Climate Investment Funds

CTF/TFC.22/7
January 15, 2019

Meeting of the CTF Trust Fund Committee
Ouarzazate, Morocco
Thursday, January 31, 2019

Dedicated Private Sector Program – Battery Storage

PROPOSED DECISION

The CTF Trust Fund Committee, having reviewed document CTF/TFC.22/7, *Dedicated Private Sector Program – Battery Storage*, welcomes the efforts of the CIF Administrative Unit and the MDBs to develop the proposal and a preliminary pipeline of battery storage project concepts.

The Committee agrees to establish a dedicated Battery Energy Storage Systems (BEES) Program under the CTF, along the lines of the Dedicated Program Sector Program (DPSP), as a separate thematic window that will be open to all CIF countries. The Committee takes note of the indicative pipeline of battery storage project concepts submitted by the MDBs and that new contributions in the scale of USD 1 billion will be needed to support an ambitious global battery storage program.

The Committee requests the contributors that are in a position to do so to consider making new contributions to support the proposed Global Battery Storage Program, with a view to launching the program by the next Trust Fund Committee meeting in June 2019.

I. Why Battery Storage?

1. Changing the world's energy systems could make one of the largest contributions to fighting climate change. A clean energy transition is already underway with the significant increase in deployment of solar power, wind power and other forms of renewable energy. However, solar and wind produce only when the sun shines or when the wind blows, so their output is variable and this variability needs to be compensated by increasing the flexibility of the power systems. Flexibility can be provided through flexible resources like gas or hydropower generation and in certain cases also by diesel generators and heavy fuel oil (HFO). Additional flexibility can be brought by interconnections with neighboring countries, demand response and storage solutions.

2. In many developing countries, gas or hydropower are not available and interconnections can take long to legislate and construct, so flexibility of power systems is hard to achieve. But battery storage that is now more available and increasingly affordable can play a significant role to integrate variable renewables into grids and therefore accelerate the decarbonization efforts in developing countries where other low-carbon flexible resources are unavailable. Batteries are also advancing deployment of distributed solutions whether to serve the needs of industrial, commercial and residential customers or in mini-grids and in support of stand-alone solar systems to increase electricity access in underserved areas of many developing countries.

3. Battery storage has a unique advantage over other sources of flexibility in power systems: it is a modular solution that can be deployed anywhere in the world (unlike pumped hydro or thermal storage deployed in conjunction with concentrating solar power plants which require particular geographical conditions) and it comes pre-packaged, often times in containers or smaller dedicated ready-to-deploy units, allowing fast deployment with minimal preparation and construction, in record times (unlike cross-border transmission). The current drawback of battery storage is that it is still more expensive than other sources of flexibility, however, with prices falling rapidly batteries are now precisely at the stage where concessional finance can bridge the gap to their financial viability, making them available for deployment today, not few years down the road, and therefore enabling clean hybrid renewables plus storage solutions, instead of new fossil plants that would be locked in for the next 3-4 decades to come.

4. The International Energy Agency (IEA), in its flagship publication of *World Energy Outlook 2018*, includes for the first time ever batteries' contribution to flexibility of power systems. The overall size of battery additions suggested by IEA by 2040 will be in the order of 320 gigawatts (GW) of grid-connected batteries, a hundred-fold increase compared to the situation today.[1] This increase in batteries' deployment together with other sources of

[1] The corresponding GWh capacity is unclear, but today an average use of battery is around 2.5 hours a day, which would translate to some 800 GWh, provided that the average use in 2040 has a similar duration. It can be, however, expected that average durations will increase over time.

flexibility should support an increase of solar PV and wind installations from just over 900 GW at the end of 2017 to some 4,250 GW in 2040.

II. Regulatory Background and Current Market Status

5. Operating a reliable electricity system requires the instantaneous matching of supply and demand. Energy storage can help maintain this balance by acting as either supply or demand, making it a flexible resource that can help grid operators manage the integration of renewable resources and respond to changes in system conditions almost instantaneously. Storage assets can participate in energy markets in a variety of ways: (i) as a generation asset, storage can provide energy, capacity, and ancillary services[2]; (ii) as a transmission and distribution network asset, storage can provide congestion relief, enhancing the capacity of the network to accommodate new power, avoiding the need for new transmission or distribution infrastructure; and (iii) as a load asset, storage can participate in demand response programs, reducing the power demanded during certain periods of the day. Storage can be directly connected to the grid and optimized by grid operators, it can be located behind-the-meter directly at a customer site or it can be part of isolated mini grid or standalone systems.

6. Despite the ability of storage to ***participate*** as an asset type across generation, transmission, distribution, or load, it is quite complicated to enable storage assets to be ***able*** to provide services simultaneously across these areas. In most advanced energy markets, to satisfy local regulations, storage must pick which service to provide. For example, if storage is participating as a generation resource providing energy or capacity, it might not also be able to provide ancillary services. Or, if storage is participating as distribution-level asset, it might not also be able to participate in the energy markets. This is especially the case in energy markets where there is a clear transmission and distribution level split, and where competitive retail energy markets exist. In that case, storage may be getting cost of service recovery as a distribution asset, and therefore cannot also compete as a merchant asset in the competitive energy markets.

7. Understanding how to enable and encourage the full participation of storage assets, whether batteries, or other types of storage, is an ongoing process even in developed countries. Utilities that are vertically integrated, or grid systems managed by state owned enterprises, may enable the full participation of storage assets in ways that the competitive energy markets cannot. This is because vertically integrated or state-owned enterprises do not struggle with the double-payment concern described above (i.e. a cost of service asset also getting merchant revenues). However, figuring out how to best support and enable the full participation of storage assets is a challenge across all energy systems and it requires support to enable effective lessons sharing across countries that will speed up policymaking and regulatory process crucial for establishing environment conducive to deployment of storage.

2 The term ancillary services is used to refer to a variety of operations beyond generation and transmission that are required to maintain grid stability and security. These services generally include, frequency control, spinning reserves and operating reserves.

8. Some of the policy focus is on setting key mandates or targets for storage deployment. Given that storage costs are still relatively high, there are various efforts to provide incentives for new storage projects. In some countries, for example, utilities are required to meet certain storage targets and are allowed to own storage assets. In other countries, the focus is on creating new market designs that enable storage to participate as an energy, capacity, and ancillary service resource either directly-connected or behind-the-meter. These are still nascent efforts and require complicated changes to existing market design models.

9. Remaining challenges are numerous across vertically integrated, state-owned enterprises, and the fully competitive markets. Interconnection standards need to be redesigned, bidding parameters need to be developed, new market products need to be created, in less developed energy systems, grid codes need to be developed that require specific frequency targets to be maintained, and new regulatory structures that encourage and enable distribution-level assets to provide key services need to be created.

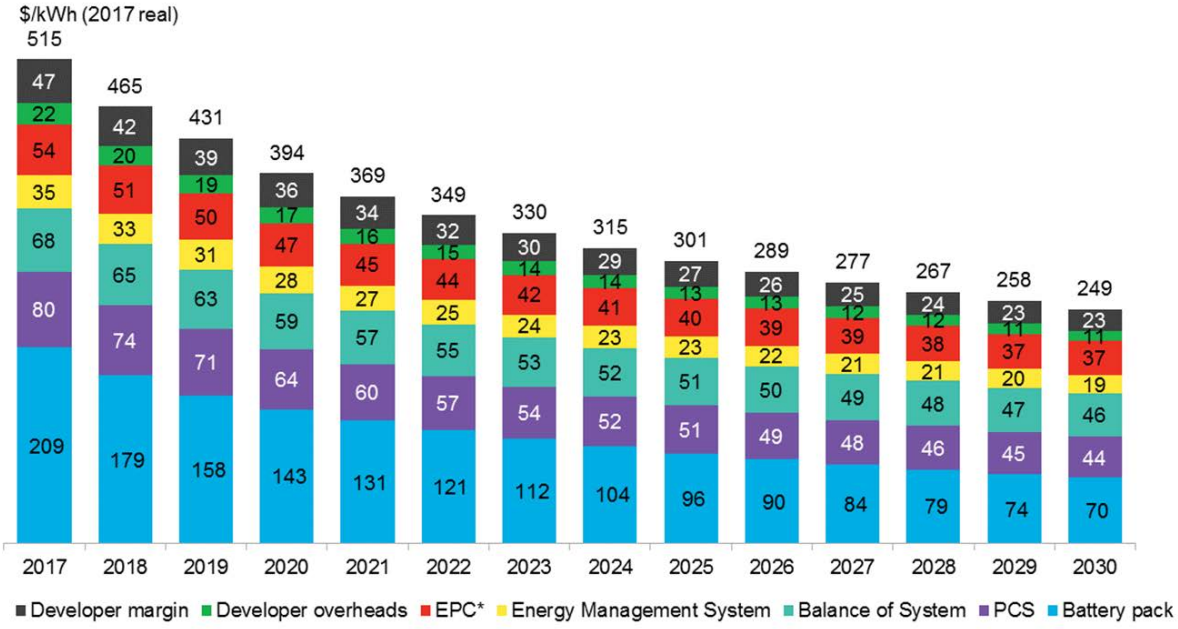
10. In terms of market status, battery storage deployment in developing countries faces two major obstacles. First, the market for stationary batteries represents still just a small part of the global batteries' market driven completely by the electric vehicles (EVs) market (11GWh of stationary batteries vs. ~400 GWh of EV batteries, cumulative, in 2017). Second, based on the WBG estimates there was roughly 4.5GWh of cumulative installed capacity of batteries in developing world in 2017, mainly used in mini grids and island applications. There is a need to create a separate market segment that caters to the needs of stationary battery storage (and not just EVs) and addresses challenges that stationary battery applications will encounter in developing countries (i.e., extreme temperatures, irregular operational regime, need for long duration storage, lack of local capacity to maintain and operate the facility, etc.).

III. The Economics of Battery Storage

11. The economics of battery storage, particularly when integrated with solar PV and wind are rapidly improving because the cost of PV, wind and batteries have fallen dramatically in recent years**.** These cost declines are expected to continue (Schmidt et al 2017, Fu et al 2017). A recent study estimated the cost of a utility scale energy storage system using a 10 MW Li-ion battery and 4-hours storage at between $385/kWh and $489/kWh (Lazard 2017). BNEF (2018) has estimated the average Li-ion installation costs which include the entire project cost to fall to $394/kWh and to $301/kWh by 2020 and 2025 respectively, in 2017 real terms, for a one-hour battery storage system (Figure 1). The lowest observed costs are expected to be significantly lower. The continued reduction of the cost of battery energy storage system (BESS) is significant. A recent study of a proposed World Bank supported hybrid solar wind and BESS in India notes that while "BESS is not yet economically viable against alternatives… the increasing need to shift generation from the afternoon solar peak output to the peak demand in the evening, combined with falling BESS costs, will improve the economics of storage in India." The analysis considered a BESS

system cost of US$390/kWh, but at US$236/kWh the ERR clears the hurdle when local and global externalities are included, or at US$187/kWh without externalities.

Figure 1. Projected Cost Evolution of Li-ion Battery Storage with a 1:1 Energy to Power Ratio (Source, Bloomberg New Energy Finance, 2018)

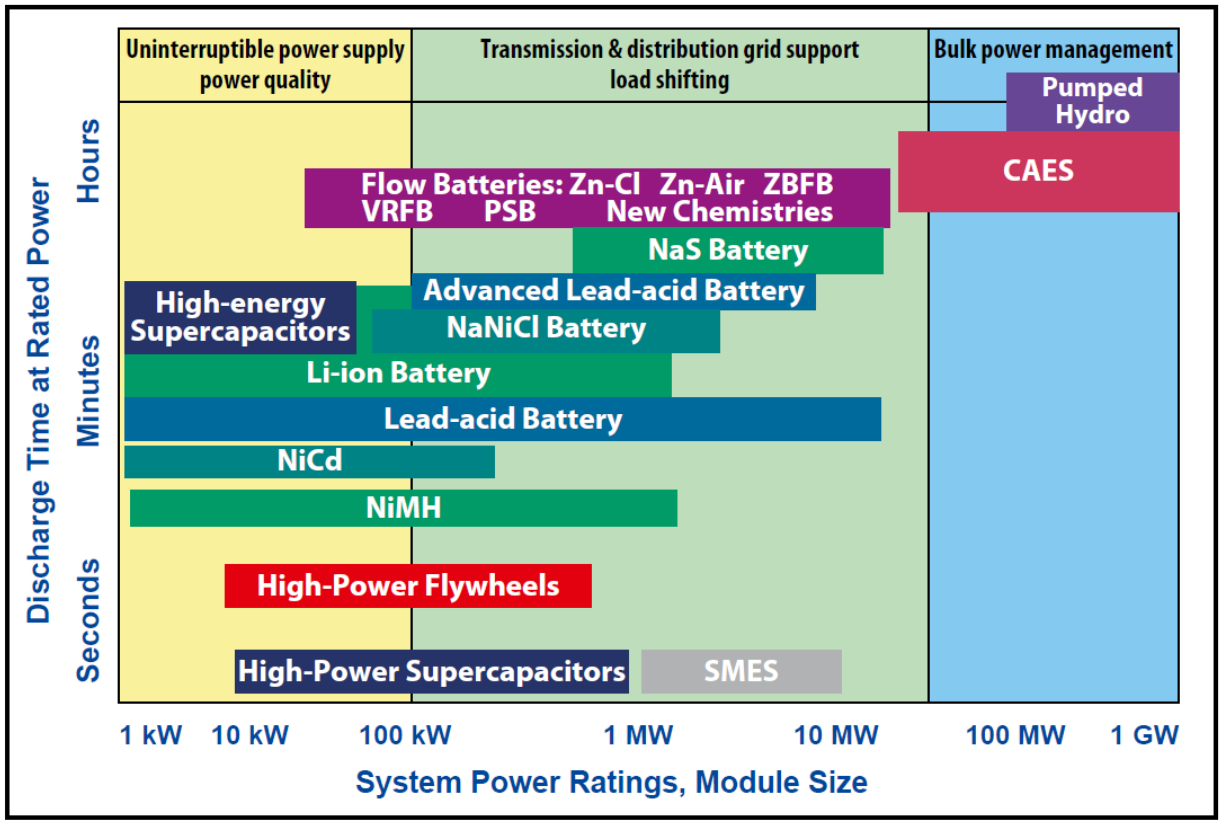


12. The number of hours of storage has an impact on the system cost of battery storage ($/kWh). It is common to discuss the installed cost of BESS on a $/kWh basis, as noted above. However, this metric when used alone can be misleading because its value for a given battery technology will depend on the number of hours of storage. The capital cost of BESS can be broadly divided into the cost of the battery pack, which will scale with hours of storage and the fixed costs for the balance of system (BoS) which depends on the power capacity ($kW). The (relatively) fixed costs include the inverter, energy management system, EPC costs and developer overhead costs and profits. For example, the BNEF (2018) $421/kWh capital cost for utility scale battery with 4 hours of storage was split roughly 50:50 with $209/kWh for battery storage and $212/kWh for the remaining costs (Figure 1). For the same BNEF example reducing the hours of storage from 4 to 2 hours would increase the installed cost from $421/kWh to $633/kWh, while decreasing the power cost from 1,684/kW to 1,266/kW.

13. Megawatt (MW) scale and discharge time also matters for battery technology choices and the cost of storage. These two factors determine the power and energy size of the battery and can impact both the choice of technology used and the levelized cost of battery storage (Figure 2). For example, Li-ion batteries and flow batteries are considered potential competitors at utility scale (although some chemistries such as flow batteries, Zinc air as

well modern Lead-acid technologies are also emerging). Cost typically increase for smaller scale energy storage. Whereas a utility scale Li-ion battery system might cost between $400 and $500/kWh for 4 hours of storage this cost might increase to more than $1,000 for residential applications.

Figure 2. Relative Position of Different Storage Technologies According to Their Discharge Time and Capacity Size
(Source: US DOE/EPRI, 2015)



IV. Business Case for BESS

14. The business case for BESS is based on the following factors:

    a) Battery storage is modular and can be easily deployed together with PV and wind farms in countries where there are no other flexibility options, or where those would take a long time to implement delaying decarbonization in these markets;

    b) Battery storage although not the only flexibility source is the fastest and the comparatively simpler option to implement, enabling countries to accelerate the deployment of variable renewables where it would take decades to adapt the dispatching systems to be able to take full advantage of renewable resources. Many of those countries currently rely on diesel for generation, and VRE+batteries are already a competitive solution to cover the demand curve; and

c) The best chemistries for stationary applications still need to demonstrate enough performance record and are not bankable. Concessional finance might be the only way to allow them to become fully commercial.

15. The barriers to BESS market growth include:

a) Lack of familiarity with Battery Storage Systems technology among utilities, regulators and financiers;

b) High upfront costs, particularly in time-shifting applications that require larger batteries;

c) Lack of adequate cost recovery mechanisms, with regulations not clearly stating the incentives for energy storage to be received from the energy, ancillary services or capacity markets, as well as for third-party or customer ownership of certain DERs;

d) Elevated risk of emerging battery technologies with performance superior to Li-ion but limited track record in utility-scale applications; and

e) Operation and maintenance challenges specific to emerging markets (e.g., high temperatures, lack of capacity to operate and maintain the BESS).

V. Current CIF Support for Battery Storage

16. The Climate Investment Funds (CIF), through the Clean Technology Fund (CTF) and the Scaling-up Renewable Energy in Low Income Countries Program (SREP), has been pioneering a number of battery storage activities as a state-of-the-art, low-carbon technology to accelerate the deployment of renewable energy for significant greenhouse gas emissions reduction and to increase energy access for economic and social development in the world's poorest countries and communities.

17. The CTF has recently spearheaded two notable battery storage initiatives: one in South Africa and another one in India. In South Africa, the CTF, in partnership with the World Bank and the African Development Bank, will provide USD 273 million concessional finance to support a large-scale distributed battery storage program linked to continuation of South Africa's Renewable Energy Independent Power Producers (REIPP) Program and to complement the operation of new wind and solar power capacity to be built under REIPPP. CTF support will also include technical assistance for the design, procurement, and supervision of energy storage infrastructure, strengthening of local capacity in operation and maintenance of large-scale batteries, and improving the enabling environments for further private investment.

18. In India, the CTF provided USD 50 million highly concessional finance for the Innovation in Solar Power and Hybrid Technologies Project to promote large-scale deployment of innovative technologies in the RE sector, including solar-wind hybrid systems, integrated energy storage for solar and wind, and floating solar PV panels. CTF finance, along with that from the World Bank, the government, and the private sector, aims to install 230 MW of solar-wind hybrid capacity, potentially with short-term energy storage, with a cumulative capacity of about 230 MW and 50 MW of stand-alone plants for solar PV with storage. Since the proposed technology is not yet commercially viable, the project intends to demonstrate the benefits expected out of storage solutions, thereby opening up the market for future private sector investments.

19. Under SREP, at least six approved projects have battery storage components with both on-grid and off-grid/mini-grid applications, to address the variability of solar PV and wind.

20. In Haiti, SREP provided USD 20 million for renewable energy for the metropolitan area to build 6-12 MW RE capacity of solar PV with battery storage, which would hybridize 2-3 EDH isolated grids, currently running on diesel power, resulting in 5-10 GWh of annual renewable energy generation, and improved access for at least 100,000 people and 1,000 enterprises/community uses. The project also aims to provide electricity access to 800,000 people and 10,000 enterprises and community service institutions, such as schools, health centers and community water pumping services, through a wide range of off-grid/mini-grid electrification options. The project draws lessons from a successful solar PV with battery storage resilience project installed in 2015.

21. In Mali, SREP provided 15 million for the Rural Electrification Hybrid System Project on renewable generation capacity with solar PV and energy storage on batteries. The project aims to increase renewable energy generation capacity in approximately 50 existing rural mini-grid power stations that currently rely exclusively on diesel generation.

22. In Solomon Islands, SREP is financing with USD 6 million renewable energy hybrid mini-grids that potentially require solar panels of 150 kW, battery storage of 300 kWh and a diesel generator as a back-up of 140 kW to connect 100 percent of the houses. Given the nascent stage of RE development in Solomon Islands, SREP financing is key to demonstrate viable approaches, reduce regulatory, financial and capacity barriers while creating the conditions for future replication and scale up.

23. In Maldives, the Preparing Outer Islands for Sustainable Energy Development Program (POISED), with USD 12 million from SREP, is helping the country to achieve a more reliable, sustainable energy sector by replacing inefficient, diesel-based power generation with solar-diesel hybrid mini-grid systems in 160 targeted medium and small islands. The project will install 21 MW of new solar capacity with 27.6 GWh/y output and 7 MWh of energy storage.

24. In Cambodia, SREP provided USD 14 million to the National Solar Park Project, the first of its kind in the country, to support the construction of 100 MW solar PV power plant. The project will have finance the solar park, transmission facilities, and supporting infrastructure constructed and strengthening the capacity of Electricité du Cambodge (EDC) – the national electric utility – to integrate renewable energy, including advanced technologies such as energy storage, into the national grid.

25. Finally, in Mongolia, the Upscaling Renewable Energy Sector Project received USD 14.6 million SREP funding for the development of the distributed renewable energy systems, with a total of 40.5 MW of solar PV and wind power in the Western and Altai-Uliastai regions. Advanced energy storage will be installed in selected sub-projects for grid stability and time-shifting. The system will supply power to more than a quarter of a million people across scattered local towns in the remote and less-developed western region of Mongolia, where communities rely on expensive, fossil fuel-based electricity imports from neighboring countries.

26. In addition to the above projects with investment and/or technical assistance components targeting battery storage, the CTF, through the Dedicated Private Sector Program, Phase III (DPSP III), is financing a Business Devleopment Facility (BDF) with a number of proposals that will look into battery/energy storage opportunities in countries such as Brazil, Cambodia, India, Indonesia, Kazakhstan, Philippines, Thailand, and Vietnam.

VI. Market Potential for Battery Storage

27. Considerable interest among client countries is emerging in investing in and preparing for BESS in their power systems. As discussed earlier, the CTF and SREP are already supporting several countries in piloting the deployment and providing technical assistance for battery storage initiatives, namely, South Africa, India, Cambodia, Haiti, Maldives, Mali, Mongolia, and Solomon Islands. The following paragraphs provide an assessment of the market potential for battery storage in selected countries and regions.

28. **South Asia.** India has recently announced a battery storage national mission to accelerate scale-up and manufacturing of BESS in the country. Pilots are being planned in several states including Rajasthan, Tamil Nadu and Andhra Pradesh. In addition, the national grid company, Power Grid, is piloting projects involving different technologies and application of BESS. Maldives is implementing a rooftop solar program with support from SREP and is considering the next phase of the program to include BESS at several locations in the system for smoother operations as penetration of variable solar in local systems will increase. In Sri Lanka, the government is requesting to assess the battery storage options for two sites of a total of 500 MW solar and wind capacity, for which prefeasibility studies have been completed but government is interested in smoother variable power deployment today as well as future deployment of renewables, targeted at 2500 MW by 2030. Bangladesh considers utilizing battery storage for frequency control ancillary services (FCAS) to improve dispatch efficiency of the power system with the objective of increasing renewables' penetration. There are also early considerations for BESS deployment in

Pakistan alongside solar scale-up planned in the Sindh province.

29. **East Asia and Pacific.** There is continued and growing demand for BESS as part of small island grids in several countries in the Pacific including Solomon Islands, Vanuatu and Kiribati, which rely heavily on expensive imported fuels. In Micronesia, for example, the country is, based on the Master Plan, targeting to achieve an RE penetration of 84% in 2034, which is reflecting the long term needs to reduce the dependency on imported fuels representing nearly 15 percent of the nominal GDP. BESS will play a crucial role to achieve this high level of RE penetration. Indonesia is scaling-up its mini-grid programs for increasing electricity access in the Eastern Islands through a new program called "Indonesia Terang", with a key role for BESS in providing longer duration electricity service in the evening. A part of this development is supported by the CTF Business Development grant. Integration and scale-up of grid level battery storage is under consideration in Vietnam to resolve transmission bottlenecks in certain parts of the network. In Mongolia rigidity of the power system comes from must run CHP plants that supply heat in winter. To enable scale up of ample variable renewables in Mongolia BESS can be a precious source of flexibility. In Myanmar, some mini-grid projects implemented by the private sector are already including modern BESS solutions and this trend is expected to continue as mini-grids-based electrification advances.

30. **Europe and Central Asia.** Turkey is considering a BESS program at the grid level for frequency control, transmission deferral, primary reserve as well as congestion management. In addition, as rooftop solar development takes root in the country, distribution level BESS is also being considered for smooth ramp-up of distributed solar. In Ukraine, Ukrenergo, the national Transmission System Operator, has identified 200 MW of primary frequency regulation that should be provided by battery storage. This should be followed by an additional 300 MW if prior implementation proves successful. This would allow Ukraine to decrease the use of costly and strategically important gas peakers that are a source of great concern from energy security and potential loss-of-revenue points of view due to fact that the imports of gas have to necessarily come from Russia. There are also early considerations for BESS deployment in Kazakhstan to support ambitious RE development plans in the country.

31. **Middle East and North Africa.** In Jordan, the national utility is keen to implement a BESS given the increasing volume of VRE that needs integration as well as to meet the increasing energy and water needs in the refugee camps where mini-grid solutions with modern BESS technologies are being planned. In addition, BESS could play a role in systems with high fuel costs such as Yemen, Lebanon as well West Bank and Gaza that are also trying to scale up renewable energy in fragile political and grid environments. Distributed models of BESS deployment are expected in these countries.

32. **Sahel and Sub-Saharan Africa.** In Sahel countries solar PV has fast become the least-cost option in many of the markets however the power systems of the region are small, weak and will take many more years to interconnect to an integrated system. However, several countries in the region such as Burkina Faso and Mali are embracing local solar resources and developing solar parks with battery storage systems being integral part of these plans due to the weakness of local grids and dispatch. Several other projects on solar plus battery storage to increase energy access are being developed in very fragile grids of the Gambia and the Central African Republic. Studies are underway in Guinea Bissau to assess the feasibility of solar plants combined with battery storage and in Senegal to assess the feasibility of grid scale battery storage to support the stable operation of the grid with the increasing penetration of renewables. In DRC battery storage is considered to effectively scale-up electricity access through distributed solar PV supported by batteries. The continued decrease in battery storage prices has also enabled the development of the off-grid market where clean energy mini-grids have emerged as a viable and promising option to increase electricity access in regions remote to the main grid. For example, Nigeria is implementing a large mini-grid program. The estimates of expected financing in West Africa, including the Sahel, in the next 3 years amount to 2 GWh of batteries when summing up batteries in hybrid solar parks and mini-grids. Grid level storage is being deployed with support from CTF in South Africa in a very large project deploying 1.4GWh of batteries, expected to create a robust market for BESS in the sub-region in the medium term. Madagascar, Malawi, Mozambique, Eswatini, and Comoros are other markets where BESS is being considered in conjunction with solar scale-up and they will benefit from early experience of South Africa.

33. **Latin America and Caribbean.** Batteries complementing solar PV installations for resilience have been already deployed for several years in Haiti. Grid level storage is being considered in Colombia, which is scaling up renewables with support from the CTF. Brazil, Argentina and Honduras are also exploring grid level BESS deployment to improve operational efficiency of their power systems. The island grids in the Caribbean would also benefit greatly from BESS to bring greater reliability and resilience in an increasingly fragile climatic conditions and break dependency on imported fuels.

34. The rising demand for battery storage in client countries would need to be met by a collective effort both from the public and private sector. For example, in the case of standalone battery storage system for grid ancillary services, this would initially follow a public-sector approach since the regulations would have to be developed and customized to incentivize BESS. As regulatory clarity and incentives are put in place, more private sector driven solutions can be implemented. In the case of commercial and industrial applications, private sector participation is likely to be more prominent as the value streams would be more clearly defined such as replacement of captive generation for stable power availability and quality, decreasing fuel consumption and costs, and price arbitrage in places where time-of-use pricing exists. However, in this case also clients would require some public-sector support to ensure that the right policies are in place to

encourage the battery storage usage focused to provide grid services that improve grid integration and increase grid penetration of clean energy in power systems.

VII. Description of the Proposed Program

35. The CIF is proposing a Global Battery Storage Program to provide concessional climate finance through its partner MDBs to invest to support CIF countries in accelerating the deployment of stationary battery storage to scale up renewable energy development. The objective of the Program is fully aligned with the objectives of the CIF (i.e., CTF and SREP) to demonstrate and deploy low-carbon technologies, to reduce the carbon footprint of the electricity sector, and to increase energy access and create economic opportunities by using renewable energy. The Program will be in line with the WBG announcement in September 2018 at the One Planet Summit and initiatives by other MDBs and will be built upon the experience of the CTF and SREP, MDBs, other financial institutions, industries, governments, and other stakeholders.

36. The scope of the Program will include investments into batteries and energy management systems supporting batteries, policy interventions, technical assistance and knowledge coordination to help countries to fully take advantage of the multiple system benefits the BESS can bring to their power systems and that is already underway in some parts of the world.

37. The Program is proposed at the scale of USD 1 billion in concessional finance, including but not limited to grants, to mobilize MDB as well as other public and private sector financing in the range of USD 4 billion for battery storage support and deployment. The leveraging ratio is expected to be 1:8 or higher with the inclusion of related RE investments.

38. The Program will provide support to client countries in the following areas:

39. Support deployment of BESS at scale: This would include support for solar/wind hybrid power projects, firm power auctions such as through Solar Parks or Scaling Solar projects with public investment in Solar Park infrastructure and private investments in generation and batteries. Such investment support would be accompanied by support to adoption and implementation of policies and regulations.

40. Policy and regulatory support would include allowing participation and fair compensation of the full range of battery storage services, whether acting as supply, demand, and/or transmission asset, promoting regulations on sustainable batteries to establish procurement practices in favor of environmentally friendly battery technologies and establishing recycling programs for a fully sustainable life cycle as well as support participation of client countries in the battery supply chain for manufacturing and assembly.

41. Finance large-scale demonstration projects: The program would support less mature but technically viable long-duration battery technologies that are currently deployed at very small scale but that have potential to support different grid services for a wide range of applications for different durations, and with the strict environmental standards, to become baseload/coal-replacement options over time and to prove over time their commercial viability at scale.

42. Support mini-grids and distributed applications: The program would support mini-grid solutions in rural areas to improve clean energy access. This category would also include hybrid or pure battery distributed projects, such as distributed/rooftop PV plus storage for public customers and for industrial, commercial or residential customers. For applications in the commercial and industrial customer segments or other close to commercial applications, the program will support public and private projects that could benefit from credit enhancement products.

43. The proposed Program on BESS will be technology agnostic and allow participation of all types of technologies if they meet performance criteria required under specific applications (e.g., response time, efficiency, depth of discharge) as well as are compliant with WBG environmental and social guidelines and standards. From an environmental perspective, the ability to extract and reuse high salvage value materials from the battery, stability of the materials used and the ability to isolate failure, operability in harsh climatic conditions and temperatures over 45°C, limited maintenance, limited toxicity, as well raw material extraction aspects will be important aspects considered by the program.

44. Annex 1 includes a sample pipeline of battery storage projects from the MDBs that could be developed in the next 18 months (March 2019 – September 2020) for funding consideration.

VIII. Role of the CIF Business Model

45. The key features of the CIF Business Model that are suited to the Global Battery Storage Program are as follows:

- Risk-Appropriate Financing Tools, at Scale
- Ability to Target New Sectors and Technologies for Transformational Impact
- Programmatic Approach
- Flexibility

46. The proposed Program would require a range of financing tools and innovative financing mechanisms. Since the Program is designed to ensure a wide array of applications of stationary battery storage technologies that are customized for different applications, this would require some flexibility in the approach. For example, in the case of new technologies that have superior technical capabilities but are comparatively expensive, concessional financing, including grants, could be provided to demonstrate the technologies at scale. This could be critical to avoid the lock-in of currently dominant

technologies, designed primarily for electric vehicles and not stationary applications. The lock-in would in the long run reduce competition among the different battery storage chemistries and would only allow cost reductions of the dominant technology, which would in turn hamper the possibility of true market transformation.

47. Moreover, the CIF's programmatic approach, as confirmed by recent independent evaluations, is well suited to lead to strong outcomes with potential to contribute to transformational change of the type needed in BESS. Attaining systemic change and scale will require strategic dialogues with and within governments to raise awareness and increase ownership; an organized and consultative way to prioritize investments; joint programming across MDBs to leveraging their balance sheets and of other financiers, key amongst which the private sector; an engagement and funding provided both for policy and regulatory work as well as investments. These features under the CIF business model and are what enabled the MDBs, Government and private sector to reach strong outcomes in the past in the deployment of CSP, geothermal or rooftop solar, among others.

48. Finally, the flexible, adaptive and swift nature of the CIF business model, such as that demonstrated through its Dedicated Private Sector Programs (DPSP) line of funding, will be key to supporting the dynamic nature of the technology and business models currently under consideration globally.

IX. Potential for Transformation

49. According to World Bank estimates, in 2017 there was approximately 4.5 GWh cumulative installed capacity of batteries in the developing world. The projection is that, without targeted support to developing countries, the market will stay concentrated in developed countries, and the cumulative stationary batteries market could be around 100 GWh by 2025. The proposed program could support approximately 17.5 GWh by 2025, and its catalyzing effect could open developing countries' market, projecting overall global installations to a range of 200-400 GWh by 2025, depending on the success of the catalyzing effect.

50. A robust portfolio of projects under this program would shift the focus of battery deployment from high-income countries to developing countries which would create a much bigger global market, thereby promoting the optimization of the design of BESS to meet the technical specifications required by emerging market stationary applications and catalyzing price reduction.

51. Battery storage systems can be used in various applications to facilitate the integration of VRE generators in power systems[3]. More VRE generation supported by BESS can translate

[3] ESMAP Bringing VRE up to scale: https://openknowledge.worldbank.org/bitstream/handle/10986/21629/ESMAP_Bringing%20Variable%20Renewable%20Energy%20Up%20to%20Scale_VRE_TR006-15.pdf

into GHG reductions if the batteries are charged with renewable electricity. Some of the most critical uses include:

- Displacing fossil-fuel generation by increasing the utilization of large-scale renewable capacity;
- Replacing diesel and HFO generators in islands, small-to-medium sized grids, and industrial applications (e.g. mines, captive power);
- Providing grid operators with a flexible, fast-response resource to manage intermittent renewable energy resources, increasing the renewable share in the system;
- Enabling power grids to be more resilient to contingencies, increasing the ability to integrate more renewable generation; and
- Enabling sustainable mini-grid solutions, predominantly based on renewable generation.

52. Battery deployment at scale would avoid GHG emissions from diesel generators and decrease emissions from other fossil fuels through higher use of solar and wind (~5Mt CO_2/year avoided directly by batteries, additional 70 Mt CO_2/year indirectly through shift to ambitious deployment scenario and even more by enabling higher deployment of wind and solar). Battery storage could start to become a feasible alternative to costly transmission infrastructure projects in some countries which are much more difficult to implement due to environmental and social constraints and enable more off-grid/mini-grid solutions, thereby speeding up electricity access in areas where grid expansion is not economically feasible.

X. Conclusion

53. The CIF Administrative Unit and the MDBs propose to the CTF Trust Fund Committee the establishment of a dedicated Battery Energy Storage Systems (BESS) Program under the CTF as a separate thematic window, along the lines of the Dedicate Private Sector Programs, that will be open to all CIF countries. Given the level of ambition outlined in this proposal, new contributions at the scale of USD 1 billion will be needed. New contributions for this purpose would be matched with a pipeline of battery storage projects from the MDBs. In the meantime, the MDBs may submit battery storage projects under the current DPSP III using existing CTF resources.

Annex 1: Sample Battery Storage Project Concepts from the MDBs

Country	Indonesia and Philippines and other CIF eligible countries
Project Title	Private sector energy storage for distributed renewable energy and energy storage and standalone energy storage in Indonesia and Philippines
Implementing MDB	Asian Development Bank (Private Sector)
Brief Description (including project objectives, components, and innovation aspects)	Indonesia currently has low levels of variable renewable energy penetration across its main grids and high reliance on diesel on islands and remote or off-grid areas. Philippines has a higher level of integration of variable renewable energy in its main grids and similarly high reliance on diesel on islands and remote or off-grid areas. This program would seek to primarily support project opportunities in the above countries covering: 1. energy storage applications focused on distributed mini-grid applications (most likely solar + storage) 2. Solar and/or energy storage integrated with diesel generators to reduce diesel use 3. Utility-scale renewable energy with energy storage 4. Stand-alone applications of on- or off-grid connected energy storage
Expected CTF Financing	$40 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant, loan, guarantee, equity
Expected Leveraging and Co-financing by Source	$40 million – ADB $40 million - Commercial or other sources $40 million – Equity
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): 50,000 t CO2e per year
	Installed capacity (MW): 70MW
	Energy savings (MWh; specify total or annual): 120,000 per year
	Other key indicators/targets, as applicable: 6-10MW of power/energy for battery energy storage systems
Expected Date of Submission to CTF Trust Fund Committee (month and year)	Q2 / Q3 2019
Expected Date of MDB Board (month and year)	Q4 2019
Status of Consultation with Recipient Country	Private sector program. ADB has already met with developers in Indonesia and Philippines including projects considering storage.

Country	CIF eligible countries in the Pacific Region; Papua New Guinea, Samoa, Solomon Islands, Tonga, Vanuatu
Project Title	Private sector energy storage to support renewable energy targets and reduced diesel use in the Pacific
Implementing MDB	Asian Development Bank (Private Sector)
Brief Description (including project objectives, components, and innovation aspects)	Pacific countries have ambitious renewable energy targets, many up to 100%. Despite ambitious renewable energy targets, Pacific countries have small grids which will make energy storage even more critical to integrate necessary levels of solar and wind generation. This program would seek to provide concessional funding to renewable energy projects that require energy storage, or even stand alone energy storage applications. Additionally, the program could support energy storage applications that directly reduce diesel use.
Expected CTF Financing	$20 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant, loan, guarantee, equity
Expected Leveraging and Co-financing by Source	$20 million – ADB $20 million - Commercial or other sources $20 million – Equity
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): 25,000 t CO2e per year
	Installed capacity (MW): 34MW
	Energy savings (MWh; specify total or annual): 60,000 per year
	Other key indicators/targets, as applicable: 3-4MW of power/energy for battery energy storage systems
Expected Date of Submission to CTF Trust Fund Committee (month and year)	Q2 / Q3 2019
Expected Date of MDB Board (month and year)	Q4 2019
Status of Consultation with Recipient Country	Private sector program. ADB has already met with many developers in the Pacific including projects considering storage.

Country	Nepal
Project Title	Power Transmission and Distribution System Strengthening Project
Implementing MDB	Asian Development Bank (Public Sector)
Brief Description (including project objectives, components, and innovation aspects)	Objectives: Power system reliability increase and optimization Components: ▪ Transmission lines ▪ Distribution system rehabilitation and modernization ▪ Energy storage system for the renewable energy integration and system stability
Expected CTF Financing	$10 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant
Expected Leveraging and Co-financing by Source	$150 million - ADB loan and Government funding
Expected Results	GHG emissions reduction (tons of CO_2 eq.; please specify total or annual): TBD tons CO_2 per year
	Installed capacity (MW/MWh): 10MW
	Energy savings (MWh; specify total or annual): TBD
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	June 2019
Expected Date of MDB Board (month and year)	Dec 2019
Status of Consultation with Recipient Country	Support from Nepal Electricity Authority is confirmed

Country	Africa
Project Title	WAPP Synchronization Project
Implementing MDB (specify public or private)	World Bank
Brief Description (including project objectives, components, and innovation aspects)	The objective of this project is to finance infrastructure to ensure synchronization and the flexibility of the systems and provide support for building regional institutions for power trade under ECOWAS (Regional Regulator-ERERA and WAPP information coordination Center-ICC). Currently, the World Bank is working with the clients in Burkina Faso, Mali and several other countries to develop large solar parks including battery storage. Battery storage would play a critical role in integrating renewables as well as ensuring reliable system operation when the system is synchronized. According to the WAPP Master Plan (September 2018), there is a need to build two additional lines (Bolgatanga - Bobo Diolasso – Bamako, Median Backbone: Kainji - Bembereke – Kara – Yendi-Ferkessedougou) to guarantee the stability of the system and additional measures to ensure the synchronization of the system. The proposed project will finance those additional measures including (i) strengthening the capacity of Static Var Compensator (SVC) in substations of the system; (ii) setting the Power System Stabilizers (PSS) of important units located at the endpoints of the system to stabilize an interzonal oscillations between the eastern and western zones of WAPP; and (iii) battery storage to support the integration of renewables and enable the environment for stable regional power exchange between the WAPP member countries. Based on the preliminary studies, by the year 2022, a total of 780 MW of battery capacity has been picked up in the steady state optimization process.
Expected CTF Financing (million USD)	USD 50 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	loan
Expected Leveraging and Co-financing by Source (million USD)	USD 200 million other concessional funds
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -743 tCO2 eq/year Total: -14,860 tCO2eq (20 years economic lifetime assumed)
	Installed capacity (MWh): 150MWh
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	June 2019
Expected Date of MDB Board (month and year)	October 2019
Status of Consultation with Recipient Country	The WAPP projects are financed by various donors, and it includes financing of infrastructure and technical assistance to the WAPP Secretariat. The World Bank has financed a synchronization study for the WAPP, which has recommended some measures to synchronize the network. In addition, the Bank has financed a study to overcome the challenges related to the massive introduction of intermittent renewable energies into the grid through battery electricity storage. The ECOWAS Commissioner for Energy and Mines has submitted a request to the World Bank to finance this project.

Country	Maldives
Project Title	Rooftop Scale-Up project
Implementing MDB (specify public or private)	World Bank
Brief Description (including project objectives, components, and innovation aspects)	Maldives consists of 26 coral atolls with 1,192 islands. Spread across 115,300 km^2 of the Indian Ocean with only 224 km^2 of land area, the country has the most dispersed geography, while also hosting one of the densest urban centers in Male'. The country achieved universal access to electricity in 2008. Currently it has 363MW of generation capacity, a third of it run privately on resort islands, and the remaining by two wholly government owned utilities – STELCO and FENAKA. Almost all the generation is diesel-fueled – the price for which is closely correlated to crude oil prices. This makes budget unpredictability an issue. The government faces fluctuating diesel imports of USD 240-400 million annually, and USD 50 million in annual fuel subsidies to the electricity sector alone. With the highest per unit electricity generation costs in South Asia, Maldives presents an opportunity for moving towards maximizing the displacement of fossil-based generation with renewable technologies using utility-scale battery storage (USBS) to facilitate greater Variable Renewable Energy (VRE) penetration. Appropriately designed USBS integrated with Energy Management System or "EMS", can increase PV penetration on island grids. USBS-hybrids are proposed to be installed and operated beginning in the Greater Male' area. a. <u>Current and Projected PV Penetration</u>: Hulhulmale' (in Greater Male') already has 10-12% of its ~8MW peak load met through the 1.5MW ASPIRE PPP solar-rooftop project, that has been operational since March 2018. Another bid of 5MW of rooftop solar is under preparation, ready for bid-launch in early 2019. This would increase RE penetration to more than 60% of Hulhulmale' load and require USBS for load stability, alongside the new PV installations. Fortunately, a 132kV line linking Male' and Hulhulmale' is expected to be completed over the next year – allowing the roof-space in Hulhulmale' to be used to service load in Male' (which has a peak exceeding 50MW). b. <u>Combining with e-Mobility Development</u>: Male is one of the most crowded cities in the world. Additionally, the rapid increase in GDP per capita has caused considerable increase in number of vehicles, increasing fossil fuel demand, greenhouse gas (GHG) emissions, and congestion. Fortunately, the compact island size can be leveraged to introduce EVs implemented through shared economy concepts, thereby reducing reliance on fossil fuel, lowering GHG emissions and road congestion, while creating service sector jobs. c. <u>Size of Battery System</u>: The World Bank proposes 20-40MWh of storage batteries – depending on economic viability of battery-PV hybrids (under PPP bidding structure) be installed starting with the Greater Male' region.
Expected CTF Financing (million USD)	USD 24 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	loan, equity

Expected Leveraging and Co-financing by Source (million USD)	USD 16 million other concession funds USD 15 million equity USD 45 million commercial/ECA debt
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -4,460 - -8,921 tCO2 eq/year Total: -89,200 - -178,420 tCO2 eq (20 years economic lifetime assumed)
	Battery Installed capacity (MWh): 20-40 MWh
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	11/15/2019
Expected Date of MDB Board (month and year)	06/15/2020
Status of Consultation with Recipient Country	The Government of Maldives (GoM) has been exposed to significant learning and interactions in renewables within the last 3-5 years. GoM is developing Hulhulmale' as a "Green City" and has shown interest in gaining policy and technology leadership showcasing the successful implementation of disruptive renewable-linked technologies for small island states. The Ministry of Environment and Energy (MEE), has a well-functioning team. The team has already gone through a full implementation cycle in a PPP mode for the Hulhulmale' project, working closely with STELCO utility officials. The team has also prepared for the next 5MW bid, which should be unveiled once the new government takes office. Training on VRE and exposure to renewable technologies in the US and Singapore has been provided to Ministry and utility officials. MEE also has qualified consultants on retainer under the ASPIRE project who are providing technical and commercial advice for bid-design and implementation. Through the successful implementation of the first bid-out PPA on Hulhulmale', there is a building consensus within the country that PPPs for a renewables-dominant generation mix will: (i) improve sector and macro-economic resilience[4], (ii) contribute to growth in tourist base and profitability, (iii) create quality jobs in sunrise industries, and (iv) propel the country towards a leadership role in "green solution" PPPs for island economies.

[4] The average height of the Maldives is 4 feet above MSL. Maldives will be first country to be affected by any increase in the sea level.

Country	Mongolia
Project Title	Mongolia – Battery Storage Frequency Regulation Project
Implementing MDB (specify public or private)	World Bank
Brief Description (including project objectives, components, and innovation aspects)	**Project Description** Mongolia has limited capacity to absorb variable renewable energy (RE) due to the prevalence of inflexible combined heat and power plants. According to the National Dispatch Center (NDC) of Mongolia, after having finalized ongoing construction projects amounting to a total installed capacity of around 250 MW of solar and wind power, no more RE plants will be allowed to connect to the grid without adequate storage solutions. Furthermore, most ancillary services (balancing and frequency control) are being provided through a link to the Russian power grid which means that Mongolia is unable to secure its own grid stability. Utility-scale battery storage solutions are seen as an alternative to importing ancillary services and as a means to enable effective and reliable integration of new RE generation – in the main grid in the Central Energy System (CES) as well as the country's more remote grids. The application of battery storage systems is also viewed as a solution in delivering sustainable power infrastructure for the country's mines – a key economic driver. As development of Mongolia's growing minerals mining industry will require reliable and secure power generation, battery storage systems could firm up and support RE integration, thus contributing to replace fossil fuel-based generation. There are three areas where the Bank plans engage on battery storage in Mongolia: • **Centralized Battery Storage Deployment**: in line with the objective of Mongolia to make itself independent of import of ancillary services, improve RE integration and increase grid stability, the country is planning to establish a modular 100 MW grid-connected battery storage system (e.g. five battery parks of 20 MW each) located next to key substations in the CES transmission and distribution network; • **Decentralized Battery Storage Deployment**: Smaller-scale battery storage in the weaker part of the CES grid as well as in the country's remote power grids; and • **Mining-related Battery Storage Deployment**: Battery storage systems to support RE for large mining operations, with a view to green mining-related investment and power supply.
Expected CTF Financing (million USD)	USD 27 million (tentative)
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant/Loan
Expected Leveraging and Co-financing by Source (million USD)	108 million USD other concessional funds
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -496 tCO2 eq/year Total: -9920 tCO2 eq (20 years economic lifetime assumed)
	Installed capacity (MWh): 100 MWh
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	FY21 (TBC)
Expected Date of MDB Board (month and year)	FY21 (TBC)

Status of Consultation with Recipient Country	The application of centralized battery storage systems in Mongolia has been a key part of the ongoing dialogue with the Minister of Energy and other key stakeholders. This is particularly true in the context of the ongoing TA on the Energy Sector Masterplan. The Masterplan inter-alia focuses on identifying investment and reform gaps to create an enabling environment for the sustainable development of the energy sector. Within this context, battery storage considerations for the medium- and long-terms have been flagged as a key focus area for the Masterplan. The feasibilities studies of the latter two activities are expected to be trust funded, as a part of the analytical work under the Masterplan and will inform potential new WB operations and priority investments.

Country	Indonesia
Project Title	Indonesia Sustainable Least-cost Electrification (ISLE)
Implementing MDB (specify public or private)	World Bank
Brief Description (including project objectives, components, and innovation aspects)	The Development Objective of the under development projectis to support the Government of Indonesia, and in particular PLN the State Utility, in adopting a platform approach for electrifying eastern Indonesia in a sustainable and cost-competitive manner while leveraging private sector investments. The proposed US$200 million would have two components: • **Component 1: Increase Access to Electricity, 50 million USD** – PLN co-financing of 100 mini-grids using newest type of long-term storage technology through innovative business models leveraging private sector • **Component 2: Reduction in Generation Cost, 150 million USD** – the main medium-size island grid in Indonesia (10 islands between 50 to 250 MW) and smaller islands (below 50 MW) upgrades with new SCADA systems, Automatic Generation Control (AGC) and battery storage to facilitate the integration of larger amount of privately-owned solar projects (targeting 300 MW of PV).
Expected CTF Financing	100 million USD
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant and concessional loan
Expected Leveraging and Co-financing by Source (million USD)	Direct private financing for Component 1 is expected to be 50 million USD and indirect private financing supported under Component 2 is expected to be 250 million USD out of a 200 million USD public investment.
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -156,111 tCO2 eq/year Total: -3,122,220 tCO2 eq (20 years economic lifetime assumed)
	Installed capacity storage (MW/MWh): *Component 1:* 50 MW/300 MWh *Component 2:* 100 MW/400 MWh
	Energy savings (MWh; specify total or annual): n/a
	Other key indicators/targets, as applicable: n/a
Expected Date of Submission to CTF Trust Fund Committee (month and year)	02/2020
Expected Date of MDB Board (month and year)	05/2020
Status of Consultation with Recipient Country	Technical Assistance under way to conduct feasibility studies and environmental and social impact assessments for mini-grids and storage/hybrid generation in selected islands.

Country	India
Project Title	India: Battery Storage Program
Implementing MDB (specify public or private)	The World Bank
Brief Description (including project objectives, components, and innovation aspects)	**Project Description:** India's ambitious goal of installing renewable energy capacity to 175 GW by 2022 is aimed, in part, at addressing the complex set of underlying challenges on energy. Renewable energy offers India an opportunity to simultaneously unlock many of the existing constraints to reliable and accessible electricity for all Indians in a sustainable manner. The rapid increase in renewable generation is starting to pose unseen challenges to the Indian grid particularly in managing the variability of renewables. The World Bank is in discussion with the Government of India for a substantial battery storage program for implementation with other energy sector and financing entities such as State Bank of India, PowerGrid and the India Renewable Energy Development Agency (IREDA). Discussions with Government of India, and other industry stakeholders have focused on two principle components that are necessary for the acceleration of battery storage systems investments in India: 1) Demand Creation, and 2) Development of a battery storage supply chain. Currently, the most significant impediment to battery storage investments is cost. This is also reflected in high cost of financing given the technical and commercial risks associated with battery storage. The overall cost of battery storage systems, and the cost of financing these, are expected to diminish as demand and supply grow, and economies of scale are realized, and through further innovation. This program will support the development of a roadmap for accelerated uptake of battery storage within the Indian power system, build capacity across both demand and supply chains, and support accelerated investments (demand creation) through pilot and demonstration projects, and low-cost catalytic financing to support broader public and private investment in battery storage systems. Four principle components are envisaged within this program: *Component 1) Transmission Level investments in Battery Storage ($300m)* Implementing Agency: PowerGrid Under this component selected pilot investments would be made in transmission level battery storage systems to provide ancillary services, maintain instantaneous balance between supply and demand, and improve the resilience and efficiency of the Indian transmission system, and its capacity to integrate high proportions of renewable energy. These pilot investments would demonstrate the utility and viability of battery storage systems at high-voltage transmission level.

	Component 2) Investments in Battery Storage to support Dispatchable Renewable Energy ($150m) Implementing Agency: IREDA Under this component a financing would be provided to support investments in battery storage, alongside investments in variable renewable energy resources, to address the increasing risk of curtailment of renewable energy generation due to transmission bottlenecks, and to better align renewable energy supply with peak demand. The Bank has already established a financing facility ($200m) to support public investments in common infrastructure (transmission evacuation) for privately sponsored solar parks. This facility will support up to $2 billion in private investments in solar parks. It is proposed that additional financing under this facility would be provided for battery storage investments which would address the risk of curtailment of energy production at these and other solar parks. *Component 3) Broad-scale investment in battery storage across the energy system ($535m)* Implementing Agency: SBI Under this component concessional financing would be made available across the potential battery storage market in India, to reduce upfront costs, create demand, and accelerate early market development. It is expected that this financing would catalyze much more significant commercial financing in the same way that a similar Bank/SBI financed rooftop solar program has in India. This financing would be made available for both public and private investments in battery storage across the power system, with particular focus on distribution level battery storage to support distributed renewable generation. *Component 4) Capacity Development ($15m)* This component would support the development of the ecosystem for battery storage, and a pipeline of future commercial investments and ongoing market development. The component would: - Provide support to central and state level institutions to develop sound policy and regulatory structures; - create market awareness; - support the development of an electric vehicle market which will initially lead to supply volumes for batteries which will affect overall cost structures; - support the development of the battery storage supply chain in India; - train public institutions, system operators, utilities, developers, financiers and other stakeholders in India's nascent battery storage market - support wholesale and retail market development to enable battery storage This program will be supported by analytical work currently being developed by the World Bank under a number of streams covering:

	- Distribution level battery storage systems; - Transmission level battery storage; - E-mobility; - Ancillary services market design. The program will also be informed by the implementation of a $200m loan project currently being prepared by the Bank to the Solar Energy Corporation of India, which will finance early battery storage investments alongside innovation solar PV, wind-solar hybrid and floating solar PV. To achieve program objectives, it is estimated that around $250m of the overall financing envelope under this program would be required to be provided on highly concessional terms.
Expected CTF Financing (million USD)	Expected CTF funding amounts to US$ 250 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant/Loan
Expected Leveraging and Co-financing by Source (million USD)	USD 550 IBRD funds USD 200 million equity
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -223,105 tCO2 eq/year Total: -4,462,100 tCO2 eq (20 years economic lifetime assumed)
	Installed capacity (MWh): 1-2 GWh for battery storage in transmission level investments and to support dispatchable renewable energy (TBC)
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	
Expected Date of MDB Board (month and year)	January, 2020
Status of Consultation with Recipient Country	There are ongoing operations and relationships with SECI as well as SBI, IREDA and POWERGRID that are planned to be scaled up for battery storage deployment. The WB team is currently engaging with SECI in the development of battery storage pilots for select sites for the states of Andhra Pradesh, Tamil Nadu and Rajasthan through the “Innovation in Solar&Hybrid Technologies” project. The Bank has an ongoing engagement with SBI to finance widespread commercial investments in rooftop solar PV, and with IREDA to finance grid-scale solar parks developed on a PPP basis.

Country	Ghana
Project Title	Ghana Rural Electrification Project
Implementing MDB (specify public or private)	Word Bank
Brief Description (including project objectives, components, and innovation aspects)	Ghana has a relatively high electricity access rate at over 83 percent (2017), second only to South Africa in sub-Saharan Africa. The country is now striving for universal access by 2030 utilizing two main approaches for the last-mile electrification i) grid extension by the distribution companies and ii) electrification through mini grids and off-grids where battery storage would be essential for the scale-up. The mini grid approach is proposed to be implemented in the Volta River region to provide access to around 150,000 households and another 150,000 households around Lake Volta would receive access through off-grid solutions. If these households gain electricity access, through scale up of mini grid and off grid solutions like rooftop solar, Ghana's access rate is expected to increase from about 84% to 94%. The World Bank, through the existing Ghana Electricity Development and Access Project (GEDAP), has supported 5 pilot mini grids projects in the Volta River basin region and the team is exploring scaling up the mini grid model based on this pilot programs to other island communities and remote communities incorporating sustainable battery storage options to provide reliable and longer duration services. Ghana has a universal tariff regime where there are two ways to approach the last mile of connection; either through cost-reflective tariffs or lowering the cost of capital that is required for the deployment of the mini grids due to the capital costs involved for battery storage. For the former approach, the current accumulated deficit of the power sector would result in further delaying the process of last mile of connection and pose financial burden to the power sector. Concessional finance is therefore required to lower the capital requirements for the mini grids incorporating battery storage. The project would assess different business models for installing, operating and managing these mini grid systems in a sustainable manner including a PPP approach to cost-effectively deploy the mini grids in a timely manner.
Expected CTF Financing (million USD)	USD 50 million
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant/Concessional debt
Expected Leveraging and Co-financing by Source (million USD)	USD 100 million IDA for mini grids USD 350 million other concessional funds for grid extension, individual solar home systems and cookstoves
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): Annual: -27,174 tCO2/year Total: -543,480 tCO2 (20 years of economic lifetime assumed)
	Installed capacity (MWh): 110MWh
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	
Expected Date of MDB Board (month and year)	June 2020

Status of Consultation with Recipient Country	The WB is working with the Government on this energy access program to increase electrification ratio from 84% to 100% and achieve universal access as the first country in the SSA region. The team, through the Ghana Energy Sector Transformation Initiative Project (P163984), is currently developing a bankable investment plan for the country through a clear electrification strategy by collecting the necessary information and lessons learned from previous electrification projects, utilize geospatial mapping to determine the limits of extending the grid, and determine the cost of standalone off-grid and mini-grid solutions where grid extension will not be feasible, in particular for the north of Ghana. From the client side, Volta River Authority (VRA), where the Volta River region falls under, has currently formed a separate unit to dedicate to mini grids to commit to the electrification of the unserved population. The Bank team is exploring with the client different business models to make the scheme sustainable, including review of the affordability, so that it can be replicated to other energy-deprived islands and remote communities.

Country	Pacific Region
Project Title	Pacific Region Renewable Energy Support Program
Implementing MDB (specify public or private)	World Bank
Brief Description (including project objectives, components, and innovation aspects)	The Pacific Islands are almost entirely dependent on imported petroleum and diesel fuel for national energy needs including electricity generation. To expand access and to improve reliability, affordability and sustainability of electricity services, the countries in the Pacific regions would have to implement a least-cost expansion plan which currently the World Bank is supporting in many of the Pacific Island countries. The Pacific Island countries have untapped potential for renewables especially solar and renewable energy can play a role in increasing access in a sustainable manner and contributing to reduction in cost of supply and the electricity tariffs. Placing a high priority on energy access and energy independence, most Pacific countries' NDC strive for a substantial increase in renewable energy, in certain cases 100% from renewable energy. Depending on the energy mix, there are some limits to the amount of variable sources of power that can be integrated, in particular intermittent generation without storage. This program would seek concessional funding to support selected countries in the Pacific region to perform the initial pilots for energy storage to support the grid-connected solar with the aim of scaling up access and renewable energy in a sustainable manner.
Expected CTF Financing (million USD)	5
Financial Instrument (grant, loan, guarantee, equity, etc.)	Grant
Expected Leveraging and Co-financing by Source (million USD)	USD 30 million WB
Expected Results	GHG emissions reduction (tons of CO2 eq.; please specify total or annual): GHG emissions reduction from battery storage (estimated by assuming 5MWh battery storage) Annual: -1,165 tCO2 eq/year Total: -23,300 tCO2 eq
	Installed capacity (MWh): 5 MWh
	Other key indicators/targets, as applicable:
Expected Date of Submission to CTF Trust Fund Committee (month and year)	n/a
Expected Date of MDB Board (month and year)	Q2 FY20
Status of Consultation with Recipient Country	The World Bank is currently engaging with the clients in the Pacific region to support the least-cost expansion plan in several countries where the need of storage has been identified. In addition to this, the teams are already working with the client to support the increase of renewable energy through solar PV which would require storage for further solar PV scale up.