Toolkit 3: Financial Model Tool User Guide
Vietnam Apparel Sector Rooftop Solar

Version 2.0, April 2022

1. Introduction

The Financial Model Tool provides users with a preliminary financial analysis of a potential rooftop solar photovoltaic (PV) system based on the site's characteristics, as entered by the user. The tool is meant to be simple and user-friendly. It seeks to provide a basic financial analysis of three different financial structures commonly utilized to procure rooftop PV. As such, this tool only conducts its analysis for electricity consumption at the annual level (rather than the monthly, daily, or hourly levels).

Therefore, this tool should only be used in the project validation stage to broadly approximate how financially feasible a rooftop PV project may be. If the tool indicates installing a PV system could be cost-effective, the user is encouraged to continue exploring PV procurement, by consulting with a PV expert to give a more refined understanding of such a system's cost-effectiveness.

Users can view the Financial Model as a simple tool for executing the financial analysis portion of the Pre-Feasibility Study described in Toolkit 2.

2. Description of the Financial Model Tool

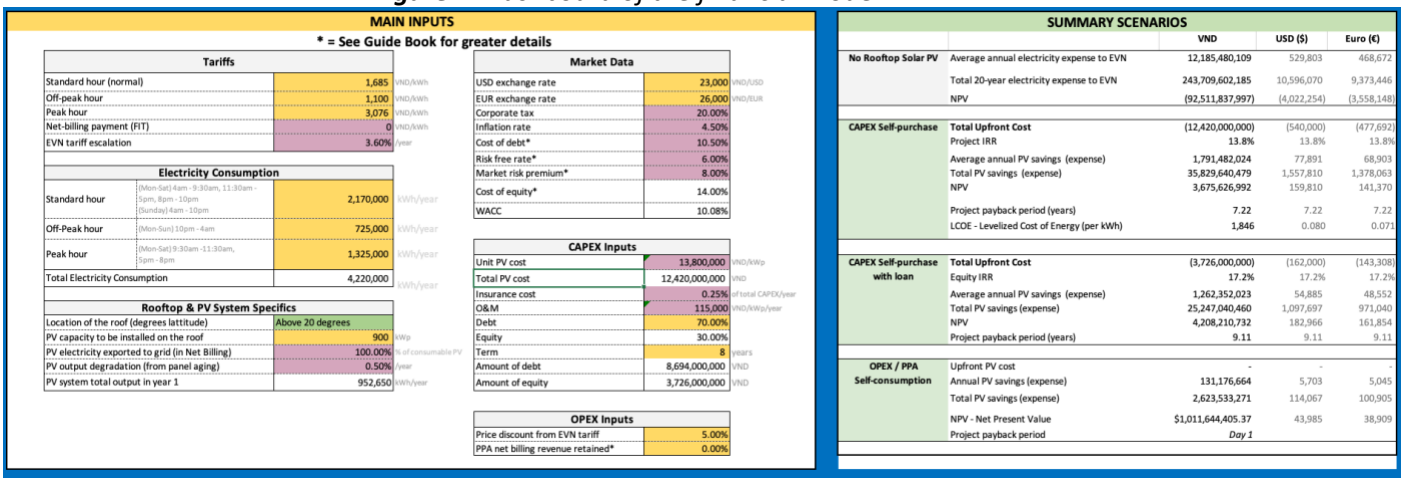
The model tool includes three worksheets within the Excel file:

1. Summary Dashboard – main worksheet where users provide inputs and see the output results
2. Financing Worksheet – where users view the details of the tool's calculations
3. Sensitivity Analysis – quickly shows impacts on key outputs of changing specific inputs

2.1. Main Inputs Dashboard

The *Summary Dashboard* on Tab 2. consists of two main parts: Summary Results and Main Inputs (**Figure 1**). A color-coding system is used to indicate different types of cells (**Figure 2**). The rest Section 2.1 will focus on the main inputs dashboard while Section 3.3 will focus on the Summary Results

***Figure 1**. Dashboard of the financial model*



MAIN INPUTS

* = See Guide Book for greater details

Tariffs		
Standard hour (normal)	1,685	VND/kWh
Off-peak hour	1,100	VND/kWh
Peak hour	3,076	VND/kWh
Net-billing payment (FIT)	0	VND/kWh
EVN tariff escalation	3.60%	/year

Electricity Consumption			
Standard hour	(Mon-Sat) 4am - 9:30am, 11:30am - 5pm, 8pm - 10pm (Sunday) 4am - 10pm	2,170,000	kWh/year
Off-Peak hour	(Mon-Sun) 10pm - 4am	725,000	kWh/year
Peak hour	(Mon-Sat) 9:30am -11:30am, 5pm - 8pm	1,325,000	kWh/year
Total Electricity Consumption		4,220,000	kWh/year

Rooftop & PV System Specifics	
Location of the roof (degrees lattitude)	Above 20 degrees
PV capacity to be installed on the roof	900 kWp
PV electricity exported to grid (in Net Billing)	100.00% % of consumable PV
PV output degradation (from panel aging)	0.50% /year
PV system total output in year 1	952,650 kWh/year

Market Data		
USD exchange rate	23,000	VND/USD
EUR exchange rate	26,000	VND/EUR
Corporate tax	20.00%	
Inflation rate	4.50%	
Cost of debt*	10.50%	
Risk free rate*	6.00%	
Market risk premium*	8.00%	
Cost of equity*	14.00%	
WACC	10.08%	

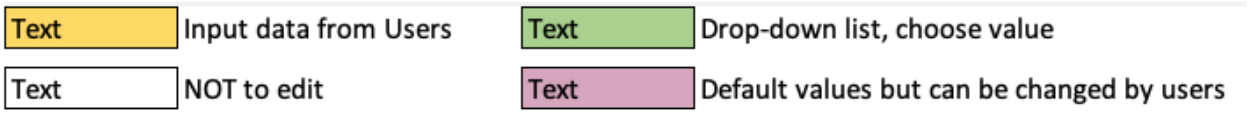
CAPEX Inputs		
Unit PV cost	13,800,000	VND/kWp
Total PV cost	12,420,000,000	VND
Insurance cost	0.25%	of total CAPEX/year
O&M	115,000	VND/kWp/year
Debt	70.00%	
Equity	30.00%	
Term	8	years
Amount of debt	8,694,000,000	VND
Amount of equity	3,726,000,000	VND

OPEX Inputs	
Price discount from EVN tariff	5.00%
PPA net billing revenue retained*	0.00%

SUMMARY SCENARIOS

		VND	USD ($)	Euro (€)
No Rooftop Solar PV	Average annual electricity expense to EVN	12,185,480,109	529,803	468,672
	Total 20-year electricity expense to EVN	243,709,602,185	10,596,070	9,373,446
	NPV	(92,511,837,997)	(4,022,254)	(3,558,148)
CAPEX Self-purchase	Total Upfront Cost	(12,420,000,000)	(540,000)	(477,692)
	Project IRR	13.8%	13.8%	13.8%
	Average annual PV savings (expense)	1,791,482,024	77,891	68,903
	Total PV savings (expense)	35,829,640,479	1,557,810	1,378,063
	NPV	3,675,626,992	159,810	141,370
	Project payback period (years)	7.22	7.22	7.22
	LCOE - Levelized Cost of Energy (per kWh)	1,846	0.080	0.071
CAPEX Self-purchase with loan	Total Upfront Cost	(3,726,000,000)	(162,000)	(143,308)
	Equity IRR	17.2%	17.2%	17.2%
	Average annual PV savings (expense)	1,262,352,023	54,885	48,552
	Total PV savings (expense)	25,247,040,460	1,097,697	971,040
	NPV	4,208,210,732	182,966	161,854
	Project payback period (years)	9.11	9.11	9.11
OPEX / PPA Self-consumption	Upfront PV cost	-	-	-
	Annual PV savings (expense)	131,176,664	5,703	5,045
	Total PV savings (expense)	2,623,533,271	114,067	100,905
	NPV - Net Present Value	$1,011,644,405.37	43,985	38,909
	Project payback period	*Day 1*		

***Figure 2**. Color-coding scheme of the Dashboard*



The Summary Dashboard is the main worksheet where users provide inputs and are able to see the output results. The Summary Dashboard worksheet also contains a number of input parameters that are particularly applicable to the Vietnam context. The Financing worksheet is where users can view the execution of the tool itself but is not meant to be edited. Finally, the Sensitivity Analysis worksheet enables user to quickly see the effect of changing specific inputs on key outputs.

The tool is designed to analyse two common financial models for Commercial and Industrial (C&I) rooftop solar in Vietnam, that are described in greater detail near the end of the document:

1. Capital Expenditure (CAPEX or "Self-Purchase" or "turnkey purchase"): This option is for users who procure the PV system themselves through a self-purchase or a loan. In a CAPEX procurement, the facility owner/electricity consumer owns both the PV system and the electricity it generates.
2. Operational Expenditure (OPEX): Under this option, the PV system is financed by third-party (i.e., not the facility owner/electricity consumer) and incorporates a Power Purchase Agreement (PPAs), it also is referred to as a "third-party PPA." Under the OPEX model, the third-party retains ownership of the PV system and the facility owner/electricity consumer purchases the generated PV electricity by the kWh from the third-party, under the PPA. This tool estimates for a project lifetime and a contract length of 20 years.

To run the model on the *Summary Dashboard*, requires five sets of data to be entered, each is described in greater detail following the list below.

1. Time-of-Use Tariff
2. Electricity Consumption
3. Rooftop specifics
4. Project upfront costs
5. Finance

2.1.1. Tariffs

- The ***Time-of-Use Tariff*** is EVN's electricity price that is applied for different periods of time throughout a day including: *standard hour*; *peak hour*; and o*ff-peak hour.* The electricity price (in the unit "VND per kWh") is applied to electricity users at commercial (businesses) and industrial (manufacturing) facilities and is regulated by the Government of Vietnam and updated on the EVN website. Rates depend on the customer category, facility voltage range, and time-of-use, and users should use the website to find the rates for the specific customer class their site falls under. Users that purchase their electricity from other providers, such as an independent power producer or landlord, may have other unique tariff structures that can be adjusted by the user.
- The *net-billing payment (*VND/kWh) is the Feed-in-Tariff (FIT), which is the price that is defined by the Government of Vietnam policy. The current fixed FIT expired on December 31, 2020, so it is set at 0.
- The *EVN tariff escalation (%):* The tariff escalation per year can be adjusted based on the assumptions and the future projections of electricity prices in Vietnam. Historically, it has ranged from 2% to 8% per year.

***Table 1**. Tariff Input Table*

Tariff	
Standard hour (normal)	
Off-peak hour	
Peak hour	
Net-billing payment (FIT)	
EVN tariff escalation	

2.1.2. Electricity Consumption

The data input for electricity consumption is the total amount of electricity consumed **in a complete one year.** The data can be gathered from accounting records and/or electricity bills provided by EVN, which lists electricity consumption and costs in each of time-of-use period (s*tandard hour, off-peak hour, and peak hour).* If the facility has only one fixed tariff during the day, it is considered the standard hour.

The regulated duration for the time-of-use is provided on EVN website and below in Table 2.

***Table 2**. Electricity consumption Input Table*

Electricity consumption		
Standard hour	(Mon-Sat) 4am - 9.30am 11.30am - 5pm, 8pm - 10pm (Sunday) 4am - 10pm	
Off-Peak hour	(Mon-Sun) 10pm - 4am	
Peak hour	(Mon-Sat) 9.30am - 11.30am, 5pm - 8pm	
Total Electricity consumption		

2.1.3. Rooftop & PV System Specifics

The data input and results from this section show the potential installed capacity of the PV system on your rooftop.

- *Major City Nearest to Location of the roof (° lattitude)*: where the facility is located. For simplification purposes, the location is chosen from the dropdown list based on the city closest to the user's site (Hanoi, Da Nang, or Ho Chi Minh City).
- *PV installed capacity on the roof (kWp):* This is the estimation of the maximum PV system capacity that could be installed on the rooftop. It depends on the availability of the roof space, while assuming that the shading and other blocking objects (such as trees and buildings) are already taken into account or removed. A rule of thumb is 1kWp of PV system would need 8 square meters of roof space. System sizes are limited to 1MW or 1.25MWp per connection to the EVN grid.
- *Solar electricity consumed on-site (%):* This is how much solar electricity produced from the PV system could be consumed directly on-site by the facilities. The amount depends on the electricity demand of your facility and the size of the PV system; it could be varied from 0-100%.
- *PV output degradation (%):* This shows the annual decline rate of electricity production generated from PV panels. The default estimation is drawn from common PV panel products available in the marketplace.
- *PV system output (kWh/year):* The output is measured by the total amount of solar electricity produced by the PV system on Year 1. And it is based on the estimation of solar irradiation in the location selected.

***Table 3**. Rooftop specifics & PV system specifics Input Table*

Rooftop specifics & PV system specifics	
Major City Nearest to Location of the roof (° lattitude)	
PV Installed capacity on the roof	
Solar electricity consumed On-Site	
PV output degradation	
PV system output	

2.1.4. Market Data

- *Corporate Tax (%)*: The tax that is applied for corporate business in Vietnam
- *Inflation Rate (%)*: This is the annual inflation rate of VND
- *Cost of Debt (%)*: The ratio of debt to return before tax. In this model, it is assumed Cost of Debt is equal to the Interest rate
- *Risk free rate (%)*: The rate of return on a zero-risk investment, used for calculating discount rates, assumed to be 6% in this model
- *Market risk premium (%)*: The difference between the expected return of an average investment in a market and the risk-free rate, used for calculating discount rates, assumed to be 8%
- *Cost of Equity (%)*: In this model, Cost of Equity is equal to Risk free rate + Market risk premium, which is understood as the average return on investment in the market.
- *WACC:* Weighted Average Cost of Capital

***Table 4**. Market Data Input Table*

Market Data	
USD exchange rate	
EUR exchange rate	
Corporate tax	
Inflation rate	
Cost of debt	
Risk free rate	
Market risk premium	
Cost of equity	
WACC	

2.1.5. CAPEX Inputs

- *Unit PV cost (VND/kWp):* The upfront investment cost for 1kWp of the PV system. The Unit CAPEX includes the cost of PV panels, inverter, civil balance of plant, electrical balance of plant, grid connection, development costs, and other costs. There is a default value in the tool, but users can go to this link for updated values if necessary.
- *Total PV cost (VND)*: This is the total investment cost of the PV system. It is equal to Unit CAPEX multiplied by PV system size (kWp).
- *Insurance cost:* This cost may vary according to project and vendor; in Vietnam the market cost could range from 0.20-0.25% of total CAPEX.
- *O&M (VND/kWp):* Cost of Operation and Maintenance. This costs also vary depends on the solar developer, it could be from 92,000 VND to 230,000 VND per kWp, depending on the type of services.

- *Debt (%):* The ratio of debt over the total CAPEX. This is varied depending on the borrower of each project.
- *Equity (%):* The ratio of return to the investor over the total CAPEX
- *Term (years):* Term of the loan in years; it could be varied based on the type of loan
- *Amount of Debt (VND):* The amount of debt over the total CAPEX, which is equal to debt (%) multiplied by total CAPEX (VND)
- *Amount of Equity (VND):* The amount of equity return to the investor over the total CAPEX, which is equal to equity (%) multiplied by total CAPEX (VND)

***Table 5**. CAPEX Inputs Table*

CAPEX Inputs	
Unit PV cost	
Total PV cost	
Insurance cost	
O&M	
Debt	
Equity	
Term	
Amount of debt	
Amount of equity	

2.1.6. OPEX Inputs

- *Price discount from EVN tariff:* C&I energy users are receiving long-term solar contracts of 15-25 years, that provide a rate which is discounted from the existing EVN rates. In Vietnam, the discounts could range from 3-20%.
- *Net billing revenue retained:* The percent of the revenue retained by the electricity buyer for sale of excess electricity as stipulated under the contract with the project developer.

***Table 6**. OPEX Inputs Table*

OPEX Inputs	
Price discount from EVN tariff	
PPA net billing revenue retained	

3. How to use the model: Step-by-step guide

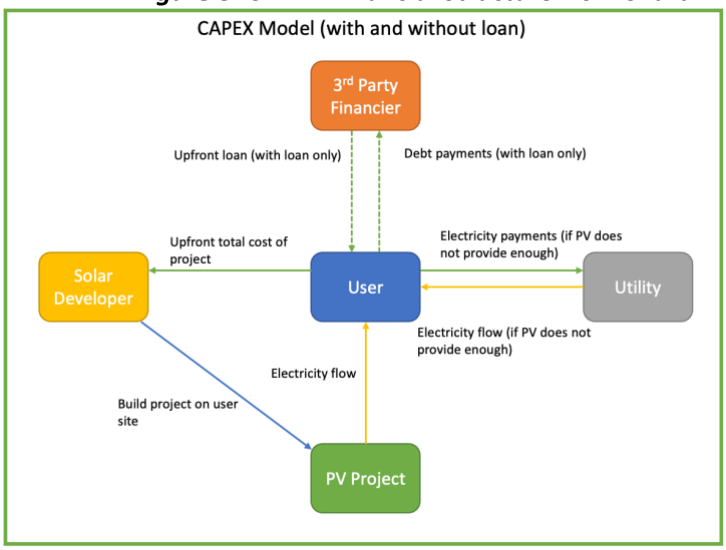
3.1. Step 1: Identify financing model: OPEX vs. CAPEX

The model is designed to identify two financial models for rooftop solar: CAPEX and OPEX.

3.1.1. CAPEX - Capital Expenditure or Self-Purchase

This option, also referred to as a "turnkey purchase," is for users who procure the solar system through a self-purchase or a loan. Utilizing this option will require that the facility owner either has sufficient capital on hand or their willingness/ability to take on debt. Either way, the site owner will own the project and all its generated power.

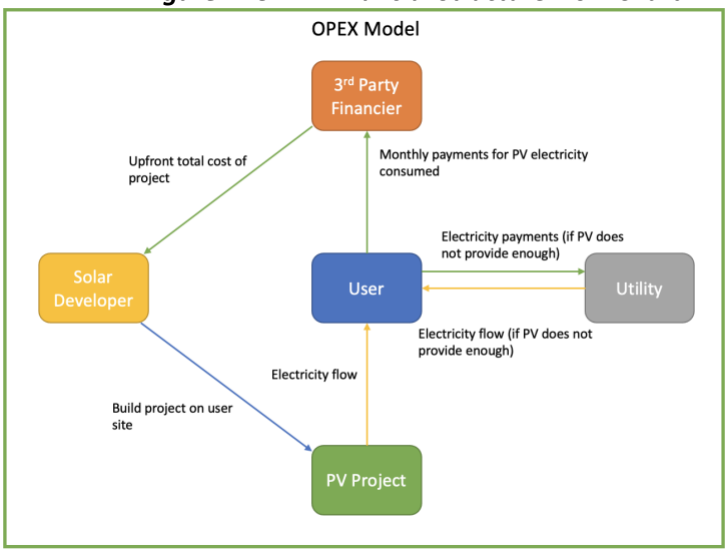
***Figure 3**. CAPEX Financial Structure Flow Chart*



3.1.2. OPEX - Operational Expenditure

The option models third-party financed projects with Power Purchase Agreements (PPAs), also referred to as a "third-party PPA," where the user can both consume solar electricity and export the excess to the grid. This tool estimates for a project lifetime and a contract length of 20 years. This option does not require capital commitments or debt appetite like the CAPEX model does, but it does preclude site ownership of the project for the life of the project.

***Figure 4**. OPEX Financial Structure Flow Chart*



The results on the **Summary Scenarios Dashboard** will show the basic financial results of each model.

3.2. Step 2: Input data:

Details of the data input are explained in Section 2. **Description of the Financial Model Tool.**

3.3. Step 3: Check Results

The results are shown in the Figure 5. Summary Scenarios Dashboard and three charts (in section 3.3.5),

all described below.

***Figure 5**. Summary Scenarios Dashboard*

SUMMARY SCENARIOS				
		VND	USD ($)	Euro (€)
No Rooftop Solar PV	Average annual electricity expense to EVN	12,185,480,109	529,803	468,672
	Total 20-year electricity expense to EVN	243,709,602,185	10,596,070	9,373,446
	NPV	(92,511,837,997)	(4,022,254)	(3,558,148)
CAPEX Self-purchase	Total Upfront Cost	(12,420,000,000)	(540,000)	(477,692)
	Project IRR	13.8%	13.8%	13.8%
	Average annual PV savings (expense)	1,791,482,024	77,891	68,903
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	Project payback period (years)	7.22	7.22	7.22
	LCOE - Levelized Cost of Energy (per kWh)	1,846	0.080	0.071
CAPEX Self-purchase with loan	Total Upfront Cost	(3,726,000,000)	(162,000)	(143,308)
	Equity IRR	17.2%	17.2%	17.2%
	Average annual PV savings (expense)	1,262,352,023	54,885	48,552
	Total PV savings (expense)	25,247,040,460	1,097,697	971,040
	NPV	4,208,210,732	182,966	161,854
	Project payback period (years)	9.11	9.11	9.11
OPEX / PPA Self-consumption	Upfront PV cost	-	-	-
	Annual PV savings (expense)	131,176,664	5,703	5,045
	Total PV savings (expense)	2,623,533,271	114,067	100,905
	NPV - Net Present Value	$1,011,644,405.37	43,985	38,909
	Project payback period	*Day 1*		

This dashboard shows key outputs from the model in three currencies (VND, USD, and Euro). The individual outputs are described below:

3.3.1. No Rooftop Solar PV

- *Average annual electricity expense to EVN:* Average annual payments to EVN for electricity over 20 years
- *Total 20-year electricity expense to EVN:* Total payments to EVN for electricity over 20 years
- *Net Present Value (NPV):* Present value of electricity costs over 20 years with no solar rooftop PV

3.3.2. CAPEX Self-purchase

- *Total Upfront Cost:* Upfront investment cost of PV (materials, installation, interconnection)
- *Project IRR:* Internal rate of return on project investment
- *Average annual PV savings (expense):* Average savings per year on electricity costs over 20 years relative to the no rooftop solar PV case
- *Total PV savings:* Total savings on electricity costs over 20 years relative to the no rooftop solar PV case
- *NPV:* Present value of all cash flows in and out of the project. In this case, cash flows in are represented by the electricity savings from the PV system, and cash flows out are represented by the PV system costs. **If this value is positive, then the project is profitable (leads to net savings), and when picking between options with different positive NPVs, users should choose the option with the highest NPV.**
- *Project payback period (years):* Time in years for solar project to pay off costs
- *LCOE – Levelized Cost of Energy (per kWh):* Cost of solar project per kWh of electricity generated. Calculated by dividing present value of costs by present value of electricity generated

3.3.3. CAPEX Self-purchase with loan

- *Total Upfront Cost:* Upfront investment cost of PV (materials, installation, interconnection)
- *Equity IRR:* Internal rate of return on equity portion of project investment
- *Average annual PV savings (expense):* Average savings per year on electricity costs over 20 years relative to the no rooftop solar PV case
- *Total PV savings:* Total savings on electricity costs over 20 years relative to the no rooftop solar PV case
- *NPV:* Present value of all cash flows in and out of the project. In this case, cash flows in are represented by the electricity savings from the PV system, and cash flows out are represented by the PV system costs. **If this value is positive, then the project is profitable (leads to net savings), and when picking between options with different positive NPVs, users should choose the option with the highest NPV.**
- *Project payback period (years):* Time in years for solar project to pay off costs

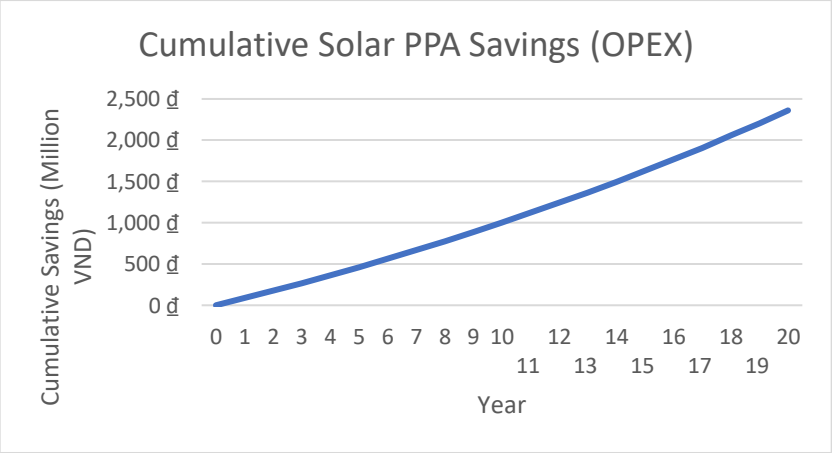
3.3.4. OPEX/PPA Self-consumption

- *Upfront PV Cost:* Upfront investment cost of PV (materials, installation, interconnection). This value will be zero for the OPEX financing structure because a third party finances the project
- *Average annual PV savings (expense):* Average savings per year on electricity costs over 20 years relative to no rooftop solar PV case
- *Total PV savings:* Total savings on electricity costs over 20 years relative to no rooftop solar PV case
- *NPV:* Present value of all cash flows in and out of the project. In this case, cash flows in are represented by the electricity savings from the PV system, and cash flows out are represented by the PV system costs. **If this value is positive, then the project is profitable (leads to net savings), and when picking between options with different positive NPVs, users should choose the option with the highest NPV.**
- *Project payback period (years):* Time in years for solar project to pay off costs. This value will be zero for the OPEX financing structure because a third party finances the project and thus bears the upfront costs, so for the user, the project is "paid back" on Day 1.

3.3.5. Charts

The Summary Dashboard also includes three charts to better visualize the results of the tool.

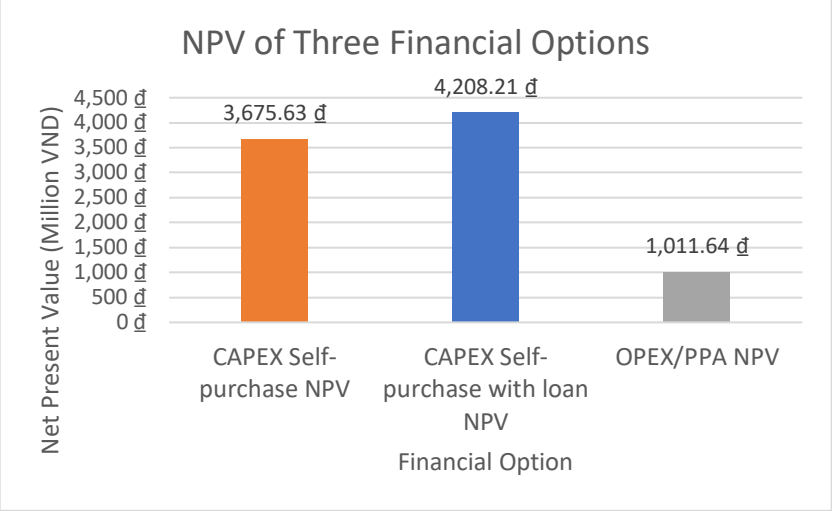
***Figure 6**. Cumulative Solar PPA Savings*



The cumulative Solar PPA Savings chart (Figure 6) shows the cumulative savings a PV system will bring

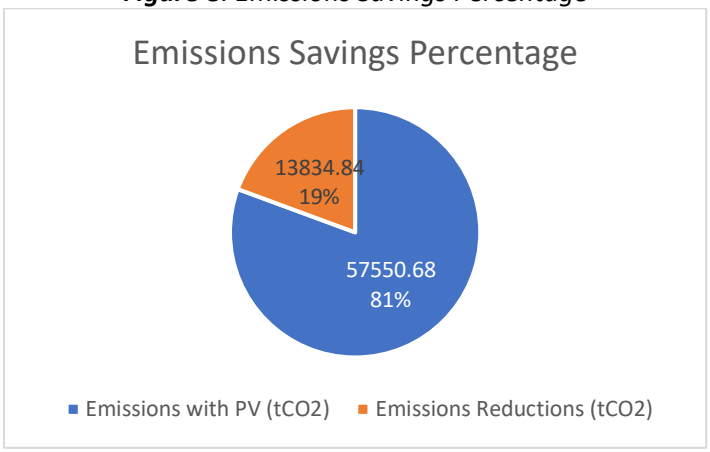
(in VND) over 20 years in the OPEX model.

***Figure 7**. NPV of Three Financial Options*



The NPV of Three Financial Options chart (Figure 7) shows the NPVs of the three different financial structure options next to each other. The option with the highest NPV (assuming its positive) would be most cost-effective for the user's site.

***Figure 8**. Emissions Savings Percentage*



Finally, the Emissions Savings Percentage chart (Figure 8) shows the emissions reductions (in orange) the user would achieve with the PV system. The blue portion of the chart is the remaining emissions even with the PV system (because the PV system doesn't meet all electricity consumption needs in this case).

3.4. Step 4: Sensitivity Analysis

The "Sensitivity Analysis" Tab enables users to adjust certain inputs and see how such adjustments change specific outputs.

3.4.1. Adjusting Inputs

***Figure 9**. Sensitivity Analysis Switches*

Key Paramater	Variable
WACC (Discount Rate)	Keep Original WACC rate
Unit PV Cost (CAPEX)	Keep Original PV Unit Cost
Tariff Rates	Keep Original Tariff Rates
Price Discount from EVN Tariff (OPEX)	Keep Original savings % off EVN Tariff Rates

Users can adjust four inputs (or switches) in this page of the tool: WACC, Unit PV Cost (CAPEX), Tariff Rates (all three, standard, peak, and off-peak all at once), and the Price Discount from EVN Tariff (OPEX) by using the dropdown menus under the "Variable" column shown in Figure 9. The dropdown menus include choices to either increase or decrease the input by 10%.

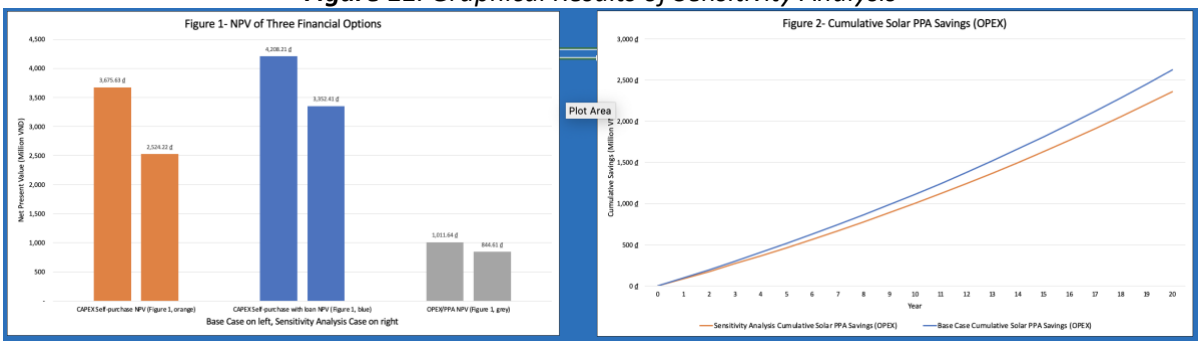
3.4.2. Interpreting Outputs

***Figure 10**. Tabular Results of Sensitivity Analysis*

BASE CASE (Left bars of Figure 1, blue on Figure 2, does not change)			
Net Present Value (NPV)	**VND**	**USD ($)**	**Euro (€)**
CAPEX Self-purchase NPV (Figure 1, orange)	3,675,626,992	159,810	141,370
CAPEX Self-purchase with loan NPV (Figure 1, blue)	4,208,210,732	182,966	161,854
OPEX/PPA NPV (Figure 1, grey)	1,011,644,405	43,985	38,909
OPEX/PPA Total PV Savings (Figure 2, blue)	2,623,533,271	114,067	100,905

SENSITIVITY ANALYSIS CASE (Right bars of Figure 1, orange on Figure 2, changes with "Variable" column)			
Net Present Value (NPV)	**VND**	**USD ($)**	**Euro (€)**
CAPEX Self-purchase NPV (Figure 1, orange)	2,524,219,094	109,749	97,085
CAPEX Self-purchase with loan NPV (Figure 1, blue)	3,352,411,141	145,757	128,939
OPEX/PPA NPV (Figure 1, grey)	844,611,539	36,722	32,485
OPEX/PPA Total PV Savings (Figure 2, orange)	2,361,179,944	102,660	90,815

***Figure 11**. Graphical Results of Sensitivity Analysis*



Once users adjust the inputs as described above, they can compare the base case to the sensitivity analysis case in both tabular (Figure 10) and graphical (Figure 11) form automatically. In both cases, the key output metrics are NPV for all three financial structures cumulative savings from PV in the OPEX financial structure. In tabular form, the base case table (left) always stays the same while the sensitivity analysis case table (right) changes based on the input adjustments. In graphical form for the cumulative PV savings in OPEX (left), the orange line represents the sensitivity analysis case while the blue line represents the base case. For the NPV of all three financial structure graph (right), the left bar for each financial structure represents the base case while the right bar represents the sensitivity analysis case.