Renewable Energy Tariff and Financial Analysis Tool

User Guide

Prayas Energy Group, Pune

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Introduction

Electricity Regulatory Commissions in India determine feed-in-tariffs for different renewable energy technologies. This Excel-based tool provides a convenient way to perform tariff calculations based on *Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012*. These guidelines are hereafter referred to as CERC Guidelines.

The tool takes user input on up to 43 variables that are used to determine the tariff and internal rate of return (IRR) for a particular technology. The tool also allows for sensitivity analysis in which the user can vary a few select inputs and observe graphically how the variation affects the tariff. Default values are provided based on the technology. More information about the default values is provided later in this guide.

In addition to tariff determination, sensitivity analysis can also be performed on a subset of the inputs – capital cost, capacity utilization factor, interest rate, discount rate, rate of return on equity and fuel costs.

The renewable technologies presently supported are Solar Photovoltaic and Solar Thermal, Wind, Small Hydro, Biogas, Bagasse Cogeneration, Biomass Gasifier and Biomass Rankine Cycle.

The tool runs in Microsoft Excel with a combination of Excel formulas and Visual Basic for Applications (VBA) code.

Revisions

Version	Date	Comments
1.0	April 30, 2012	Initial version. • Supports Solar PV/Thermal, Wind, Biogas, Bagasse Co-generation, Biomass Gasifier and Biomass Ranking Cycle Projects. Bagasse Co-generation option can be used for all non-fossil fuel co-generation projects. • Incorporates basic sensitivity analysis to study affect of changes in the inputs – capital expenditure, O&M expenses, capacity utilization, interest rate, discount rate, return on equity and fuel – on tariff.

Intended audience

The tool can be used by anyone who wishes to study the financial aspects of a renewable energy project including but not limited to civil society groups, regulators, project developers, financiers and policy analysts. Some knowledge of renewable energy and financial terminology is useful to make best use of the tool. This guide and the tool referred to are written with the expectation that the users of this tool are familiar with basic use of Microsoft Excel.

Disclaimer

While every effort has been made to make the tool user friendly, error-free and accurate, it is possible that it can be improved further. We are open to suggestions and constructive feedback on improving the tool.

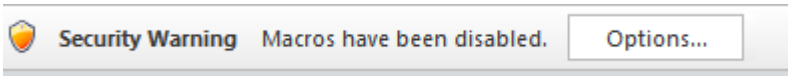
The tariff tool is provided on as 'as-is where-is' basis and only as a guide. Appropriate professional help should be sought before any commercial decisions are made. PRAYAS accepts no liability from the use of the results from this tool.

System Requirements

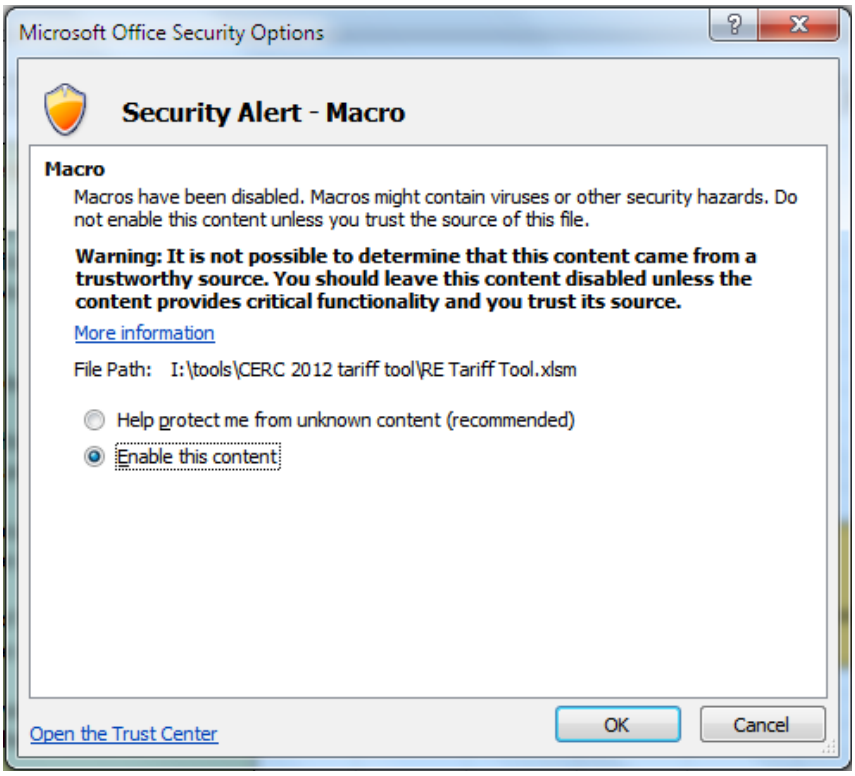
1. Machine: At least 512 MB RAM, 600MHz CPU
2. Operating System: Windows XP and above
3. The tool works best with Microsoft Office 2007 and above. It works with Microsoft Office 2003 as well with the exception of some minor features such as tab navigation. Unfortunately, the tool does not work with LibreOffice or OpenOffice. This is because the front-end of the tool is written in Visual Basic for Applications (VBA), the implementation of which is incompatible with open source office tools.
4. The font Calibri is used through the Excel workbook, hence viewing is optimal if the font is supported.

Instructions

1. Excel Security Options need to be verified on the machine on which the tool is run. Depending on the security options, macros may need to be enabled. If macros are disabled by default, when the workbook is opened, a security warning may show up in the following two ways:
   i. A security warning shows up in the toolbar at the top of the spreadsheet that looks like the following:

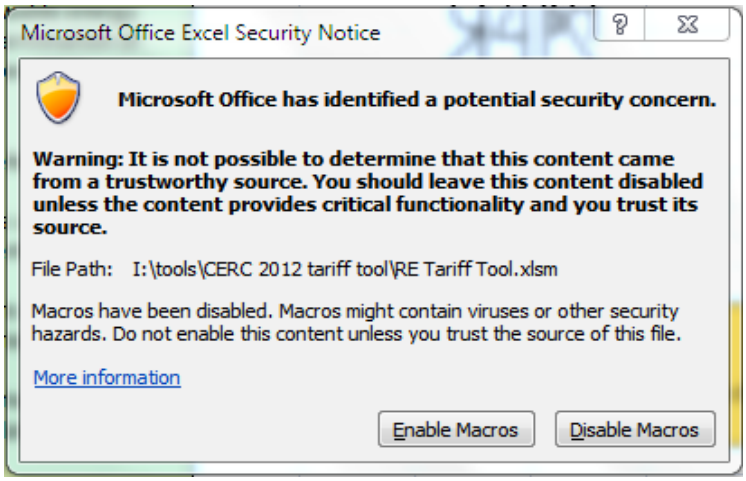


When the button titled "Options..." is clicked, the following dialog box appears:



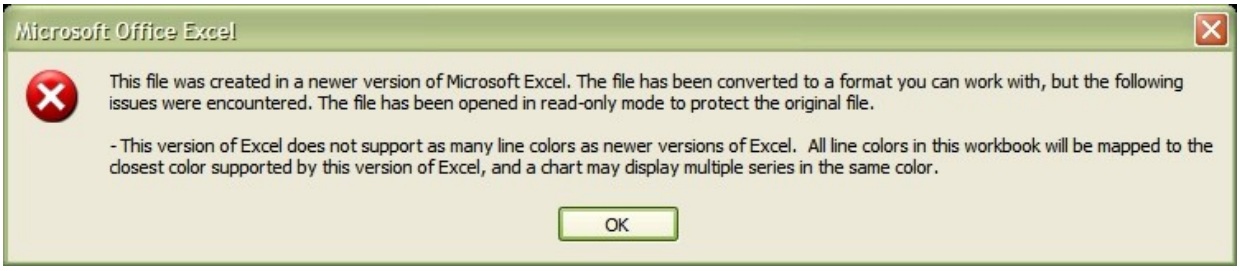
The "Enable this content" radio box needs to be checked and the "OK" button clicked in order for the tool to run.

   ii. Alternatively, the following popup may show up. The "Enable Macros" button needs to be clicked for the tool to run.

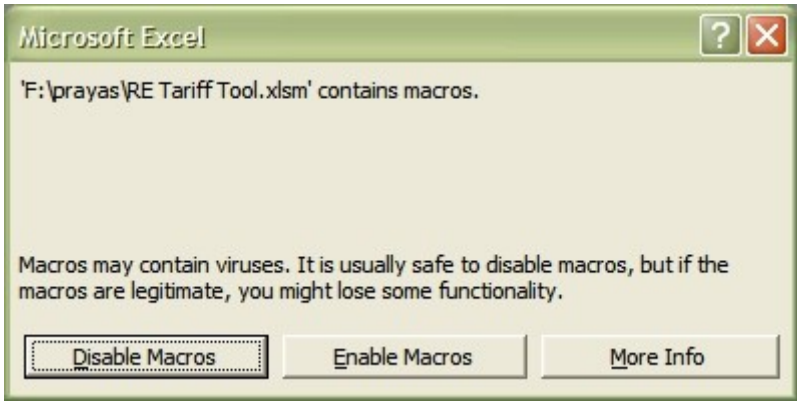


Note: this version of the popup has been observed only in some instances.

iii. When opening the spreadsheet in Office 2003 running with the Microsoft Office Compatibility Pack, the popup appears as below.



When "OK" button is clicked in the above dialog box, the following popup appears. "Enable Macros" button needs to be clicked.

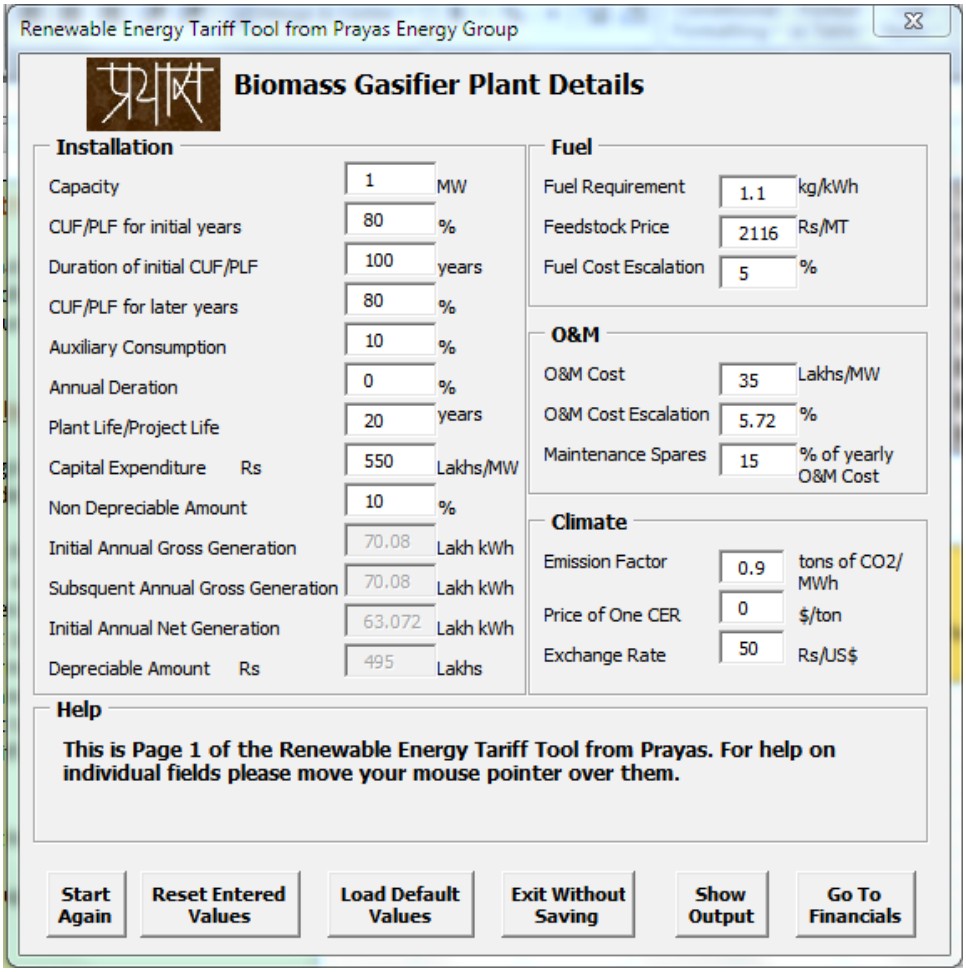


2. After enabling macros at startup, the user is taken to the Introduction sheet. It is recommended that the instructions on this page are read before the tool is used for the first time. After reading the instructions, the "Run Tariff Tool" button on the Introduction sheet can be clicked to run the tariff tool.

3. When the "Run Tariff Tool" button is pressed, the following form pops up:

Select the appropriate technology from the drop down menu and click on "Plant Details" button.

4. When the "Plant Details" button is clicked on the first form, the following form pops up:



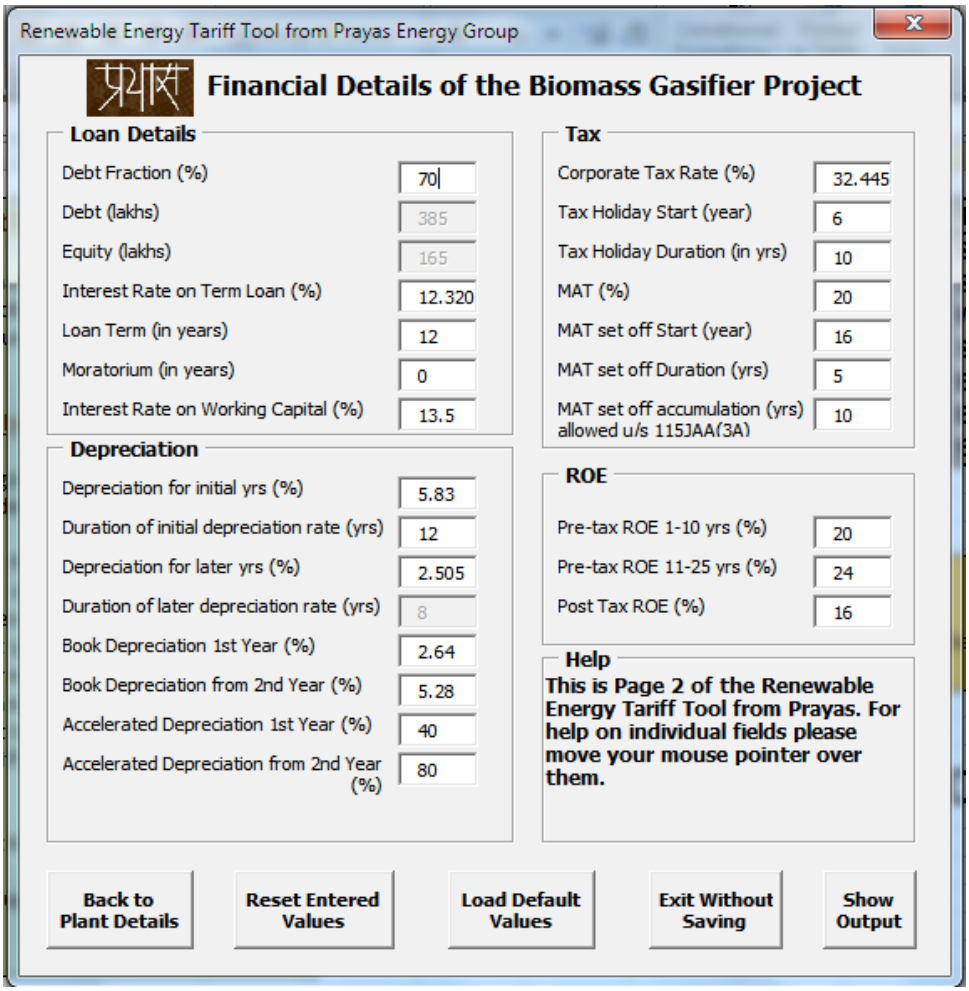
This is the second page of the input form. In this page, the physical plant details such as installed capacity, capital cost and operation & maintenance costs of the plant can be entered. In addition, climate related parameters (emission factor, price of carbon units) can also be entered. Note that the climate related parameters are not plant specific. They have been included in this page only due to space considerations.

The bottom of the page consists of a series of buttons. Following is the description of the actions performed by clicking these buttons:

- Start Again
  - This will take the user back to the first form where the type of technology is selected.
- Reset Enetered Values
  - Resets the values in the form entered during this session to the stored default values.
- Load Defaults Values
  - Resets the default values to the original values provided by Prayas Energy Group. Note that this action resets the values of the fields on the next page of the form that contains the financial details as well.
- Exit Without Saving
  - Ignores any changes made to the form during the current session and closes the form.
- Show Output
  - Applies the changes made to entries on this form and shows the resultant output on the “Summary Results” sheet.
- Go To Financials

- Applies the changes made to the entries on this form and proceeds forward to the second page of the form where financial details can be entered. The details of this form are described below.

5. The following form appears when "Next" button is clicked on the second page of the form:



This is the third and final page in the input form. Financial details of the project can be entered on this page including loan and depreciation details, tax structure and return on equity (ROE) requirements.

The bottom of the page consists of a series of buttons, similar to the first page. Following is the description of the actions performed by clicking these buttons:

- Back to Plant Details
  - Opens the previous page of the form where Plant Details can be entered. The details of this page are described above.
- Update
  - Clicking this button overwrites the default values that appear when the page is opened with the values entered during the current session. If no changes were made to the entries in the form during the current session, clicking this button will have no effect.
- Reset Entered Values
  - Resets the values in the form entered during this session to the stored default values.
- Load Default Values
  - Resets the default values to the original values provided by Prayas Energy Group. Note that this will modify values of the fields that appear on the previous page of the form that contains the physical plant details.

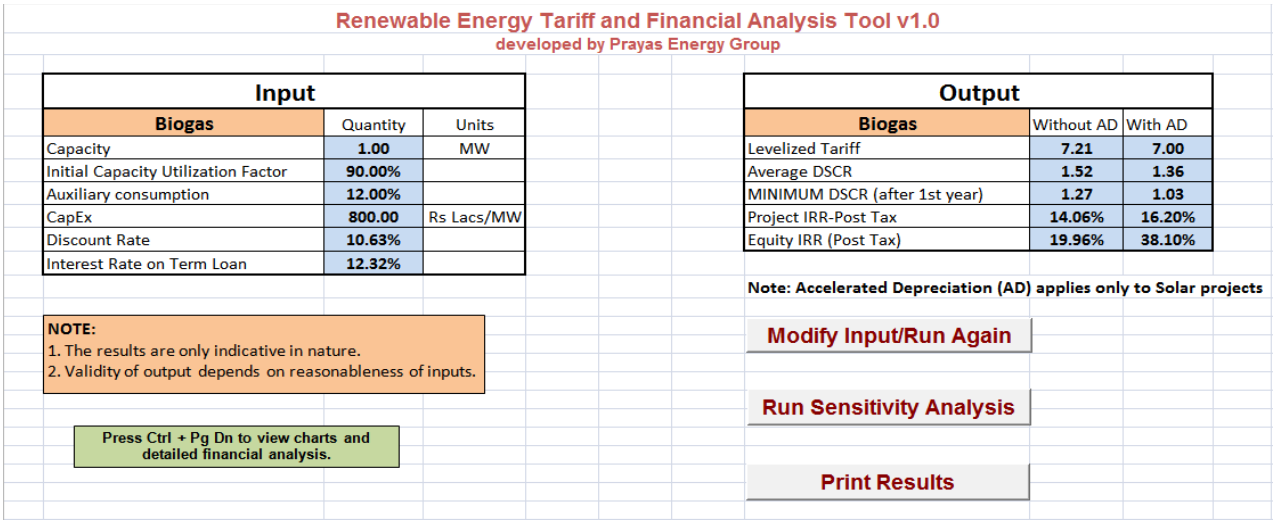
- Exit Without Saving
  - Ignores any changes made to the form during the current session and closes the form.
- Show Output
  - Applies the changes made to entries on this form and shows the resultant output on the "Summary Results" sheet.

6. Please note that:
   - The title on the Plant Details and Financials pages change according to the technology selected. In the screen shots provided above, they refer to "Biomass Gasifier" since that technology was selected in the first page.
   - When changes are made to a field in a page, that field is highlighted by the background color changing to yellow and the foreground color to blue. This helps the user to easily see which field were modified during the current session.

Tariff Output and Sensitivity Analysis

"Summary Results" sheet

Consolidated high level output appears on the "Summary Results" sheet in the workbook (screen shot below).



In this sheet,

- To the top left is a table showing a subset of the input parameters.
- To the top right is the Output table showing the levelized tariff, debt service coverage ratio and post-tax IRR for the given inputs with and without accelerated depreciation.
- In the center (to the left) is a button titled "Modify Input/Run Again". Clicking this button has the same effect of clicing on the "Run Tariff Tool" in the Introduction sheet. That is, the technology selection page that is described above pops up.
- In the center (to the right) is another button titled "Run Sensitivity Analysis". This button needs to be clicked to observe how tariff changes with changes in some of the inputs. This is discussed in more detail in the "Sensitivity Analysis" section below.

"Tariff Chart" sheet

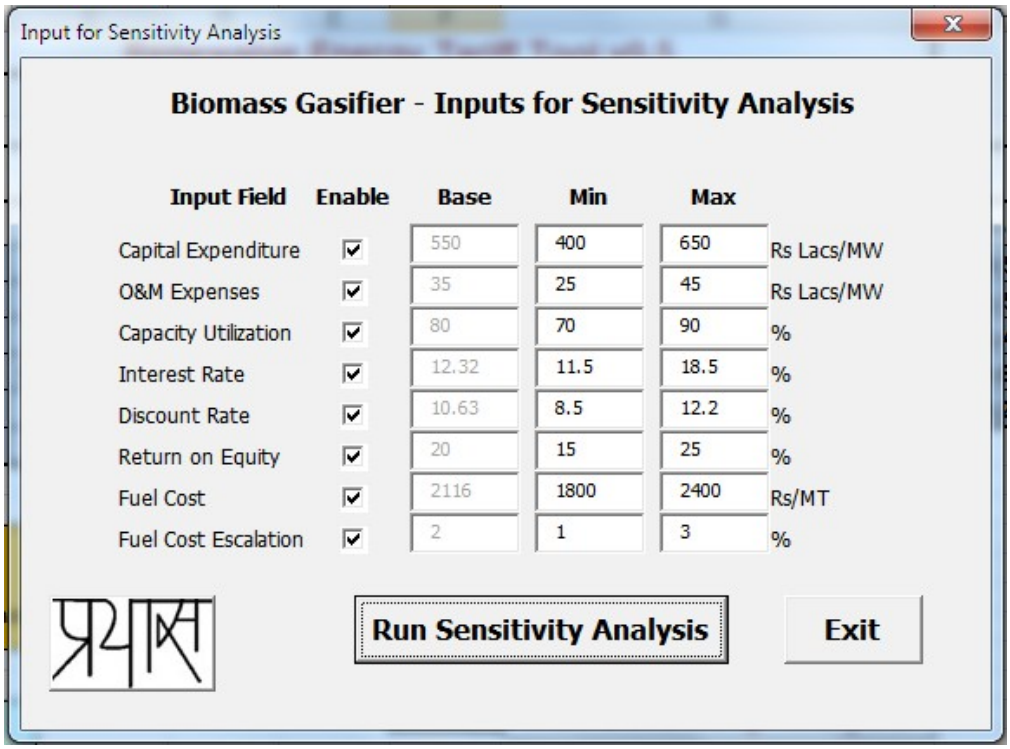
This sheet consists of a graph depicting the different components of the tariff resulting from the provided inputs. The levelized tariff with and without accelerated depreciation is also shown in this graph. Another view of the same is shown in the "Tariff breakup Chart" sheet.

The rest of the sheets show profit/loss calculations, cash flows, balance sheet and intermediate calculations.

Sensitivity Analysis

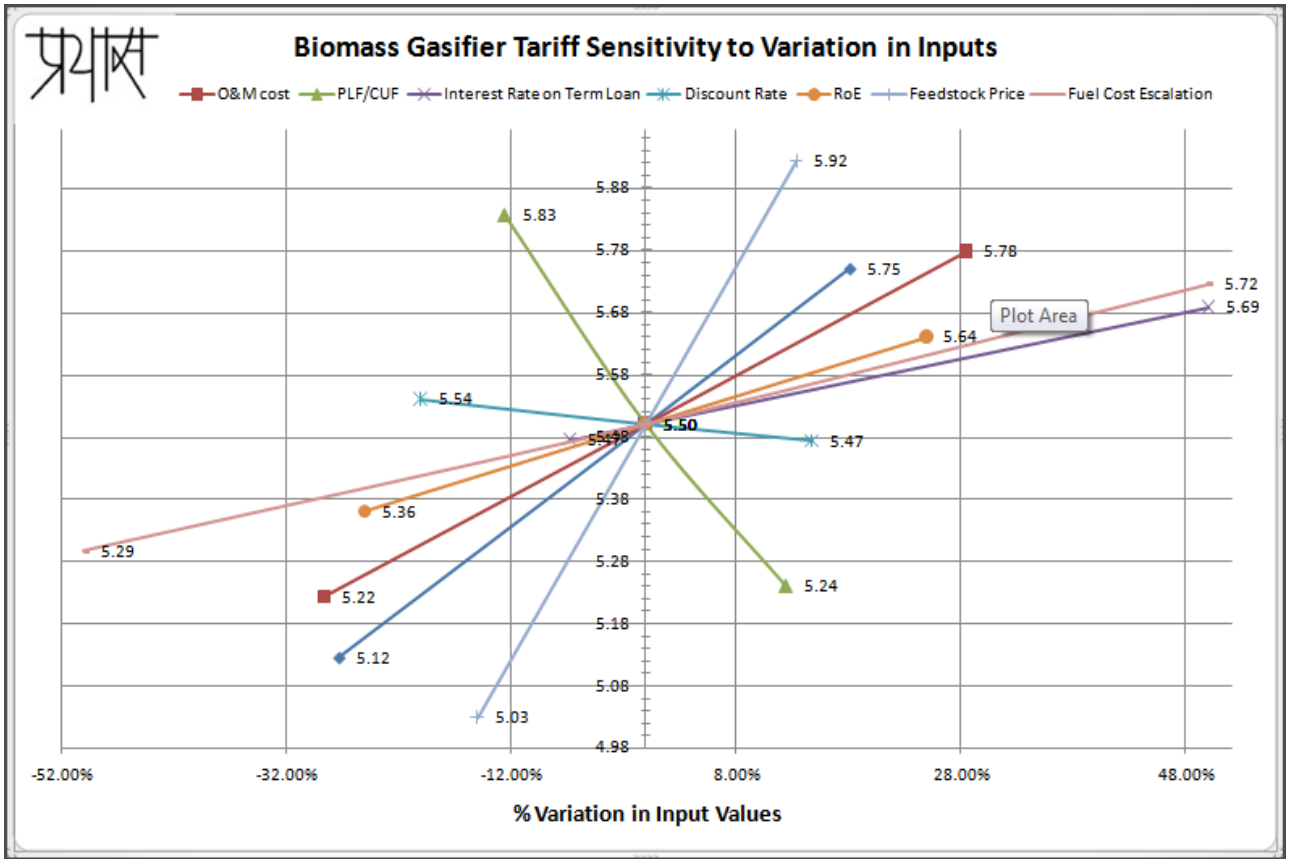
Sensitivity analysis allows the user to vary a few select inputs and observe graphically how the variation affects the tariff. Each of the inputs selected for sensitivity analysis is varied while the rest of the inputs stay constant at the base values, i.e., values chosen through the main tariff tool form. Sensitivity analysis can be triggered by clicking on the "Sensitivity Analysis" button on the summary sheet.

When this button is clicked, the following form shows up:



As with the main tariff tool form, the title of the Sensitivity Analysis form reflects the technology last chosen in the main tariff tool. As can be seen above, a few of the inputs chosen in the tariff tool are presented for sensitivity analysis. Each of these inputs can be enabled or disabled (for sensitivity analysis purposes). The base values chosen for these values are shown and the range of values can be provided by the user. After the necessary ranges are provided, the "Run Sensitivity Analysis" button can be clicked to do the analysis. Once the tariffs are computed for the different ranges of inputs, the user is taken to the Sensitivity chart.

Sensitivity Chart



The vertical axis shows the tariff and the horizontal axis shows the % variation in the inputs. The inputs to this chart can be viewed in the "Sensitivity" sheet.

Some suggested ranges of the different inputs with respect to Sensitivity Analysis have been provided in the next section.

Printing the Results

The "Summary Results" sheet also displays the following button which can be used to print the output results.

Clicking on this button prints the "Summary Results" sheet and the "Tariff Chart" and "Sensitivity Chart" graphs. If other sheets need to be printed, the Excel Print command can be used.

Assumptions

Default Values

1. The default capacity utilization factor (CUF also referred to as plant load factor, PLF) for Wind has been taken as 25% in the tool. Per CERC Guidelines Regulation 26(1), the following CUF values are recommended based on the wind power density of the project. It is left to the user to enter the appropriate CUF.

Annual Mean Wind Power Density (W/m2)	CUF
Upto 200	20%
201-250	22%
251-300	25%
301-400	30%
> 400	32%

2. The default capital cost for small hydro projects (SHP) has been taken as Rs 700 lacs/MW. Per CERC Guidelines Regulation 28(1), the following capital costs are recommended based on the host state/region and capacity of the hydro power project. It is left to the user to enter the appropriate capital cost based on the following table:

Region	Project Size	Capital Cost (Rs Lacs/MW)
Himachal Pradesh, Uttarakhand and North Eastern States	Below 5 MW	770
	5 to 25 MW	700
Other States	Below 5 MW	600
	5 to 25 MW	550

3. The default CUF for small hydro projects provided in the tool is 45%. According to CERC Guidelines Regulation 30, the normative CUF is 45% for Himachal Pradesh, Uttarakhand and North Eastern States and 30% for other states. In addition, the CERC Guidelines state that the "normative CUF is net of free power to the home state if any, and any quantum of free power if committed by the developer over and above the normative CUF shall not be factored into the tariff." The user needs to enter the appropriate CUF based on this regulation.
4. Likewise, default O&M expense for small hydro projects is taken as Rs 25 Lakhs/MW. The user needs to enter the O&M expenses according to the following table:

Region	Project Size	O&M Expenses (Rs Lacs/MW)
Himachal Pradesh, Uttarakhand and North Eastern States	Below 5 MW	25
	5 to 25 MW	18
Other States	Below 5 MW	20
	5 to 25 MW	14

5. With reference to biomass rankine cycle projects, CERC Guidelines Regulation 41 states this: "The use of fossil fuels shall be limited to the extent of 15% of total fuel consumption on annual basis." However, the tool does not have a provision to enter a fossil fuel input. This will be considered for a future update of the tool.
6. The default value for the feedstock price for biomass rankine cycle projects is set to Rs 2695/tonne. According to the CERC Guidelines Regulation 44, state-wise normative feedstock prices are as follows:

State	Biomass Price Rs/tonne
Andhra	2315
Haryana	2635
Maharashtra	2695
Punjab	2756
Rajasthan	2300
Tamil Nadu	2277
UP	2355
Other States	2476

7. The default fuel requirement for biomass rankine cycle projects is 1.212 kg/kWh. This is calculated from the normative values of Station Heat Rate (Regulation 38: 4000 kCal/kWh) and Calorific Value (Regulation 43: 3300 kCal/kg) provided in the CERC Guidelines.
8. For co-generation projects, a default CUF of 50% has been used. The normative values provided in the CERC Guidelines are as follows:

State	Operating Days	Plant Load Factor (%)
Uttar Pradesh and Andhra Pradesh	120 days (crushing) + 60 days (off-season) = 180 days operating days	45%
Tamil Nadu and Maharashtra	180 days (crushing) + 60 days (off-season) = 240 days operating days	60%
Other States	150 days (crushing) + 60 days (off-season) = 210 days operating days	53%

9. For co-generation projects, the default fuel requirement is 1.6 kg/kWh. This is calculated from the normative values of Station Heat Rate (Regulation 51: 3600 kCal/kWh) and Calorific Value (Regulation 52: 2250 kCal/kg) provided in the CERC Guidelines.
10. The default feedstock price for biomass gasifier projects is set to Rs 2116/tonne.
11. The default fuel escalation rate for biomass rankine cycle, bagasse co-generation and biomass gasifier projects is 3%. Please note that according to CERC Guidelines Regulations 44, 53 and 73, "the normative escalation factor of 5% per annum shall be applicable at the option of the … project developer".
12. For biomass gasifier and biogas projects, capital subsidy has been assumed in the default capital cost values provided by the tool. These can be modified according to CERC Guidelines Regulations 66 and 76 if capital subsidy is not applicable to the project.

Calculations

1. Discount Rate is equal to the post-tax weighted average cost of capital. It is calculated using the

following formula:

```
Discount Rate = Debt % * Term Loan Interest Rate * (1-Corporate Tax Rate)
                + Equity % * (Post-tax ROE)
```

2. Annuity Factor, used to calculate levelized tariff, is calculated using the following formula:

$$\text{Annuity Factor} = \frac{((1 + d)^n - 1)}{(d * (1 + d)^n)}$$

where d = Discount Rate and n = Plant Life

3. For , the Project and Equity IRR shown in the Summary Results Sheet can be displayed as "#NUM!" or "#DIV/0!".

   "#NUM!" shows up in cases where multiple solutions are found for the IRR. No guess is provided to the IRR function in Excel, since the expected IRR can vary depending on the inputs provided. In the absence of a guess, the solver cannot choose between the solutions computed, hence it returns a "#NUM!" result.

   "#DIV/0!" can occur if the IRR solver in Excel finds no root or returns an extraordinarily high value.

   The Goal Seek tool in Excel (available under Data → "What-If Analysis" → "Goal Seek" in Excel 2007 and later or under Tools → "Goal Seek" in Excel 2003) can be used to further analyze both issues.

4. Where applicable, for biomass projects, fuel requirement is derived from the normative station heat rate and biomass calorific value provided by CERC Guidelines.

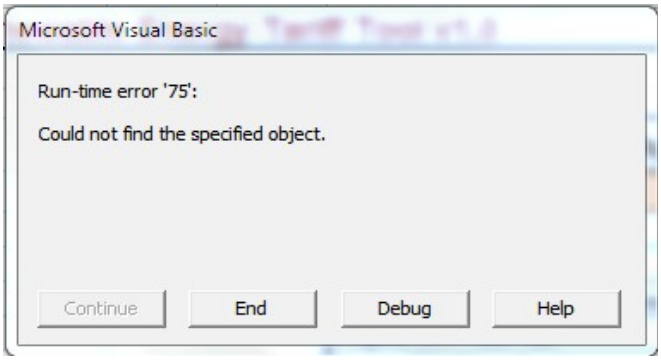
$$\text{Fuel requirement (kg/kWh)} = \frac{\text{station heat rate (kCal/kWh)}}{\text{calorific value (kCal/kg)}}$$

Suggested Ranges for Sensitivity Analysis

Input	CUL/ PLF	Capex (w/o subsidy)	Feedstock Price	Debt Fraction	Interest Rate	Term Loan Duration	ROE	Emission Factor	CER Price
Source	%	Rs Lacs/MW	Rs/ton	%	%	years	%	tons of CO_2/MWh	$/ton
Solar PV	15-25	900-1100	Not Applicable	60-80	5-15	7-20	10-25	0.8-1.1	10-20
Solar Thermal	20-40	1100-1400							
Wind	15-35	450-650							
Small Hydro	25-50	450-750							
Biogas	60-90	~1000	~1000						
Bagasse	40-70	350-500	1000-2000						
Biomas Gasifier	60-80	500-600	1500-3000						
Biomas Rankine Cycle	60-80	400-500	1500-3000						

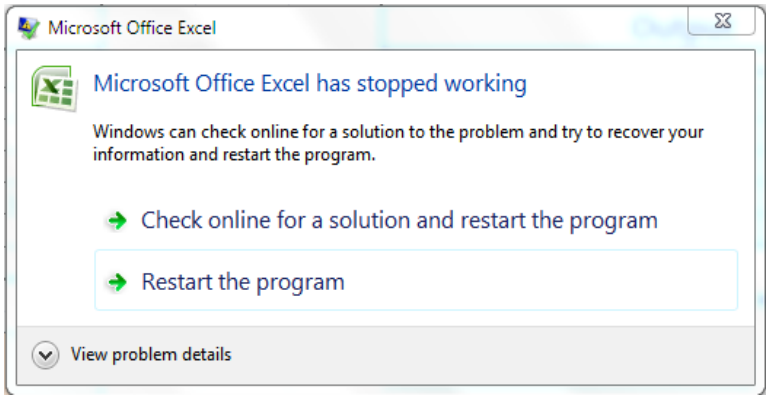
Known Limitations

1. Although reasonable checks are in place, the tool has not been test to ensure that it works error-free when extreme values are input.
2. Ranges allowed for the different inputs are very broad and should not be considered as real-world ranges.
3. An intermittent bug has been observed when running the tool and if Excel is idle for sometime. This bug causes Microsoft Excel to crash and manifests itself in one or more of the following ways:
    - When this error happens, the following pop-up message appears when the tariff tool button is clicked:



      In this case, click on the “End” button to close this pop-up and close the workbook without saving and restart it.

    - When saving the excel workbook, the following pop-up message appears:



      In this case, just close this pop-up window by clicking on the cross at the top right hand corner of the window.

   This issue is being investigated. At this time, the root cause of the problem has not been identified. While it is not clear what causes the issue, it seems to happen when the worksheet is left idle for some time after the tariff tool macro is run. Any inconvenience caused is deeply regretted.

Future Enhancements

1. Better help text for guidance in entering the input data.
2. Incentive programs for Renewable energy.
3. State-specific considerations.
4. Ability to calculate return on equity given a particular tariff.
5. Ability to provide fossil fuel input for biomass rankine cycle projects.
6. Ability to do a side-by-side comparison of alternative scenarios.
7. Multiple term-loans.
8. Multiple currency options.

Kindly note that these features are being considered, however, no schedule is available for their incorporation in the tool. Additional features will be implemented based on feedback received for the current version of the tool.

The spreadsheet and macros have been protected in order to prevent inadvertent changes that can cause the tool to become unusable. If anyone is interested in the unprotected version of the tool, they can contact the developers at the email address provided below.

This Renewable Energy Tariff tool was developed by Prayas Energy Group, Pune. Any questions can be directed to energy@prayaspune.org or to +(91) 20-25420720/65205726 Monday-Friday 10:00am – 6pm.