Clean Energy Emission Reduction (CLEER) Calculator User Guide

Guidelines for Quantifying GHG Emissions Reduced or Avoided from Clean Energy Activities Conducted Under the USAID Global Climate Change Initiative

May 2019

This document was prepared for the United States Agency for International Development (USAID) by ICF under Cooperative Agreement No. AID-OAA-LA-11-00003.

Version 3.1

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INTRODUCTION

The USAID Clean Energy Emission Reduction (CLEER) Calculator provides methodologies and calculations for estimating greenhouse gas (GHG) emissions reduced or avoided from a variety of activities under the Clean Energy Pillar of the Global Climate Change Initiative. The Calculator should be used by Operating Units (OUs), Implementing Partners, or others with clean energy programs and actions to report on Indicator 4.8-7:

"Greenhouse gas emissions, estimated in metric tons of CO_2 equivalent [tCO_2e], reduced, sequestered, and/or avoided as a result of USG assistance."

This User Guide can assist OUs using the CLEER Calculator to generate estimates of emissions reduced or avoided for annual reporting.

Organization

The User Guide is organized into four main sections:

1. **Introduction**
2. **Instructions** – Provides general information for navigating and inputting data into the Microsoft Excel-based Calculator.
3. **FAQs** – Provides answers and option for troubleshooting common questions and issues.
4. **Data Collection Needs** – Describes the data required for estimating emission reductions for each of the following CLEER Calculators:
    - Clean Energy GHG Calculator
    - Solar Photovoltaic Systems
    - Solar Thermal Systems
    - Wind Turbine Systems
    - Hydroelectric Systems
    - Geothermal Power Systems
    - Geothermal Direct Heat Systems
    - Geothermal Heat Pumps
    - Biomass Energy
    - Anaerobic Digesters
    - Building Energy Efficiency
    - Appliance Energy Efficiency
    - Transmission and Distribution System Upgrades – Technical Loss Reductions
    - Stranded Natural Gas Capture Systems

Downloading the Calculator & Additional Information

Calculators and the complete CLEER Protocol, which includes the calculation methodologies that support each Calculator, can be downloaded from the following site:
https://pages.usaid.gov/E3/GCC/ghg-accounting-tools

The **CLEER Tool** compiles the Calculators and relevant materials in an online program, which is available at:
https://www.CLEERTool.org

INSTRUCTIONS

Each of the CLEER Calculators has the same basic structure with four main components—**Instructions**, **Data Input**, **Calculations**, and **Results**—that guide the user to enter the necessary information to quantify Indicator 4.8-7 in the reporting year.

Users should follow the steps outlined below in order to estimate a value for Indicator 4.8-7.

STEP 1 – Review the Instructions

The **Instructions** page of the Calculator contains general information about the Calculator including the type of action it addresses, definitions, and instructions for entering data.

Navigating the Calculator

Each page of the Calculator includes icons at the top and bottom that allow the user to navigate throughout the Calculator.

The white arrow buttons at the top of each page allow the user to navigate to the next page, the previous page, or the beginning home page at any time.

The blue arrow buttons at the bottom of each page guide the user to the next step in the Calculator after entering or reviewing information on each page.

Input Field Color-Coding

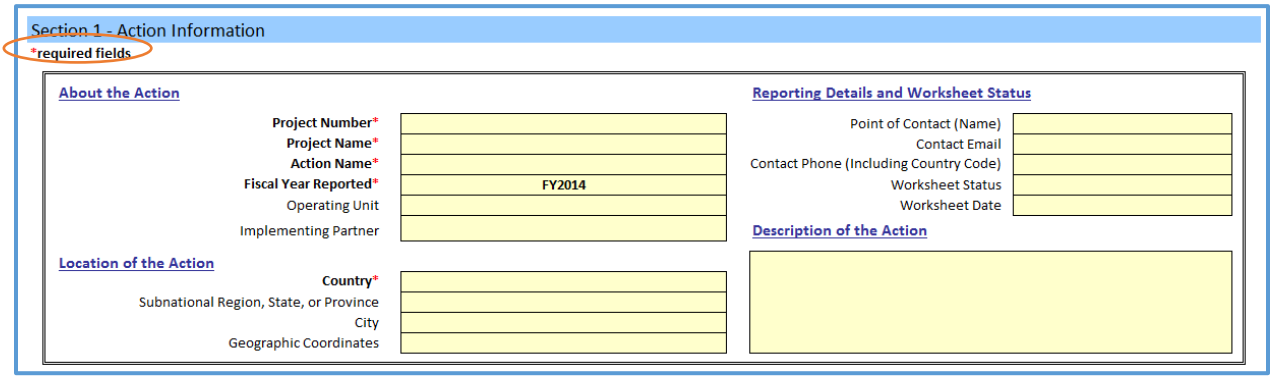
Input fields in the Calculator are color-coded based on the type of information needed from the user.

- **Yellow** fields are for key data inputs and are filled in by the user. Many contain dropdown menus with standard entries.
- **Blue** fields are input fields where the user can override default values. The Calculator provides many default values to help estimate emission reductions. The user can choose to enter alternate values if information is available to improve on these defaults.
- **Green** and **White** fields contain values calculated by the Calculator. The user cannot alter these fields.

Cell Color Legend:
Input Fields
Alternative Fields
GHG Reduction Estimates
Calculations

STEP 2 – Enter General Information about the Action

The second page of the Calculator—**Data Input**—contains two sections for the user to enter specific information about the action. Users should enter general information about the action into Section 1, such as action name, USAID program, location of the action, and fiscal year of reporting:

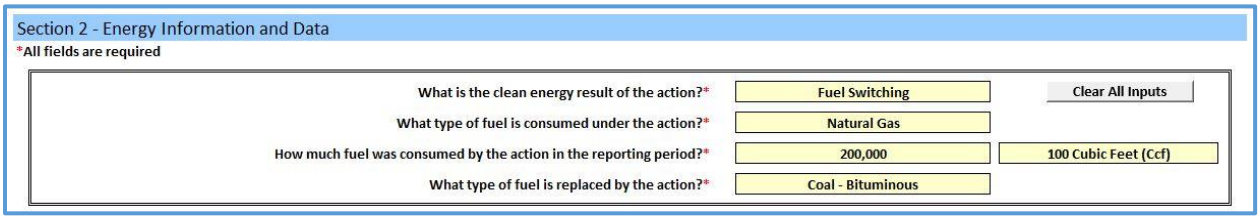


Users should enter information in as many fields as possible. Fields with a red asterisk * are required and must be populated by the user. All required fields must be completed for the Calculator to estimate emission reductions.

STEP 3 – Enter Energy-Related Information and Data

Users should enter additional information about the action's energy use into Section 2 of the **Data Input** page, such as:

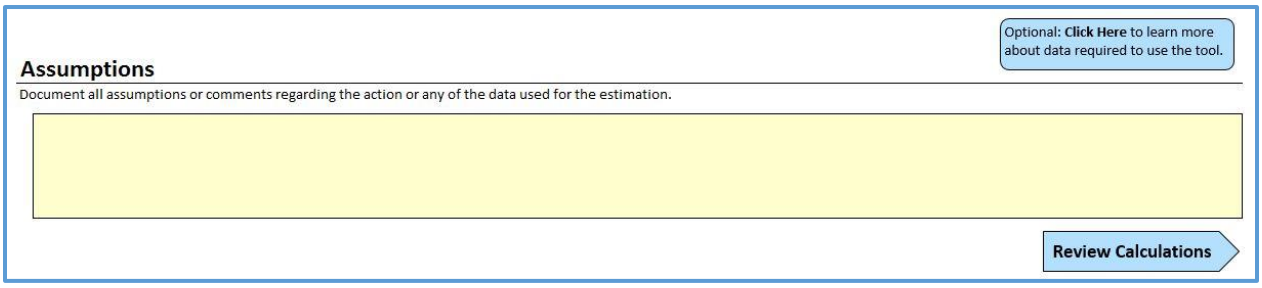
- The type of clean energy action
- The technology or fuel used under the action
- The amount of fuel or electricity generated, consumed, or saved under the action
- The type of fuel or electricity replaced by the action



All fields in Section 2 should be completed in order, starting from the top. These questions may vary slightly between different Calculators depending on the action type. **CLEAN ENERGY GHG CALCULATOR DATA COLLECTION NEEDS** describes the data needs for each Calculator by action type.

All assumptions or comments about the action and its energy use should be documented in the **Assumptions** section provided at the bottom of the page. OUs should record any information about the action or data that support the inputs entered into the Calculator. Examples include whether the

data represents a partial year or is incomplete, whether data was directly measured or estimated, the source of alternate values, or how and why alternative values were calculated. This information will be useful for anyone reviewing the accuracy and transparency of the emission reduction estimates.

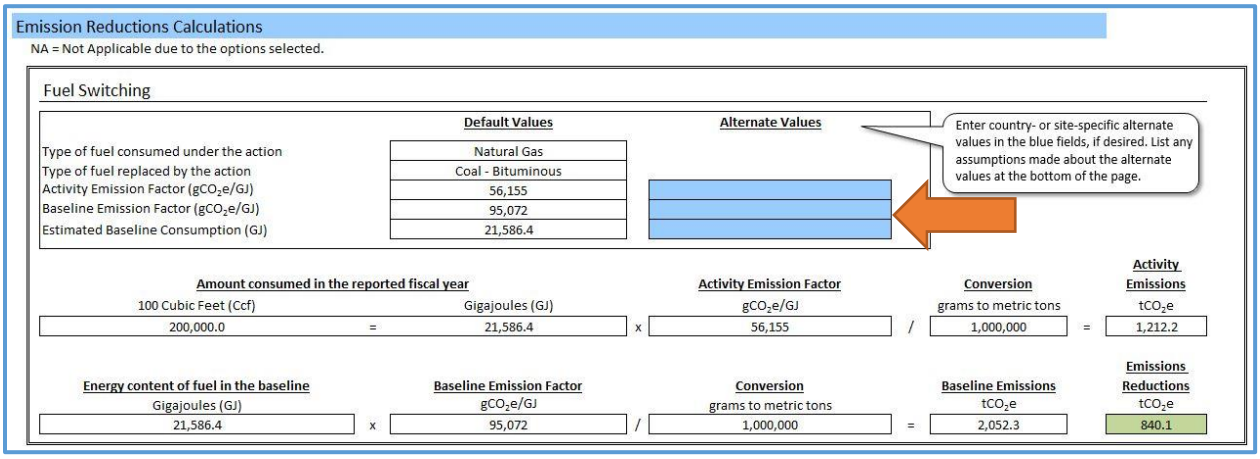


Once all the questions have been answered and data entered, proceed to the next page by clicking the "Review Calculations" blue arrow.

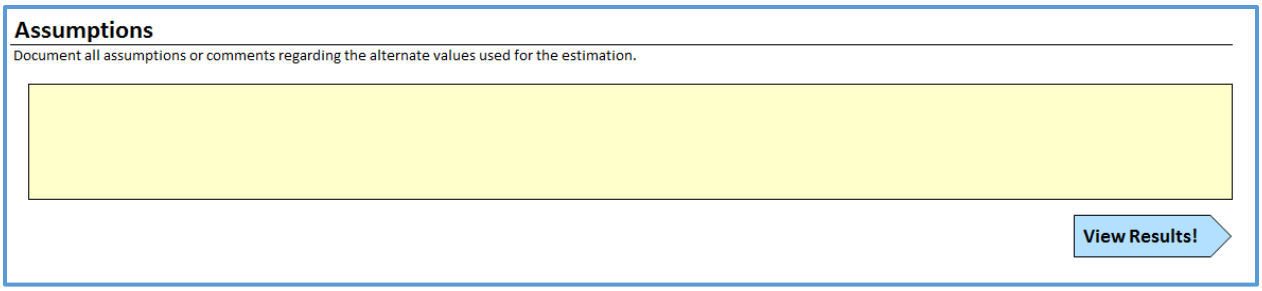
STEP 4 - Review Your Calculations

On the **Calculations** page, users should review all values used to generate the estimate of reductions, which include inputs, Calculator-provided default values, and the emission reduction estimate.

At this point, users can override Calculator-provided default values if necessary to better reflect the action. For example, the Calculator provides a country average grid emission factor for electricity consumption. The user may wish to override the default value with operating or build margin emission factors, if applicable.



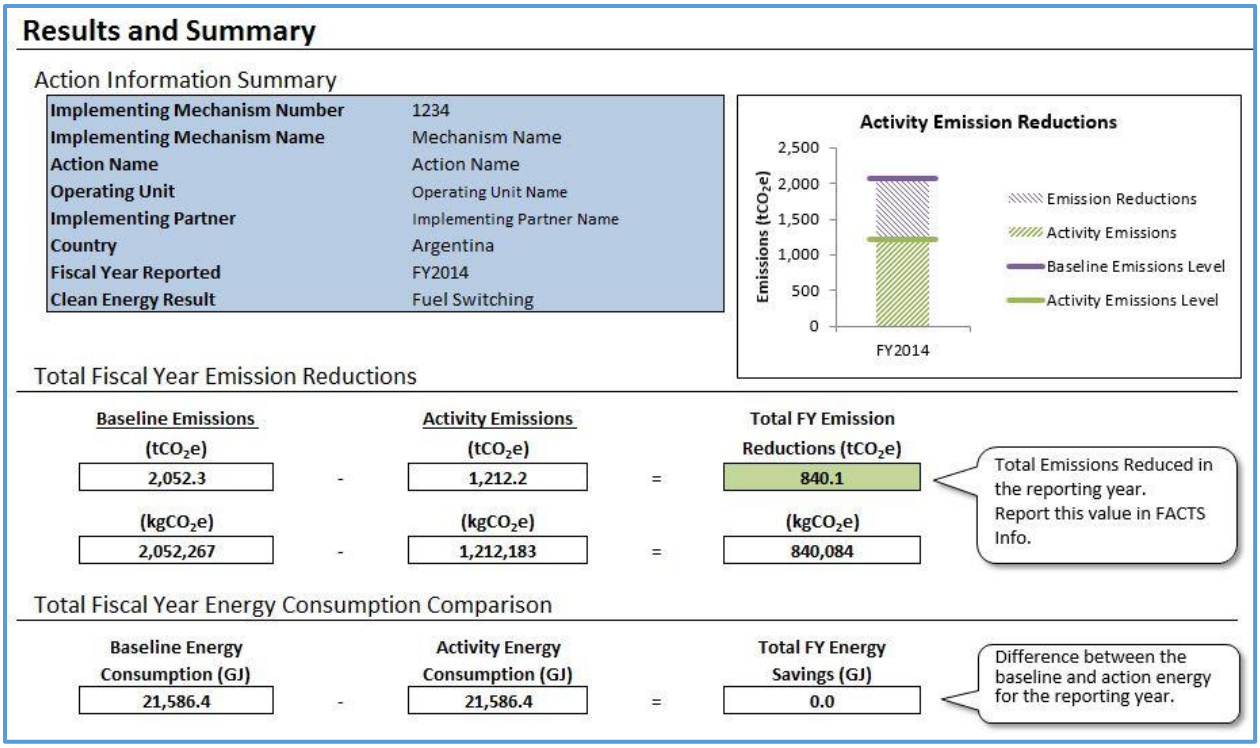
The data source and justification for using alternate values should be documented in the **Assumptions** section at the bottom of the page.



After reviewing the data and calculations, proceed to the next page by clicking the "View Results".

STEP 5 - View Your Results

The **Results** page summarizes the action information and total emission reductions, indicated by the dark green field. Total Fiscal Year Emission Reductions for this action, in metric tons of carbon dioxide equivalent (tCO_2e), can be entered into the FACTS Info database for reporting on Indicator 4.8-7.



For programs with multiple actions where multiple clean energy results occur, emission reductions from each action should be calculated individually using the CLEER Calculator, then aggregated across missions or countries to reflect overall program emission reductions reported to FACTS Info.

The total energy savings of the reporting year, defined as the difference between the baseline and activity energy, is also provided. This value should not be reported under Indicator 4.8-7.

FREQUENTLY ASKED QUESTIONS

1) Where do I get input data?

Input data, such as energy consumption and/or savings for each action type, should be requested from the action implementing partners (IPs).

2) Why is the Calculator not calculating emission reductions?

Confirm that information or data have been entered into all the required fields (indicated by a *). For example, if the country location of the action or the amount of energy generated under the action is not populated, then the Calculator will not calculate emission reductions.

3) Where can I change default values?

Alternate values can be entered in the blue fields on the **Calculations** page of the Calculator, which will override the default values provided in the Calculator. Be sure to document the reasoning behind overriding the default values, as well as the source of the alternate value (e.g., how it was calculated or chosen).

4) Where can I find alternate values for overriding default values?

The Appendices of the CLEER Protocol include all of the default values used in the CLEER Calculators, as well as additional emission factors and technological defaults that a user may choose to input. Users may also desire to input other known values that may be more accurate to the region or action than the default values, many of which are national or international average factors.

5) What type of assumptions/comments should I document?

OUs should document any information about the action or data that support the inputs entered into the Calculator. Examples include whether the data represents a partial year or is incomplete, whether data was directly measured or estimated, the source of alternate values, or how and why alternative values were calculated.

6) What value do I report?

OUs should report Total Fiscal Year Emission Reductions as the value for Indicator 4.8-7, which is calculated on the **Results** page of each Calculator. This value will include all emissions reduced or avoided as a result of the action. Programs with multiple actions should use the Calculator to calculate the GHG Indicator for every action, and then aggregate the values across actions to report the sum of reductions for the GHG Indicator.

7) What if I have data and specifics on the amount of technology installed or adopted but not energy generated/saved?

If energy data is not known, OUs can use the technology-specific CLEER calculators to estimate the energy impacts of their action and use that to estimate projections using the GHG Projections Calculator, available at www.CLEERTool.org. Technology-specific projection calculators are currently under development.

8) What if I do not understand an input field?

When you click on an input cell, a message may appear with further guidance on the input field. For further guidance, OUs can refer to the Protocol.

9) Where can I find more information?

For more details on **Indicator 4.8-7**, see the GCC Indicator Handbook at **http://f.state.sbu/Pages/Indicators.aspx**

The **CLEER Protocol** presents complete guidelines for quantifying GHG emission reductions from USAID clean energy activities. It also includes the calculation methodologies that support the CLEER Calculators, as well as all the default data and assumptions used in the Calculators. The Protocol is available at:
https://www.CLEERTool.org

CLEAN ENERGY GHG CALCULATOR DATA COLLECTION NEEDS

The Clean Energy GHG Calculator can be used to calculate GHG emission reductions from USAID Clean Energy actions when the amount of energy consumed or saved is known. Action types include:

- Renewable Electricity Generation
  - An action that increases or enables new capacity to generate electricity from renewable sources by replacing conventional sources of power (e.g., grid power or diesel generators). Renewable sources include solar photovoltaic, wind turbine, geothermal, and hydroelectric power systems.
- Fuel Switching
  - An action that exchanges a conventional energy source with a less emissive or alternative energy source.
- Energy Use Efficiency
  - An action that reduces the amount of energy consumed by the end user through technology upgrades or energy efficient practices.

Table 1 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential source, and typical values or units.

Table 1: Clean Energy GHG Calculator Data Collection Needs

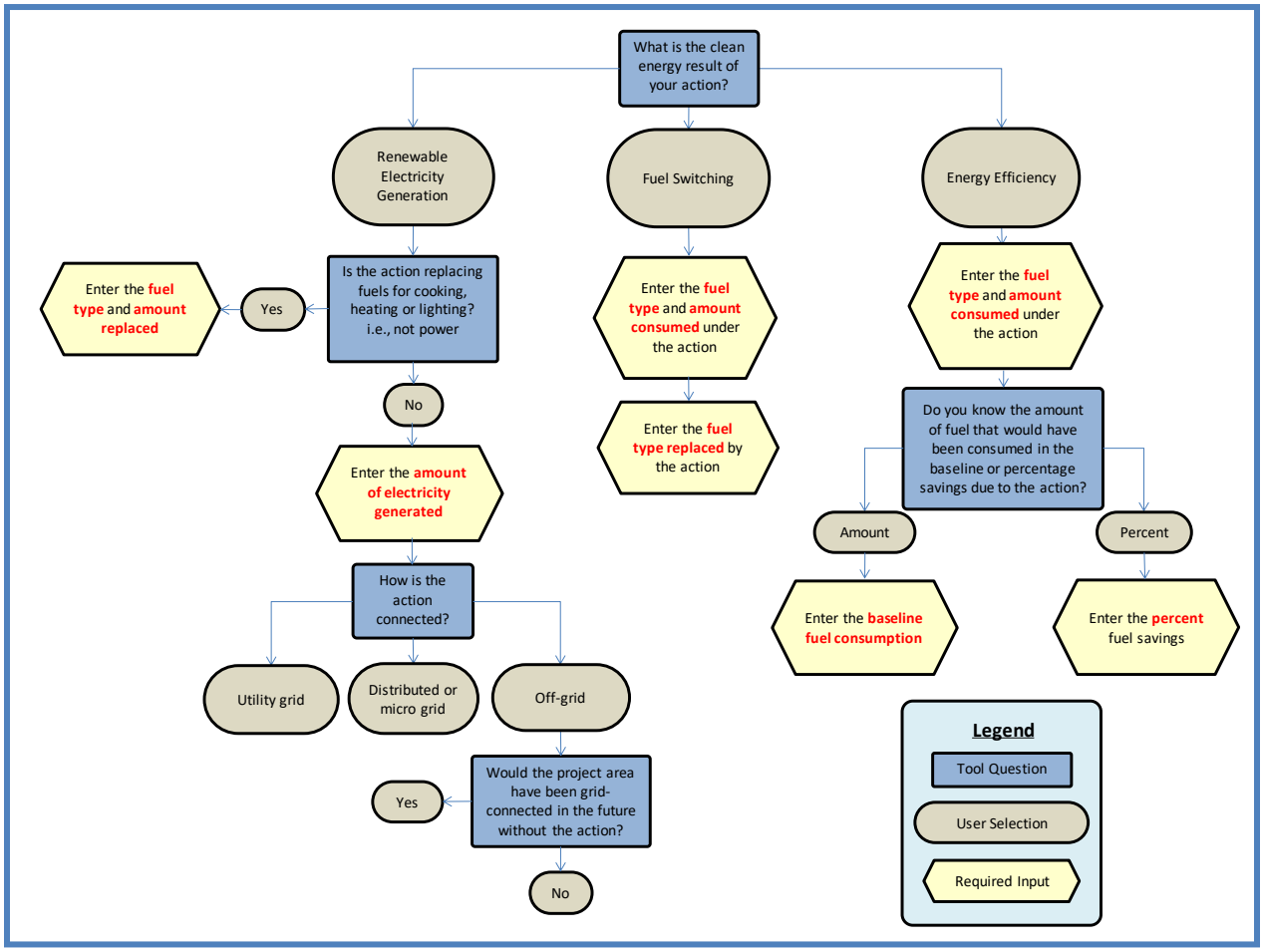
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Renewable Electricity Technology Type**	The type of renewable energy technology implemented by the action in the reporting year	Solar Photovoltaic Wind Power Geothermal Power Hydroelectric Power
User-Provided	**Fuel Type**	The type of traditional or alternate fuel consumed in the baseline and/or activity in the reporting year	See a list of potential fuel types in Appendix A of the User Guide
User-Provided	**Electricity Generated or Consumed**	Quantity of electricity consumed or generated by the action in the reporting year	Kilowatt-hours (kWh) Megawatt-hours (MWh)
User-Provided	**Activity Fuel Consumed**	Amount of alternate fuel consumed in the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type.
User-Provided	**Percent Fuel Savings**	Percent of fuel savings as a result of the action in the reporting year	Percent (0-99%)
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution (%)	Percent (0-99%)

Source	Parameter	Definition	Typical Value/Units
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol.

Figure 1 outlines the questions, user selection options, and required input data for the **Clean Energy GHG Calculator**. For each path, all corresponding data inputs are necessary for estimating the GHG Indicator.

Figure 1: Clean Energy GHG Calculator Pathways



SOLAR PHOTOVOLTAIC SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Solar Photovoltaic Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of photovoltaic (PV) systems to generate electricity for on-site consumption
- The installation of PV arrays to generate electricity to supply to the grid
- Enabling activities that directly lead to increased implementation of or access to solar PV generation in the reporting year

Table 2 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 2: Solar Photovoltaic Systems Calculator Data Collection Needs

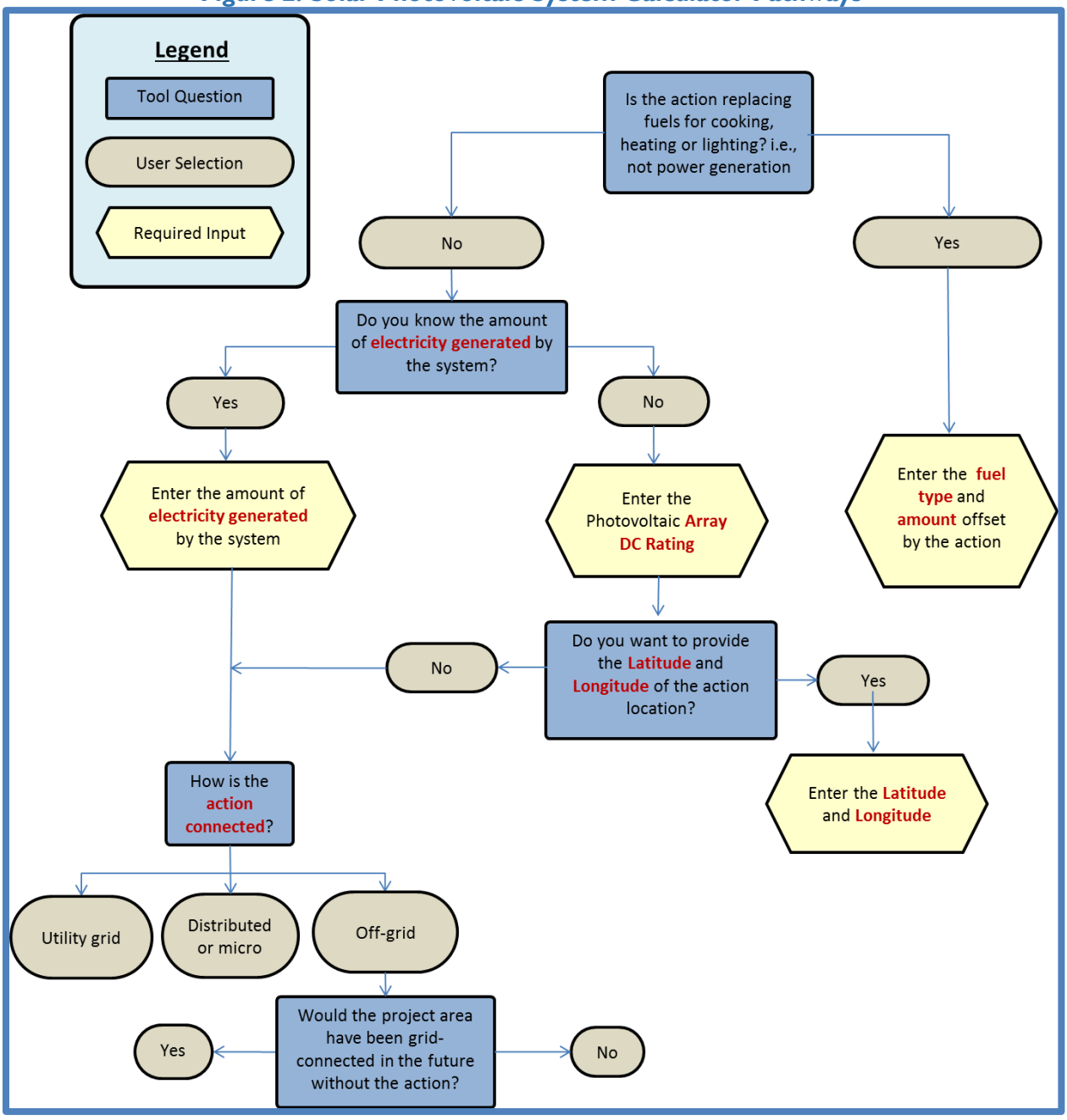
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Electricity Generated**	Quantity of electricity consumed or generated under the action in the reporting year	Kilowatt hours (kWh); Megawatt hours (MWh)
User-Provided	**Array DC Rating**	DC rated capacity of the solar PV array	Kilowatts (kW); Megawatts (MW)
User-Provided	**Fuel Type**	The type of traditional or alternate fuel consumed in the baseline and/or action in the reporting year	See a list of potential fuel types in Appendix A of the User Guide
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type.
User-Provided	**Latitude and Longitude**	Geographic coordinates specific to the location of the action	Latitude between -90° and 90° Longitude between -180° and 180°
Default: NASA/NREL	**Capacity Factor**	Calculated as the product of the efficiency of the system and average-day insolation incident on a tilted surface at specific coordinates	Percent (0-99%)
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Source	Parameter	Definition	Typical Value/Units
Default: Assumed 365 days of annual operation	**Operational Days per Year**	Number of days per year that the system is operation. If not entered, the calculator assumes the system was operational for the entire year.	Days/Year

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 2 outlines the questions, user selection options, and required input data for the **Solar Photovoltaic Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 2: Solar Photovoltaic System Calculator Pathways



SOLAR HEATING SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Solar Heating Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of solar thermal systems to generate space heating or hot water for on-site consumption
- Enabling activities that directly lead to increased implementation of or access to solar thermal applications in the reporting year

Types of systems for which this section applies are:[1]

- Unglazed flat plate collector systems
- Glazed domestic hot water systems (DHW) in one- and multi-family houses or businesses
- Evacuated tube collectors
- Combined domestic hot water and space heating systems in one- and multi-family houses

Table 3 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 3: Solar Heating Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Solar Thermal System Type**	The type of solar thermal technology implemented under the action in the fiscal year	Unglazed flat plate collector; Glazed domestic hot water; Evacuated tube collectors; Combined domestic hot water and space heating
User-Provided	**Area**	Area of the collector aperture	Square meters (m^2)
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity

[1]Unglazed flat plate collectors are usually made of a black polymer, without a frame, with a glass cover and insulation on the backside. These collectors are low cost but have high thermal losses.

Glazed flat plate collectors are flat plate absorbers fixed in a frame, with a single and double layer of glass on the top and an insulation panel at the backside. These are the most popular type of solar thermal collectors and are used in hot water, space heating and process heating applications.

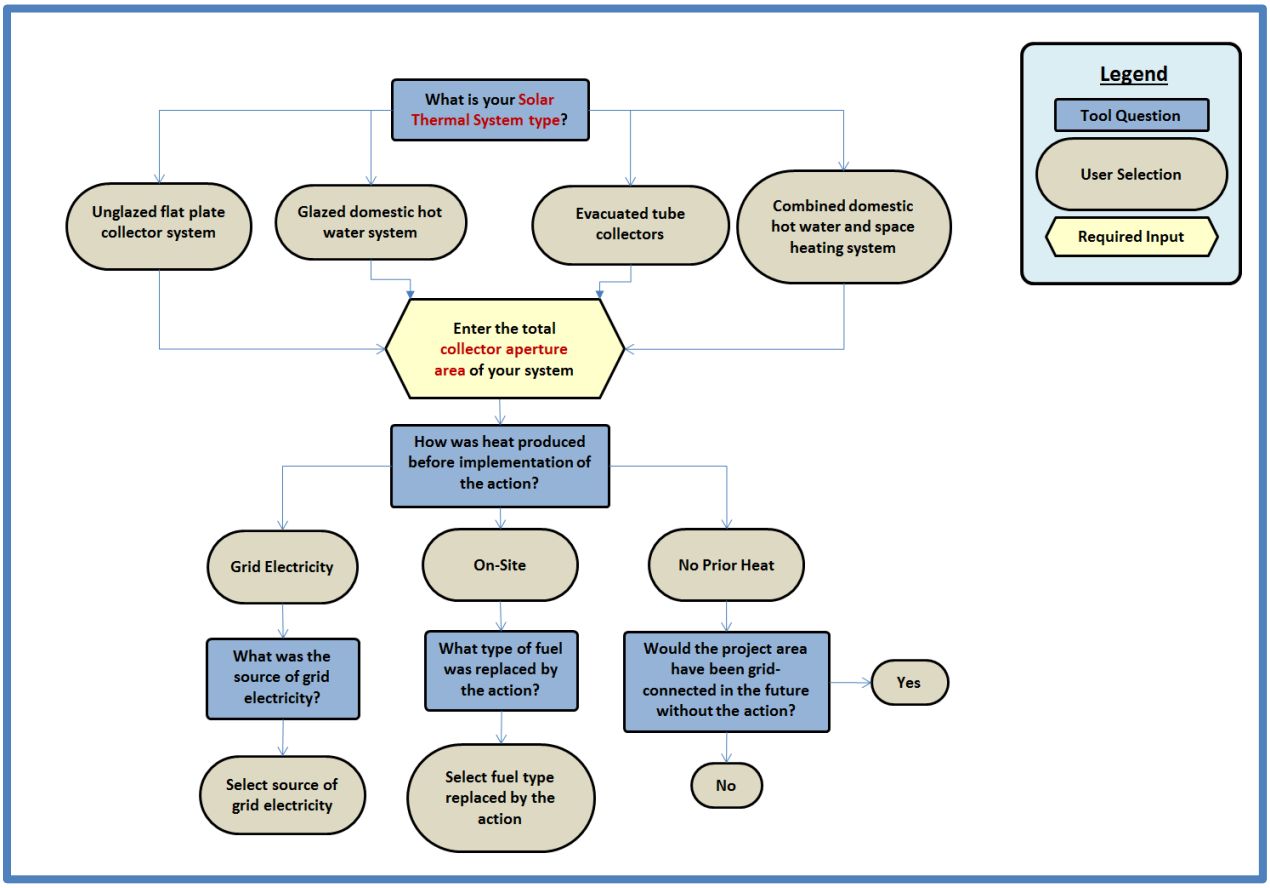
Evacuated Tube Collectors are collectors with the absorbers enclosed in a sealed vacuum tube. These are relatively expensive but have a high efficiency. These collectors are used in high temperature applications such as hot water, space heating, and process heating applications. Source: UNFCCC (2006)

Source	Parameter	Definition	Typical Value/Units
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/kWh_{th} of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 3 outlines the questions, user selection options, and required input data for the **Solar Heating Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram may also help determine information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 3: Solar Heating Systems Calculator Pathways



WIND TURBINE SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Wind Turbine Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of wind turbines to generate electricity for on-site consumption
- The installation of wind turbines to generate electricity to supply to the grid

Table 4 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

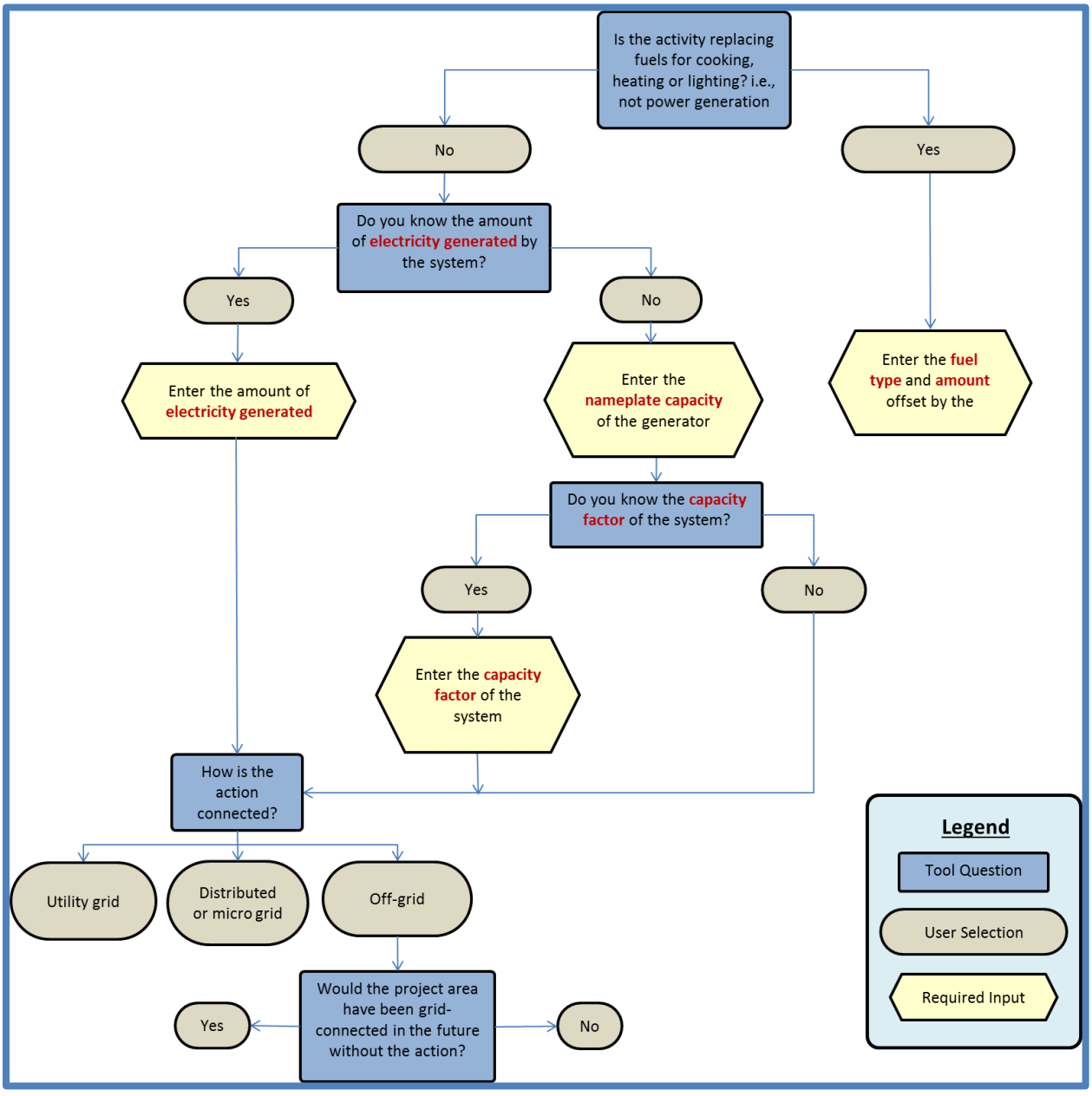
Table 4: Wind Turbine Systems Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Fuel Type**	The type of traditional or alternate fuel consumed in the baseline and/or action in the reporting year	See a list of potential fuel types in Appendix A of the User Guide
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type
User-Provided	**Electricity Generated**	Quantity of electricity generated under the action in the reporting year	Kilowatt-hours (kWh) Megawatt-hours (MWh)
User-Provided	**Nameplate Capacity**	Nameplate capacity rating of the wind turbine	Kilowatts (kW) Megawatts (MW)
User-Provided	**Total Operating Hours per Year**	Number of hours per year the wind turbine unit is operational	Hours/Year
Default: IEA (2011)	**Capacity Factor**	Country specific wind capacity factor	Percent (0-99%)
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country (%)	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 4 outlines the questions, user selection options, and required input data for the **Wind Turbine Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 4: Wind Turbine Systems Calculator Pathways



HYDROELECTRIC SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Hydroelectric Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of conventional hydroelectric dam systems to generate electricity for on-site consumption
- The installation of hydroelectric systems to generate electricity to supply to the grid
- Enabling activities that directly lead to increased implementation of or access to hydroelectric generation in the reporting year

Table 5 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 5: Hydroelectric Systems Calculator Data Collection Needs

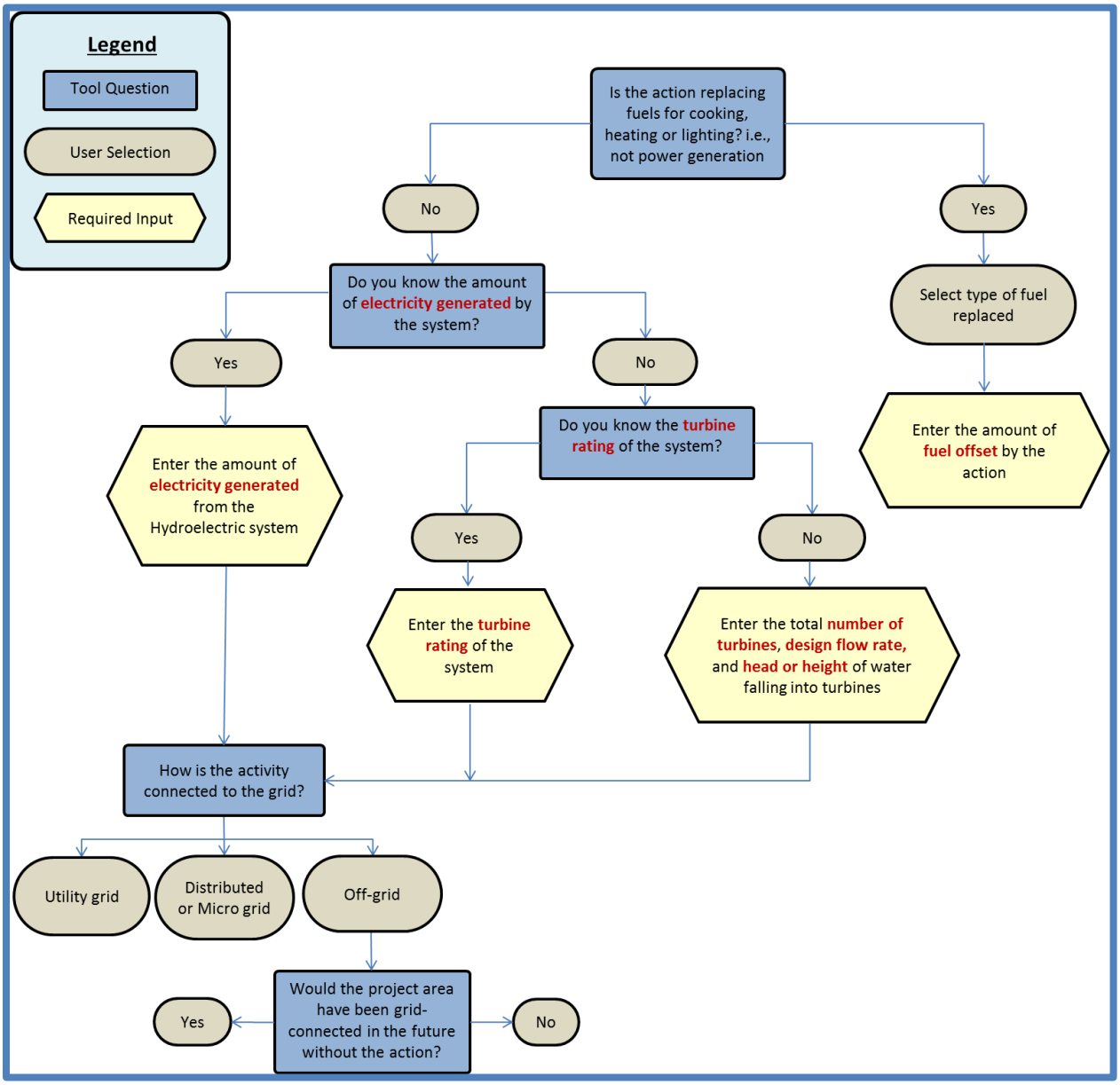
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Electricity Generated**	Amount of electricity generated by the system in the reporting year	Kilowatt hours (kWh); Megawatt hours (MWh)
User-Provided	**Turbine Rating**	Rated capacity of the hydroelectric turbine	Kilowatts (kW); Megawatts (MW)
User-Provided	**Operating Hours per Year**	Number of hours per year that the system is operation. If not entered, the calculator assumes the system was operational for the entire year (8,760 hours in a year)	Hours/Year
User-Provided	**Flow Rate**	Nominal water flow rate through the turbine	meters cubed per second (m^3/s)
User-Provided	**Head**	The nominal head, which is the height of the water falling into the turbine	Meters (m)
User-Provided	**Number of Turbines**	The number of hydroelectric turbines in the system	Unitless
Default: Intpow (2013)	**Hydroelectric Capacity Factor**	The capacity factor of the hydroelectric system	Percent (0-99%)
User-Provided	**Fuel Type**	The type of traditional or alternate fuel consumed in the baseline and/or action in the reporting year	See a list of potential fuel types in Appendix A of the User Guide
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type.

Source	Parameter	Definition	Typical Value/Units
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: Kaltschmitt (2007)	**Efficiency of Turbine**	The operational efficiency of the turbine in converting the energy of water to rotational energy	Percent (0-99%)
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 5 outlines the questions, user selection options, and required input data for the **Hydroelectric Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 5: Hydroelectric Systems Calculator Pathways



GEOTHERMAL POWER SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Geothermal Power Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of geothermal systems to generate electricity for on-site consumption
- The installation of geothermal systems to generate electricity to supply to the grid
- Enabling activities that directly lead to increased implementation of or access to geothermal generation in the reporting year

Table 6 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

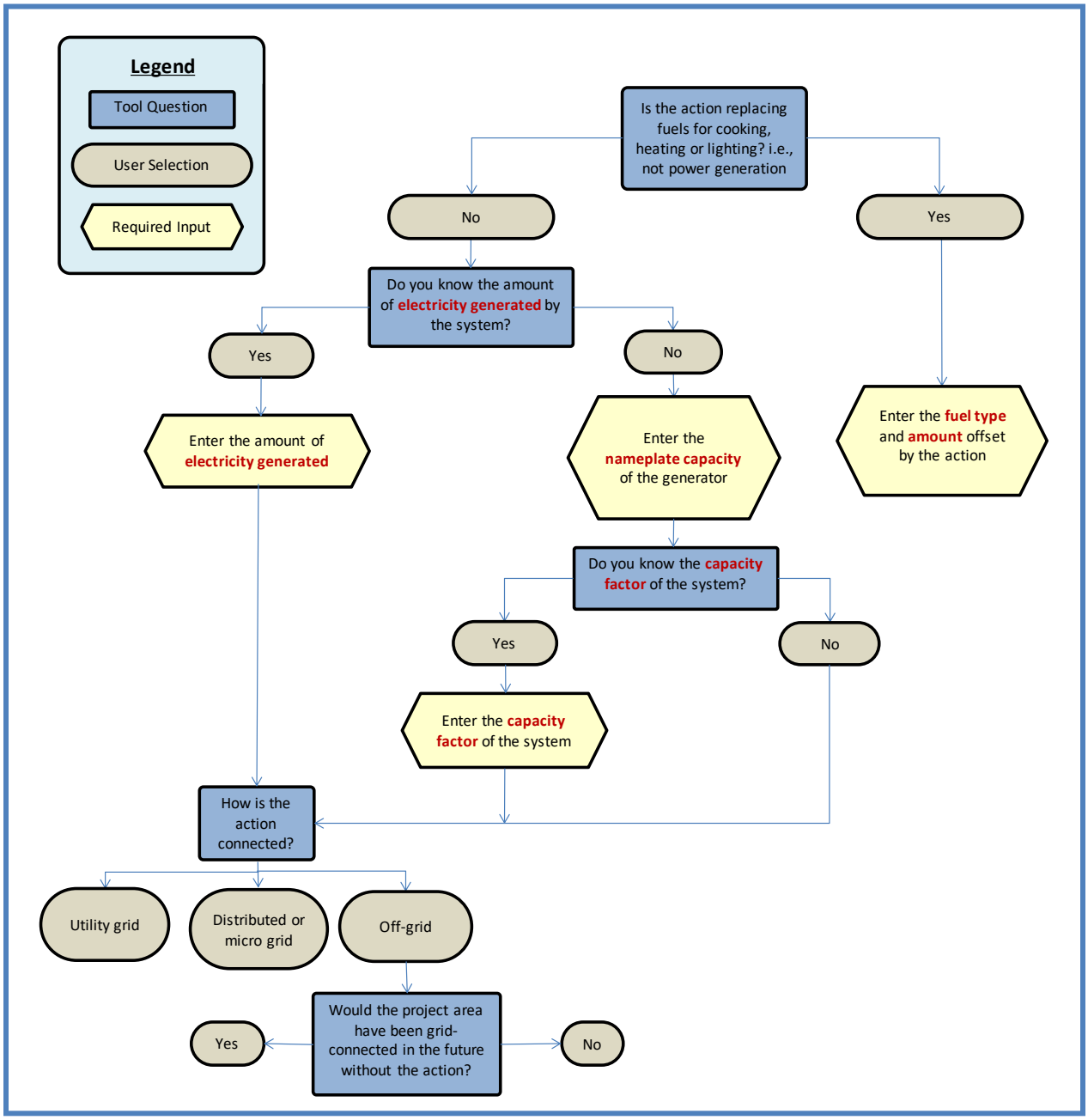
Table 6: Geothermal Power Systems Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Electricity Generated**	Amount of electricity generated by the system in the reporting year	Kilowatt hours (kWh); Megawatt hours (MWh)
User-Provided	**Nameplate Capacity**	Nameplate rating of geothermal system	Kilowatt (kW); Megawatt (MW)
User-Provided	**Total Operating Hours per Year**	Number of hours per year the geothermal unit is operational (h)	Hours/Year
Default: IEA (2011)	**Capacity Factor**	Country specific geothermal power capacity factor	Percent (0-99%)
User-Provided	**Fuel Type**	The type of traditional or alternate fuel consumed in the baseline and/or action in the fiscal year	See a list of potential fuel types in Appendix A of the User Guide
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type.
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country (%)	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 6 outlines the questions, user selection options, and required input data for the **Geothermal Power Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 6: Geothermal Power Systems Calculator Pathways



GEOTHERMAL DIRECT HEAT SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Geothermal Direct Heat Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of geothermal systems for direct heating for on-site consumption
- Enabling activities that directly lead to increased implementation of or access to geothermal heat generation in the reporting year

Table 7 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

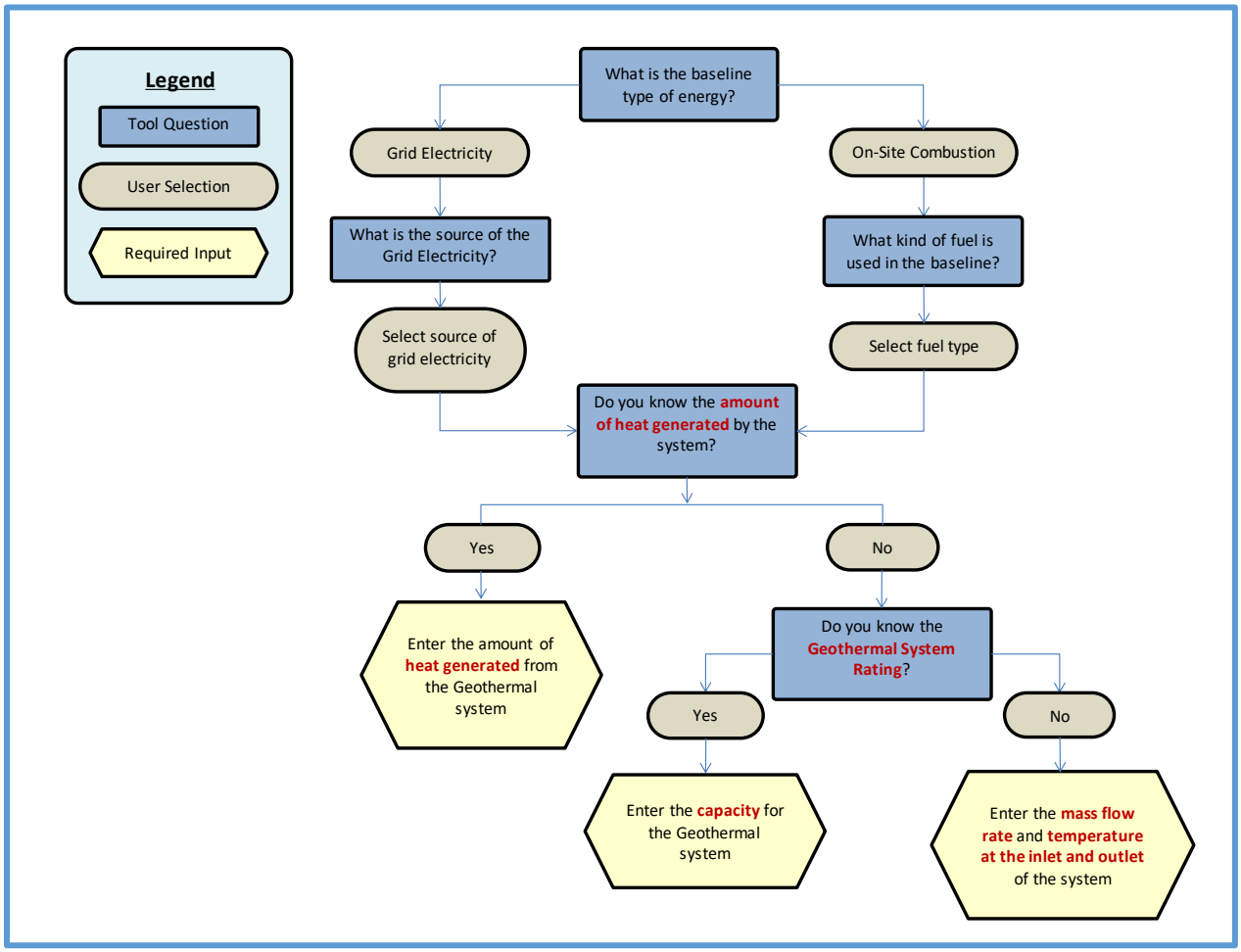
Table 7: Geothermal Direct Heat Systems Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Amount of Heat Generated**	Amount of heat generated from the geothermal system, in the reporting year	Gigajoules (GJ)
User-Provided	**Geothermal System Rating**	Nameplate capacity of geothermal system	Kilowatts (kW)
User-Provided	**Mass Flow Rate**	The mass of water that flows through the system per unit time	Kilograms per second (kg/s)
User-Provided	**Temperature of the Inlet**	Temperature measured at the inlet of the geothermal system	Celsius (°C)
User-Provided	**Temperature of the Outlet**	Temperature measured at the outlet of the geothermal system	Celsius (°C)
User-Provided	**Operation Hours per Year**	Number of hours per year the geothermal system is operational at full capacity	Hours/Year
Default: Lund (2013)	**Capacity Factor**	Ratio of annual heat delivered and its potential annual output capacity	Percent (0-99%)
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 7 outlines the questions, user selection options, and required input data for the **Geothermal Direct Heat Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 7: Geothermal Direct Heat Systems Calculator Pathways



GEOTHERMAL GROUND SOURCE HEAT PUMPS CALCULATOR DATA COLLECTION NEEDS

The **Geothermal Ground Source Heat Pumps Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The installation of geothermal heat pumps for space heating, or cooling, or both using heat pumps for on-site consumption
- Enabling activities that directly lead to increased implementation of or access to geothermal heat pumps in the reporting year

Table 8 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 8: Geothermal Ground Source Heat Pumps Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Heat Pumps Used for Heating or Cooling**	Identify if Heat Pump system is used for heating or cooling purposes. The calculator will need to be used twice to estimate electricity consumed for heating as well as cooling purposes.	Heating Cooling
User-Provided	**Coefficient of Performance**	Total amount of heat transferred to (cooling) or from (heating) the ground by the heat pump per unit electricity consumed by the system	Unitless
User-Provided	**Heating Load or Cooling Load**	The amount of energy used to heat or cool space using geothermal heat pumps	Megawatt hours (MWh) Gigajoules (GJ)
User-Provided	**Electricity Consumed**	Amount of electricity consumed by the system in the reporting year	Kilowatt hours (kWh) Megawatt hours (MWh)
User-Provided	**Nameplate Capacity**	Nameplate capacity of Heat Pump system	Kilowatts (kW) Megawatts (MW)
User-Provided	**Length of Piping**	The length of the pipe used in the geothermal heat pump	Feet (ft) Meters (m)
User-Provided	**Flow Rate**	The flow rate of the geothermal heat pump	Gallons per Minute per Ton of heating or cooling (GPM/Ton) Cubic meters per minute per Ton of heating or cooling (m^3/min) Liters per minute per Ton of heating or cooling (L/min)

Source	Parameter	Definition	Typical Value/Units
Default: IEA (2014)	**Grid Line Loss Factor**	Average annual grid line loss due to transmission and distribution, by country	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 8 and Figure 9 outlines the questions, user selection options, and required input data for the **Geothermal Ground Source Heat Pump Systems Calculator**. Depending on if the system is used for heating or cooling, follow the diagrams below to understand how sets of inputs are grouped together to complete the calculations. The diagrams will also be helpful in determining information you may need to collect in the future. The diagrams are color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 8: Geothermal Ground Source Heat Pump Systems Calculator Pathways – Heating

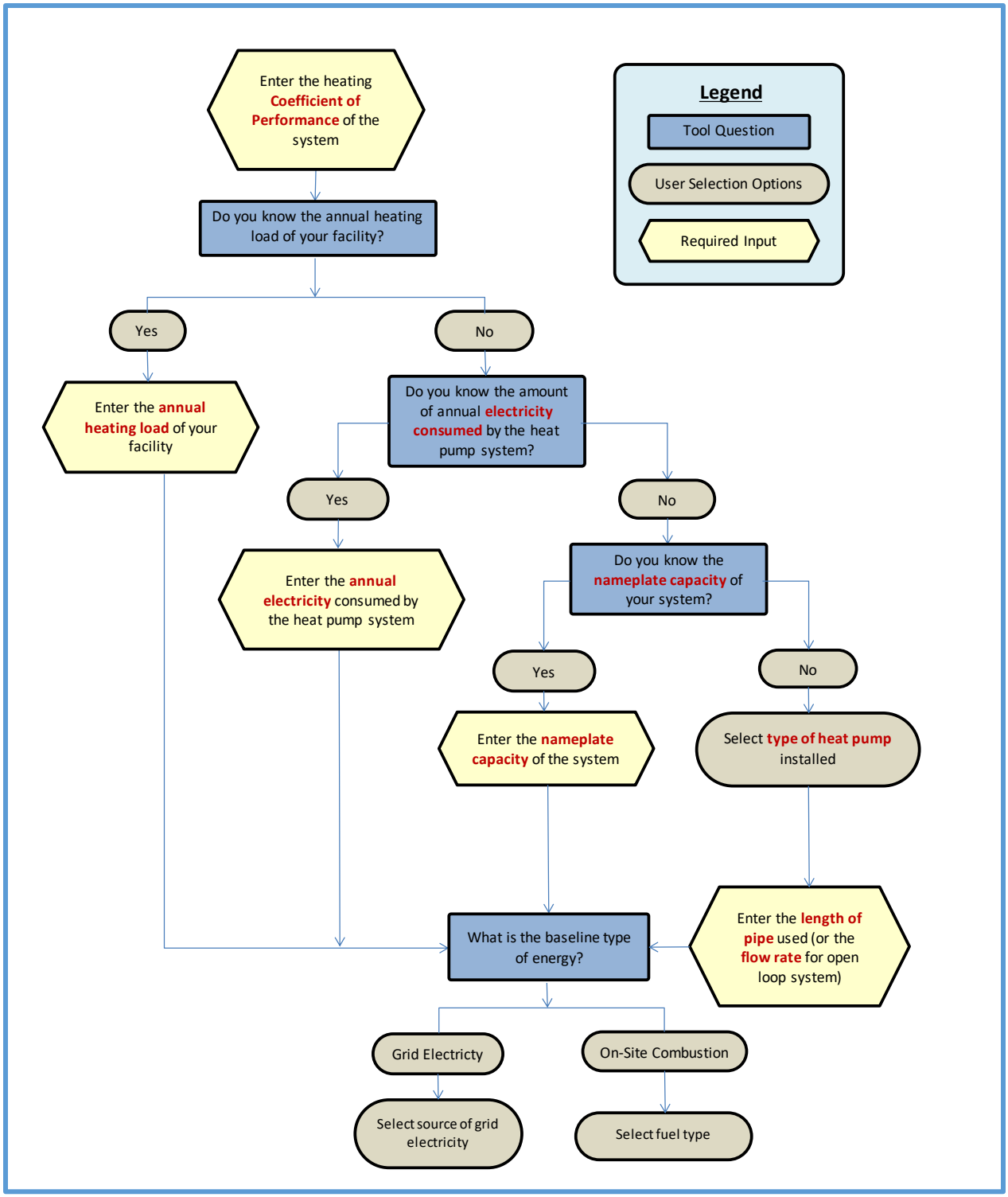
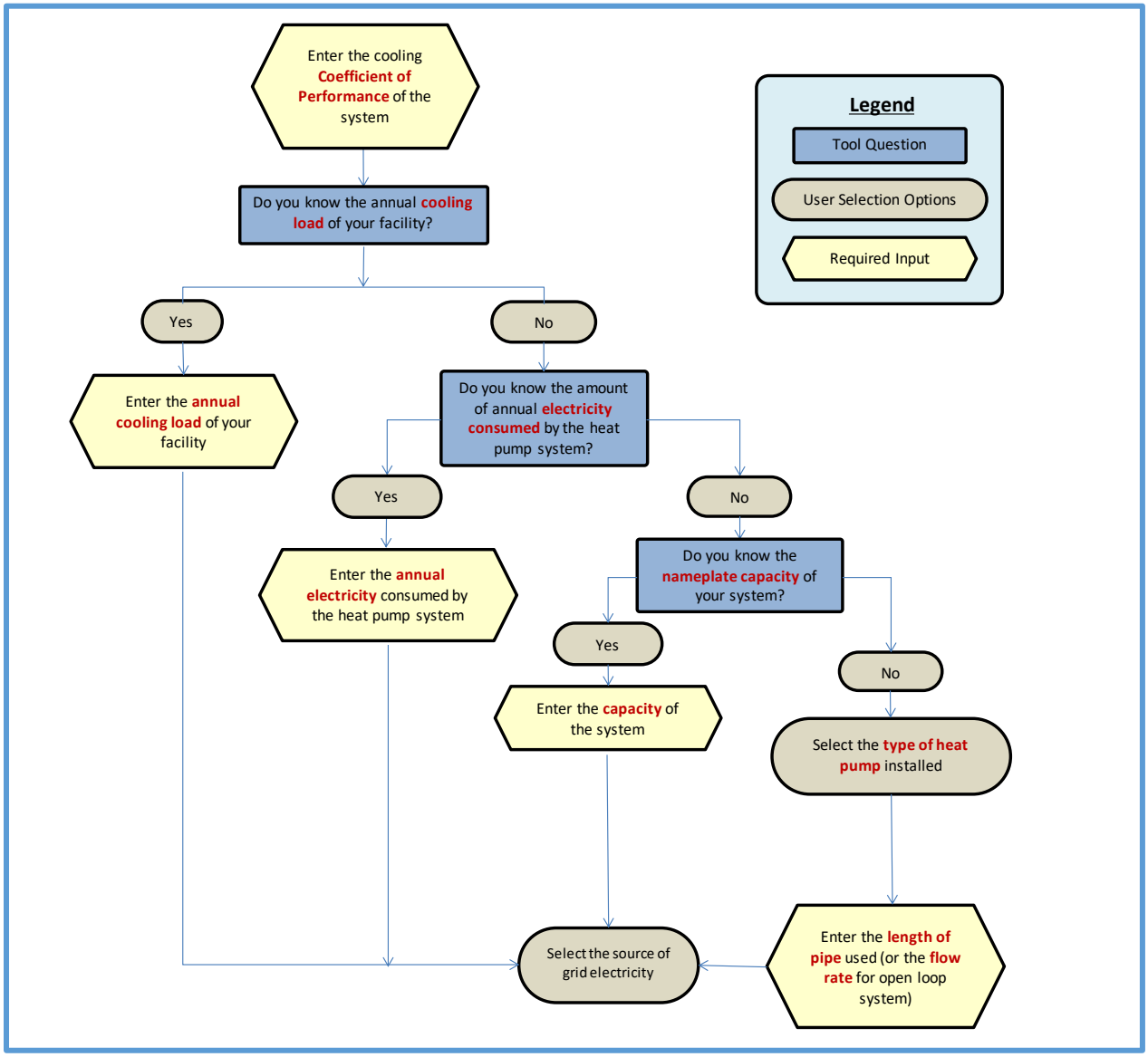


Figure 9: Geothermal Heat Pump Systems Calculator Pathways – Cooling



BIOMASS ENERGY CALCULATOR DATA COLLECTION NEEDS

The Biomass Energy Calculator can be used to estimate GHG emissions reduced from USAID clean energy activities such as:

- The direct combustion of biomass (e.g., agricultural and forest residues, wood chips, briquettes, and pellets) for the production of thermal energy (heat or steam) or electricity.
- Enabling activities that directly lead to increased use of biomass resources for direct combustion at the residential and commercial scale.

Table 9 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 9: Biomass Energy: Select Fuels Calculator Data Collection Needs

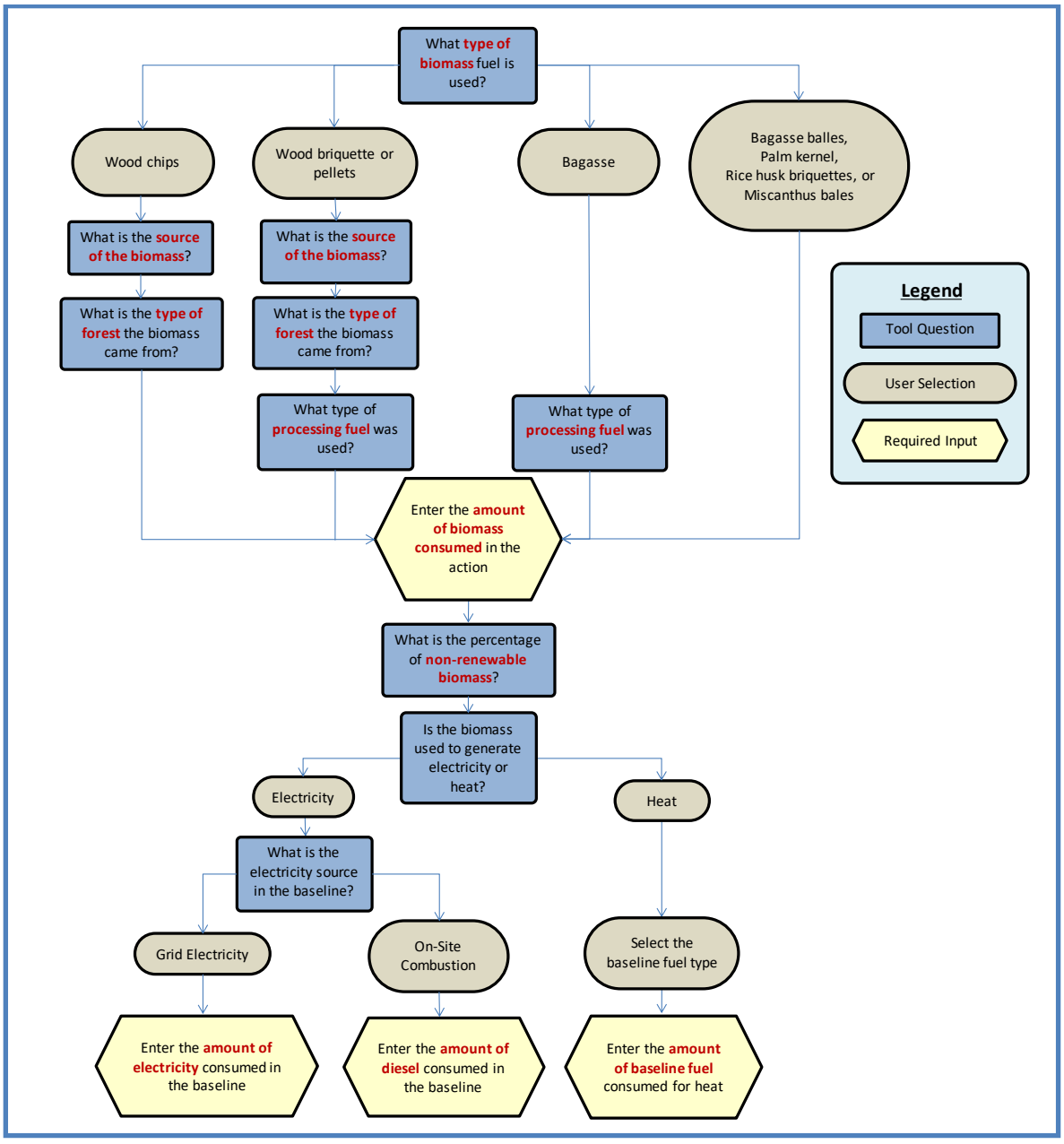
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Type of Biomass**	The type of biomass used as fuel	User-selected Option (e.g., wood chips, charcoal, wheat straw)
User-Provided	**Source of Biomass**	Option to describe the source of biomass	Forest residues Short Rotation Forestry
User-Provided	**Amount of Biomass Fuel Consumed**	Quantity of biomass consumed	Gigajoules (GJ), or one of the volumetric units, by fuel type
User-Provided	**Forest Type**	The type of forest the biomass originated from	Temperate Tropical and Subtropical
User-Selected	**Processing Fuel**	Fuel used to process the biomass	Wood Natural Gas
User-Provided	**Fraction of Non-Renewable Biomass**	Fraction of the biomass fuel that originates from non-renewable sources	Percent (0-100%)
User-Provided	**Baseline Electricity Consumed**	Amount of electricity consumed in the baseline of the reporting year	Kilowatt-hours (kWh) Megawatt-hours (MWh)
User-Provided	**Baseline Fuel Type**	Type of fuel used for heating purposes in the baseline action	User-selected Option (e.g., charcoal, diesel)
User-Provided	**Baseline Fuel Consumed**	Amount of traditional fuel consumed in the baseline of the reporting year	Gigajoules (GJ), or one of the volumetric units, by fuel type.
Default	**Generator Efficiency**	Efficiency of the diesel generator used to generate electricity	Percent (0-99%)

Source	Parameter	Definition	Typical Value/Units
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity
Default: IPCC (2006)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	tCO_2e/GJ of fuel

Note: All default values are available in the Appendices of the CLEER Protocol.

Figure 10 outlines the questions, user selection options, and required input data for the **Biomass Energy Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table below the diagram. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 10: Biomass Energy Calculator Pathways



ANAEROBIC DIGESTERS CALCULATOR DATA COLLECTION NEEDS

The **Anaerobic Digesters Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The use of anaerobic digesters to break down animal waste in order to generate biogas (methane)
- Enabling activities that directly lead to increased implementation of or access to recovery and use of biogas (methane) through anaerobic digestion in the reporting year

Table 10 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 10: Anaerobic Digesters Calculator Data Collection Needs

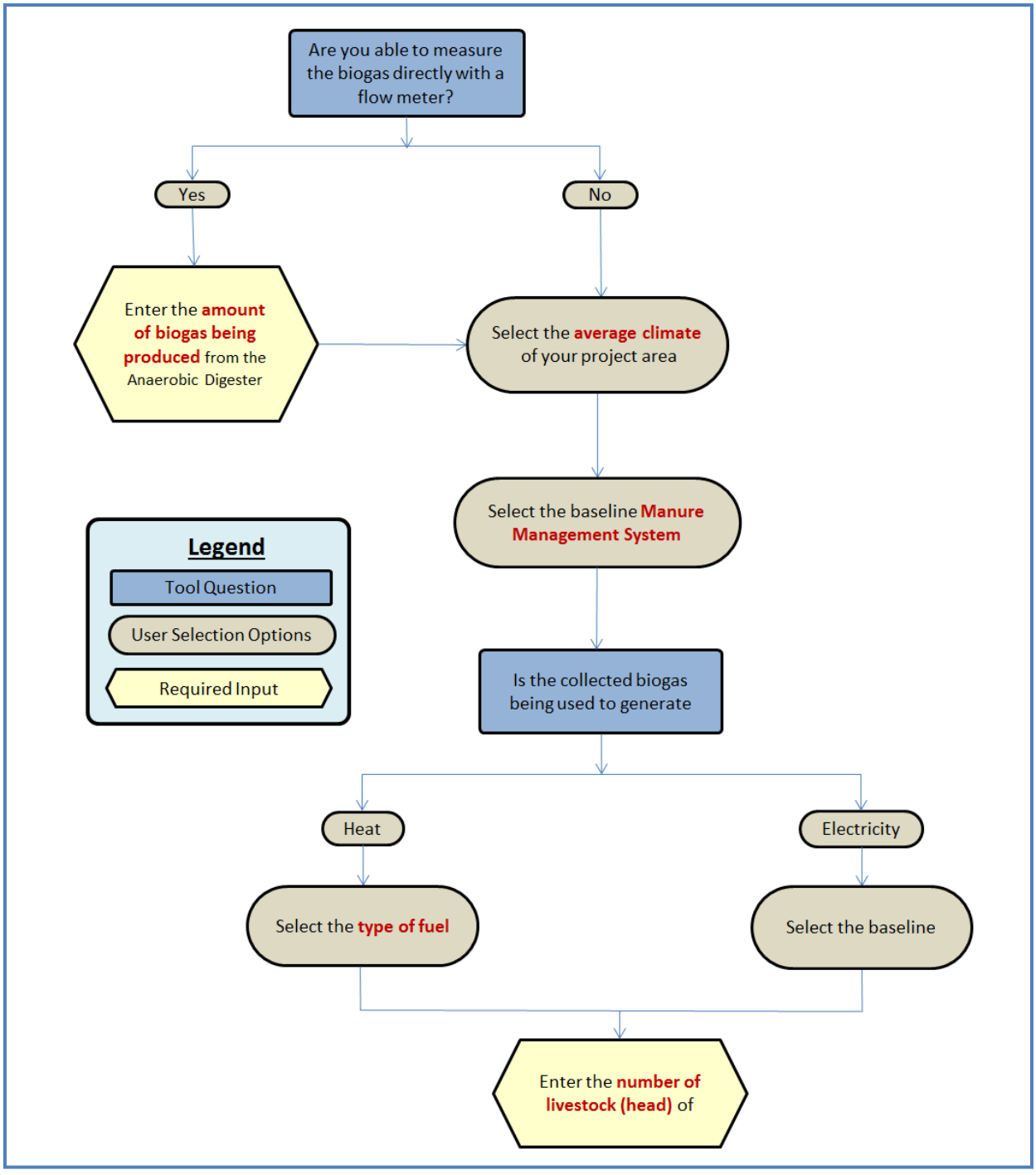
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Biogas Produced**	The volume of biogas produced, including both CH_4 and CO_2, measured with a flow meter, in the reporting year	Cubic Meter (m^3)
User-Provided	**Livestock Population**	The number of livestock, per animal type and climate in the reporting year	Head
Default: EPA (2004), EPA (2011)	**Methane Fraction**	The portion of biogas that is CH_4	0.60 (Unitless)
Default: Wischnewski (2013)	**Density of Methane**	The density of methane gas, which varies according to the average ambient temperature	kg/m^3
Default: IPCC (2006b)	**Volatile Solids**	The amount of volatile solids produced per day, per livestock type, in the reporting year	kg/(head·day)
Default: IPCC (2006b)	**Production Capacity$_{CH4}$**	Maximum methane producing capacity, per livestock type, in the reporting year	$m^3CH_4/kgVS$
Default: IPCC (2006b)	**Methane Conversion Factor**	Methane Conversion Factor (MCF) for manure management system, by temperature	Percent (0-100%)
Default: UNFCCC (2005)	**Fugitive Emission Rate**	The percent of fugitive emissions in the reporting year. Default of 15%.	Percent (0-99%)
Default: EPA (2004)	**Methane Energy Content**	The energy content of methane gas. Default at 1000 Btu/ft^3	Btu/ft^3
Default: EPA (2015)	**Heat Rate$_{ICE}$**	The average heat rate of an internal combustion engine. Default of 14,393 Btu/kWh	Btu/kWh

Source	Parameter	Definition	Typical Value/Units
Default: IPCC (2006b)	**Nitrogen Excretion**	The amount of nitrogen excreted per animal head by region in the reporting year	kg Nitrogen Excreted
Default: IPCC (2006b)	**Emission Factor$_{N2O}$**	Emission factor for N_2O-N for each manure management system type	(kgN_2O–N)/(kg Nitrogen Excreted)
Default: IPCC (2006a)	**Fuel-Specific Emission Factor**	GHG emission factor for specific fuel types	gCO_2e/GJ of fuel
Default: IEA (2014)	**Line Loss Rate**	Average grid line loss due to transmission and distribution, by country	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	The average GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure **11** outlines the questions, user selection options, and required input data for the **Anaerobic Digesters Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 11: Anaerobic Digesters Calculator Pathways



BUILDING ENERGY EFFICIENCY CALCULATOR DATA COLLECTION NEEDS

The Building Energy Efficiency Calculator can be used to estimate GHG emissions reduced from USAID clean energy activities such as:

- Improving building efficiency using various measures that lead to reduced energy consumption compared to the baseline scenario,
- Replacing less efficient baseline technologies with more energy efficient ones, or
- Enabling activities that directly lead to increased implementation of or access to building energy efficiency measures in the reporting year.

Table 11 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 11: Building Energy Efficiency Calculator Data Collection Needs

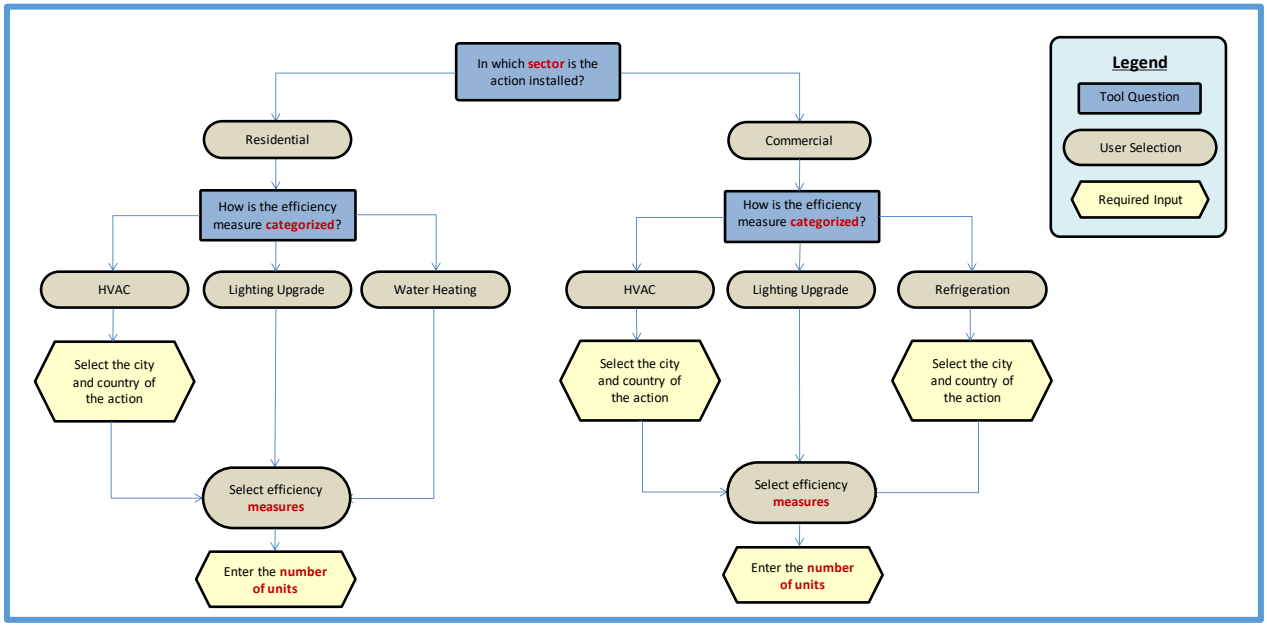
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Sector**	The sector in which the energy efficiency measure was implemented	Residential Commercial
User-Provided	**Category**	The category of the energy efficiency measures	Sector-specific
User-Provided	**Measure**	The energy efficiency measures which are specific to the category chosen	Category-specific
User-Provided	**Number of Units**	The total number of units of efficiency installed under the measure	Measure-specific
User-Selected	**Nameplate Power**	Nameplate Power rating of the equipment	Kilowatt (kW)
Default: IEESAG (2012)	**Operational Hours**	Total number of hours the equipment is operational in the reporting year	Hours (h)
Default: IEESAG (2012)	**Full Load Hours**	The total number of hours that the HVAC equipment is assumed to run at full load in the reporting year	Hours (h)
User-Selected	**Nameplate Capacity**	Nameplate capacity of the HVAC equipment	Kilowatt (kW)
User-Selected	**Coefficient of Performance**	The amount of heat delivered per unit electricity consumed by the HVAC system	Measure-specific
Default: DOE EnergyPlus	**Cooling Degree Days (CDD)**	The cooling degree days of the selected city	Location-specific

Source	Parameter	Definition	Typical Value/Units
Default: Based on Confidential Data	**Constants**	Constants are determined after a curve fit of office cooling electricity as a function of CDD	Unitless
Default: IEA (2009)	**Line Loss Rate**	Average grid line loss due to transmission and distribution (%), country specific	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity

Note: All default values are available in the Appendices of the CLEER Protocol.

Figure 12 outlines the questions, user selection options, and required input data for the **Building Energy Efficiency Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table below the diagram. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered. Green shapes indicate the option of entering an alternative value for a specific input.

Figure 12: Building Energy Efficiency Calculator Pathways



LIGHTING, APPLIANCES AND OTHER EQUIPMENT EFFICIENCY CALCULATOR DATA COLLECTION NEEDS

The **Lighting, Appliances and other Equipment Efficiency Calculator** can be used to estimate GHG emissions reduced from USAID clean energy activities such as:

- Improving appliance efficiency that leads to reduced energy consumption compared to the baseline scenario,
- Replacing less efficient baseline appliances with more energy efficient appliances, or
- Enabling activities that directly lead to increased implementation of or access to energy efficient appliances in the reporting year.

Table 12 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 12: Lighting, Appliances and other Equipment Efficiency Calculator Data Collection Needs

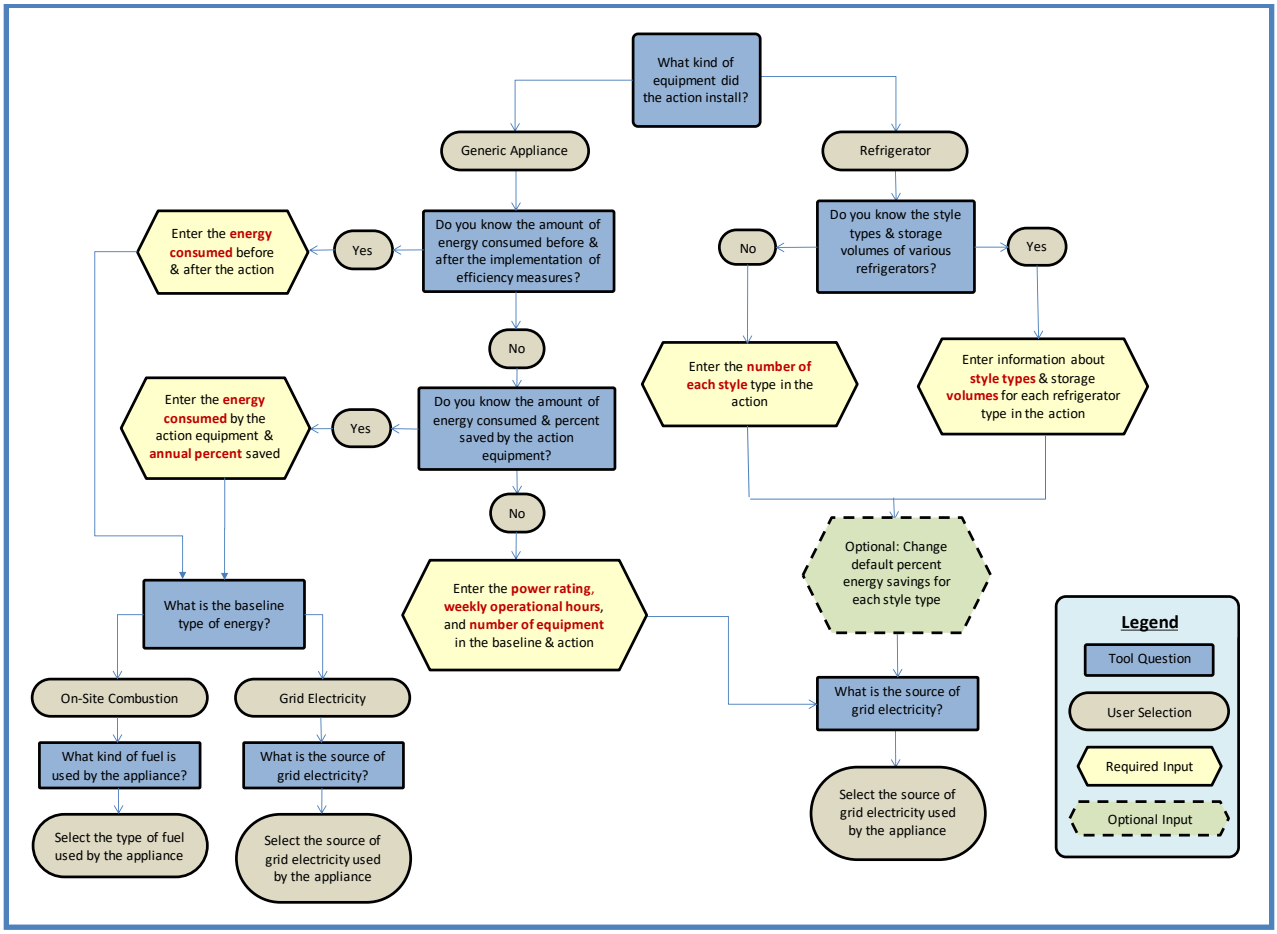
Source	Parameter	Definition	Typical Value/Units
User-Provided	**Annual Energy Consumed**	Energy consumed by the appliances in the baseline or installed by the action (kWh or GJ)	Kilowatt-hours (kWh) Megawatt-hours (MWh)
User-Provided	**Action Appliance Percentage Savings**	Percentage savings offered by the appliances installed by the action as established by the manufacturer (%)	Percent (0-99%)
User-Provided	**Number of Appliances**	The total number of appliances replaced in the baseline and installed under the action	Unitless
User-Provided	**Power Rating of Appliance**	The rated power rating of the baseline and the action appliance (kW)	Kilowatt (kW)
User-Provided	**Hours of Operation per Week**	The total number of hours per week that the appliances are operated (h)	Hours/Week
Default: Assumed 52 weeks of annual operation	**Annual Number of Operational Weeks**	Total number of weeks the appliance is operational in the reporting year	Weeks/Year
User-Provided	**Number of Refrigerator Units**	The total number of units replaced on the baseline and installed by the action for specific style types	Unitless

Source	Parameter	Definition	Typical Value/Units
Default: US EPA EnergyStar (2007)	**$Const_1$ and $Const_2$**	Constants used to determine energy consumed by specific style type refrigerators, compacts and freezers, as presented in EnergyStar Program Requirements	Unitless
User-Provided	**Fresh Volume**	Volume of the fresh food compartment of the refrigerator	Cubic feet (ft^3)
User-Provided	**Freezer Volume**	Volume of the freezer compartment of the refrigerator or the entire volume of the freezer	Cubic feet (ft^3)
Default: Based on Confidential Data	**Annual Electricity Consumption**	Annual energy consumed for a sample refrigerator type for baseline and action based on assumed energy efficiency	Kilowatt-hours (kWh)
Default: US EPA EnergyStar (2007)	**Action Refrigerator Percent Savings**	Percentage savings offered by the refrigerators installed by the action as established by the manufacturer (%)	Percent (0-99%)
Default: IEA (2014)	**Line Loss Rate**	Average grid line loss due to transmission and distribution (%), country specific	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity

Note: All default values are available in the Appendices of the CLEER Protocol.

Figure 13 outlines the questions, user selection options, and required input data for the **Lighting, Appliance and other Equipment Efficiency Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table below the diagram. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered. Green shapes indicate the option of entering an alternative value for a specific input.

Figure 13: Lighting, Appliances and other Equipment Efficiency Calculator Pathways



TRANSMISSION AND DISTRIBUTION SYSTEM UPGRADES - TECHNICAL LOSS REDUCTIONS CALCULATOR DATA COLLECTION NEEDS

The **Transmission and Distribution System Upgrades - Technical Loss Reductions Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The replacement of transmission and distribution (T&D) lines with new lines that leads to a change in line loss percentage
- The connection of regions that did not previously have transmission lines

Table 13 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

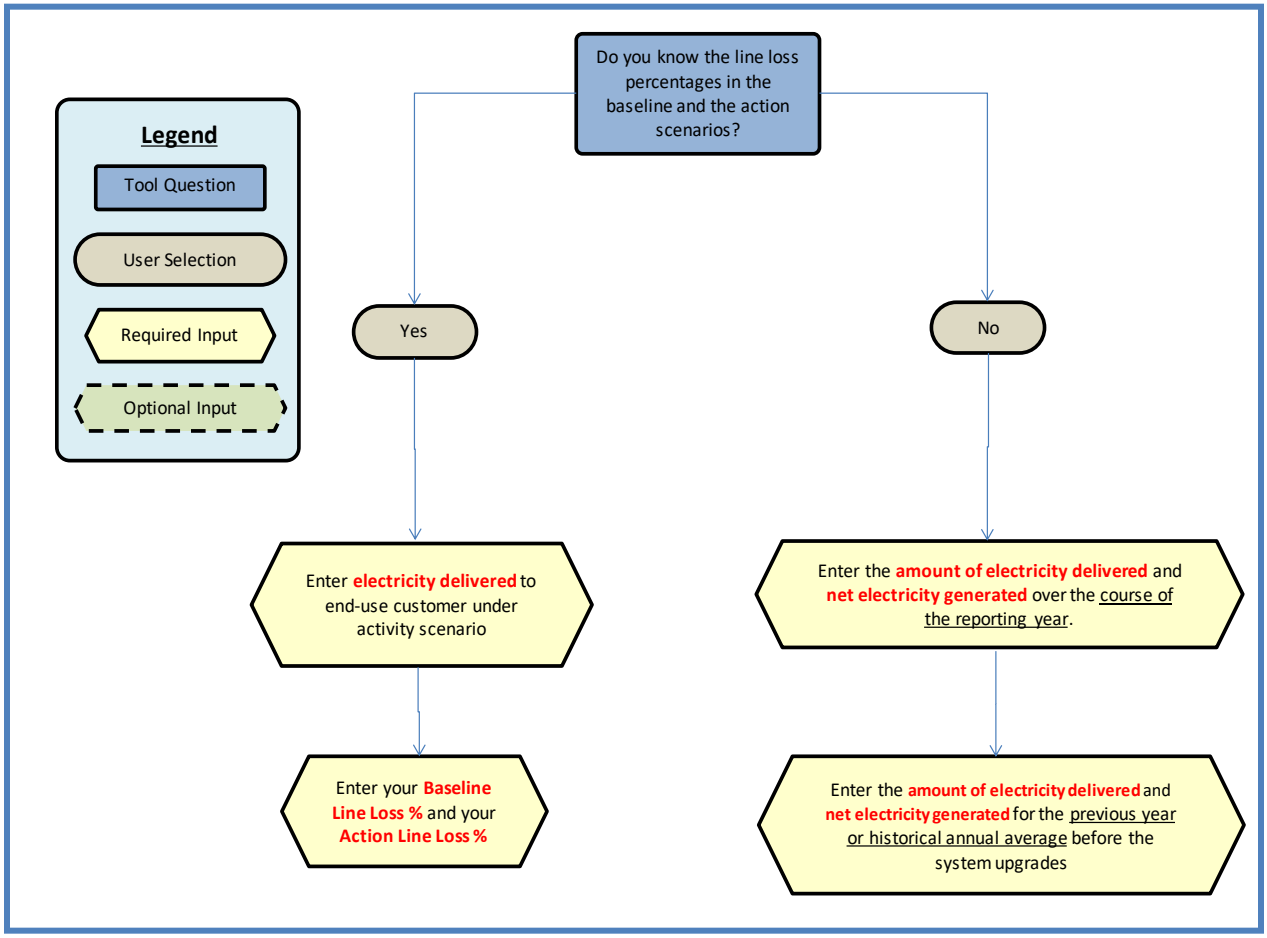
Table 13: Transmission and Distribution System Upgrades - Technical Loss Reductions Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Electricity Delivered Before System Upgrades**	The amount of electricity delivered to the customers served by the upgraded network configuration for either the previous year or an annual average	Kilowatts (kW); Megawatts (MW)
User-Provided	**Net Electricity Generated Before System Upgrades**	The amount of electricity generated for the customers served by the upgraded network configuration for either the previous year or an annual average	Kilowatts (kW); Megawatts (MW)
User-Provided	**Net Electricity Delivered in the Reporting Year**	The amount of electricity delivered to the customers served by the upgraded network configuration in the reporting year	Kilowatts (kW); Megawatts (MW)
User-Provided	**Baseline Technical Line Loss Rate**	Technical Transmission and Distribution Line Loss Rate in the reporting year	Percent (0-99%)
User-Provided	**Action Technical Line Loss Rate**	Technical Transmission and Distribution Line Loss Rate in the reporting year	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Average combined marginal GHG emission factor for grid electricity, by country	tCO_2e/kWh of electricity

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 14 outlines the questions, user selection options, and required input data for the **Transmission and Distribution System Upgrades - Technical Loss Reductions Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 14: Transmission and Distribution System Upgrades - Technical Loss Reductions Calculator Pathways



STRANDED NATURAL GAS CAPTURE SYSTEMS CALCULATOR DATA COLLECTION NEEDS

The **Stranded Natural Gas Capture Systems Calculator** can be used to calculate GHG emission reductions from USAID clean energy activities such as:

- The capture of flared or stranded vented gas and its conversation to compressed natural gas (CNG), liquefied natural gas (LNG), or electricity via a gas turbine or microturbine
- Enabling activities that directly lead to increased implementation of or access to capturing flared and stranded vented gas

Table 14 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 14: Stranded Natural Gas Capture Systems Calculator Data Collection Needs

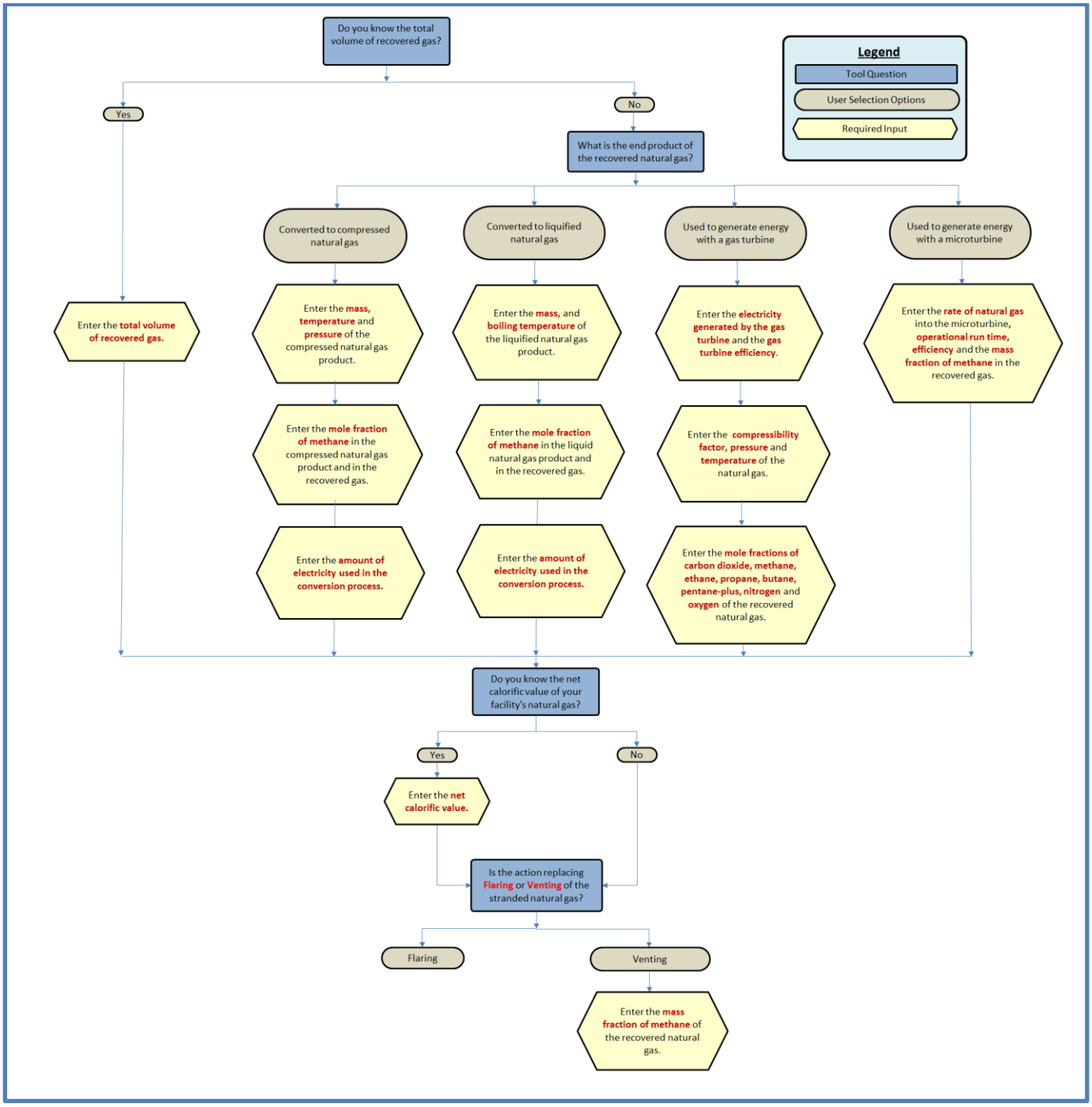
Source	Parameter	Definition	Typical Value/Units
User-Provided or Calculated	**Total Volume of Recovered Gas**	The volume of natural gas that was flared or stranded vented after accounting for natural gas that was used on-site	m^3
User-Provided	**Pressure**	The pressure of the compressed natural gas product and the pressure at STP	Pa or PSI Pressure at STP: 101,325 Pa
User-Provided	**Temperature**	The temperature of the compressed natural gas product and the recovered natural gas and at STP	K, C or F Temperature at STP: 273.15 K
User-Provided	**Amount of Compressed Natural Gas Product**	The amount of compressed natural gas	Kilogram (kg)
Default, Engineering Toolbox	**Density of Methane**	Density of methane at standard conditions	0.717 kg/m^3
User-Provided	**Amount of Liquefied Natural Gas Product**	The amount of compressed natural gas or liquefied natural gas	Kilogram (kg)
User-Provided	**Boiling Temperature**	The boiling point temperature of liquefied natural gas product	Kevlin (K)
Default, Engineering Toolbox	**Density of Methane**	Density of liquefied natural gas at boiling point	425.61 kg/m^3
User-Provided	**Mole Fraction of Methane in Compressed**	Mole fraction of CH_4 in recovered natural gas, compressed natural gas and liquefied natural gas	Unitless

Source	Parameter	Definition	Typical Value/Units
	Natural Gas Product		
User-Provided	**Amount of Electricity Produced**	The amount of electricity that was produced by the recovered natural gas to produce the CNG	kWh
User-Provided	**Compressibility Factor**	Compressibility factor at actual conditions for natural gas. You may use either a default compressibility factor of 1, or a site-specific compressibility factor based on actual temperature and pressure conditions.	Unitless
User-Provided	**Turbine Efficiency**	Gas combustion efficiency	Percent (0-100%)
Default, IEA (2013)	**Natural Gas Combustion Emission Factor**	The amount of CO_2 released when burning natural gas	56.155 kg CO_2/GJ
User-Provided	**Fuel Input Rate**	Fuel input rate for microturbine	MJ/h
User-Provided	**Microturbine Efficiency**	Microturbine efficiency	Percent (0-100%)
User-Provided	**Operational Run Time**	The operational run time of the microturbine	hours
User-Provided	**Mass Fraction of Methane in Recovered Gas**[1]	Mass fraction of CH_4 in recovered natural gas	Unitless
User-Provided	**Mole Fraction of the Hydrocarbon Constituents**	Mole fraction of hydrocarbon constituents (methane, ethane, propane, butane, and pentane-plus) in recovered gas	Unitless
User-Provided	**Net Calorific Value of Gas**	The amount of energy released for a specific composition and volume of natural gas	GJ/ m^3
Default, IEA (2014)	**Natural Gas Emission Factor**	GHG emission factor for Natural Gas	tCO_2e/GJ

Note: All default values are available in the Appendices of the CLEER Protocol. Some elements required for the methodology calculations may be excluded, because they are provided for the user in the calculator.

Figure 15 outlines the questions, user selection options, and required input data for the **Stranded Natural Gas Capture Systems Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which is chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered.

Figure 15: Stranded Natural Gas Capture Systems Calculator Pathways



REGULARIZATION OF UNAUTHORIZED ELECTRICITY CONNECTIONS CALCULATOR DATA COLLECTION NEEDS

The **Regularization of Unauthorized Electricity Connections Calculator** can be used to calculate GHG emission reductions from USAID energy efficiency activities such as:

- Use of post-paid meters with or without energy efficiency measures
- Use of pre-paid meters with or without energy efficiency measures
- Replacing postpaid meters with prepaid meters

Table 15 identifies necessary data the user should collect for estimating GHG emission reductions, which may vary by action. The table provides supporting information such as the definition, potential data source, and typical values or units.

Table 15: Regularization of Unauthorized Electricity Connections Calculator Data Collection Needs

Source	Parameter	Definition	Typical Value/Units
User-Provided	**Regularization Action**	The type of regularization action taken by the operating unit	n/a
User-Provided	**Average Annual Electricity Consumption Per Customer**	Average quantity of electricity consumed per customer before and/or after regularization	Kilowatt-hours (kWh)
Default: USAID (2017)	**Intervention Factor**	Regularization-specific factor by which intervention can be expected to reduce electricity use	Percent (0-99%)
Default: IGES (2015) IEA (2014)	**Grid Electricity Emission Factor**	Combined marginal GHG emission factor for grid electricity (IGES) or average grid emission factor (IEA), by country	tCO_2e/kWh of electricity

Figure 16 outlines the questions, user selection options, and required input data for the **Regularization of Unauthorized Electricity Connections Calculator**. Follow the diagram below to understand how sets of inputs are grouped together to complete the calculations. The diagram will also be helpful in determining information you may need to collect in the future. The diagram is color-coded to differentiate the type of input. Highlighted data inputs are further explained in the table below the diagram. Blue shapes are questions asked in the calculator, which determine the set of inputs necessary. Grey shapes indicate a user-selected answer which are chosen from a drop down menu. Yellow shapes indicate a user-input that is manually entered. Green shapes indicate the option of entering an alternative value for a specific input.

Figure 16: Regularization of Unauthorized Electricity Connections Calculator Pathways