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GRIDOPTIMAL-INDIA: PROMOTING BUILDING-GRID OPTIMIZATION IN SOUTH ASIA

**Guidance Document for Using the GridOptimal - South Asia
Metrics Calculation Spreadsheet Tool**

New Buildings Institute (NBI)

South Asia Regional Energy Partnership (SAREP)

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We believe this document will enhance building-grid integration outcomes in India and South Asia, benefiting stakeholders on both sides of the meter, including building owners, occupants, distribution utilities, and society as a whole.

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INTRODUCTION

This document serves as a guidance note and accompanies the standalone “GridOptimal-South Asia Metrics Calculator” spreadsheet tool, which plots and analyzes the results of extensive energy modeling of common Indian buildings. The goal of the tool is to visualize and quantify the load reduction benefits of various energy-saving interventions in buildings, including retrofits and controls, that improve energy efficiency and adjust controls to provide short-term demand response. These load reduction benefits are placed in the context of the electricity grid to highlight which interventions can best avoid peak demand on the grid.

The primary expected user for this tool is building project teams/building developers, to assess the impact of energy efficiency and demand response interventions at an example building. The tool may also be used by jurisdictions and code officials, utility staff, and planners and advocates for research purposes.

Tool introduction:	
Objective/Purpose of tool:	
Developed via funding from USAID, in collaboration with SAREP, National Smart Grid Mission, and Environmental Design Services, the goal of this tool is to visualize and quantify the load reduction benefits of energy-saving interventions in buildings. The benefits are placed in the context of the local electricity grid, to highlight how building interventions can ease peak demand on the electric grid.	
Inputs:	
The tool is broadly split into two use cases: 1) using inbuilt parameters for Indore and Gurgaon, and 2) using custom inputs. Detailed instructions for each use case are provided below. Broadly, the tool requires one year of hourly electric grid data, one year of hourly electricity data for a building before and after intervention(s), and electricity tariff details. In the 'Inbuilt' case, grid data has been provided by utility partners, building data has been provided through energy modeling with predefined interventions, and tariff data has been provided for the partner regions. The 'Custom' case allows the user to supply their own data for one or all of these parameters.	
Outputs:	
Electricity use, electricity cost, peak demand, and coincident peak demand of a building before and after intervention(s). Comparison of hourly demand differences on the day when the electric grid has the highest load. Insights into the grid's peak demand day load profile.	
Stakeholder use cases:	
<ul style="list-style-type: none"> •Building project teams: Assess the impact of specific building energy efficiency and demand response interventions •Jurisdictions/code officials: Identify interventions to encourage through energy codes •Utility staff: Research efficiency and demand response interventions in buildings, building types, and locations inform program design and incentive allocations •Planners and advocates: Assess the impacts and compare the values of various energy efficiency and demand response interventions 	
Instructions for use:	
Inbuilt parameters for Indore and Gurgaon	Custom
For stakeholders in Indore, Gurgaon, or similar climactic region	For stakeholders in other climactic regions
User selects from building types, building interventions, grid data, and tariffs that are already defined	User can define custom building types, interventions, grid data, and/or tariffs
Hourly building data in the tool is based upon energy modeling that aligns with SUPER ECBC standards for calculation/output representation	Hourly building data is supplied by the user.
Step-by-step instructions:	Step-by-step instructions:
	1. In the Calculator tab, select "Custom" for the building type, and intervention. If the building is

Figure 1. Snapshot of introduction page of the tool.

HOW TO USE THE CALCULATOR

The tool is designed to accept inputs from users for ease-of-use. The tool is broadly split into two use cases:

Use case #1 - using inbuilt parameters for Indore and Gurgaon. In this case, users simply need to select a building type, location, and intervention from the dropdown menus at the top of the page to populate the summary table and graphics. See the Metric Methodology section for further details about the particular building types and interventions modeled.

Use case #2 - using custom inputs. See table below for more detail.

REQUIRED DATA INPUTS

For both use cases, the tool requires the same basic data inputs. In the inbuilt case, many inputs are pre-filled, as shown in Table 1.

Table 1. Summary of data inputs.

Data input	Use case #1: Inbuilt	Use case #2: Custom
One year of hourly electric grid data (demand data)	Pre-filled with data provided by Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Ltd. (MPWZ Discom, Madhya Pradesh) and Dakshin Haryana Bijli Vitran Nigam Ltd. (DHBVN Discom, Haryana).	User may supply their own.
Peak period for the electric grid (typically 4 hours of highest use)	Pre-filled based on utility data as described above.	If user supplies their own demand data, they may define the peak window.
One year of hourly electricity data for a building before and after intervention(s) (typically gathered from a building energy model exercise)	Pre-filled with custom energy modeling data. Energy modeling completed by project partner Environment Design Solutions (EDS) using eQUEST in collaboration with NBI, and MPWZ Discom and DHBVN.	User may complete building energy modeling using software (such as eQUEST or EnergyPlus) to supply their own.
Electricity tariff details	Pre-filled for the Madhya Pradesh Electricity Regulatory Commission 2023-2024 tariff (MPERC), and the Haryana Electricity Regulatory Commission tariff that became effective April 2021 (HERC).	Same as Inbuilt.

NAVIGATION

The primary tabs that users will interact with in the tool are as follows:

- **Intro:** Description of the tool and use cases.

- **Navigation:** Summary of all tabs in the tool and their use.
- **Calculator:** Allows user to define inputs and review output data and graphics. This is the primary tab for use.
- **Custom Inputs:** This tab allows the user to input custom hourly building data and/or hourly grid data for the custom use case.
- **Peak Params:** Displays the peak 4-hour period for the grid data. This is used to calculate the coincident peak for the building. For custom grid data this period must be defined by the user.

INSTRUCTIONS FOR INBUILT USE CASE

To utilize the inbuilt parameters, the user should first navigate to the “Calculator” tab. This is the primary tab for use, which allows the user to define inputs and review output data and graphics.

The steps for use are as follows:

	A	B	C	D
1	User Inputs (Select from dropdown menus)			
2	Select Building Type:	Assembly		
3	Select Location:	Gurgaon		
4	Select Intervention:	Efficient HVAC		
5				
6	Select Tariff (for Custom input only):	HERC 4.2		
7	Summary Outputs			

Figure 2. User inputs on the Calculator tab.

1. In cell B2, use the dropdown menu to select a building type. The options include:
 - a. Residential
 - b. Assembly
 - c. Hospital
 - d. Hotel
 - e. Large Office
 - f. Secondary School
 - g. Shopping Mall
 - h. Small Office
 - i. Strip Retail
 - j. University
2. In cell B3, use the dropdown menu to select the location. The tool includes energy modeling and electricity grid data for two locations: Indore and Gurgaon (Haryana). In Cell B3, users can select between the two options in the dropdown menu. See ‘Custom Use Case’ below for how to use the Custom option.
3. In cell B4, use the drop-down menu to select the energy efficiency or demand response intervention of interest. The available options will depend on the building type selected.
4. Review the results in the Summary Outputs table (cells A7:D13). Column B shows the baseline annual energy consumption for all fuels in the selected building and location, annual electricity usage and cost, annual peak kW, and the coincident peak kW. Column C shows the same information for the building after the selected intervention is applied, and column D shows the percentage savings between the baseline building and the building with the intervention applied.

	A	B	C	D
1	User Inputs (Select from dropdown menus)			
2	Select Building Type:	Assembly		
3	Select Location:	Gurgaon		
4	Select Intervention:	Efficient HVAC		
5				
6	Select Tariff (for Custom input only):	HERC 4.2		
7	Summary Outputs			
8		Baseline	Efficient HVAC	Savings (%)
9	Total Energy (All fuels, kWh)	2,722,962	2,090,649	23%
10	Total Electricity (kWh)	2,707,067	2,022,582	25%
11	Annual Electricity Cost (Rs.)	₹ 21,668,911	₹ 16,244,799	25%
12	Annual Peak kW	947	803	15%
13	Coincident Peak kW	845	670	21%
14				

Figure 3. Summary outputs on the calculator tab.

- Review the results in the summary output graphics, which include: the hourly building demand on the grid's peak demand day, the demand profile of the grid on the peak day, and a set of bar charts that show a visual representation of the information in the Summary Outputs table.

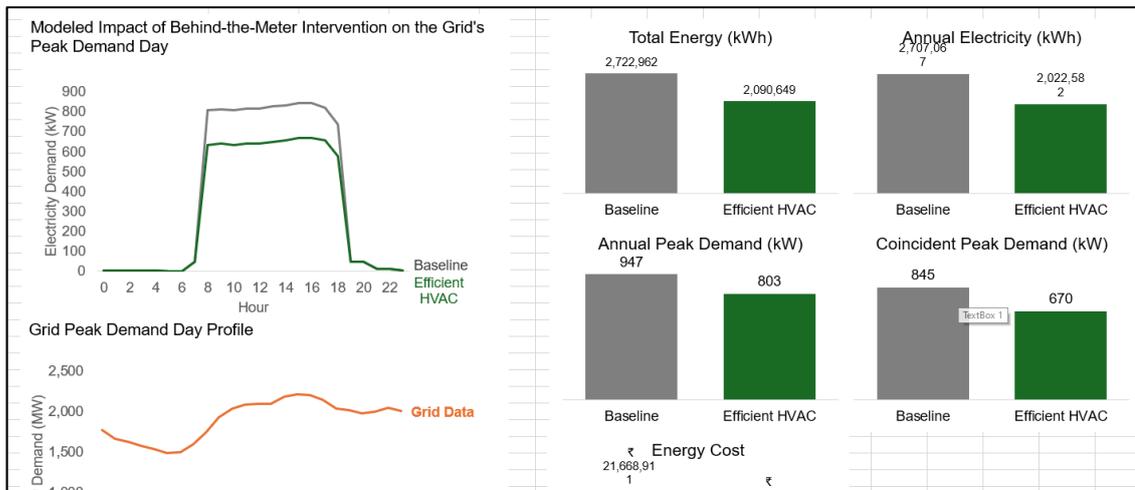


Figure 4. Summary graphics on the Calculator tab.

INSTRUCTIONS FOR CUSTOM USE CASE

In the custom use case, the user can input their own data to customize certain parameters. The user should first navigate to the “Calculator” tab as in the inbuilt case.

The steps for use are as follows:

1. In cell B2, use the dropdown menu to select the Custom-building type. Users who have not completed their own building energy modeling but who do have custom grid data may elect to use one of the inbuilt building types instead, but this is not a typical expected use case.
2. In cell B3, use the dropdown menu to select the location.
 - a. If the user wishes to use Indore or Gurgaon grid data, they may select these options.
 - b. If the user wishes to import their own grid data, select the Custom option.
3. In cell B4, use the dropdown menu to select Custom.
4. In cell B6, use the dropdown menu to select which tariff structure to use. This version of the tool supports the selection of several tariff options from HERM and MPERC only.

	A	B	C	D
1	User Inputs (Select from dropdown menus)			
2	Select Building Type:		Custom	
3	Select Location:		Custom	
4	Select Intervention:		Custom	
5				
6	Select Tariff (for Custom input only):		HERC 4.2	
7	Summary Outputs			

Figure 5. User inputs with Custom selections.

5. Navigate to the “Custom Inputs” tab.

	A	B	C	D	E	F	G	H
1	Input your custom hourly building and grid load profiles into the table below, add a peak window in the "Peak Params" tab, and select "Custom" from the corresponding dropdown menus in the "Calculator" tab							
	Hour of Year	DateTime	Month	Baseline Building Model Electricity kWh	Intervention Building Model Electricity kWh	Baseline Building Model Fuel kBtu	Intervention Building Model Fuel kBtu	Custom Grid Load MW
2								
3	1	1/1/2023 0:00	1	1	1	1	1	1
4	2	1/1/2023 1:00	1	1	1	1	1	1
5	3	1/1/2023 2:00	1	1	1	1	1	1

Figure 6. Snapshot of Custom Inputs tab.

6. Paste in the custom hourly building load profiles, which are the result of the user’s independent energy modeling of their own selected intervention(s), as directed.
 - a. Column D: Baseline building electricity consumption (kWh)
 - b. Column E: Building electricity consumption after intervention is applied (kWh)
 - c. Column F: Baseline building consumption of any fuels other than electricity (kBtu)
 - d. Column G: Building consumption of any fuels other than electricity after the intervention(s) are applied to the model (kBtu)

7. If the user has selected Custom grid data in cell B3 of the Calculator tab, complete the following:
 - a. Paste in the custom hourly grid load data in column H of the Custom Inputs tab.
 - b. Navigate to the Peak Params tab and define the peak grid load window in cells B4 and C4. A four-hour window is expected, although any period can be used. This is used to determine the peak coincidence kW of the building, which is cells B13 and B14 in the Calculator tab.
8. Return to the Calculator tab to review the outputs, as described in items 4 and 5 of the Inbuilt use case.

METRIC METHODOLOGY

The methodology for the primary metric inputs and outputs are included in this section.

BUILDING TYPE

The building types included in this tool were selected based on feedback from stakeholders and a literature review showing that these building types make up most of the existing building area throughout India. Hourly building data in the tool is based upon energy modeling that aligns with SUPER ECBC standards for calculation/output representation.

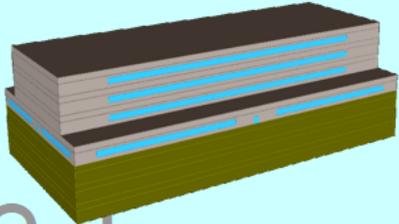
ECBC update: Baseline Building Specifications			
Category		Specification Descriptions	
Climate Zones (CZ)		Composite Hot and Dry Temperate (CZ1)	Warm and Humid (CZ2) Cold and Sunny Cold and Cloudy (CZ3)
Building Type		Institutional	
Building Prototype		Hospitals	
Building Geometry and Form			
Total Floor Area (m ²)		30,000	
Building shape		Rectangle	
Aspect Ratio (Lower floors)		2	
Aspect Ratio (Upper floors)		3	
Number of Floors		5	
Number of Basement		2	
Basement Area (m ²)		15,000	
Building Model			
Area Distribution*			
Entrance lobby, lift lobby, with waiting rooms		5%	

Figure 7. Example building energy modeling specifications.

INTERVENTIONS

For the ten building types identified above, this tool includes energy modeling results before and after selected energy efficiency and demand response interventions. Five interventions were modeled for commercial building types and seven interventions were modeled for the residential building type. These behind-the-meter interventions are deployable solutions that may be incentivized by market actors with the goals of reducing costs for electricity generators and customers alike, listed in Table 2. Detailed information about the building characteristics and intervention specifications, such as building envelope, setpoints, equipment COP, and lighting power densities is available in a supplementary “Building Model Input Summary” spreadsheet.

Table 2. Modeled building interventions by sector.

MODELED BUILDING INTERVENTIONS BY SECTOR		
INTERVENTION TYPE	COMMERCIAL	RESIDENTIAL
Efficiency	Efficient HVAC	Efficient HVAC
	Efficient Lighting	Efficient Lighting
		Efficient Appliances
		Efficient Ceiling Fan
		Efficient Water Heating
Demand Response	HVAC Demand Response	HVAC Demand Response
	Lighting Demand Response	
Combined	Combined Interventions	Combined Interventions

ENERGY COST (TARIFF)

Depending on the selected building type and location, the tool will estimate energy costs based on published tariffs, including variable costs and monthly fixed charges from the Madhya Pradesh Electricity Regulatory Commission FY2023-24 [Tariff Order](#) and Haryana Electricity Regulatory Commission Distribution & Retail Supply [Tariff](#). A select few representative tariffs have been selected, as opposed to including all potential tariff options.

Using monthly total and peak electricity use data from the energy models (or user-supplied models, in the Custom use case), we calculate the total annual energy cost for the appropriate tariff based on the user-selected building type, shown in Table 3. Details for the tariffs and monthly calculations are available for advanced users in the “Tariffs” tab.

Table 3. Tariff structure by building type.

TARIFF	STRUCTURE	BY	BUILDING	TYPE
BUILDING TYPE		INDORE TARIFF*	GURGAON TARIFF**	
Residential		LV1.2	1.2	
Large Office		LV2.2	4.2	
Small Office		LV2.2	4.2	
Hospital		LV2.2	4.2	
Assembly		LV2.2	4.2	
Hotel		LV2.2	4.2	
Strip Retail		LV2.2	4.2	
Shopping Mall		LV2.2	4.2	
Secondary School		LV2.1	4.2	
University		LV2.1	4.2	

* per Madhya Pradesh Electricity Regulatory Commission Tariff Order

** per Haryana Electricity Regulatory Commission Distribution & Retail Supply Tariff

ANNUAL PEAK

The annual peak calculation provides a straightforward comparison of the baseline case and the intervention, comparing the top hour of electricity demand shown in the energy model at any point in the year. For example, the baseline model may show a peak demand of 1000 kW on June 18 at 4PM, and the intervention case shows a peak demand of 750 kW on August 1 at 2PM. While this metric provides overall content on how much the intervention may limit demand from the grid, looking specifically at peak reduction *when the grid is under stress* is also important, and covered under coincident peak.

COINCIDENT PEAK

The coincident peak metric provides a customized view into the impact of the intervention within the context of the building’s local electricity grid. For the two modeled locations, Indore and Gurgaon, the tool defines a four-hour window, or “Peak Coincidence Window” during which data shared by the utilities indicates the electricity grid is at its peak for the year. These values are pre-defined in the tool (shown in Table 4), though advanced users may update the start and end date and time for the window to explore the impact of the interventions during other times.

Based on the peak coincidence window, the coincident peak metric calculates the peak electricity demand in kW for the baseline and intervention case during the four-hour window only. The benefit of this metric is that it informs electricity grid operators about how much load reduction they can anticipate during the time it matters most to them – when the grid is under the most stress and electricity generation and procurement costs are highest.

Table 4. Pre-defined peak periods (four hours) for each electricity grid.

PRE-DEFINED FOUR-HOUR PEAK PERIODS FOR EACH ELECTRICITY GRID		
PEAK COINCIDENCE WINDOW	START	END
Indore	June 12, 2023 13:00	June 12, 2023 16:00
Gurgaon	August 21, 2023 14:00	August 21, 2023 17:00

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