

RUCBREC-G Tool

Regulators' and Utilities' Coalition for a Balanced, Resilient,
Efficient and Clean Grid Tool

Tool Manual

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Regulators' and Utilities' Coalition for a Balanced, Resilient, Efficient and Clean Grid
(RUCBREC-G) Tool

The RUCBREC-G tool evaluates complementary business models and proposes to combine investments both behind and front of the meter to reduce power procurement costs and defer investments in distribution, transmission and generation capacity upgrade while creating additional revenue streams. It attempts to assess the impact of multiple interventions on the DisCom's aggregate revenue requirement (ARR) at the feeder-level, for a period of 15 years (a norm used by most of the regulators while assessing capital expenditure proposals from DisComs).

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1. Objective

The objective of this tool is to provide cost benefit analysis of different approaches that can be taken towards optimizing energy supply and distribution. The tool can estimate the impact of the following interventions

- Energy Efficiency Measures
- Solar Generation
- Energy Storage
- Supply of ‘surplus’ electricity units to Electric Vehicles (EV)

The tool allows user to enter parameters related to aspects of energy procurement, distribution, finance and efficiency. It also offers control over financial parameters associated with the transmission and supply of energy.

With this tool, you can create a scenario that allows you to configure and test out different combinations of interventions, change feeder and DisCom level parameters, and review its impact on the overall financials. You can create multiple such scenarios and compare them to see which configuration is a better fit.

The tool can be used to create up to 5 scenarios for 8 different customer types. It allows configuring of the following parameters for each customer.


- Demand, energy, and wheeling charges
- Contract demand factor
- Annual increase in energy consumption
- Custom ToD profiles

2. General Instructions


- The tool is built on Excel 2019, but for the most part is compatible with versions going back up to 2013.
- It is a macro-enabled excel workbook. The user needs to click ‘*Allow macros*’ in the yellow ribbon that prompts when the workbook is opened.
- **It does not have any auto-save features and the workbook should be saved just like any other Excel document.**
- The workbook is in manual calculation mode, which means any change of parameters will not immediately reflect a change in the calculations but should be followed by clicking the below displayed calculator icon.

Calculator icon to refresh all calculations



- If you make any changes on the  ‘**FEEDER DATA**’ tab, please ensure to click on the ‘*calculator*’ button. Since the feeder data is the base input for all calculations, this button acts as a ‘Total Re-Calculate’ for all calculations in all the existing scenarios. Note: This calculation takes a while to compute.
- The tool follows the below displayed color system for indicating if a value is an editable user input or a calculated value.

 User Input

 Calculated Value (cannot be edited)

- The tool comes pre-configured with a Baseline and a User Scenario. The parameters for the baseline scenario may be tweaked. No interventions can be added to the baseline.
- The User Scenarios ‘*Scenario 1*’ may be modified and is a sample scenario with all interventions added for demonstration. This scenario can be deleted.
- Each scenario is independent of other scenarios and any changes applied to one scenario (or the baseline) do not affect other scenarios.
- You can reconfigure the Baseline scenario and make use of the ‘*Copy Scenario From*’ option to create similar scenarios.

3. Tool Structure and Navigation

The tool has been divided into multiple tabs for convenience of use as well as a logical grouping of similar utilities and provisions. These tabs can be navigated using the Navigation bar on top. Below is a list of all the user interactable tabs followed by instructions on each of those.

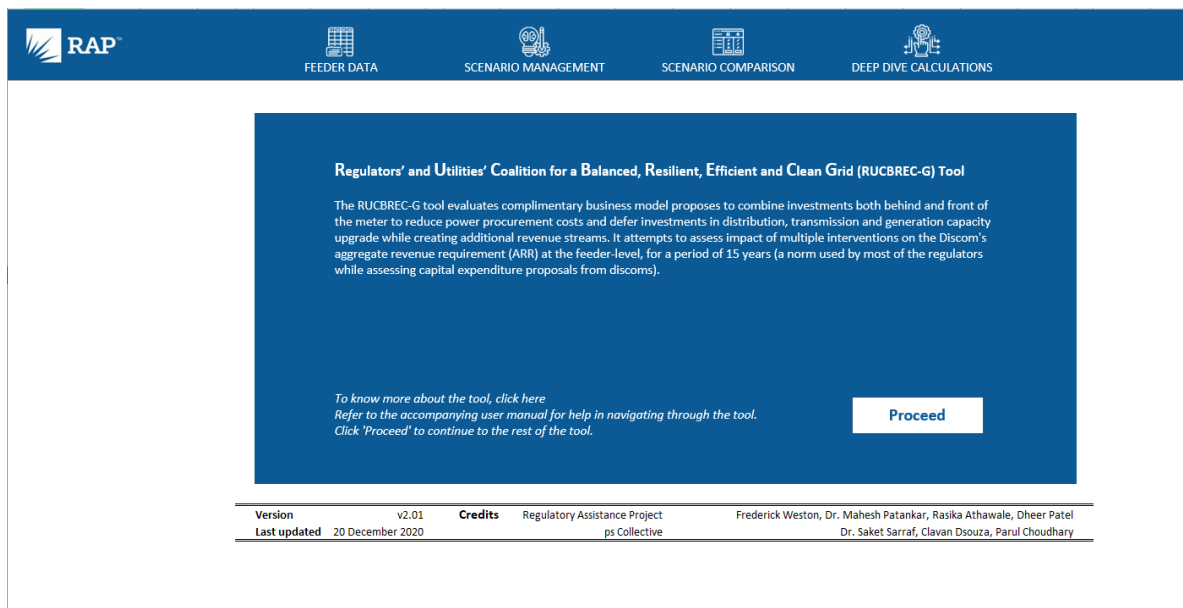
- A. Landing page
- B. Feeder Data
- C. Scenario Management
- D. Scenario Comparison
- E. Deep Dive Calculations

The screenshot displays the RUCBREC-G Tool interface. At the top, a yellow banner shows a "SECURITY WARNING" that "Macros have been disabled," with an "Enable Content" button. Below this is a blue navigation bar with icons for "FEEDER DATA," "SCENARIO MANAGEMENT," "SCENARIO COMPARISON," and "DEEP DIVE CALCULATIONS." An orange callout points to the "Enable Macros" button. The main area is the "Landing Page" for the "Regulators' and Utilities' Coalition for a Balanced, Resilient, Efficient and Clean Grid (RUCBREC-G) Tool." It contains introductory text about the tool's purpose and a "Proceed" button. An orange callout points to the "Proceed" button. At the bottom, a footer table provides version and credit information.

Version	v2.01	Credits	Regulatory Assistance Project	Frederick Weston, Dr. Mahesh Patankar, Rasika Athawale, Dheer Patel
Last updated	20 December 2020	ps Collective		Dr. Saket Sarraf, Clavan Dsouza, Parul Choudhary

The second screenshot shows the "Feeder Data" tab selected. The interface includes a left sidebar with "Scenario 1" details and a "Create Scenario" button. The main area displays a "Hourly Average Demand at Busbar (kW)" graph. The graph shows demand over a 24-hour period, with a legend for "Baseline," "Scenario," "Rooftop Solar PV," "Grid," and "Charging/Discharging." An orange callout points to the "Feeder Data" tab. Another orange callout points to the "Scenario Management" tab. A third orange callout points to the "Scenario Comparison" tab. A fourth orange callout points to the "Deep Dive Calculations" tab.

a) Landing page



The screenshot shows the landing page of the RUCBREC-G Tool. At the top, there is a dark blue navigation bar with the RAP logo on the left and four icons with labels: FEEDER DATA, SCENARIO MANAGEMENT, SCENARIO COMPARISON, and DEEP DIVE CALCULATIONS. The main content area is white and contains a large blue box with the following text:

Regulators' and Utilities' Coalition for a Balanced, Resilient, Efficient and Clean Grid (RUCBREC-G) Tool

The RUCBREC-G tool evaluates complimentary business model proposes to combine investments both behind and front of the meter to reduce power procurement costs and defer investments in distribution, transmission and generation capacity upgrade while creating additional revenue streams. It attempts to assess impact of multiple interventions on the Discom's aggregate revenue requirement (ARR) at the feeder-level, for a period of 15 years (a norm used by most of the regulators while assessing capital expenditure proposals from discoms).

*To know more about the tool, [click here](#)
Refer to the accompanying user manual for help in navigating through the tool.
Click 'Proceed' to continue to the rest of the tool.*

A white button with the text **Proceed** is located at the bottom right of the blue box.

At the bottom of the page, there is a table with the following information:

Version	v2.01	Credits	Regulatory Assistance Project	Frederick Weston, Dr. Mahesh Patankar, Rasika Athawale, Dheer Patel
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This is a welcome screen to provide a basic introduction to the tool. It also serves the purpose, to ensure the user allowed macros to run when the workbook opens. The top navigation links do not work on this tab and the only way to proceed to rest of the tool is **‘Proceed’** button.

This tab also has some background details, key ideas and assumptions listed, which can be accessed through the **‘click here’** link.

b) Feeder Data

Basic inputs about the feeder

Name of Feeder
DisCom
State
City

Year of Data
No of Customers
Data input method

Total Capacity
DT
Per Customer Capacity (KVA-Nos.)

'Save edits' Button

No. of customers, and type of input

Customer Details

Feeder Data

TOD Consumption for Feeder			
Consumer type	Input % Share	Annual Capacity per customer	
Domestic	45.00%	6305.9	
Commercial	33.00%	4624.3	
Industrial	22.00%	3082.9	

% Load Share by Consumer Type			
C1	C2	C3	
Domestic	Commercial	Industrial	
45.00%	33.00%	22.00%	
6305.9	4624.3	3082.9	

Breakup by Consumer Type (KVA)			
Date	Time	Aggregate Consumption	
1/1/2019	12 AM	4,300	
1/1/2019	1 AM	4,300	
1/1/2019	2 AM	4,300	
1/1/2019	3 AM	4,300	
1/1/2019	4 AM	4,300	
1/1/2019	5 AM	4,300	
1/1/2019	6 AM	4,451	
1/1/2019	7 AM	4,465	
1/1/2019	8 AM	5,141	
1/1/2019	9 AM	5,324	
1/1/2019	10 AM	5,477	
1/1/2019	11 AM	5,821	
1/1/2019	12 PM	5,499	
1/1/2019	1 PM	4,983	
1/1/2019	2 PM	5,155	
1/1/2019	3 PM	5,313	
1/1/2019	4 PM	5,487	
1/1/2019	5 PM	6,176	
1/1/2019	6 PM	6,508	
1/1/2019	7 PM	6,178	

This tab is designed to allow the input of feeder data at an hourly level. User may start with entering the meta data about the feeder like its name, location, etc.

The user sets up the model by configuring the year for which data is being entered, the number of customers and the granularity of the available data at the feeder level.

Note, entering a leap year creates an additional 24 rows for entering data for 29th Feb, however, these numbers are not used in any of the calculations.

There are two ways to enter hourly data for the feeder into the tool.

- By Percent Split:** This method allows the user to enter aggregated hourly data of all customers. It is then split towards customers based on ‘% share’ input given by the user for each customer type.
Any unallocated share is assigned to an in-built ‘Not Modelled’ customer, and is not accounted for in the calculations.
- By Hour:** This method allows the user to enter the hourly data for each customer.

These numbers are the foundation of this tool. Any change made in this tab would require full re-calculation of all scenarios. This is to be done manually using the ‘*Calculator*’ button provided on this tab.



Remember to re-calculate changes, by clicking on the calculator button.

c) Scenario Management

The screenshot displays the RAP Scenario Management interface. The left pane shows a list of scenarios: Baseline and Scenario 1. Scenario 1 is highlighted as the active scenario. The middle pane contains navigation options: Parameters, Interventions, Results, and Graphs. The right pane displays detailed parameters and results for Scenario 1, including Total Cost, Revenue from Sales, Rooftop Solar PV, and Grid Power Procurement. Callouts indicate that the left pane shows 'Active Scenarios', the right pane shows 'Scenario KPIs (Compared with Baseline)', and the middle pane shows 'Parameters, Interventions and Scenario Outputs'.

Scenario	Total Cost	Revenue	Power Procured
Baseline	₹ 260.8 cr	₹ 389.6 cr	4.2 MWh
Scenario 1	₹ 260.8 cr	₹ 389.6 cr	4.2 MWh

Scenario 1 KPIs (Compared with Baseline):

- Total Cost: -3.06%
- Revenue: -2.80%
- Power Procured: -16.33%

Parameters, Interventions and Scenario Outputs:

- DisCom Parameters: Total unit sales, Year on year growth in sales, Distribution network cost, APFC for wholesale power procurement.
- Customer Specific Parameters: C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27, C28, C29, C30, C31, C32, C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44, C45, C46, C47, C48, C49, C50, C51, C52, C53, C54, C55, C56, C57, C58, C59, C60, C61, C62, C63, C64, C65, C66, C67, C68, C69, C70, C71, C72, C73, C74, C75, C76, C77, C78, C79, C80, C81, C82, C83, C84, C85, C86, C87, C88, C89, C90, C91, C92, C93, C94, C95, C96, C97, C98, C99, C100.
- Financial Parameters: Interest rate, Discount rate, Equity as % of capex, Return on equity, Sharing of returns within DisCom regulated and other unit, Debt repayment period.
- DisCom Capex Inputs: Intra-state Transmission loss, Distribution loss, Capital cost of grid upgrade, Transmission charges, New generation fixed cost, Load factor on feeder.

Left pane: Scenario
Middle pane: Navigation
Right pane: Inputs and results

This is the primary interactive tab of the tool. User can create and configure scenarios based on various parameters and interventions. The summary of the results associated with the scenario and various graphs can be accessed from this tab. The key results of the selected scenario as compared to the baseline are displayed on the top of the right pane.

The **SCENARIO MANAGEMENT** tab is divided into three vertical panes. The left pane lists the baseline and various user configured scenarios. The central pane allows the users to navigate through different aspects of the scenario configuration like the base parameters, define set of interventions, see results and graphs associated with the scenario outcome. The right pane is for user data input and display of results.


You can select the **Current Scenario** (e.g., Scenario 1 in the image above) by clicking on it in the left pane. The values of key outcomes namely the Total cost, Revenue and Power Procured for scenario as compared with the Baseline is also displayed here.

The screenshot displays the RAP Scenario Management interface with the 'Create Scenario' dialog box open. The dialog box prompts for 'Scenario Name' and 'Copy from Scenario (optional)'. The background shows the same interface as the previous screenshot, but with the 'Create Scenario' dialog box open.

Scenario Name:

Copy from Scenario (optional):


Create Scenario

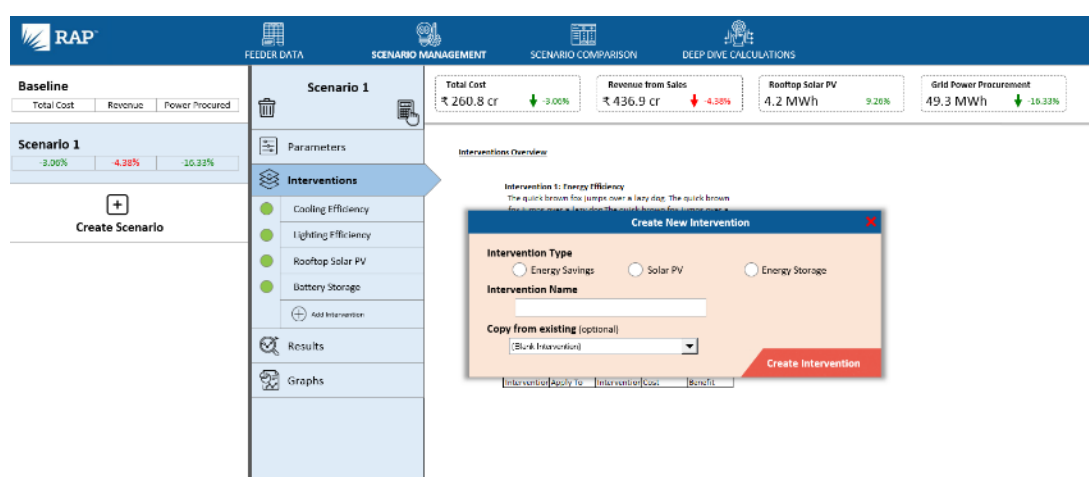
The **Create Scenario**  functionality is used to create a new scenario to estimate the combined impact of choice of parameters and a set of interventions. This option allows you to create a copy of an existing scenario or create a new scenario from scratch.

The middle pane provides navigation to the various options within each scenario.

- **Parameters:** Allows you to configure the values related to the DisCom and its customers. These include DisCom, Customer, Financial, Capex and Growth-related parameters. The values of different parameters are entered in the right hand pane
- **Interventions:** Three interventions namely Energy Efficiency (EE), Roof Top solar PV (RTPV), and Battery Energy Storage (BES) can be modeled using the RUCBREC_G tool. The tool allows you to estimate the impact of adding these interventions to the DisCom portfolio.

Three types of interventions namely Energy Savings (Cooling or Lighting efficiency), Rooftop Solar PV and Battery Storage can be currently modeled using this tool. The tool allows you to estimate the impact of adding these interventions to the DisCom portfolio under alternative business models.

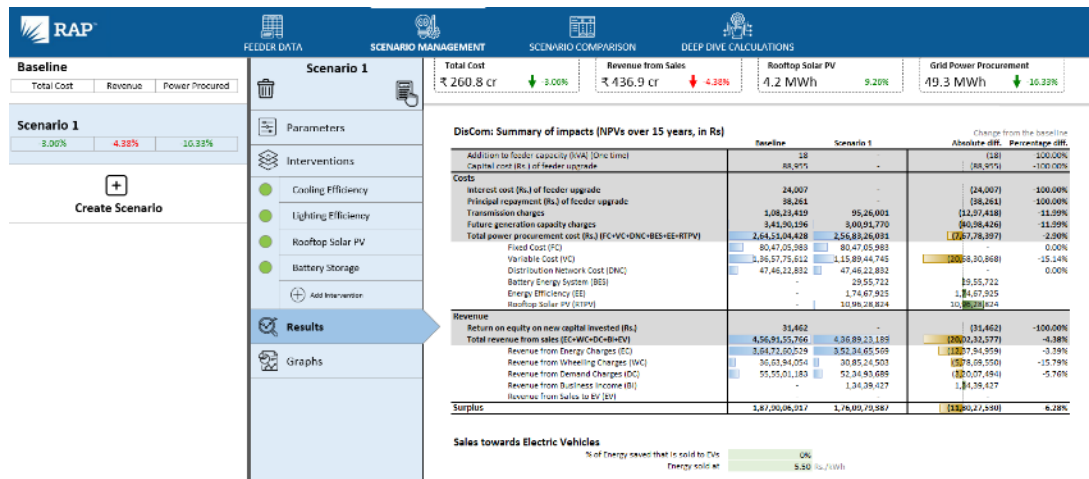
The  **'Add Intervention'** button allows you to add and configure a new intervention to the current scenario. You can also copy an existing intervention from an existing scenario into the current scenario. Some interventions are customer-specific (e.g., cooling and lighting efficiency), while others are applied at the transformer level. Multiple interventions of the same type may be applied to different customers.



The various interventions of the active scenario are listed in this pane. You can click these interventions to configure its parameters. Interventions can either be deleted or toggled off (using the green circle, ●) to see their impact.

- **Results:** Clicking on the results tab displays the output summary for the current scenario in the right pane. It lists the 15-year net present value (NPV) of costs and revenues streams based on the active scenario's configurations. Detailed components of these streams are also provided. It also compares these results with the Baseline scenario to assess the magnitude of the impact.

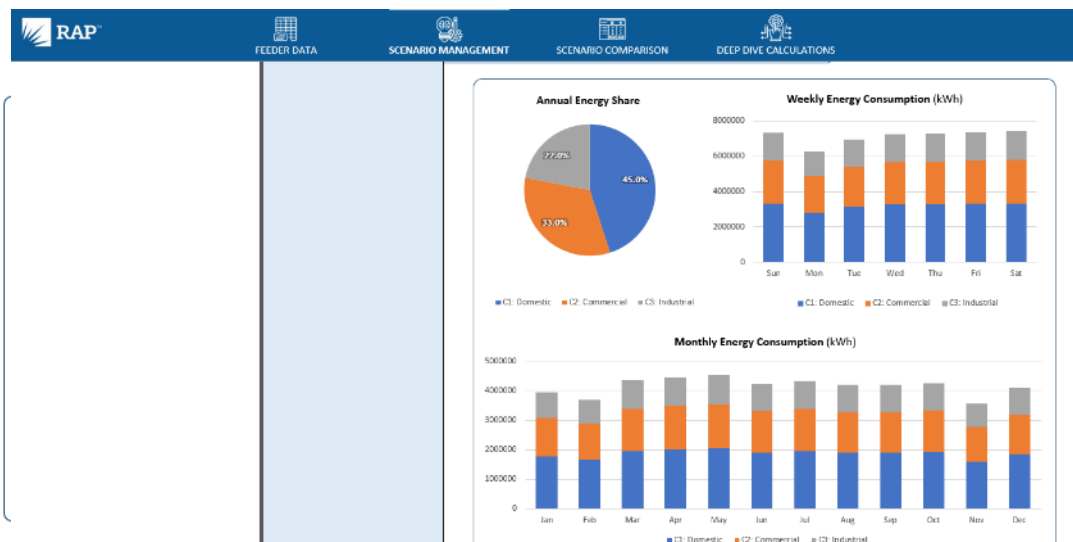
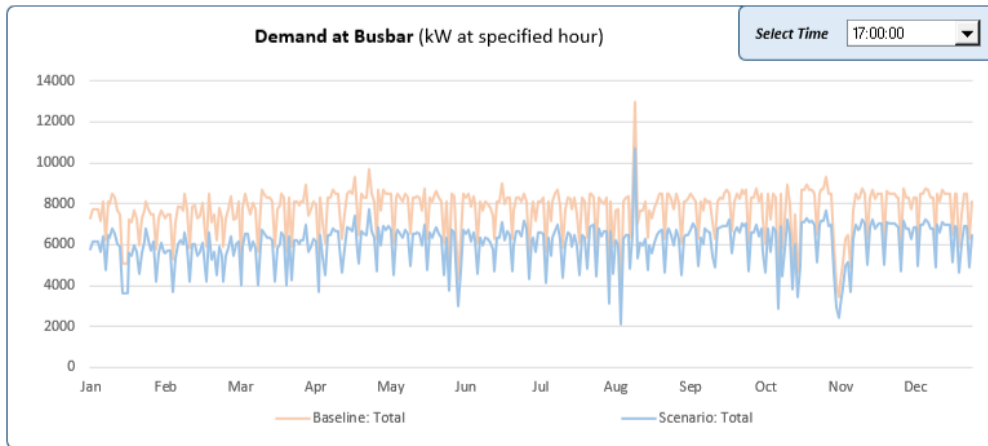
The *results* also include the Ratepayer Impact test Measure (RIM) values and impact on consumer bills to support decision making as per regulatory compliance.



The user may choose to explore the impact of additional revenue generated by selling the saved energy to Electric Vehicles (EV). They can choose the percent of the saved energy compared to the baseline that is sold to electric vehicles at a user specified rate. Note that these calculations are suggestive and users should use other tools for detailed impact of energy sales to EV.

- **Graphs:** This section compares the Current and Baseline scenarios and provides the outputs in a graphical formal. It has various graphs and options to view the usage and impact for the entire year or a user specified period.





d) Scenario Comparison

DisCom: Summary of impacts (NPVs over 15 years, in Rs)

	Baseline	Scenario 1	Scenario to compare	Absolute diff.	Percentage diff.
Addition to feeder capacity (kVA) (One time)	18	-	-	-	-100.00%
Capital cost (Rs.) of feeder upgrade	88,955	-	-	(88,955)	-100.00%
Costs					
Interest cost (Rs.) of feeder upgrade	24,007	-	-	(24,007)	-100.00%
Principal repayment (Rs.) of feeder upgrade	38,261	-	-	(38,261)	-100.00%
Transmission charges	10,823,419	9,526,001	9,526,001	(1,297,418)	-11.99%
Future generation capacity charges	34,190,196	30,091,770	30,091,770	(4,098,426)	-11.99%
Total power procurement cost (Rs.) (FC+VC+DNC+BES+EE+RTPV)	2,645,104,428	2,568,326,031	2,568,326,031	(76,778,397)	-2.90%
Fixed Cost (FC)	804,705,983	804,705,983	804,705,983	-	0.00%
Variable Cost (VC)	1,365,775,612	1,158,944,745	1,158,944,745	(206,830,867)	-15.14%
Distribution Network Cost (DNC)	474,622,832	474,622,832	474,622,832	-	0.00%
Battery Energy System (BES)	-	2,955,722	2,955,722	2,955,722	100.00%
Energy Efficiency (EE)	-	17,467,925	17,467,925	17,467,925	100.00%
Rooftop Solar PV (RTPV)	-	109,628,824	109,628,824	109,628,824	100.00%
Revenue					
Return on equity on new capital invested (Rs.)	31,462	-	-	(31,462)	-100.00%
Total revenue from sales (EC+WGC+DC+BI+EV)	4,569,155,766	4,368,923,189	4,368,923,189	(200,232,577)	-4.38%
Revenue from Energy Charges (EC)	3,647,260,529	3,523,465,569	3,523,465,569	(123,794,959)	-3.39%
Revenue from Wheeling Charges (WGC)	366,394,054	308,524,503	308,524,503	(57,869,550)	-15.79%
Revenue from Demand Charges (DC)	555,501,183	523,493,689	523,493,689	(32,007,494)	-5.76%
Revenue from Business Income (BI)	-	13,439,427	13,439,427	13,439,427	100.00%
Revenue from Sales to EV (EV)	-	-	-	-	-
Surplus	1,879,006,917	1,760,979,387	1,760,979,387	(118,027,530)	-6.28%

Ratepayer Impact test Measure (RIM)

	Baseline	Scenario 1
Total DisCom sales (MU)	-	100,000.00
Benefits (NPV of avoided supply cost, Rs)	-	206,830,868

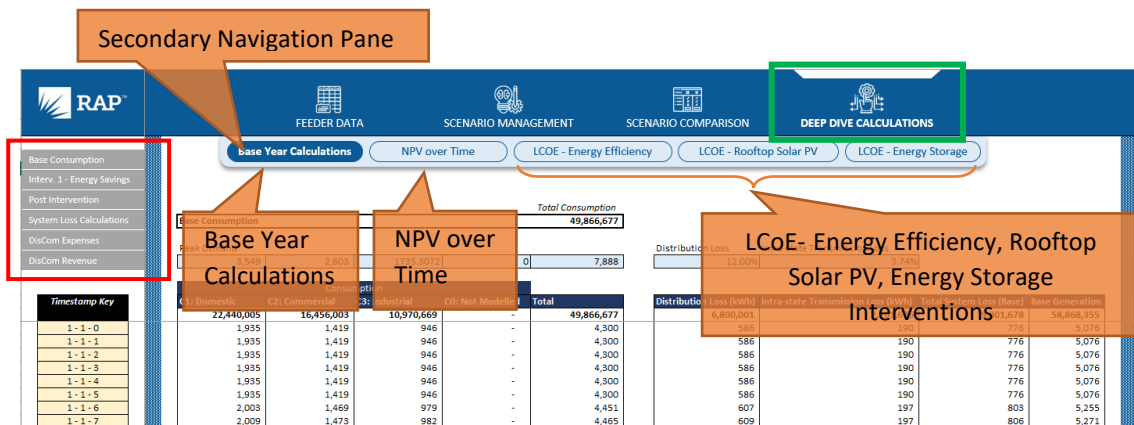
This tab lists the outputs of the baseline and all the scenarios at a single place, allowing a side-by-side comparison of their financials outcomes. This tab is very similar in contents to the ‘Results’ section in the **SCENARIO MANAGEMENT** tab.

You can also select any one scenario to compare with the baseline.



Click “Refresh calculations” button to ensure any changes made in the ‘Scenario management’ tab is correctly displaced here.

e) Deep Dive Calculations



This tab provides detailed information about detailed calculations, intermediate calculations, disaggregated data, and inner workings of the tool. This entire section is not editable and is only provided to get a deeper understanding of the backend calculations. The calculations displayed in this tab are for on the active scenario selected in the **‘SCENARIO MANAGEMENT’** tab.

The tab is further divided based on sub-sections which can be accessed through the secondary navigation pane.

- **Base Year Calculations:** This tab displays the hourly impact of the interventions in the current year only. The tab starts with the Feeder inputs on the very left and as we move towards the right, the various Interventions are applied, and financial values calculated based on the outputs. A quick-link section is provided on the top-left to help navigate this tab.
- **NPV over Time:** This tab builds on the outputs provided by ‘*Base Year Calculations*’ and extrapolates the numbers for up to 15 years. A lot of the components are broken down and listed here. It provides detailed summary for all the calculations.
- **LCOE – Energy Efficiency, Rooftop Solar PV, Energy Storage:** This section is used to calculate the **Levelized Cost of Energy** for each of the interventions.

These tabs reference the various parameters provided in the **Interventions** section of **SCENARIO MANAGEMENT** and use them to calculate the LCOE. This value is displayed back in the relevant intervention section and used in the various intervention related calculations.

Abbreviations

APPC	Average Power Purchase Cost
BES	Battery Energy System
CapEx	Capital Expenditure
DisComs	Distribution Companies
DNC	Distribution Network Cost
DT	Distribution Tariff
EE	Energy Efficiency
EV	Electric Vehicles
LCoE	Levelized Cost of Energy
MU	Million Units
M&V	Measurement and Verification
NPV	Net Present Value
PV	Photovoltaic
RE	Renewable Energy
RIM	Ratepayer Impact Test Measure
RTPV	Rooftop Solar PV
ToD	Time of the Day
TR	Ton of Refrigeration
YoY	Year on Year

