated by gender, age, income as appropriate? 4. Is it clear who will use the evaluation results and for what purpose(s)? 5. Is the evaluation methodology the most rigorous and feasible possible? 6. Is it clear how an evaluation (performance or impact) will contribute to the evidence base in the sector? 7. Are there interim/continuous evaluation results which could help inform decisions during the compact life? If so, is such an evaluation built into the evaluation plan? 8. Do the potential benefits and learning from an evaluation of the program outweigh the costs? 9. Are there sufficient human and financial resources in the MCC, MCA and IEs to conduct necessary data collection/ reporting during the life of the evaluation? Are data collection costs known and budgeted for?	Based on discussions with MCC, MCA, other donors, and government of Benin stakeholders, it is clear that there is strong commitment for and interest in evaluation of OGEAP, both the enabling environment and OCEF activities. **The evaluation team discussed key evaluation questions with various stakeholders during the scoping visit, and while there was a wide range of interest, the evaluation team has summarized that interest into priority questions in the EDR.** The evaluation of the enabling environment and the grant facility as a whole is more straightforward, with less risk than the proposed impact evaluation(s) of individual grants. The main risks on the overall PE side are on the potential for bias in qualitative interviews without a counterfactual design (though this is less of a concern for the more process or implementation focused questions and will be mitigated by interviewing multiple stakeholders to triangulate results) and that the evaluation will be unable to set a true baseline. On the IE side, the main risk initially stems from challenges in identifying a suitable comparison group due to the lack of detailed knowledge about targeting. These risks and mitigations are discussed in detail in the EDR. Both evaluations have important potential learning value. There is wide interest in learning which models (if any) are viable for private sector expansion of off-grid electricity in Benin. Moreover, there is significant interest in understanding how the enabling environment and grant facility might be able to spur additional investment in the sector. From the IE side, the literature is unclear on the extent to which rural electrification spurs increased production. These represent important potential learning areas that we believe outweigh the costs of the evaluation.

7.2 STAKEHOLDER COMMENTS AND EVALUATOR RESPONSES

This annex will be populated for the Final Evaluation Design Report based on SI responses to MCC, MCA-Benin II, and local stakeholder comments on the Draft Evaluation Design Report.

7.3 EVALUATION BUDGET

Per MCC's instructions regarding sensitivities around future procurements, the evaluation budget corresponding to this Evaluation Design Report has been provided to MCC separately.