

Introduction to RU-LESS Tool User Input Interface

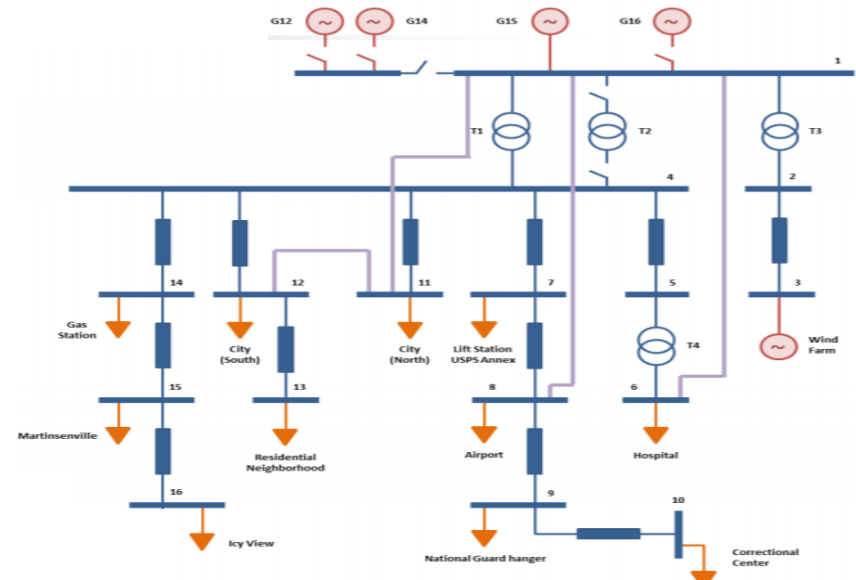
Rutgers University

RU LESS

What does RU-LESS model solve?

- The arbitrary multi-locational micro-grid (MG) consists of:

- Multiple demand nodes
- Existing on-site generation/storage technologies



- We are interested to solve following problems:

- What is the value of MG for distribution network?
- What is the impact of MG on rate-payers financial?
- What is the impact of MG on the grid?



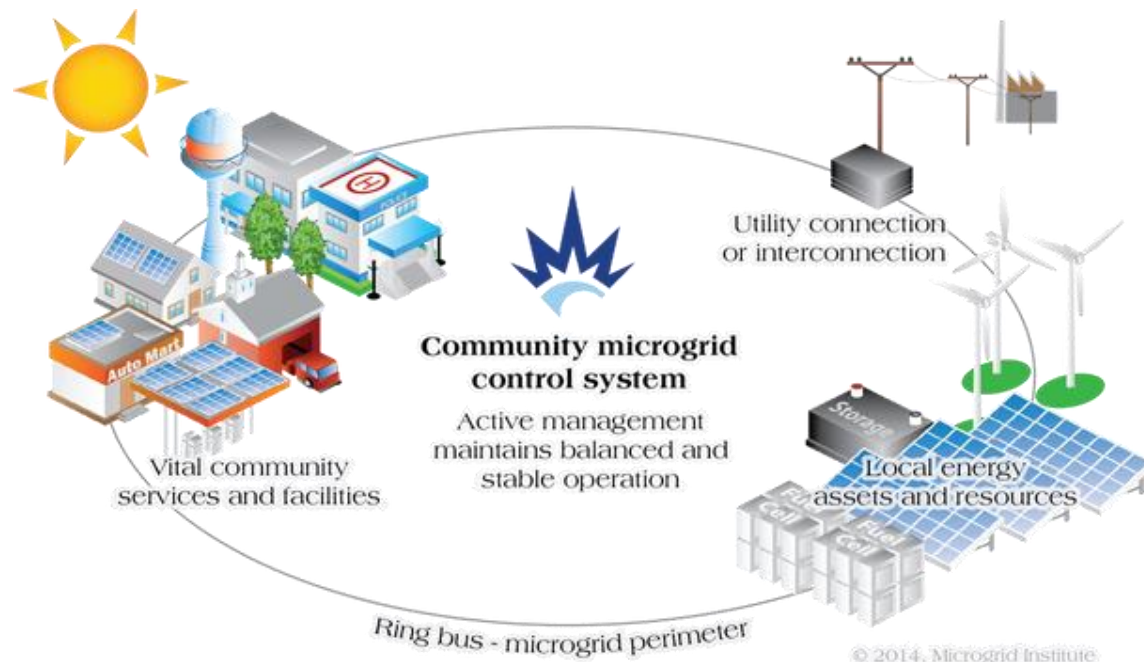
What does RU-LESS optimization model offer?

- Impact of MG on the facility annual energy cost, located at different nodes.
- Impact of MG on the real / reactive power loss.
- Impact of MG on the voltage fluctuation at different nodes.
- Impact of MG on the peak electricity demand at different nodes.
 - This will result in capacity upgrade deferral.
- Impact of MG on the resiliency capability.



Data requirement in RU-LESS

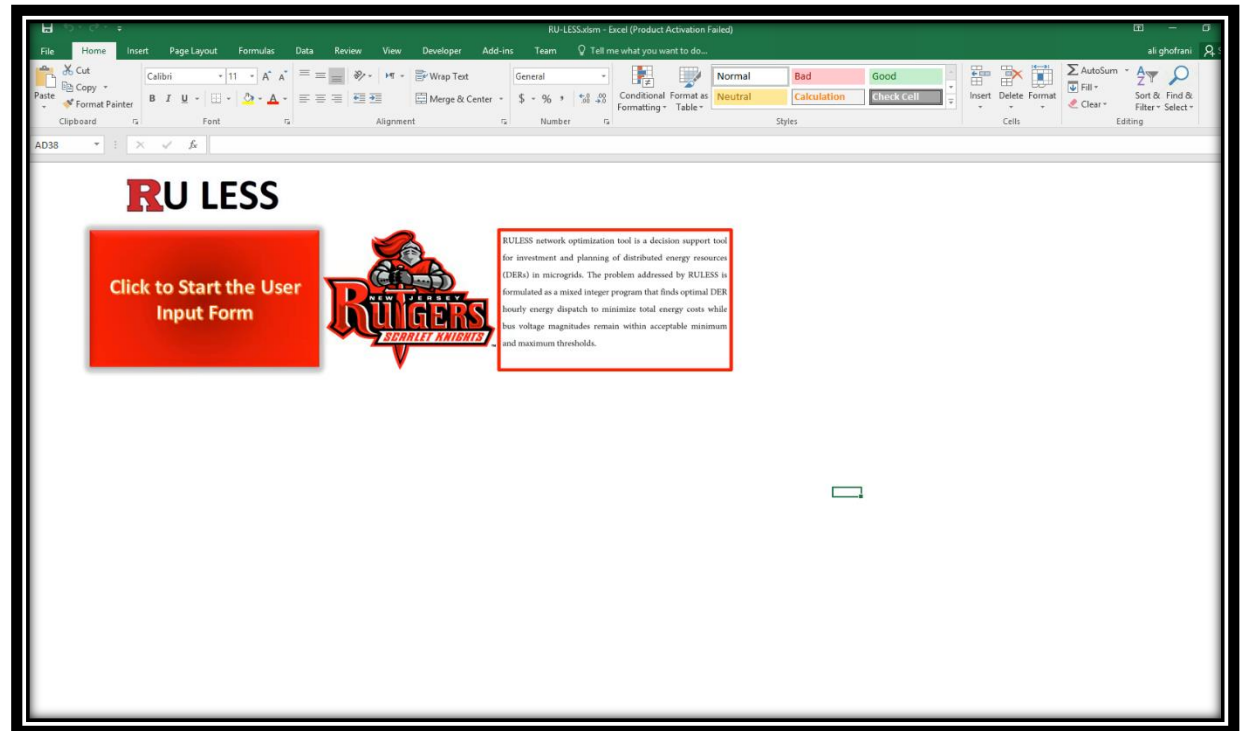
- Pre-post configuration
 - The current or prior configuration of the system
 - The post configuration design and portfolio



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RU-LESS Data Input Interface

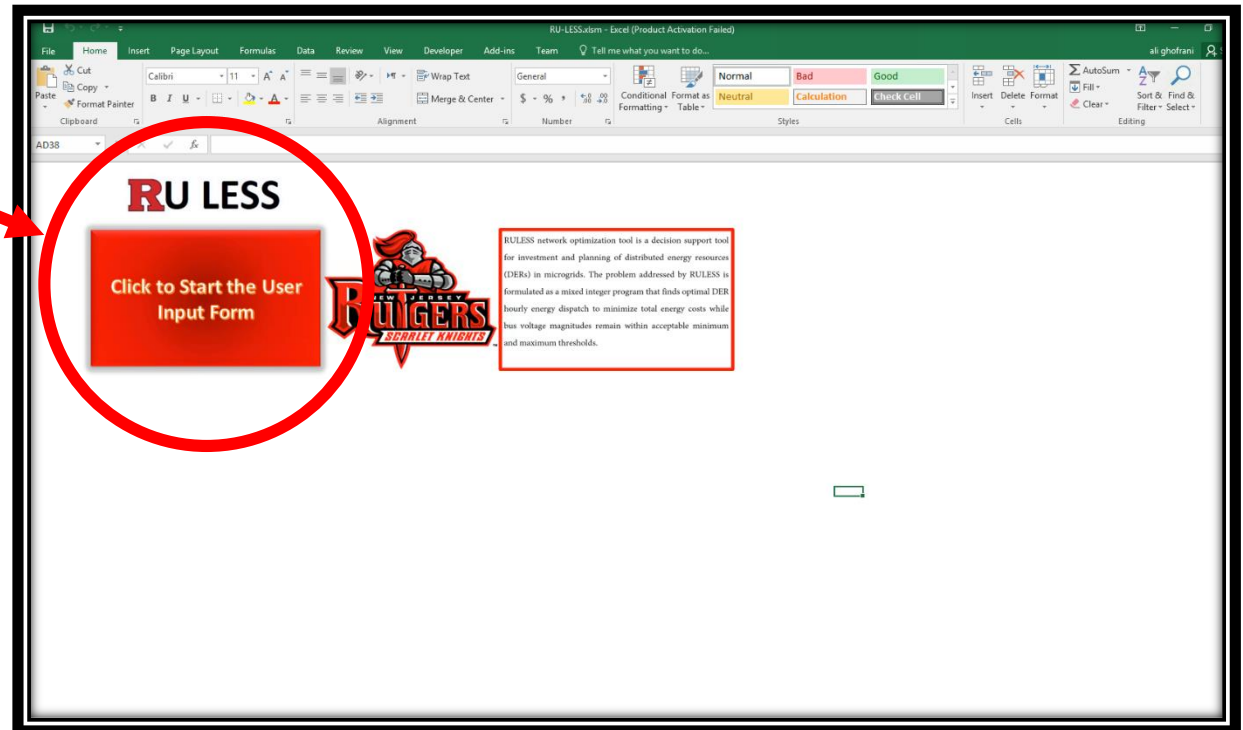
- Rutgers has developed a user-friendly graphical interface to collect the desired data for evaluation of the proposed TCMG configurations.
- There is no need to install any .exe file
- Two Excel files need to be opened by the user
 - Pre-Design
 - Post Design Case



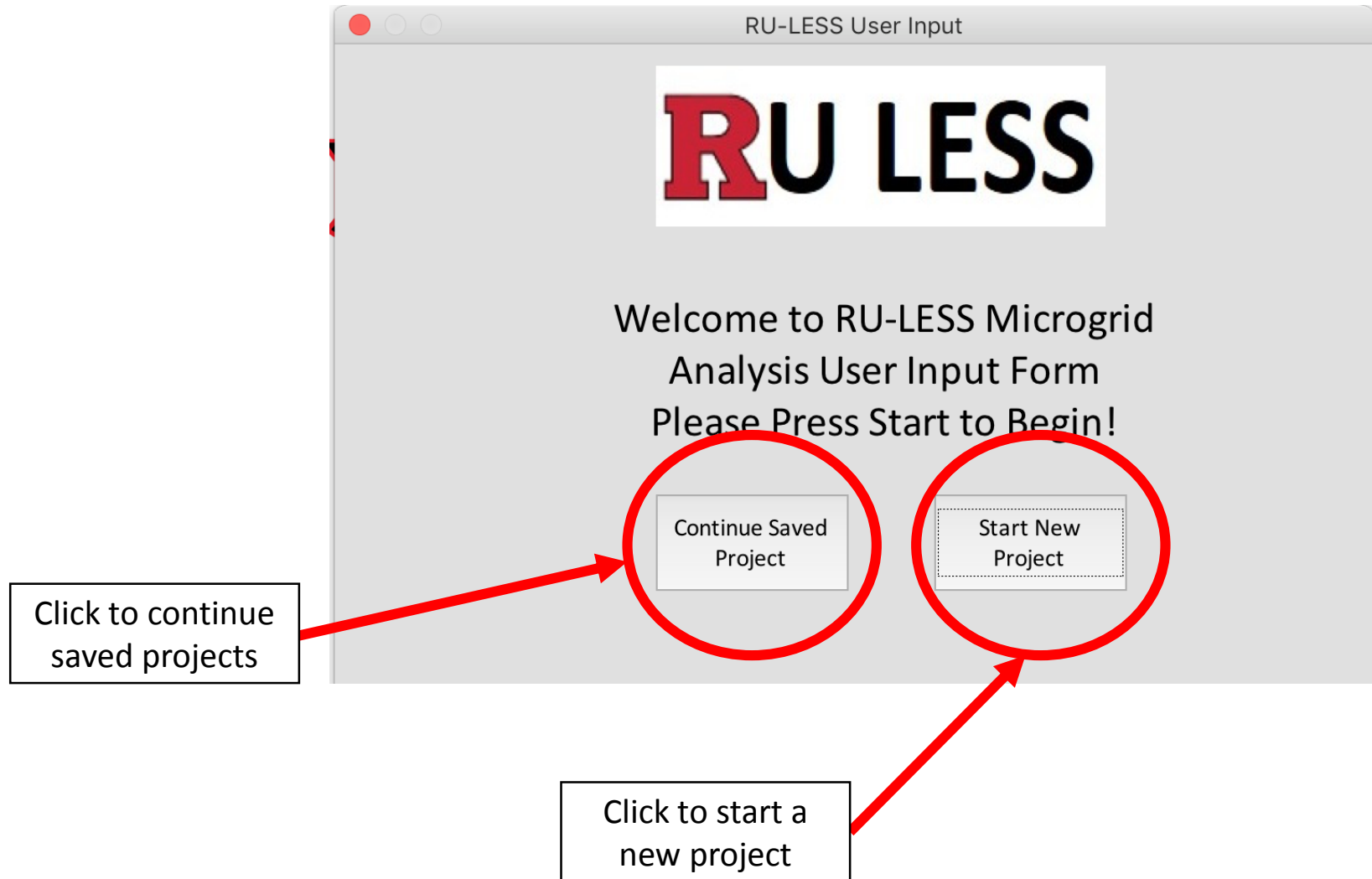
1- Initiation

- Simply open the Excel file and click on the red button to start the user forms

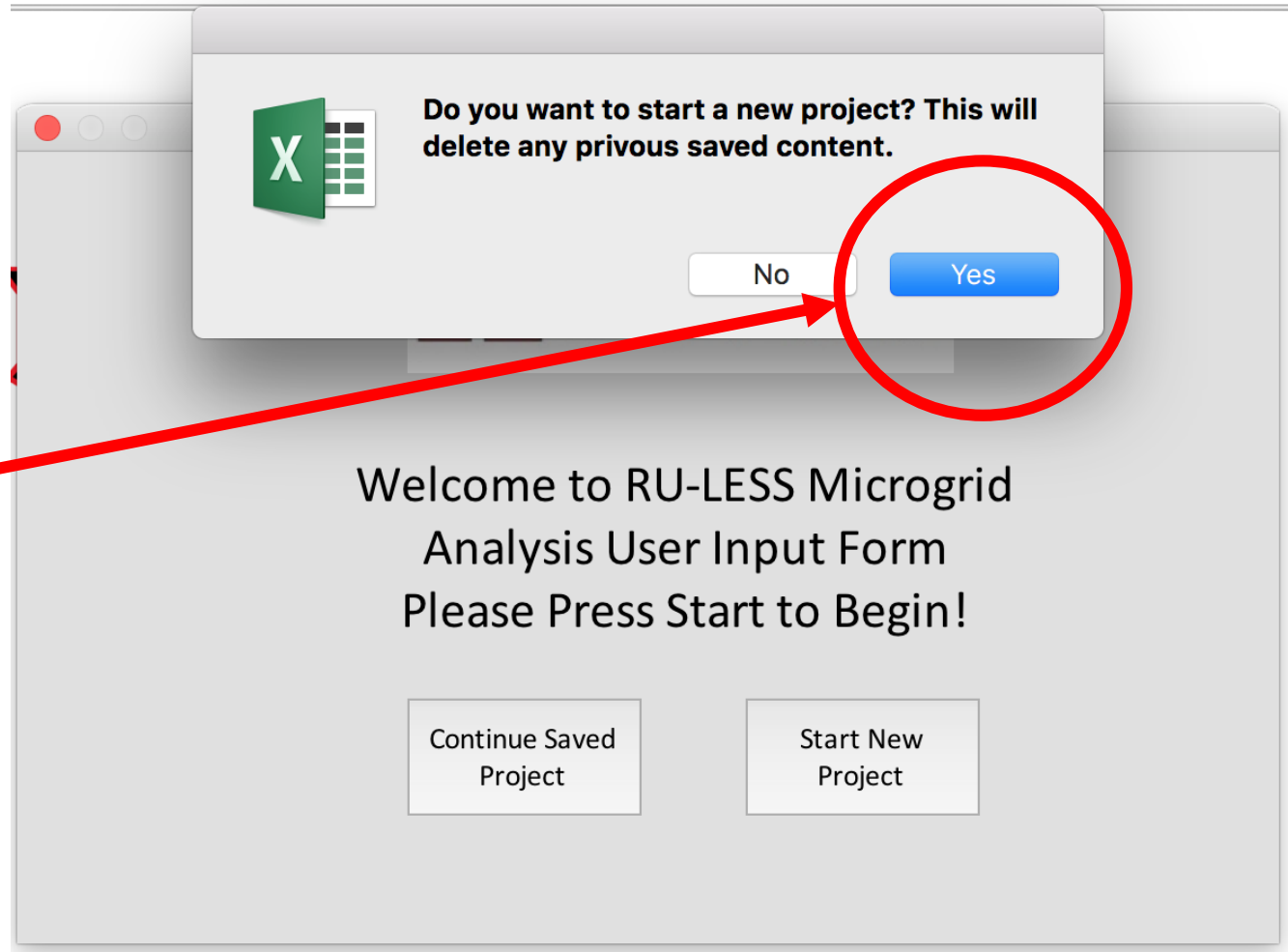
Click to start!



2- Start new project or continue saved projects



3- Start a new project



Deletes the previous projects and starts a new one

4- What information is needed?

Project Description

Utility information

Number of buses

Bus definition

Technology description

Demand definition

Network topology

Comments on data and submitting

5- Inputsheet structure

At any stage of the process, the interface is composed of three main sections:

- Quick access bar: At any stage the user can have access to the preferred section
- Main section: The information is added in this section
- Section description: Presents details on the main section

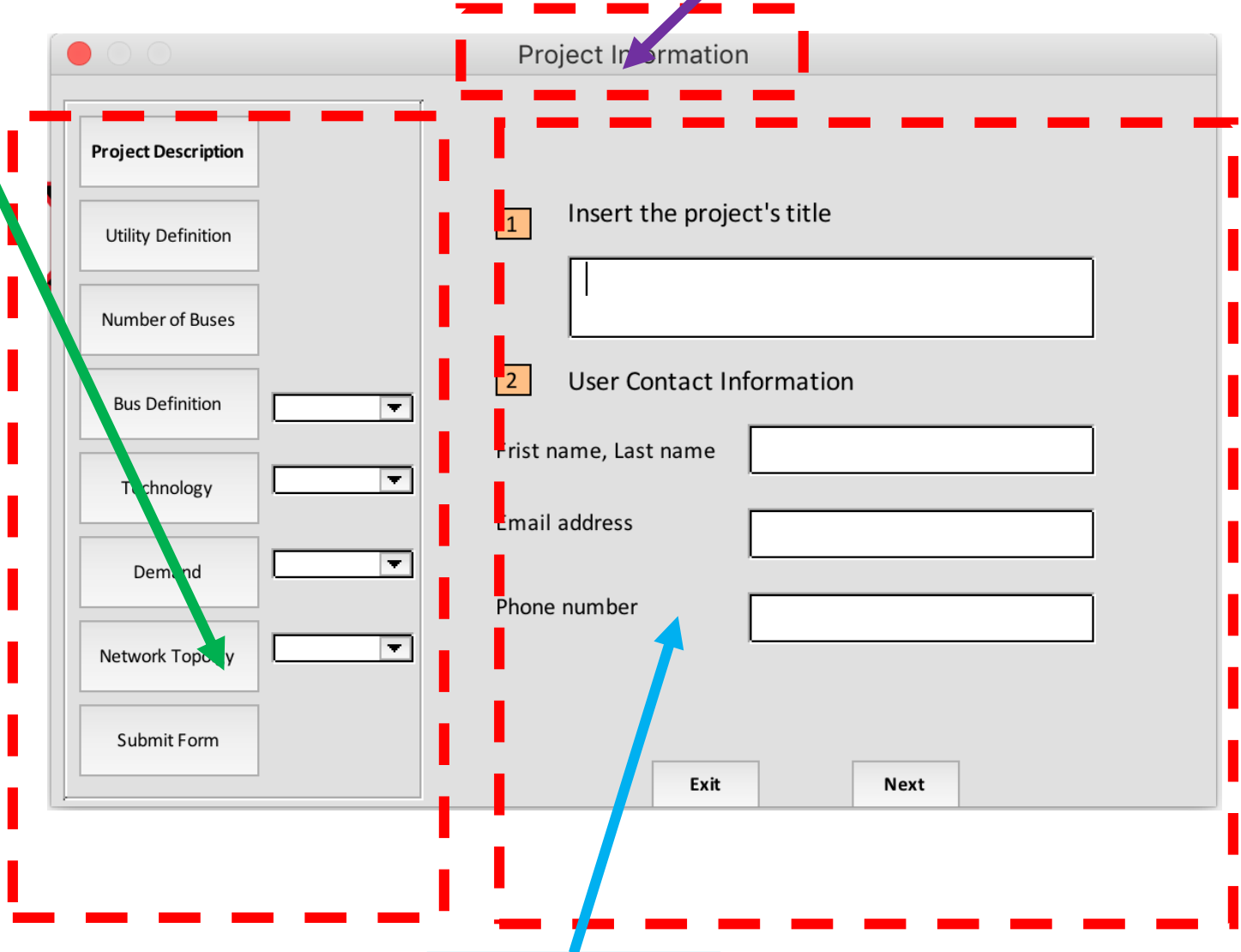
The screenshot shows a window titled "Project Information" with a sidebar on the left and a main content area on the right. The sidebar contains a "Project Description" section with buttons for "Utility Definition", "Number of Buses", "Bus Definition", "Technology", "Demand", and "Network Topolgy", along with a "Submit Form" button. The main content area has two numbered sections: "1 Insert the project's title" with a text input field, and "2 User Contact Information" with input fields for "Frist name, Last name", "Email address", and "Phone number". At the bottom right are "Exit" and "Next" buttons.

6- Main window

Quick access bar

At any stage, the user can have access to different sections

Main section description



Main section

7- Project description

We need to first identify the project and acquire a point of contact for possible further discussion on the TCMG project

The screenshot shows a web form titled "Project Information" with a sidebar on the left and a main content area on the right. The sidebar contains several sections: "Project Description" (highlighted with a red dashed box), "Utility Definition", "Number of Buses", "Bus Definition" (with a dropdown menu), "Technology" (with a dropdown menu), "Demand" (with a dropdown menu), "Network Topology" (with a dropdown menu), and "Submit Form". The main content area is divided into two steps: Step 1, "Insert the project's title", with a text input field containing "Rutgers TCMG in Piscataway"; and Step 2, "User Contact Information", with input fields for "First name, Last name" (Alan, Smith), "Email address" (smith@rutgers.edu), and "Phone number" ((xxx) xxx-xxxx). At the bottom are "Exit" and "Next" buttons. Annotations include: a purple box labeled "Project name" pointing to the title field; a green box labeled "Contact information" pointing to the email field; a blue box at the bottom left stating "At any stage of the progress, you can click on this button to change the info" with an arrow pointing to the "Submit Form" button; and a yellow box at the bottom right stating "You can click next to go to the next step" with an arrow pointing to the "Next" button.

8- Utility

We need to know the rate structures that are used for this project. Please specify what Gas/Elec. utility company is involved in this project.

The screenshot shows a software window titled "Rate Structure Definition". On the left, a sidebar contains several sections: "Project Description", "Utility Definition" (highlighted with a red dashed box), "Number of Buses", "Bus Definition" (with a dropdown menu), and "Submit Form". A blue arrow points from the "Utility Definition" section to a text box that says: "At any stage of the progress, you can click on this button to change the utility info".

The main area is titled "Energy Tariff" and contains two dropdown menus. The "Elec. Utility Name" dropdown is set to "JCP&L". A purple arrow points from a text box "Click to find a list of Elec. Utility companies" to this dropdown. Below it, the "Gas Utility Name" dropdown is open, showing a list of options: "NJNG", "PSE&G", "NJNG" (highlighted in blue), and "Other". A green arrow points from a text box "Utility list" to this list. A blue arrow points from a text box "Click to find a list of gas Utility companies" to the "Gas Utility Name" dropdown.

At the bottom of the window, there are "Previous" and "Next" buttons. A yellow arrow points from a text box "You can click next to go to the next step" to the "Next" button.

9- Number of buses

- ✓ Definition of bus: A bus (also called node) in a MG configuration is a location within the MG that contains:
 - Thermal or electric load (e.g. buildings)
 - Power generation technology
 - Cold/thermal/electric storage
 - Chiller and boiler
 - Common coupling point to the main power grid
- ✓ One can consider multiple elements described above to define a bus (We also call a bus “Node” as well)
 - These elements should be in a reasonable close vicinity
 - For instance, an office building and a district chiller, solar panels, and battery storage next to the building



We suggest the user first decide about the number of buses and make a list of the buses with the elements that are included

Quick access to this page. (changing the number of buses in the middle of the project is not suggested!)

Specify the number of buses

Number of Buses

Project Description

Utility Definition

Number of Buses

Bus Definition

Technology

Demand

Network Topology

Submit Form

How many electric buses are included in your microgrid network?

3

Previous Next

10- Bus/Node description

The screenshot shows a web form titled "Bus 1 Details". On the left, there are tabs for "Project Description", "Utility Definition", "Number of Buses", "Bus Definition", "Technology", "Demand", "Network Topology", and "Submit Form". The "Bus Definition" tab is active, showing a dropdown menu with "Node 1", "Node 2", and "Node 3" selected. The main form area contains six numbered steps:

- 1 Assign a name for this bus if applicable: CAIT Building
- 2 Physical address of the bus if applicable: 100 Brett Rd, Piscataway, 08854
- 3 Is this bus a slack bus? (if the microgrid is grid-connected, a slack bus is the point of common coupling): No
- 4 Does the bus contain any electricity/thermal demand?: Yes
- 5 Is hourly demand (electricity/thermal) data available for this node?: Yes
- 6 Is any battery storage installed in this: No

Below these steps is a section titled "Assign the number of technologies if they exist in the vicinity of the bus" with three rows:

7	Number of Power Generation Assets	2
8	Number of Chillers and Boilers	2
9	Number of Thermal/Cold Storage Assets	1

At the bottom of the form are "Previous" and "Next" buttons.

The Bus that is being described

Specify if the bus is a slack bus

Specify if the bus contains demand

Specify if the demand data is available

Specify if the bus contains battery

First select the desired bus (Node) from the dropdown button and click on **Bus Definition** button to jump to the page to describe that bus

Go to next or previous bus

Specify number of different technologies



If the number of nodes is not assigned yet, you are not able to use the quick access buttons



Power generation technologies includes any type of generation such as renewable, CHP, etc.



Maximum number for assets in each node is:
1- Power generation: 12
2- Chiller/Boiler: 6
3- Thermal/Cold Storage: 6
If the number of assets exceeds the max, please use aggregate capacity and average the parameters.

11- Technology description

You can always change the values previously specified in Bus definition here

Battery Parameters

Depending on the number of defined technologies, press on the button to specify the parameters of that power gen technology

Depending on the number of defined chillers/boilers, press on the button to specify the parameters of that technology

Depending on the number of defined hot/cold storage, press on the button to specify the parameters of that technology

Go to next or previous bus

Bus 1 Technology Input

1 Is any battery storage installed? Yes

2 Number of Power Generation Assets 2

3 Number of Boilers or Chillers 2

4 Number of Thermal/Cold 1

5 Click to Enter Electric Storage Parameters

6 Click on Generation Buttons to Insert the Power Generation Parameters

Asset #1	Asset #2

7 Click on Thermal Gen Buttons to Insert the Thermal/Chilled Water Generation Parameters

Asset #1	Asset #2

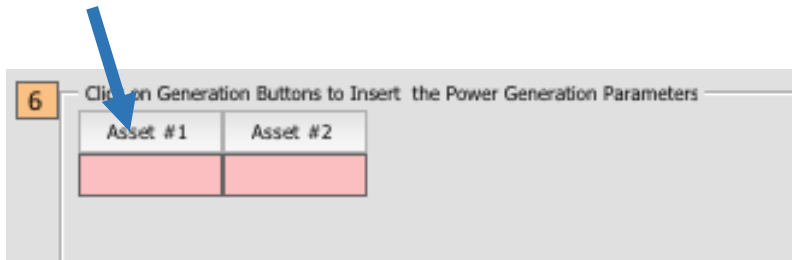
8 Click on Thermal Str Buttons to Insert the Thermal/Chilled Water Storage Technologies

Asset #1

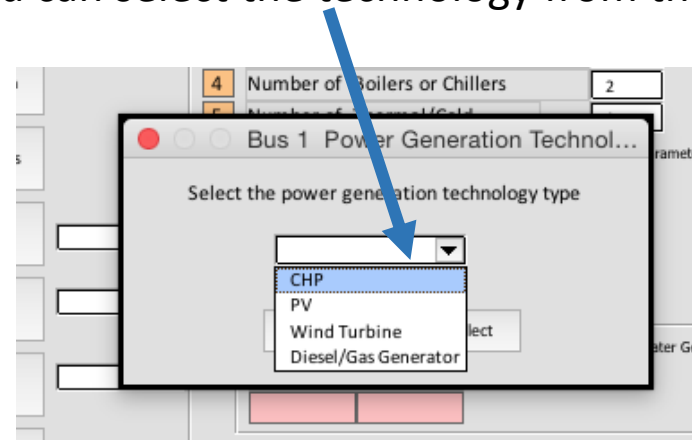
Previous Next

12- Technology parameters

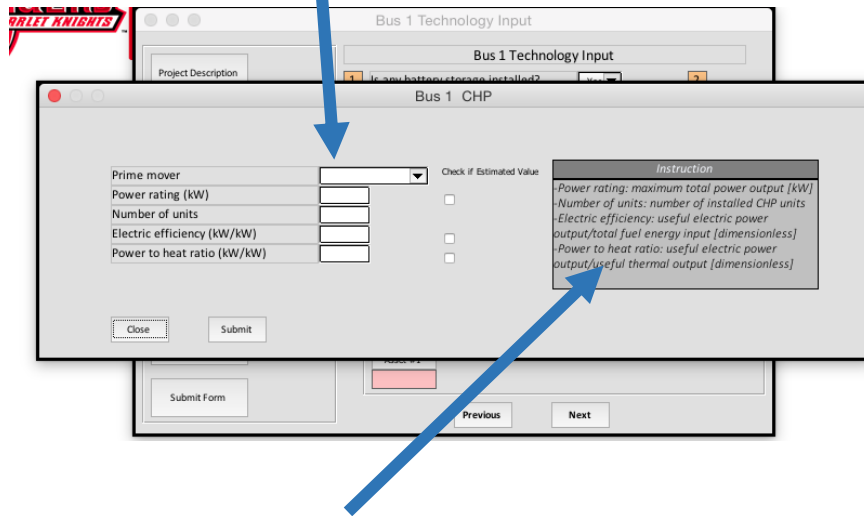
a- Select an asset



b-You can select the technology from the window

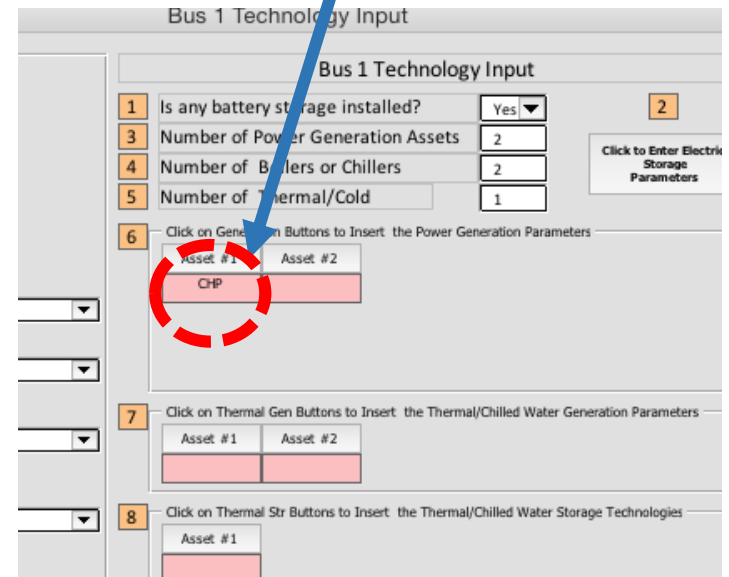


c-After selecting the technology, a list of parameters will be available to be filled out.



Instruction for the parameters

d-After filling out the parameters, the selected technology will show up under the asset number.



13- Technology parameters

For the sections that dataset is requested, simply copy and paste the desired column in the provided space.

The 'Bus 1 PV' dialog box contains the following fields and instructions:

- Number of cells: []
- Power rating (kW): []
- Panel area (m2): []
- Solar panel efficiency (%): []
- Open circuit voltage (V): []
- Max power voltage (V): []
- Max power current (Amp): []

Insert the hourly solar radiation data if available (yyyy-MM-dd HH):

(yyyy-MM-dd HH)	Solar Radiation (kW/m2)
12/31/16 16:00	
12/31/16 17:00	
12/31/16 18:00	
12/31/16 19:00	
12/31/16 20:00	
12/31/16 21:00	
12/31/16 10:00	
12/31/16 11:00	

Close Submit

Instruction

- Power rating: Nominal power [kW]
- Panel area: Area [m2]
- Efficiency: Solar panel efficiency at the normal condition [%]
- Open circuit voltage: maximum voltage available from a solar cell [V]
- Max power voltage: voltage at the nominal power
- Max power current: current at the nominal power
- Solar radiation hourly profile: hourly solar radiation on tilted panels [kW/m2]

The 'Bus 1 Technology Input' main form includes the following sections:

- Project Description
- Utility Definition
- Number of Buses
- Bus Definition
- Technology
- Demand
- Network Topolgy
- Submit Form

Bus 1 Technology Input

- 1 Is any battery storage installed? Yes
- 2 Number of Power Generation Assets 2
- 3 Number of Boilers or Chillers 2
- 4 Number of Thermal/Cold Storage 1
- 5 Click on Generation Buttons to Insert the Power Generation Parameters
- 6 Asset #1: CHP, Asset #2: Diesel
- 7 Click on Thermal Gen Buttons to Insert the Thermal/Chilled Water Generation Parameters
- 8 Asset #1: Absorption, Asset #2: ElectricC
- 8 Click on Thermal Str Buttons to Insert the Thermal/Chilled Water Storage Technologies
- Asset #1: ThermalStr

Previous Next

After completing the parameters for each technology, the assets are shown under the related section.

Go to next or previous step

14- Demand data

A- Click on next button to insert the demand

B- There are three cases:

- The bus/node contains demand and demand data is available
- The bus/node contains demand and demand data is not available
- The bus/node does not contain demand

- The bus/node contains demand and demand data is available

- The bus/node contains demand and demand data is not available

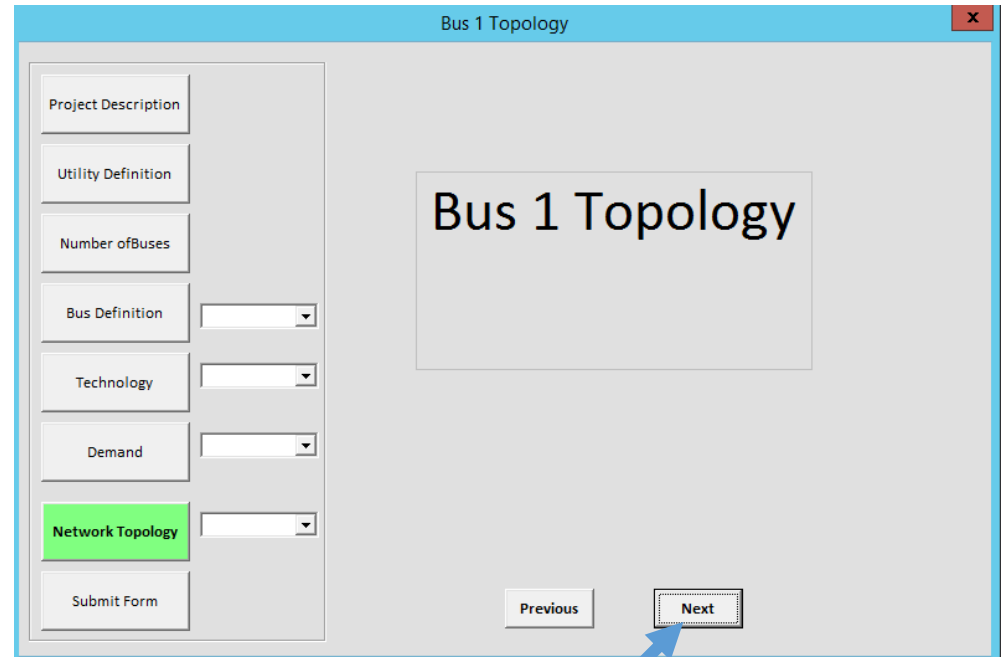
1	(yyyy-MM-dd HH)	Electricity (kW)	Thermal (Btu)	2	3
		1033.66	1033.66	GLP	???
		1210.06	1210.06		
		1416.7	1416.7		
		1789.74	1789.74		
		1537.66	1537.66		
		1628.38	1628.38		
		1754.28	1754.28		
		1063.9	1063.9		
		1205.02	1205.02		
		1003.42	1003.42		
		1593.1	1593.1		
		1215.1	1215.1		

Specify the rate schedules for elec. And gas

15- Network Topology

A- It should be specified how the current bus/node is connected to other buses/nodes.

- Cable connection between the nodes
- Piping connection between the nodes
 - Hot/medium/ low temp piping
 - Chilled water



The screenshot shows a software window titled "Bus 1 Topology". On the left side, there is a vertical stack of form fields: "Project Description", "Utility Definition", "Number of Buses", "Bus Definition" (with a dropdown arrow), "Technology" (with a dropdown arrow), "Demand" (with a dropdown arrow), "Network Topology" (with a dropdown arrow and highlighted in green), and "Submit Form". The main area of the window contains a large box with the text "Bus 1 Topology". At the bottom right of the window, there are two buttons: "Previous" and "Next". A blue arrow points from a text box below to the "Next" button.

Click next to access to the network connection for the bus

16- Network Topology connection

Three fields should be considered.

1- Power network

2- Hot/medium/low temp piping network

3- Chilled water piping network

Bus 1 network connection

1 Power network connection

Nodes that are connected to node 1 | |

List of connected nodes

2 High temperature water network connection

Nodes that are connected to node 1 | |

List of connected nodes

3 Chilled water network connection

Nodes that are connected to node 1 | |

List of connected nodes

Previous Next

Instruction

-Define the topology of the network by creating the list of nodes that are connected to this node form drop-down list.

- Find the preferred node from the drop-down list and press select to connect it to the current node, to remove an already added node, find it from the drop-down list and press deselect.

Connected nodes to the current node will appear in these fields

Bus 1 network connection

1 Power network connection

Nodes that are connected to node 1 | |

List of connected nodes Node 2 Node 3

2 High temperature water network connection

Nodes that are connected to node 1 | Node 2 |

List of connected nodes Node 2

3 Chilled water network connection

Nodes that are connected to node 1 | Node 3 |

List of connected nodes Node 2 Node 3

Previous Next

Select a bus/node from the list to connect it to the current bus/node. If you want to remove an already connected node select it from the list and press **Deselect**.

Go to next step

17- Power network constraints

One has to specify maximum/minimum acceptable voltage and angles for the specific bus.

The screenshot shows a dialog box titled "Bus 1 Topology" with a sub-section "Bus 1 Bus Voltage Parameters". It contains four input fields: "Maximum acceptable voltage (kV)", "Minimum acceptable voltage (kV)", "Maximum acceptable voltage angle (rad)", and "Minimum acceptable voltage angle (rad)". An instruction box on the right states: "Specify the minimum and maximum value for voltage magnitude and angle. If the node is a slack bus, specify the voltage magnitude at the microgrid slack (reference) bus. Note that if the microgrid is grid-connected, the slack bus is the point of common coupling." Navigation buttons "Previous" and "Next" are visible.

Details of the cables connecting nodes should be specified

The screenshot shows a dialog box titled "Bus 1 Power Network Connection". It features two rows of input fields for "Bus 1-2 cable parameters" and "Bus 1-3 cable parameters". Each row includes fields for "Length (m)", "Resistance (ohm/m)", "Inductance (mH/m)", "Ampacity (Amp)", and "Power Capacity (kW)". An instruction box on the right lists: "Length: Cable length [m]", "Resistance: Cable resistance [ohm/m]", "Inductance: Cable inductance [mH/m]", "Ampacity: Cable ampere capacity [amp]", and "Power capacity: Cable power capacity [kW]". Navigation buttons "Previous" and "Next" are present.

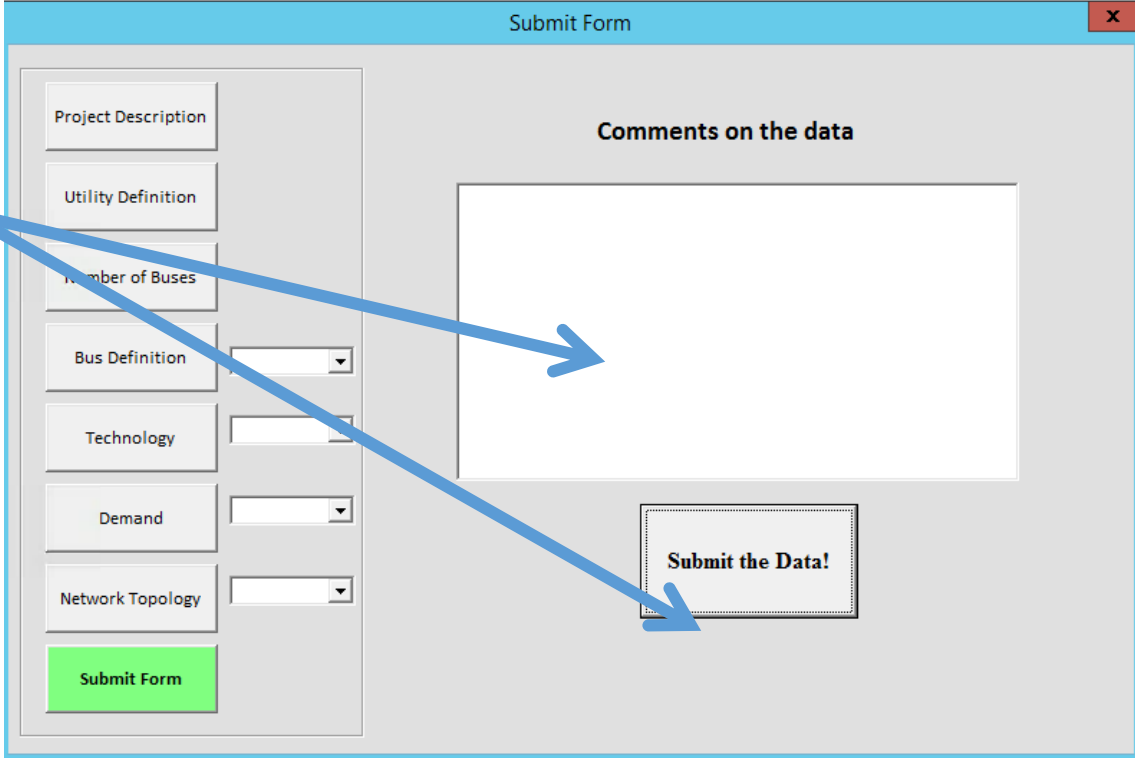
And also the piping system

The screenshot shows a dialog box titled "Bus 1 Hot Temperature Water Network". It includes a "Bus 1-2 pipe parameters" input field with three associated fields: "Length (m)", "Capacity (Btu/hour)", and "Thermal Loss Coefficient (% per meter)". Navigation buttons "Previous" and "Next" are located at the bottom.

18- Submit the data

After completion of the all steps, the user can submit the data and add any specific comment regarding the provided information

You can always save the files and continue the projects.



A pdf file (Form.pdf) will be generated for the review of the user. Also, the data will be available in .xls (FinalData.xls) in the same folder.



Before submitting the data, please make sure that the generated pdf and excel files are all closed!

19- Sending the data to LESS

RU-LESS requires the users to submit 3 files for pre-design and 3 files for post-design configurations. Please send the files to A.Ghofrani@rutgers.edu

File checklist:

- 1- RULESS-PRE.xlsm
- 2- RULESS-POST.xlsm
- 3- Form-PRE.pdf
- 4- Form-POST.pdf
- 5- FinalData-PRE.xls
- 6- FinalData-POST.xls