SIMULATIONS

What-If SAVi Simulations on a Sustainable Recovery 2020

Why Investing in Solar Photovoltaic Energy Generation Is a Pragmatic Recovery Plan for Rural Communities in Ghana

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The Rationale for the What-If Sustainable Asset Valuation (SAVi) Simulations

Planning a sustainable recovery requires that we look ahead and forecast how spending today will play out in the national and global economy in the years to come. It is also important that the ongoing, unprecedented wave of public spending triggers a sustainable recovery, one that has the environment, climate, and social cohesion at its core. The Sustainable Asset Valuation (SAVi) What-If simulations are designed to inform this debate by helping us understand the economic and societal benefits that can be realized when public spending is targeted at sustainable infrastructure. Simulations are inspired by ongoing recovery plans and are based on authoritative data and real science.

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Section 1. About This What-If Simulation

This simulation estimates the impact of sustainable recovery financing for the installation of solar photovoltaic (PV) energy generation plants in a rural community in Ghana. For this What-If simulation, we draw from preliminary work and simulations undertaken with the Green Climate Fund (GCF). We explored what could happen if the GCF provided financial support to bring down interest rates on loans for solar PV energy generation plants in rural communities.

In this simulation, we look at the benefits of investing in solar PV energy generation. This intervention is assumed to take place on 10,000 acres (4,047 hectares [ha]) and affect 44,000 livelihoods. Reliable and climate-resilient energy generation is essential to successful sustainable community development. The use of solar power leads to more stable and predictable electricity costs in the longer term by reducing reliance on fossil fuels and imported oil which is subject to global market forces. In addition, energy generation is essential for irrigation and for food processing, both of which are closely linked to the livelihoods of farmers in agricultural communities. Investing in solar energy reduces the risk of capacity outages and makes power generation more resilient to climate change impacts. Taken together, these reduce economic risks for farmers in the long run. Table 1 summarizes the assumptions for the scope and capacity of solar PV energy generation plants that are considered in this What-If simulation.

Table 1. Solar PV energy generation

Intervention	Key assumptions	Rationale for investment	GCF sustainable recovery financing
Solar PV energy generation	• Installation of solar PV energy generation assumes that all 44,000 people within the project area consume the average amount of energy demanded per capita in Ghana (351.3 kilowatt hours (kWh)/person/year). • A distinction is not made for the type of solar PV installed. This could either be solar panels for households or a solar farm for the project region. Differences in costs and benefits of the two options are negligible. • A project timeline of 25 years is assumed.	• Energy generation investments are essential for irrigation and for food processing. • Investing in solar energy reduces the risk of capacity outages and makes power generation more resilient to climate change impacts, thereby reducing the economic risks for farmers in the long run. • By reducing the reliance on fossil fuels and oil imported at global prices, using solar power leads to more stable and predictable electricity costs in the longer term.	• Financial support to reduce interest rates on loans in the first five years of project implementation from 25.5% to 8%

However, the persistent challenge in Ghana is the high cost of commercial lending for solar PV—interest rates sit at 25.5%. Given such high interest rates and the additional economic turbulence for rural communities caused by the COVID-19 pandemic, the financial feasibility of solar PV projects and the ability to repay loans suffer. Moreover, the recent drop in fossil fuel prices makes renewable energy less price competitive, at least in the short run.

To enable a sustainable and climate-resilient economic recovery of communities through investment in solar PV installation, public donors and lenders such as the GCF could provide concessional finance or other support measures to improve the financial feasibility of such interventions. This simulation explores "what if" the GCF were to offer recovery support that reduces interest rates from 25.5% to 8% on loan repayments in the first five years of project implementation. This simulation assumes that the GCF seeks to target lending to sectors that bring additionality in terms of financing, climate resilience, greenhouse gas emissions reductions, as well as societal benefits.

Section 2. The SAVi Simulation Results

Overview

This SAVi assessment consists of:

(1) A comparison of the costs and benefits of solar PV energy generation with and without GCF sustainable recovery financing available.

(2) A valuation of avoided carbon emissions (co-benefit), comparing emissions from energy generation through grid-connected thermal generation (diesel) with emissions from solar PV energy generation.

Without GCF sustainable recovery support, loans for solar PV energy generation in Ghana are tied to commercial interest rates of 25.5%. GCF sustainable recovery financing can be provided to lower the interest rate to 8%. We assume that the GCF support covers 30% of required loans to implement the project; the rest of the required loans are assumed to be covered by private sector investors who have been crowded in by the GCF involvement and hence realize the value of the project. Table 2 provides details on assumptions for the two financing scenarios considered in this What-If simulation.

Table 2. Assumptions of the two financing scenarios

Sustainable recovery, high concessional finance from GCF	
Interest rate	8%
Repayment period	10 years
Annual payment amount from borrowers during 10-year repayment period	USD 2,705,000
Commercial lending, no GCF support	
Interest rate	25.5%
Repayment period	10 years[1]
Annual payment amount from borrowers during 10-year repayment period	USD 5,161,000

Table 3 presents an overview of the simulation results for the first five years of project implementation. Table 4 presents results over the entire 25-year project lifetime. The results suggest that solar energy generation is more economically attractive if GCF sustainable recovery financing is available (total costs are lower than the avoided electricity purchase expenditure within five years). The lower capital costs associated with emissions-intensive alternative technologies, such as diesel energy generation, typically make them more economically attractive in the short term. On the other hand, our analysis shows that solar PV is already cost competitive in the short term (with GCF support) and even more over the long term (with and without GCF support). Solar PV also avoids carbon emissions. These are valued as the social cost of carbon (SCC) and further increase the net results of both scenarios if integrated into the cost-benefit analysis (CBA).

Table 3. Overview of SAVi simulation short-term results (USD)

Cumulative result for solar PV after five-year timeline (in USD)		
Cost and benefit positions	**No GCF support (25.5% interest rate)**	**GCF support (8% interest rate)**
(A) Total costs (incl. interest rate costs on loan repayment)	36,188,000	23,909,000
(B) Avoided cost of purchasing electricity from the grid	26,896,000	26,896,000
(C) Avoided SCC	26,412,000	26,412,000
Net societal benefit (B)+(C)-(A)	**23,578,000**	**35,857,000**

[1] GCF lending period can be longer that 10 years.

Table 4. Overview of SAVi simulation long-term results (USD)

Cumulative result for solar PV after 25-year timeline (USD)		
Cost and benefit positions	**No GCF support (25.5% interest rate)**	**GCF support (8% interest rate)**
(A) Total costs (incl. interest rate costs on loan repayment)	58,159,000	33,602,000
(B) Avoided cost of purchasing electricity from the grid	134,478,000	134,478,000
(C) Avoided SCC	132,062,000	132,062,000
Net societal benefit (B)+(C)-(A)	**208,380,000**	**232,937,000**

Table 5 provides an overview of the GCF sustainable recovery financing conditions as well as the cumulative greenhouse gas emissions that would be avoided if solar PV is installed to replace fossil fuel-based alternatives.

Table 5. Lending volume and climate benefits of GCF sustainable recovery financing

Loan total covered by GCF	Climate additionality provided
The capital expenditure for proposed solar PV energy plants with the required capacity of 10.08 megawatts (MW) is **USD 18,149,000**.	If the GCF provides financing for solar PV energy generation, it will replace the need to use fossil fuel alternatives. As a result, **4,260,056 tons of carbon dioxide equivalent (CO_2eq)** emissions will be avoided over the 25-year project timeline.

A Closer Look at the Results Should GCF Support not Be Available

First, in order to generate enough energy for all 44,000 people and supporting businesses in the proposed project area, the simulation estimates that 10.083 MW of solar energy capacity is required. This amounts to USD 18.149 million in capital cost expenditures.

Second, maintaining the solar PV energy generator requires a total of USD 262,157 annually. This amounts to operation and maintenance (O&M) costs of USD 1.092 million in the first five years and USD 6.554 million by the end of the project lifetime.

Third, considering loans are required to implement solar PV energy generation, and assuming commercial interest rates of 25.5% to be repaid over 10 years, a total of USD 33.456 million in interest rate payments will be owed by project owners.

Fourth, generating solar energy in this community will yield savings in terms of avoided cost from purchasing electricity from the grid. These savings will amount to USD 26.896 million in the first five years and 134.478 million over the 25 years.

Finally, solar energy generation avoids emissions that are associated with alternative energy generation technologies. Compared to diesel energy generation, solar PV energy generation avoids 4.26 Mt of CO_2eq emissions over the project lifetime. These emissions reductions are associated with an economic benefit to society measured as the avoided SCC, which is a measure of the loss of human welfare that is caused by emitting one additional ton of CO_2e emissions (Nordhaus, 2017). Considering the avoided 4.26 Mt CO_2eq, the avoided SCC amounts to USD 132.061 million over the 25-year project lifetime.

In the short term, investments in solar PV energy generation cost more due to the high commercial interest rate of 25.5% than the avoided electricity purchase expenditure. However, as shown in Table 7, investments in solar PV energy generation are economically attractive in the long term, with a societal benefit of USD 208.38 million by the end of the 25-year project lifetime.

A Closer Look at the Results Should GCF Support Be Available

If GCF sustainable recovery financing is available to reduce interest rates to 8%, investments in solar PV energy generation become more economically attractive for borrowers in the short term (Table 6) and even more in the long term (Table 7). Societal benefits will amount to USD 232.937 million by the end of the 25-year project lifetime. This is an additional benefit of USD 24.557 million compared to the case when the GCF does not offer support.

Table 6. Overview of SAVi simulation short-term results (USD)

Cumulative result for solar PV after five-year timeline (USD)		
Cost and benefit positions	**No GCF support (25.5% interest rate)**	**GCF support (8% interest rate)**
Total O&M costs	1,092,000	1,092,000
Total capital cost	18,149,000	18,149,000
Total interest payment amount (25.5% interest)	16,728,000	4,449,000
(A) Cumulative costs	**36,188,000**	**23,909,000**
(B) Avoided cost of purchasing electricity from the grid	**26,896,000**	**26,896,000**
(C) Avoided SCC related to diesel energy generation	**26,412,000**	**26,412,000**
Net societal benefit (B)+(C)-(A)	**17,120,000**	**29,398,000**

Table 7. Overview of SAVi simulation long-term results (USD)

Cumulative result for solar PV after 25-year timeline (USD)		
Cost and benefit positions	**No GCF support (25.5% interest rate)**	**GCF support (8% interest rate)**
Total O&M costs	6,554,000	6,554,000
Total capital cost	18,149,000	18,149,000
Total interest payment amount (25.5% interest)	33,456,000	8,899,000
(A) Cumulative costs	**58,159,000**	**33,602,000**
(B) Avoided cost of purchasing electricity from the grid	**134,478,000**	**134,478,000**
(C) Avoided SCC related to diesel energy generation	**132,062,000**	**132,062,000**
Net societal benefit (B)+(C)-(A)	**208,380,000**	**232,937,000**

Section 3. Using the Results of This Simulation

This SAVi What-If simulation analyzed the costs and benefits of community-based solar PV energy generation under different financing scenarios. A purely commercial lending scenario was compared to a scenario where the GCF would provide sustainable recovery financing. The simulation results demonstrate that investing in solar PV to replace electricity generation from fossil fuel alternatives is only cost competitive in the short-term (five-year time horizon) if sustainable recovery support is provided by the GCF to reduce interest rates for loans. Commercial lending rates for energy projects in Ghana would not make this investment appear attractive for project owners over a five-year time horizon. In the long term, however, investing in solar PV pays off irrespective of whether or not GCF provides financial support.

Considering that rural communities face intensified economic challenges in the aftermath of the COVID-19 pandemic, it is crucial to make investment decisions for community members also attractive over shorter time horizons—especially if the investments would contribute to sustainable community development. Investing in solar PV to replace electricity consumption based on fossil fuel alternatives also reduces the carbon footprint of rural communities. The positive net results when incorporating the avoided SCC into the analysis, as done in this What-If simulation, make this intervention indeed a pragmatic sustainable recovery investment. Therefore, to realize community investments into solar PV at this point in time, it is reasonable for public donors and funders such as the GCF to provide sustainable recovery support.

Section 4: Design of the Simulation

Table 8. Simulation details

Indicator	Explanation
Cumulative amount spent on O&M costs	Considering an estimated USD 26/kW/year in O&M costs, the estimated 10,082.97 kW in required capacity would lead to an annual USD 262,000 spent on O&M. These costs would continue to accrue over the lifetime of the generator, leading to USD 6,554,000 spent on O&M by the end of the generator's lifetime.
Cumulative amount spent on loan repayment (25.5% interest)	Power consumption was estimated at 351.3 kWh/person/year (International Energy Agency [IEA], 2014). Given the 44,000 people affected, this gives a total of 15,457,200 kWh demanded annually, or 386,430,000 kWh demanded over the 25 years of the investment lifetime. Assuming a 17.5% generation capacity, the power generation capacity required for the solar power intervention is estimated at 10,082.97 kW. Assuming a capital investment costs of USD 1,800 per kW, and considering this project would require 10,082.97 kW of capacity, the capital investment required would be USD 18,149,354.21. When considering a 25.5% interest rate and a 10-year loan repayment period, annual payments of USD 5,161,000 would be required from borrowers to cover the principle and the interest payments. This would amount to USD 51,605,000 spent by borrowers to cover capital costs and interest on loan repayments by the end of the loan repayment period.
Cumulative amount spent on loan repayment (8% interest)	When considering an 8% interest rate and a 10-year loan repayment period for the same investment volume to establish the 10,082.97 kW solar power generation capacity, annual payments of USD 2,705,000 would be required from borrowers to cover the principle and the interest payments. This would amount to USD 27,048,000 spent by borrowers to cover capital costs and interest on loan repayments by the end of the loan repayment period.
Cumulative benefits to borrowers from avoiding purchasing electricity from the grid	Assuming a market price for solar power of USD 0.35/kWh, and assuming 386,430,000 kWh is demanded over the 25 years, total revenues in terms of avoiding the purchase of grid power over the lifetime of this intervention would amount to USD 134,477,541.9.
Cumulative avoided SCC	This simulation estimates that solar power energy generation avoids 16.9 ton/kW of CO_2 emissions. This would mean a lifetime total of 4,260,056.751 tons of CO_2 emissions avoided if solar power were implemented opposed to purchasing electricity from the grid. Following Nordhaus (2017), we use an estimate USD 31/ton of CO_2 emitted for the SCC. Using the estimated 4,260,056.751 tons of CO_2 emissions avoided from biogas energy generation, USD 132,061,759.3 in SCC can be avoided over the 25-year lifetime of the investment.

References

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International Energy Agency (IEA). (2014). *Electric power consumption (kWh per capita)-Ghana*. https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC?locations=GH

About SAVi

The SAVi is a simulation service that helps governments and investors value the many risks and externalities that affect the performance of infrastructure projects. It integrates best-in-class climate data from the EU Copernicus Climate Data Store.

The distinctive features of SAVi are:

- Valuation: SAVi values, in financial terms, the material environmental, social, and economic risks and externalities of infrastructure projects. These variables are ignored in traditional financial analyses.
- Simulation: SAVi combines the results of systems thinking and system dynamics simulation with project finance modelling. We engage with asset owners to identify the risks material to their infrastructure projects and then design appropriate simulation scenarios.
- Customization: SAVi is customized to individual infrastructure projects.

Check out the SAVi track record, on-line demo, and academy at www.iisd.org/savi.

For more information visit our website: iisd.org/sustainable-recovery