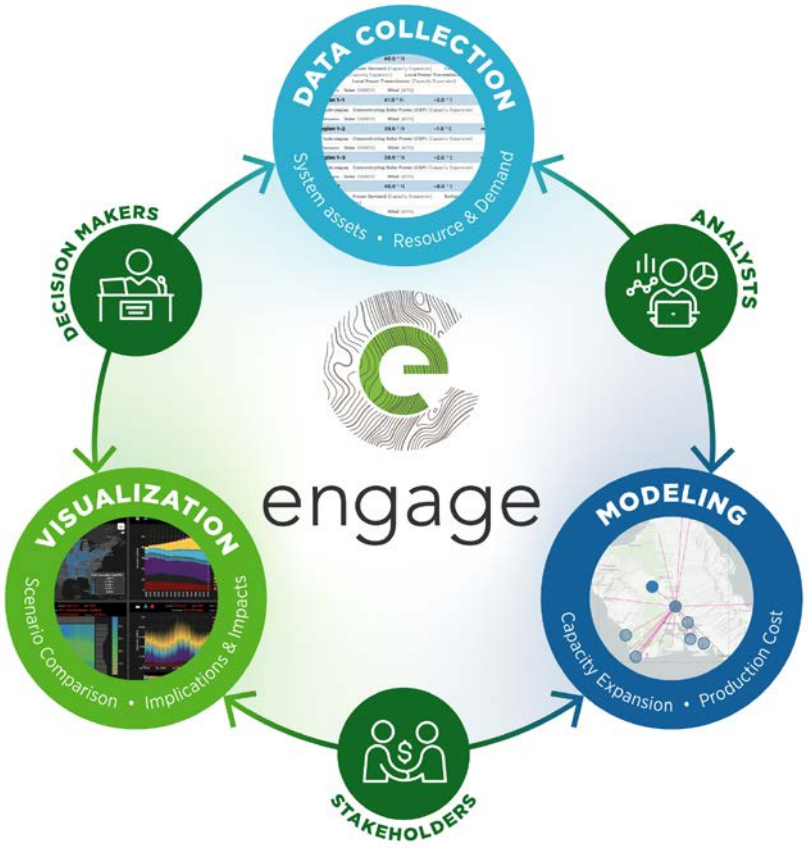
USAID Haiti Training Session #2: Introduction to Engage

Cameron Weiner, National Renewable Energy Laboratory

Big Picture: Design Themes

Accessibility

Communication



Flexibility

Collaboration

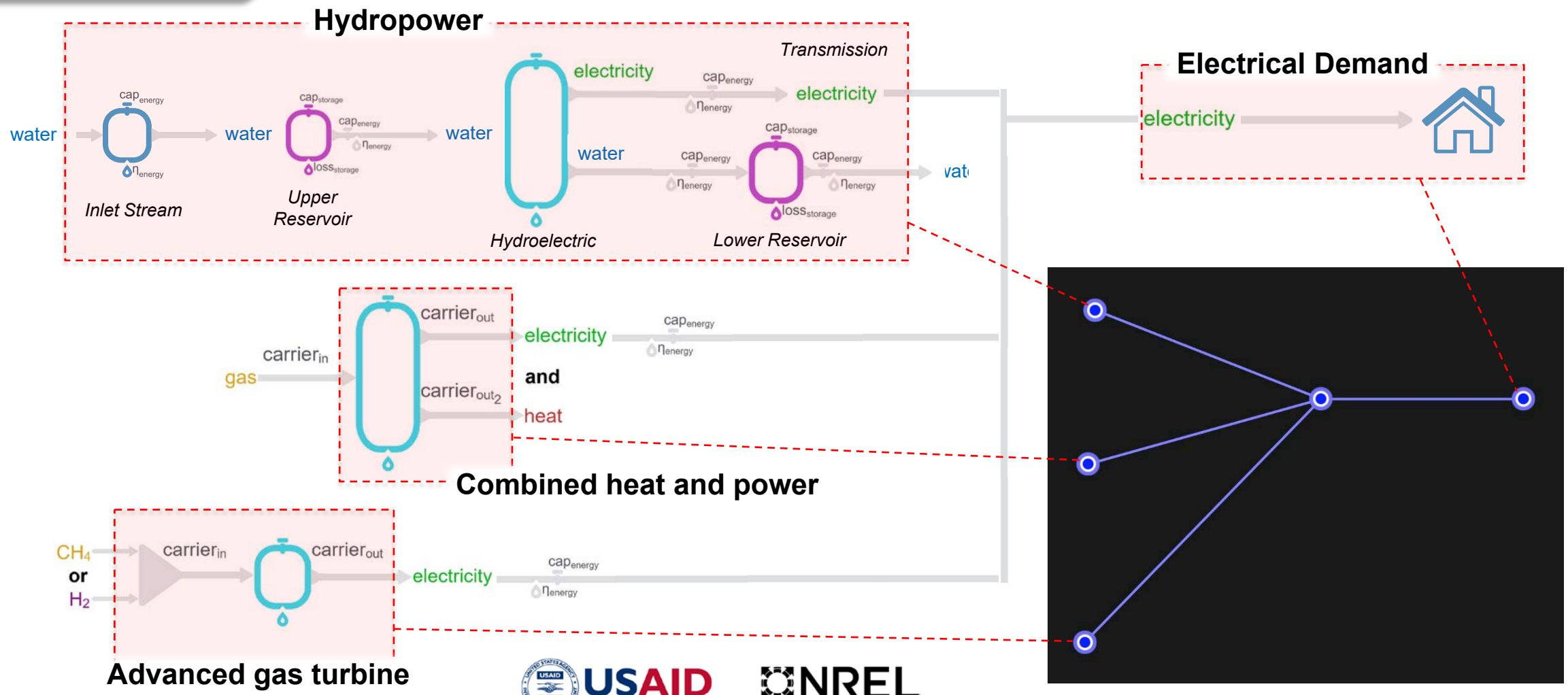
USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Technology Archetypes and Carriers

https://www.callio.pe/

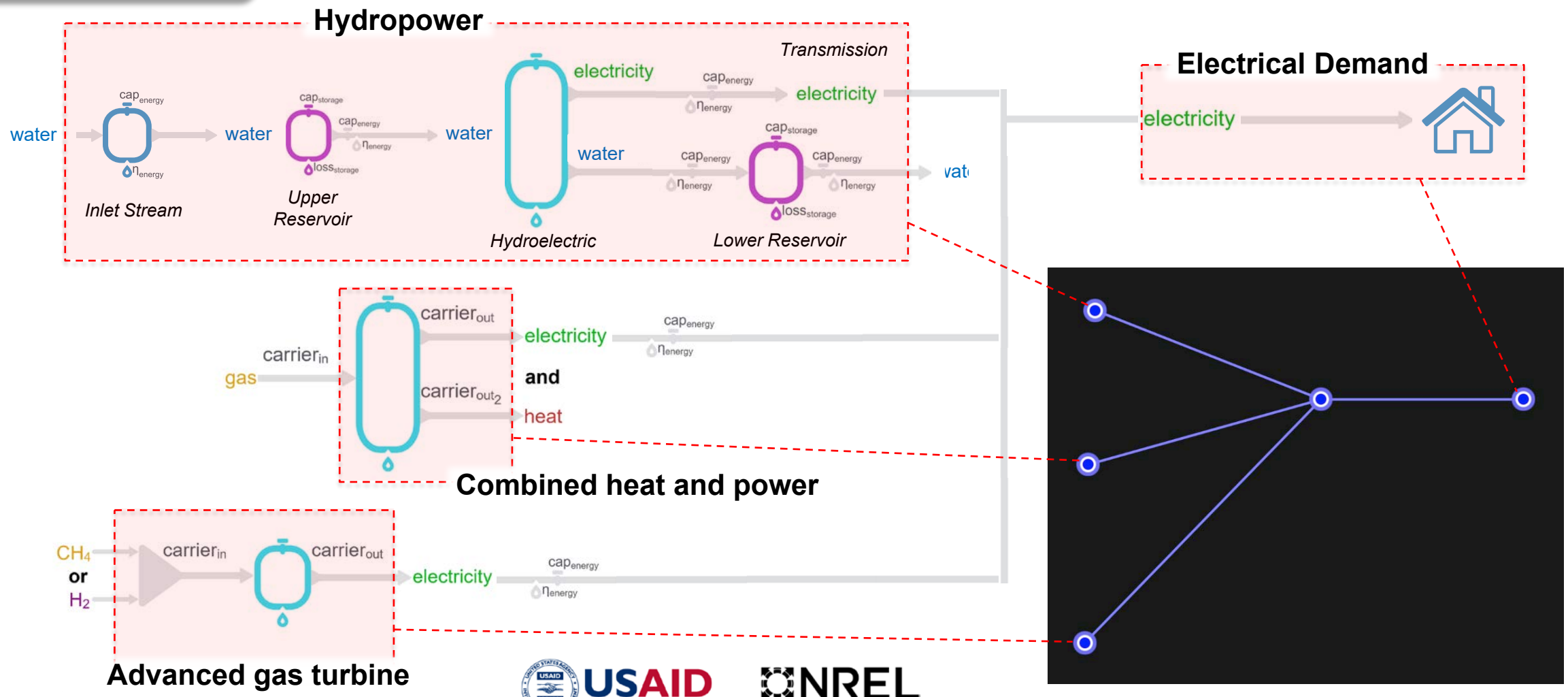
Flexibility



Technology Archetypes and Carriers

https://www.callio.pe/

Flexibility



Engage Building Blocks

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

Engage Building Blocks

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

Solar PV

Turning on a light

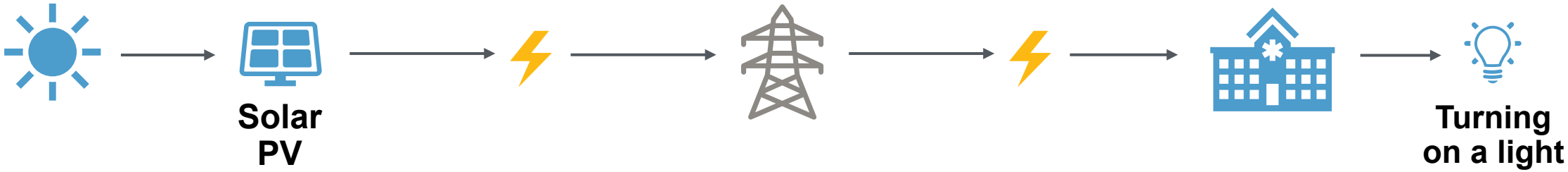
Engage Building Blocks

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes



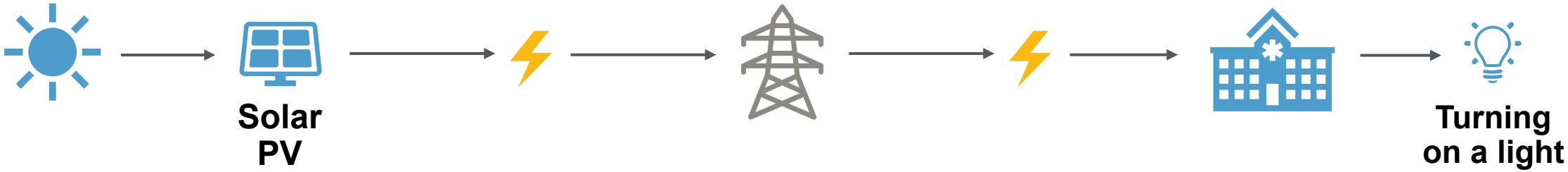
Engage Building Blocks

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes



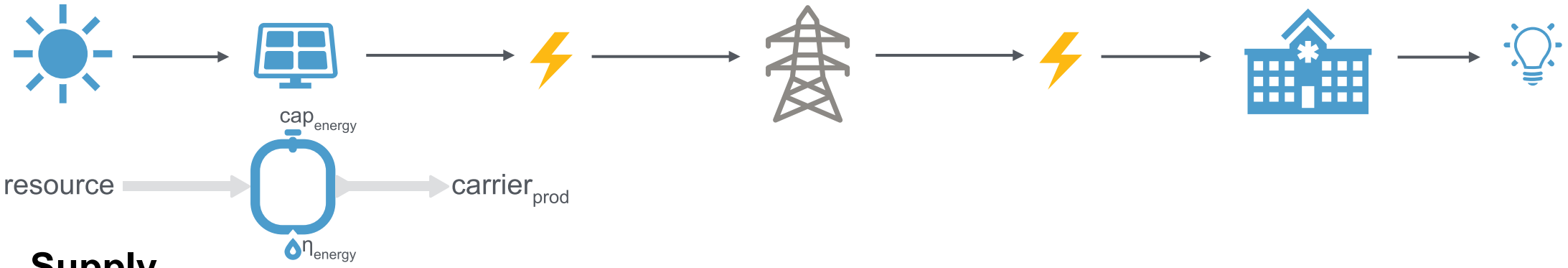
Supply Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes



Supply

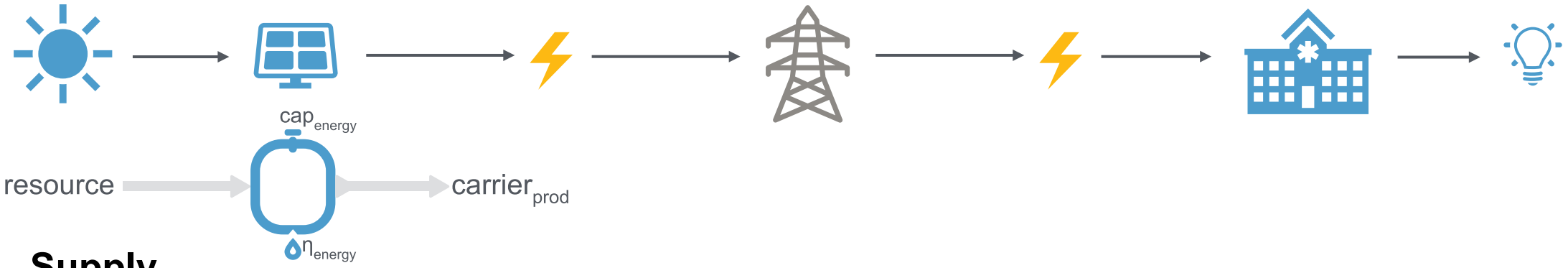
Supply Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes



Supply

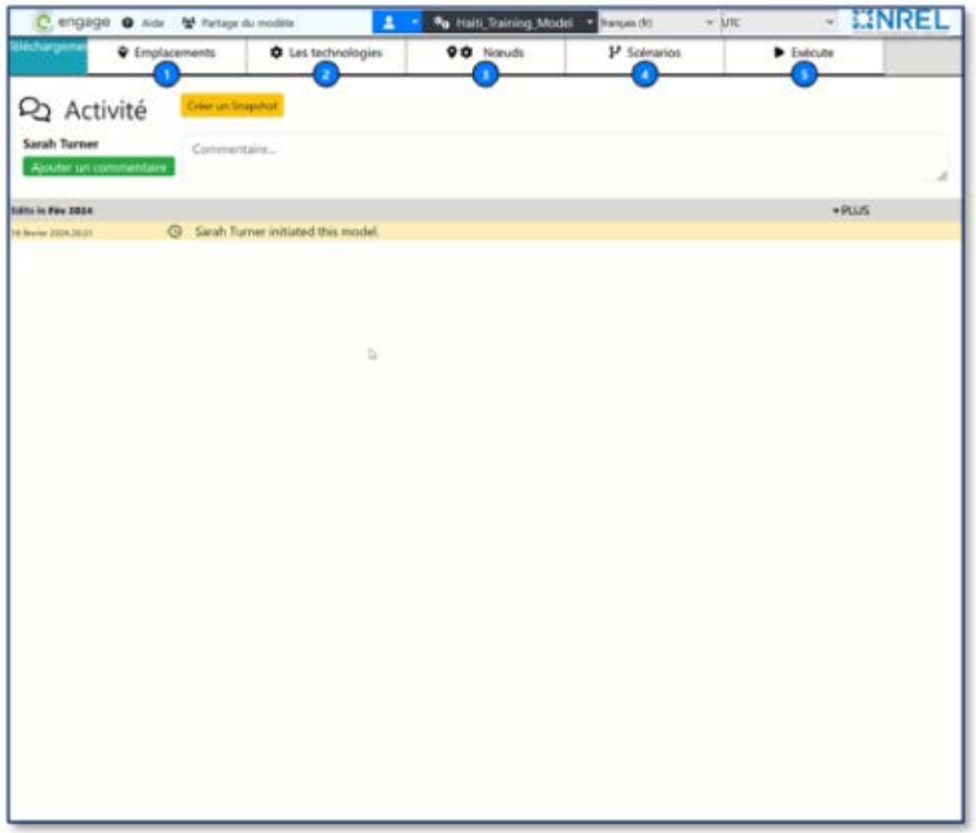
Supply Archetype

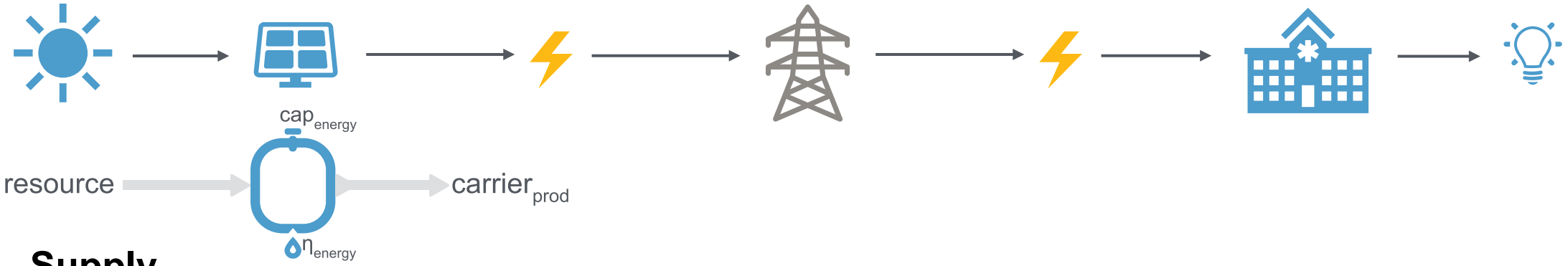
engage

Simulates how energy or commodities moves through a given system

carriers

archetypes





Supply

Supply Archetype

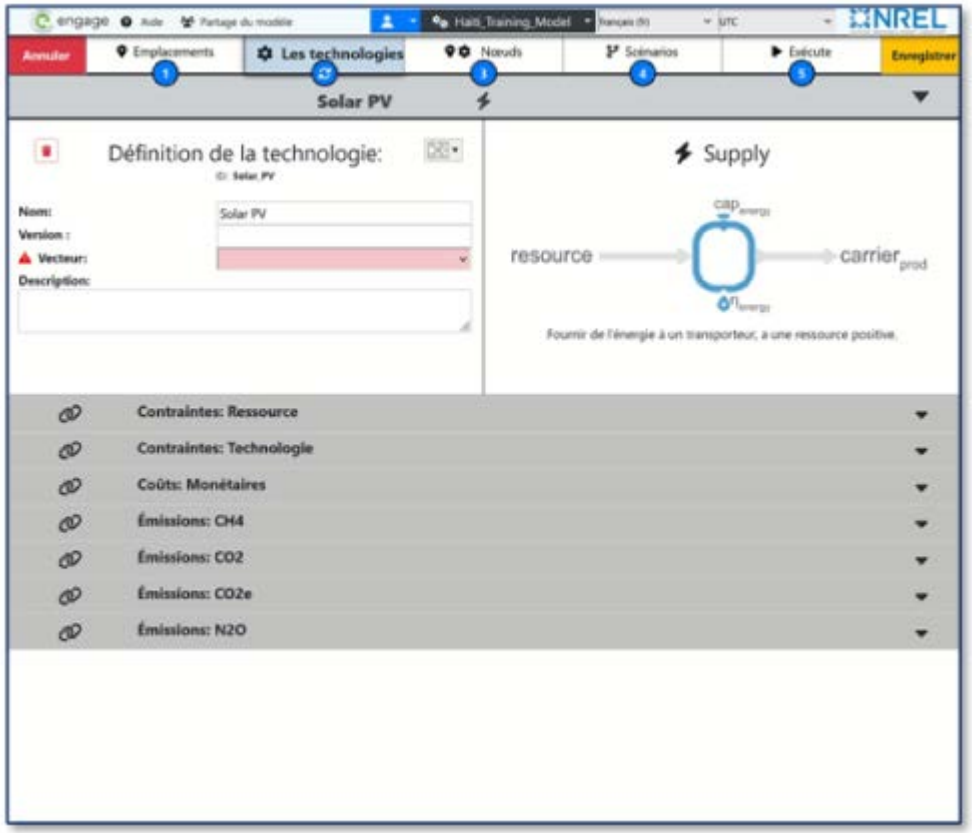
engage

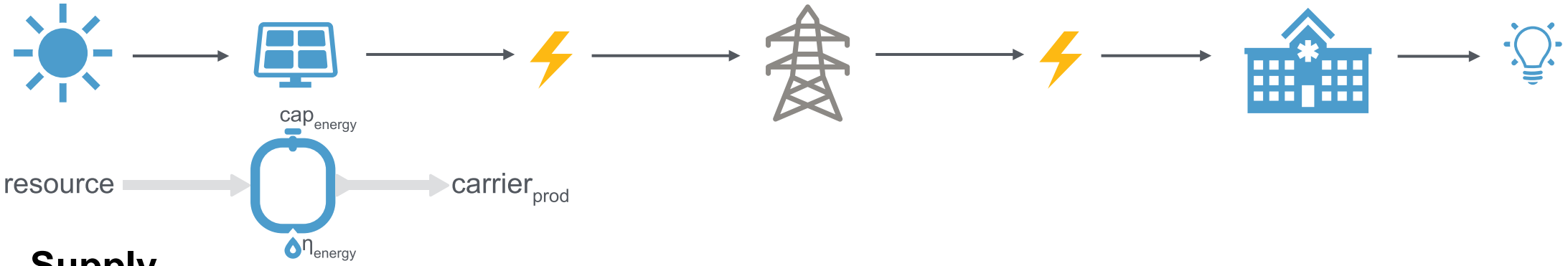
Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [ ]
- [ ]
- [ ]
- [ ]





Supply

Supply Archetype

engage

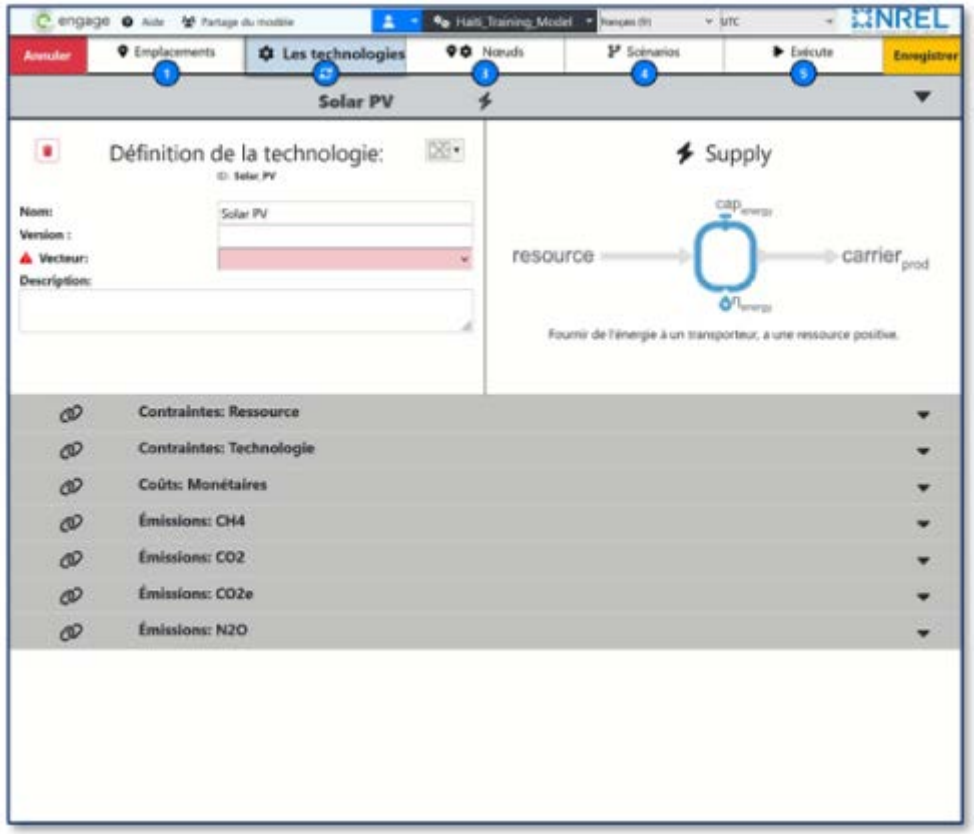
Simulates how energy or commodities moves through a given system

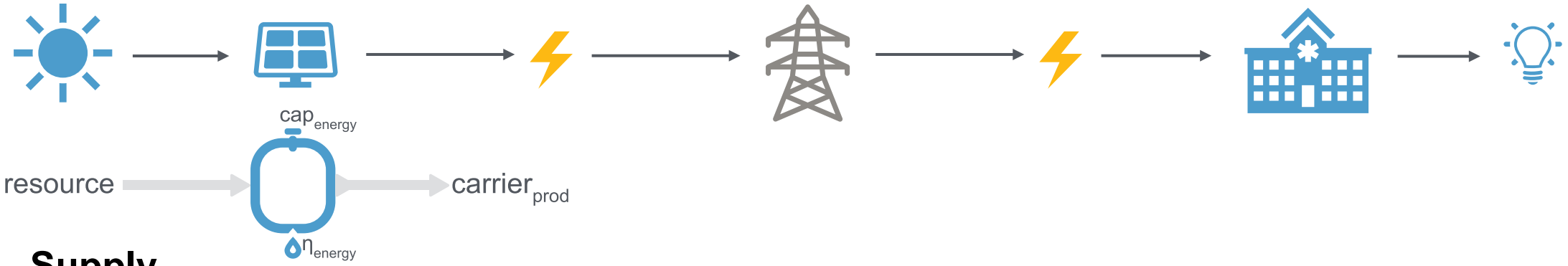
carriers

archetypes

- Supply
-
-
-
-
-

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





Supply

Supply Archetype

engage

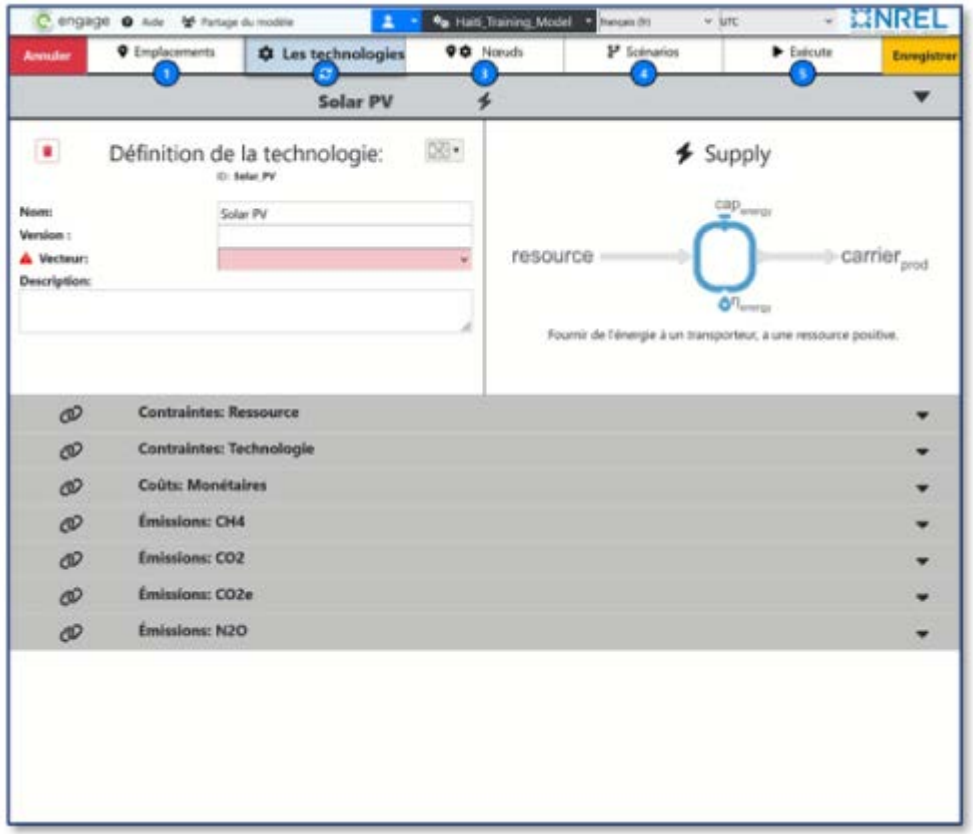
Simulates how energy or commodities moves through a given system

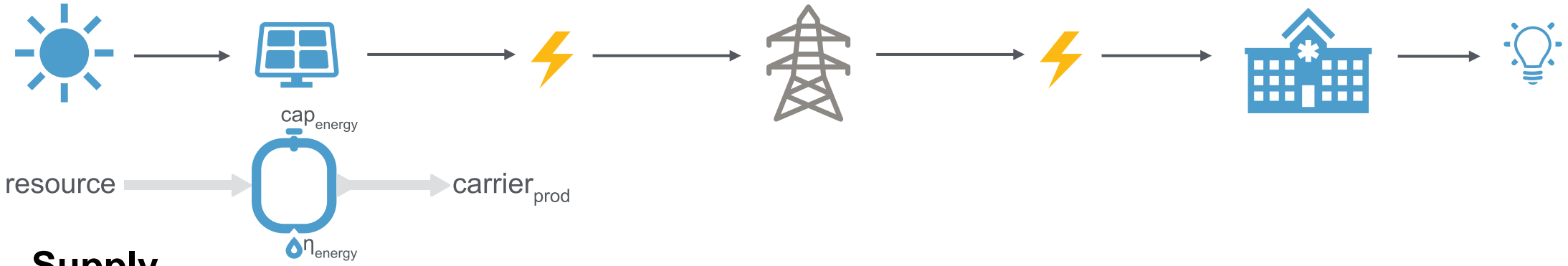
carriers

archetypes

- ☑ 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

Supply Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

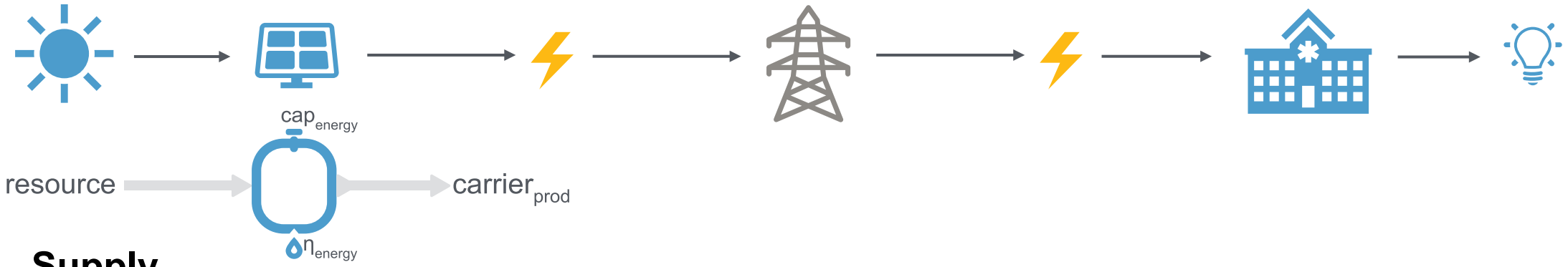
- ☑ Supply
- ☐
- ☐
- ☐
- ☐

- 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**

Wind
Nuclear
CCGT*
Coal
Biomass

Electric Supply

* Combined cycle gas turbine



Supply

Supply Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- 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**

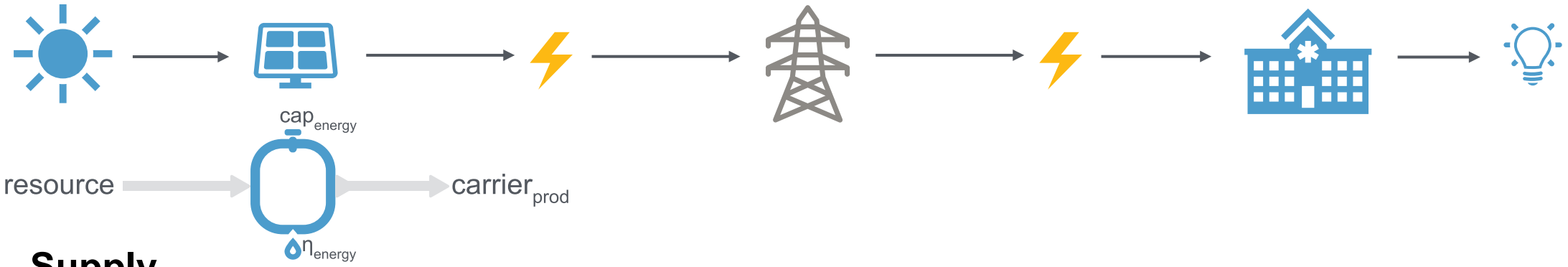
Wind
Nuclear
CCGT*
Coal
Biomass

Electric Supply

* Combined cycle gas turbine

Natural gas imports
Thermal energy (steam)
Water from reservoirs

Commodity Supply



Supply

Supply Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- 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**

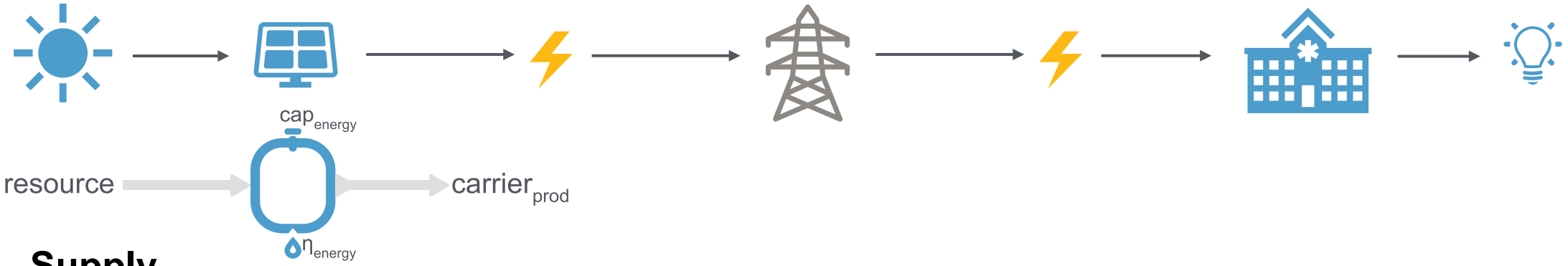
Wind
Nuclear
CCGT*
Coal
Biomass

Electric Supply

* Combined cycle gas turbine

Natural gas imports
Thermal energy (steam)
Water from reservoirs

Commodity Supply



Supply

Supply Archetype

engage

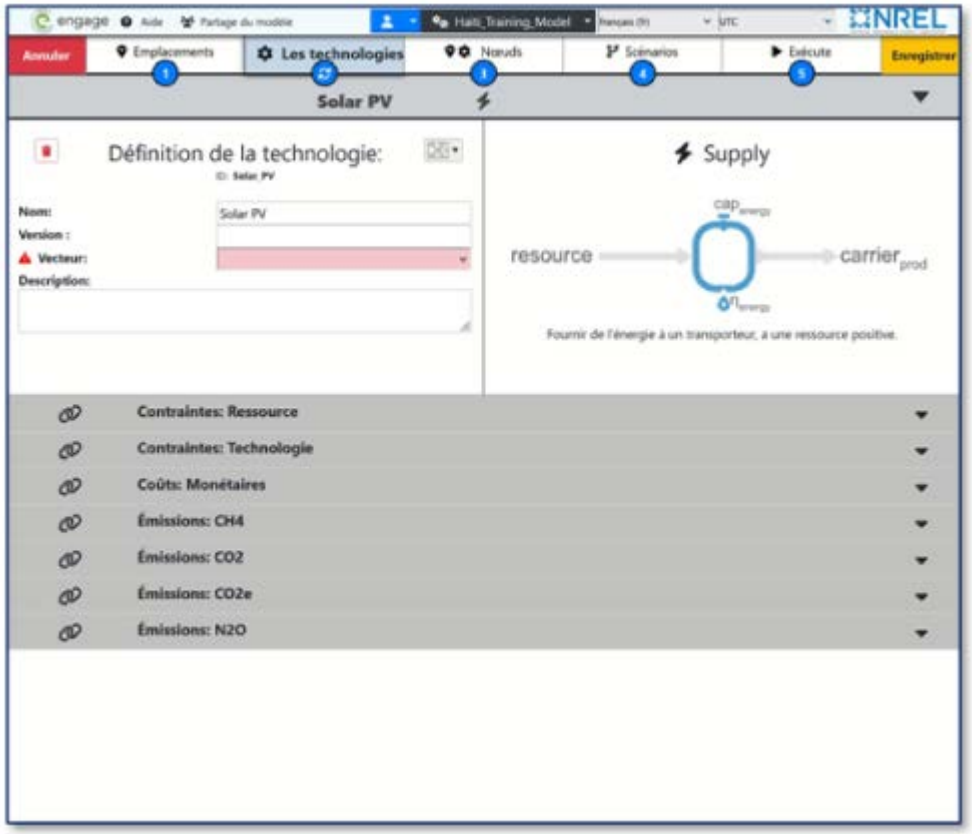
Simulates how energy or commodities moves through a given system

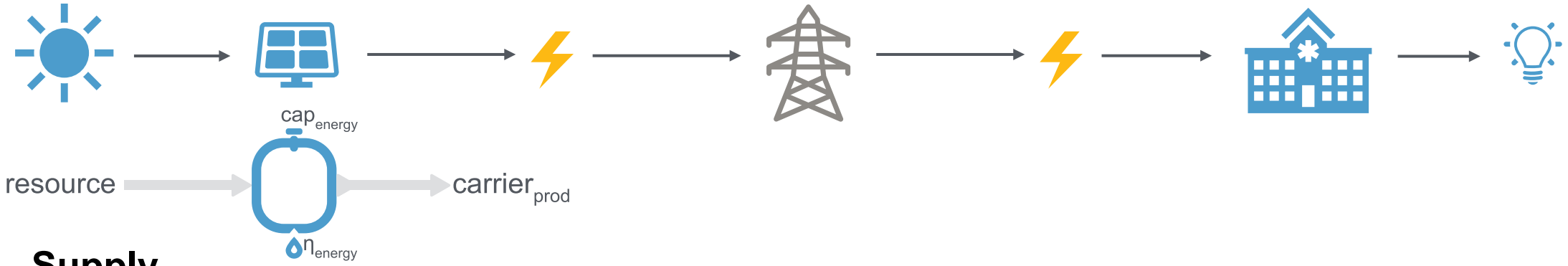
carriers

archetypes

- ☑ 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

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Supply Archetype

engage

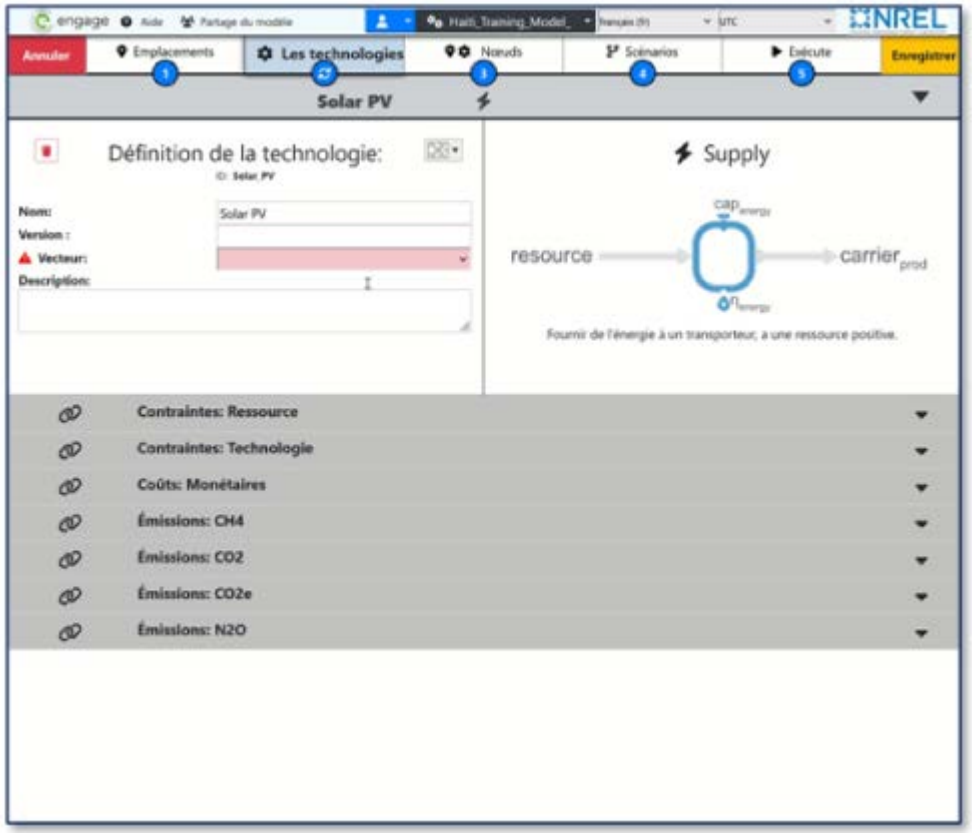
Simulates how energy or commodities moves through a given system

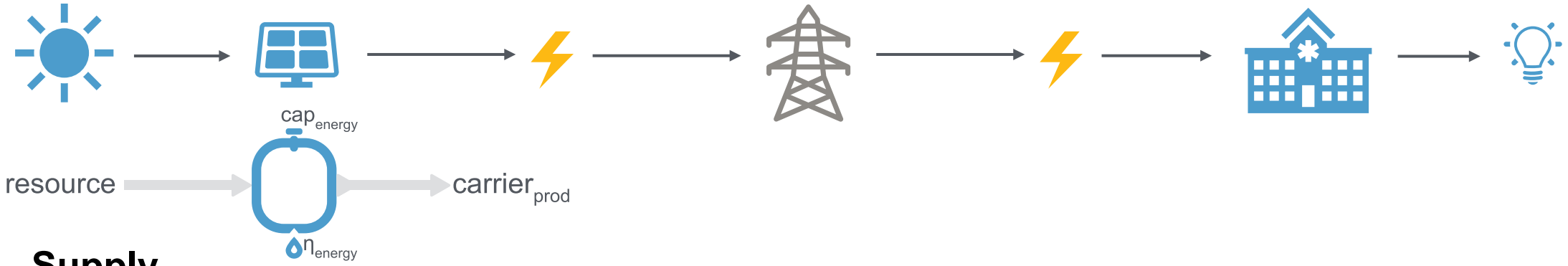
carriers

archetypes

- ☑ 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

Supply Archetype

engage

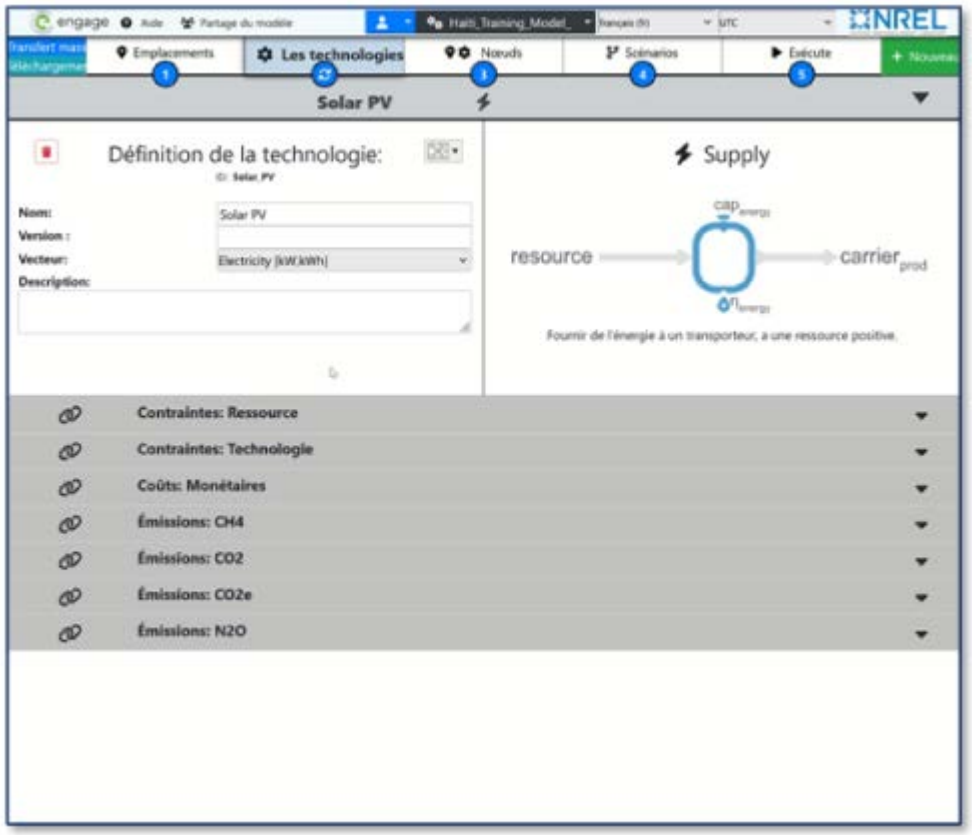
Simulates how energy or commodities moves through a given system

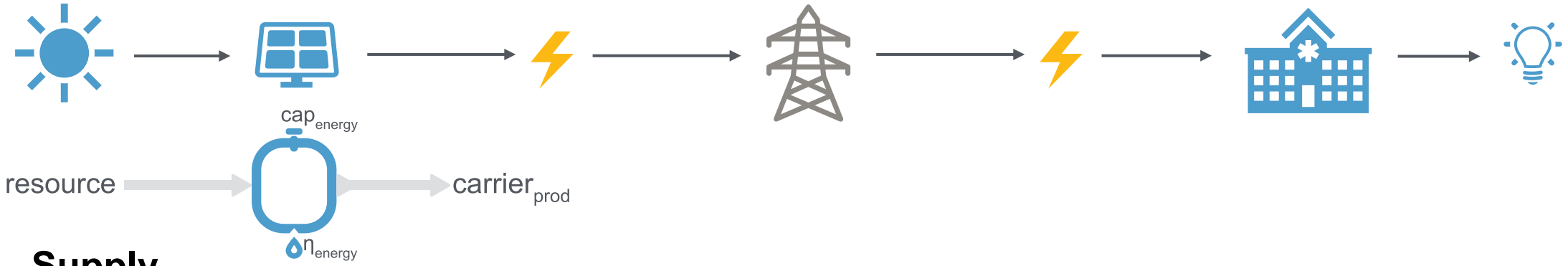
carriers

archetypes

- ☑ 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

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Supply Archetype

engage

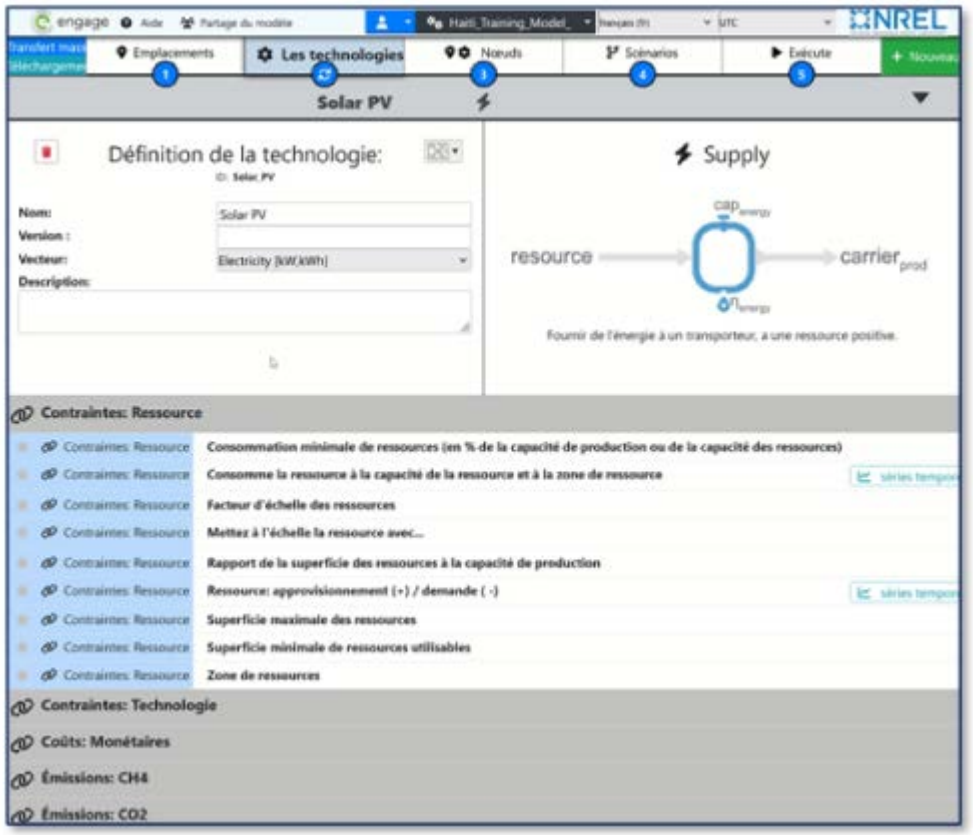
Simulates how energy or commodities moves through a given system

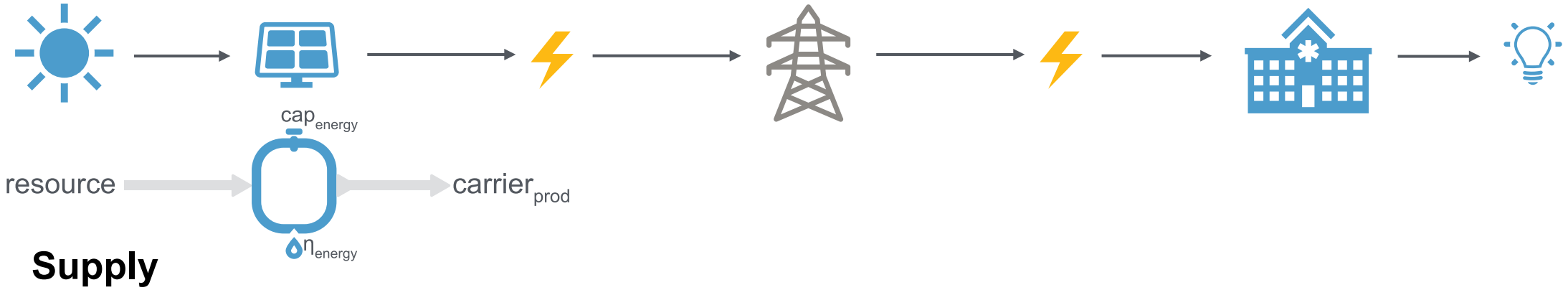
carriers

archetypes

- ☑ 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

engage

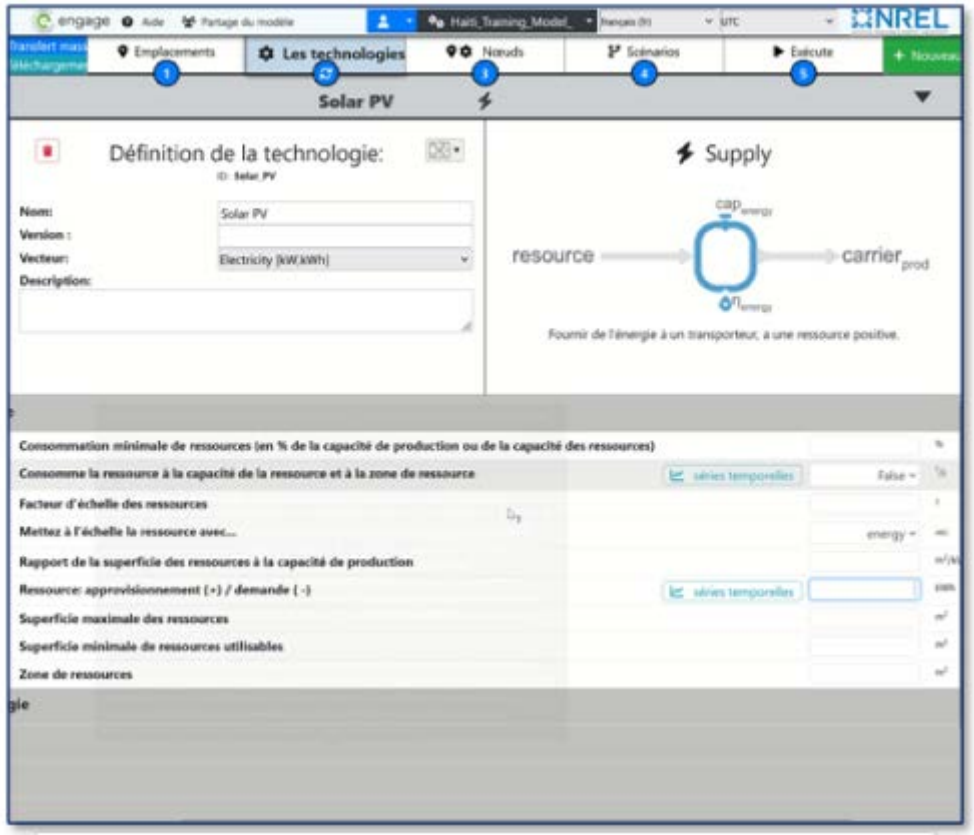
Simulates how energy or commodities moves through a given system

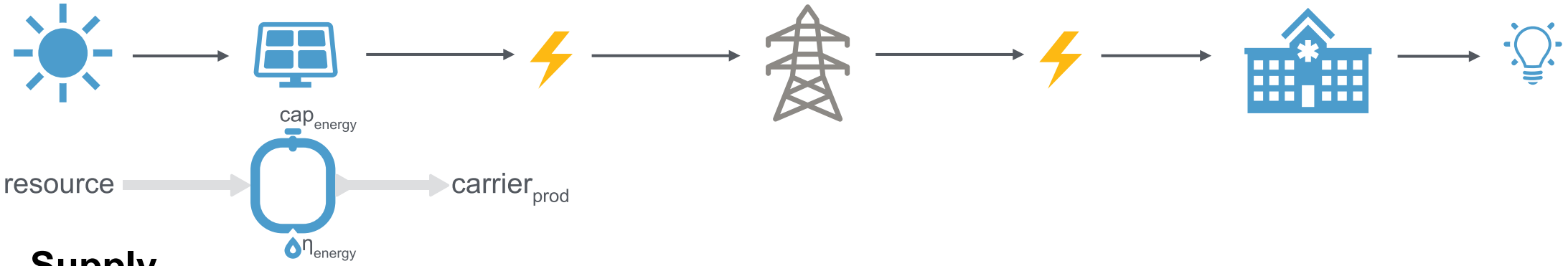
carriers

archetypes

- ☑ 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

Supply Archetype

engage

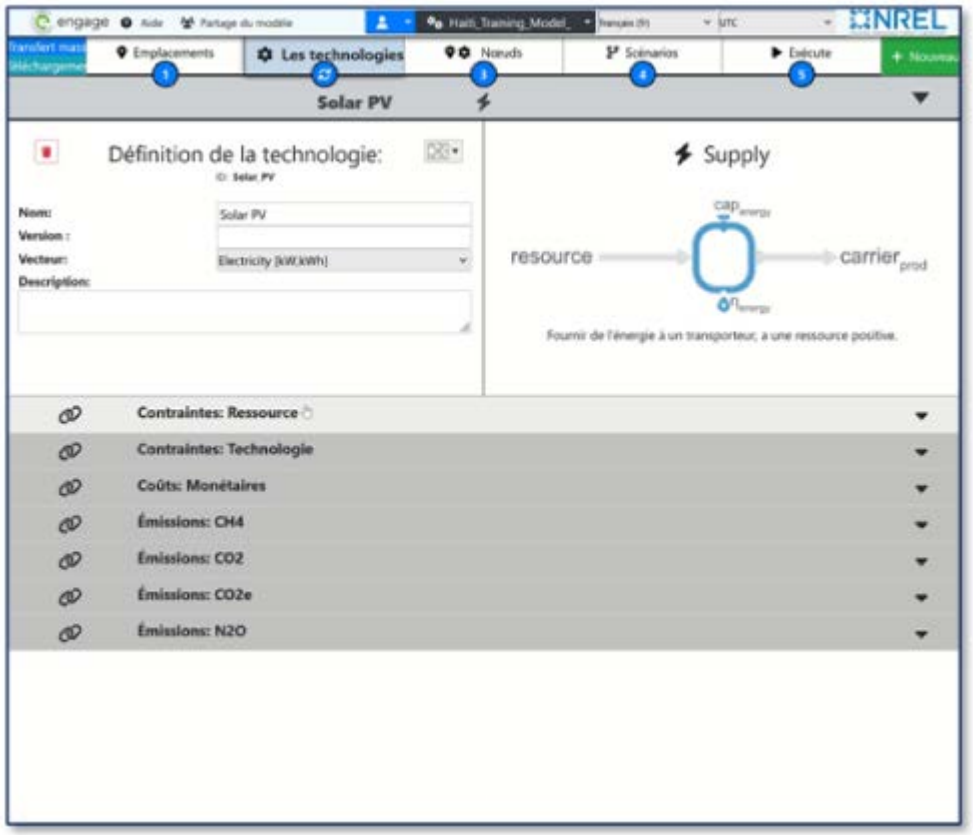
Simulates how energy or commodities moves through a given system

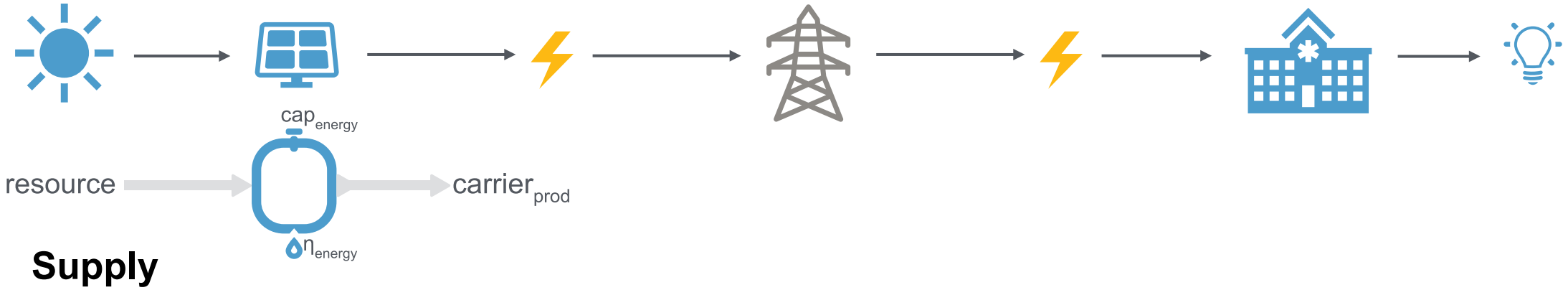
carriers

archetypes

- ☑ 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

engage

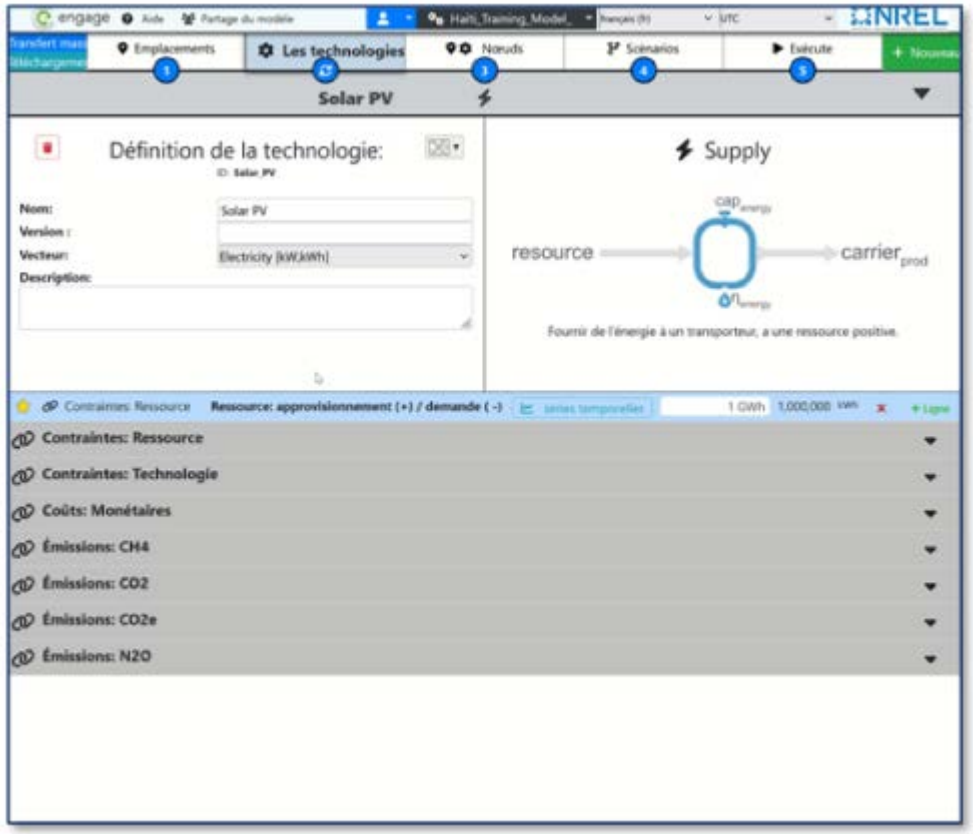
Simulates how energy or commodities moves through a given system

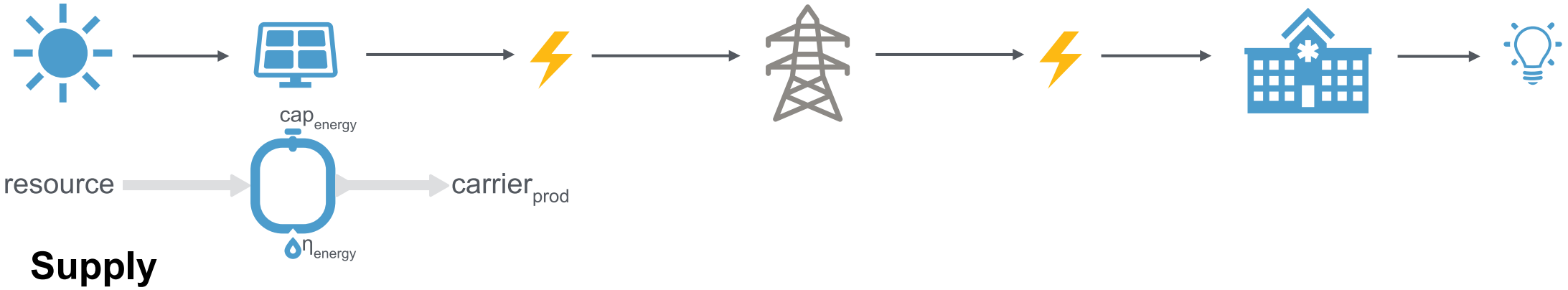
carriers

archetypes

- ☑ 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

engage

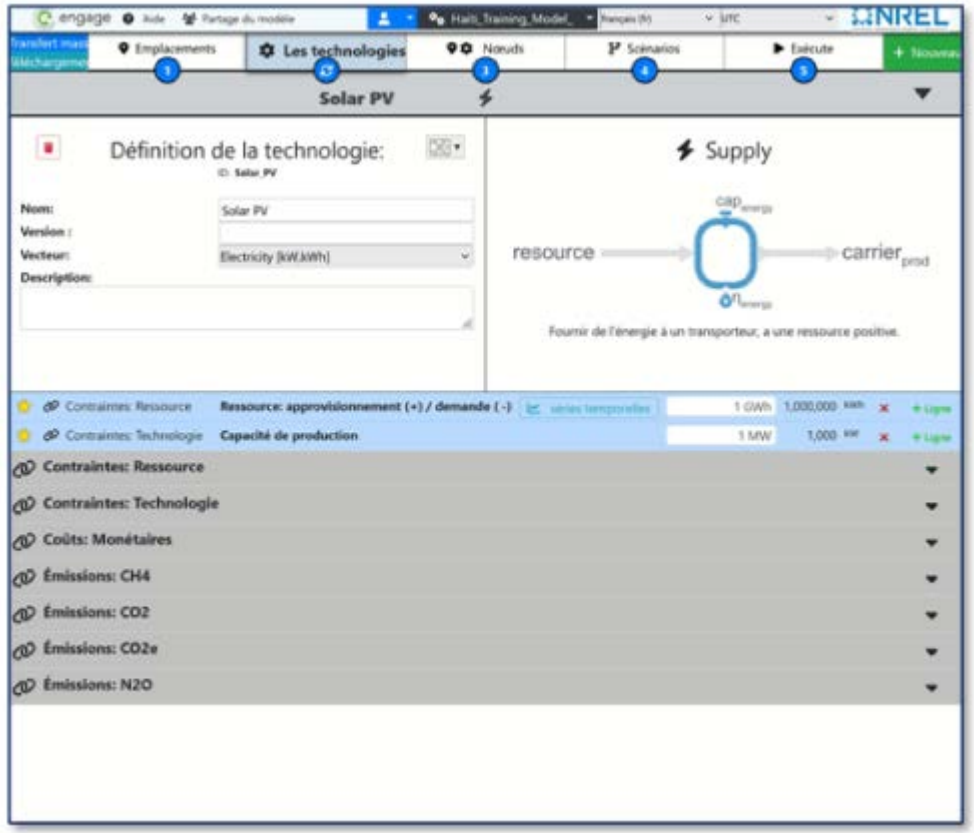
Simulates how energy or commodities moves through a given system

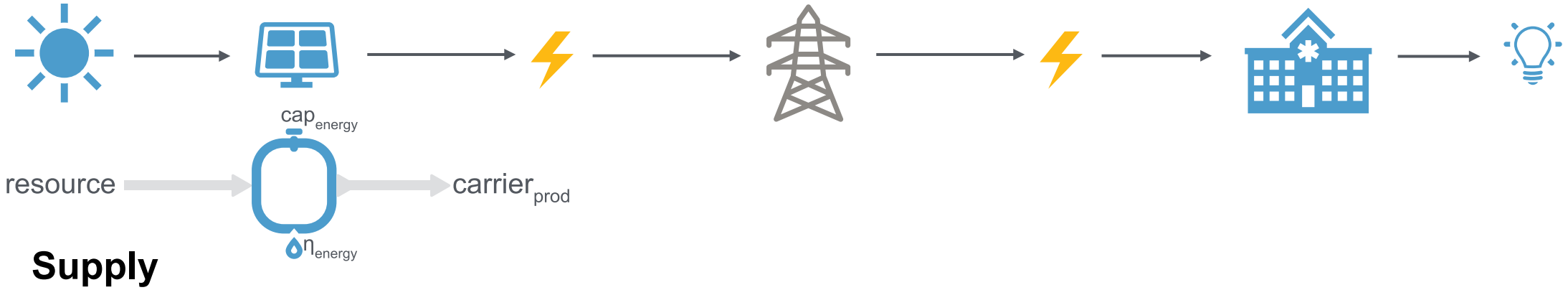
carriers

archetypes

- ☑ 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**





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Supply Archetype

engage

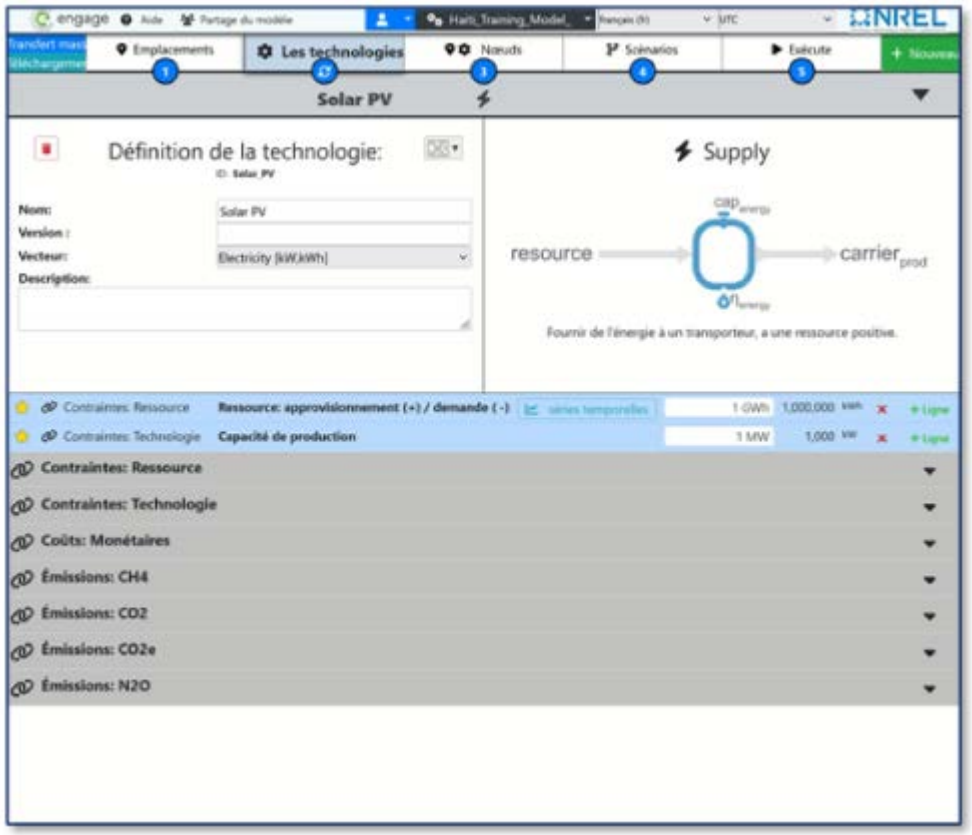
Simulates how energy or commodities moves through a given system

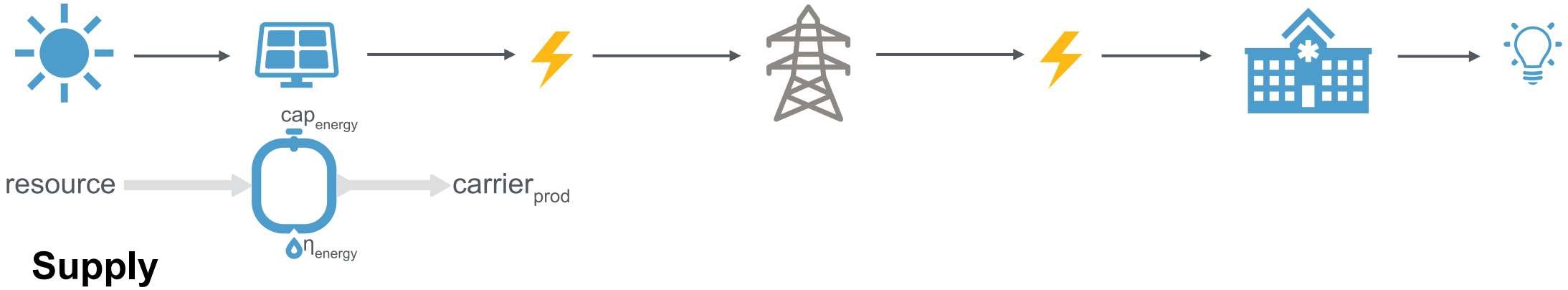
carriers

archetypes

- ☑ 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**





Modeling Technology Costs

engage

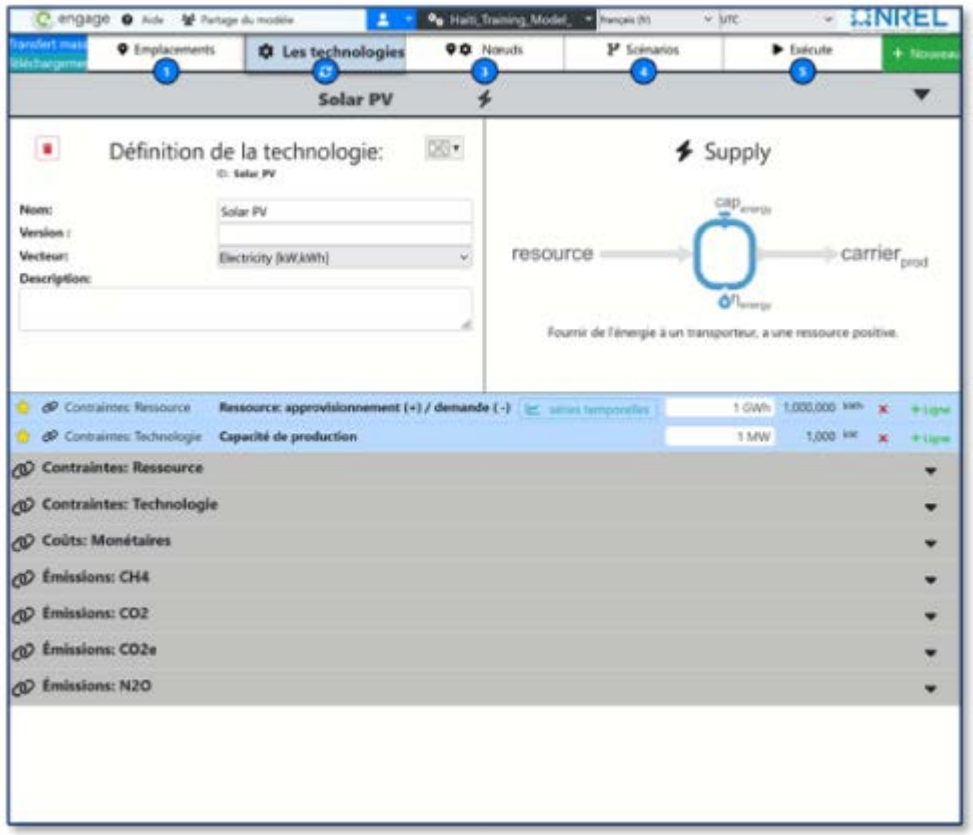
Simulates how energy or commodities moves through a given system

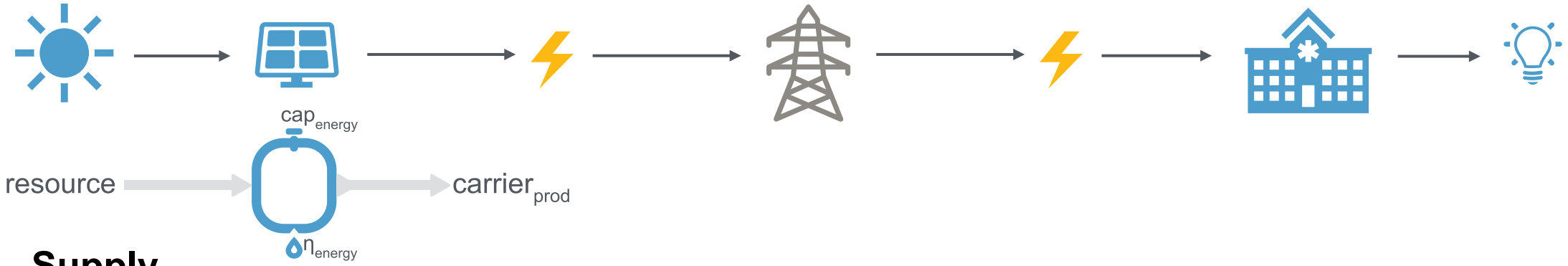
carriers

archetypes

- [x] Supply
- [ ]
- [ ]
- [ ]
- [ ]

Costs Engage Can Model





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

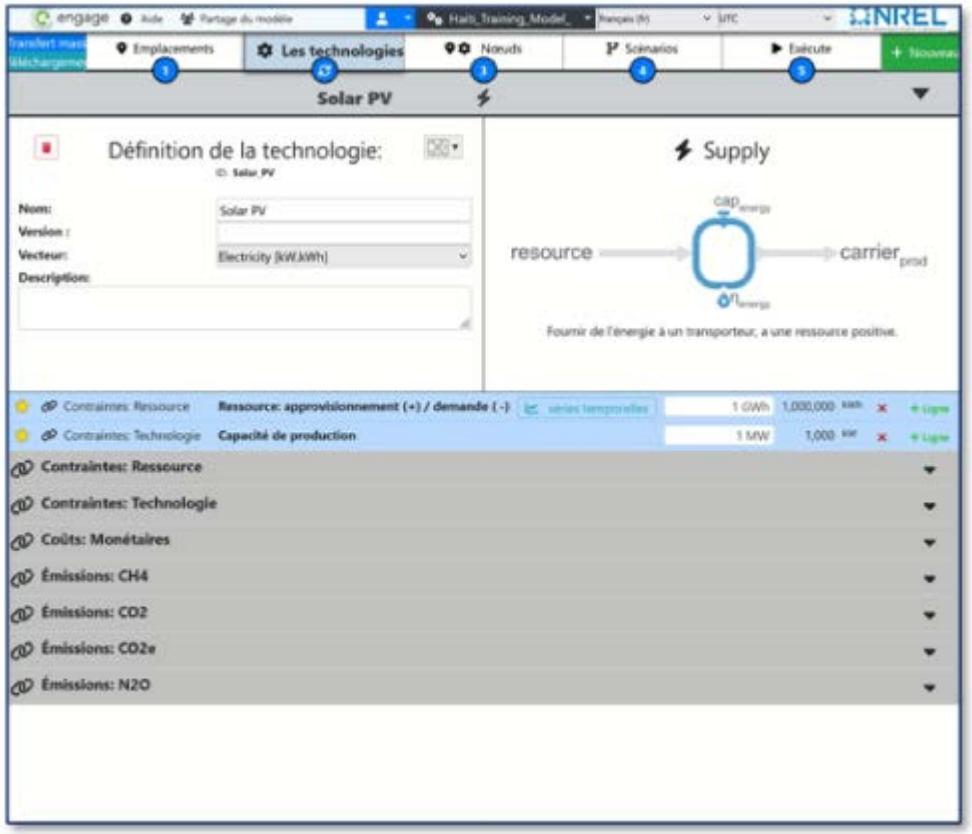
carriers

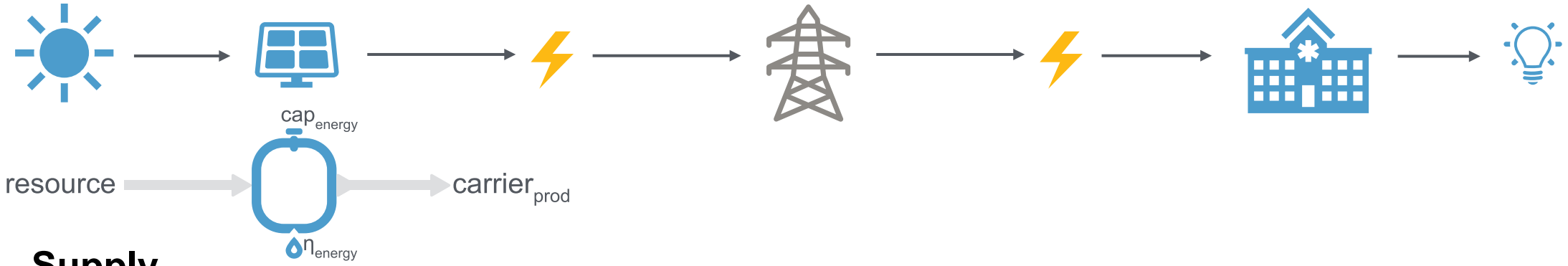
archetypes

- Supply
-
-
-
-
-

- Power purchase agreements (PPAs)

Costs Engage Can Model





Supply

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

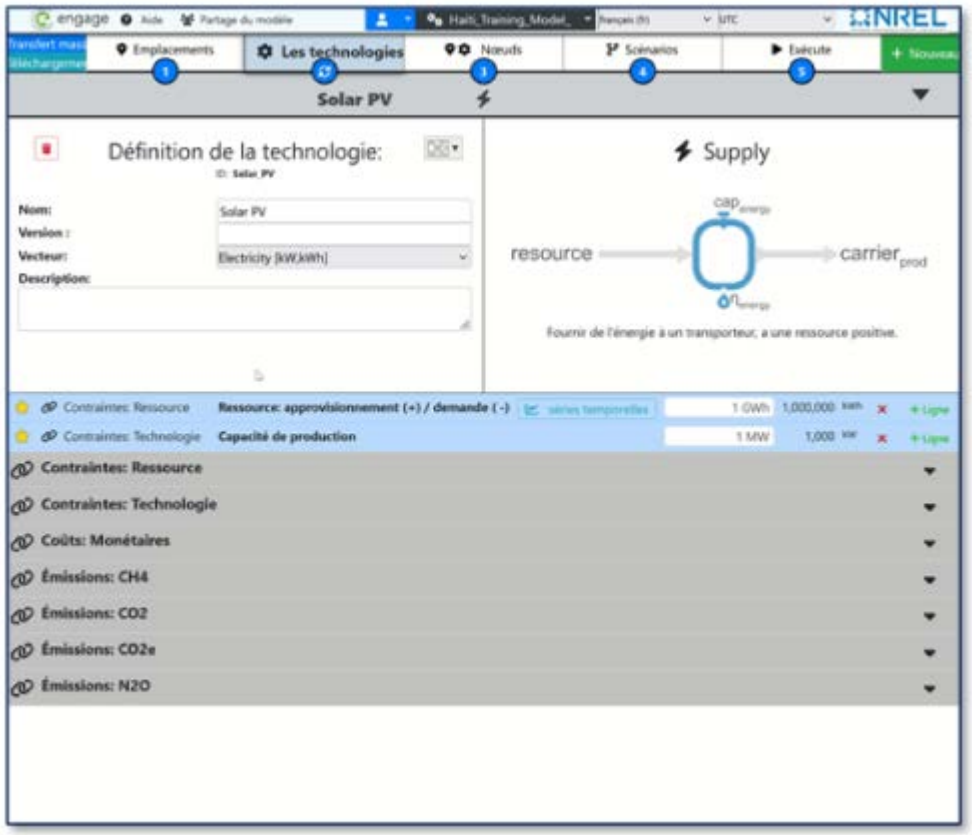
carriers

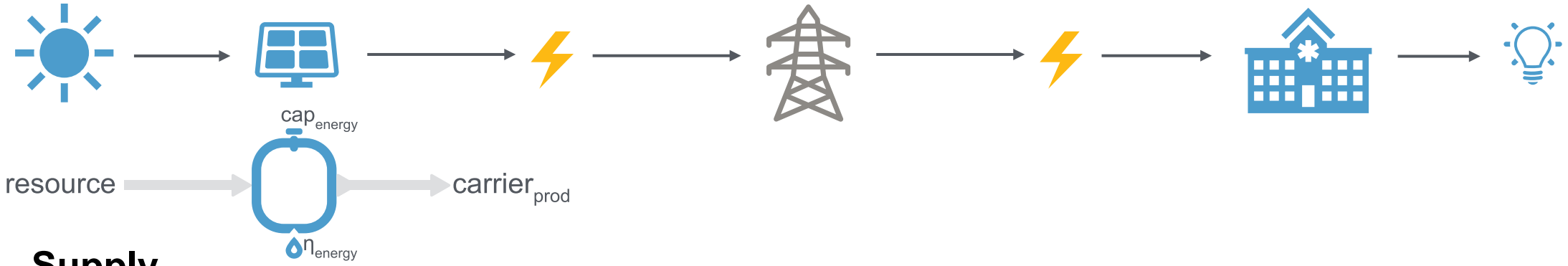
archetypes

- ☑ Supply
- ☐
- ☐
- ☐
- ☐

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

Costs Engage Can Model





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

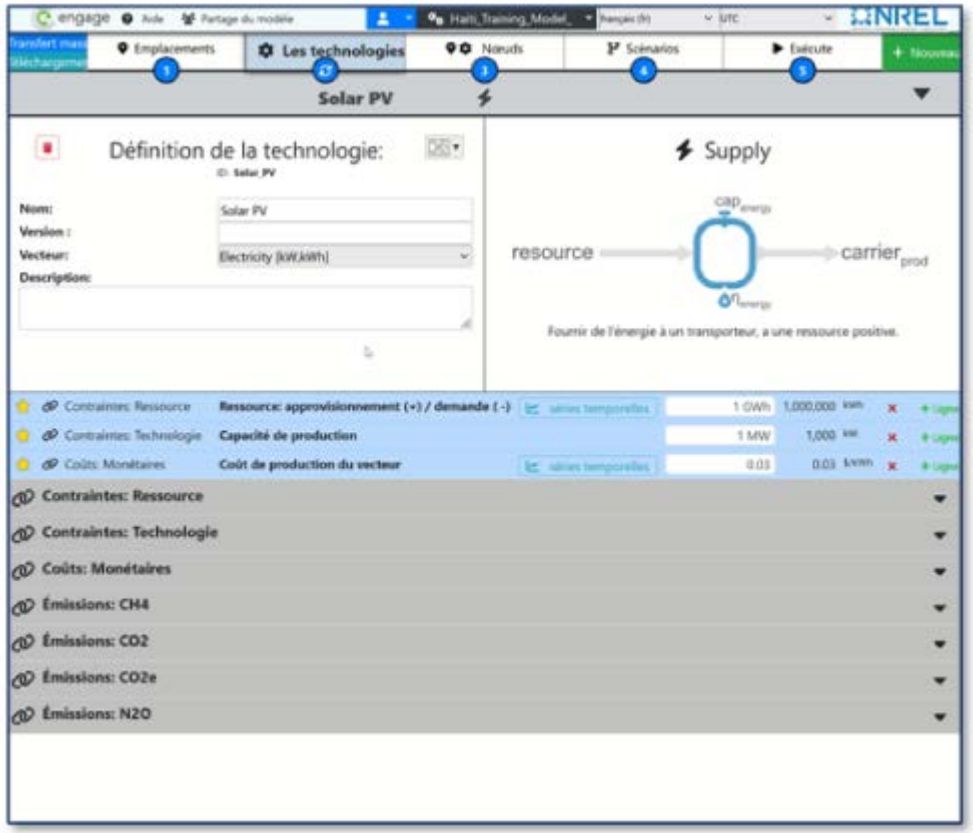
carriers

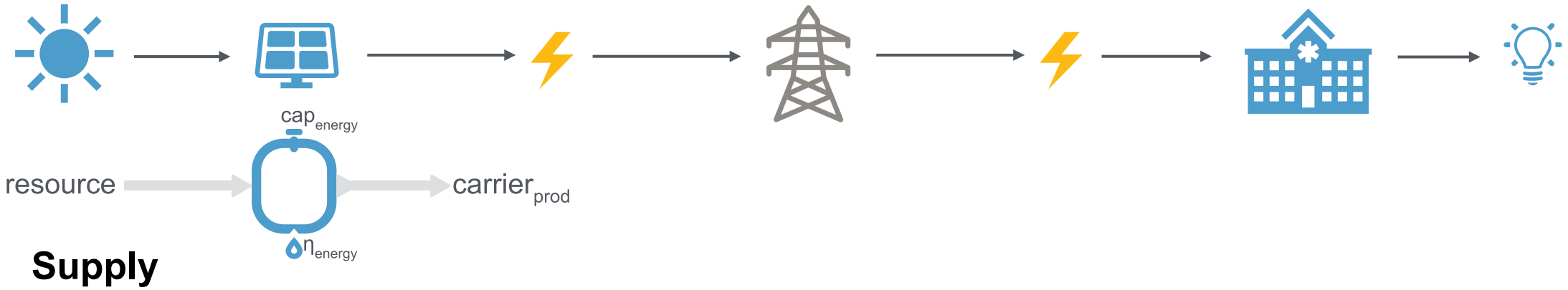
archetypes

- ☑ Supply
- ☐
- ☐
- ☐
- ☐

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

Costs Engage Can Model





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

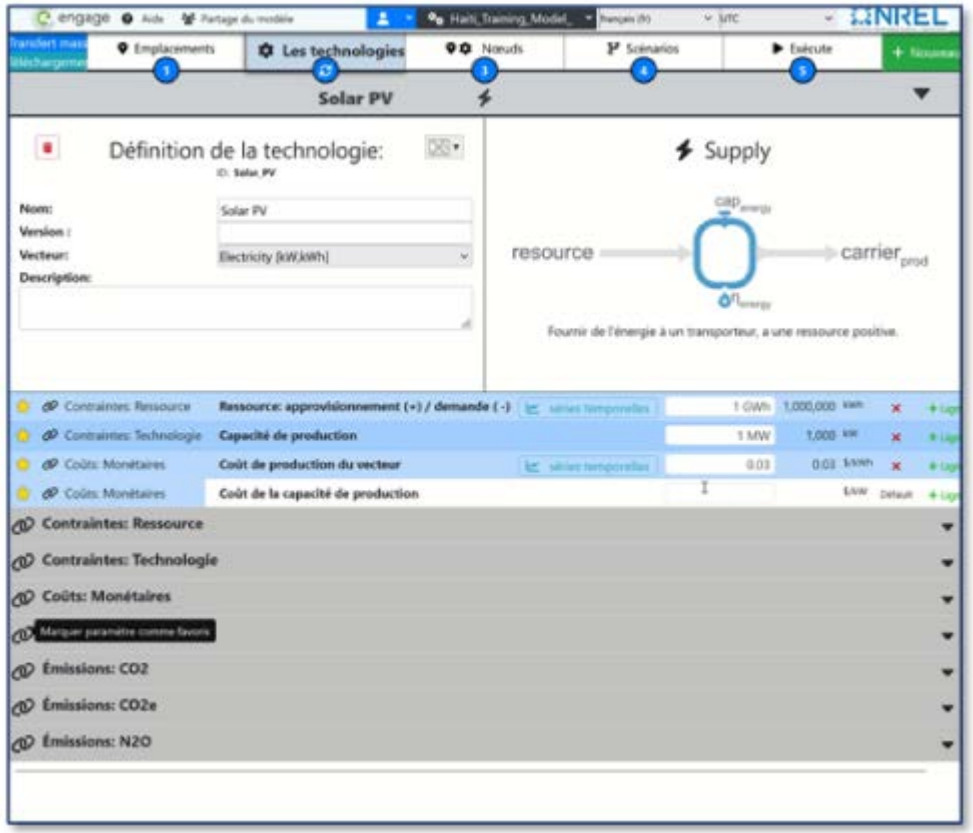
carriers

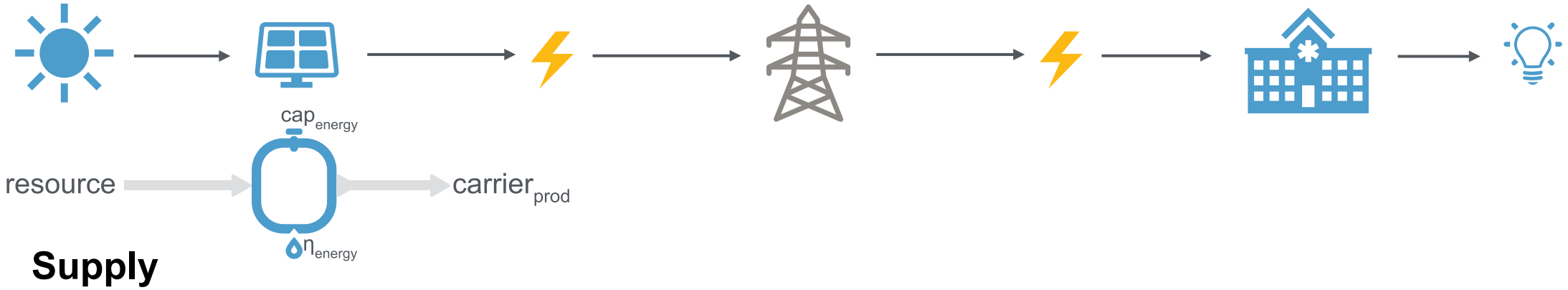
archetypes

- Supply
- ☐
- ☐
- ☐
- ☐

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

Costs Engage Can Model





Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

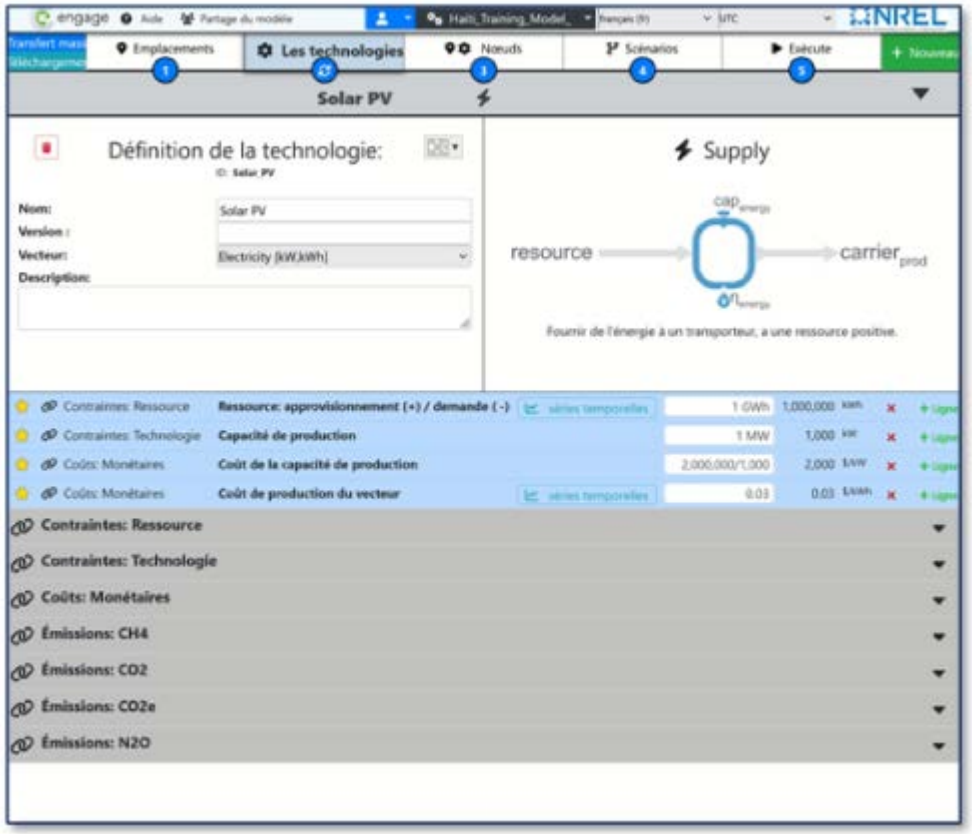
carriers

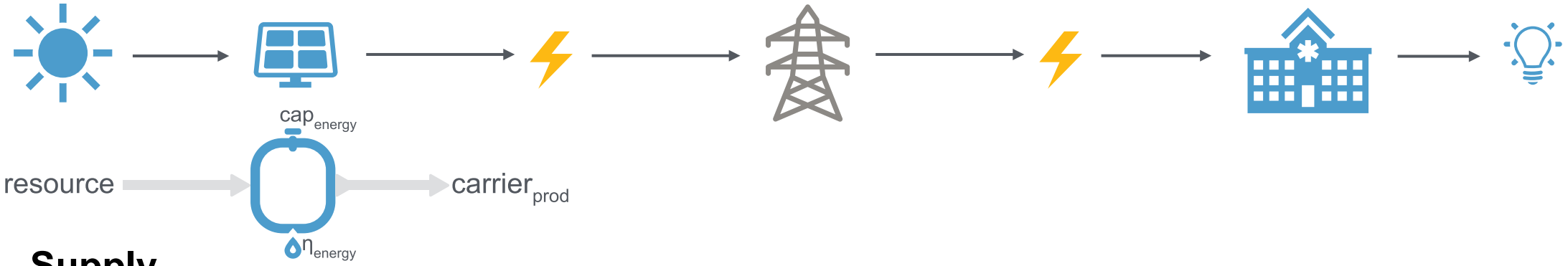
archetypes

- Supply
- ☐
- ☐
- ☐
- ☐

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

Costs Engage Can Model





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

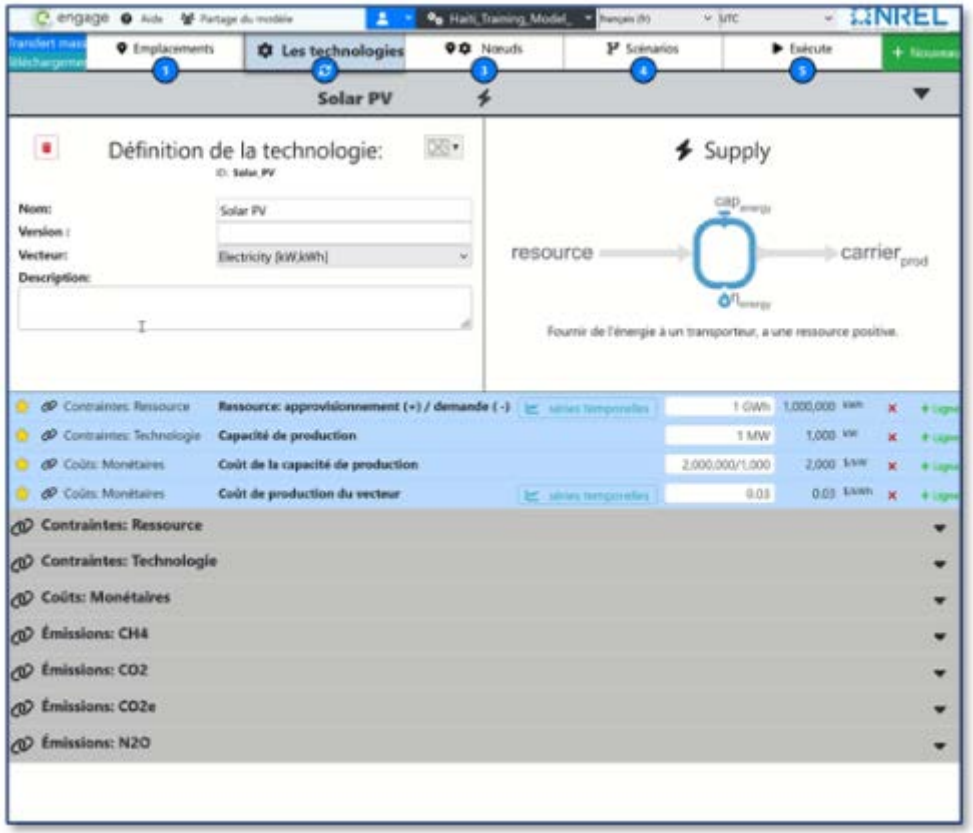
carriers

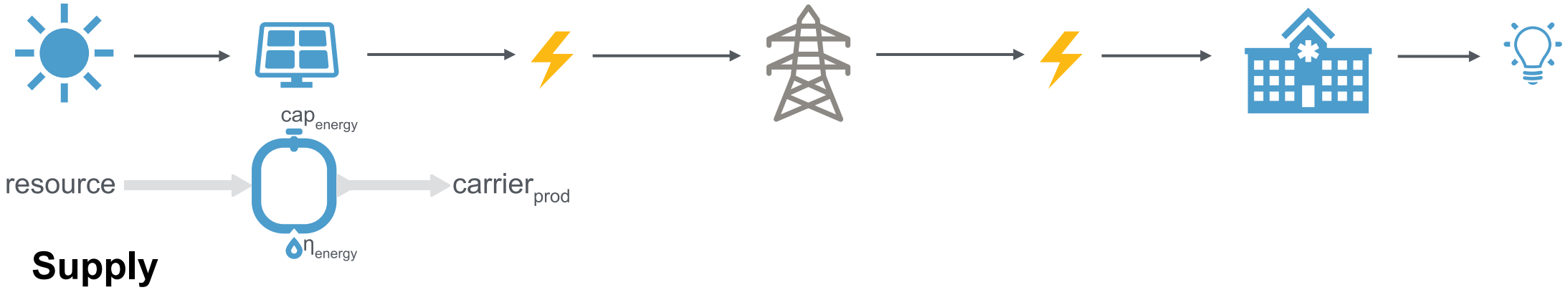
archetypes

- Supply

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

Costs Engage Can Model





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

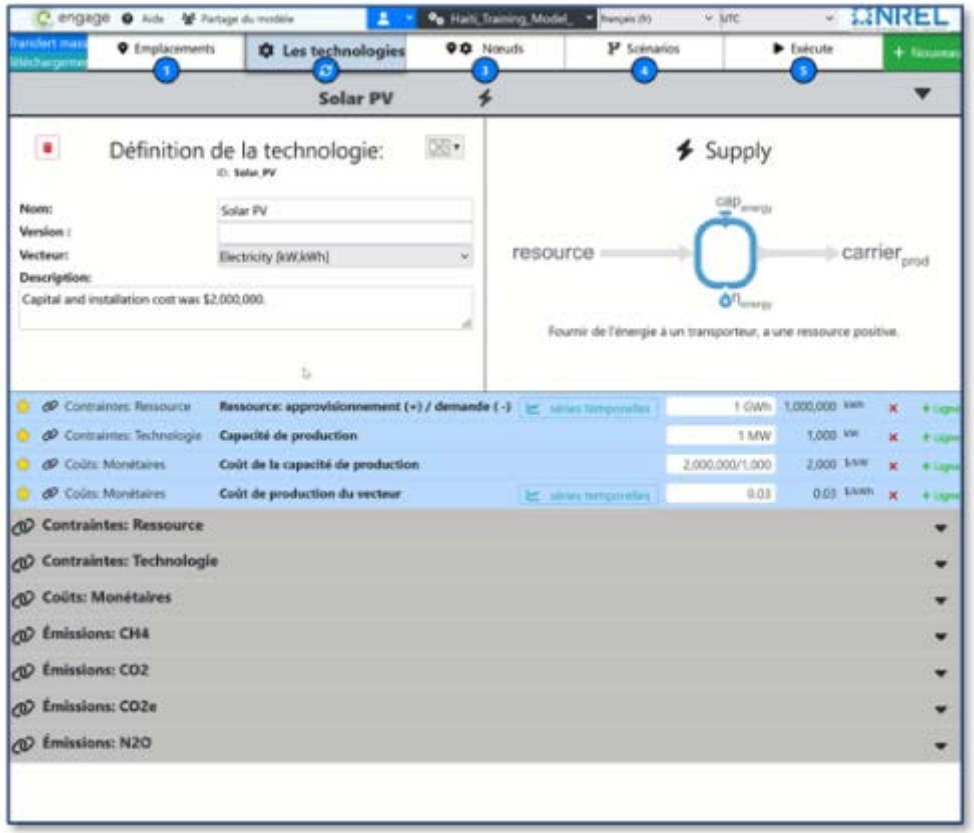
carriers

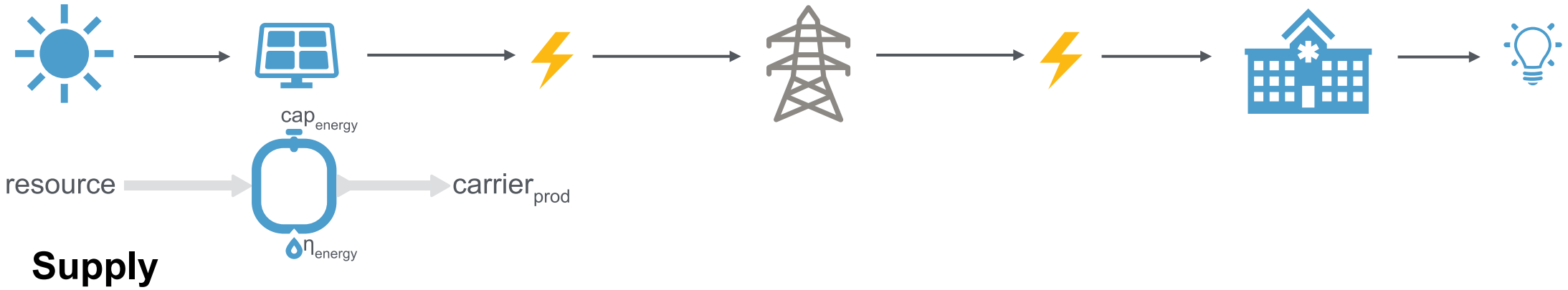
archetypes

- ☑ 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 Technology Costs

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

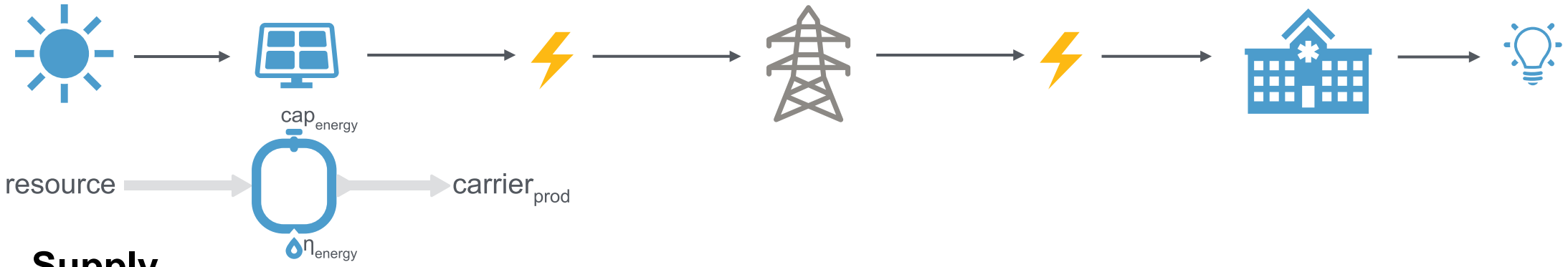
Supply

- 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



Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

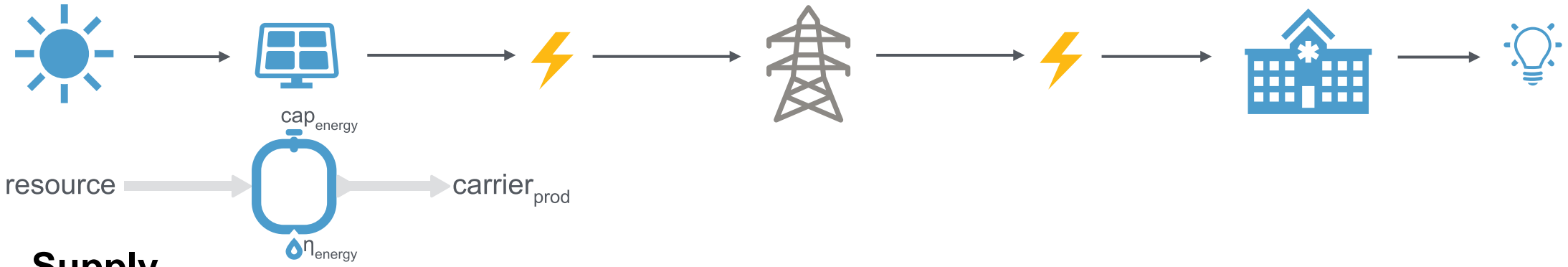
- Supply
- ☐
- ☐
- ☐
- ☐

- 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

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

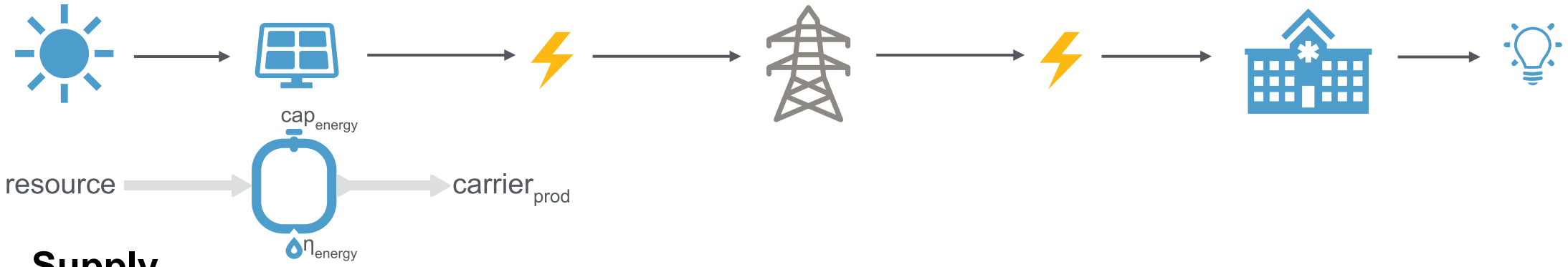
Supply

- 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

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

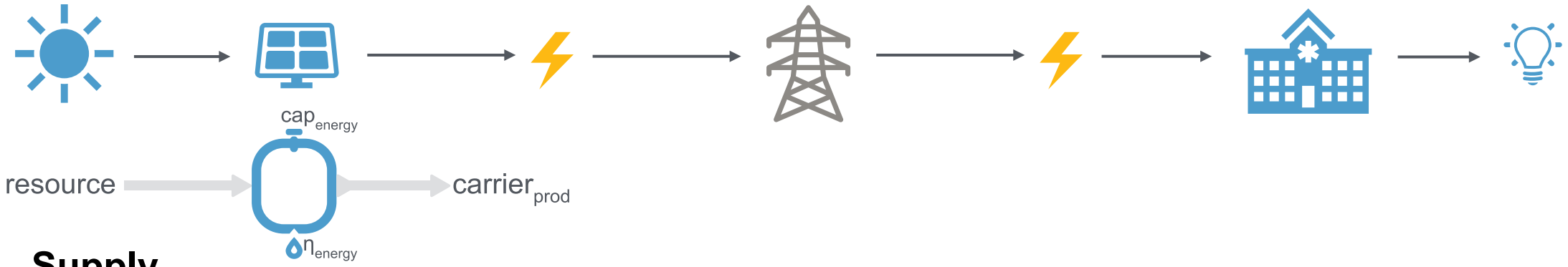
- ☑ Supply
- ☐
- ☐
- ☐
- ☐

- 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.

Modeling Reminders



Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

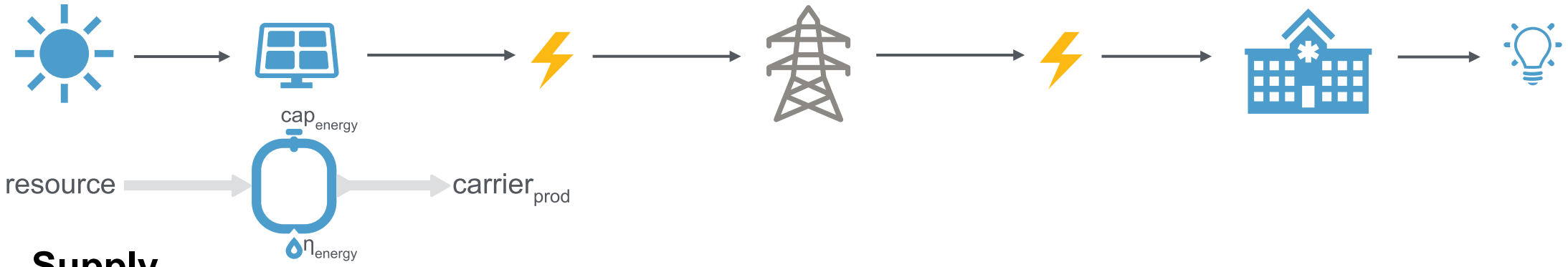
- ☑ Supply
- ☐
- ☐
- ☐
- ☐

- 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



Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

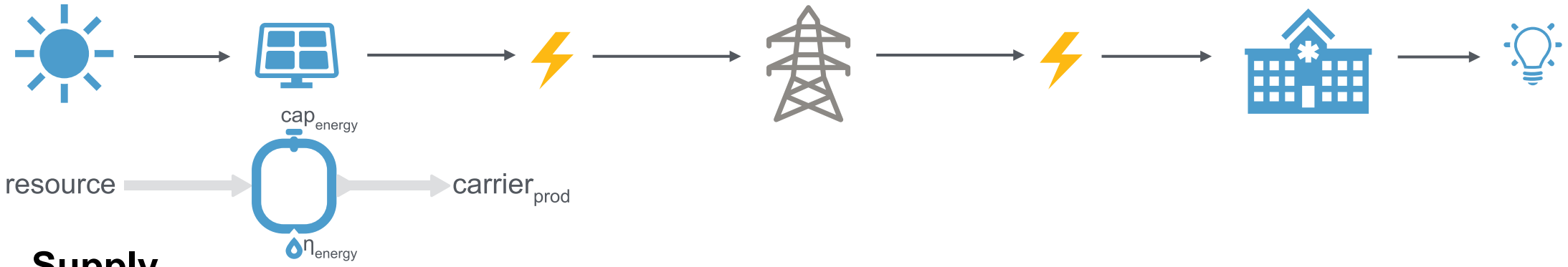
- Supply
- ☐
- ☐
- ☐
- ☐

- 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



Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

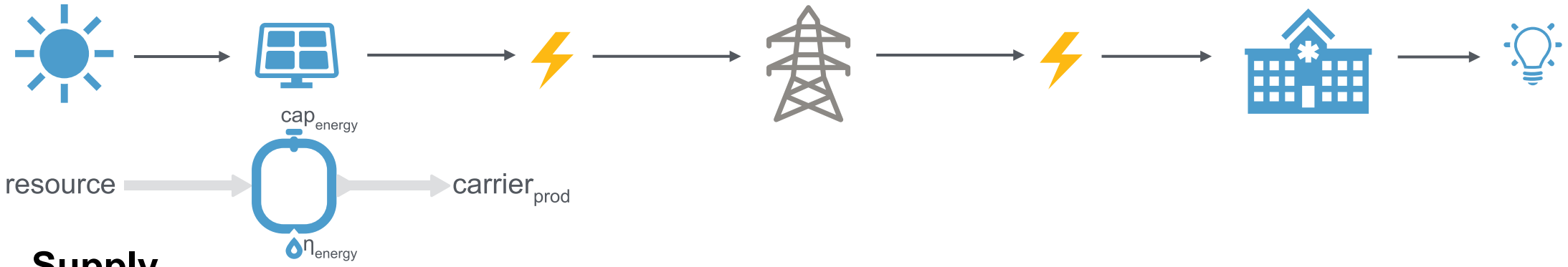
- ☑ Supply
- ☐
- ☐
- ☐
- ☐

- 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



Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

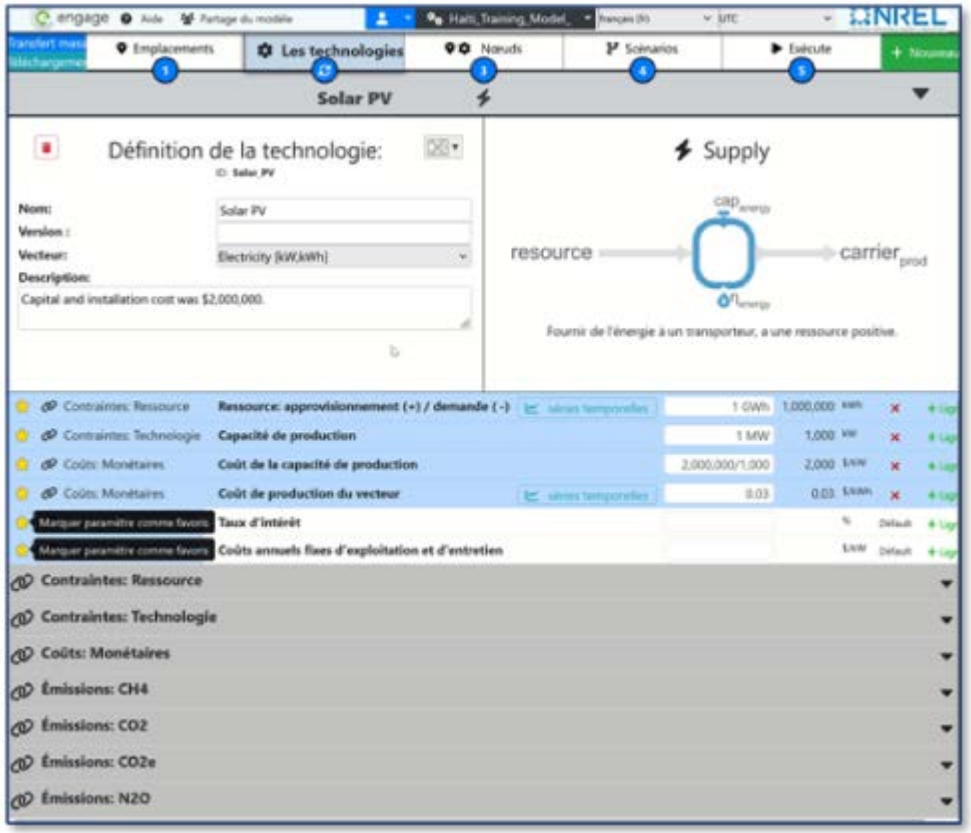
carriers

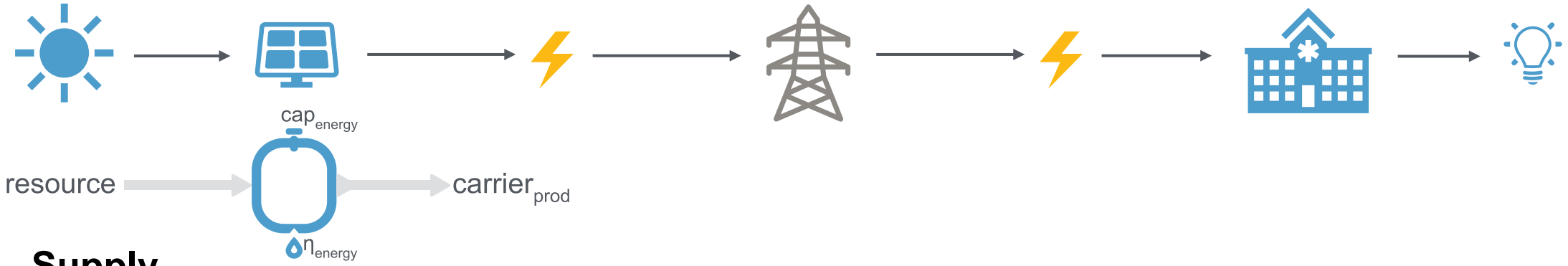
archetypes

- [x] 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





Supply

Modeling Technology Costs

engage

Simulates how energy or commodities moves through a given system

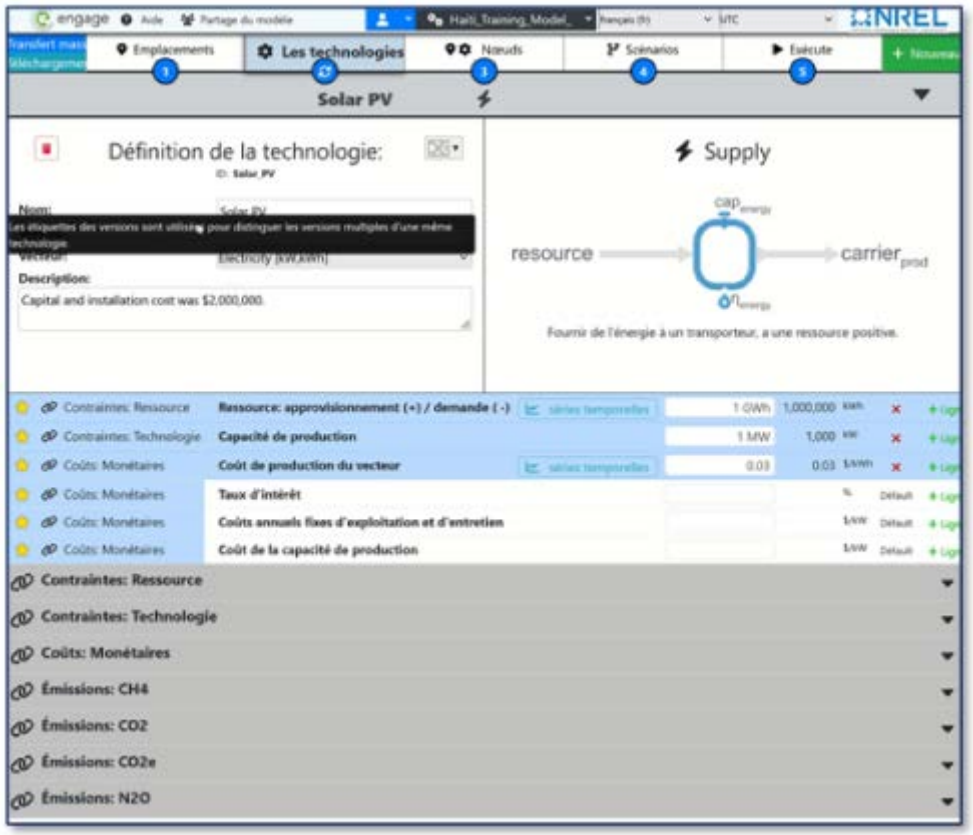
carriers

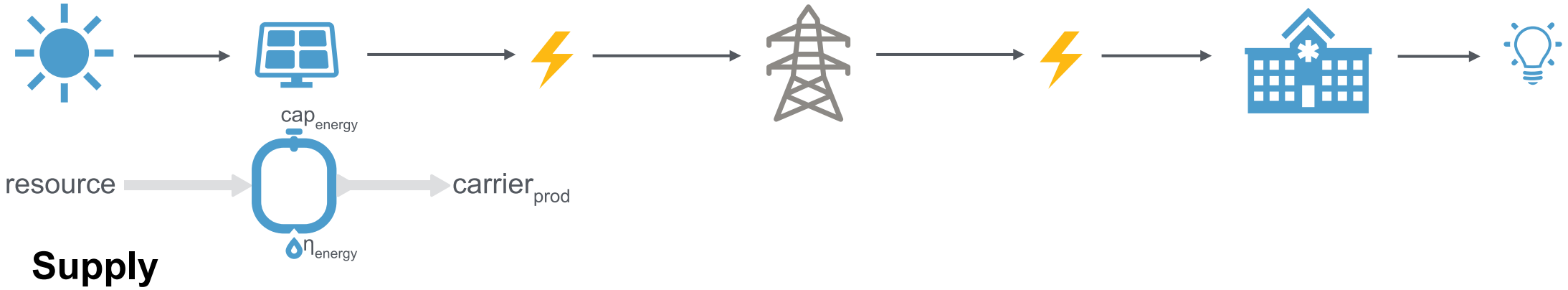
archetypes

- ☑ 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





Transmission Archetype

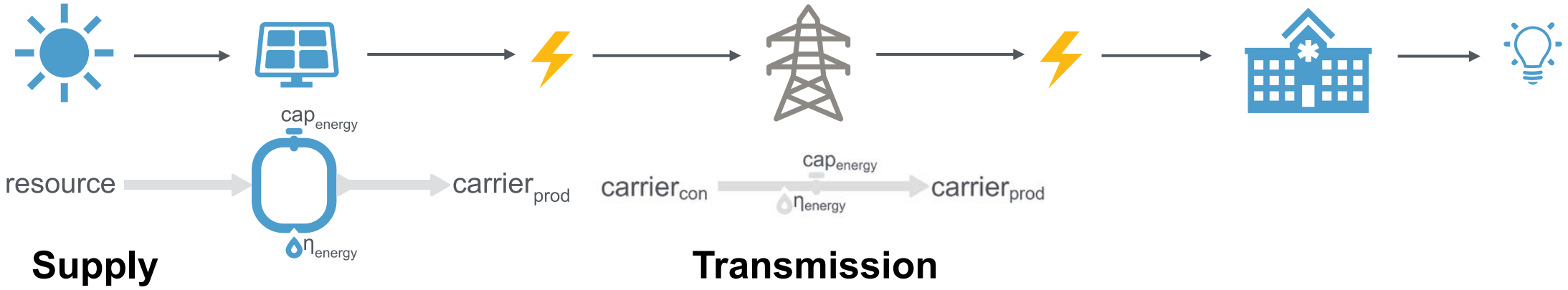
engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [ ]
- [ ]
- [ ]



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐
- ☐

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

Distribution Lines

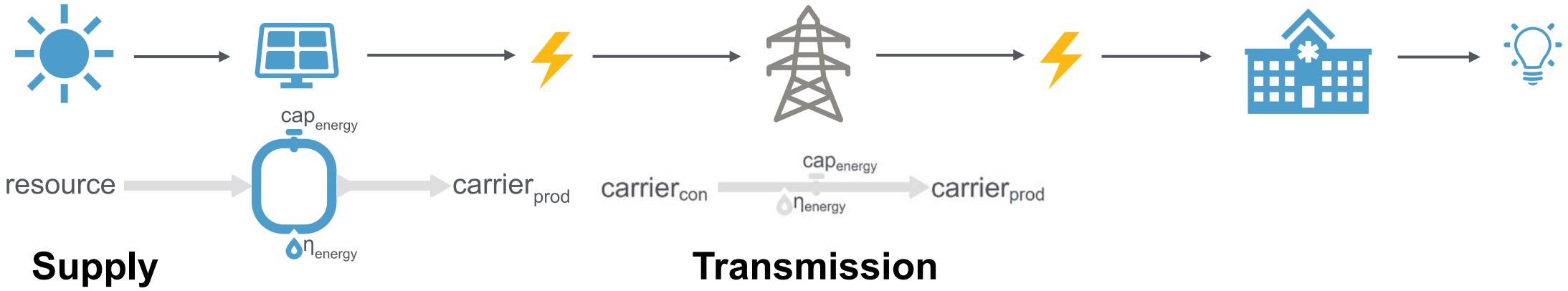
Natural gas pipelines

Rivers

Steam pipes

Freight trains

Transmission Examples



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

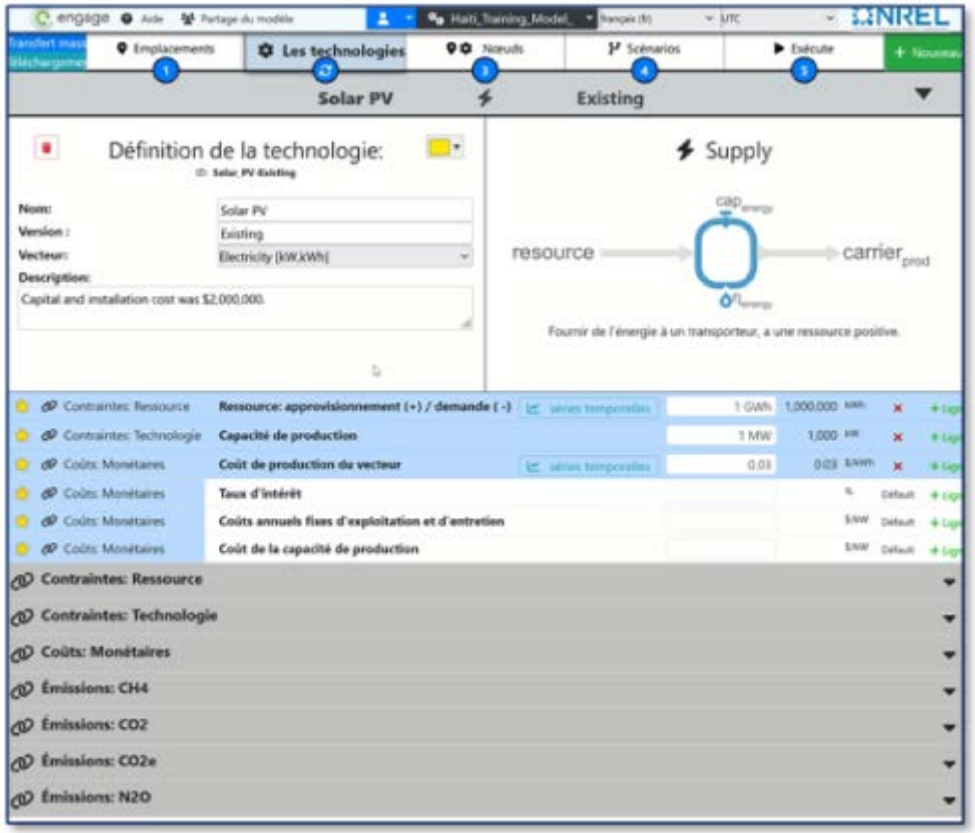
Simulates how energy or commodities moves through a given system

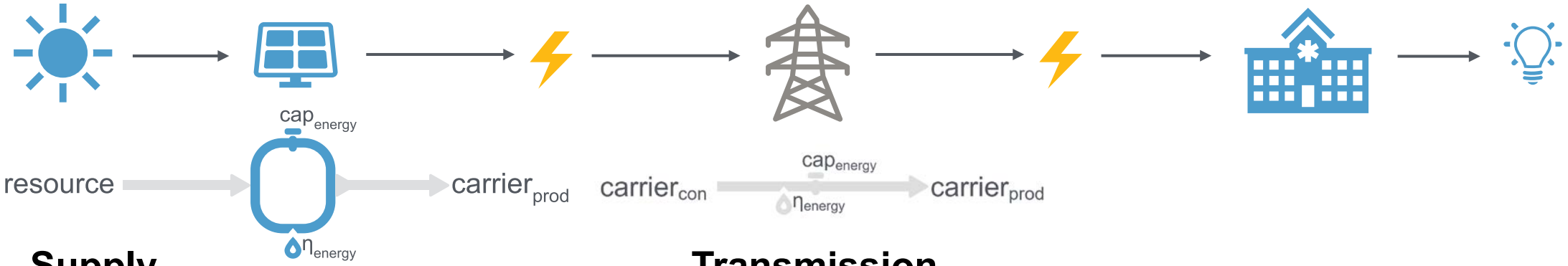
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐

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





Supply **Transmission**

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

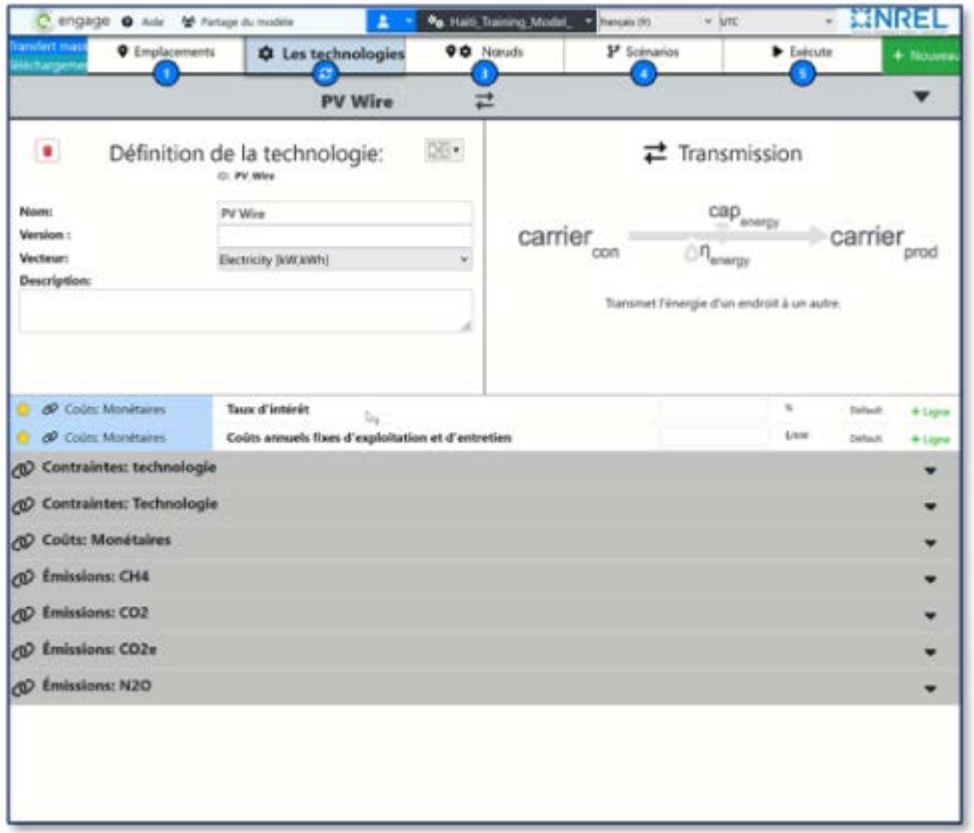
Simulates how energy or commodities moves through a given system

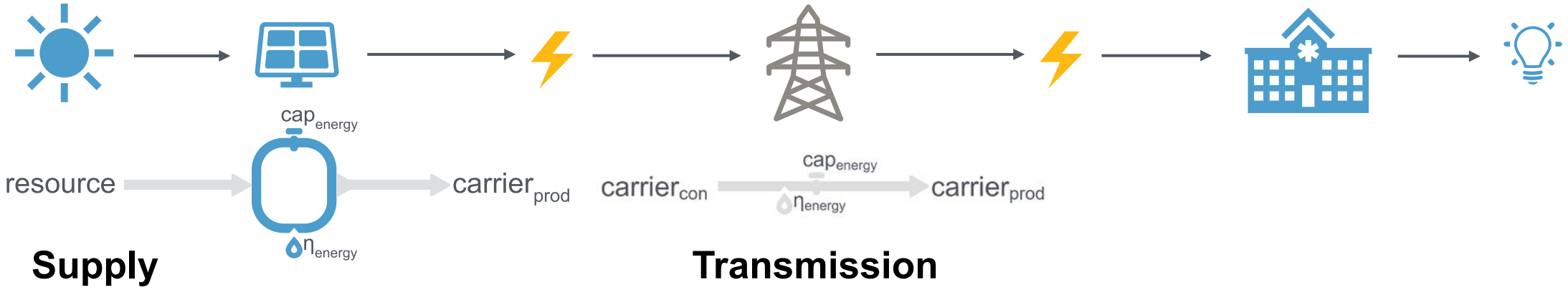
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐

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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

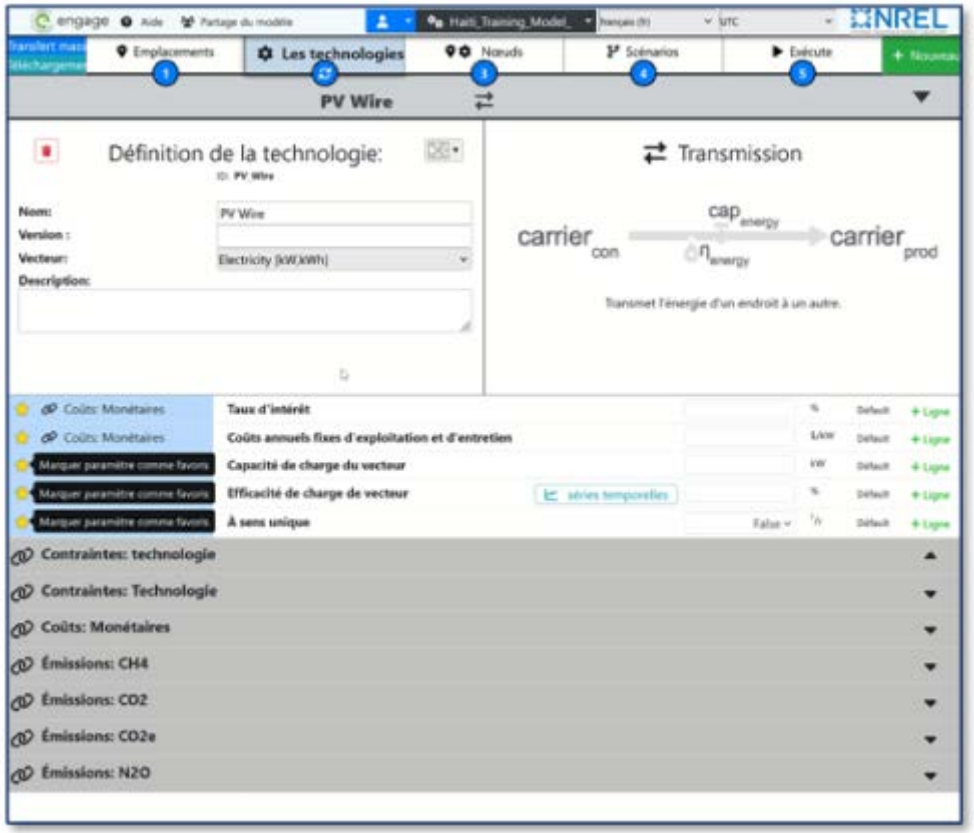
Simulates how energy or commodities moves through a given system

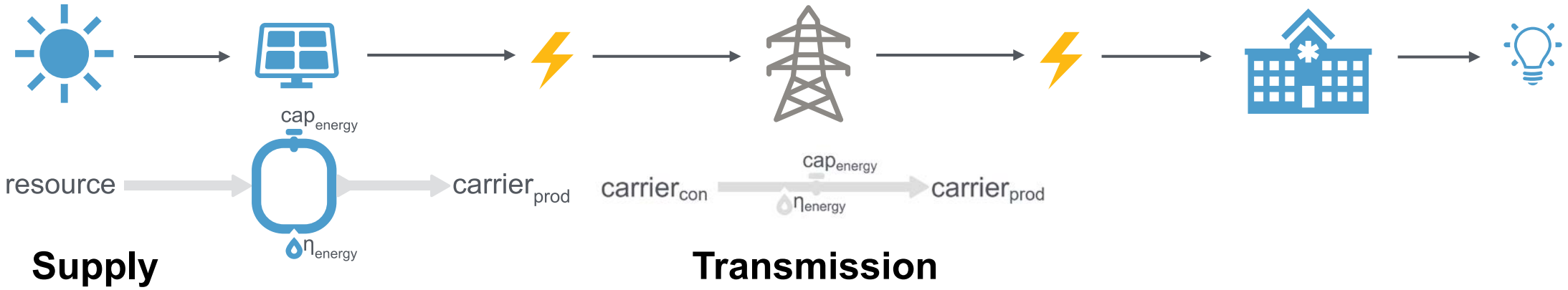
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐

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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

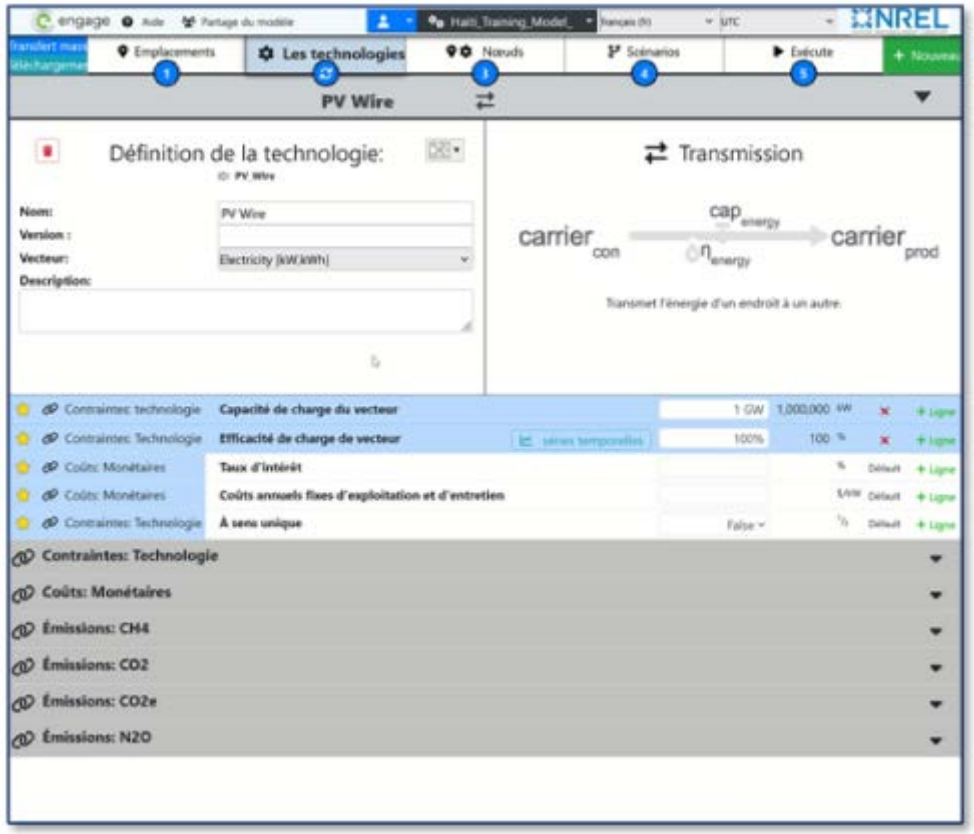
Simulates how energy or commodities moves through a given system

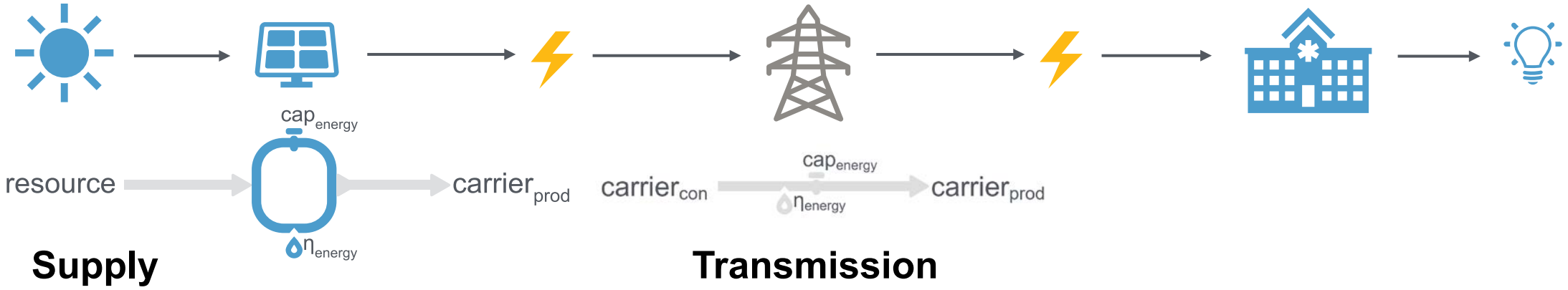
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐

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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

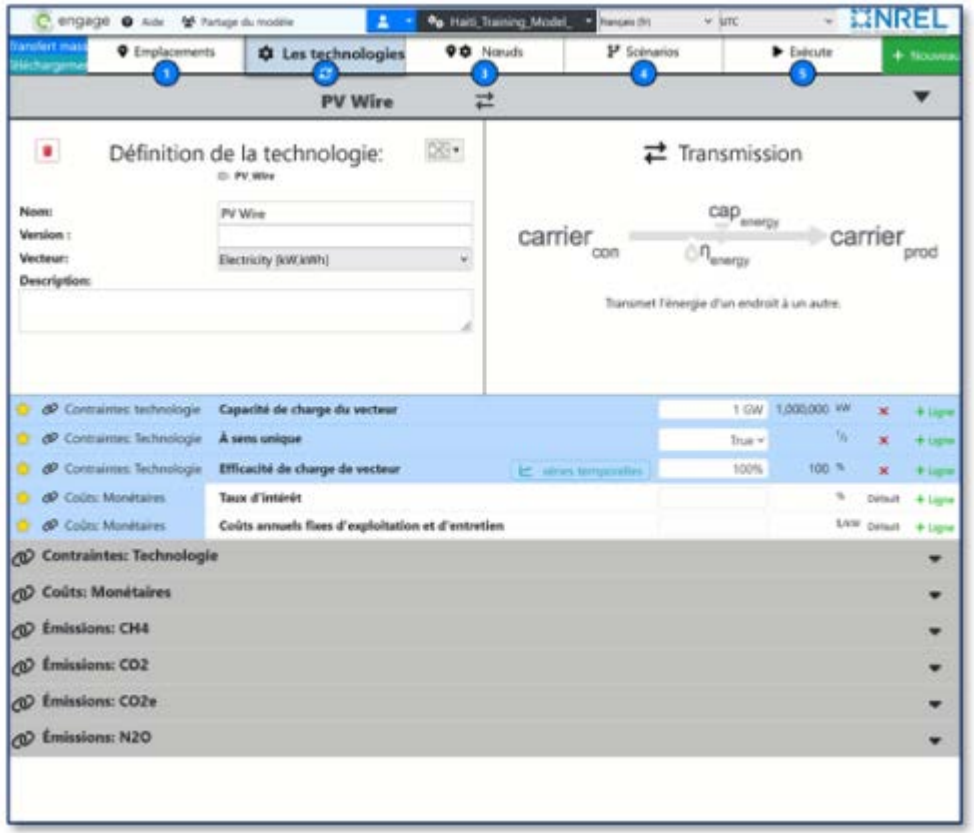
Simulates how energy or commodities moves through a given system

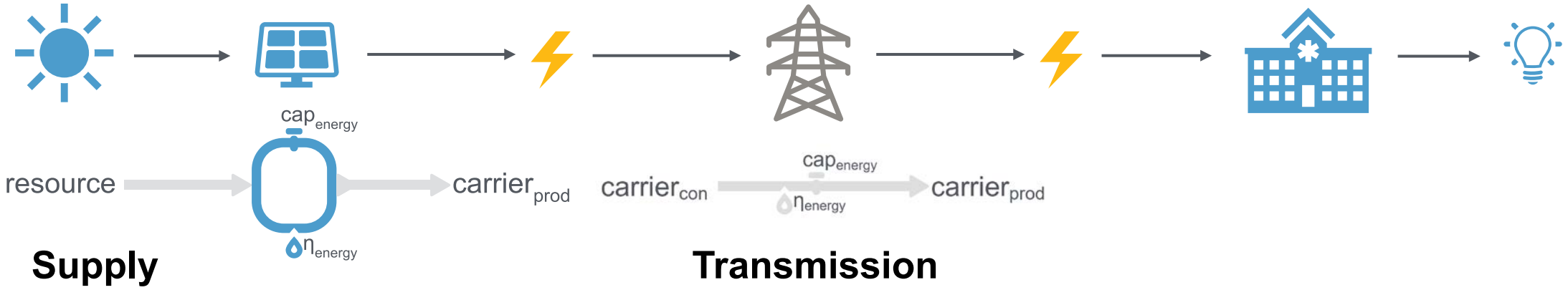
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐
- ☐

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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

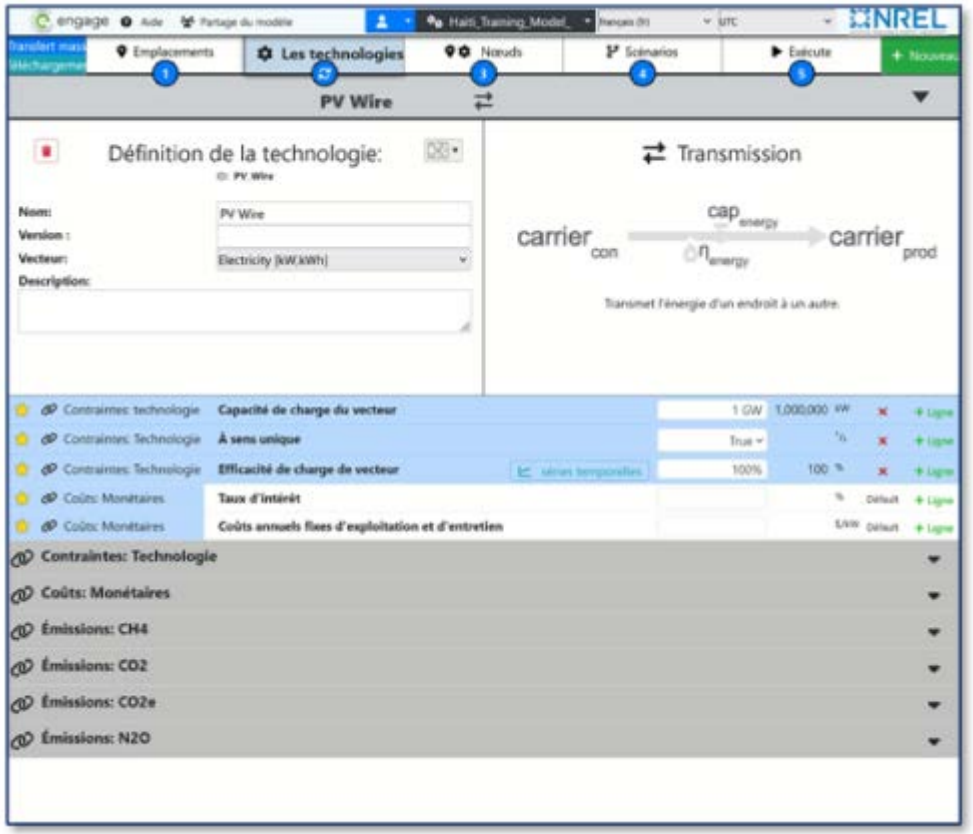
Simulates how energy or commodities moves through a given system

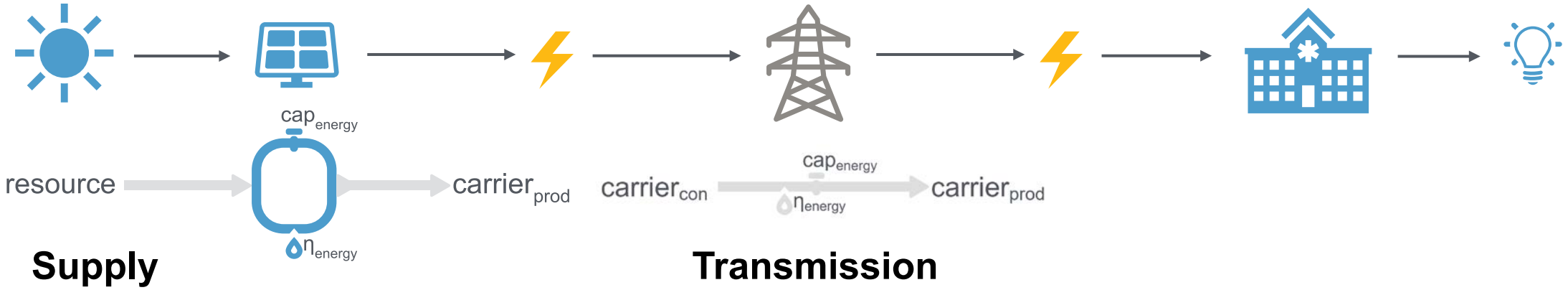
carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☐
- ☐
- ☐
- ☐

- 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Transmission Archetype

engage

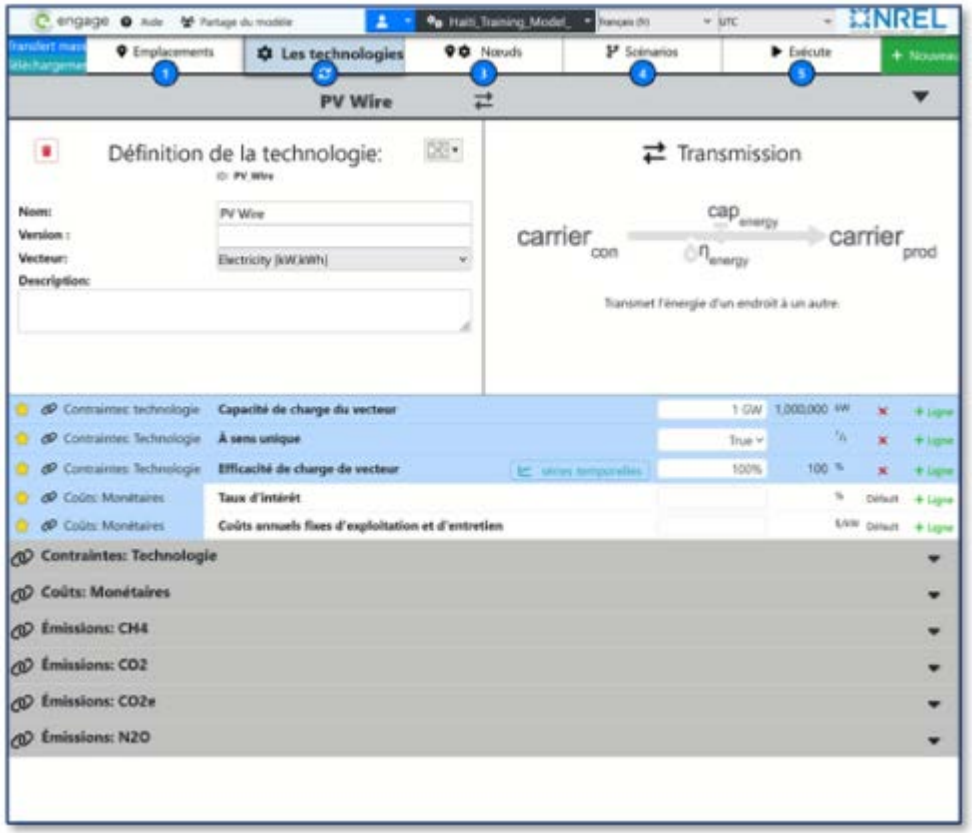
Simulates how energy or commodities moves through a given system

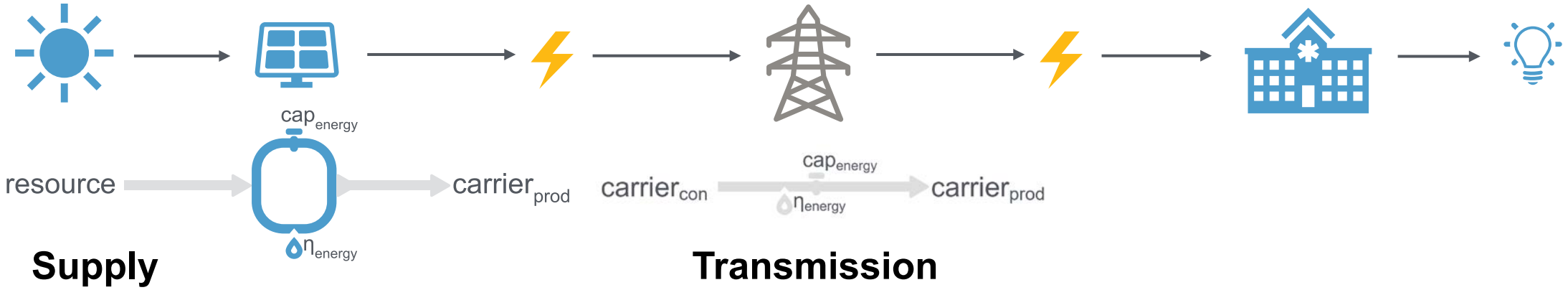
carriers

archetypes

- [x] Supply
- [x] Transmission
- [ ]
- [ ]
- [ ]
- [ ]

- 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Demand Archetype

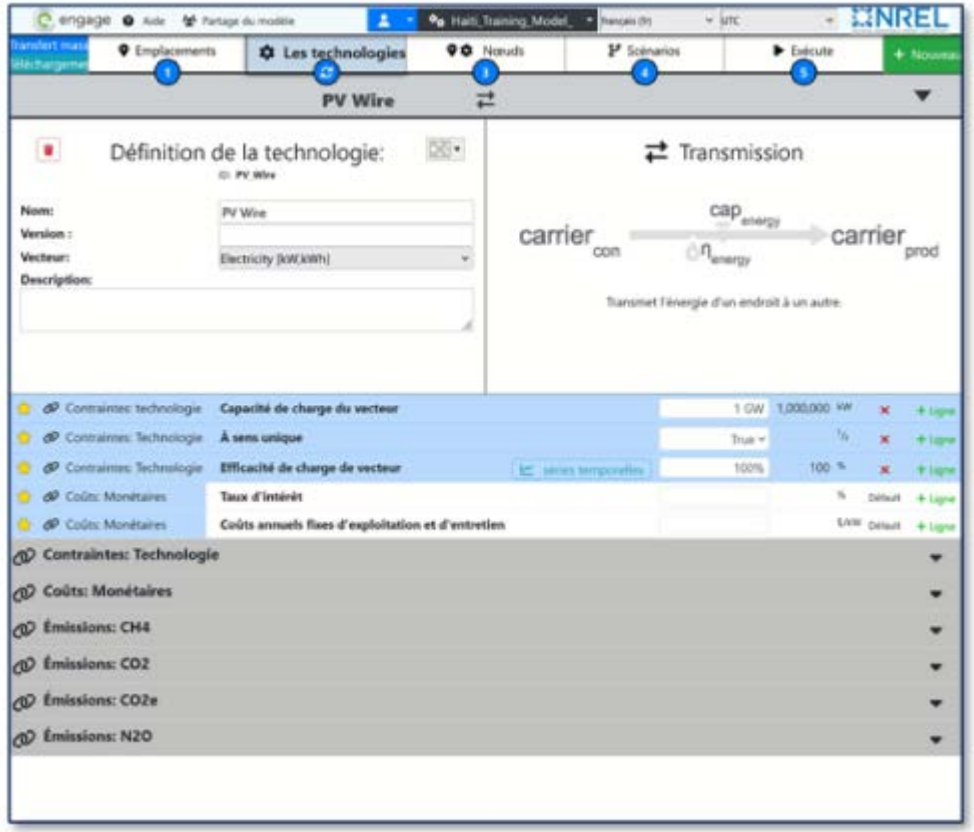
engage

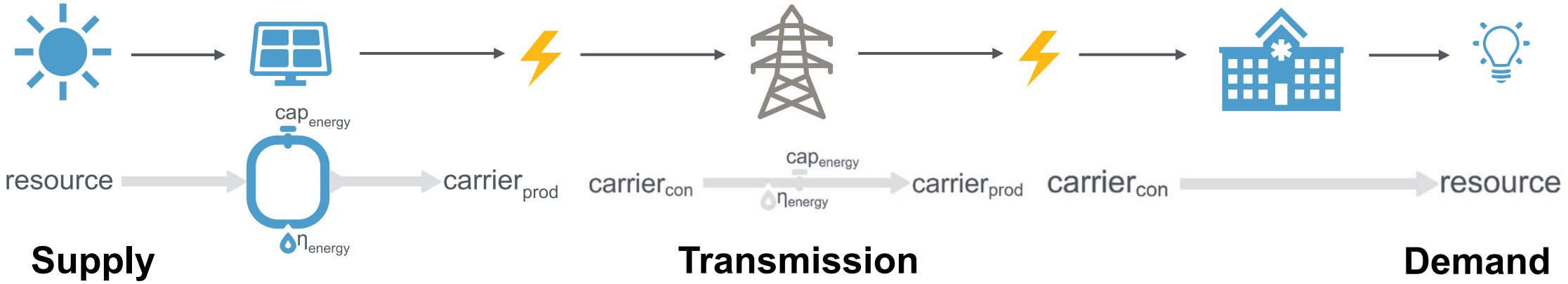
Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Demand Archetype

engage

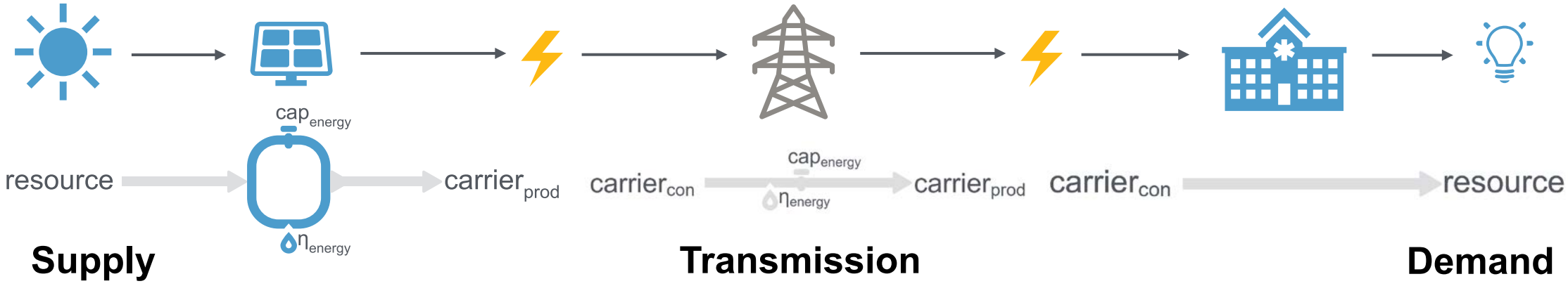
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Demand Archetype

engage

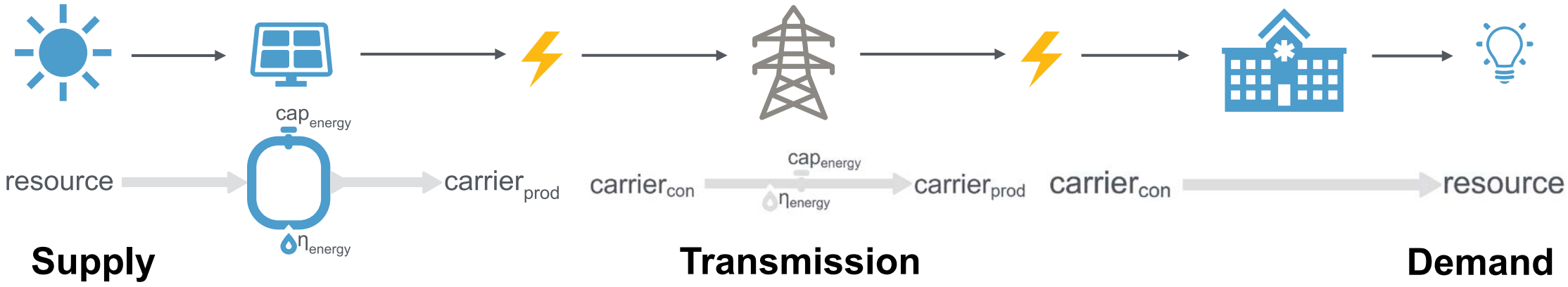
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

- 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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Demand Archetype

engage

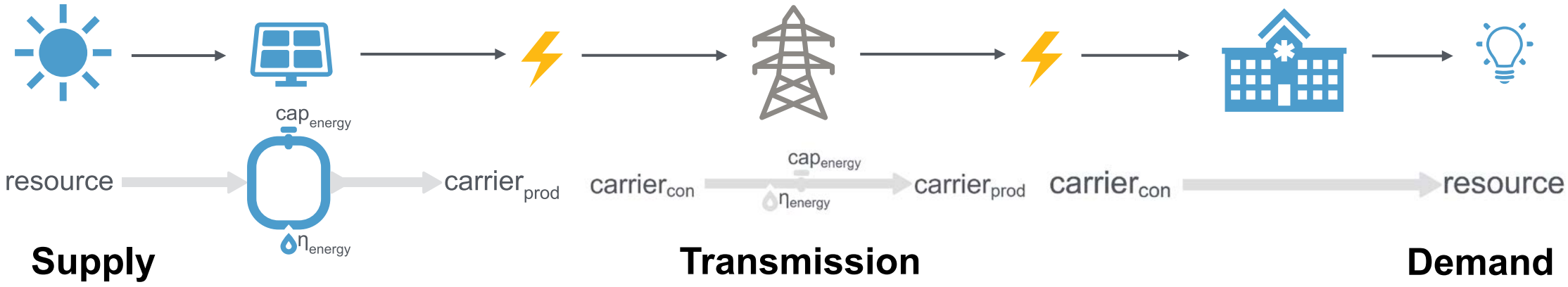
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

- 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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

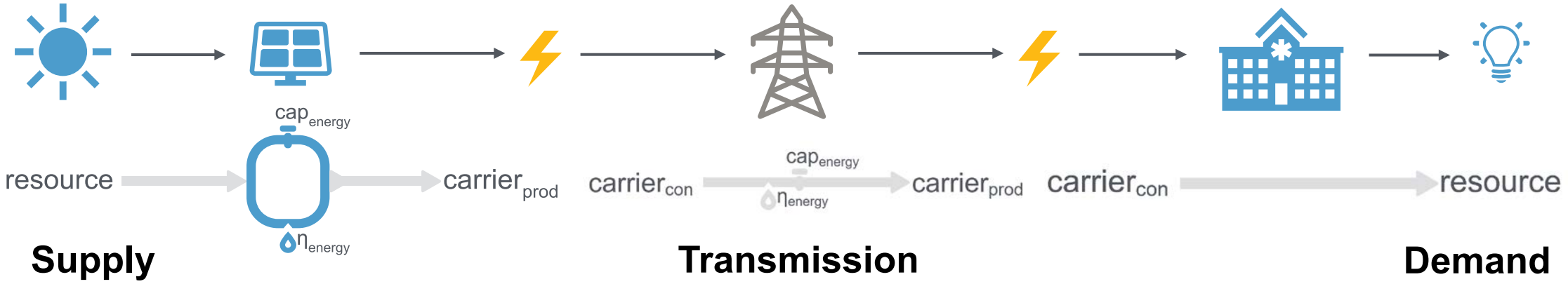
carriers

archetypes

- Supply
- Transmission
- Demand

- 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

Timeseries



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

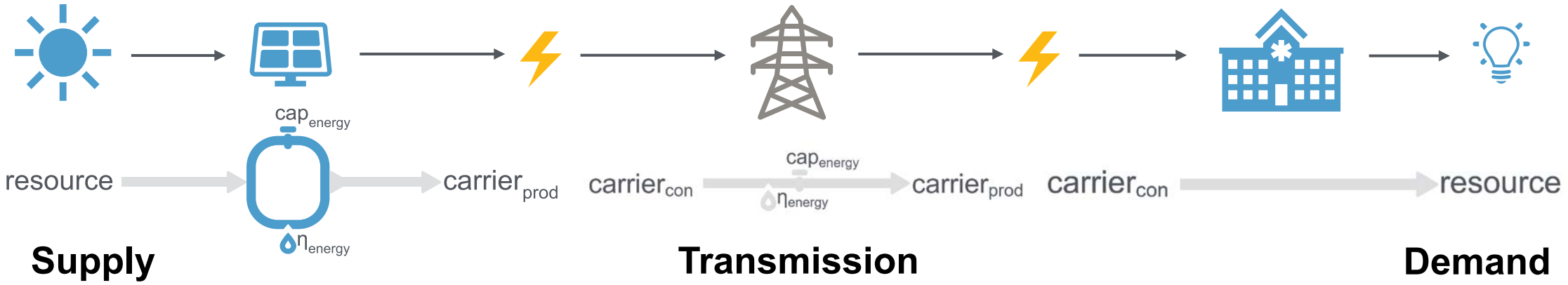
archetypes

- Supply
- Transmission
- Demand

- 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

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

Timeseries



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

- 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

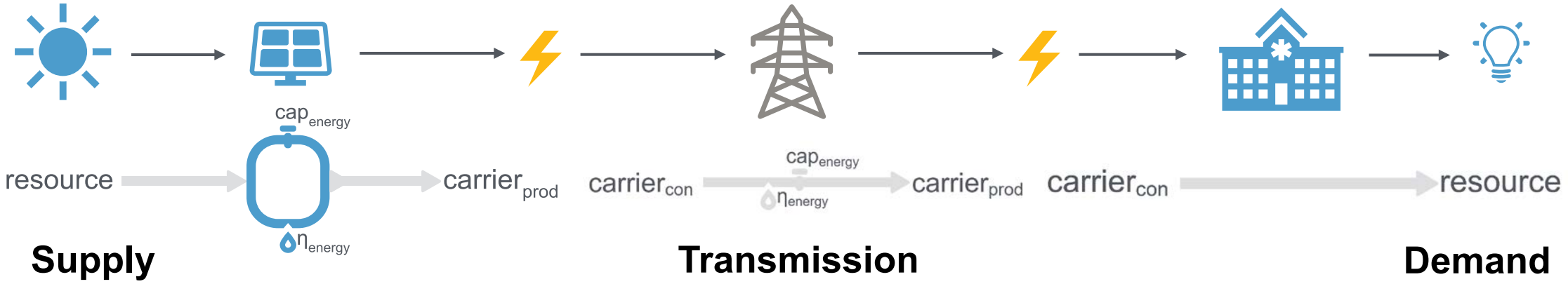
A timeseries is a **set of data** that tracks a specific **variable overtime**

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

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

Timeseries

* Engage default run time



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

- 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

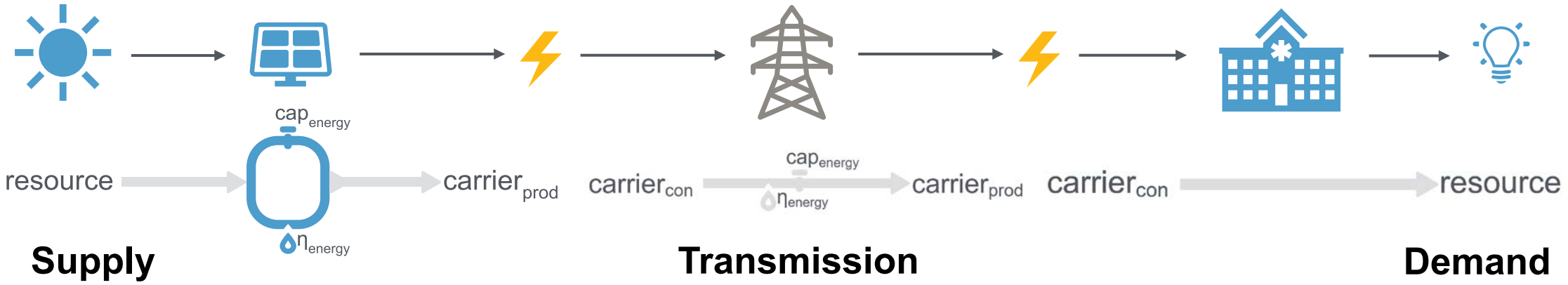
A timeseries is a **set of data** that tracks a specific **variable overtime**

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

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

Timeseries

* Engage default run time



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

- 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

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

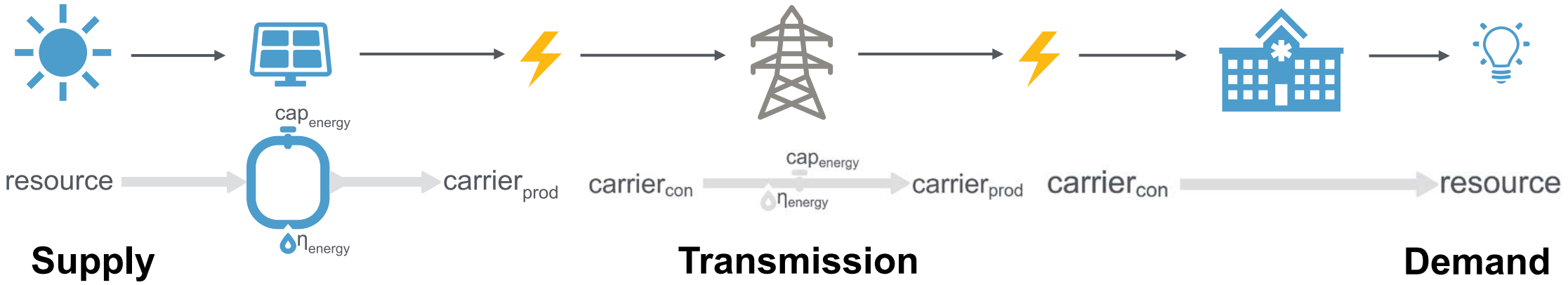
Calliope can process any type of data at **any timestep** in a csv file like:

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

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

Timeseries

* Engage default run time



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

- 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

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:

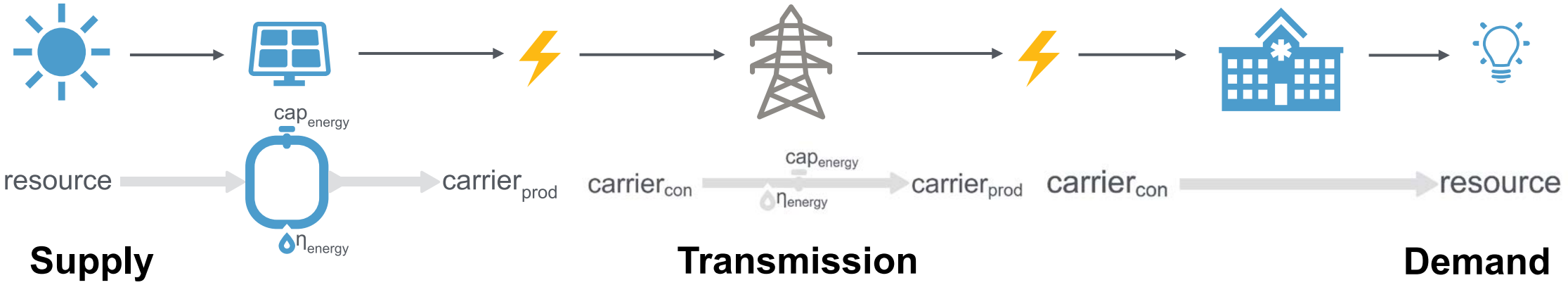
- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

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

* Engage default run time



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- Supply
- Transmission
- Demand

- 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

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:

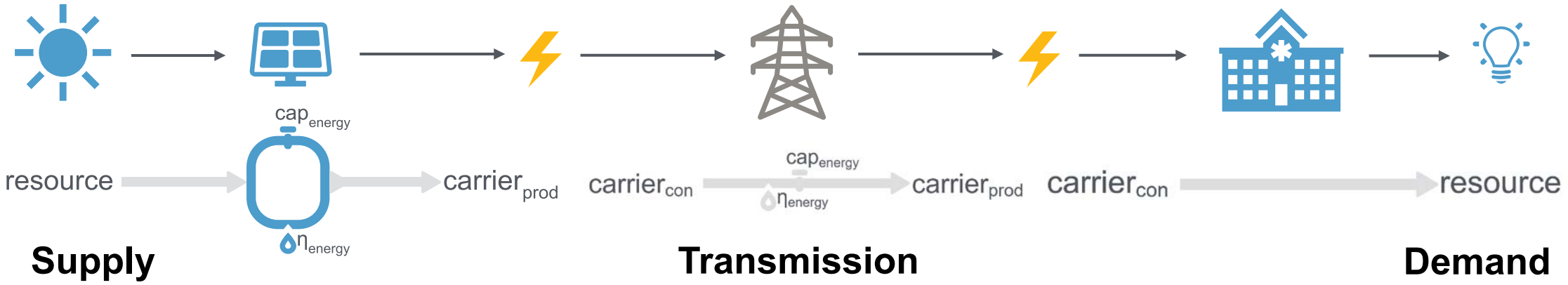
- 15-minute intervals
- 1-hour intervals*
- 1-month intervals

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

* Engage default run time

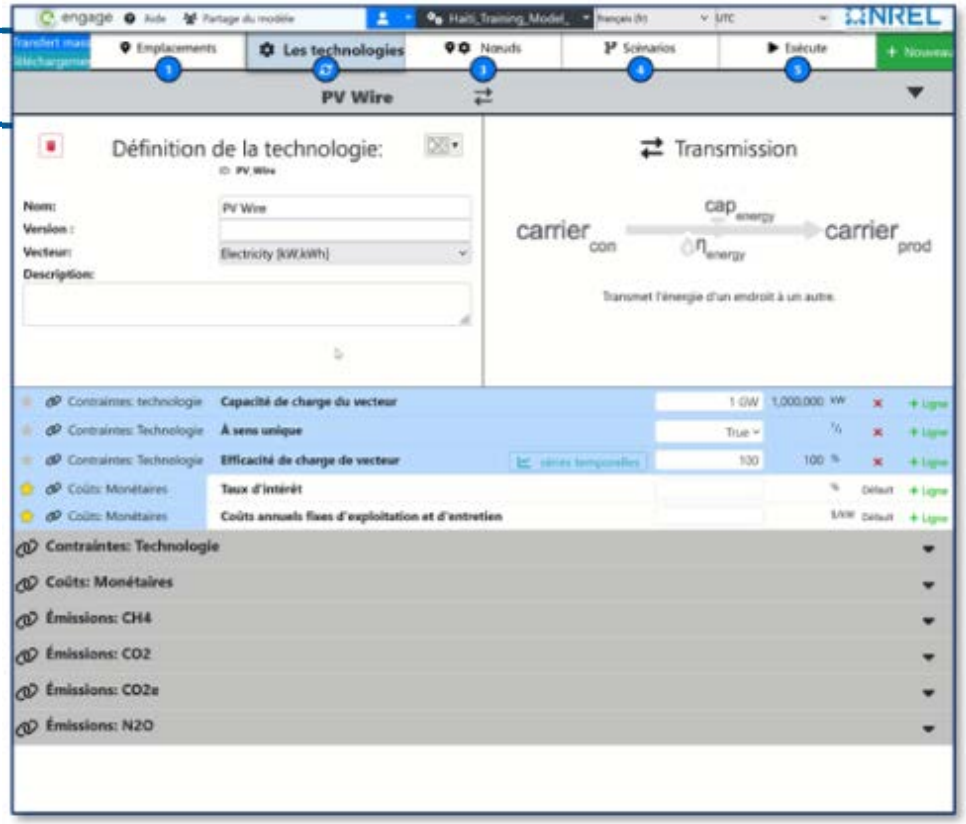


USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

reopt.nrel.gov



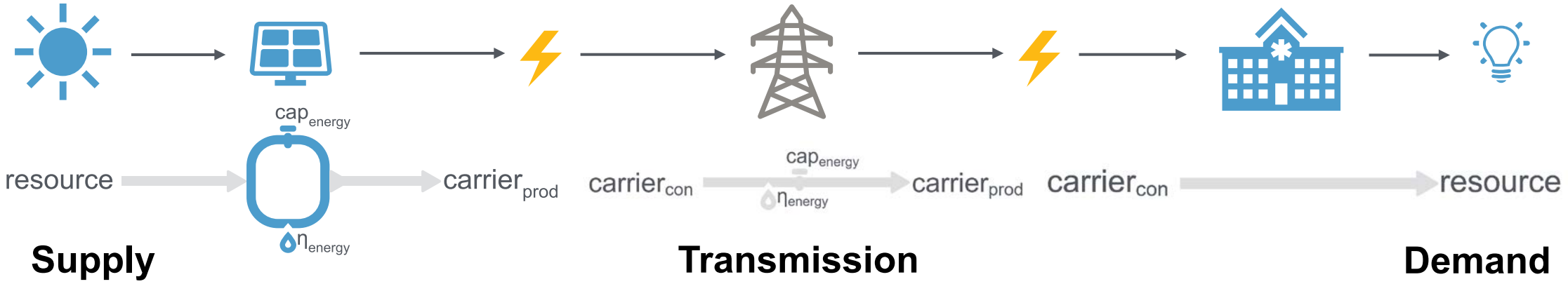
engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

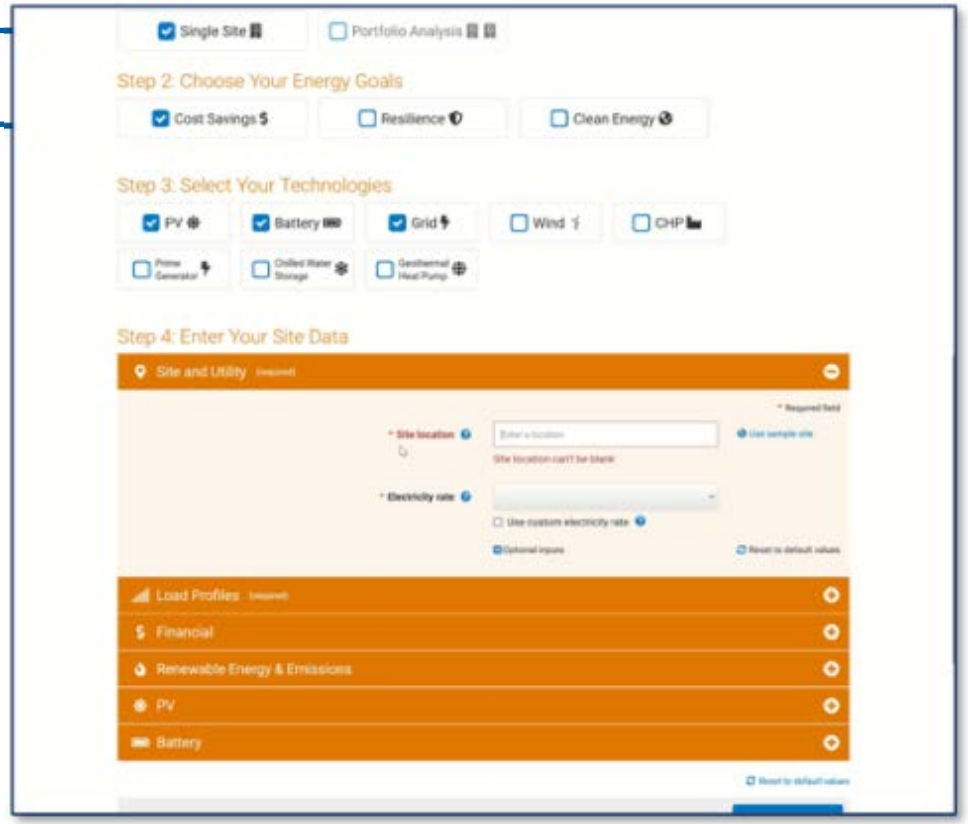


USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

reopt.nrel.gov



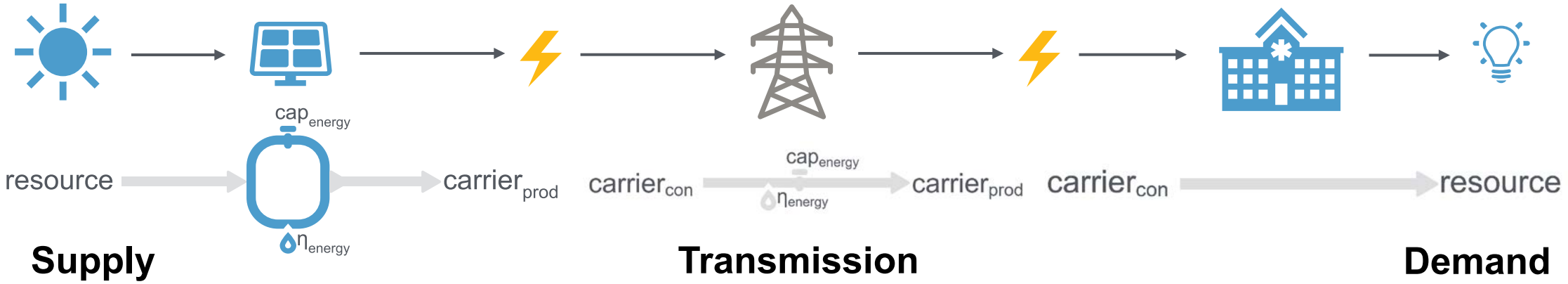
engage

Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

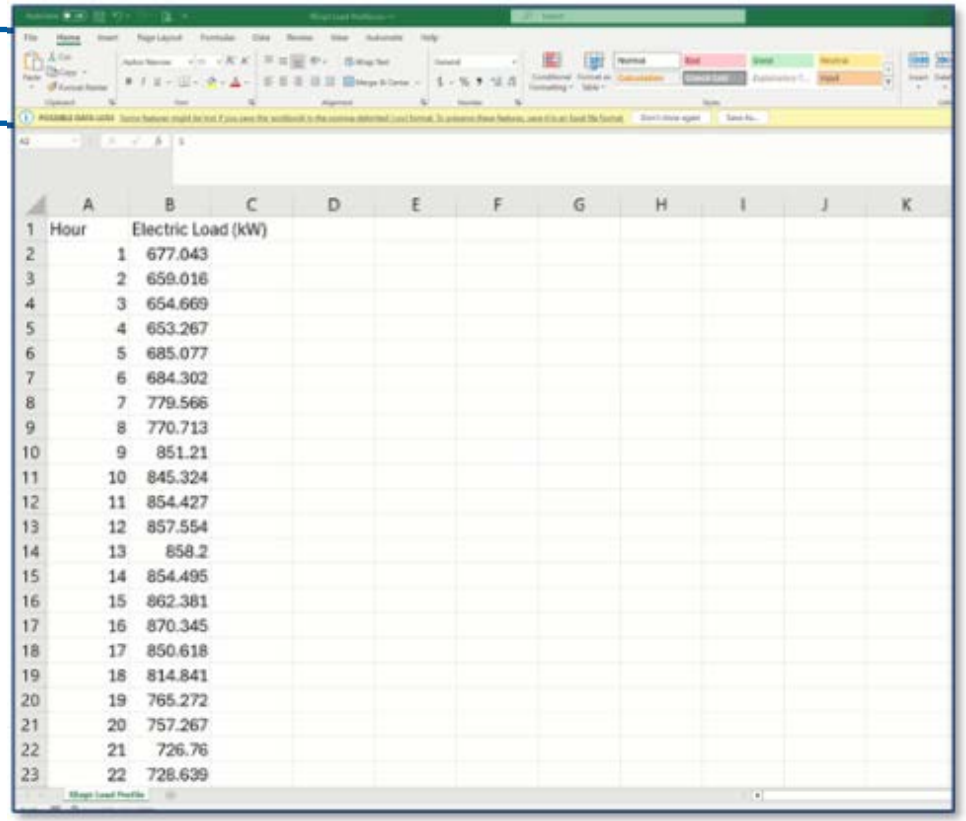


USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

reopt.nrel.gov



	A	B	C	D	E	F	G	H	I	J	K
1	Hour	Electric Load (kW)									
2	1	677.043									
3	2	659.016									
4	3	654.669									
5	4	653.267									
6	5	685.077									
7	6	684.302									
8	7	779.566									
9	8	770.713									
10	9	851.21									
11	10	845.324									
12	11	854.427									
13	12	857.554									
14	13	858.2									
15	14	854.495									
16	15	862.381									
17	16	870.345									
18	17	850.618									
19	18	814.841									
20	19	765.272									
21	20	757.267									
22	21	726.76									
23	22	728.639									

engage

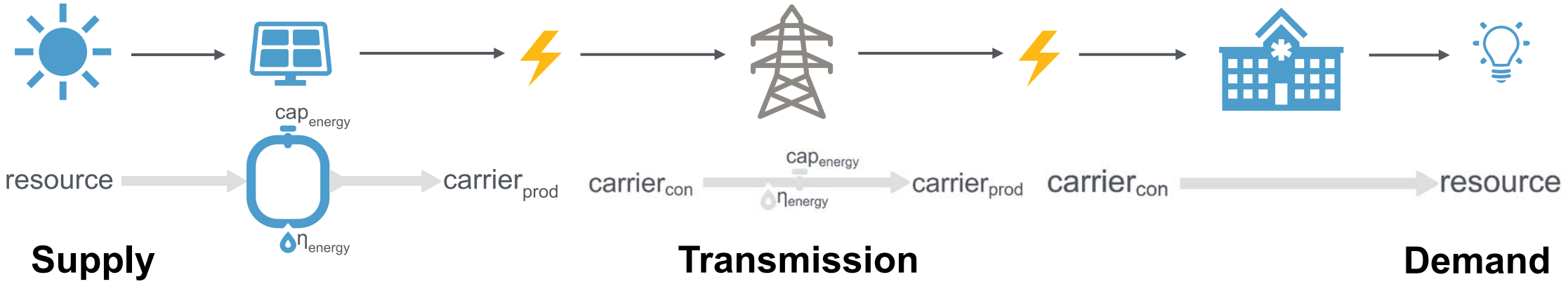
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

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

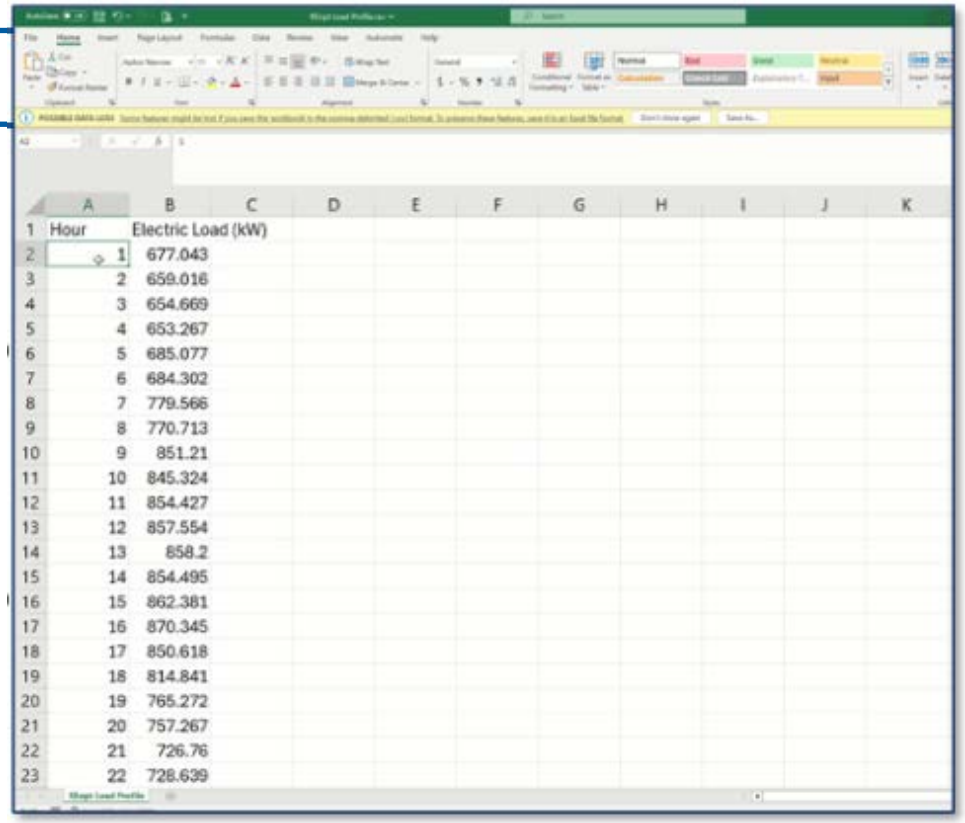


USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

reopt.nrel.gov



Hour	Electric Load (kW)
1	677.043
2	659.016
3	654.669
4	653.267
5	685.077
6	684.302
7	779.566
8	770.713
9	851.21
10	845.324
11	854.427
12	857.554
13	858.2
14	854.495
15	862.381
16	870.345
17	850.618
18	814.841
19	765.272
20	757.267
21	726.76
22	728.639

engage

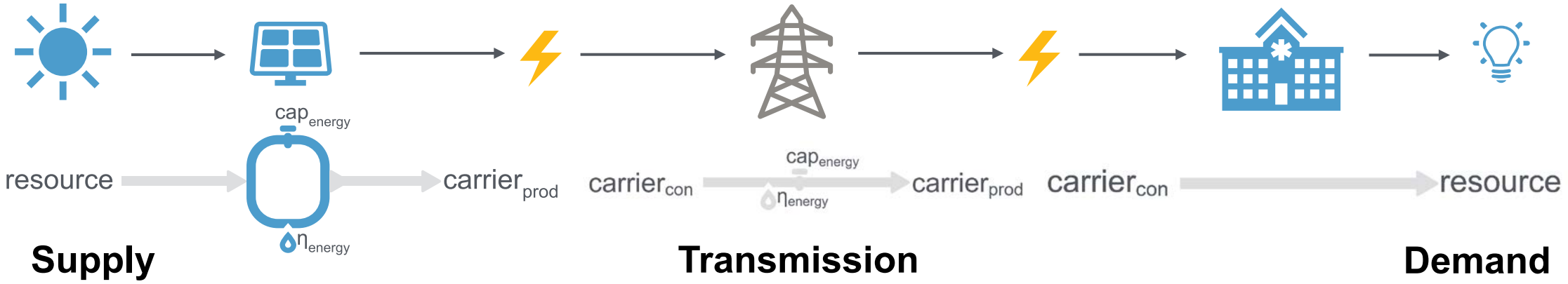
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

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

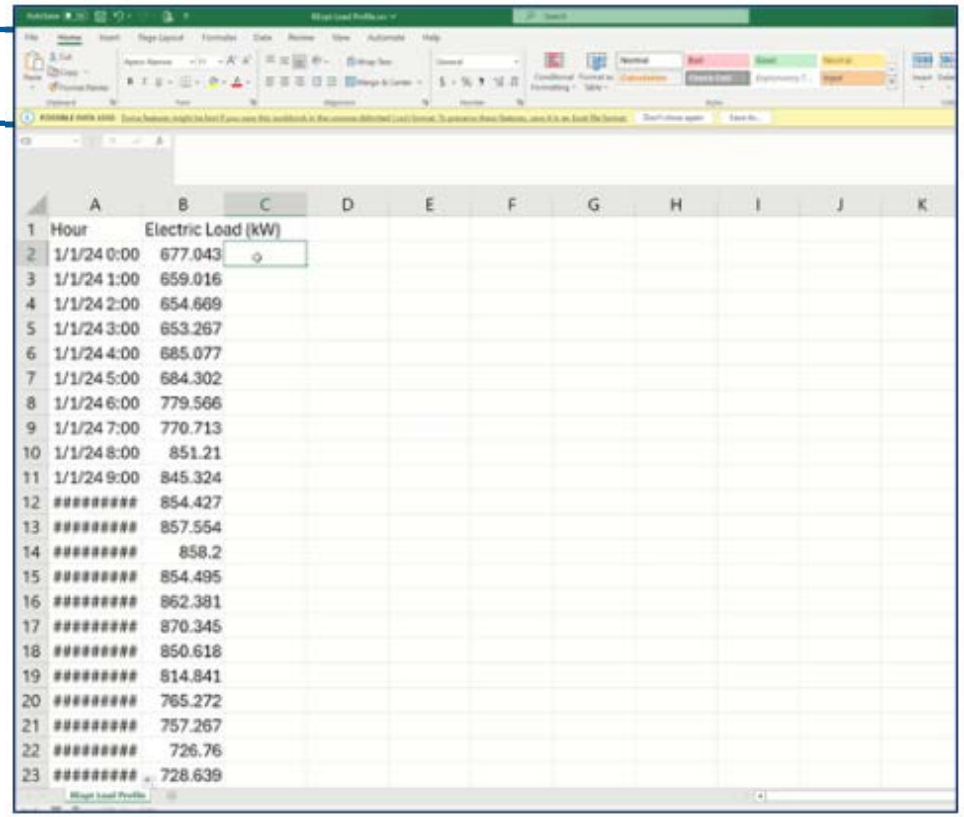


USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

reopt.nrel.gov



	A	B	C
1	Hour	Electric Load (kW)	
2	1/1/24 0:00	677.043	
3	1/1/24 1:00	659.016	
4	1/1/24 2:00	654.669	
5	1/1/24 3:00	653.267	
6	1/1/24 4:00	685.077	
7	1/1/24 5:00	684.302	
8	1/1/24 6:00	779.566	
9	1/1/24 7:00	770.713	
10	1/1/24 8:00	851.21	
11	1/1/24 9:00	845.324	
12	#########	854.427	
13	#########	857.554	
14	#########	858.2	
15	#########	854.495	
16	#########	862.381	
17	#########	870.345	
18	#########	850.618	
19	#########	814.841	
20	#########	765.272	
21	#########	757.267	
22	#########	726.76	
23	#########	728.639	

engage

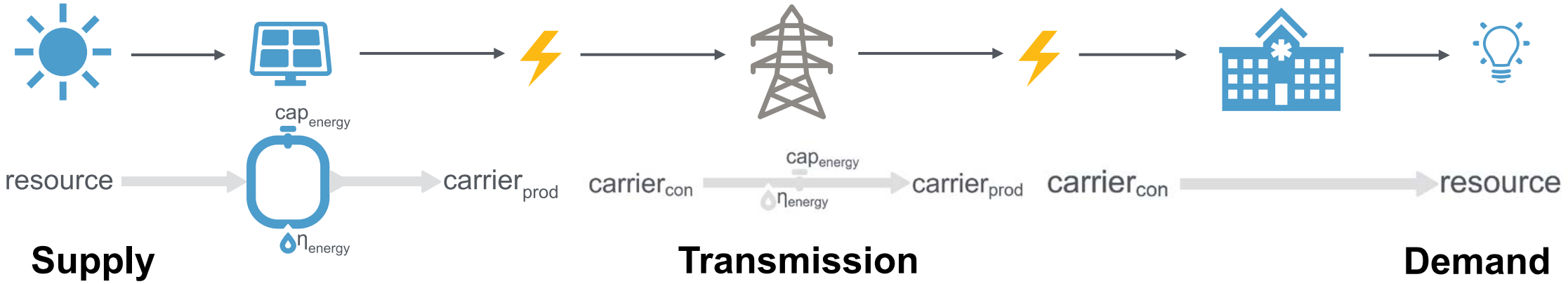
Simulates how energy or commodities moves through a given system

carriers

archetypes

- ☑ Supply
- ☑ Transmission
- ☑ Demand
- ☐
- ☐

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

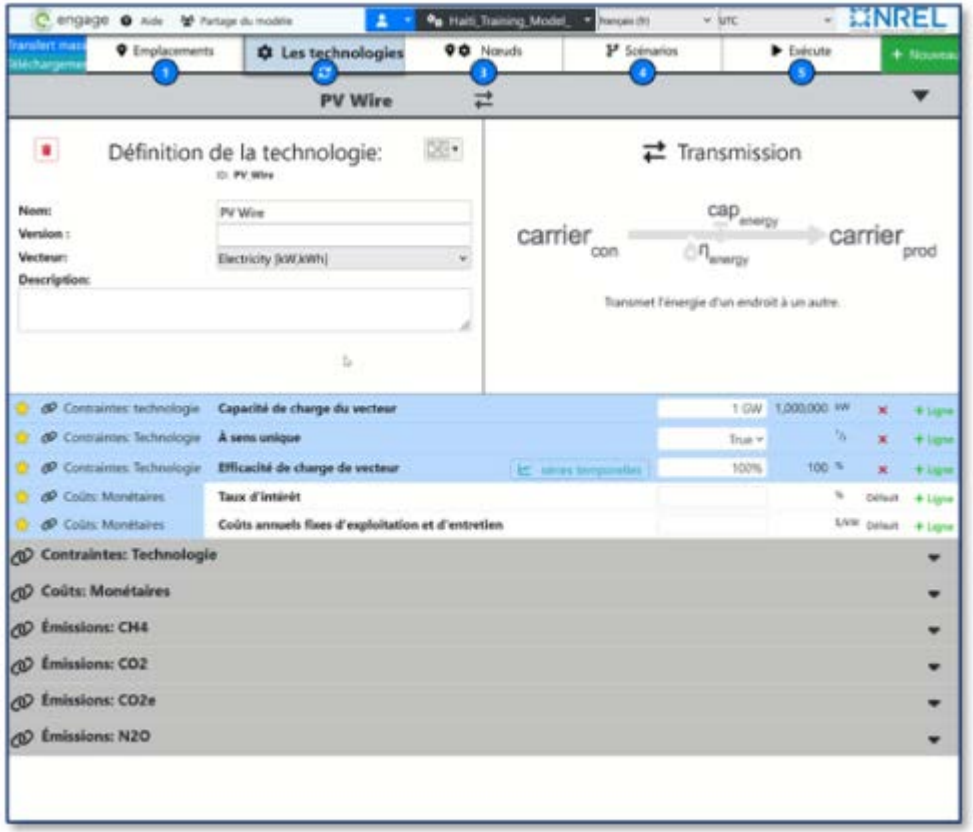
Simulates how energy or commodities moves through a given system

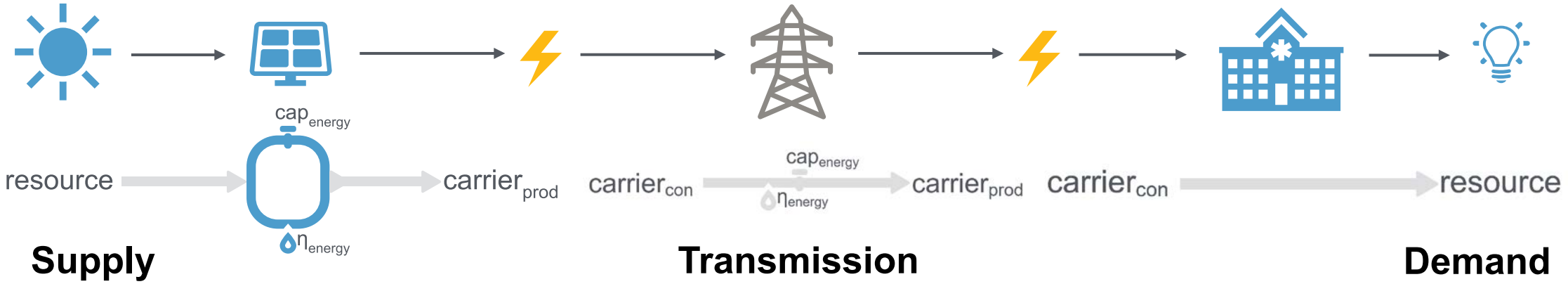
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

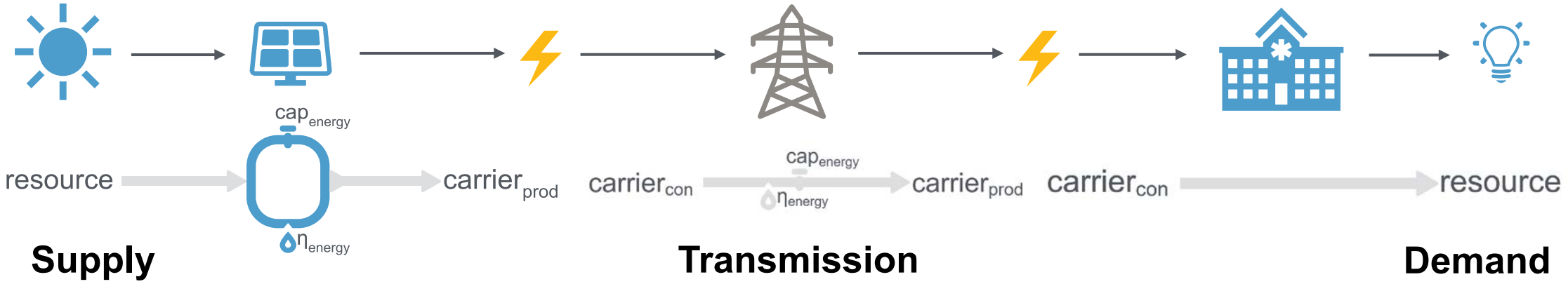
Simulates how energy or commodities moves through a given system

carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] Demand
- [ ]
- [ ]

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



Timeseries

engage

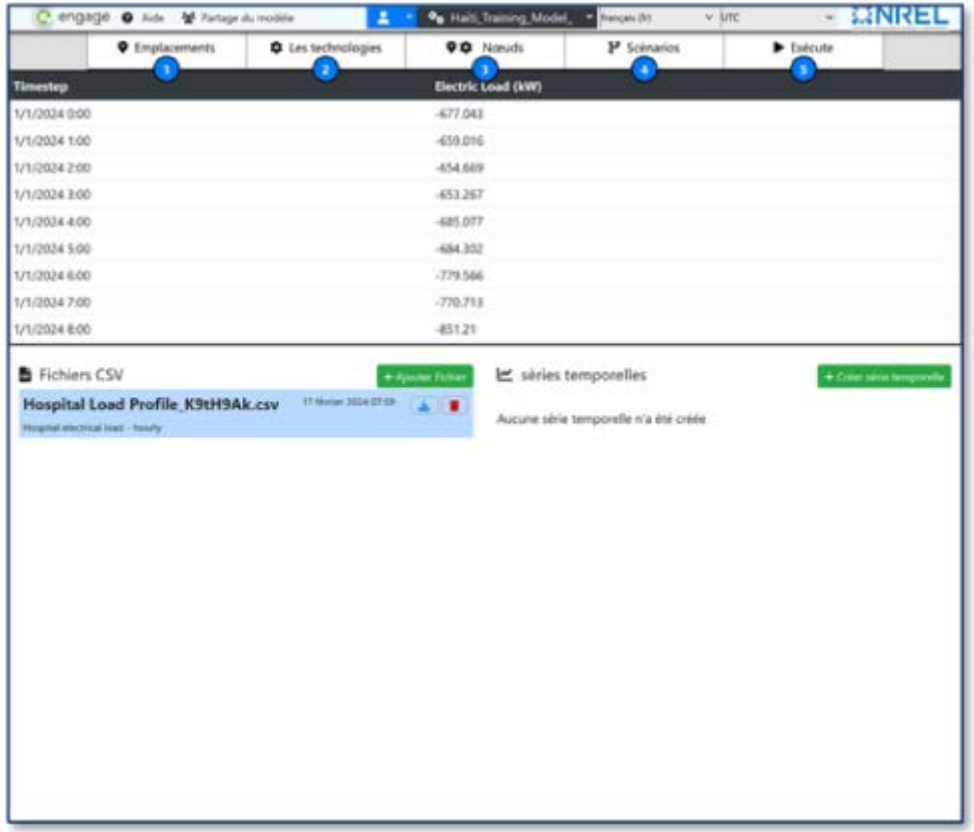
Simulates how energy or commodities moves through a given system

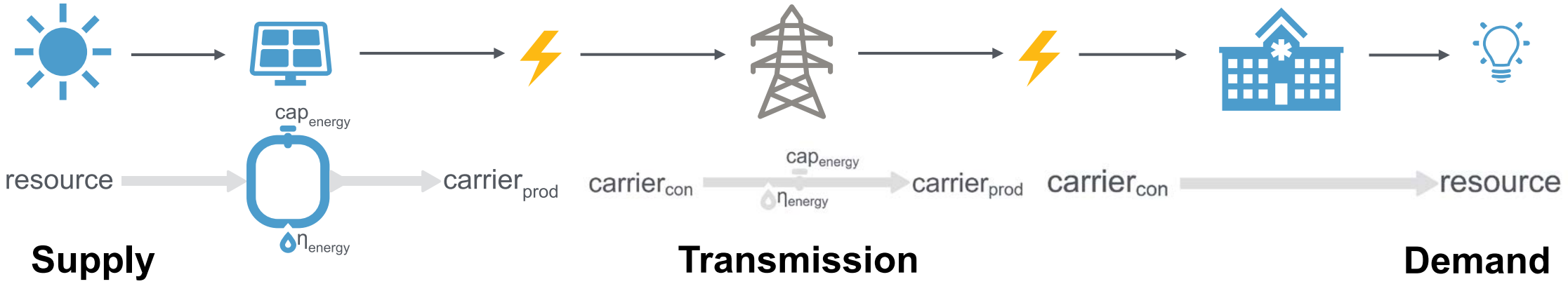
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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

engage

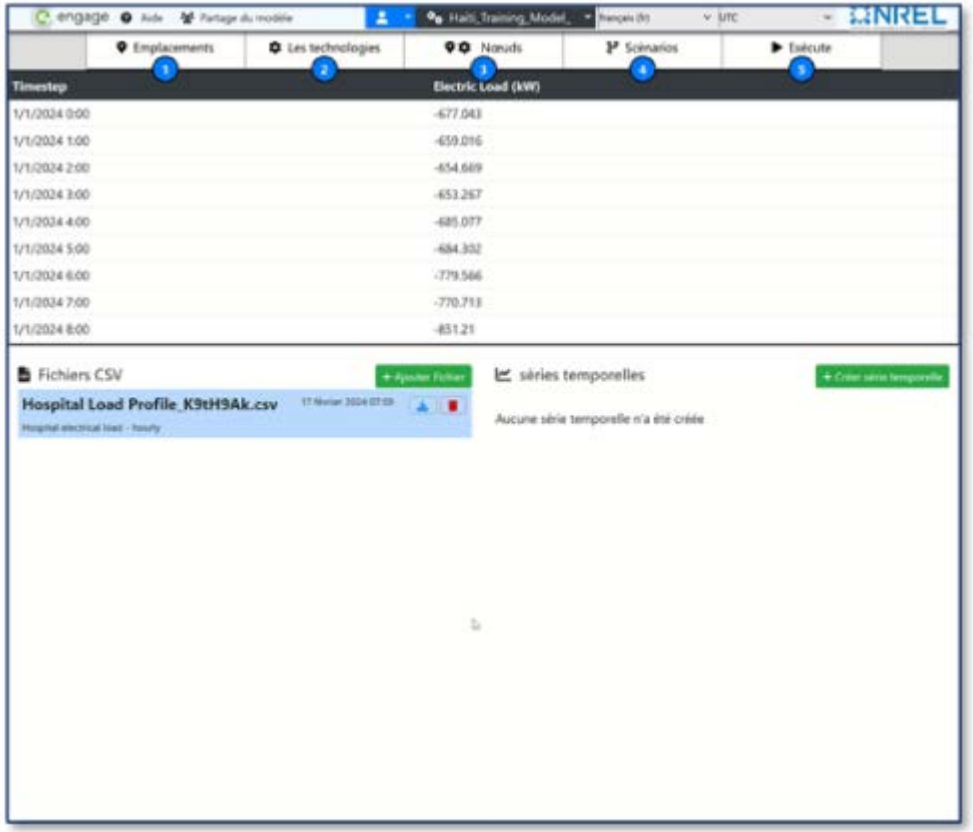
Simulates how energy or commodities moves through a given system

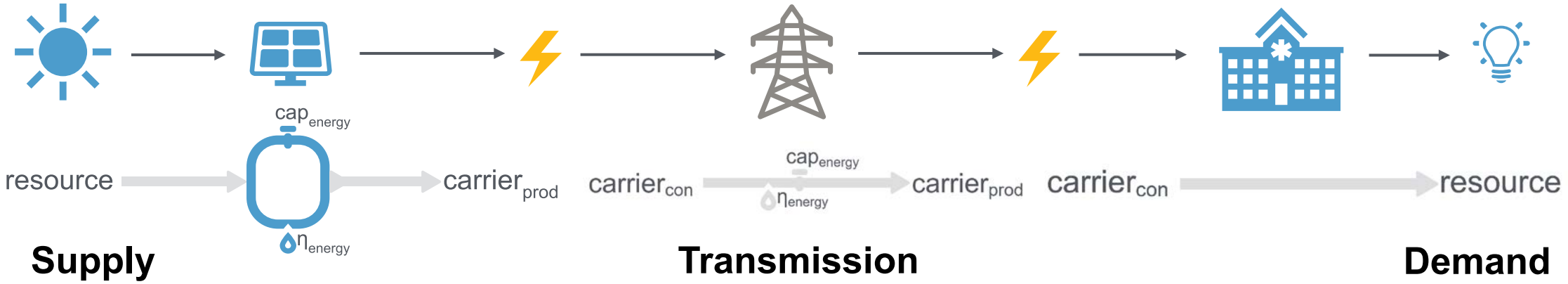
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

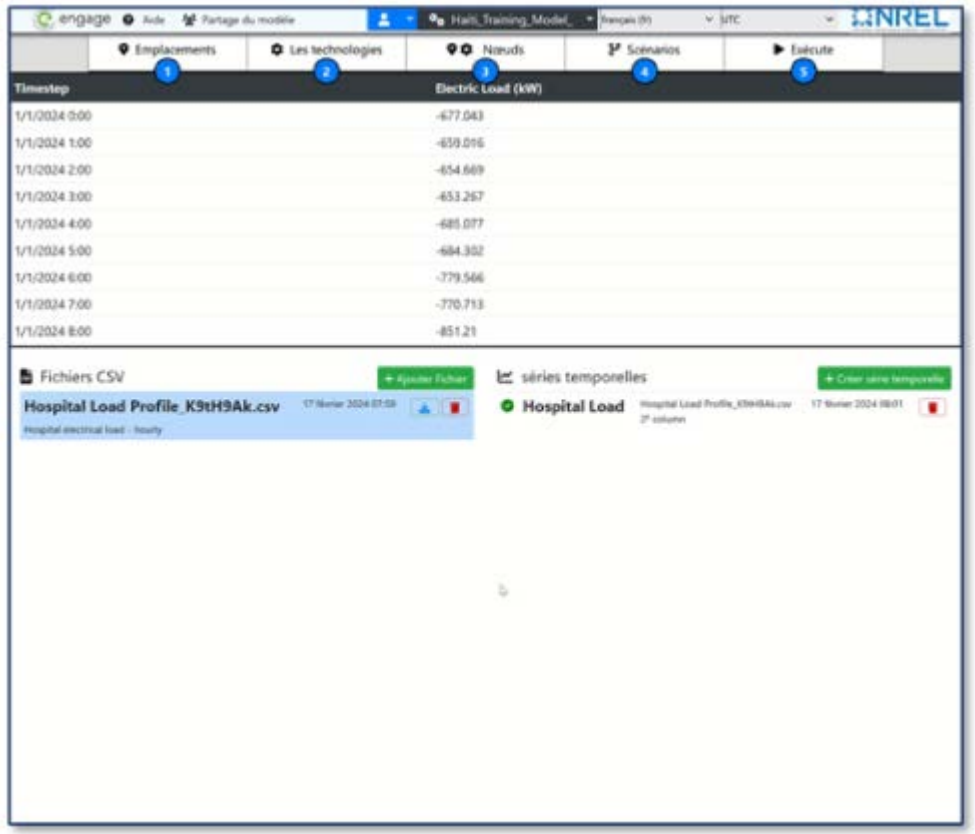
Simulates how energy or commodities moves through a given system

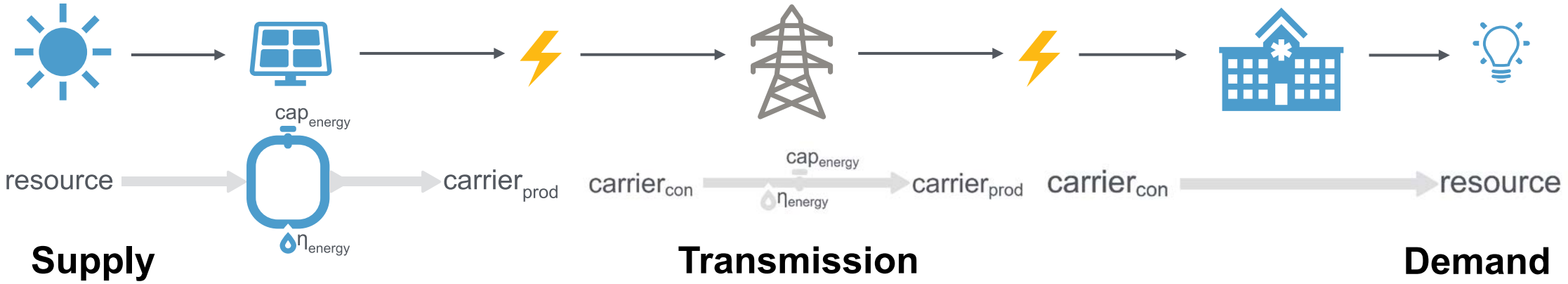
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

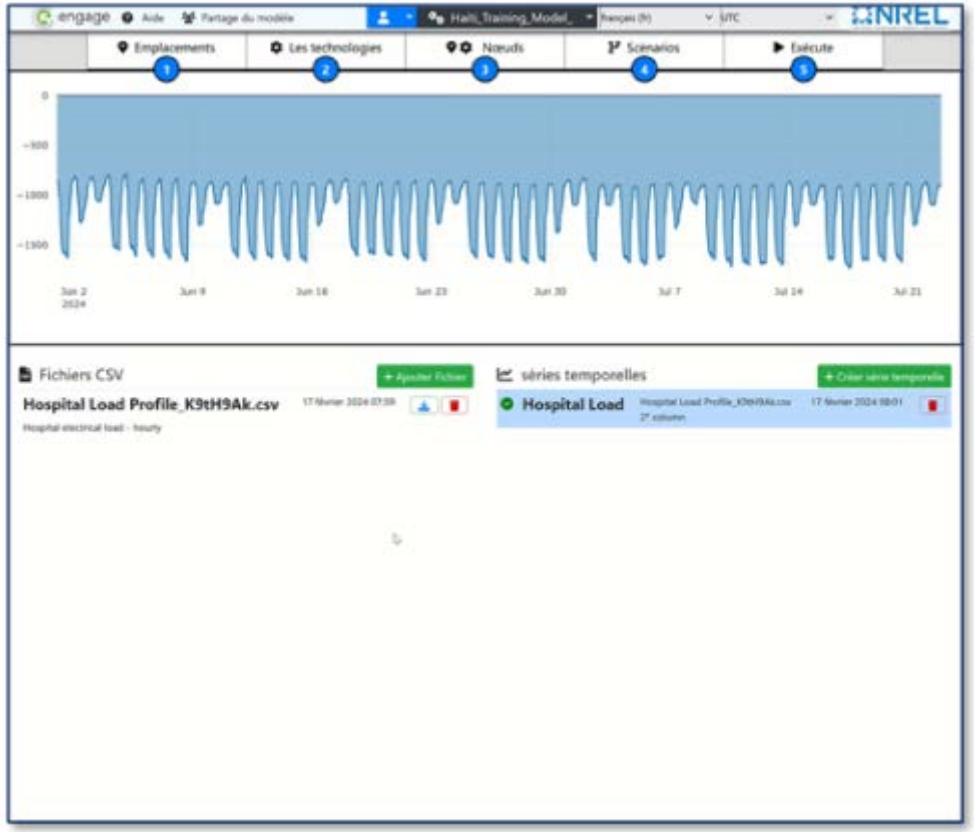
Simulates how energy or commodities moves through a given system

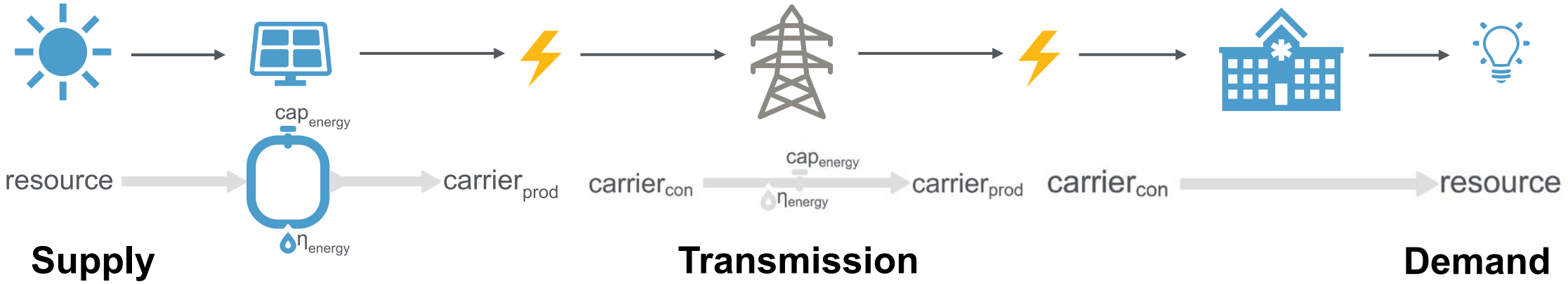
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

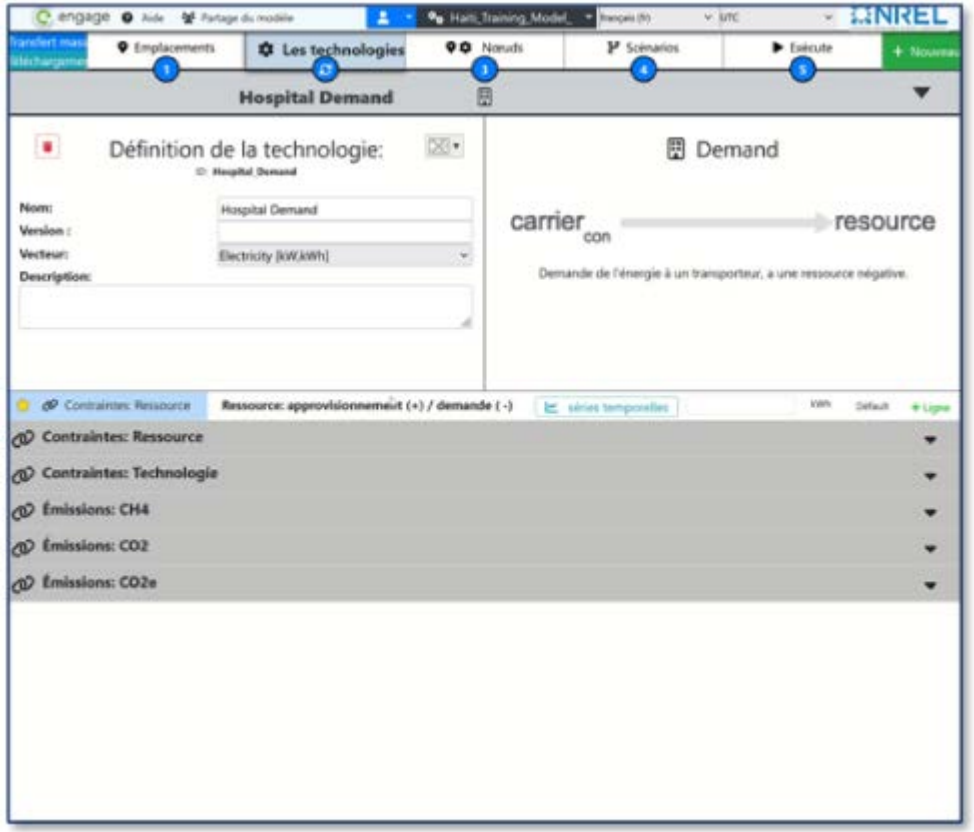
Simulates how energy or commodities moves through a given system

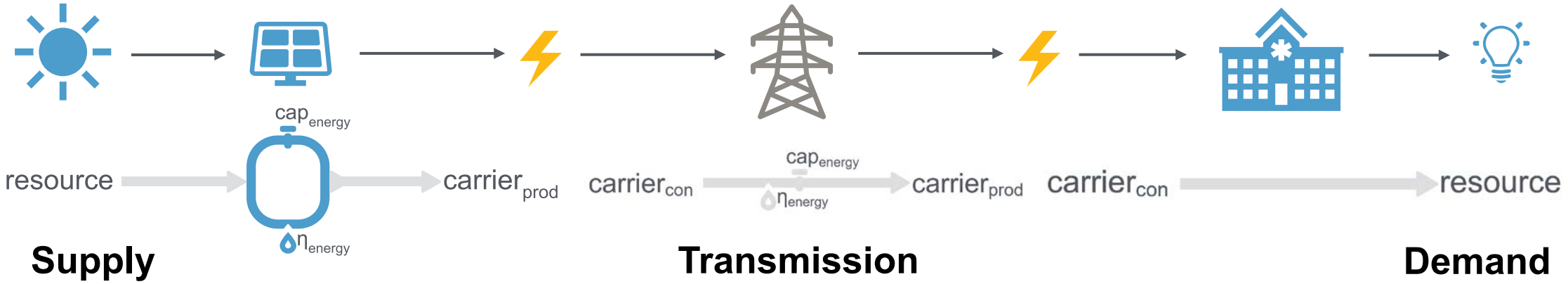
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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





USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Timeseries

engage

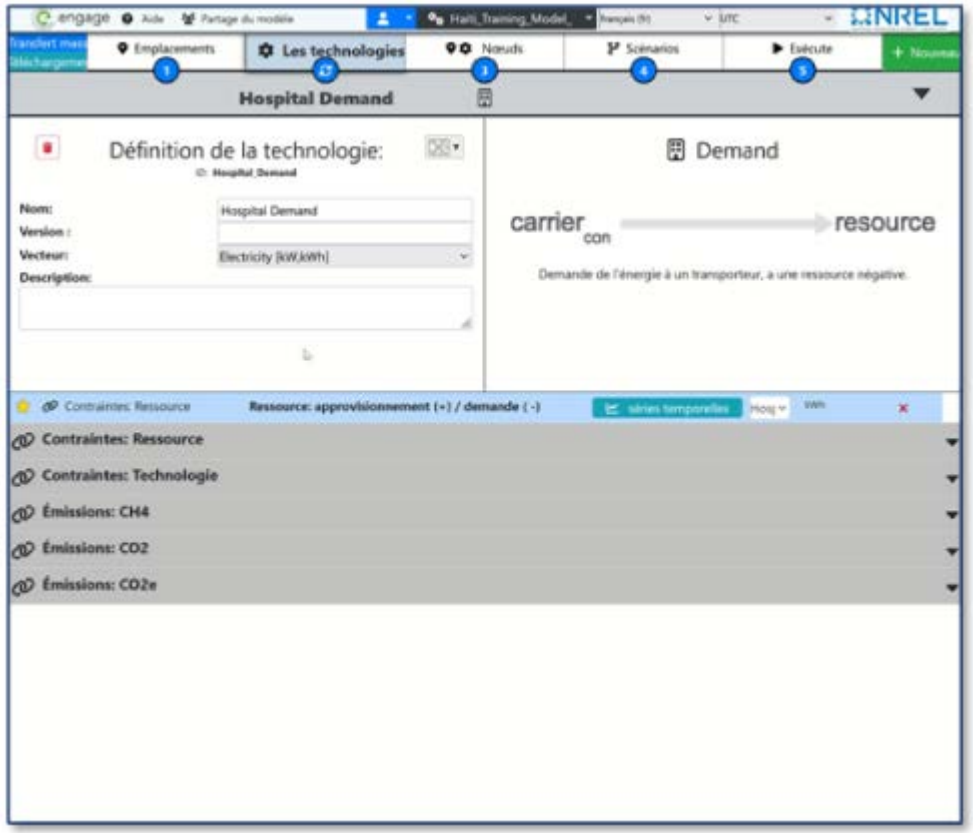
Simulates how energy or commodities moves through a given system

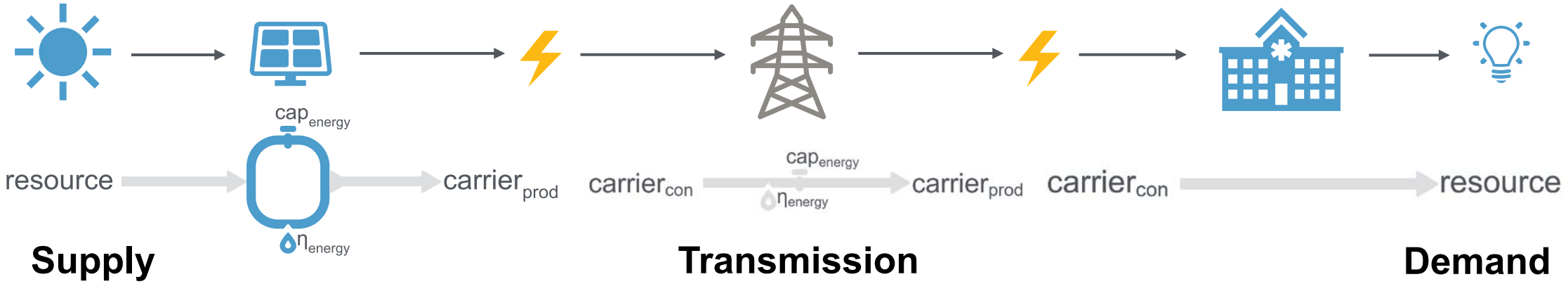
carriers

archetypes

- [x] Supply
- [x] Transmission
- [x] 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

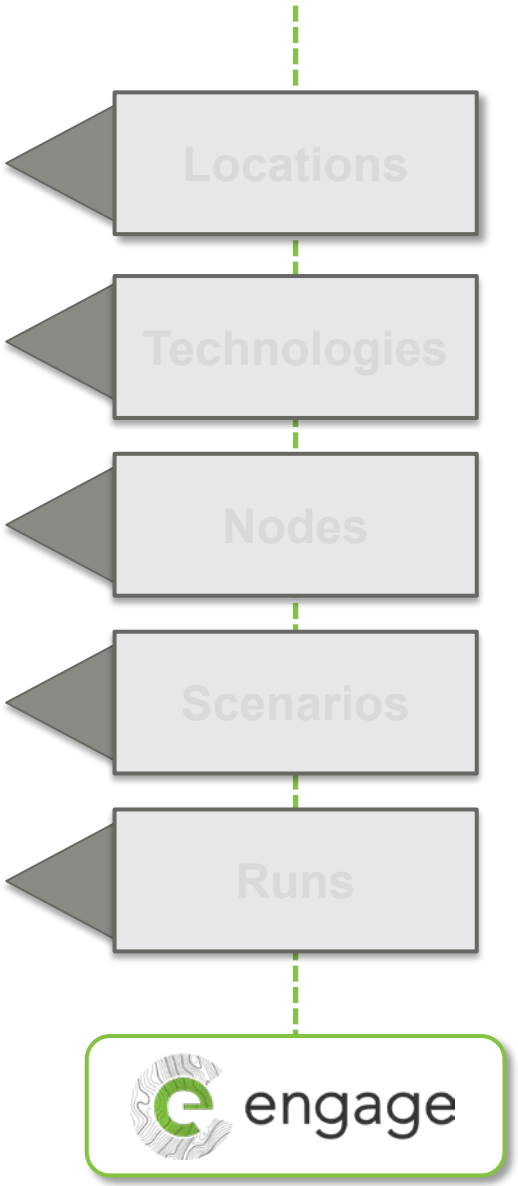




USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process



Model Building Process

1 **Locations**

Technologies

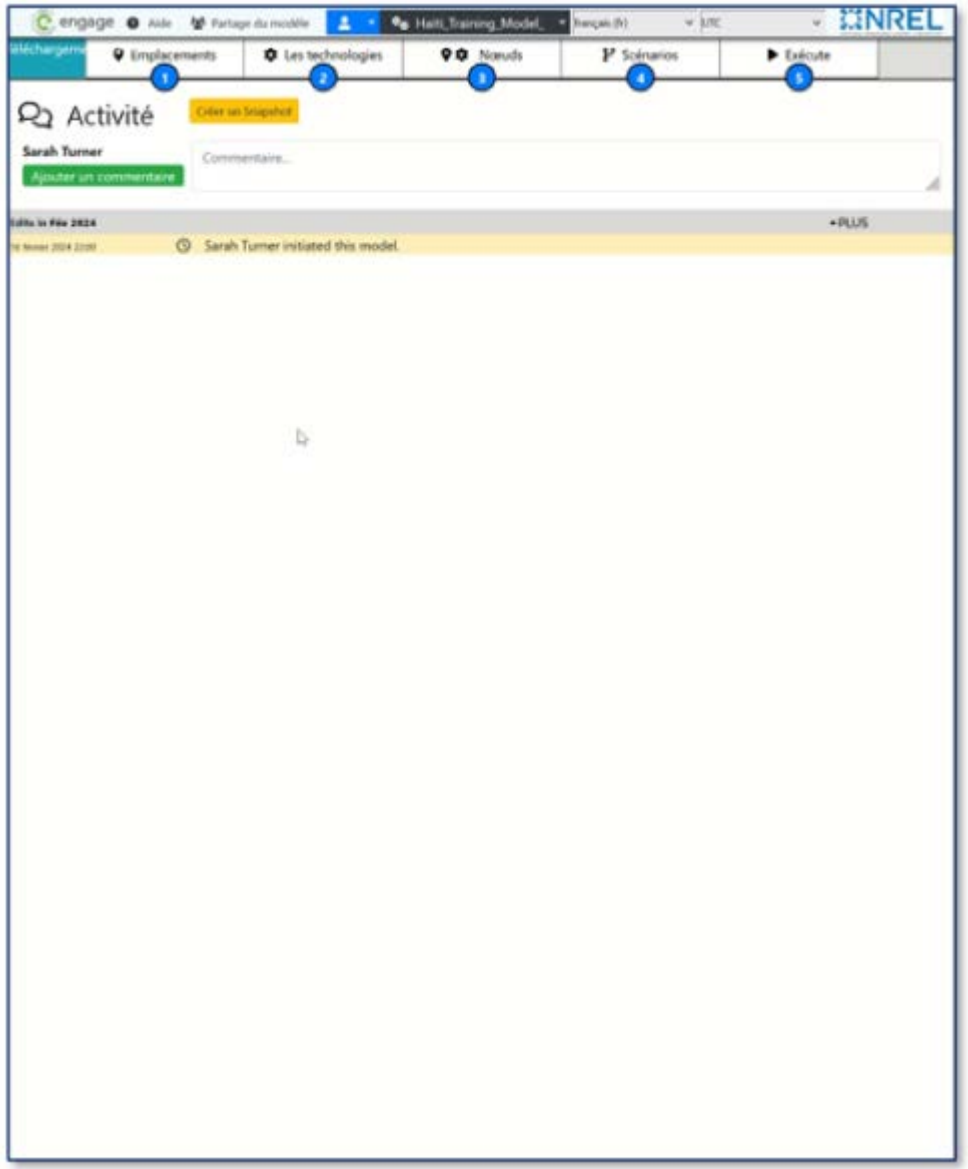
Nodes

Scenarios

Runs

engage

Function: Create representative locations for technologies within the model



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

Technologies

Nodes

Scenarios

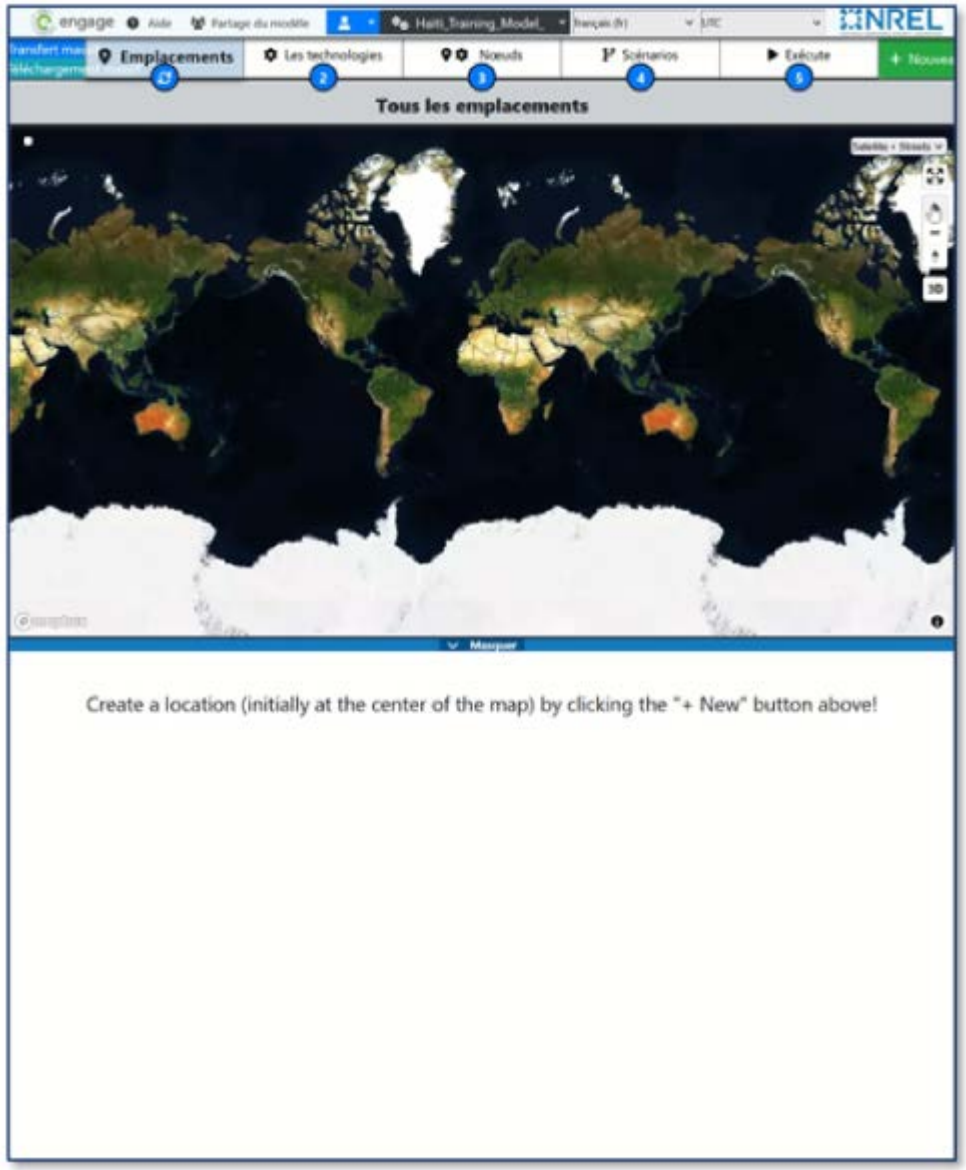
Runs

engage

Function: Create representative locations for technologies within the model

Mapbox features allow users to:

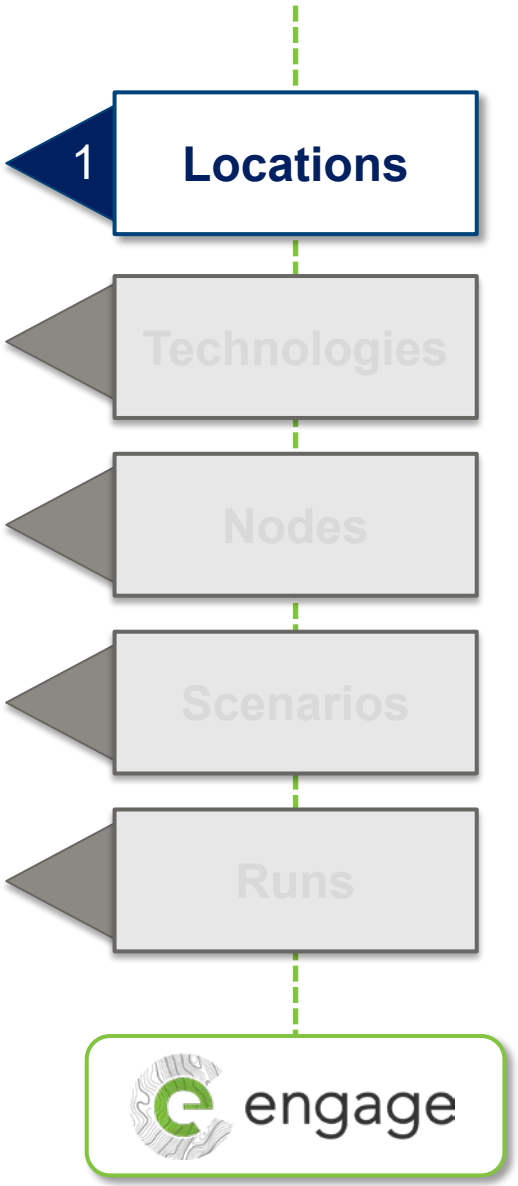
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

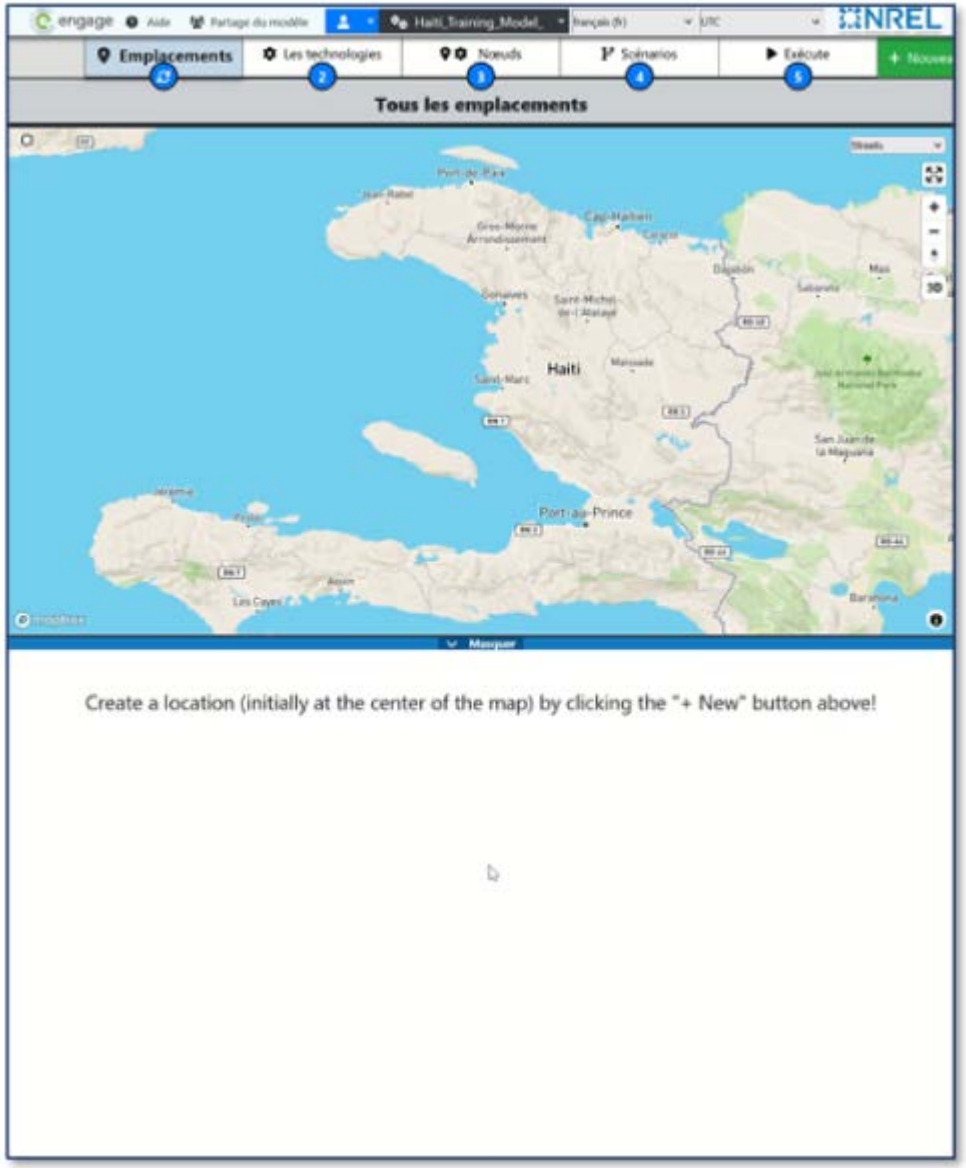
Model Building Process



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



Model Building Process

1 **Locations**

Technologies

Nodes

Scenarios

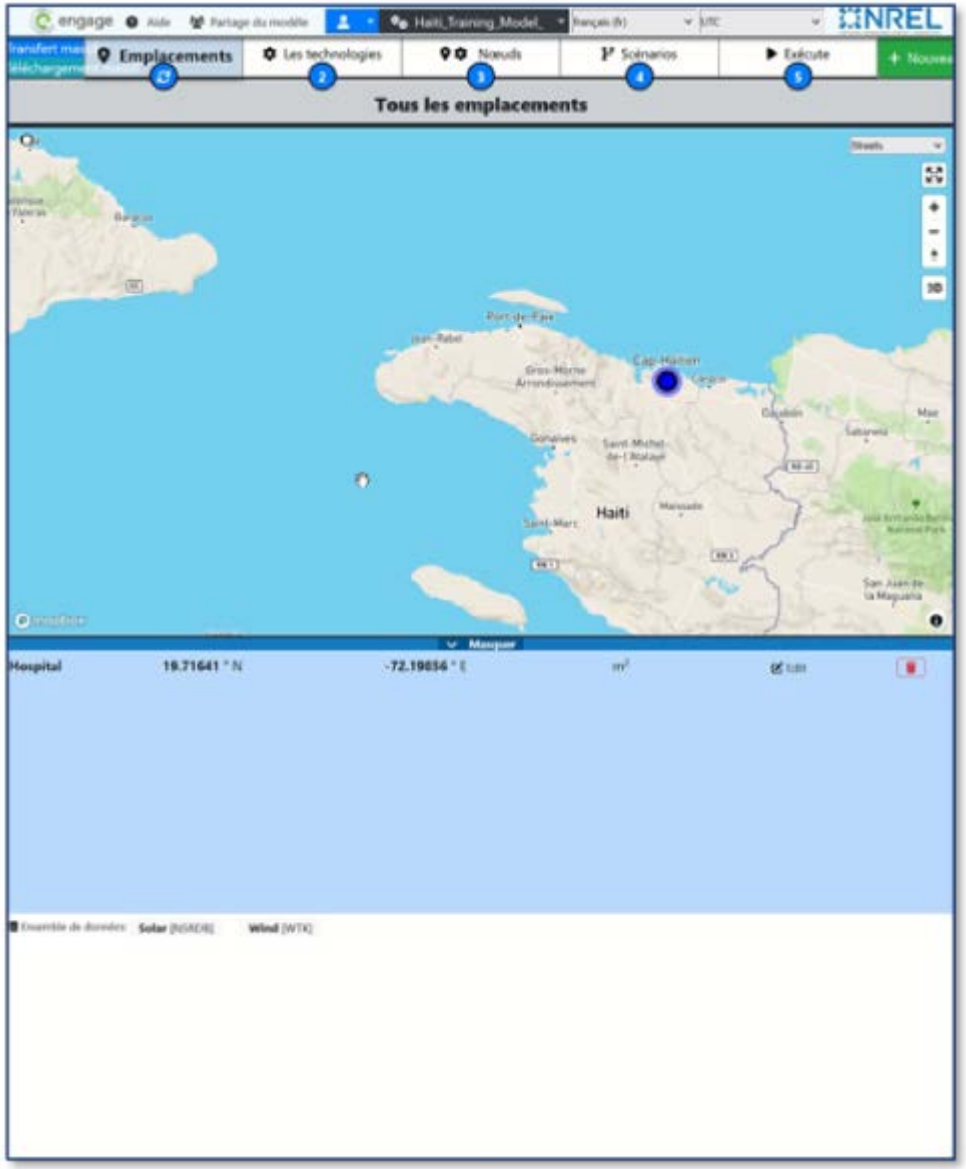
Runs

engage

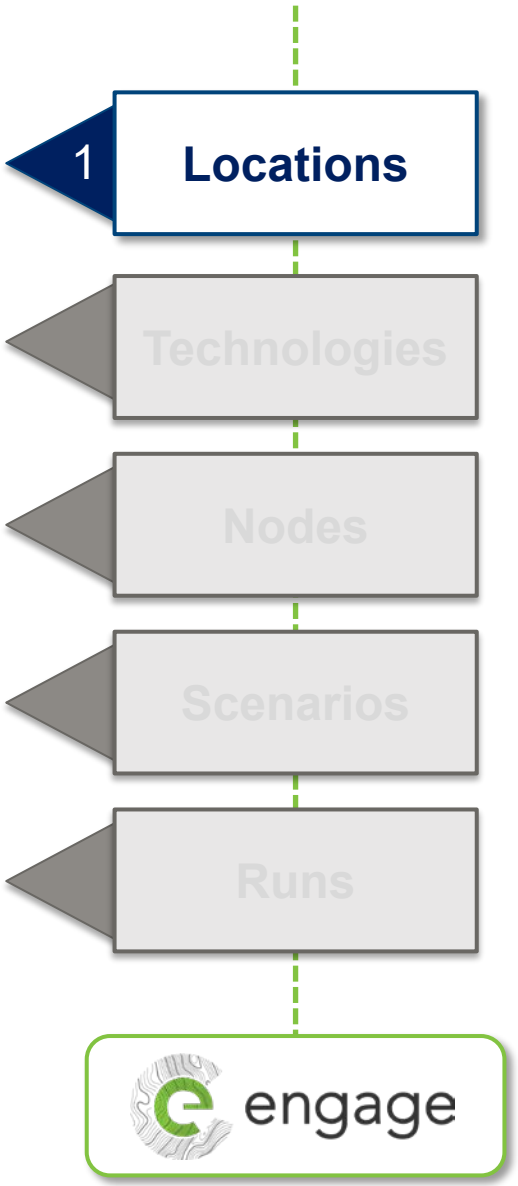
Function: Create representative locations for technologies within the model

Mapbox features allow users to:

- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging



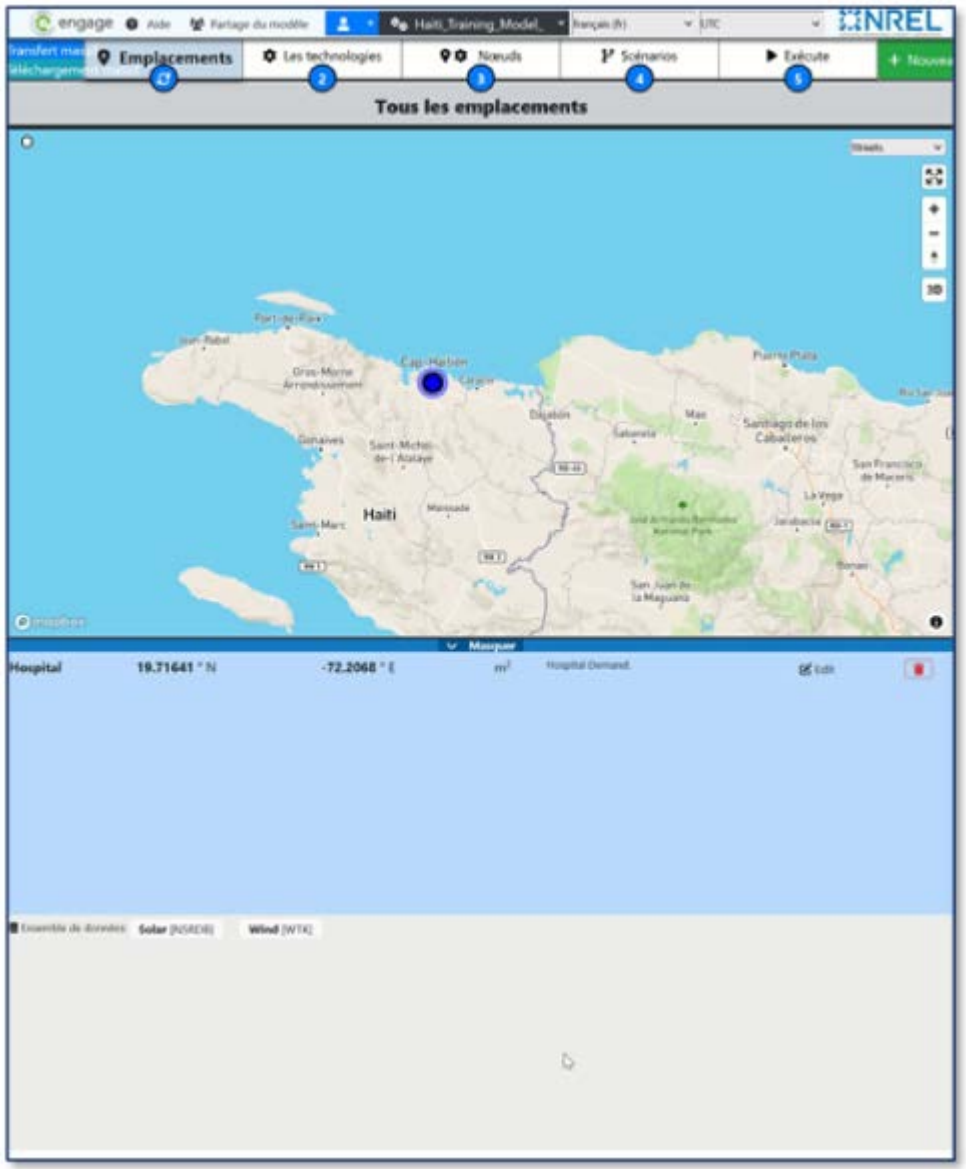
Model Building Process



Function: Create representative locations for technologies within the model

Mapbox features allow users to:

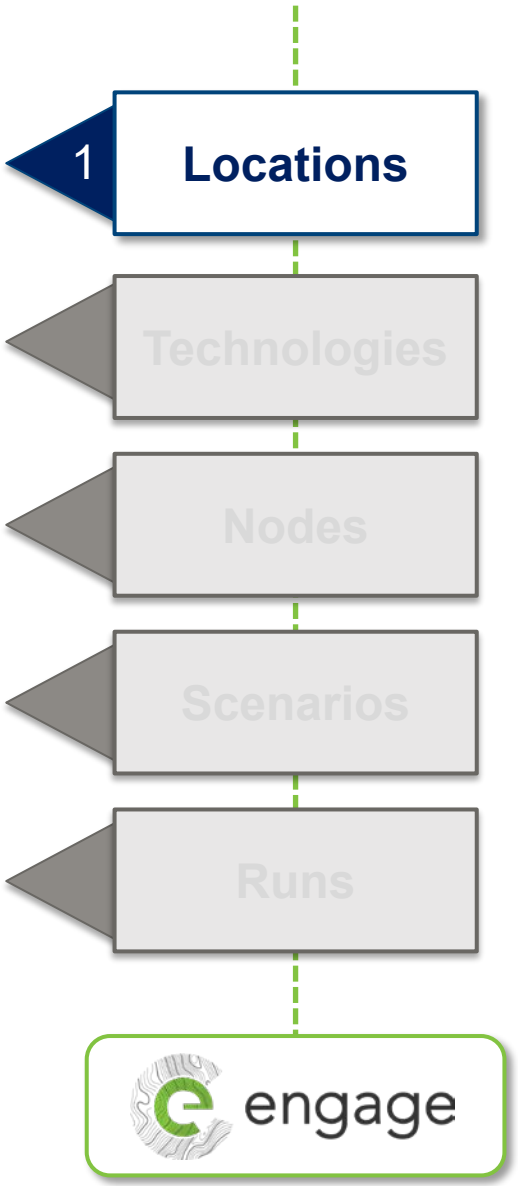
- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

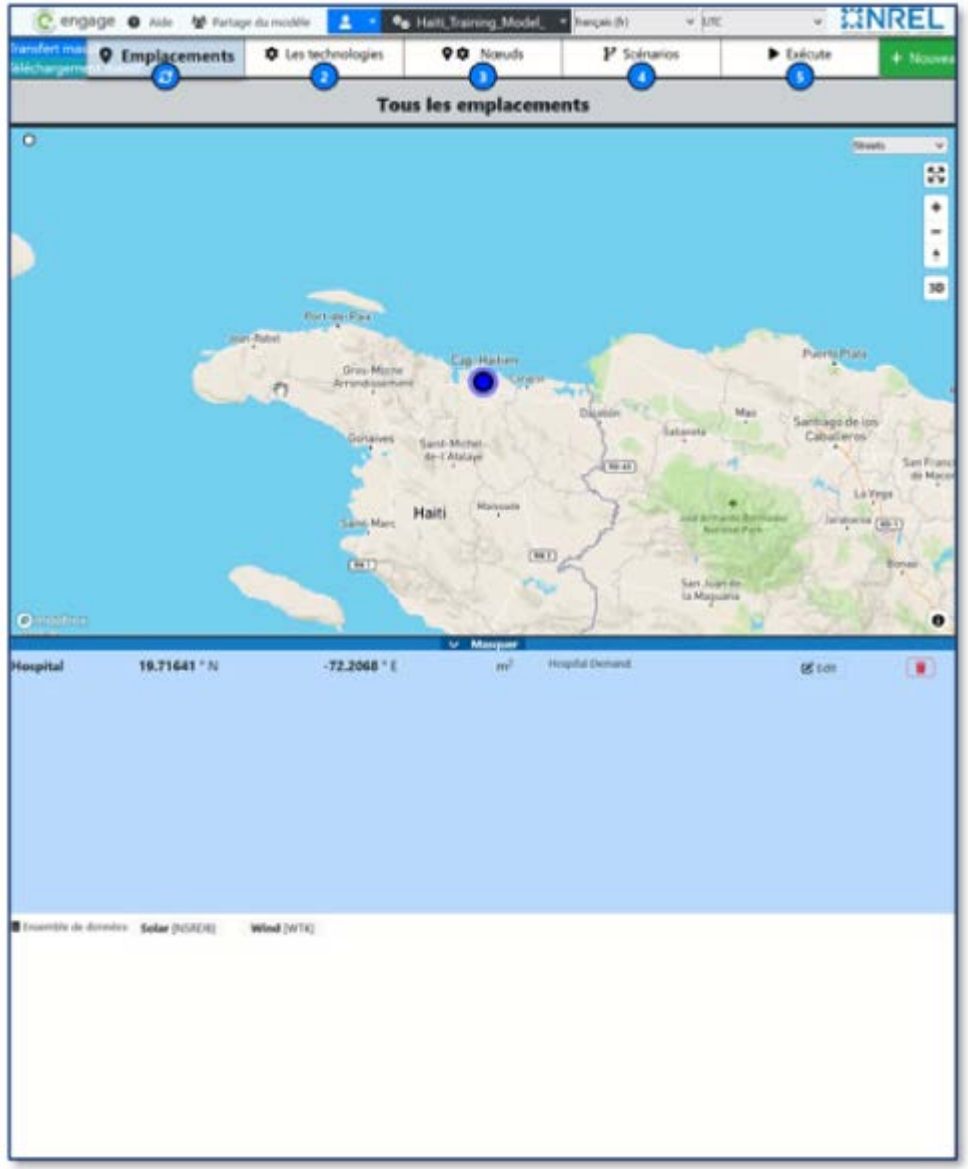


Function: Create representative locations for technologies within the model

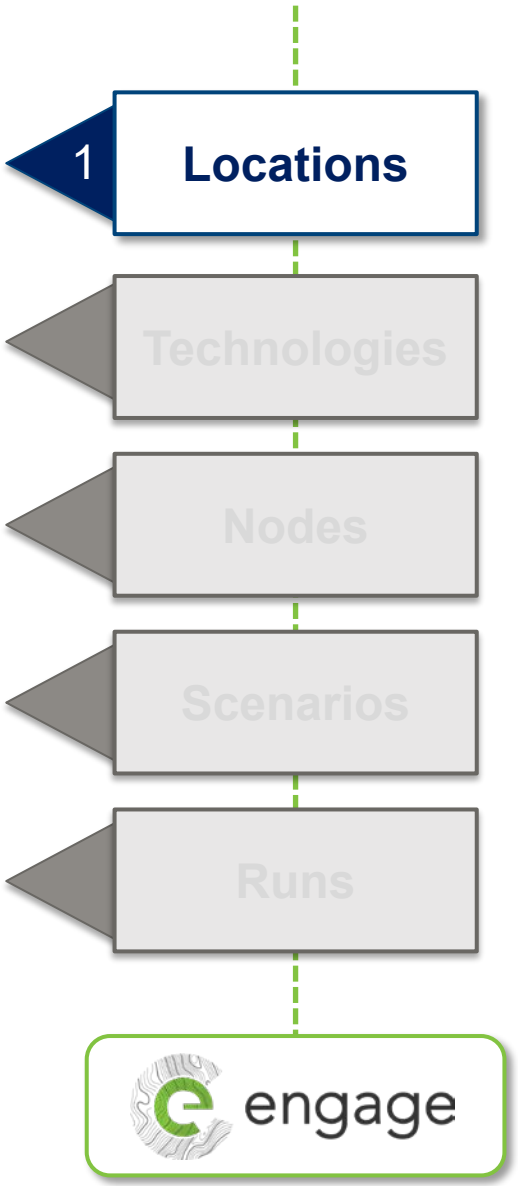
Mapbox features allow users to:

- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

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



Model Building Process



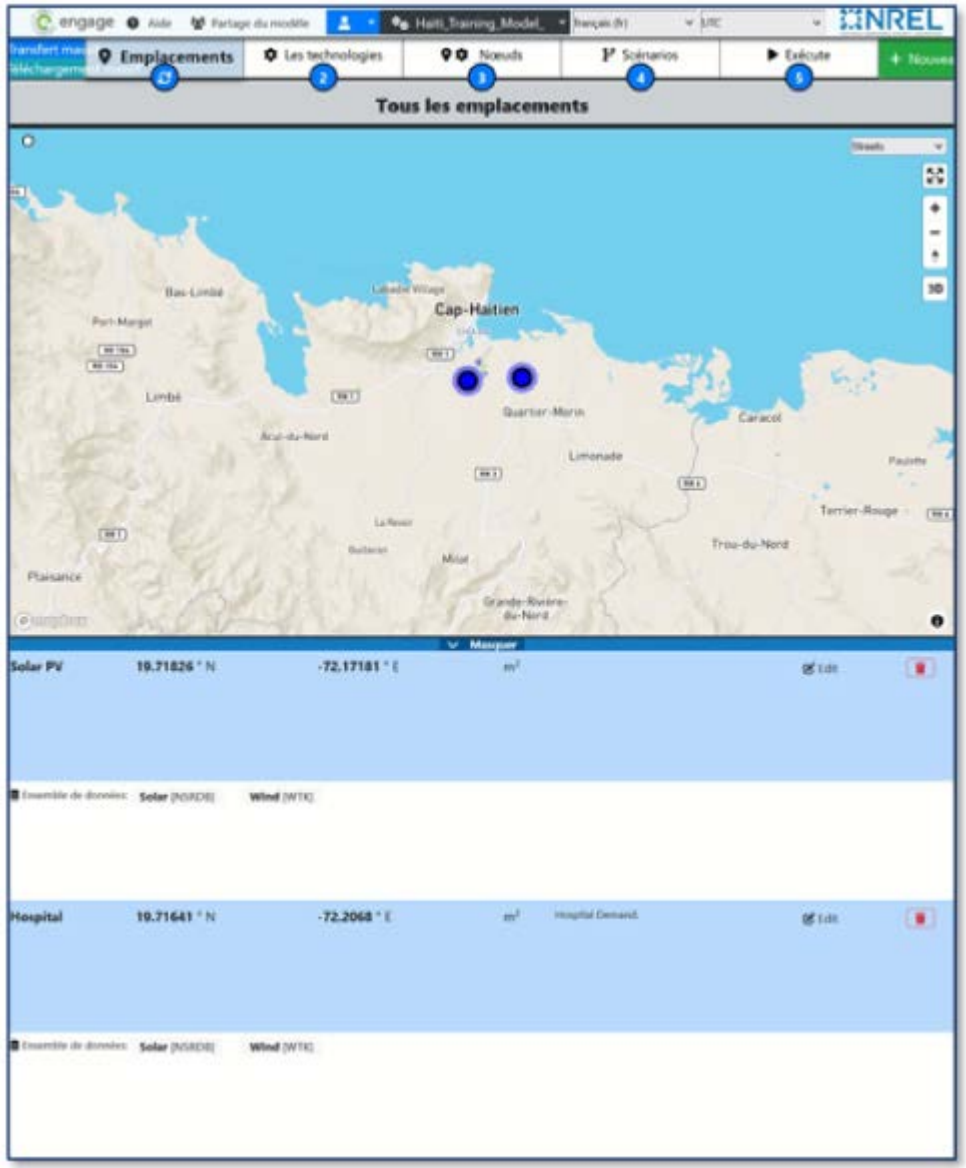
Function: Create representative locations for technologies within the model

Mapbox features allow users to:

- **Zoom** in on specific locations
- **Examine** street maps
- **View** satellite imaging

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**

Technologies

Nodes

Scenarios

Runs

engage

Function: Create representative locations for technologies within the model

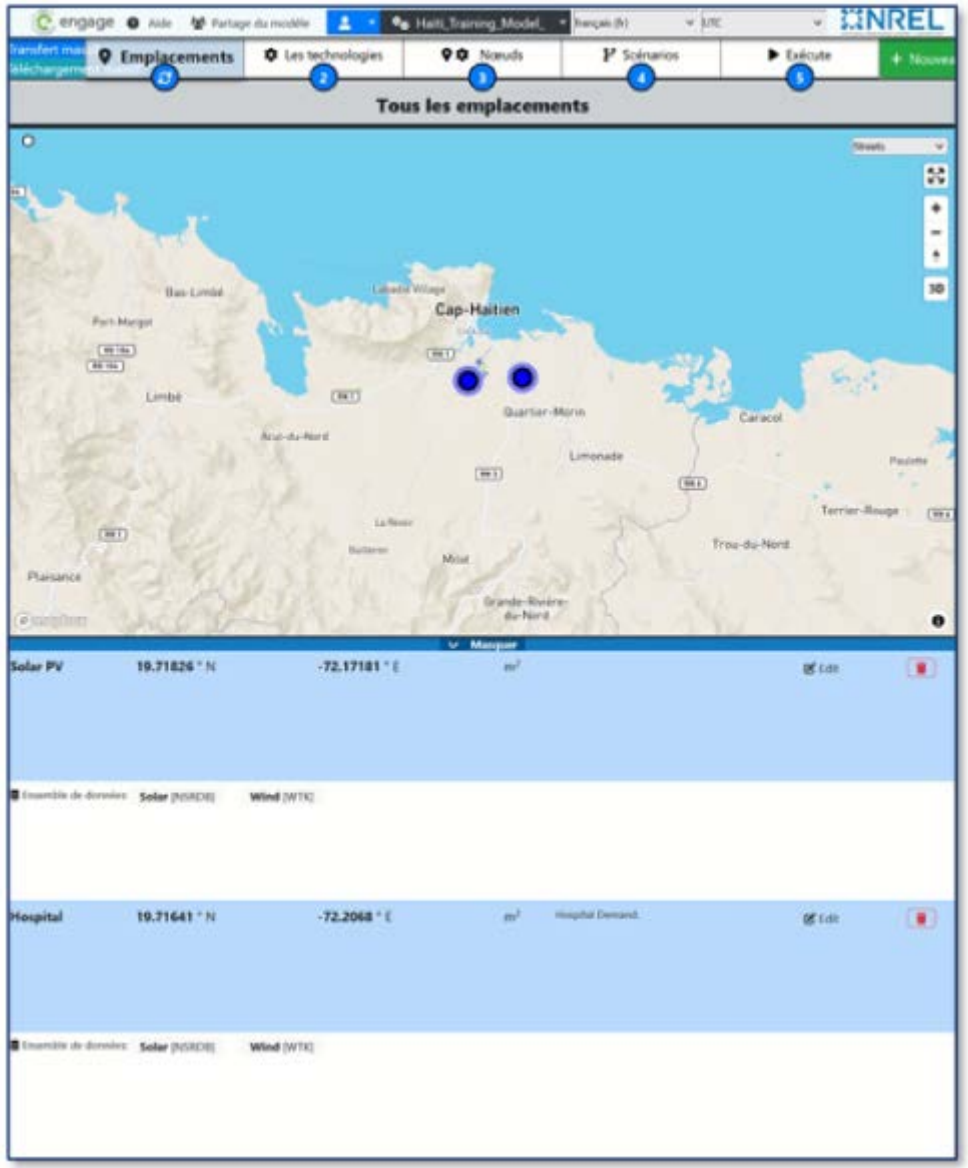
Mapbox features allow users to:

- **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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

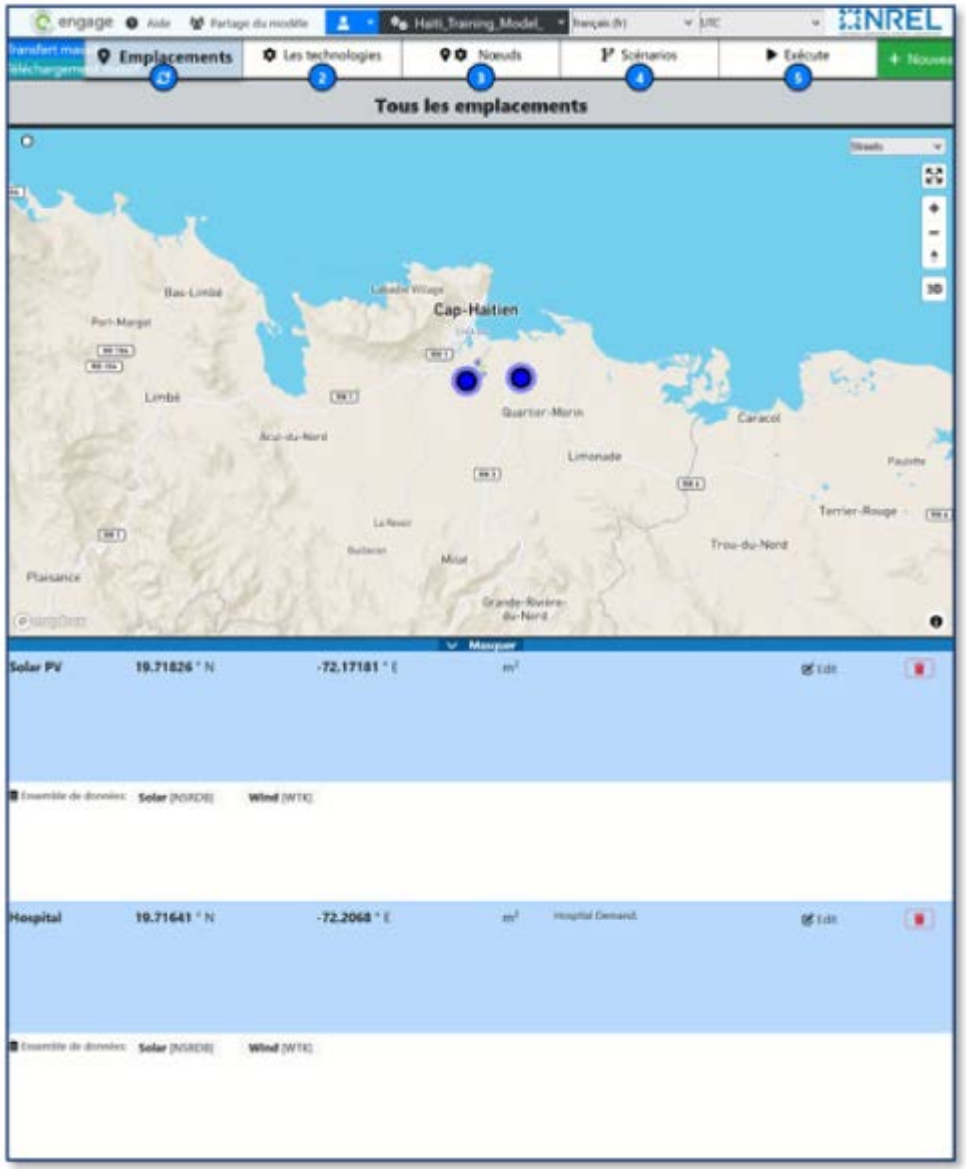
2 **Technologies**

Nodes

Scenarios

Runs

engage



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

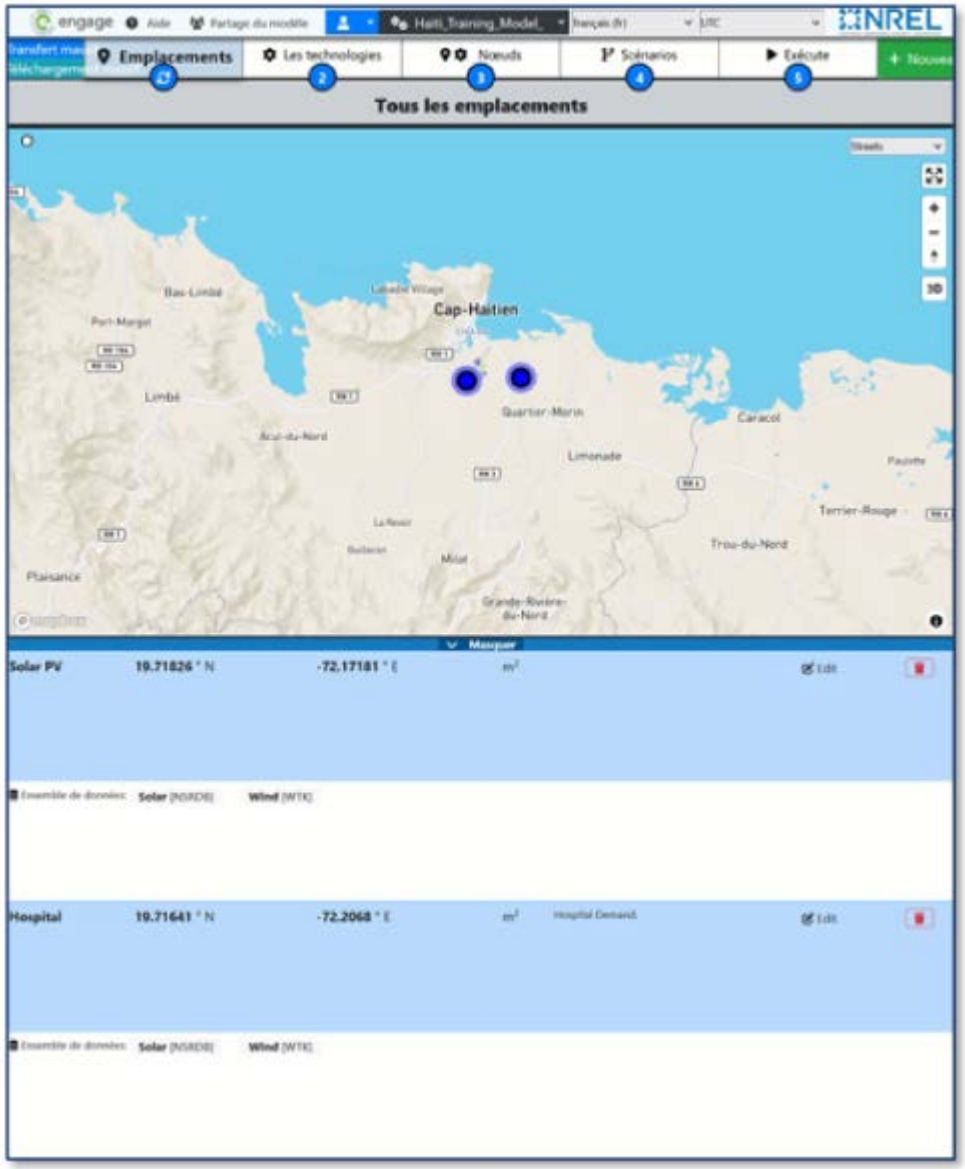
3 **Nodes**

Scenarios

Runs

engage

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



Model Building Process

1 **Locations**

2 **Technologies**

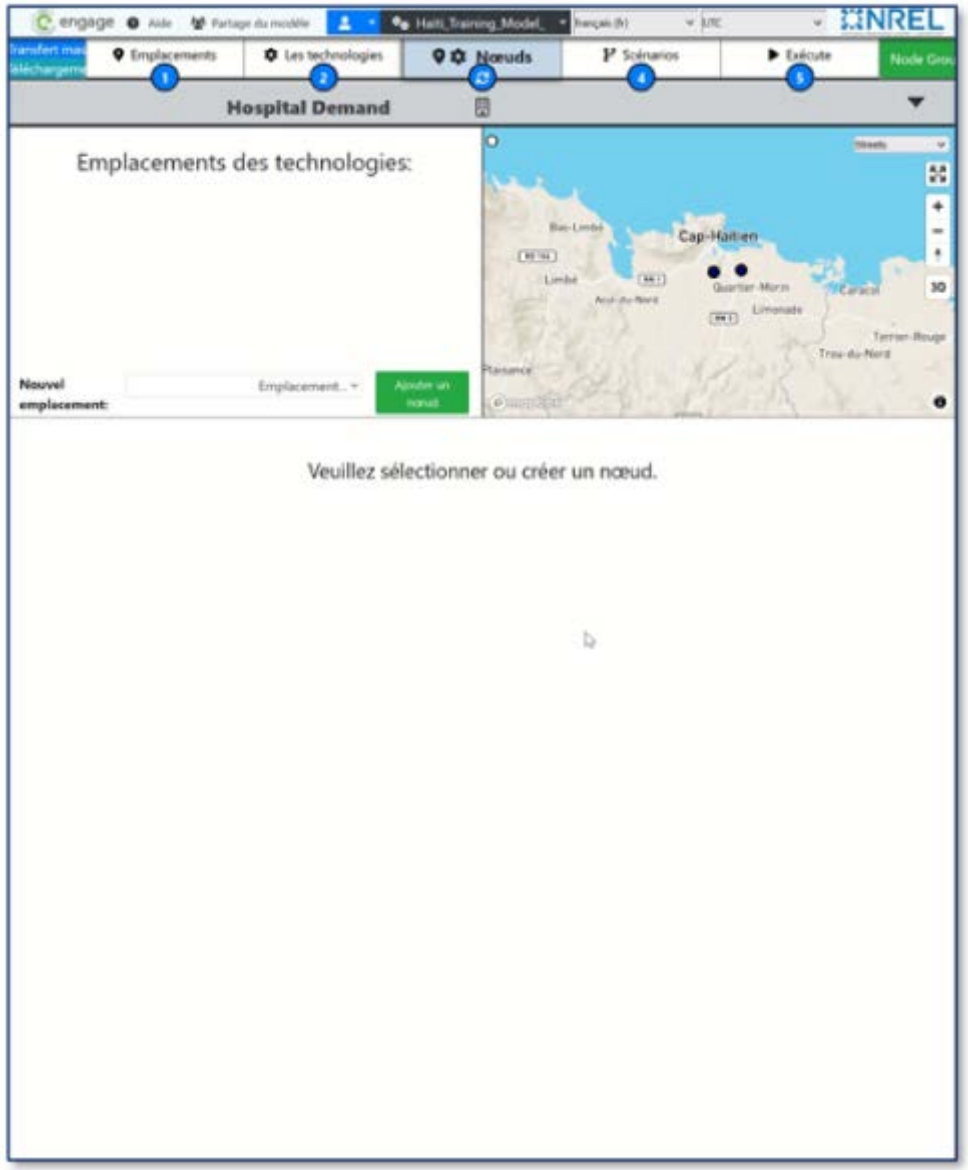
3 **Nodes**

Scenarios

Runs

engage

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



Model Building Process

1 **Locations**

2 **Technologies**

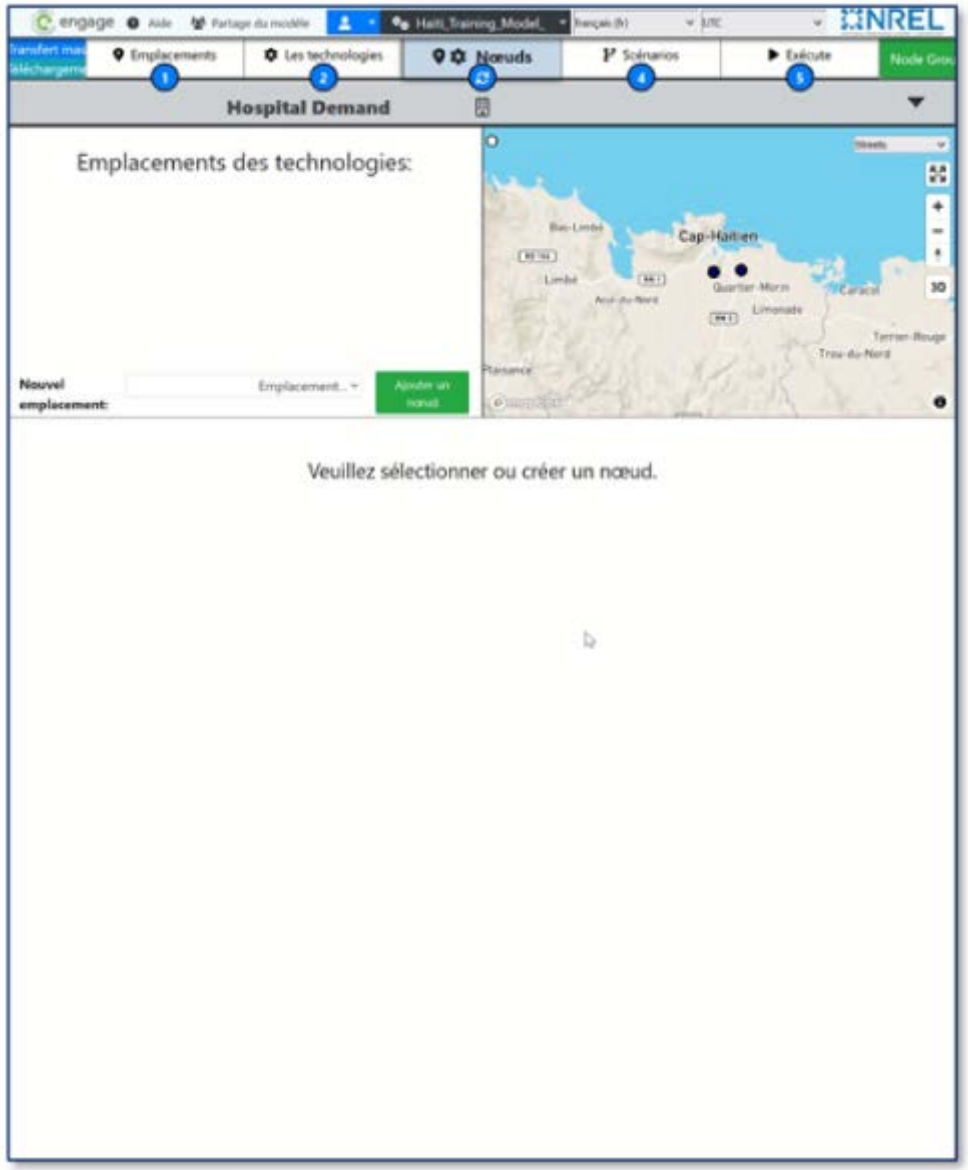
3 **Nodes**

Scenarios

Runs

engage

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



Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

Scenarios

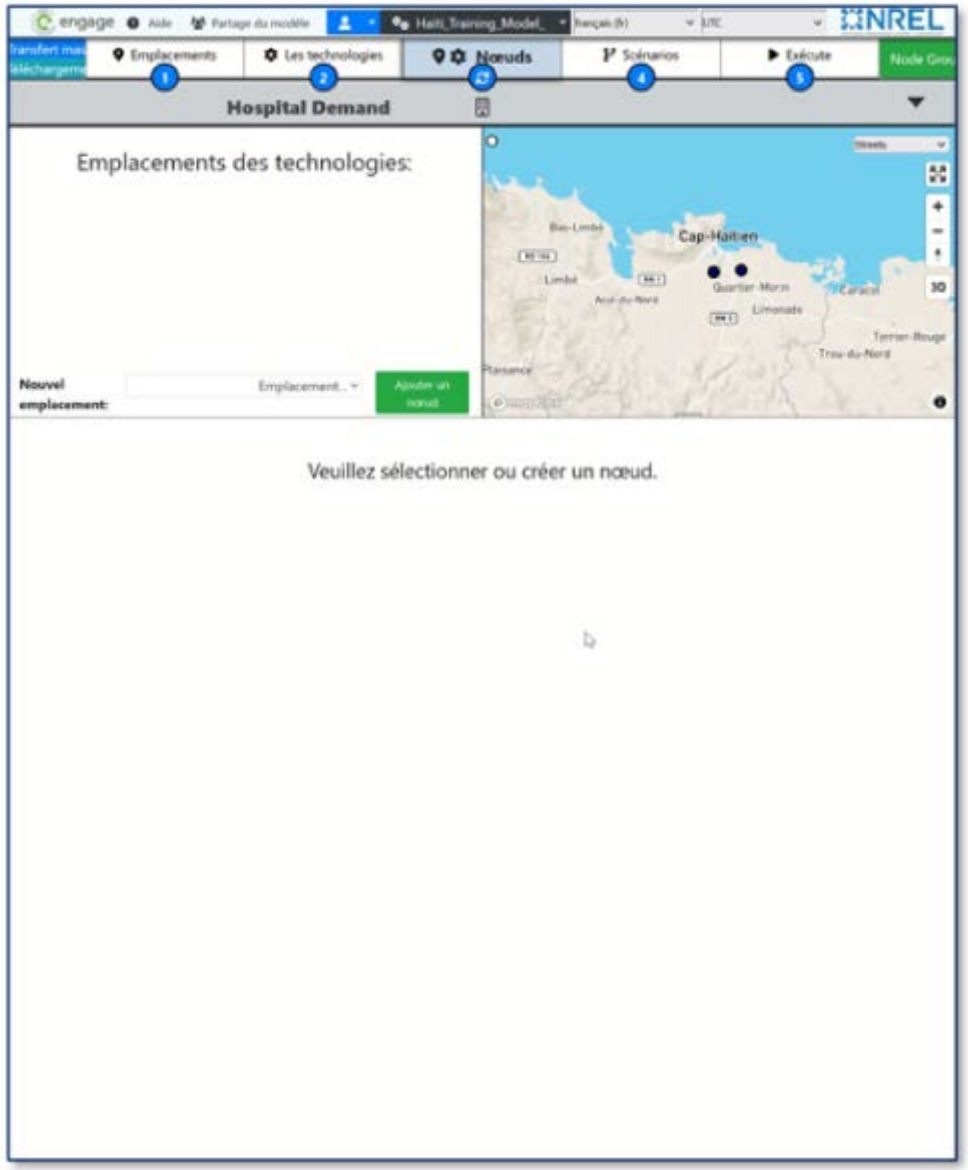
Runs

engage

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**



Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

Scenarios

Runs

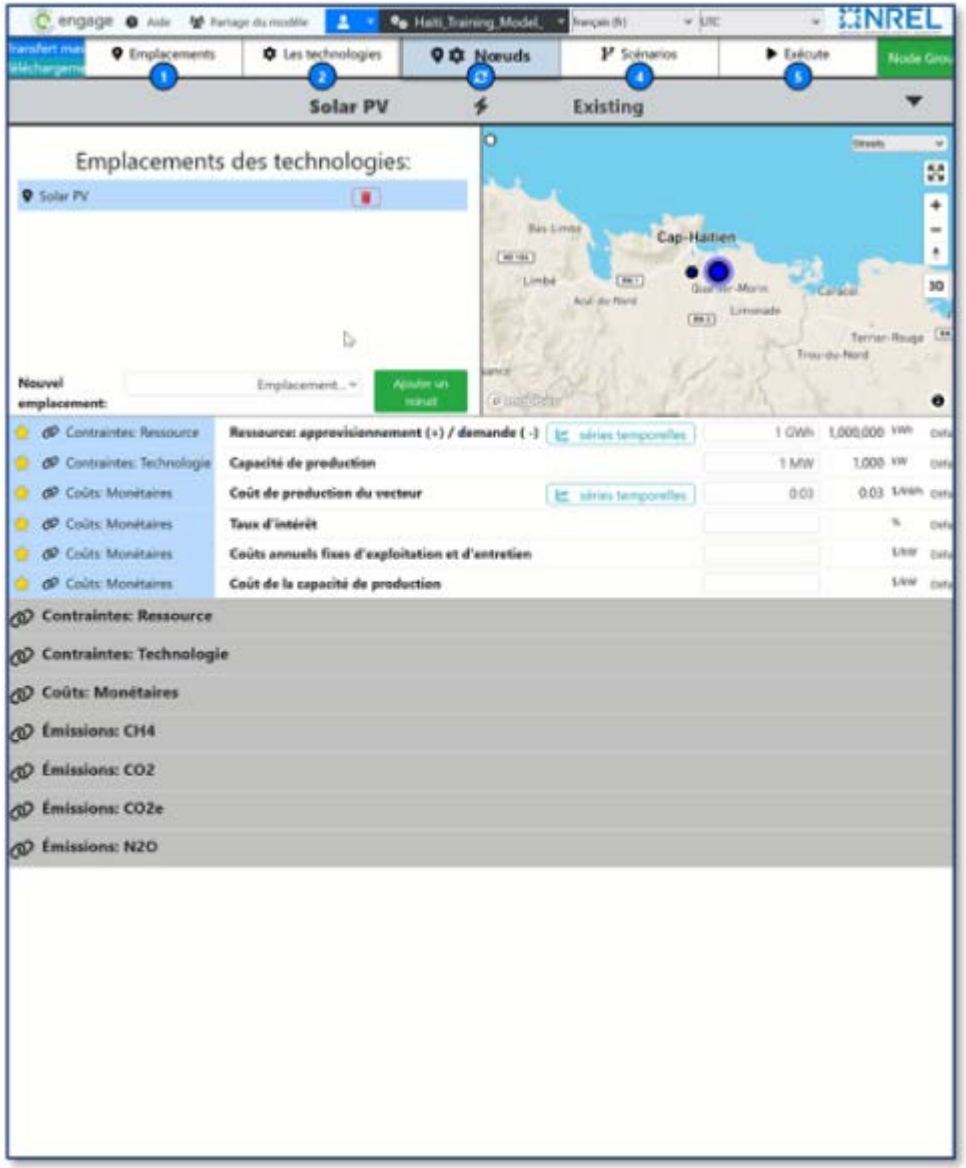
engage

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**



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

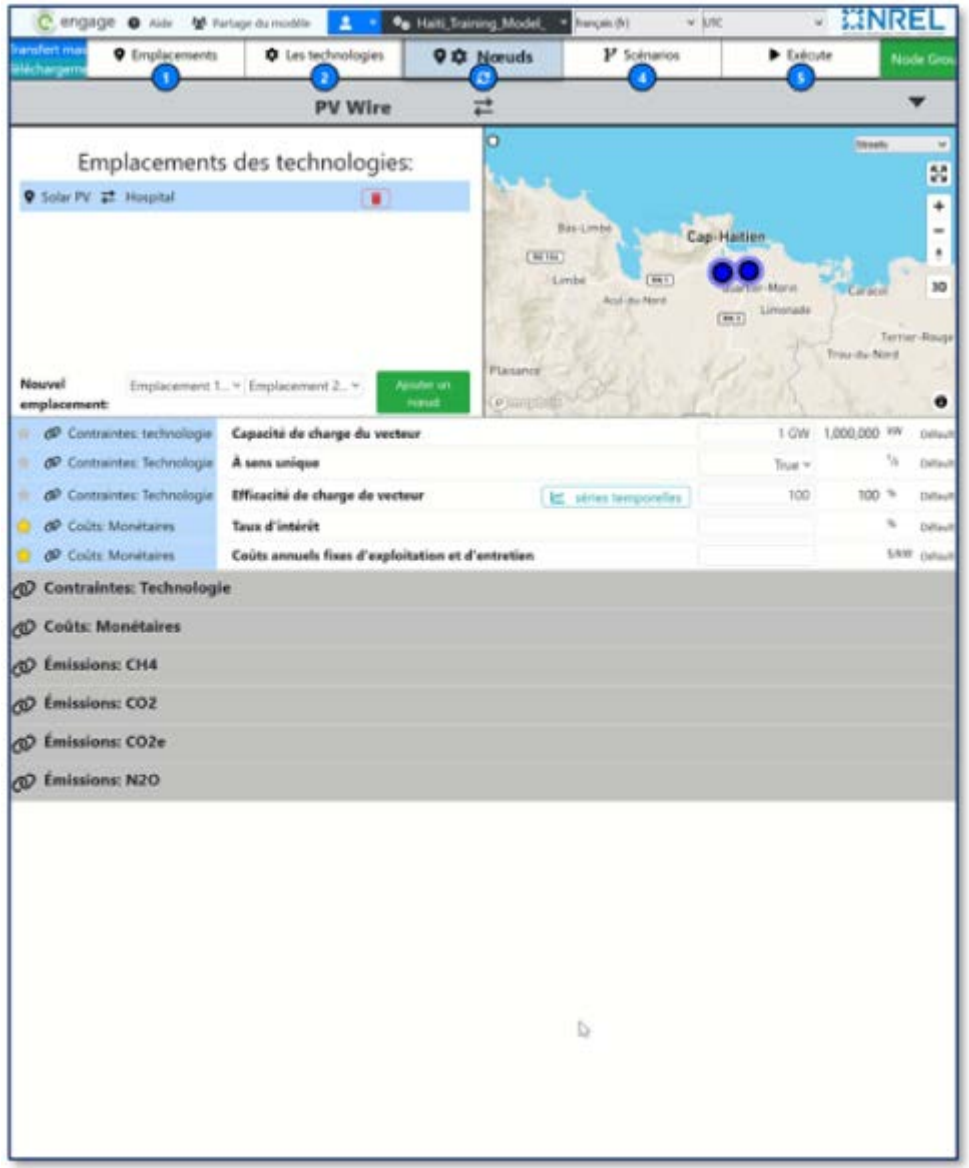
3 **Nodes**

4 **Scenarios**

Runs

engage

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

Runs

engage

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

Model Building Process

1 **Locations**

2 **Technologies**

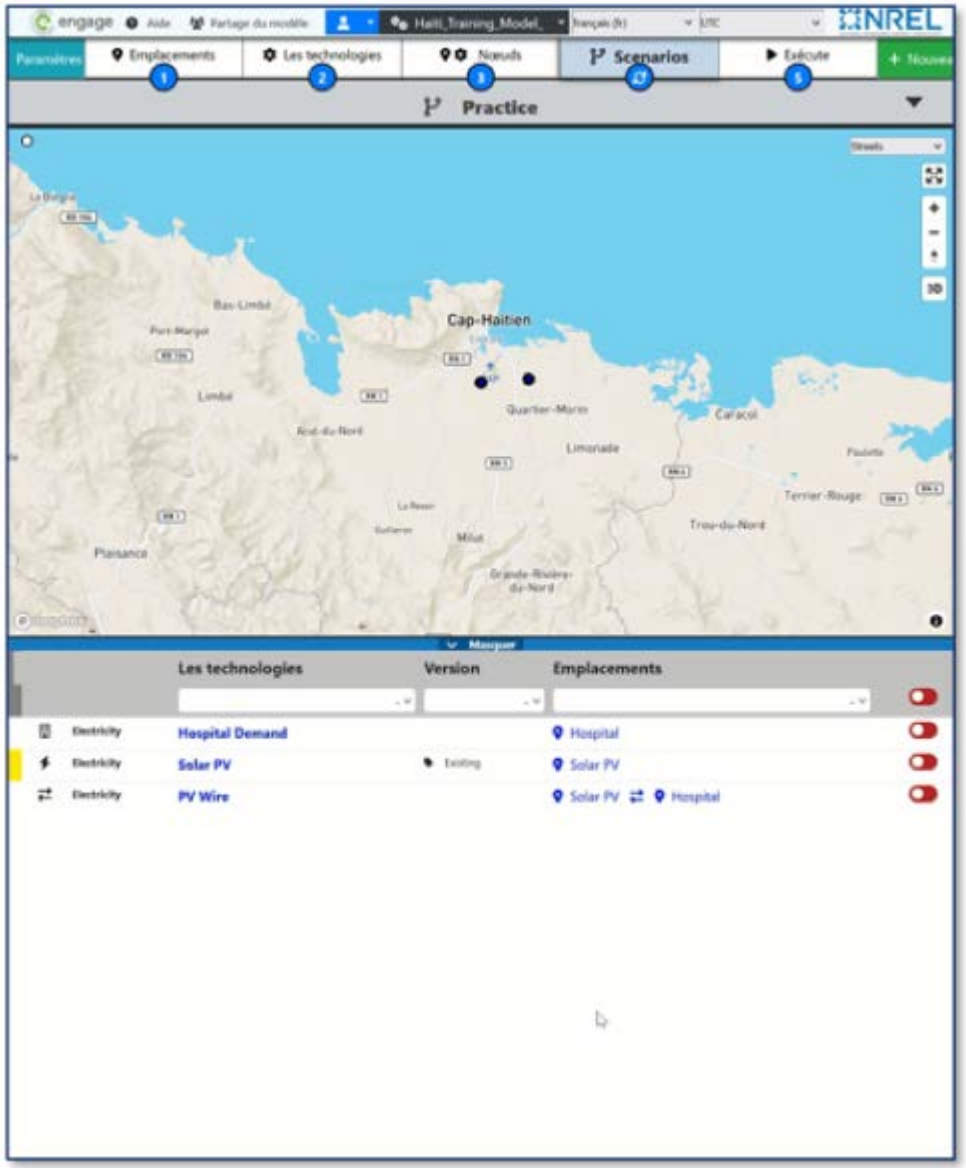
3 **Nodes**

4 **Scenarios**

Runs

engage

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



Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

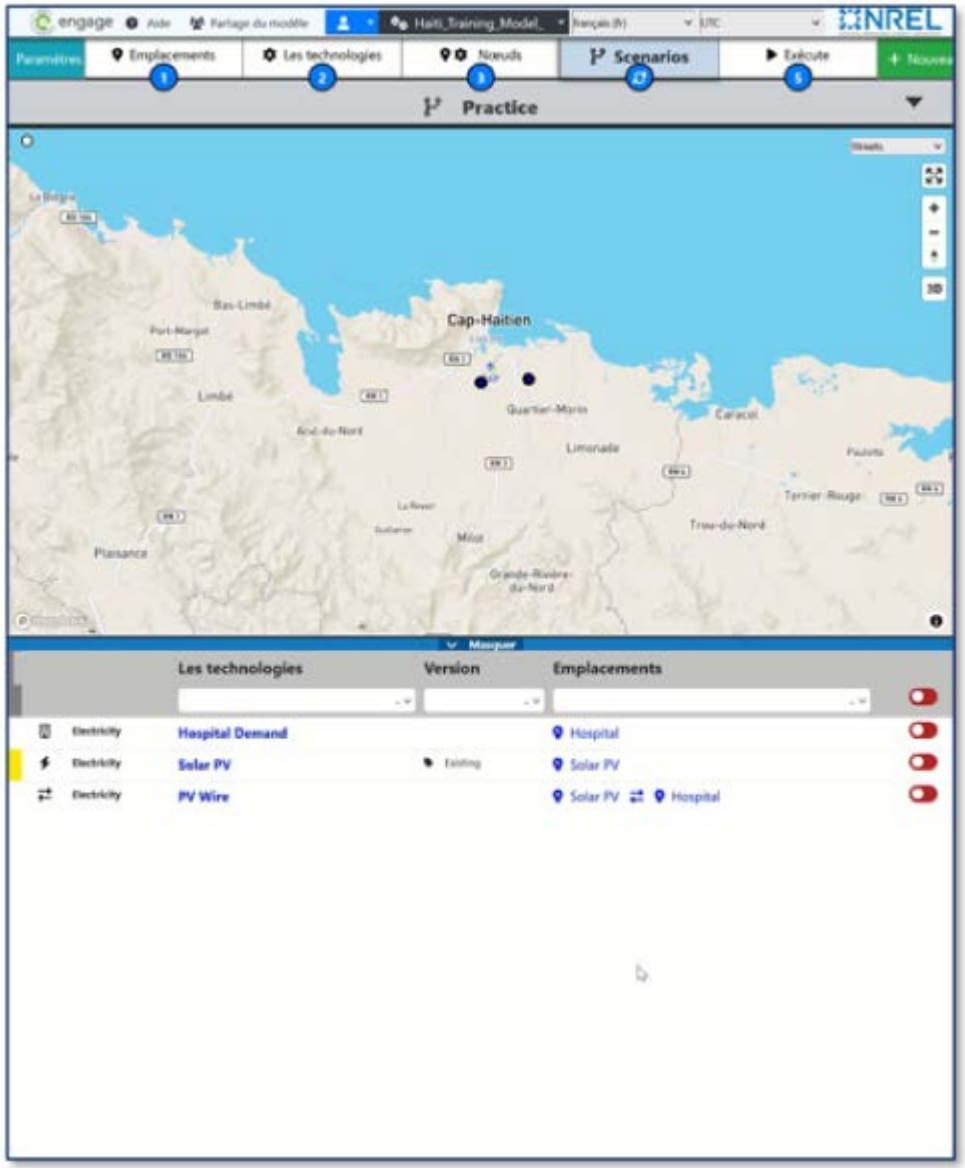
4 **Scenarios**

Runs

engage

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

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



Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

Runs

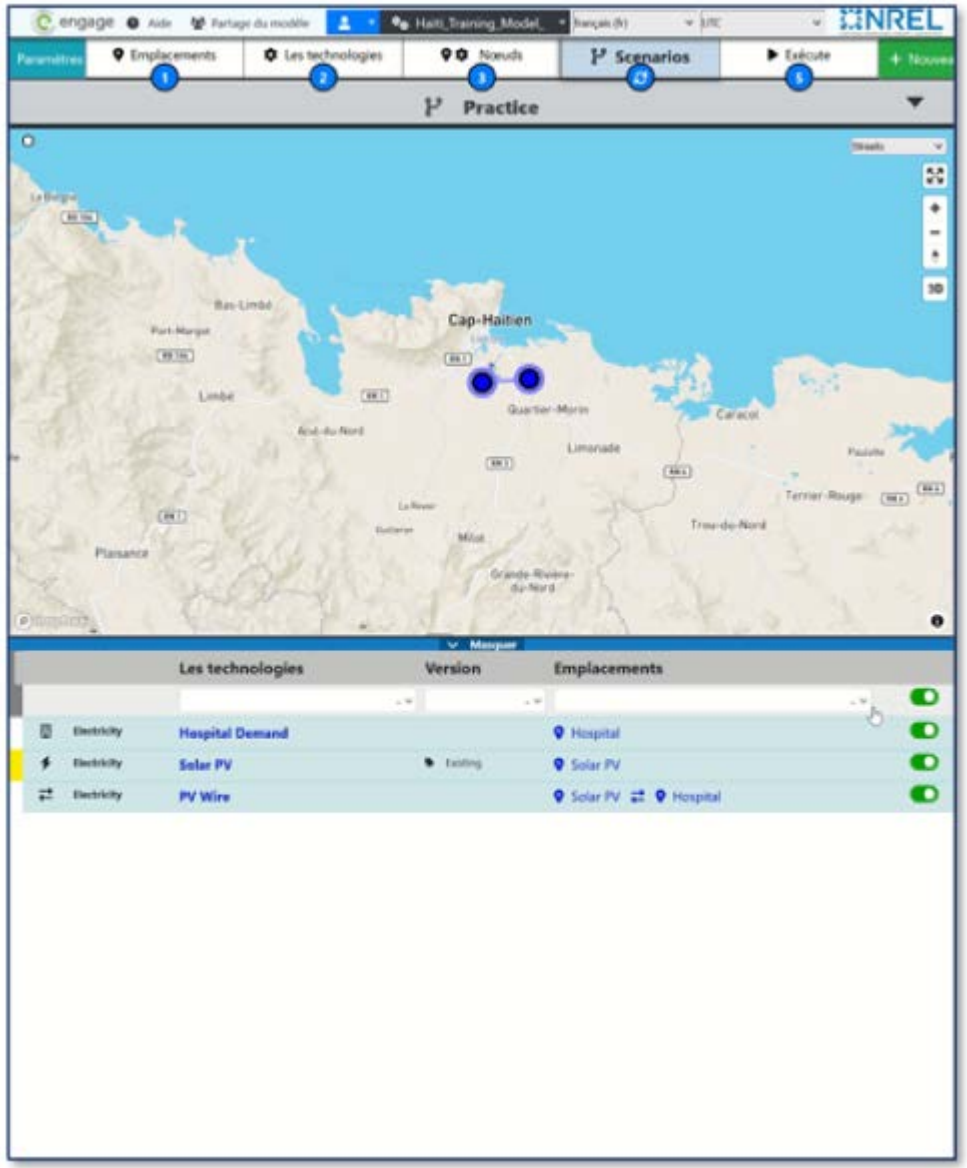
engage

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**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

Runs

engage

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

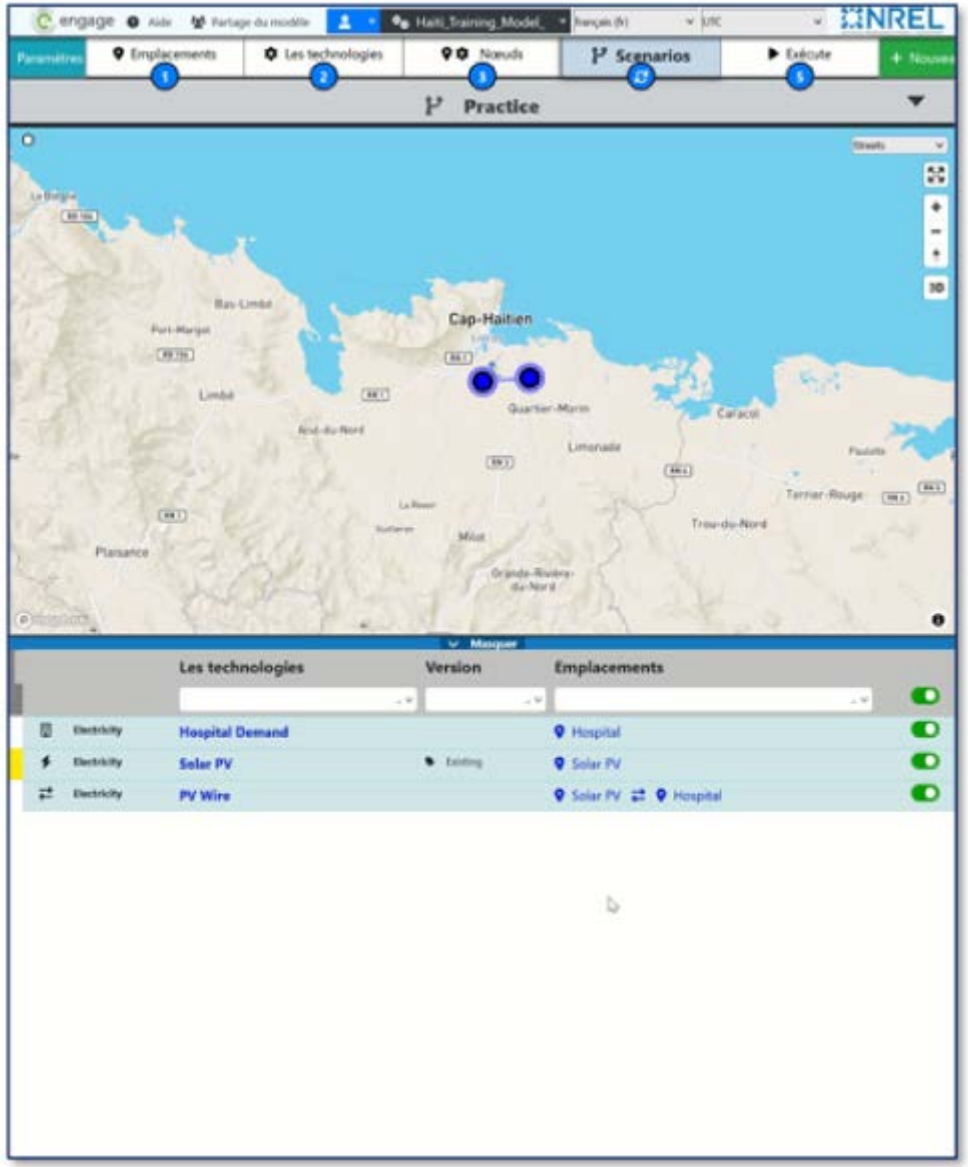
Activate technologies at specific locations by enabling their **correlating nodes**

Organize nodes by their:

- Archetype technology
- Version tag
- Location

Create overarching model constraints that apply to all nodes like:

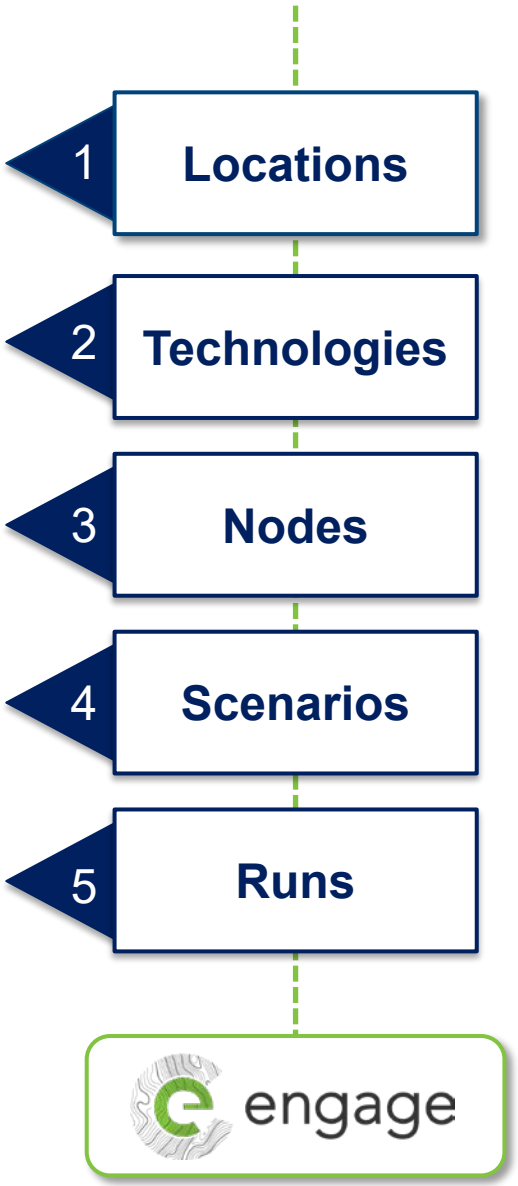
- A carbon cap
- A reserve margin
- An object class



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process



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

Model Building Process

1 **Locations**

2 **Technologies**

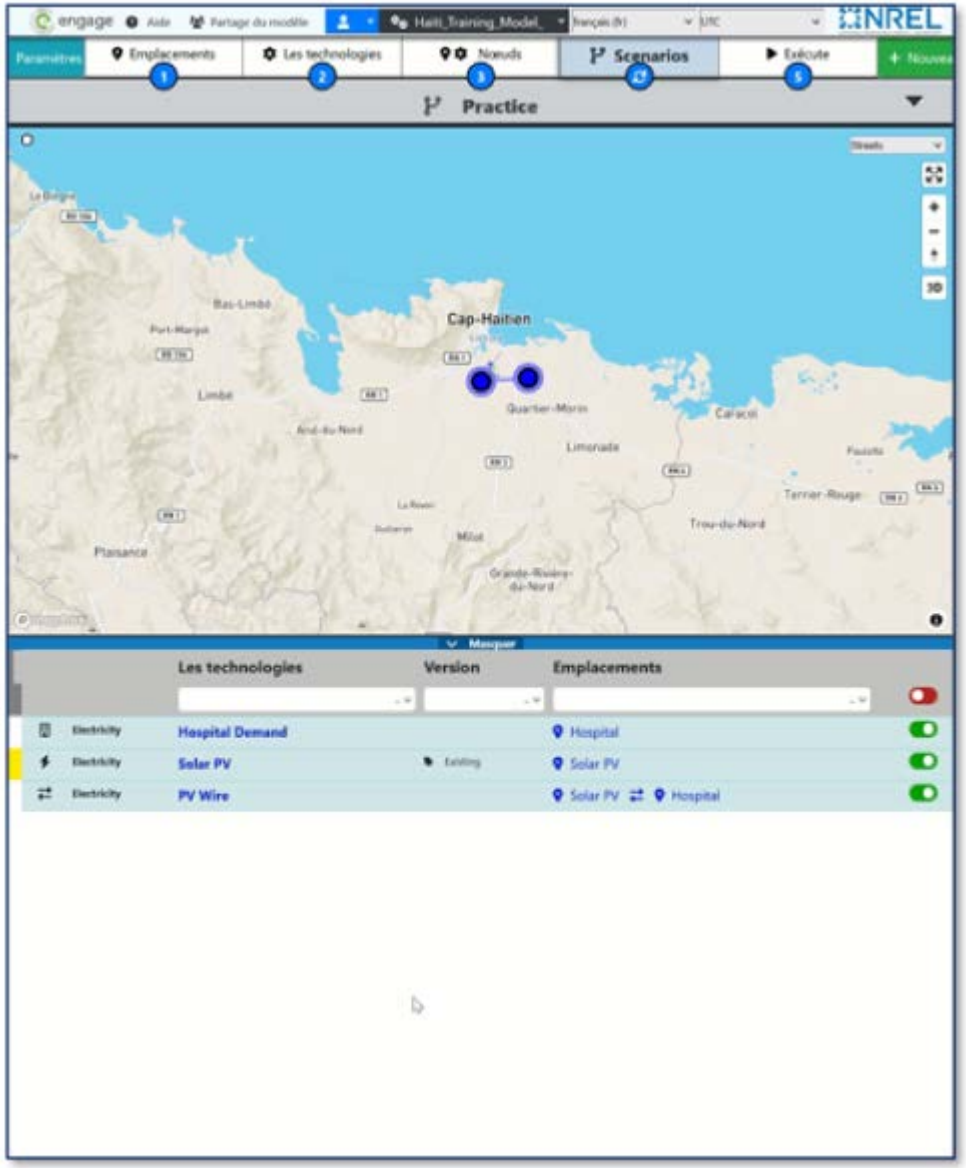
3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

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



Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

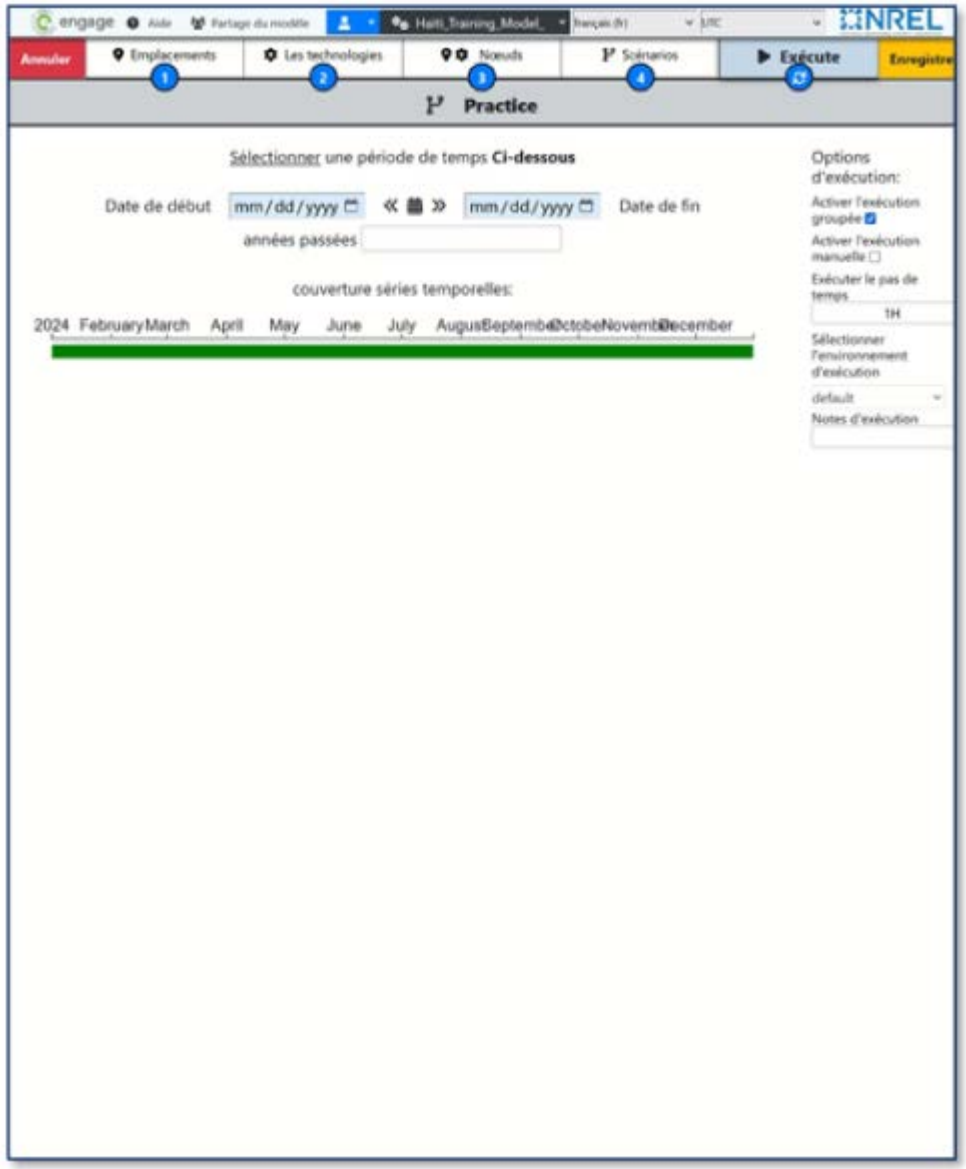
5 **Runs**

engage

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)



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

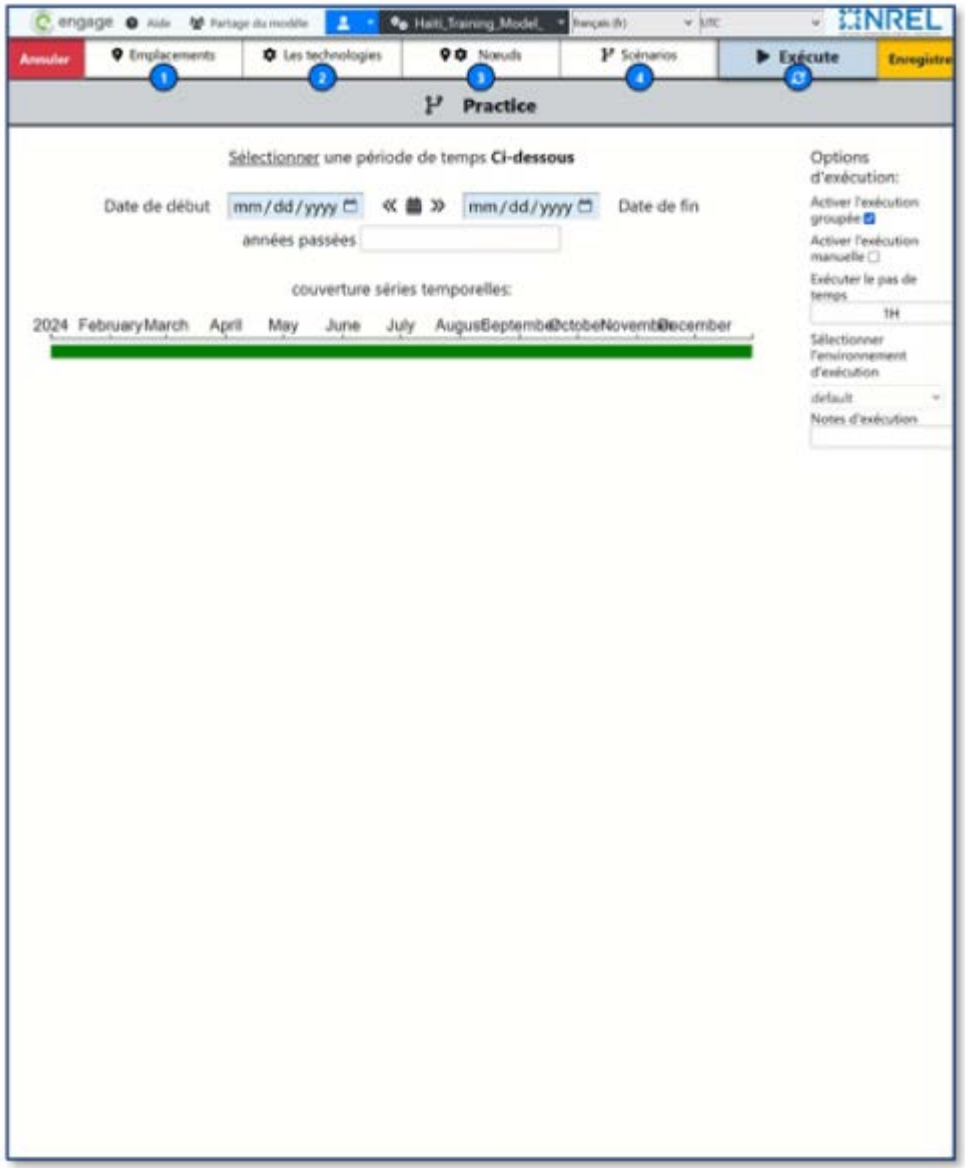
5 **Runs**

engage

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)



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

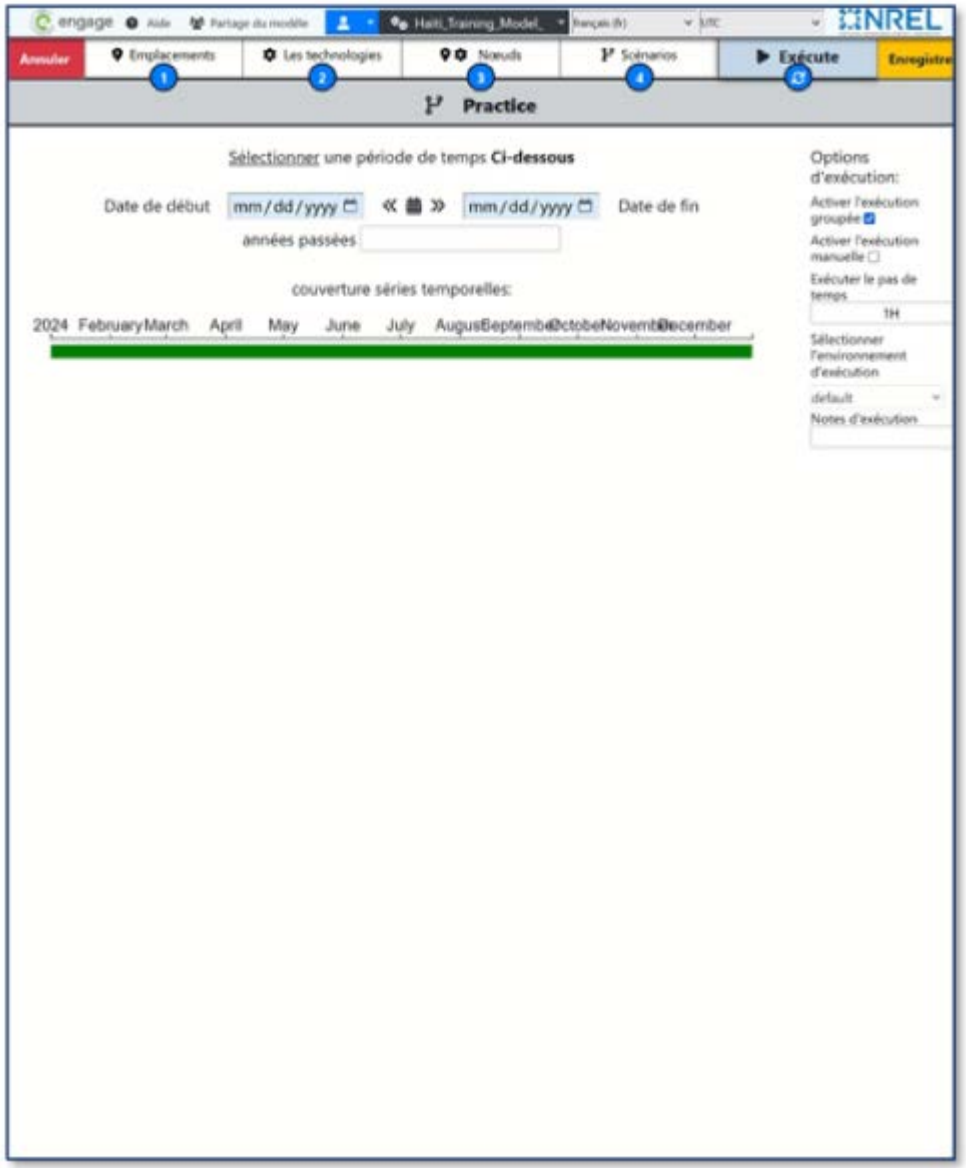
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

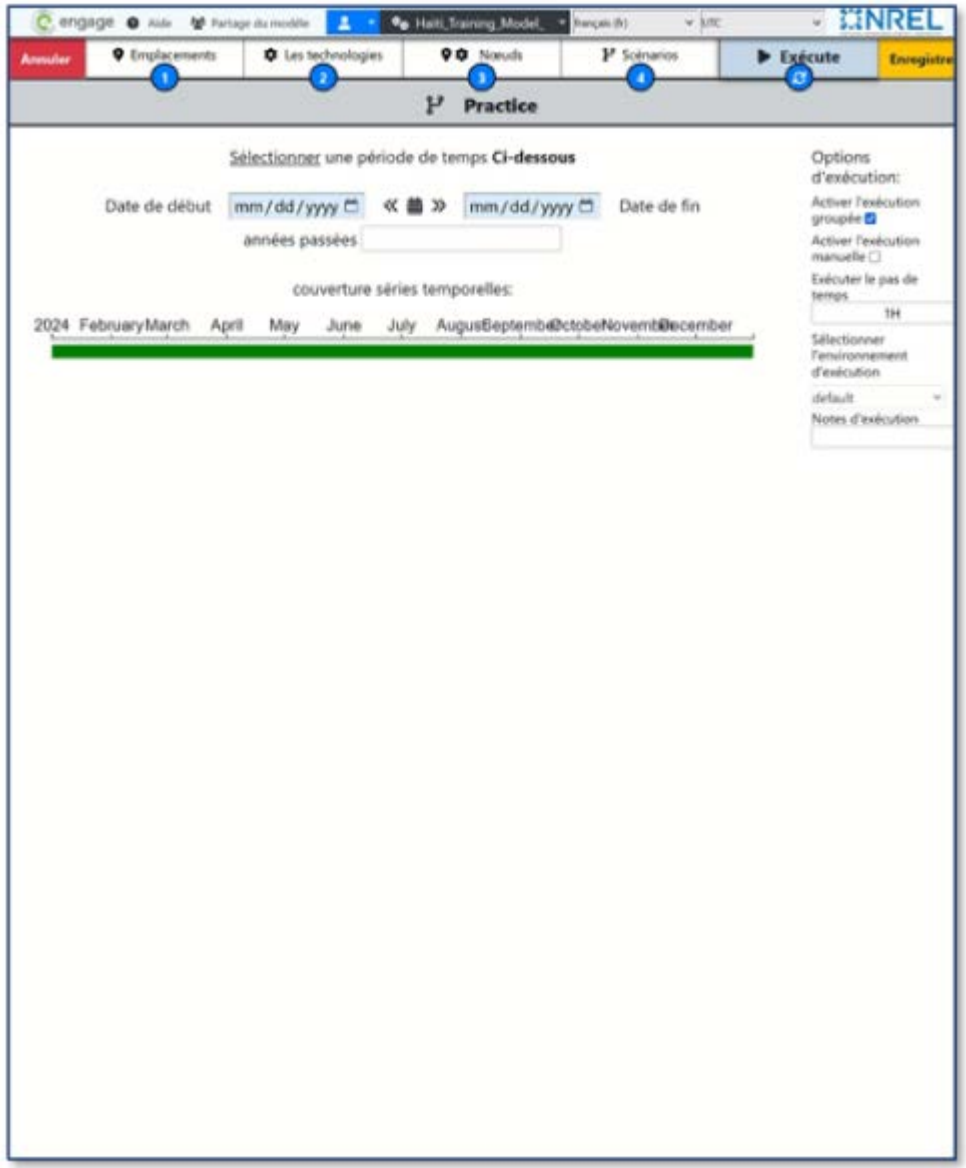
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

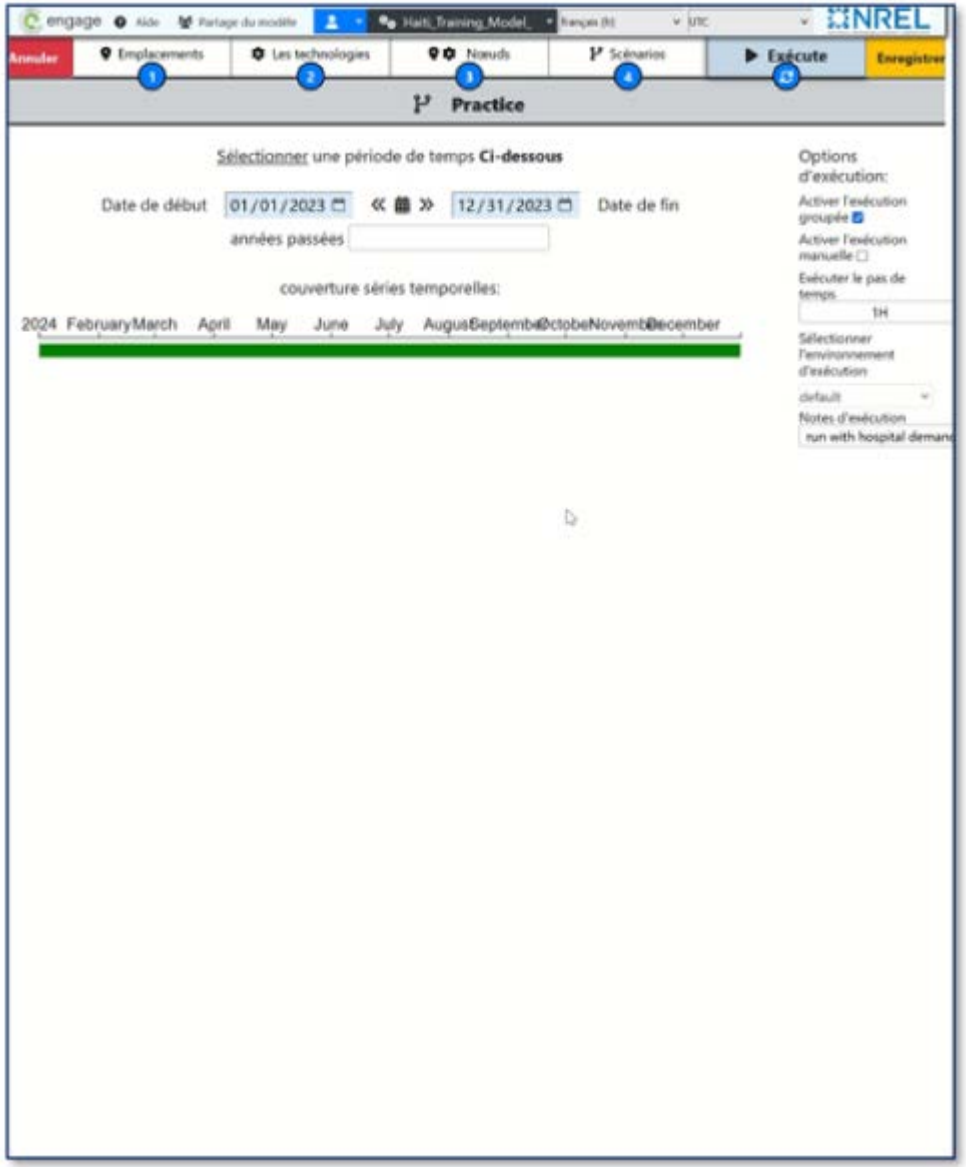
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

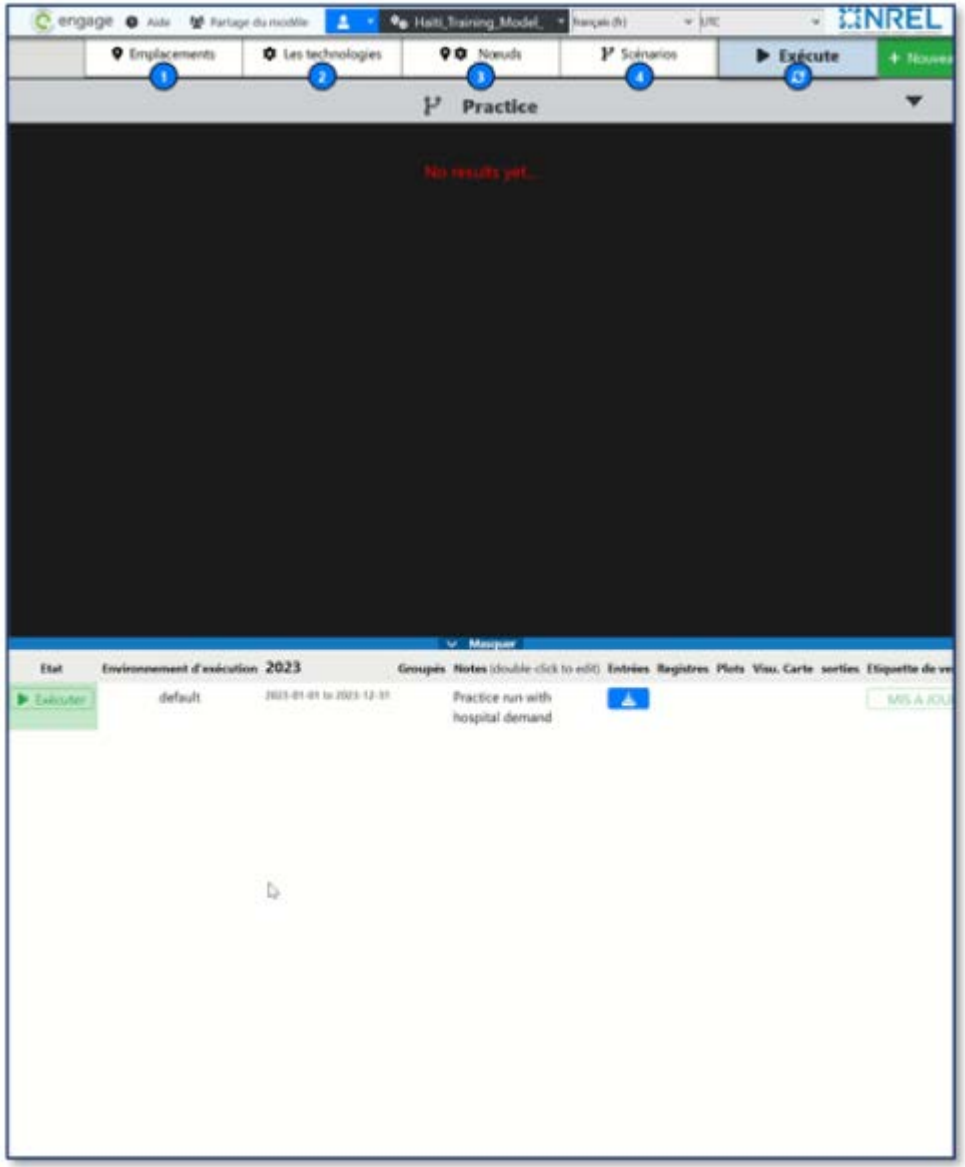
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

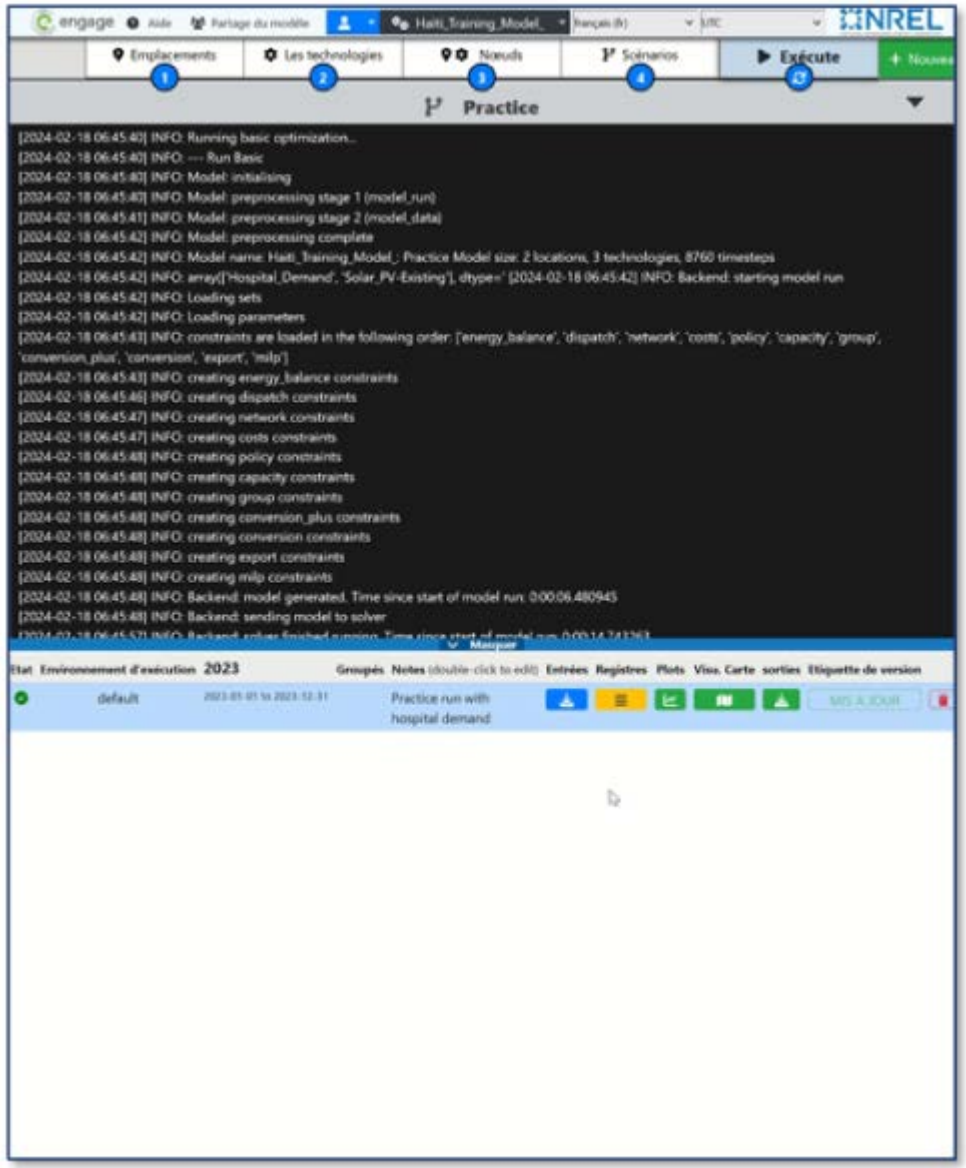
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

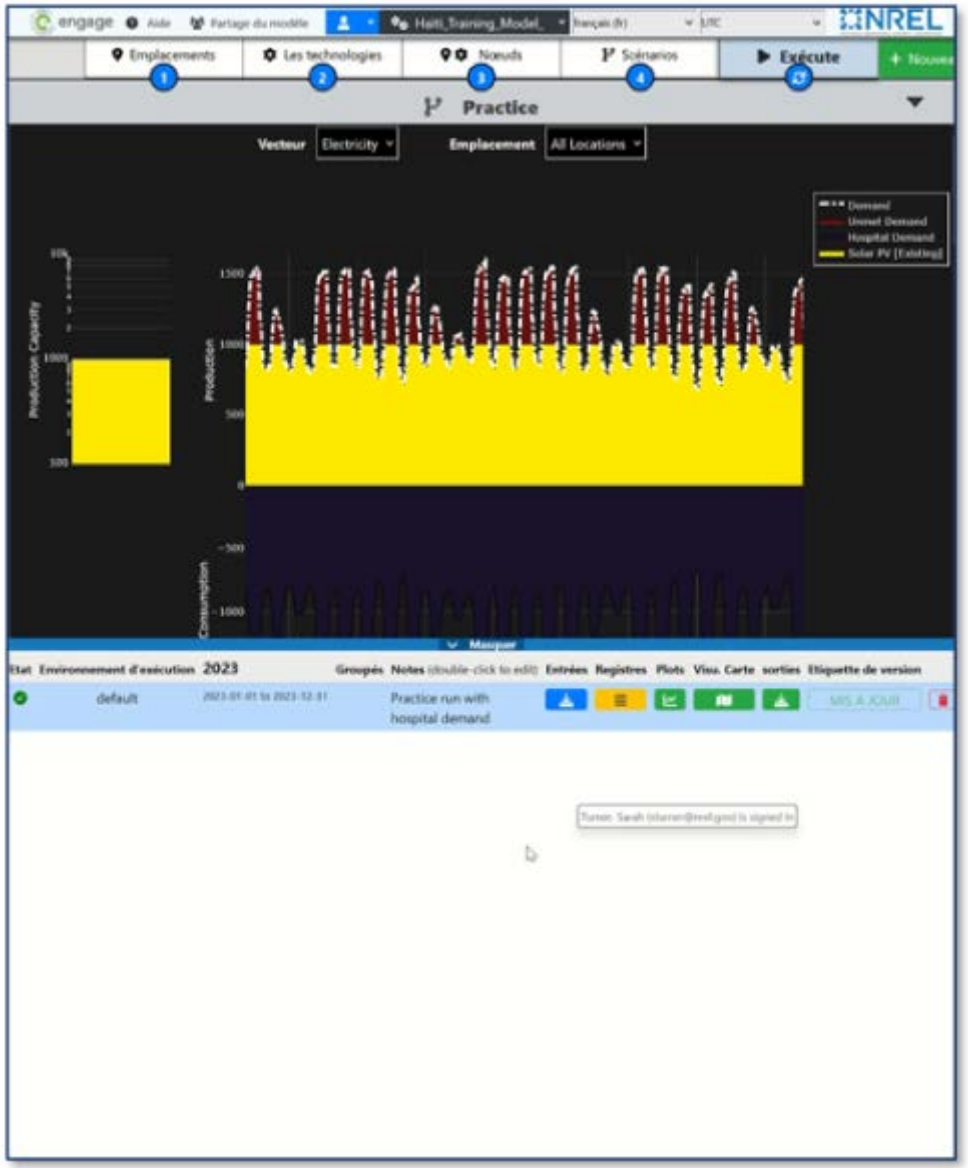
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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



USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Model Building Process

1 **Locations**

2 **Technologies**

3 **Nodes**

4 **Scenarios**

5 **Runs**

engage

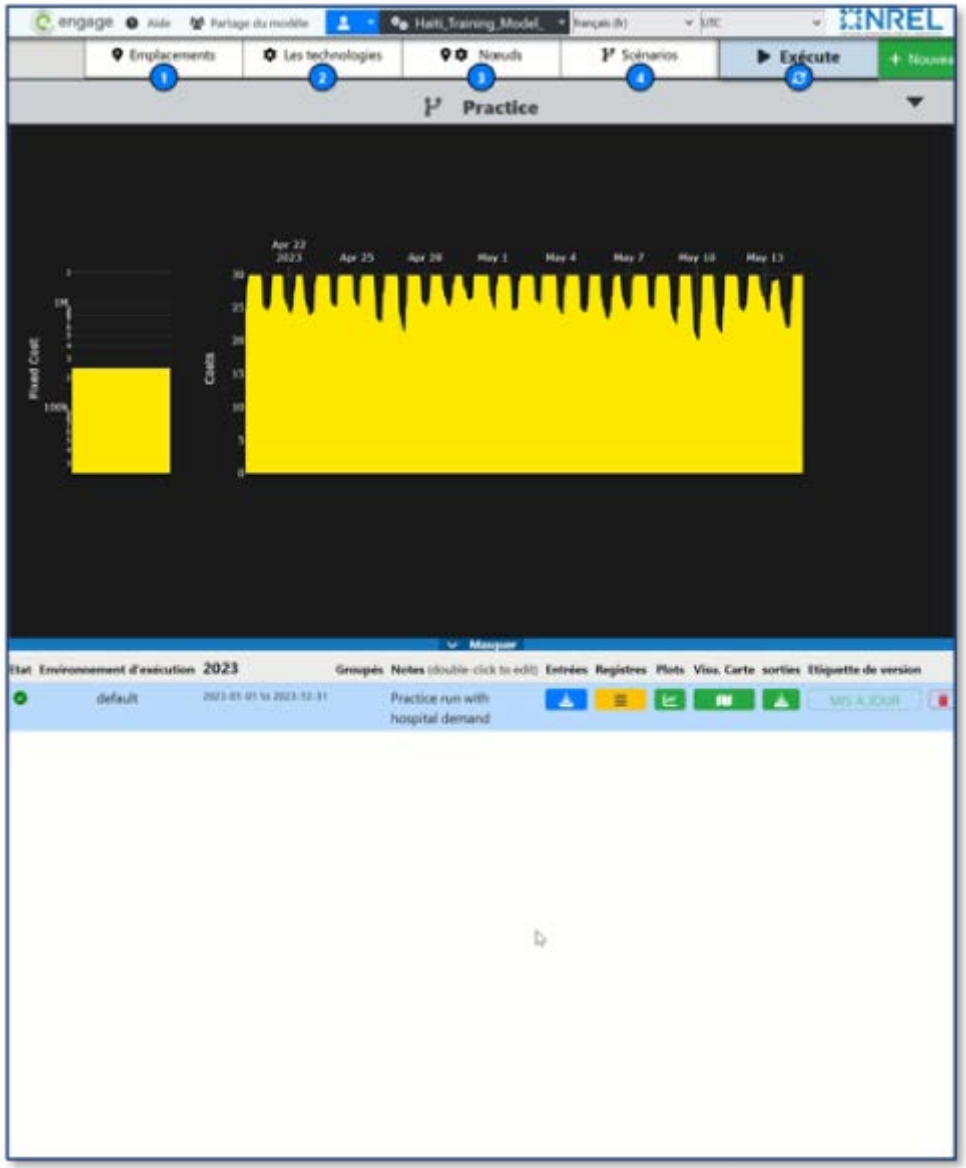
Function: Renders configured scenario into a Calliope problem and runs scenario for evaluation

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

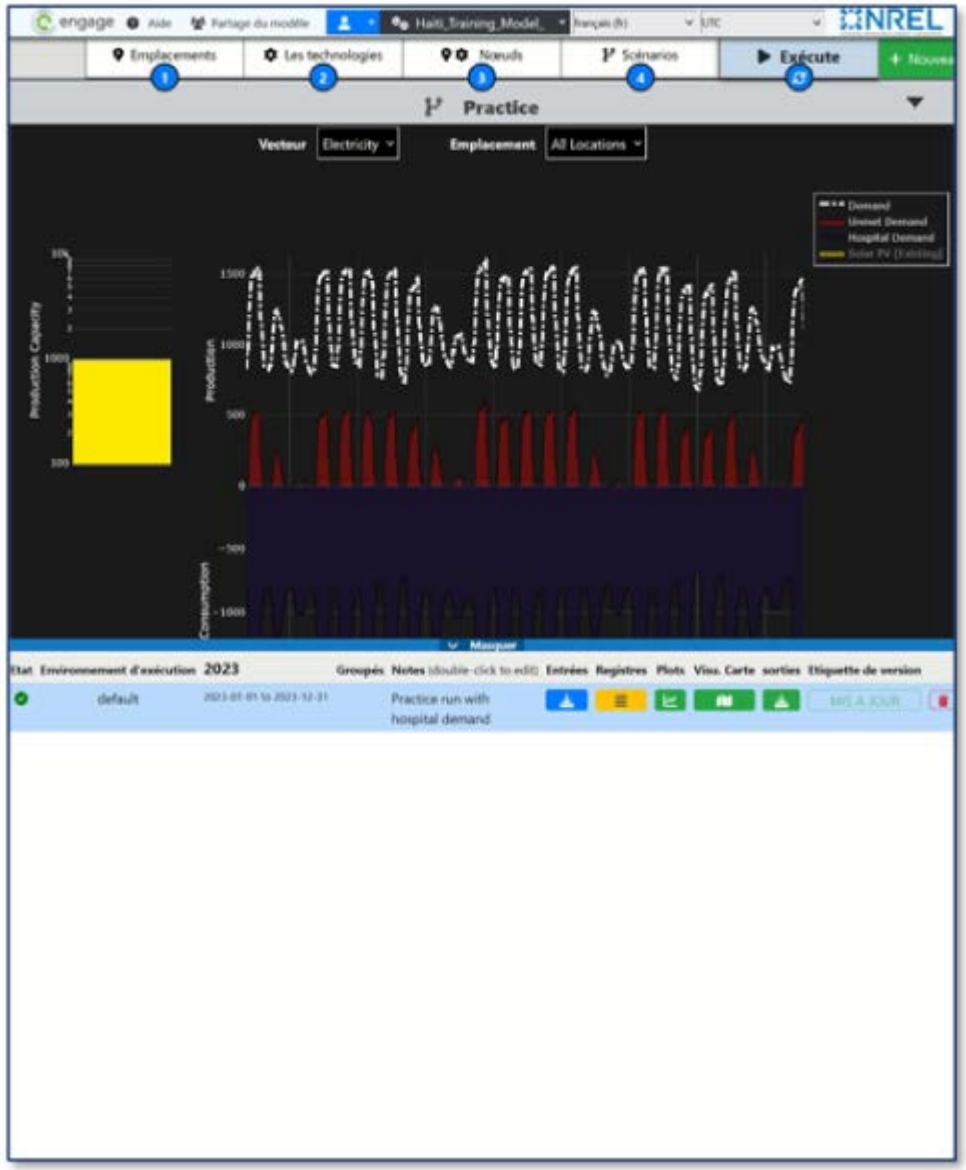


Next Training Session

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?



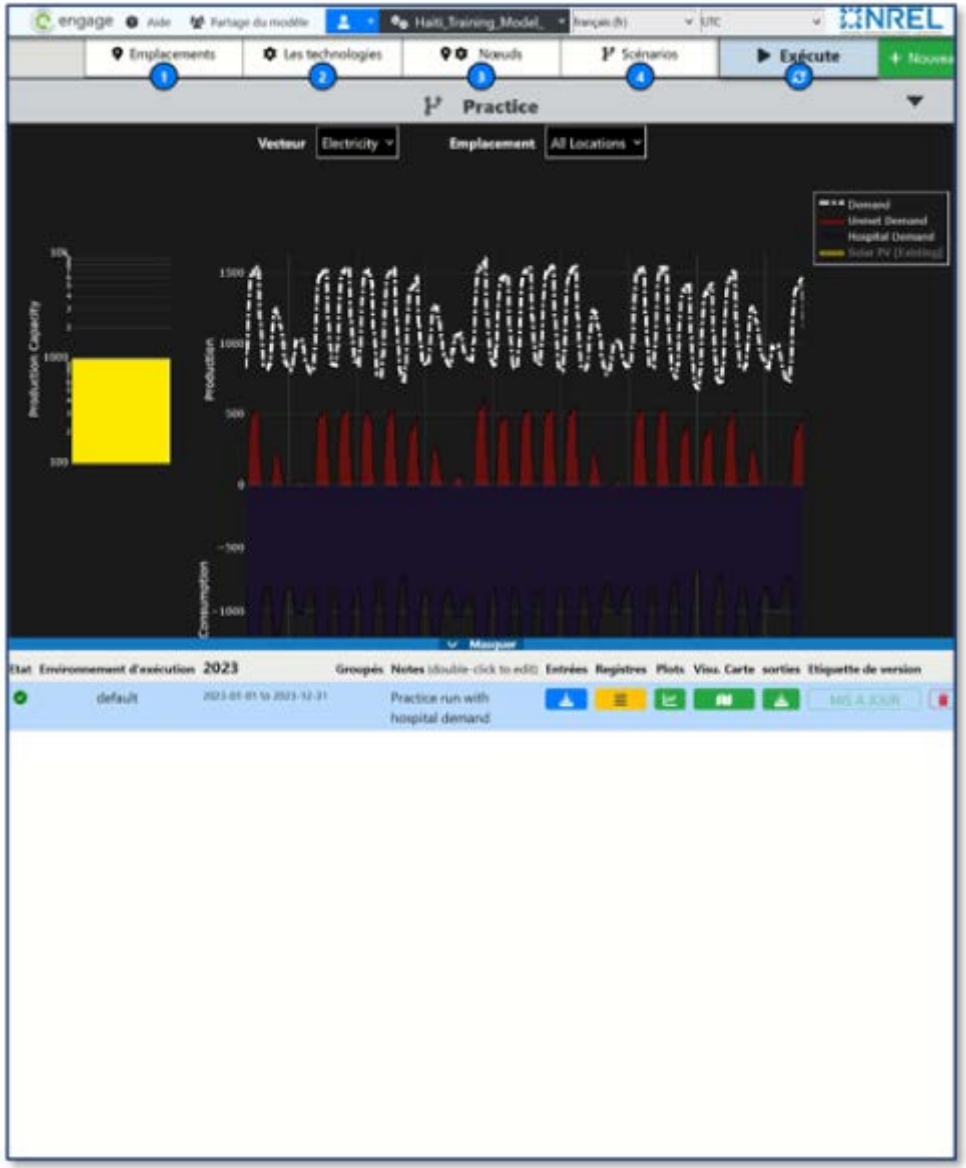
engage

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Next Training Session

- Capacity expansion modeling
- Advanced archetype technologies



engage

USAID FROM THE AMERICAN PEOPLE

NREL Transforming ENERGY

Thank you!

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

This work was authored, in part, by the National Renewable Energy Laboratory (NREL), operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the United States Agency for International Development (USAID) under Contract No. IAG-19-2120. The views expressed in this report do not necessarily represent the views of the DOE or the U.S. Government, or any agency thereof, including USAID. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

NREL/PR-7A40-88836