USAID Haiti Training Session #2: Introduction to Engage

Cameron Weiner, National Renewable Energy Laboratory
Big Picture: Design Themes

Accessibility

Flexibility

Communication

Collaboration
Technology Archetypes and Carriers

Flexibility

Hydropower
- Inlet Stream
- Upper Reservoir
- Hydroelectric
- Lower Reservoir
- Transmission
- Electricity
- Combined heat and power
- Advanced gas turbine

Electrical Demand
- Electricity
- House
Technology Archetypes and Carriers

Flexibility

Hydropower

Inlet Stream

Upper Reservoir

Hydroelectric

Lower Reservoir

Transmission

Combined heat and power

Advanced gas turbine

Electrical Demand

Combined heat and power
Engage Building Blocks

Simulates how energy or commodities moves through a given system.
Engage Building Blocks

Simulates how energy or commodities moves through a given system

- Solar PV
- Turning on a light
Engage Building Blocks

Simulates how energy or commodities moves through a given system

Solar PV → Turning on a light
Engage Building Blocks

Simulates how energy or commodities moves through a given system

Solar PV → Turning on a light
Supply Archetype

Simulates how energy or commodities moves through a given system.
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply
Supply Archetype

Simulates how energy or commodities moves through a given system.

Supply Archetype
Supply Archetype

Simulates how energy or commodities moves through a given system.
Supply Archetype

Simulates how energy or commodities moves through a given system.

Supply

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.).
Supply Archetype

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

Simulates how energy or commodities moves through a given system.

Supply archetypes:
- Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.).
- Appropriate for simple technologies with an infinite supply or a capacity factor.

Electric Supply
- Wind
- Nuclear
- CCGT* (Combined cycle gas turbine)
- Coal
- Biomass

Commodity Supply
- Natural gas imports
- Thermal energy (steam)
- Water from reservoirs

* Combined cycle gas turbine
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply archetypes

- Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an infinite supply or a capacity factor

Supply

Electric Supply

- Wind
- Nuclear
- CCGT* (Combined cycle gas turbine)
- Coal
- Biomass

Commodity Supply

- Natural gas imports
- Thermal energy (steam)
- Water from reservoirs

* Combined cycle gas turbine
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

- Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an infinite supply or a capacity factor
Supply Archetype

Simulates how energy or commodities moves through a given system

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

Simulates how energy or commodities moves through a given system

- Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an infinite supply or a capacity factor
Supply Archetype

Simulates how energy or commodities moves through a given system

• Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)

• Appropriate for simple technologies with an **infinite supply** or a **capacity factor**

Supply archetypes

- Supply

resource ➔ carrier\(_{prod}\) ➔ cap\(_{energy}\) ➔ electricity ➔ transmission ➔ electricity ➔ building ➔ light
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply

- Takes a **resource** and produces a **defined carrier** (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an **infinite supply** or a **capacity factor**
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply

- Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.)
- Appropriate for simple technologies with an infinite supply or a capacity factor

Supply archetypes

resource -> carrier<sub>prod</sub> -> cap<sub>energy</sub> -> carrier<sub>prod</sub> -> building -> light
Supply Archetype

Simulates how energy or commodities moves through a given system

Supply archetypes

• Takes a resource and produces a defined carrier (power, water, diesel, natural gas, etc.)

• Appropriate for simple technologies with an infinite supply or a capacity factor

Supply
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply archetypes

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Annual operation and maintenance costs (O&M)
- Interest rates (%)

Costs Engage Can Model
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply archetypes:
- Power purchase agreements (PPAs)

Costs Engage Can Model

[Diagram showing the flow of energy from resource to carrier and finally to light bulb]

[Table showing cost components:
- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Annual operation and maintenance costs (O&M)
- Interest rates (%)]
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply archetypes

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)

Costs Engage Can Model

resource ➔ carrier_{prod} ➔ \text{cap}_{energy} ➔ \text{energy} ➔ power ➔ \text{carrier}_{prod} ➔ \text{building} ➔ \text{light}
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)

Costs Engage Can Model

Supply archetypes:

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
Modeling Technology Costs

Simulates how energy or commodities moves through a given system.

Supply archetypes:
- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Annual operation and maintenance costs (O&M)
- Interest rates (%)

Costs Engage Can Model
Modeling Technology Costs

Simulates how energy or commodities move through a given system.

Supply

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)

Costs Engage Can Model

Supply archetypes:

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
Modeling Technology Costs

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
Modeling Technology Costs

**engage**
Simulates how energy or commodities moves through a given system

**carriers**

Supply

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

**Costs Engage Can Model**

resource ➔ cap_{energy} ➔ carrier_{prod} ➔... ➔ light bulb

---

[Images and diagrams related to energy supply and modeling technology costs]
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply

• Power purchase agreements (PPAs)
• Fuel and variable costs ($/kWh)
• Capital and fixed costs ($/kW)
• Interest rates (%)
• Annual operation and maintenance costs (O&M)

Costs Engage Can Model

1. Coax the model into generating cash flows that will have the desired modeling impact.

Modeling Reminders

- Critical for capacity expansion modeling
- Be consistent in representations.
  - Ex: consistent treatment of sunk costs, interest rates
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply archetypes

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model

Modeling Reminders

1. Coax the model into generating cash flows that will have the desired modeling impact.
   - Critical for capacity expansion modeling

Supply
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply

• Power purchase agreements (PPAs)
• Fuel and variable costs ($/kWh)
• Capital and fixed costs ($/kW)
• Interest rates (%)
• Annual operation and maintenance costs (O&M)

Costs Engage Can Model

1. Coax the model into generating cash flows that will have the desired modeling impact.
   • Critical for capacity expansion modeling

Modeling Reminders

Supply
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply archetypes

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model

1. Coax the model into generating cash flows that will have the desired modeling impact.
   - Critical for capacity expansion modeling

2. Be consistent in representations.

Modeling Reminders
Modeling Technology Costs

Supply archetypes:
- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model

1. Coax the model into generating cash flows that will have the desired modeling impact.
   - Critical for capacity expansion modeling

2. Be consistent in representations.
   - Ex: consistent treatment of sunk costs, interest rates

Modeling Reminders
Modeling Technology Costs

Simulates how energy or commodities moves through a given system.

Supply

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model

1. Coax the model into generating cash flows that will have the desired modeling impact.
   - Critical for capacity expansion modeling

2. Be consistent in representations.
   - Ex: consistent treatment of sunk costs, interest rates

Modeling Reminders
Modeling Technology Costs

Simulates how energy or commodities moves through a given system

Supply

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model

Modeling Reminders

1. Coax the model into generating cash flows that will have the desired modeling impact.
   - Critical for capacity expansion modeling

2. Be consistent in representations.
   - Ex: consistent treatment of sunk costs, interest rates

Supply
Modeling Technology Costs

Simulates how energy or commodities moves through a given system.

Supply archetypes:

- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model:

- Simulation of energy or commodity movements through a system.
- Archetypes include:
  - Power purchase agreements (PPAs)
  - Fuel and variable costs ($/kWh)
  - Capital and fixed costs ($/kW)
  - Interest rates (%)
  - Annual operation and maintenance costs (O&M)

Diagram representation of energy flow from resource to carrier to utility and then to consumer.
Modeling Technology Costs

Simulates how energy or commodities moves through a given system.

Supply archetypes:
- Power purchase agreements (PPAs)
- Fuel and variable costs ($/kWh)
- Capital and fixed costs ($/kW)
- Interest rates (%)
- Annual operation and maintenance costs (O&M)

Costs Engage Can Model:

![Diagram showing the flow of energy from resource to light bulb, including symbols for cap-energy, carrier_prod, and resource.]
Transmission Archetype

Simulates how energy or commodities moves through a given system

Supply
Transmission
Transmission Archetype

Simulates how energy or commodities moves through a given system

Supply

Transmission

- Carries a carrier from one location to another in Engage

Transmission Examples

- Distribution Lines
- Natural gas pipelines
- Rivers
- Steam pipes
- Freight trains

Supply

Transmission
Transmission Archetype

- Carries a carrier from one location to another in Engage

Supply

Transmission Archetype

Simulates how energy or commodities moves through a given system

- Carries a carrier from one location to another in Engage

Supply

Transmission
Transmission Archetype

Supply

- Carries a carrier from one location to another in Engage

Transmission Archetype

Simulates how energy or commodities moves through a given system

carriers
Transmission Archetype

Supply

- Carries a carrier from one location to another in Engage

Transmission

Simulates how energy or commodities moves through a given system

**Engage**

**carriers**

**archetypes**

Resource → Cap_{energy} → Carrier_{prod} → Lightweight → Carrier_{con} → Cap_{energy} → Carrier_{prod} → Lightbulb
Transmission Archetype

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
  - Carries a carrier from one location to another in Engage

![Diagram of energy flow from resource to transmission to final use](image.png)

Resource → Carrier Prod → Transmission → Carrier Prod → Final Use
Transmission Archetype

Simulates how energy or commodities moves through a given system

- Supply archetypes
- Transmission archetypes

- Carries a carrier from one location to another in Engage
- Copper plate transmission is a modeling approach that assumes energy can flow without issues
Transmission Archetype

- **Supply**
  - Carries a carrier from one location to another in Engage
  - Copper plate transmission is a modeling approach that assumes energy can flow without issues
    - Ideal when focusing on a model’s generation capabilities

Simulates how energy or commodities moves through a given system
Transmission Archetype

- **Supply**
  - Carries a *carrier* from one location to another in Engage

- **Transmission**
  - Copper plate transmission is a modeling approach that assumes energy can flow without issues
    - Ideal when focusing on a model’s generation capabilities

Simulates how energy or commodities moves through a given system...
Demand Archetype

Simulates how energy or commodities moves through a given system

Supply
Transmission
Demand
Demand Archetype

Simulates how energy or commodities moves through a given system

- Supply
  - Consumes and removes carriers from a system through a resource with a negative value
  - Resource is always negative to represent a need the model is serving
  - The scale of negative resources can vary, from individual apartments to cities to entire markets
Demand Archetype

Simulates how energy or commodities moves through a given system

Supply

- Consumes and removes carriers from a system through a resource with a negative value

Transmission

- Resource is always negative to represent a need the model is serving

Demand

Supply

Transmission

Demand

resource → carrier_{prod} → carrier_{con} → resource
Demand Archetype

Simulates how energy or commodities moves through a given system.

- Supply: consumes and removes carriers from a system through a resource with a negative value.
  - Resource is always negative to represent a need the model is serving.
  - The scale of negative resources can vary, from individual apartments to cities to entire markets.

Supply Archetypes:
- Supply
- Transmission
- Demand
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
  - Consumes and removes carriers from a system through a resource with a negative value
  - Resource is always negative to represent a need the model is serving
  - The scale of negative resources can vary, from individual apartments to cities to entire markets

Transmission

Demand

A timeseries is a set of data that tracks a specific variable over time. Calliope can process any type of data at any timestep in a csv file:

- 15-minute intervals
- 1-hour intervals
- 1-month intervals

Recommend uploading timeseries at intervals that match the model's desired runtimes. Increased granularity will improve model precision but can also lead to longer runtimes.
A timeseries is a set of data that tracks a specific variable over time.

**Timeseries**

Simulates how energy or commodities move through a given system.

- **Supply**
  - Consumes and removes carriers from a system through a resource with a negative value.

- **Transmission**
  - Resource is always negative to represent a need the model is serving.
  - The scale of negative resources can vary, from individual apartments to cities to entire markets.

- **Demand**

Calliope can process any type of data at any timestep in a csv file:

- 15-minute intervals
- 1-hour intervals
- 1-month intervals

Recommend uploading timeseries at intervals that match the model's desired runtimes.

Increased granularity will improve model precision but can also lead to longer runtimes.

Calliope is a tool developed by USAID and NREL to support the transformation of energy systems.
A timeseries is a set of data that tracks a specific variable overtime. Calliope can process any type of data at any timestep in a csv file like:

- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

Recommend uploading timeseries at intervals that match the model’s desired runtimes. Increased granularity will improve model precision but can also lead to longer runtimes.
Timeseries

Simulates how energy or commodities move through a given system.

Supply
- Consumes and removes carriers from a system through a resource with a negative value.
- Resource is always negative to represent a need the model is serving.
- The scale of negative resources can vary, from individual apartments to cities to entire markets.

Transmission

Demand

A timeseries is a set of data that tracks a specific variable overtime.

Calliope can process any type of data at any timestep in a csv file like:
- 15-minute intervals
- 1-hour intervals
- 1-month intervals

Calliope can process any type of data at any timestep in a csv file like:
- 15-minute intervals
- 1-hour intervals
- 1-month intervals

Increased granularity will improve model precision but can also lead to longer runtimes.

US AID
DOE Office of Energy Efficiency and Renewable Energy

*Engage default run time
Timeseries

Simulates how energy or commodities moves through a given system.

- **Supply**
  - Consumes and removes carriers from a system through a resource with a negative value
  - Resource is always negative to represent a need the model is serving
  - The scale of negative resources can vary, from individual apartments to cities to entire markets

- **Transmission**

- **Demand**

A timeseries is a set of data that tracks a specific variable overtime.

Calliope can process any type of data at any timestep in a csv file like:
- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

Recommend uploading timeseries at intervals that match the model’s desired runtimes.

* Engage default run time
A timeseries is a set of data that tracks a specific variable overtime.

Calliope can process any type of data at any timestep in a csv file like:
- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

Recommend uploading timeseries at intervals that match the model’s desired runtimes.

Increased granularity will improve model precision but can also lead to longer runtimes.

Timeseries

Simulates how energy or commodities moves through a given system.

Supply
- Consumes and removes carriers from a system through a resource with a negative value
- Resource is always negative to represent a need the model is serving
- The scale of negative resources can vary, from individual apartments to cities to entire markets

Transmission

Demand

USAID
Transforming ENERGY

* Engage default run time
Timeseries

Calliope can process any type of data at any timestep in a csv file like:
- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

Recommend uploading timeseries at intervals that match the model's desired runtimes.

Increased granularity will improve model precision but can also lead to longer runtimes.

* Engage default run time
Timeseries

Simulates how energy or commodities moves through a given system

Supply
Transmission
Demand

resource → cap_{energy} → carrier_{prod} → carrier_{con} → carrier_{prod} → resource

Supply
Transmission
Demand
Timeseries

Simulates how energy or commodities moves through a given system

Supply
- Transmission
- Demand

Supply
- Transmission
- Demand

resource → carrier_{prod} → cap_{energy} → carrier_{con} → cap_{energy} → carrier_{prod} → resource
Timeseries

Simulates how energy or commodities moves through a given system

- Csv files uploaded to Engage must be in the date-time format

Supply
Transmission
Demand

Csv files uploaded to Engage must be in the date-time format
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the date-time format

Csv files uploaded to Engage must be in the date-time format

- Only csv files can be converted to timeseries in Engage
**Timeseries**

Simulates how energy or commodities move through a given system.

- Supply
- Transmission
- Demand

Csv files uploaded to Engage must be in the **date-time format**

Demand timeseries should be uploaded as **negative values**

---

**Supply**

- resource
- carrier\_prod
- n\_energy
- cap\_energy

**Transmission**

- carrier\_prod
- carrier\_con
- cap\_energy
- n\_energy

**Demand**

- resource
**Timeseries**

- **Supply**
  - Csv files uploaded to Engage must be in the **date-time format**
  - Demand timeseries should be uploaded as **negative values**

**archetypes**

- Supply
- Transmission
- Demand

**Engage**

Simulates how energy or commodities moves through a given system

**carriers**
Timeseries

- Csv files uploaded to Engage must be in the **date-time format**
- Demand timeseries should be uploaded as **negative values**
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the date-time format
- Demand timeseries should be uploaded as negative values
- Only csv files can be converted to timeseries in Engage
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the date-time format
- Demand timeseries should be uploaded as negative values
- Only csv files can be converted to timeseries in Engage
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the date-time format
- Demand timeseries should be uploaded as negative values
- Only csv files can be converted to timeseries in Engage
Timeseries

Simulates how energy or commodities moves through a given system

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the **date-time format**
- Demand timeseries should be uploaded as **negative values**
- Only **csv files** can be converted to timeseries in Engage
**Timeseries**

Simulates how energy or commodities move through a given system.

- **Supply**
- **Transmission**
- **Demand**

- Csv files uploaded to Engage must be in the **date-time format**
- Demand timeseries should be uploaded as **negative values**
- Only **csv files** can be converted to timeseries in Engage
Timeseries

Simulates how energy or commodities moves through a given system.

- Supply
- Transmission
- Demand

- Csv files uploaded to Engage must be in the date-time format.
- Demand timeseries should be uploaded as negative values.
- Only csv files can be converted to timeseries in Engage.
Model Building Process

- Locations
- Technologies
- Nodes
- Scenarios
- Runs
Function: Create representative locations for technologies within the model.
Model Building Process

1. **Locations**

**Function:** Create representative locations for technologies within the model

Mapbox features allow users to:
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

Every technology in Engage must have an assigned location, but not every location has to have a technology. Multiple technologies can be assigned to one location, but a transmission technology must:
- Be used to connect supply to demand
- Have two assigned locations
Model Building Process

1. **Locations**
   - **Function:** Create representative locations for technologies within the model
   - Mapbox features allow users to:
     - **Zoom** in on specific locations
     - **Examine** street maps
     - **View** satellite imaging

2. **Technologies**
3. **Nodes**
4. **Scenarios**
5. **Runs**
**Model Building Process**

**Function:** Create representative locations for technologies within the model

Mapbox features allow users to:
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

**Locations**
Model Building Process

1. **Locations**

**Function:** Create representative locations for technologies within the model

Mapbox features allow users to:
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

- Multiple technologies can be assigned to one location, but a transmission technology must:
  - Be used to connect supply to demand
  - Have two assigned locations
Model Building Process

1. Locations

**Function:** Create representative locations for technologies within the model

Mapbox features allow users to:
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

**Every technology** in Engage must have an **assigned location**, which is critical for creating and enabling nodes.
Model Building Process

1. **Locations**

   **Function:** Create representative locations for technologies within the model

   Mapbox features allow users to:
   - **Zoom** in on specific locations
   - **Examine** street maps
   - **View** satellite imaging

   **Every technology** in Engage must have an **assigned location**, which is critical for creating and enabling nodes

   **Multiple technologies** can be assigned to one location, but a **transmission technology** must:
Model Building Process

1. Locations

**Function:** Create representative locations for technologies within the model

Mapbox features allow users to:
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

**Every technology** in Engage must have an **assigned location**, which is critical for creating and enabling nodes

**Multiple technologies** can be assigned to one location, but a **transmission technology** must:
- Be used to **connect** supply to demand
- Have **two assigned** locations
Model Building Process

1. Locations
2. Technologies
   - Nodes
   - Scenarios
   - Runs
Model Building Process

1. **Locations**

2. **Technologies**

3. **Nodes**

Function: Assign technologies to locations in the model to measure, control, and analyze energy/commodity flows.
Model Building Process

1. **Locations**
   - **Function:** Assign technologies to locations in the model to measure, control, and analyze energy/commodity flows

2. **Technologies**
   - Automatically populates parameters listed under the Technologies page so that users can:
     - Create multiple versions of the same technologies
     - Customize technology parameters to be locationally-specific
   - All technologies will require the assignment of at least one location, while transmission technologies require two locations.

3. **Nodes**

- **Scenarios**

- **Runs**

---

**engage**

---

**US AID**

**NREL**

Transforming ENERGY
Model Building Process

**Function:** Assign technologies to locations in the model to measure, control, and analyze energy/commodity flows

1. **Locations**
   - Function: Automatically populates parameters listed under the Technologies page so that users can:
     - Create multiple versions of the same technologies
     - Customize technology parameters to be locationally-specific
   - All technologies will require the assignment of at least one location, while transmission technologies require two locations.

2. **Technologies**

3. **Nodes**

Scenarios

Runs

engage
Model Building Process

1. Locations
   - Function: Assign technologies to locations in the model to measure, control, and analyze energy/commodity flows
   - Automatically populates parameters listed under the Technologies page so that users can:
     - Create *multiple versions* of the same technologies
     - Customize technology parameters to be *locationally-specific*

2. Technologies

3. Nodes

Scenarios

Runs

engage
Model Building Process

1. **Locations**

Function: Assign technologies to locations in the model to measure, control, and analyze energy/commodity flows

Automatically populates parameters listed under the Technologies page so that users can:

- Create **multiple versions** of the same technologies
- Customize technology parameters to be **locationally-specific**

All technologies will require the assignment of **at least one location**, while **transmission technologies** require **two locations**

2. **Technologies**

3. **Nodes**

4. **Scenarios**

5. **Runs**
Model Building Process

1. **Locations**

2. **Technologies**

3. **Nodes**

4. **Scenarios**

**Function:** Build scenarios by enabling nodes and setting overarching model constraints.
**Function:** Build scenarios by enabling nodes and setting overarching model constraints.
Model Building Process

1. **Locations**
2. **Technologies**
3. **Nodes**
4. **Scenarios**

**Function:** Build scenarios by enabling nodes and setting overarching model constraints.

- **Locations**
- **Technologies**
- **Nodes**
- **Scenarios**
Model Building Process

1. **Locations**
2. **Technologies**
3. **Nodes**
4. **Scenarios**

**Function:** Build scenarios by enabling nodes and setting overarching model constraints

**Activate** technologies at specific locations by enabling their **correlating nodes**
**Function:** Build scenarios by enabling nodes and setting overarching model constraints

**Activate** technologies at specific locations by enabling their **correlating nodes**

**Organize nodes** by their:
- Archetype technology
- Version tag
- Location
**Model Building Process**

1. **Locations**
   - **Function:** Build scenarios by enabling nodes and setting overarching model constraints
   - **Activate** technologies at specific locations by enabling their *correlating nodes*
   - **Organize nodes** by their:
     - Archetype technology
     - Version tag
     - Location
   - **Create overarching model constraints** that apply to all nodes like:
     - A carbon cap
     - A reserve margin
     - An object class

2. **Technologies**

3. **Nodes**

4. **Scenarios**
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation.
Model Building Process

1. **Locations**

2. **Technologies**

3. **Nodes**

4. **Scenarios**

5. **Runs**

**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation.
**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation.

Engage **limits runs to one year**, which means Engage runs can...

- ✔ Over one year (ex: \(1/2023\) to \(1/2025\))
- ✗ Beyond one year (ex: \(5/2023\) to \(1/2024\))
- ✔ Within a year (ex: \(4/2023\) to \(8/2023\))
- ✔ Up to one year (ex: \(1/2023\) to \(12/2023\))
**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage **limits runs to one year**, which means Engage runs can…

- ❌ Over one year (ex: 1/2023 to 1/2025)
- ❌ Beyond one year (ex: 5/2023 to 1/2024)
- ✔ Within a year (ex: 4/2023 to 8/2023)
- ✔ Up to one year (ex: 1/2023 to 12/2023)

**Model Building Process**

1. **Locations**
2. **Technologies**
3. **Nodes**
4. **Scenarios**
5. **Runs**
**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage **limits runs to one year**, which means Engage runs can…

- ✗ Over one year (ex: 1/2023 to 1/2025)
- ✗ Beyond one year (ex: 5/2023 to 1/2024)
- ✔ Within a year (ex: 4/2023 to 8/2023)
- ✔ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect **run timesteps at any interval**, including:

- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
Model Building Process

**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage **limits runs to one year**, which means Engage runs can…
- ✗ Over one year (ex: 1/2023 to 1/2025)
- ✗ Beyond one year (ex: 5/2023 to 1/2024)
- ✓ Within a year (ex: 4/2023 to 8/2023)
- ✓ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect **run timesteps at any interval**, including:
- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage **limits runs to one year**, which means Engage runs can…
- ❌ Over one year (ex: 1/2023 to 1/2025)
- ❌ Beyond one year (ex: 5/2023 to 1/2024)
- ✓ Within a year (ex: 4/2023 to 8/2023)
- ✓ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect **run timesteps at any interval**, including:
- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage limits runs to one year, which means Engage runs can…

✗ Over one year (ex: 1/2023 to 1/2025)
✗ Beyond one year (ex: 5/2023 to 1/2024)
✓ Within a year (ex: 4/2023 to 8/2023)
✓ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect run timesteps at any interval, including:

• 15-minute
• 30-minute
• 1-hour (default)
• 2-hour
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage limits runs to one year, which means Engage runs can…

❌ Over one year (ex: 1/2023 to 1/2025)
❌ Beyond one year (ex: 5/2023 to 1/2024)
✔ Within a year (ex: 4/2023 to 8/2023)
✔ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect run timesteps at any interval, including:

- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
**Function:** Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage **limits runs to one year**, which means Engage runs can…
- ❌ Over one year (ex: 1/2023 to 1/2025)
- ❌ Beyond one year (ex: 5/2023 to 1/2024)
- ✔ Within a year (ex: 4/2023 to 8/2023)
- ✔ Up to one year (ex: 1/2023 to 12/2023)

Engage can collect **run timesteps at any interval**, including:
- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

Engage limits runs to one year, which means Engage runs can…
- Over one year (ex: 1/2023 to 1/2025)
- Beyond one year (ex: 5/2023 to 1/2024)
- Within a year (ex: 4/2023 to 8/2023)
- Up to one year (ex: 1/2023 to 12/2023)

Engage can collect run timesteps at any interval, including:
- 15-minute
- 30-minute
- 1-hour (default)
- 2-hour
Next Training Session

1. How much capacity did the model build?

2. Was there unmet demand?

3. How much did it cost to operate the solar farm for one year?
Next Training Session

• Capacity expansion modeling

• Advanced archetype technologies
Thank you!

Contact engage@nrel.gov with any issues or questions.